

Setup of a smart building living lab

A journey from data to insight, and from insight to control

October 13, 2022

Jan-Willem Dubbeldam

KROPMAN
GEBOUWAUTOMATISERING

KROPMAN
INSTALLATIE TECHNIEK

Introduction

- Jan-Willem Dubbeldam
- Head of TCC department
- Technical Competence Center
 - Software development department (InsiteSuite)
 - Support Building Automation dept.
 - Participate in research projects

Agenda

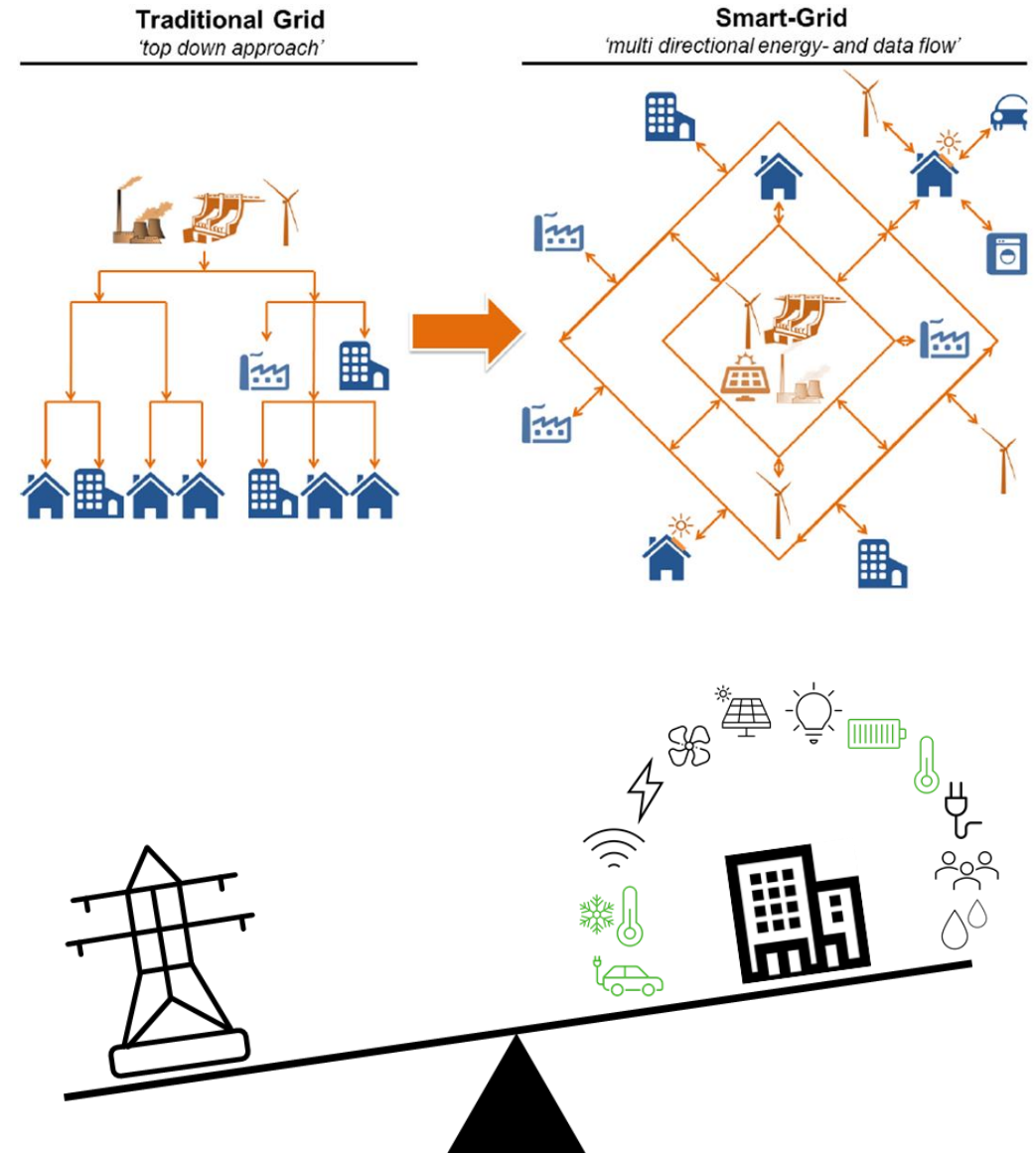
- Motivation & Trends
- Kropman Breda building
- History of InsiteView
- Product development steps
- Plans
- Questions

Motivation & Trends

- Energy flexibility
 - Consume, produce and buffer energy
 - Participate in smart grid
- Electrification
 - Solar panels
 - Battery systems
 - EV charging infrastructure
 - Heat pumps
- Internet of Things
- Individual comfort
- Predict behavior based on data instead of models

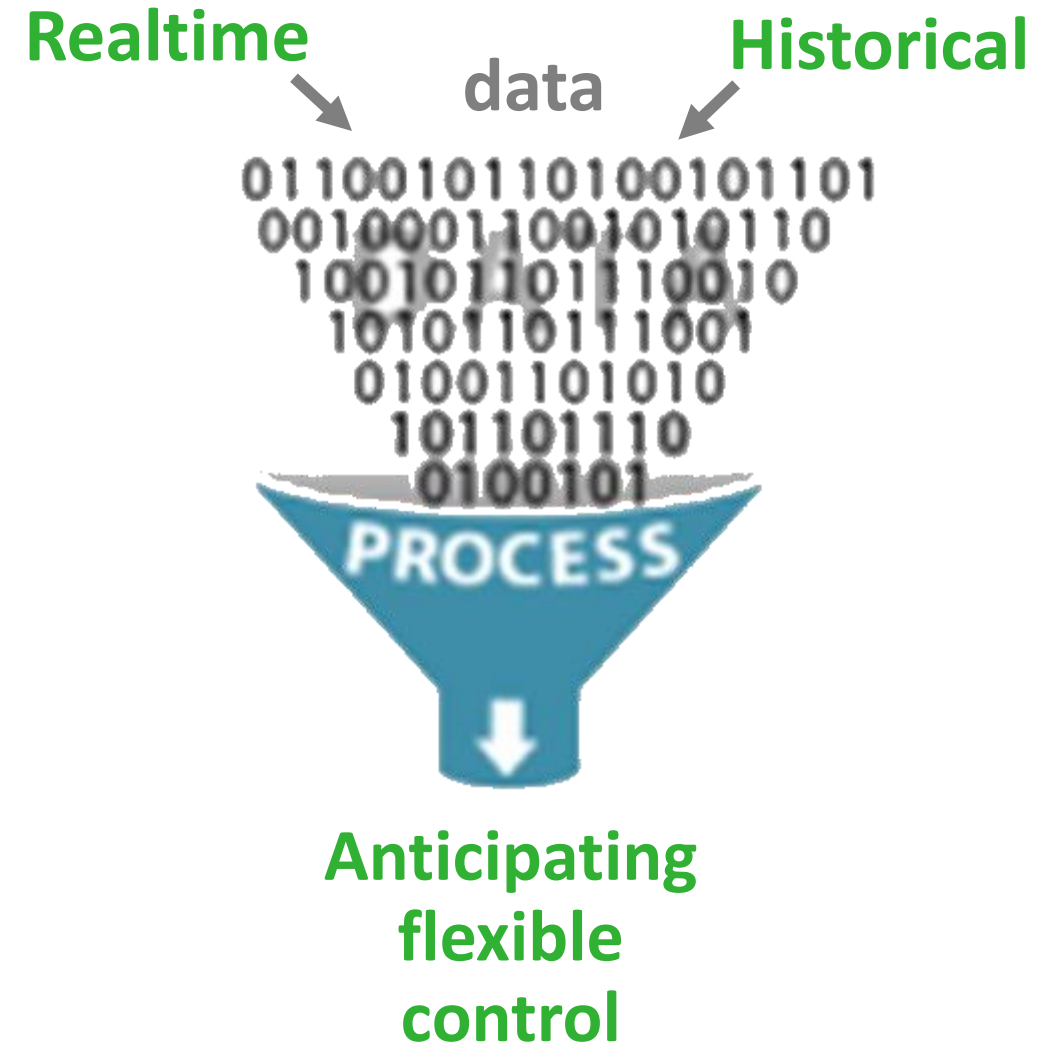
Need for:

- ➔ Integrated data management
- ➔ Efficient (anticipating) control of energy



Journey

*From data to insight,
from insight to control*



Kropman Breda building

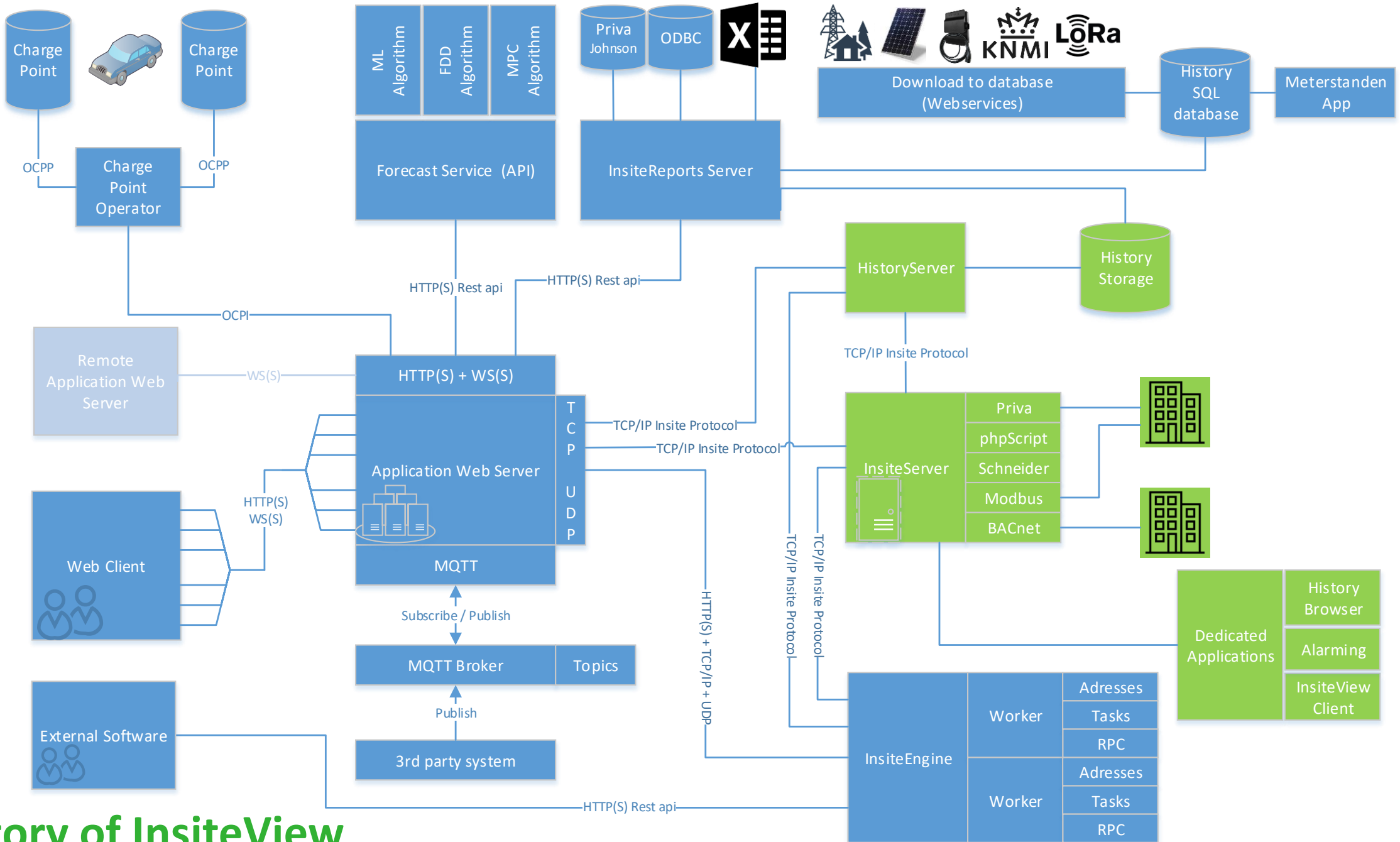
- Built in 1994
- 1.700 m²
- Most frequently built 'standard' office building
- Solid and boring



HVAC

- Gas: HR-boiler
- Electrical : steam humidifier, compression cooling machine, lighting, AHU, BMS

“if we can make it here, we can make it anywhere...”



History of InsiteView

InsiteView - Kropman Breda

Verbinding Bewerken Extra Venster Help

Gebruiker: Kropman

LBK Kantoren

KropmanBreda Insite View®
LBK Kantoren

Luchtbehandeling

14,5 °C
13,8 °C
21,0 °C
Tijdprogramma in

CV-installatie
GKW-installatie

28 Pa
77 %
Aan 100 %
300 Pa 19,2 °C 7,7 g/kg
300 Pa 18,0 °C 7,0 g/kg
55,3 %
87 Pa
25,8 °C
Uit 0 %
83 %
45 %
LBK groep

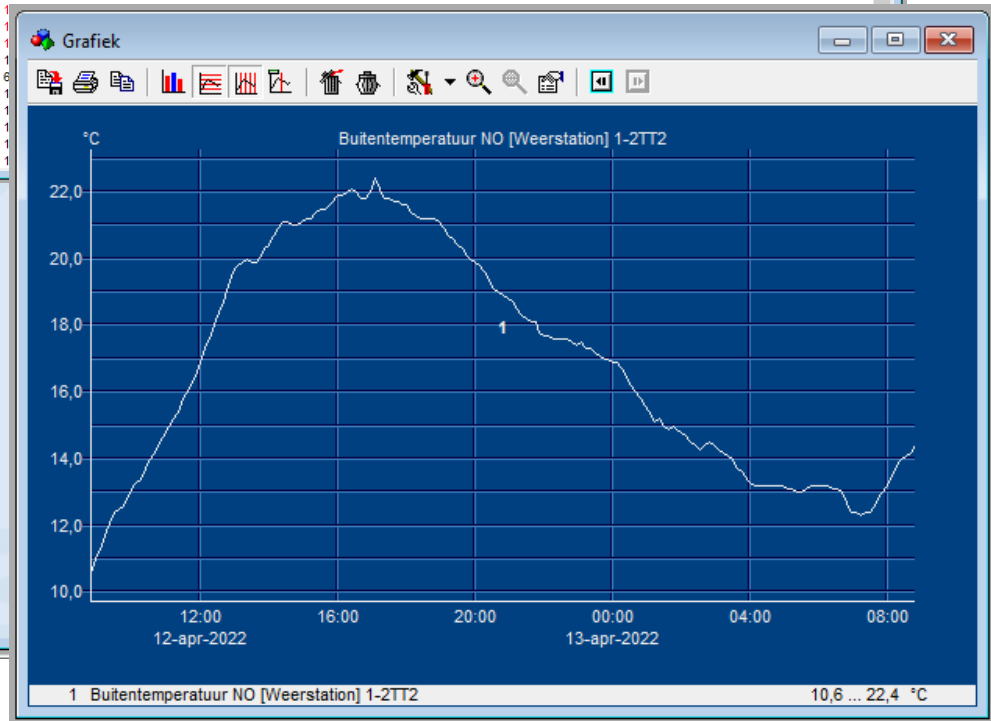
Zuid-West
Noord-Oost
Ruimte 1.0
Ruimte 1.05
Noord-Oost
Zuid-West

© Copyright 2018 Kropman B.W. - All rights reserved

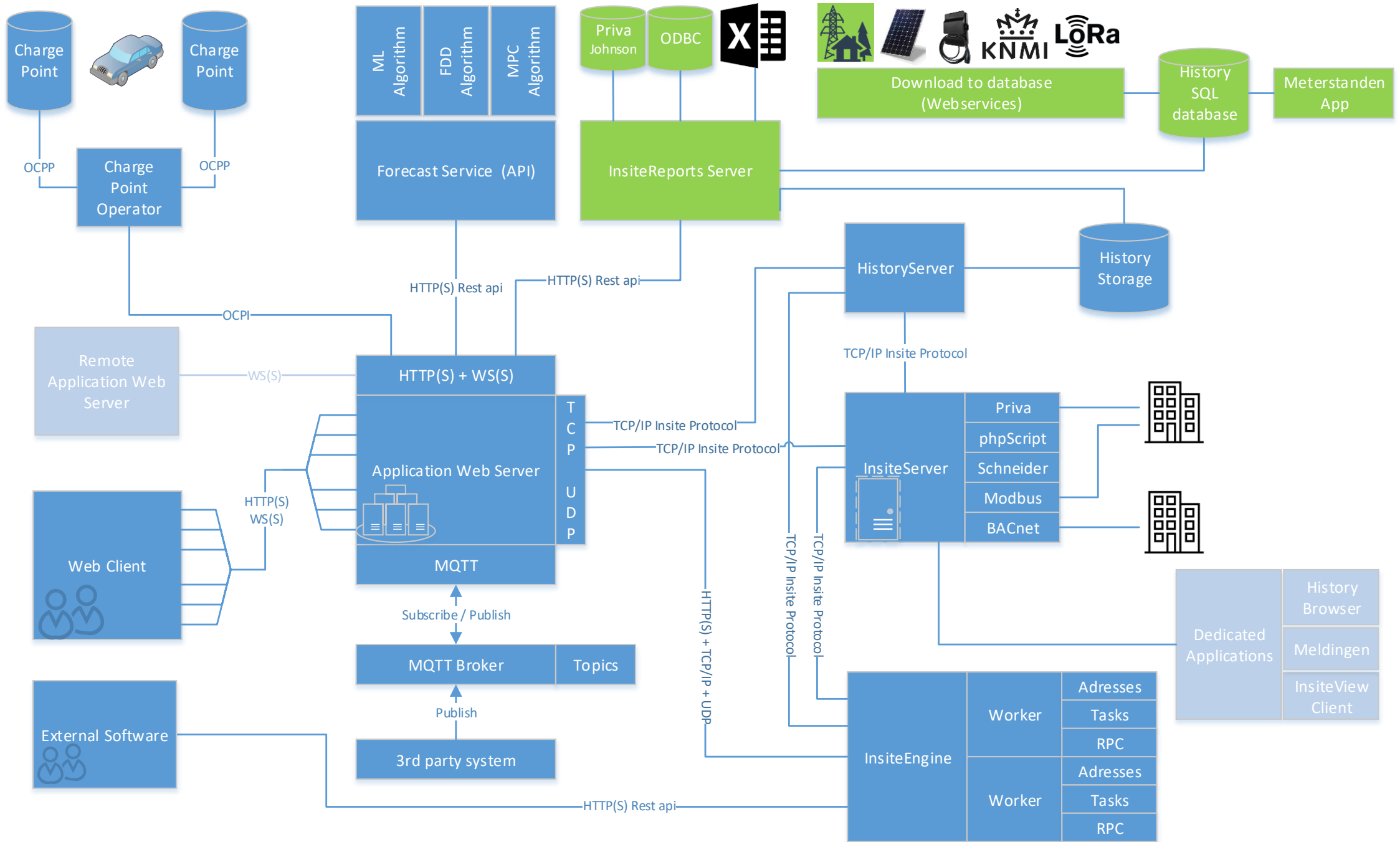
Meldingen - Actieve storingen

38 meldingen

Sys Datum/Tijd	Onderstation	Omschrijving	Installatiedeel	Code	Type	Urgentie	Status
09-04-2022 01:29:52	1	- Summary Warning Unit 1	4.3.1 bms controlled inverter		Storing	Laag	Nog accepteren
01-04-2022 15:10:40	2	Onbekende meldcode : 26			Computer	Laag	Nog accepteren
01-04-2022 15:05:05	1	DALI-01 - Channel 1			Communicatie	Laag	Nog accepteren
01-04-2022 15:02:25	1	Afzuigventilator	Luchtbehandeling	1-5AV1	Storing	Hoog	Nog accepteren
01-04-2022 15:02:25	1	Toevoventilator	Luchtbehandeling	1-STV1	Storing	Hoog	Nog accepteren
01-04-2022 15:03:23	1	Vorstthermostaat	Luchtbehandeling	1-STZA1	Storing	Hoog	Nog accepteren
01-04-2022 15:02:25	1	Warmtewiel	Luchtbehandeling	1-SWW1	Storing	Hoog	Nog accepteren
01-04-2022 15:02:21	1	Stuurstroombew. 24V	Algemeen		Storing	Hoog	Nog accepteren
01-04-2022 15:05:17	2	DALI-02 - Channel 1			Communicatie	Laag	Nog accepteren
01-04-2022 15:03:32	25	Poort : Lon geen communicatie met LON netwerk!			Poort	Hoog	Nog accepteren
01-04-2022 15:04:58	34	Comprinet poort 'Priva BlueID' via udp poort '192...			Poort	Hoog	Nog accepteren
01-04-2022 15:03:54	34	Comprinet poort 'Priva BlueID' via udp poort '192...			Poort	Hoog	Nog accepteren
01-04-2022 15:03:32	12	Comprinet poort 'HX RK1' via udp poort '192.168...			Poort	Hoog	Nog accepteren
01-04-2022 07:44:56	1	NW versturing naar GBS mislukt! Reden: Cache...			Nieuwe Waarde	Laag	In
01-04-2022 16:57:11	1	dP koelmachine	Koudeopwekking	1-4PdA1	Storing	Hoog	Nog accepteren
01-04-2022 15:02:20	1	Netwachter	Algemeen		Storing	Hoog	Nog accepteren
29-03-2022 15:08:15	3	Onbekende meldcode : 26			Computer	Laag	Nog accepteren



Product development steps in cooperation with research



Periodes

Maand Tijdkeuze Data groeperen Navigatie

Jaar	Maand	Dag		Jaar	Maand	Dag	
2008	07	01	t/m	yyyy	mm	end	X

Datapunten

		Periode										Kolom aggregatie
		Koude laden [MWh]	Cumulatief laden [MWh]	Koude ontladen [MWh]	Cumulatief Ontladen [MWh]	Cumulatief balans [MWh]	Balans [%]	Koude laden [m³]	Koude ontladen [m³]	Productiviteit Koude laden [kWh/m³]	Productiviteit Koude ontladen [kWh/m³]	
Tijdpunten	1	X										
	2	c_p_1	c_p_11	c_p_2	c_p_12	c_p_13	c_p_9	c_p_4	c_p_5	c_p_6	c_p_7	
	...											
	-	v_r_a_1_c_p_1	v_r_a_1_c_p_11	v_r_a_1_c_p_2	v_r_a_1_c_p_12	v_r_a_1_c_p_13	v_r_a_1_c_p_9	v_r_a_1_c_p_4	v_r_a_1_c_p_5	v_r_a_1_c_p_6	v_r_a_1_c_p_7	
	-	v_r_a_2_c_p_1	v_r_a_2_c_p_11	v_r_a_2_c_p_2	v_r_a_2_c_p_12	v_r_a_2_c_p_13	v_r_a_2_c_p_9	v_r_a_2_c_p_4	v_r_a_2_c_p_5	v_r_a_2_c_p_6	v_r_a_2_c_p_7	
	Totaal	v_r_a_3_c_p_1	v_r_a_3_c_p_11	v_r_a_3_c_p_2	v_r_a_3_c_p_12	v_r_a_3_c_p_13	v_r_a_3_c_p_9	v_r_a_3_c_p_4	v_r_a_3_c_p_5	v_r_a_3_c_p_6	v_r_a_3_c_p_7	

Eigenschappen

Periode kolom

Kolom verwijderen

Code: c_p_1

Meetpunt

Databron: ASR (AMEV-huis) [IV32]

Filter:

Datapunten:

- LTEO 1 - Ontladen - energie maandtabel [MWh] [9.1.2384]
- LTEO 1 - Laden - energie maandtabel [MWh] [9.1.2359]
- Grondwaterverplaatsing Ontladen Maand [Energiregistratie- LTEO 1] [*1000 m3] [9.1.2381]
- Grondwaterverplaatsing Laden Maand [Energiregistratie- LTEO 1] [*1000 m3] [9.1.2356]

Download: Sorteren:

Functie: return \$field_value;

Titel: Koude laden [MWh]

Decimalen: 1

Grenswaarden: Max: <= Min: >

Productiviteit en Energiebalans

Periode [jaar-maand]	2008-07 t/m 2022-04									
	Koude laden [MWh]	Cumulatief laden [MWh]	Koude ontladen [MWh]	Cumulatief Ontladen [MWh]	Cumulatief balans [MWh]	Balans [%]	Koude laden [m³]	Koude ontladen [m³]	Productiviteit Koude laden [kWh/m³]	Productiviteit Koude ontladen [kWh/m³]
07-2008	3.6	3.6	0.0	0.0	-3.6	-100.0	0.2	0.0		
08-2008	0.0	3.6	0.0	0.0	-3.6	-100.0	0.0	0.0		
09-2008	0.0	3.6	15.8	15.8	12.2	62.9	0.0	1.2		
10-2008	0.7	4.3	1264.0	1279.8	1275.5	99.3	0.0	33.6		
11-2008	1.0	5.3	124.0	1403.8	1398.5	99.2	0.1	32.1		
12-2008	356.0	361.3	10.0	1413.8	1052.5	59.3	40.5	1.9		
2008	361.3	361.3	1413.8	1413.8			40.9	68.8	8.8	20.6
01-2009	232.9	594.2	0.7	1414.5	820.3	40.8	32.7	0.1		
02-2009	193.8	788.0	0.0	1414.5	626.5	28.4	32.9	0.0		
03-2009	55.9	843.9	0.0	1414.5	570.6	25.3	11.2	0.0		
04-2009	2.0	845.9	0.0	1414.5	568.6	25.2	0.4	0.0		
05-2009	0.0	845.9	0.0	1414.5	568.6	25.2	0.0	0.0		
06-2009	0.0	845.9	66.9	1481.4	635.5	27.3	0.0	9.2		
07-2009	0.0	845.9	134.3	1615.7	769.8	31.3	0.0	18.1		
08-2009	0.0	845.9	122.2	1737.9	892.0	34.5	0.0	16.7		
09-2009	0.0	845.9	113.6	1851.5	1005.6	37.3	0.0	16.6		
10-2009	0.2	846.1	6.4	1857.9	1011.8	37.4	0.0	1.0		
11-2009	15.0	861.1	4.0	1861.9	1000.8	36.8	2.0	0.7		
12-2009	263.7	1124.8	0.0	1861.9	737.1	24.7	32.2	0.0		



Straatnaam 8
1234 AB Plaatsnaam

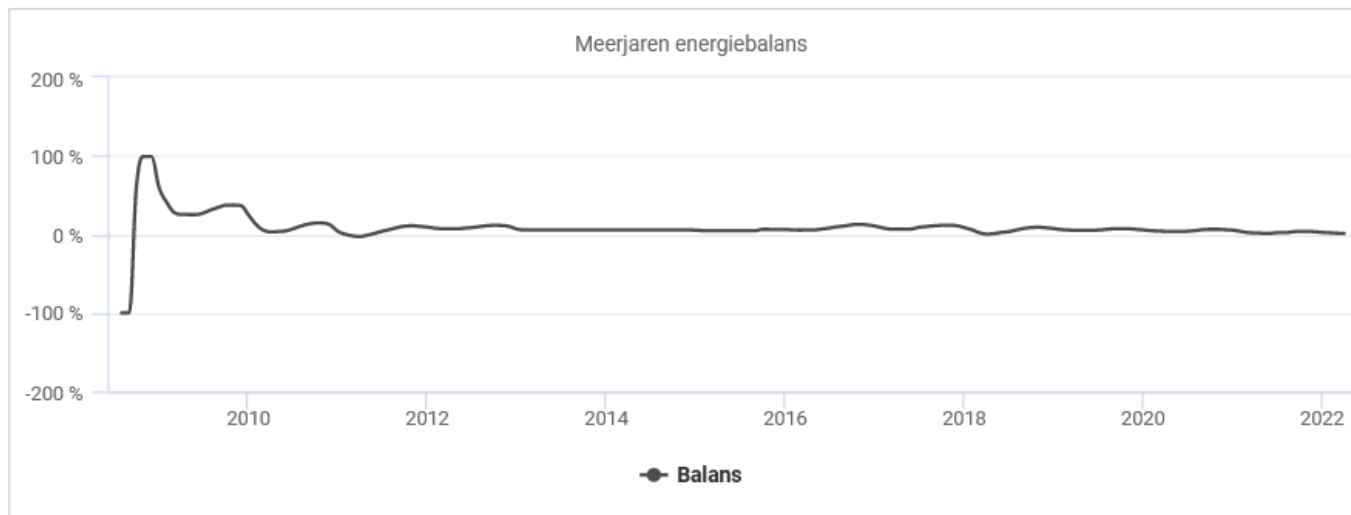


Koude opslag in de bodem
vanaf eerste ingebruikname
(Warmtelevering aan het gebouw)

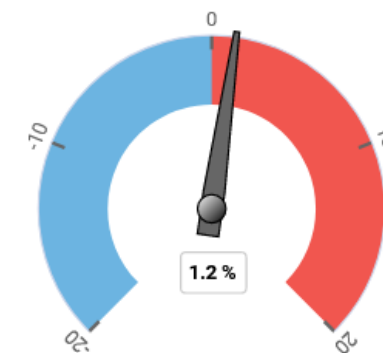
7079.0 MWh

Warmte opslag in de bodem
vanaf eerste ingebruikname
(Koudelevering aan het gebouw)

7246.7 MWh



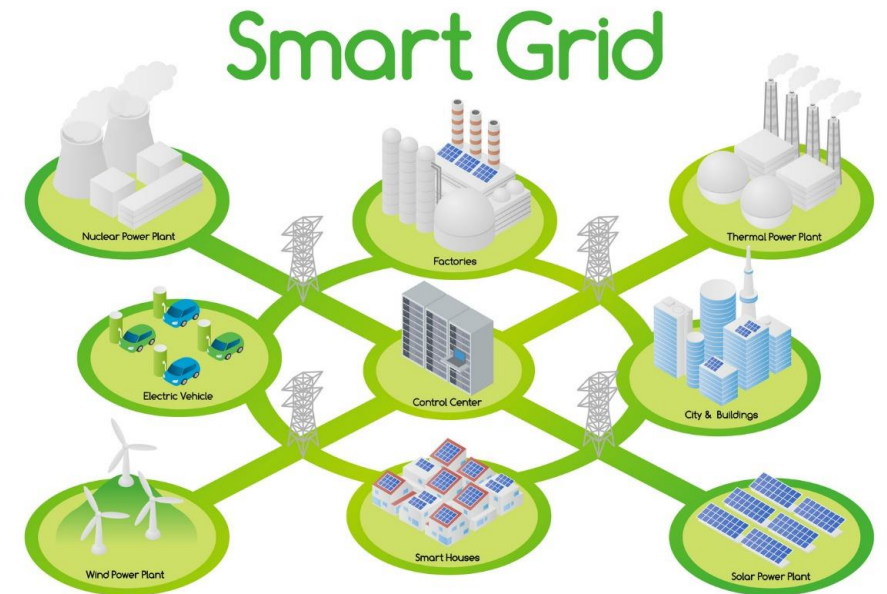
Huidig energetisch evenwicht

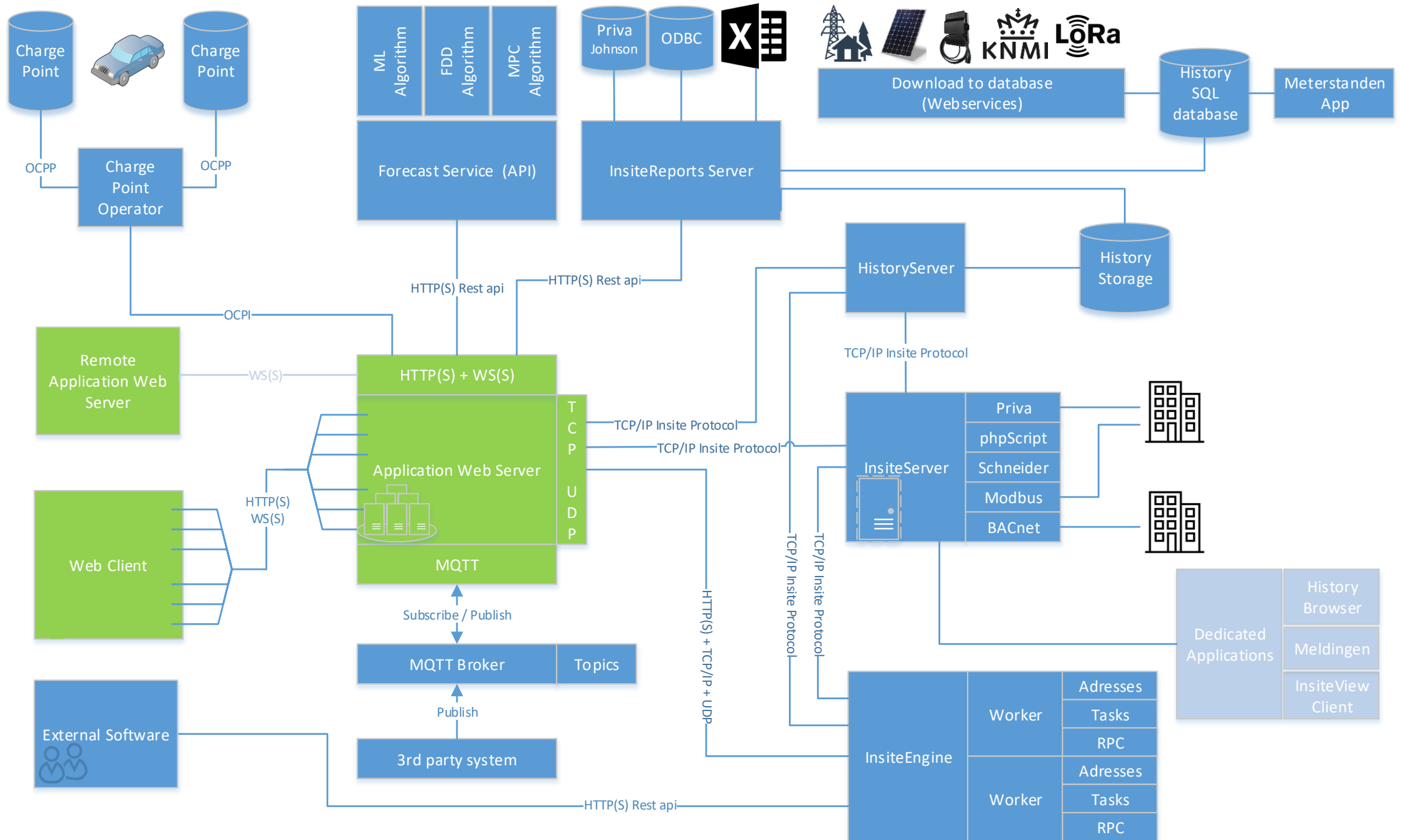


Warmteoverschot

Research

- Energy monitoring of sub systems
(Tom Thomassen, master Tu/E)
- Energy flexibility of building
(Kennedy Aduda, PhD Tu/E)

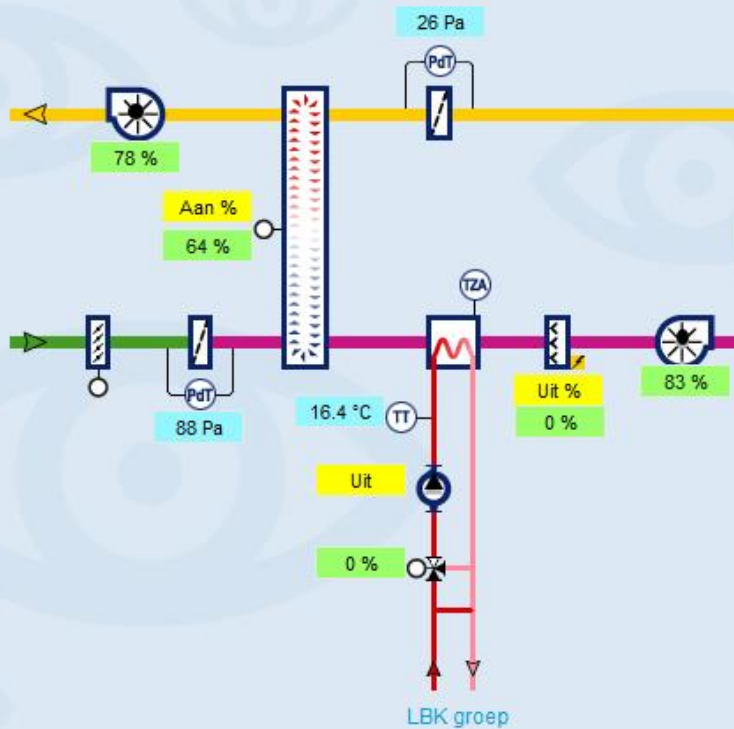






no 15.3 °C
zw 14.8 °C
21.0 °C
Tijdprogramma in

CV-installatie
GKW-installatie



© Copyright 2018 Kropman B.V. - All rights reserved

Meldingen - kropman nijmegen

Actieve storingen

Groeperen: -

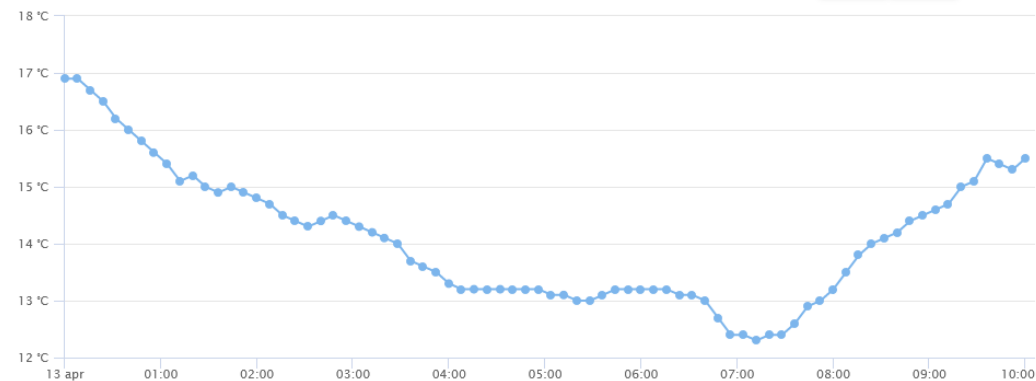
Rijen per pagina: 20 1-7 van 7

PcTijd ↓	OsNr	Melding	InstDeel	Code	Type	Urgentie	Status
2022-04-08 05:31:32	1	Inblaasttemperatuur	Luchtbehan...	1-6TT01	Minimum Gr...	Hoog	Uit
2022-04-08 05:31:32	1	Relatief inblaasvocht	Luchtbehan...	1-6MT...	Maximum Gr...	Hoog	Uit
2022-04-08 05:31:32	1	Relatief inblaasvocht	Luchtbehan...	1-6MT...	Opnemer St...	Hoog	Uit
2022-04-05 12:03:28	1	Afz.vent.naar gereedsch	Luchtbehan...	1-6AV2	Storing	Hoog	Geaccepteerd
2022-04-05 12:03:28	2	Ketel					
2022-04-05 12:03:28	10	Onbe					
2022-03-26 13:00:57	13	Tijdp					

Grafiek

DAG WEEK MAAND JAAR DATUM SELECTIE

wo 13 april 2022



Y-as bereik: Automatisch

Datapunten vast zetten



- local
- Venster
- Bibliotheek
- Sjabloon
- Breda
- Verlichting
- sliders

Kleur 20

Intensiteit 20

Legenda

- Lamp aan 5500 Lux
- Lamp aan 4000 Lux
- Lamp aan 3000 Lux
- Lamp uit

Automatisch

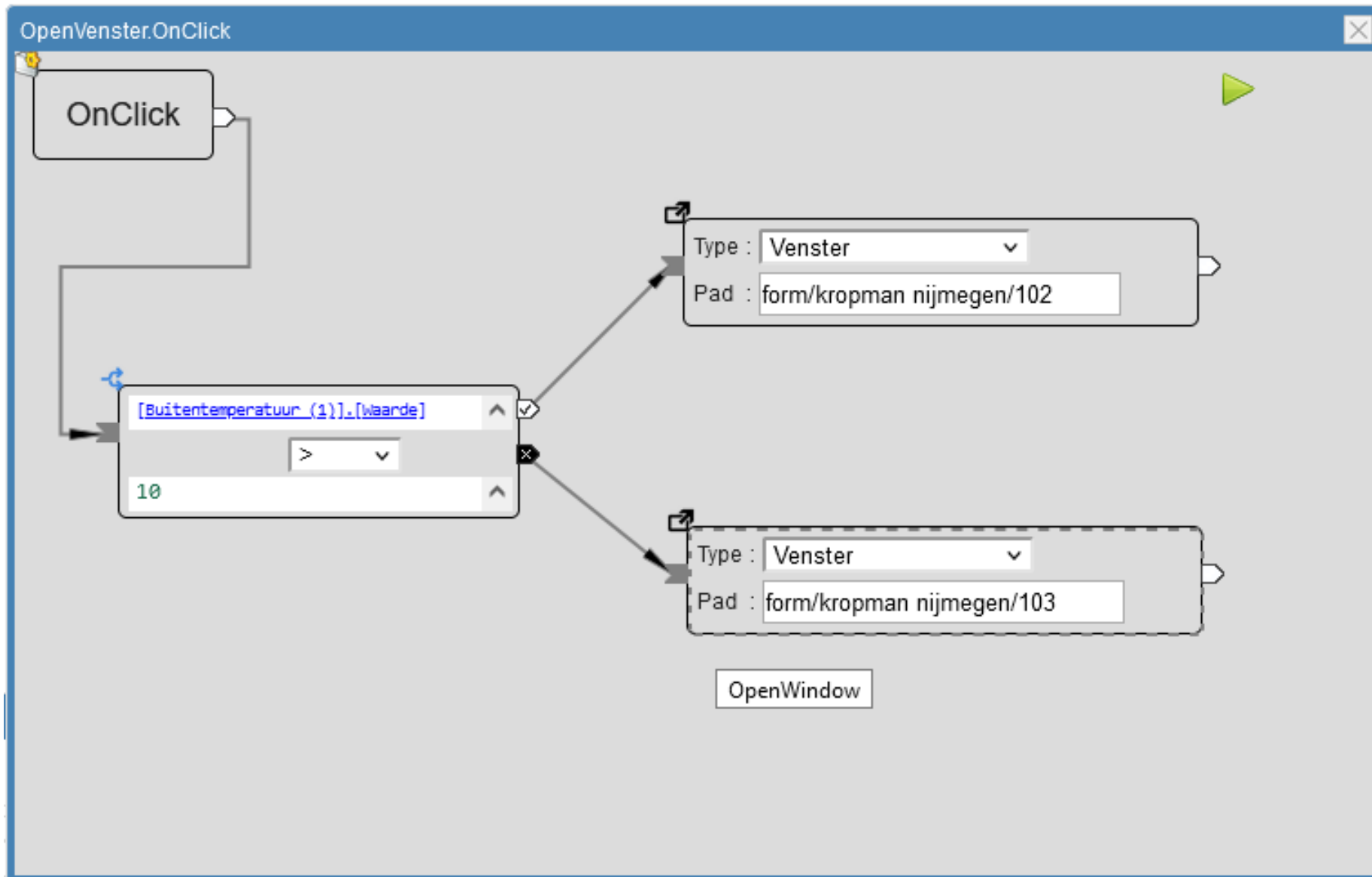
Party mode 1

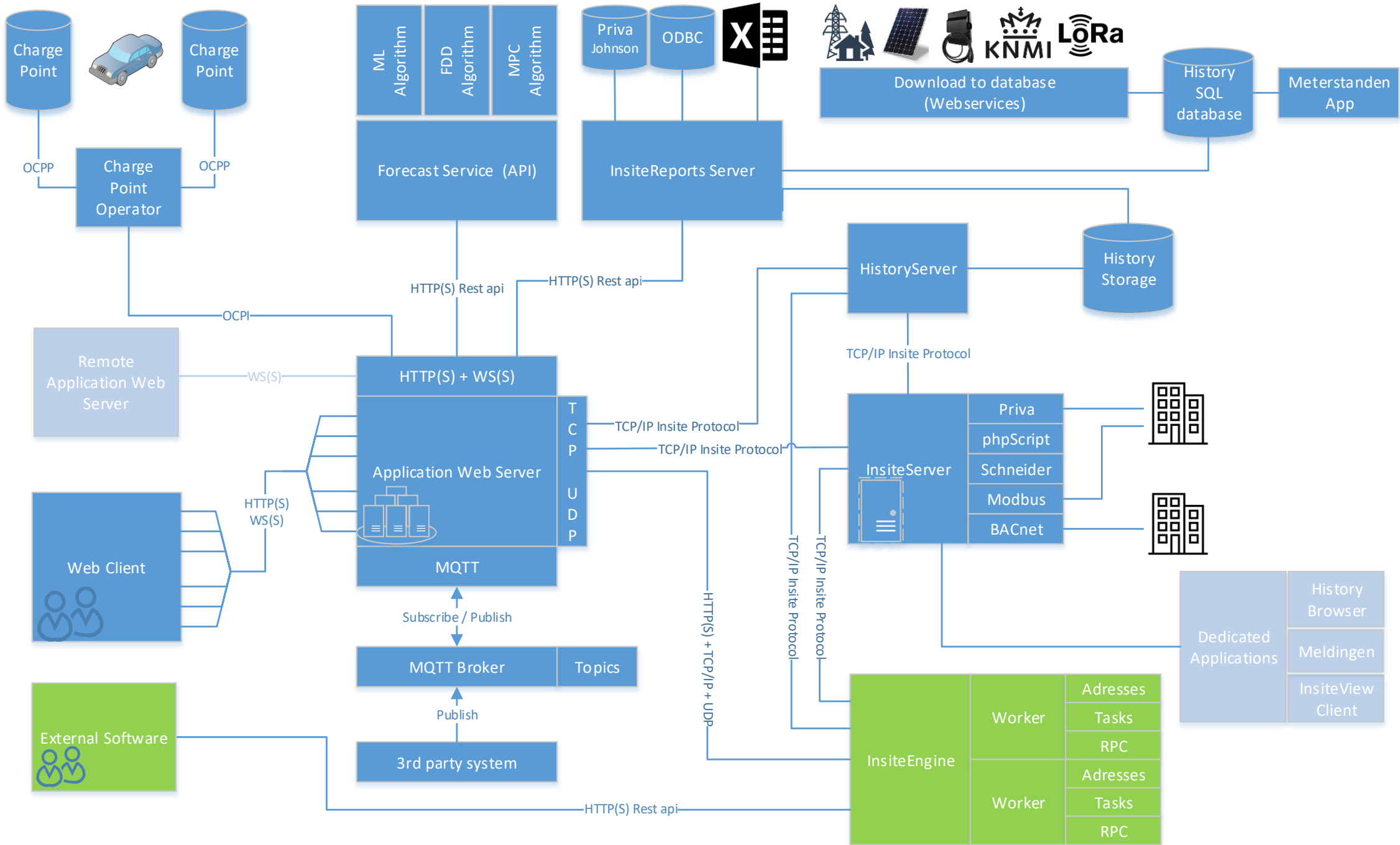
Party mode 2

Alles uit

Kleur 50

Intensiteit 0

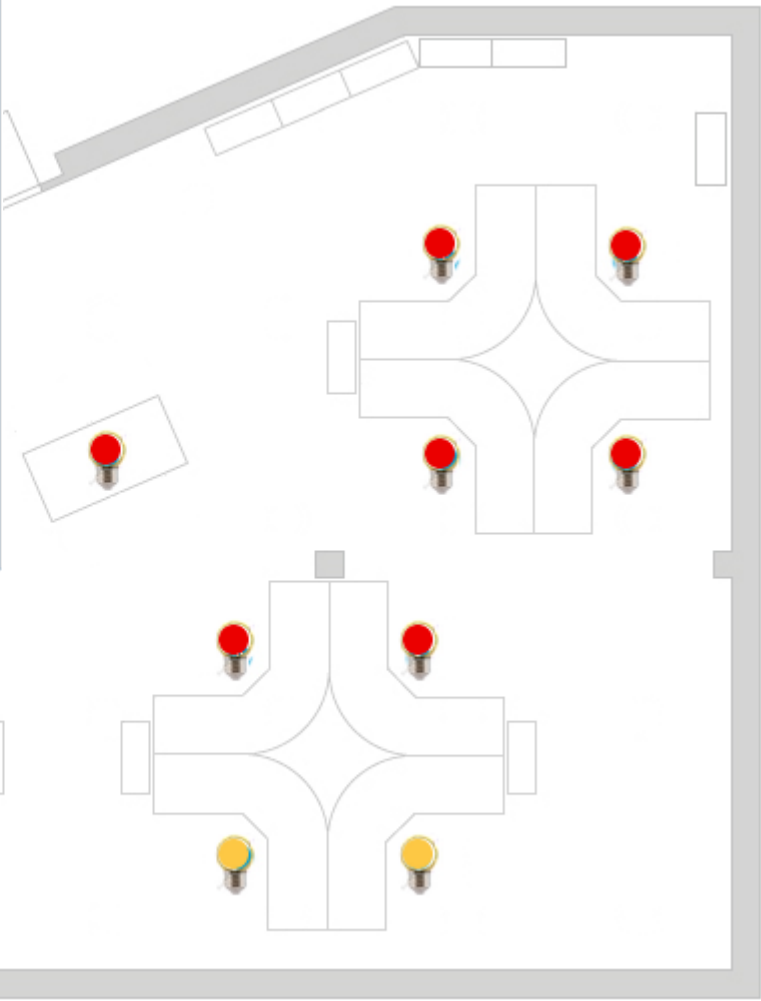
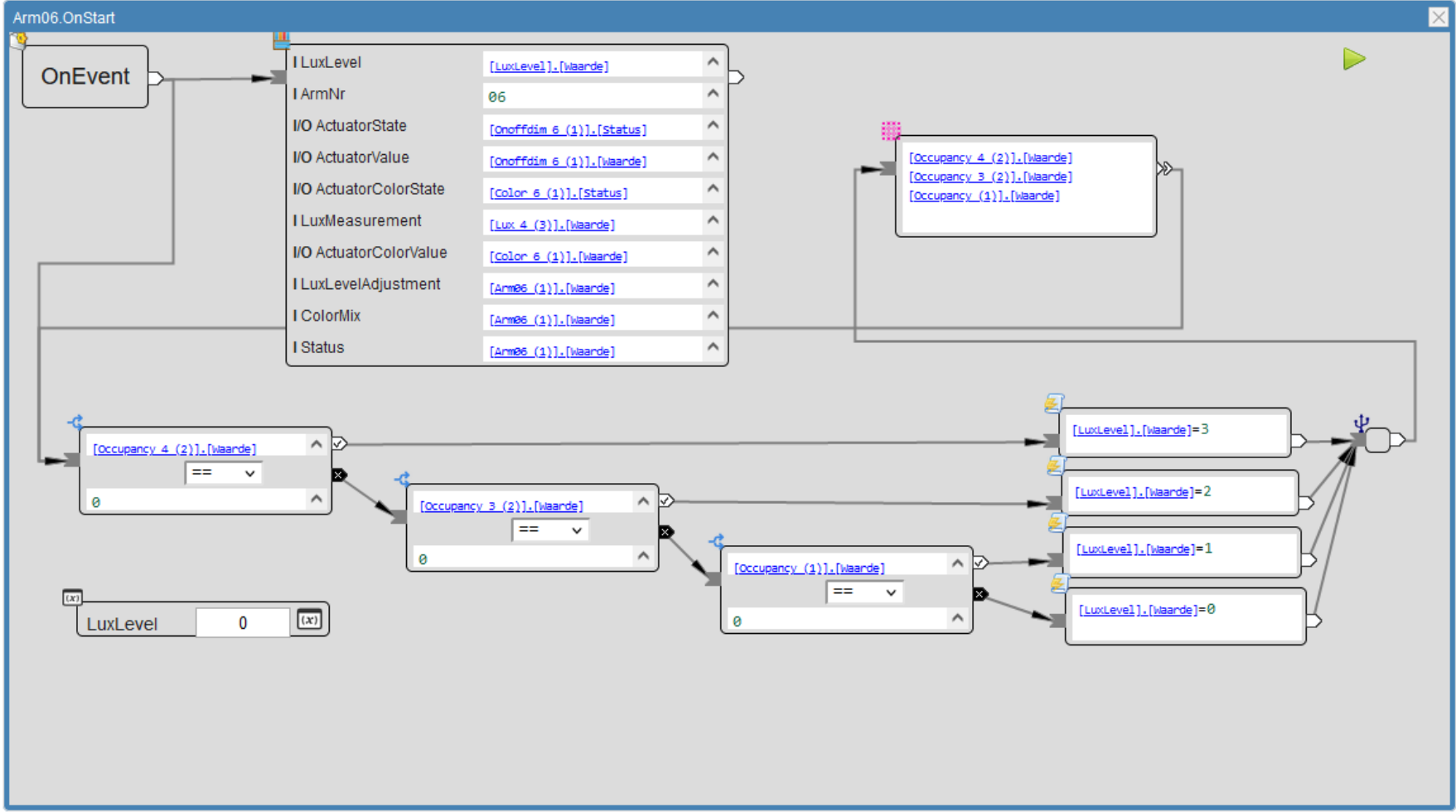


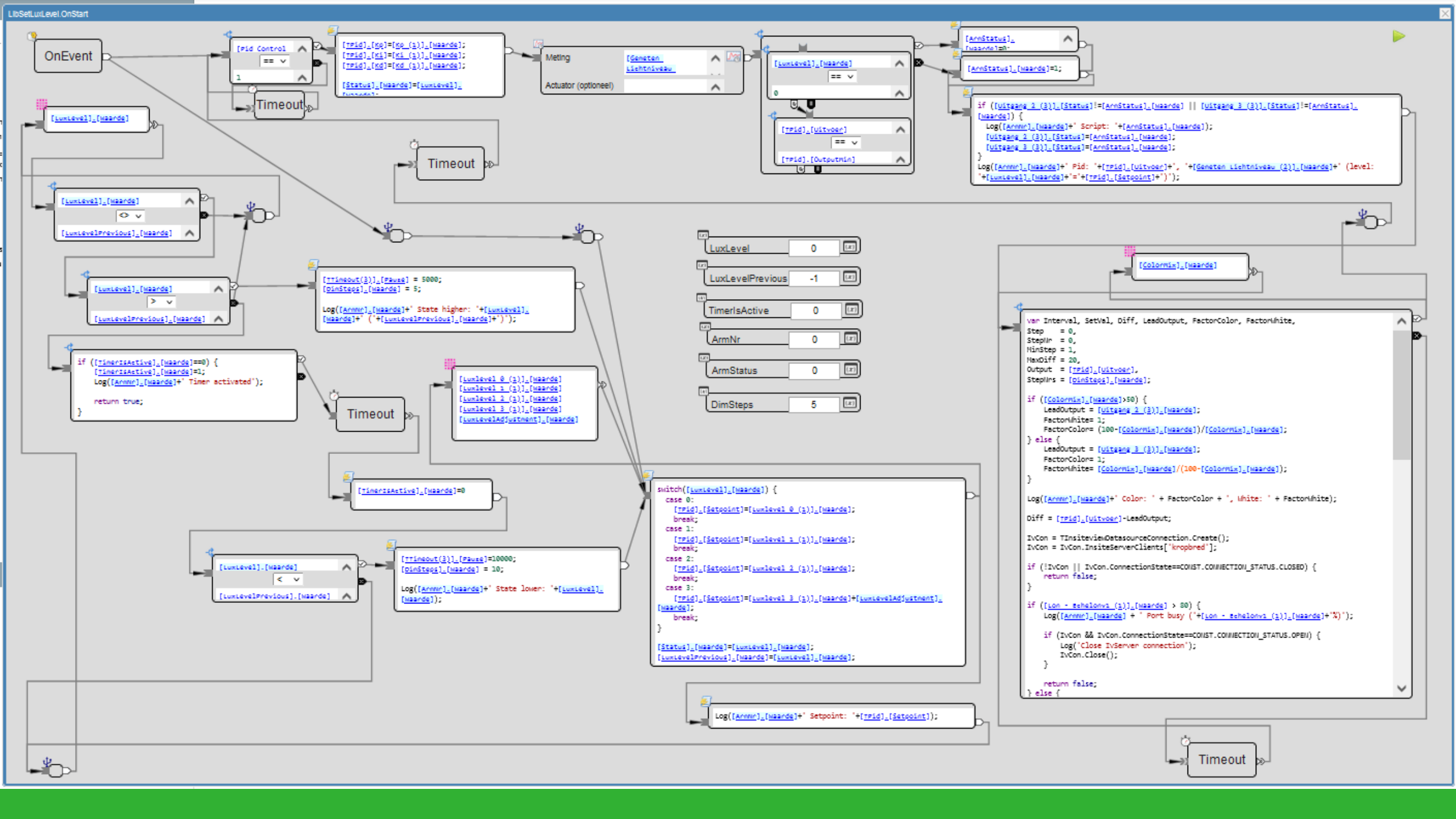


Research

- Individual lighting system
(Timmy Leabodan, PhD Tu/E)
- Influence light on perception of comfort
(Samantha Peeters and Thijs Kruisselbrink, PhD Tu/E)
- Battery control system
(Rick Cox, master Tu/E)

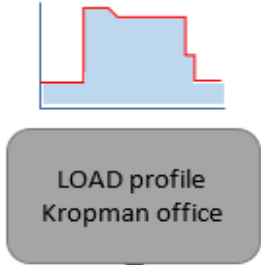




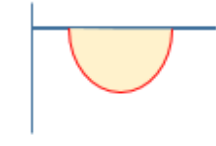


Battery control system

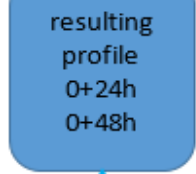
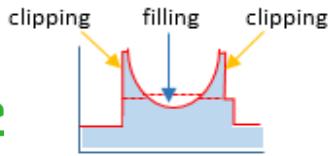
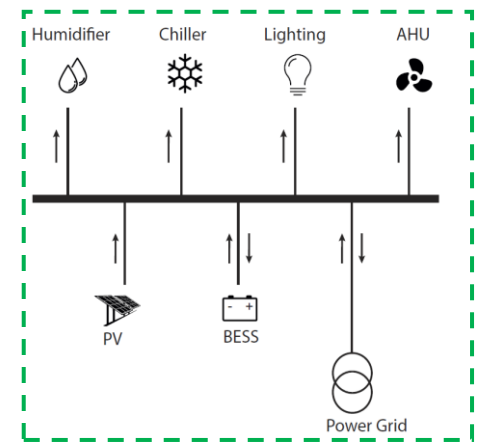
BACnet,
Modbus, etc.



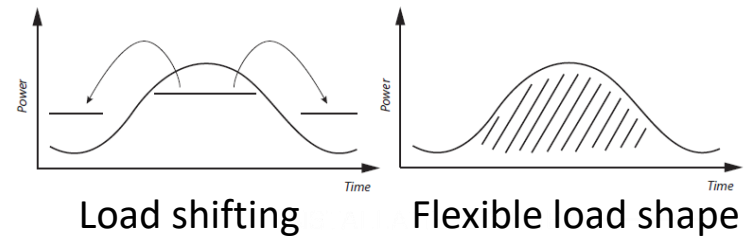
Verwacht verbruiksprofiel



Verwacht productie profiel



or....
OCPI

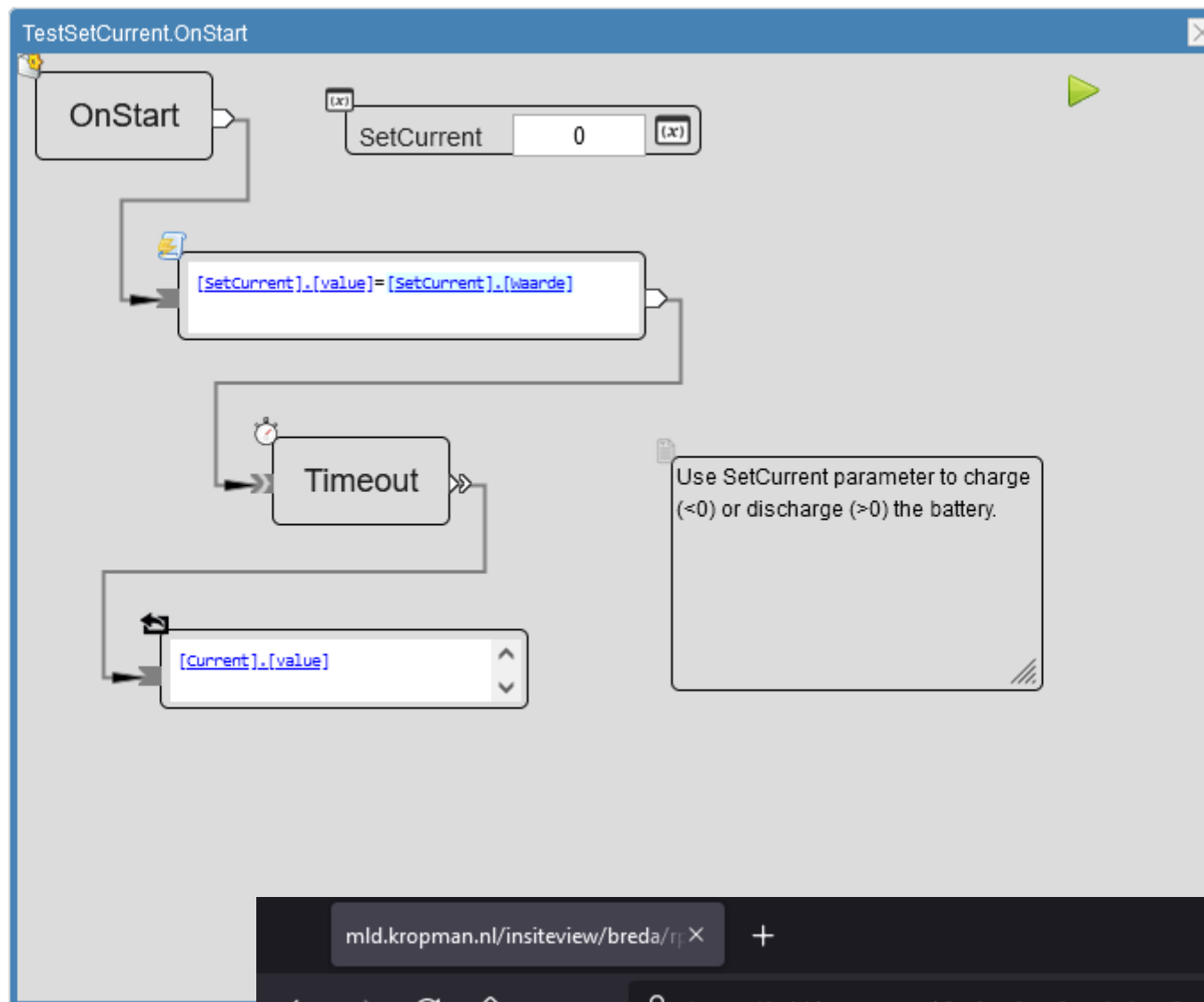


Insite Suite



API, SOAP, JSON, OSGP, ..

- local
- Venster
- Bibliotheek
- Sjabloon
- Navigatie
- Alias
- InsiteReports
- Machine Learning
- MQTT
- OCPI
- InsiteView
- InsiteEngine
 - Default.Breda
 - Werker 0
 - Logboek
 - Adressen
 - Taken
 - Battery
 - TestSetCurrent
 - ClimatDesk
 - Rpc
 - BatteryTest
 - Battery/TestSetCurrent
 - Petros Zimianitis TuE
 - Werker 1



Eigenschappen

TIvNextWorkerRpcClientNode

Algemeen

Key: [Copy](#)

Active:

Name:

Componenten

- Algemeen
- InsiteEngine

mld.kropman.nl/insiteview/breda/rpc

https://mld.kropman.nl/insiteview/breda/rpc/battery/testsetcurrent?SetCurrent=5&key=1

JSON Onbewerkte gegevens Headers

Opslaan Kopiëren Alles samenvouwen Alles uitvouwen JSON filteren

▼ result:

```
Current: 5
```


- local
- Venster
- Bibliotheek
- Sjabloon
- Navigatie
- Alias
- InsiteReports
- Machine Learning
- MQTT
- OCPI
- ChessWise
- InsiteView
- InsiteEngine
- Default.Breda
- Werker 0
 - Logboek
 - Adressen
 - Battery
 - Control
 - ExternalControl
 - Conversion
 - Test
 - Taken
 - Rpc
 - Werker 1
 - Sessies

ExternalControl

Setpoints

Set current (<0 charge, >0 discharge)	value:	<input type="text" value="0"/>	A	<input type="checkbox"/>
Connect	value:	<input type="checkbox"/>		<input type="checkbox"/>
Disconnect	value:	<input type="checkbox"/>		<input type="checkbox"/>
Full charge	value:	<input type="checkbox"/>		<input type="checkbox"/>

Messages

Error	value:	<input type="text" value="Hit SoC boundary 0%. ("/>		<input type="checkbox"/>
-------	--------	---	--	--------------------------

Configuration

Max current charge	input:	<input type="text"/>		
Max current discharge	value:	<input type="text" value="30"/>	A	
Active control	value:	<input type="text" value="2"/>		
Controls	entry:	<input type="text"/>		
Last datetime current switched between charge and discharge	value:	<input type="text" value="2022-09-27 17:00"/>	yyyy-mm-dd h	
Last set current	value:	<input type="text" value="0"/>	A	
Time between charge and discharge	value:	<input type="text" value="60"/>	s	
Full charge enabled up to SoC	value:	<input type="text" value="90"/>		<input type="checkbox"/>
Minimum SoC	value:	<input type="text" value="10"/>	%	<input type="checkbox"/>
Max temperature of battery	value:	<input type="text" value="40"/>	°C	<input type="checkbox"/>

input:	<input type="text"/>
ymin:	<input type="text" value="-5.0"/>
ymax:	<input type="text" value="-30.0"/>
points:	<ul style="list-style-type: none"> 0: <ul style="list-style-type: none"> x: <input type="text" value="0.0"/> y: <input type="text" value="-30.0"/> 1: <ul style="list-style-type: none"> x: <input type="text" value="90.0"/> y: <input type="text" value="0.0"/> 2: <ul style="list-style-type: none"> x: <input type="text" value="95.0"/> y: <input type="text" value="0.0"/>

Eigenschappen

TTypeValue

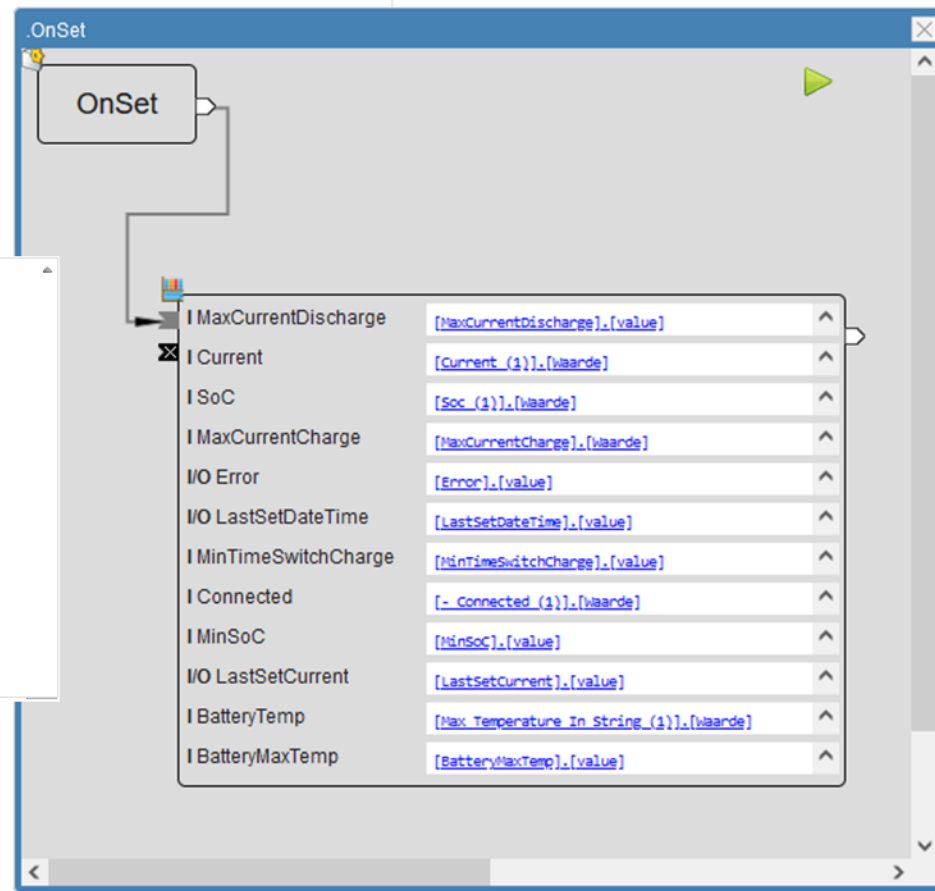
Algemeen

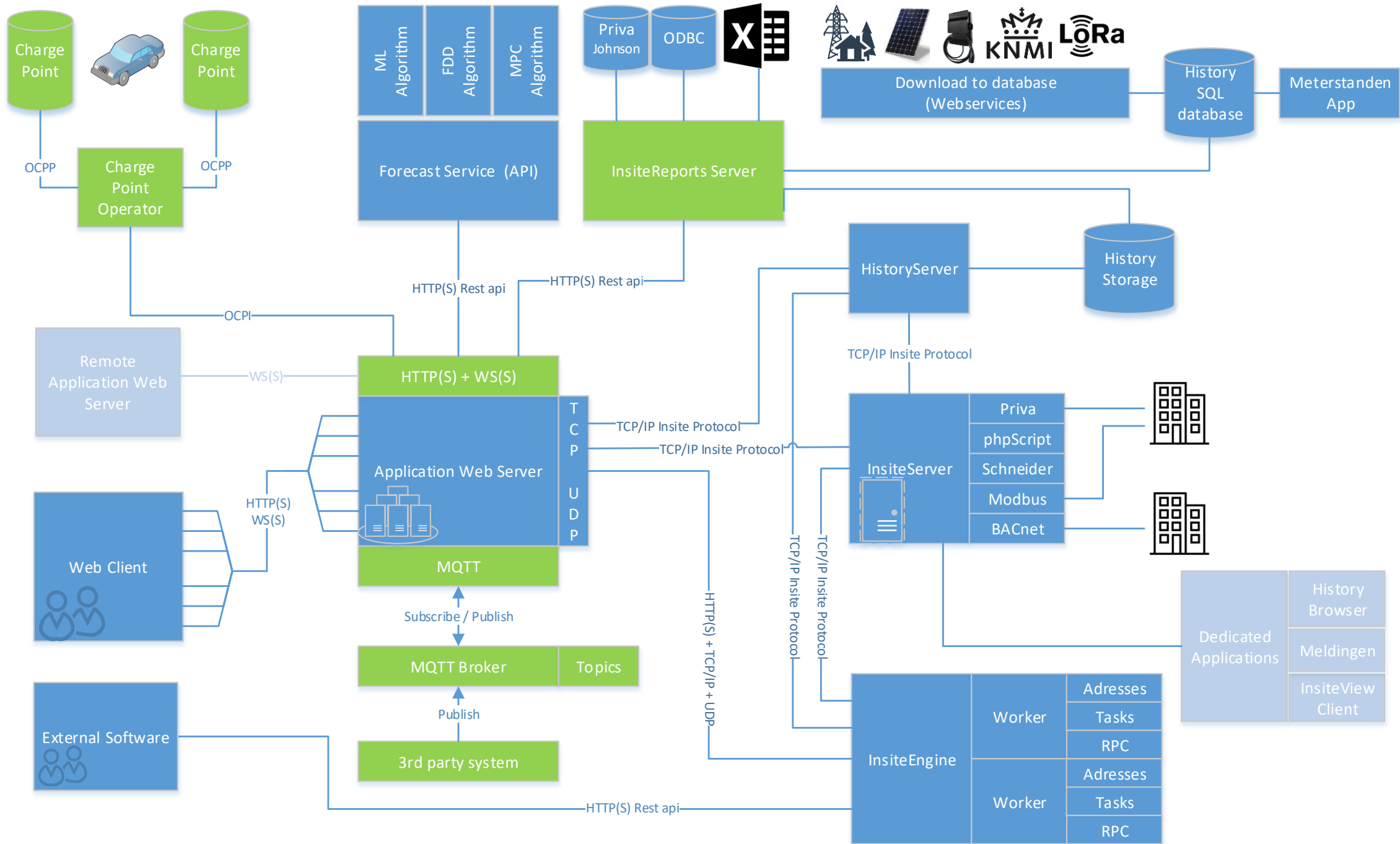
Description:

OnGet:

OnSet:

Unit:





- OCPI
- asr
- breda
 - Zuilenstraat 96, Breda
 - 1800286*1 (AVAILABLE)
 - 1800286*2 (AVAILABLE)
 - 1800291*1 (AVAILABLE)
 - 1800291*2 (CHARGING)
 - Meter waarden
 - Sessie
- InsiteView
- InsiteEngine

```

Sessie [73567989/1802521*2]
    2
    IEC_62196_T2
    SOCKET
    AC_3_PHASE
    230
    32
    2022-04-13T06:27:44Z
    1112
  }
}
total_cost: 0
visual_numb NL-ENE-C22803010-D
token_uid: 04378082126880
kwh: 24.25
status: ACTIVE
start_datetim 2022-04-13T06:27:13Z
contract_id: NL-ENE-C22803010-D
remote_last_ 2022-04-13T10:06:01Z

```

- MQTT
 - HKL-CM-1-02-A
 - extapi/data/ehub
 - extapi/data/eso
 - extapi/control/request
 - extapi/data/esm
 - extapi/control/response
 - extapi/control/result
 - extapi/data/sso

- InsiteReports
- IvsKropman
 - Kropman_
 - Breda
 - Nieuw rapport
 - 0. Omschrijving Showcase
 - 1. & 2. Prestatie indicatoren
 - 3. PV opwekking & Accu-opslag
 - 4. Warmte Koude Opslag (WKO)
 - 5. Reports Breda kantoor 1.05
 - Algemeen
 - Cursus
 - Demo
 - Gast
 - Klantendag
 - Living Lab Breda
 - 2.1 Bedrijfsvoering 2, (LAATSTE UUR)
 - 1.1 Bedrijfsvoering 1, (LAATSTE UUR)
 - 2.3 Bedrijfsvoering 2, (LAATSTE WEEK)
 - 1.3 Bedrijfsvoering 1, (LAATSTE WEEK)
 - 3.1 PQ 1, Spanning (LAATSTE UUR)
 - 1.2 Bedrijfsvoering 1, (LAATSTE DAG)
 - 2.2 Bedrijfsvoering 2, (LAATSTE DAG)

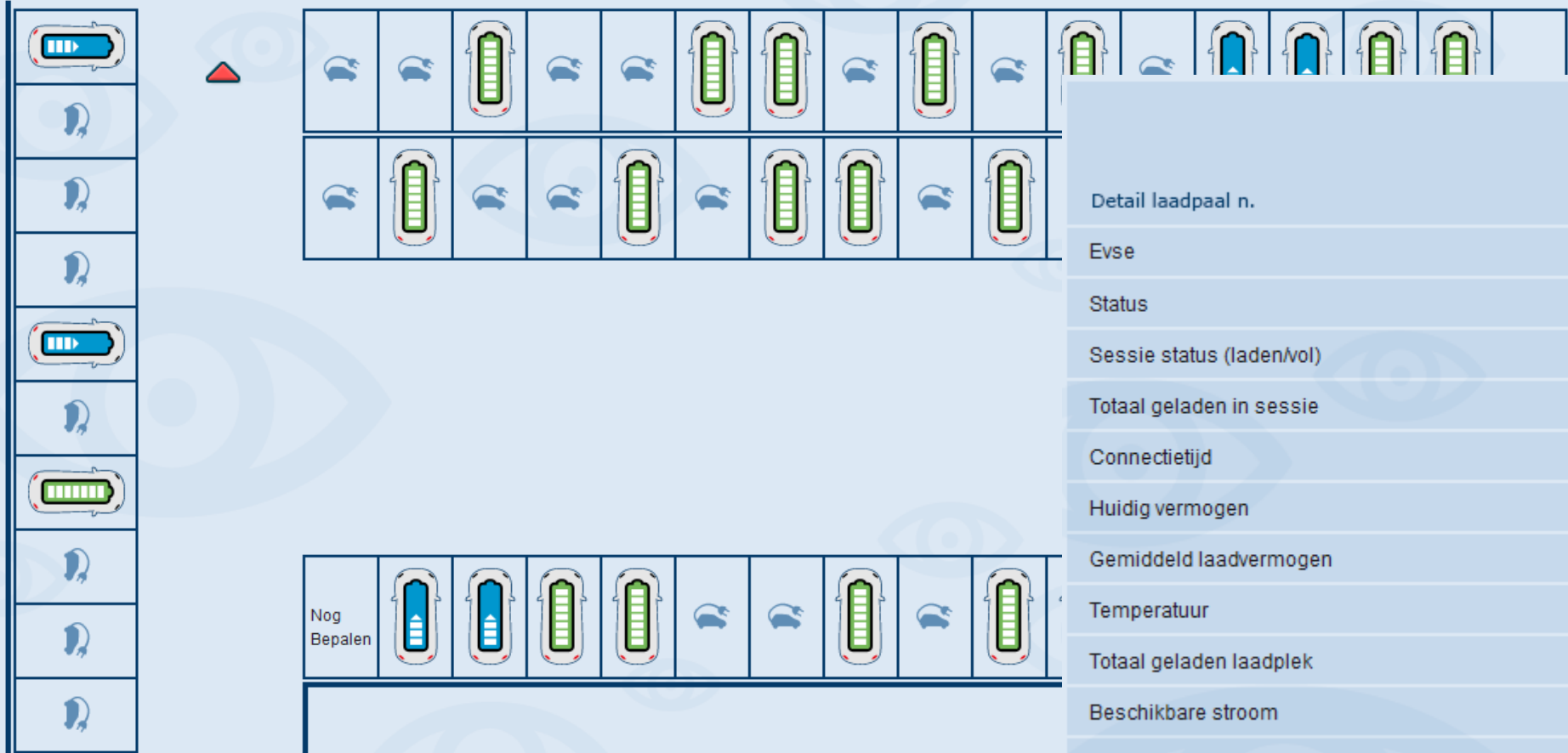
2.1 Bedrijfsvoering 2, (LAATSTE UUR)			
Periode	2022-04-13 11:00:00 t/m 2022-04-13 11:59:59		
[jaar-maand-dag uur:min:sec]	Tijdpunten [dagafkorting uur:min]	HV Kracht Vermogen Schijnbaar [Energie Meters] [kVA] [3.1.56373]	Gelijktijdigheidsfactor
	wo 11:00	5.74	4.3
	wo 11:01	5.74	4.3
	wo 11:02	5.74	4.3
	wo 11:03	5.74	4.3
	wo 11:04	5.74	4.3
	wo 11:05	5.74	4.3
	wo 11:06	5.74	4.3
	wo 11:07	5.74	4.3
	wo 11:08	5.74	4.3
	wo 11:09	5.74	4.3
	wo 11:10	5.74	4.3
	wo 11:11	5.74	4.3
	wo 11:12	5.74	4.3
	wo 11:13	5.74	4.3

14.8 °C
203 W/m²

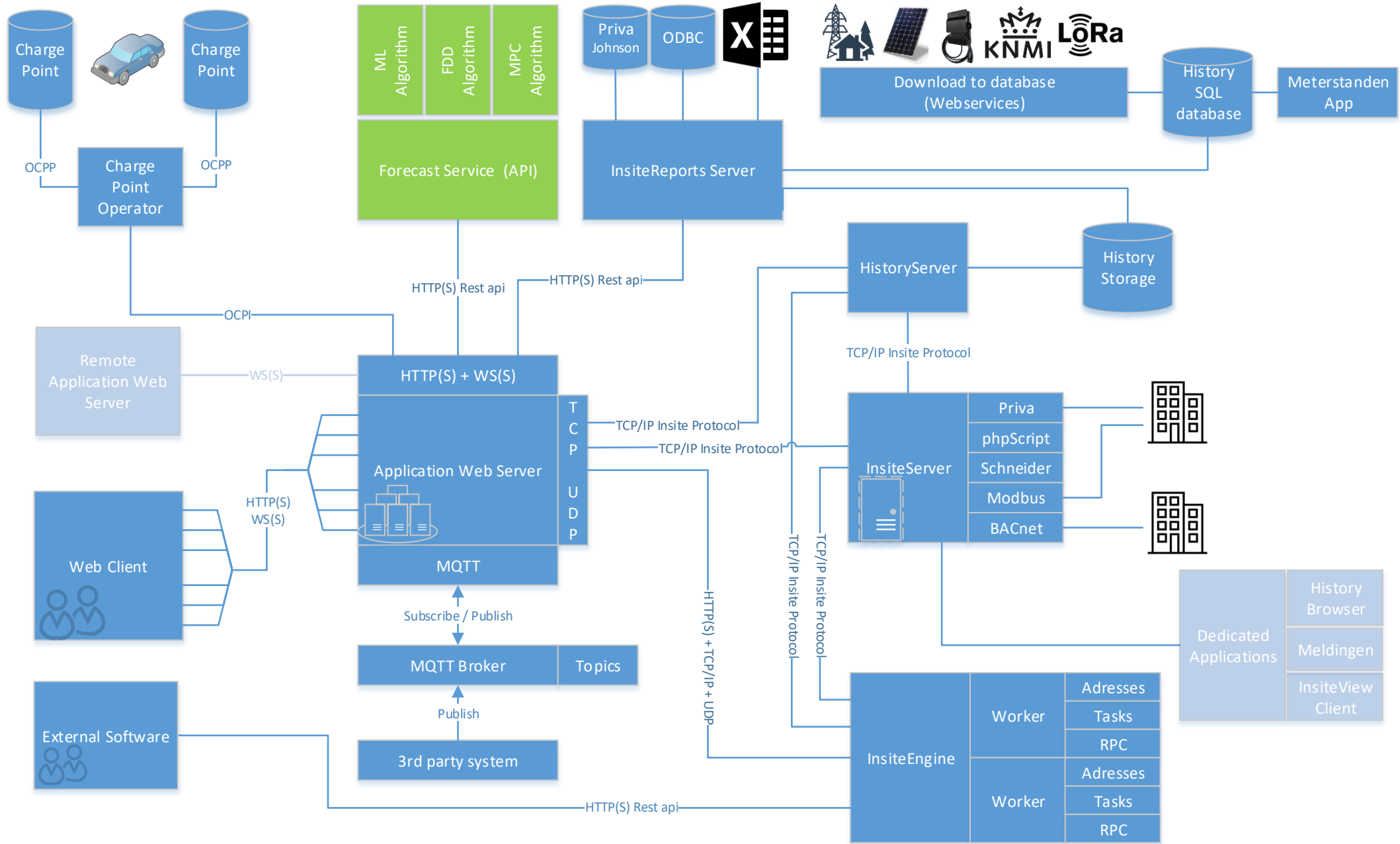
Legenda:

Laden
 Ontladen
 Vol
 Storing
 Laadplaats

- Startpagina
- Laadplein
- Laadplekken
- Begane grond



Detail laadpaal n.	AK-E-4-4
Evse	1802553*2
Status	ACTIVE
Sessie status (laden/vol)	CHARGING
Totaal geladen in sessie	10.6 kWh
Connectietijd	1.4 uur
Huidig vermogen	4.3 kW
Gemiddeld laadvermogen	4.8 kW
Temperatuur	28.0 °C
Totaal geladen laadplek	2564.7 kWh
Beschikbare stroom	6.0 A
Actuele stroom (L1, L2, L3)	6 A 6.1 A 6 A



- Machine Learning
- PcLocal
- Kropman Breda
- Bestanden
 - elektraverbruik per maand.csv
 - Elektraverbruik

Machine Learning model - Elektraverbruik

Date :

Boolean :

Time series index :

Targets :

Data preparation
Remove record on empty :

Algorithm : XGBoost

Maximum depth : 3 (1 - 100)

Learning rate for boosting. The lower the value is more conservative but will also need more trees to converge : 1 (0 - 1)

Number of estimators used : 100 (1 - 1024)

Can be gbtrees/gblinear/dart. The dart option adds dropout to prevent overfitting. The gblinear option creates a regularized linear model similar to lasso regression : gbtrees

Can be gain/weight/cover/total_gain/total_cover. The dart option adds dropout to prevent overfitting. The gblinear option creates a regularized linear model similar to lasso regression : gain

Index
regelkast
stoombevochtiger
koelmachine

Train

Data files management

- GET /session/{session_token}/projects/{prj_guid}/fileslist Data Files List
- POST /session/{session_token}/projects/{prj_guid}/files Data File Upload
- POST /session/{session_token}/projects/{prj_guid}/files/base64 Data File Upload64
- DELETE /session/{session_token}/projects/{prj_guid}/files/{filename} Data File Delete
- GET /session/{session_token}/projects/{prj_guid}/files/{filename}/rename Data File Rename

Data files download

- GET /session/{session_token}/projects/{prj_guid}/files/{filename} Data File Download
- GET /session/{session_token}/projects/{prj_guid}/files/{filename}/base64 Data File Download Base64
- GET /session/{session_token}/projects/{prj_guid}/files/{filename}/header Data File Download Header

Models management

- GET /session/{session_token}/projects/{prj_guid}/models MI Models List
- POST /session/{session_token}/projects/{prj_guid}/models MI Model Train
- DELETE /session/{session_token}/projects/{prj_guid}/models/{ml_guid} MI Model Delete
- POST /session/{session_token}/projects/{prj_guid}/models_mp MI Model Train Mp

Models usage

- GET /session/{session_token}/projects/{prj_guid}/models/{ml_guid}/info MI Get Info

Research

- **Fault Detection and Diagnoses**
(Shobhit Chitkara and Anand Thamban, PhD Tu/E)
- **Predict occupation of EV's**
(Ward, master Tu/E)
- **MPC for solar panel combined with battery system**
(Koen and Bram, master Tu/E)

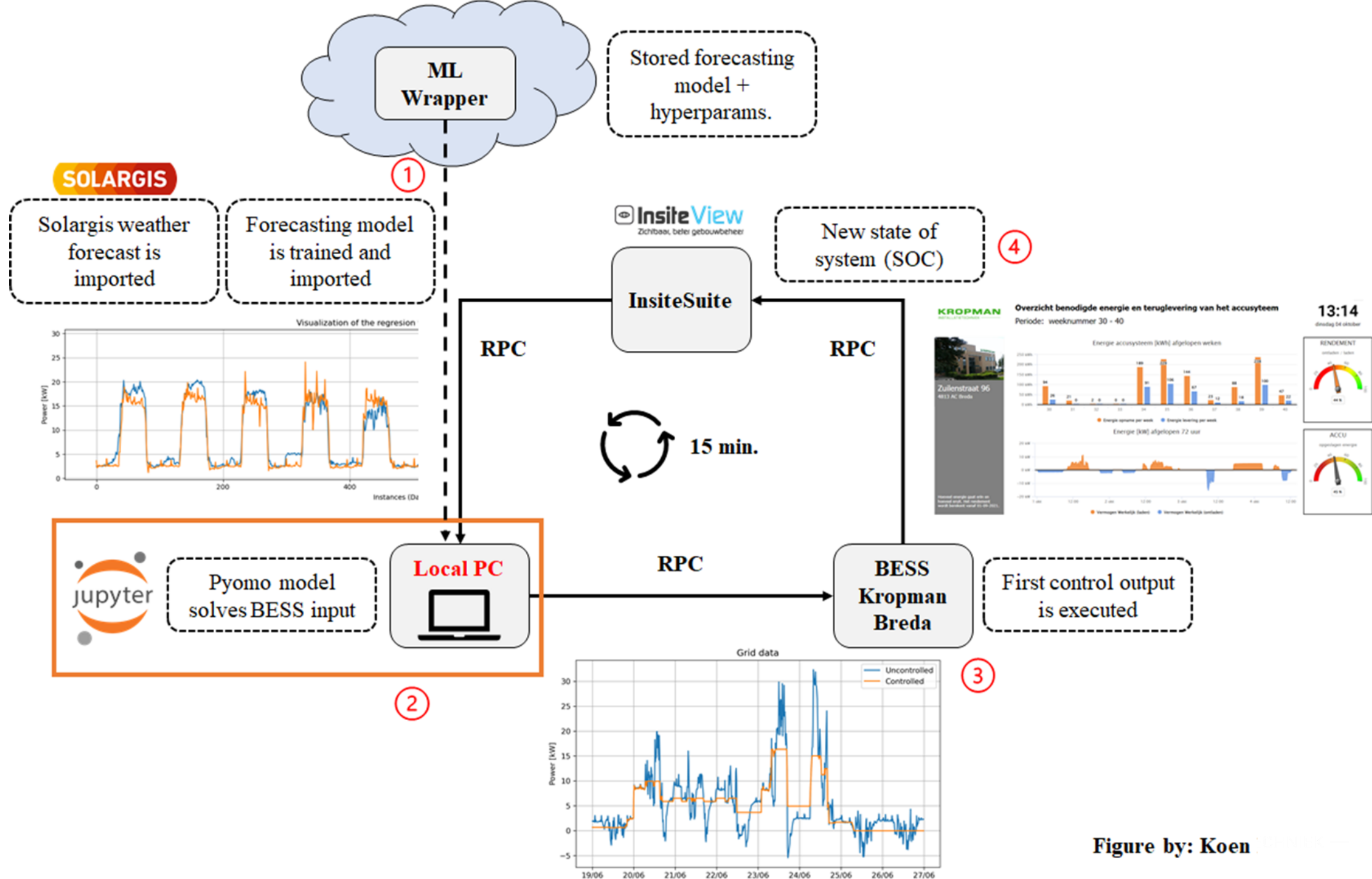


Figure by: Koen



a.s.r.
de nederlandse
verzekering
maatschappij
voor alle
verzekeringen



Startpagina



Energiregistratie



Zonnepanelen



Laadpalen 1^e verdieping




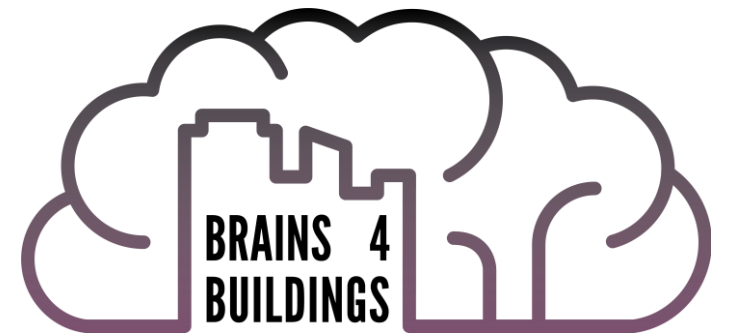
Laadpalen begane grond



Insite View

Plans

- Start business unit for creating advanced anticipating controls on top of  **InsiteSuite**
- Make building data available in uniform way



Thank you for your attention!

Any questions?