



## How IoT enables operational excellence for off-grid systems at scale – A case study from Nigeria



Hendrik Broering | CDO

AMMP Technologies | ECOWAS Sustainable Energy Forum | October 2019



Algeria

Libya

Egypt

Saudi Arabia

Mauritania

Mali

Niger

Chad

Sudan

Eritrea

Yemen

Nouakchott

Dakar

Senegal

The Gambia

Guinea-Bissau

Bamako

Burkina Faso

Niamey

Sabon Gari Market

N'Djamena

Conakry

Guinea

Sierra Leone

Côte d'Ivoire

Ghana

Togo

Benin

Nigeria

Central African Republic

South Sudan

Ethiopia

Djibouti

Monrovia

Liberia

Abidjan

Accra

Lome

Port Harcourt

Cameroon

Bangui

Douala

Yaounde

São Tomé and Príncipe

Libreville

Gabon

Republic of the Congo

Democratic Republic of the Congo

Kinshasa

Uganda

Kenya

Somalia

Mogadishu

Nairobi

Olenguruone

Arusha

Mombasa

Rwanda

Burundi

Tanzania

Dar es Salaam

Georgetown

Google

# Sabon Gari Market

Second largest industrial centre in Nigeria

## 12,000 SHOPS

With customer foot traffic of 1 million people monthly

## NO GRID

Market is entirely  
off-grid

## 3.0-5.0kVA

shared generators power  
the whole market

A centre powered by fossil-fuel gensets



# The Rensource solution: Deployment of 100 decentralized solar mini-grids across the market



# The Rensource solution: Deployment of 100 decentralized solar mini-grids across the market

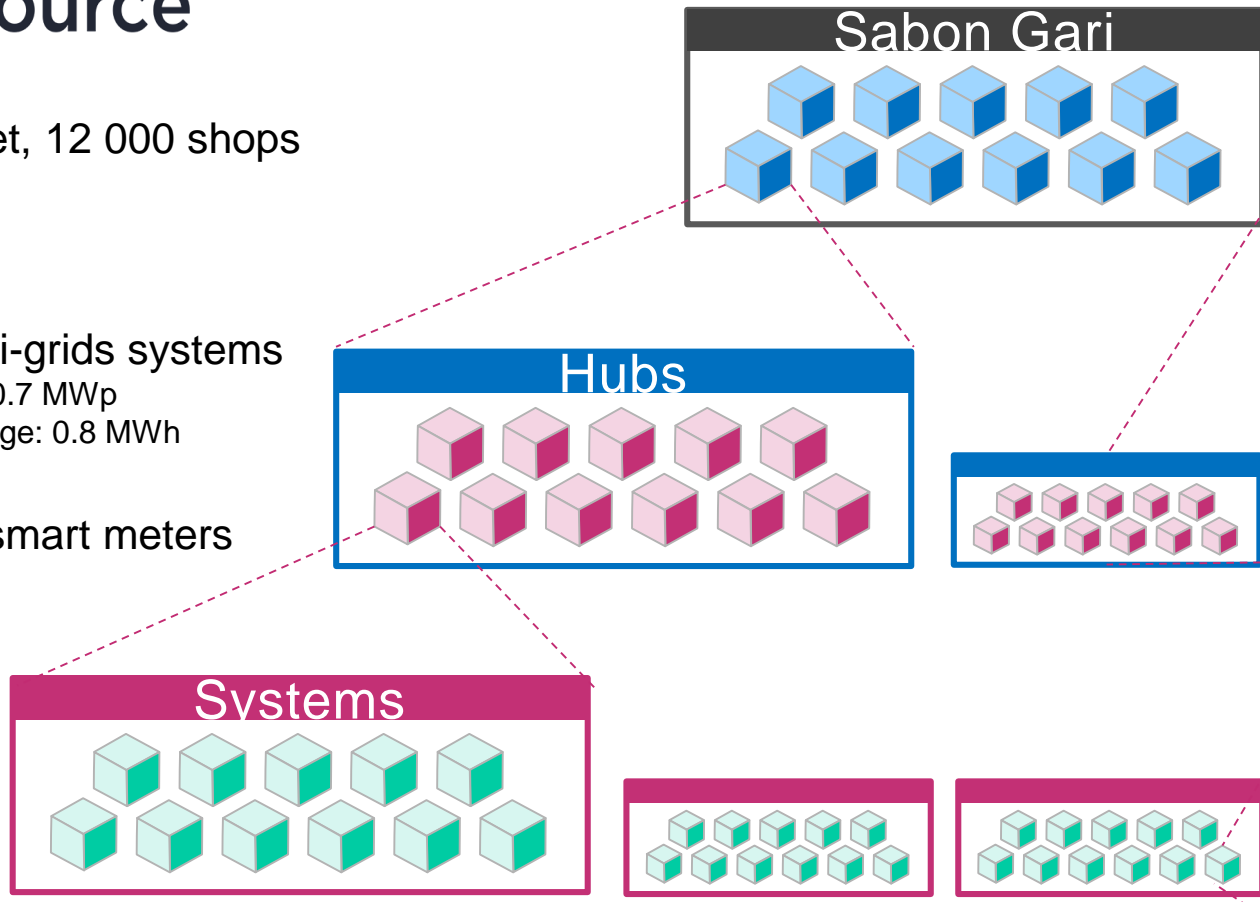


1 market, 12 000 shops

8 hubs

100 mini-grids systems  
Total PV: 0.7 MWp  
Total storage: 0.8 MWh

5000+ smart meters



It is operationally challenging to manage such a high number of decentralized off-grid systems including all connected customers

### The goal

Operate **100 mini-grids** with a total of more than **5000 smart meters** efficiently

### The challenges





## AMMP network operations center (NOC)

AMMP core

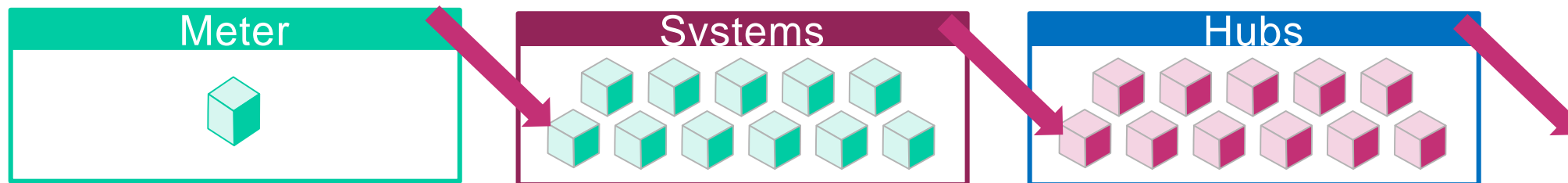
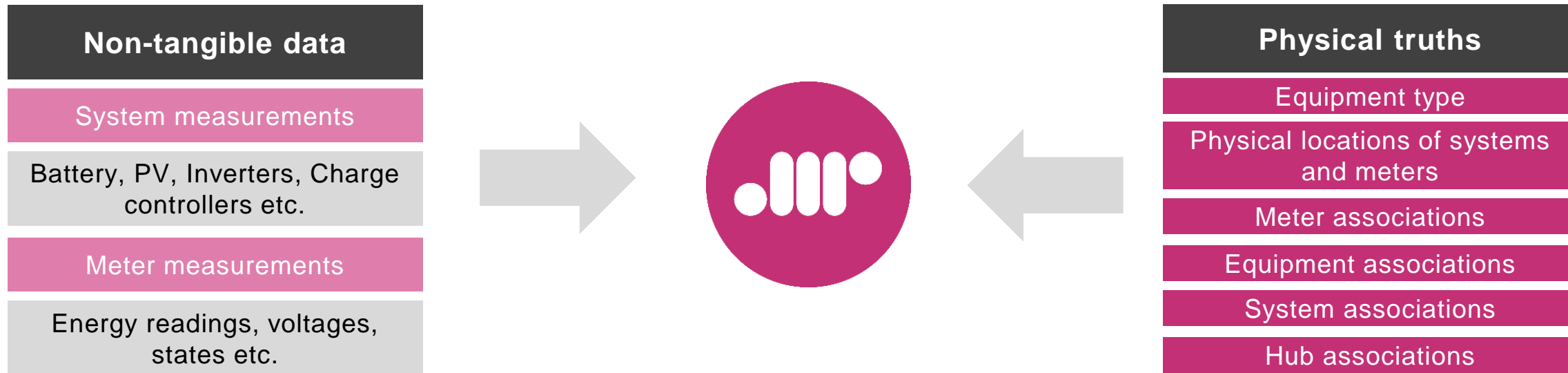


Data storage,  
analytics, and  
visualization

**Two things need to be at the core of the NOC...**

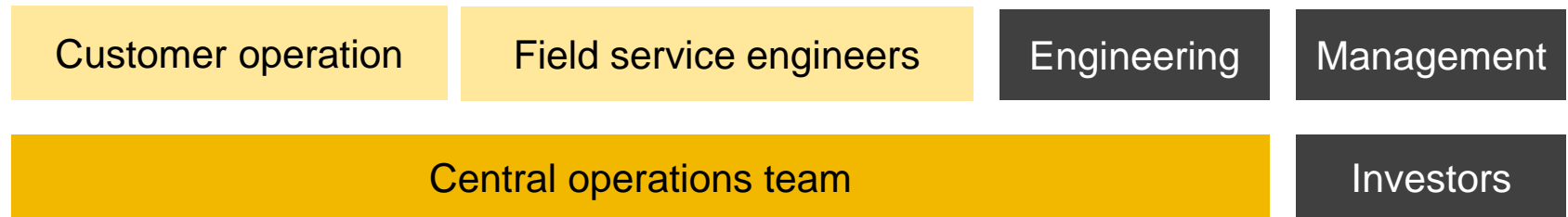
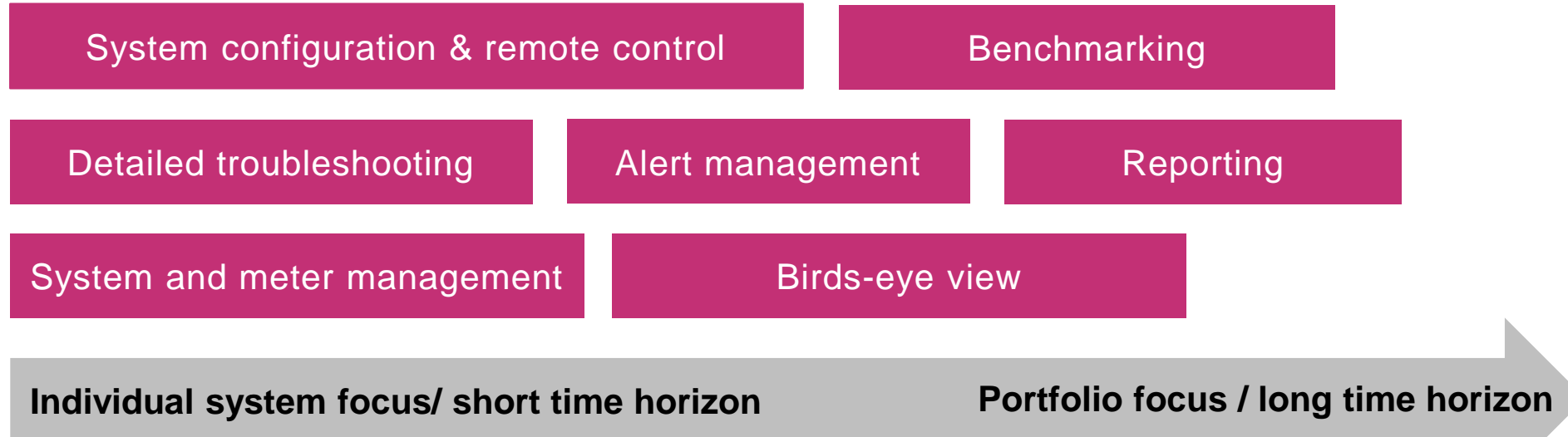


# 1. The NDC needs to combine non-tangible data acquisition with physical "ground truth"



## 2. Different stakeholders in the organization need different type of information and functionalities

### Network operations center





# Example 1

## Hierarchical dashboarding



Site filter All

AMMP 1.0 | HOW TO USE

Site Name	Generation	Battery	Output	Connection
<b>Edaiken</b> Number of hubs : 1 Number of systems : 2				# of systems with communication issue : 3
<b>Ikenne</b> Number of hubs : 1 Number of systems : 5				# of systems with communication issue : 5
<b>Iponri</b> Number of hubs : 2 Number of systems : 12	# systems with MPPT imbalance : 3	# of systems with high cell V issues : 1 # of systems with temp issues : 6 # of systems with low cell V issues : 1 # of systems with high cell V difference : 1 # of systems with high cell V difference for more than 5h : 1	# of systems ve bus state error : 2	
<b>Isikan</b> Number of hubs : 3 Number of systems : 7				# of systems with communication issue : 3





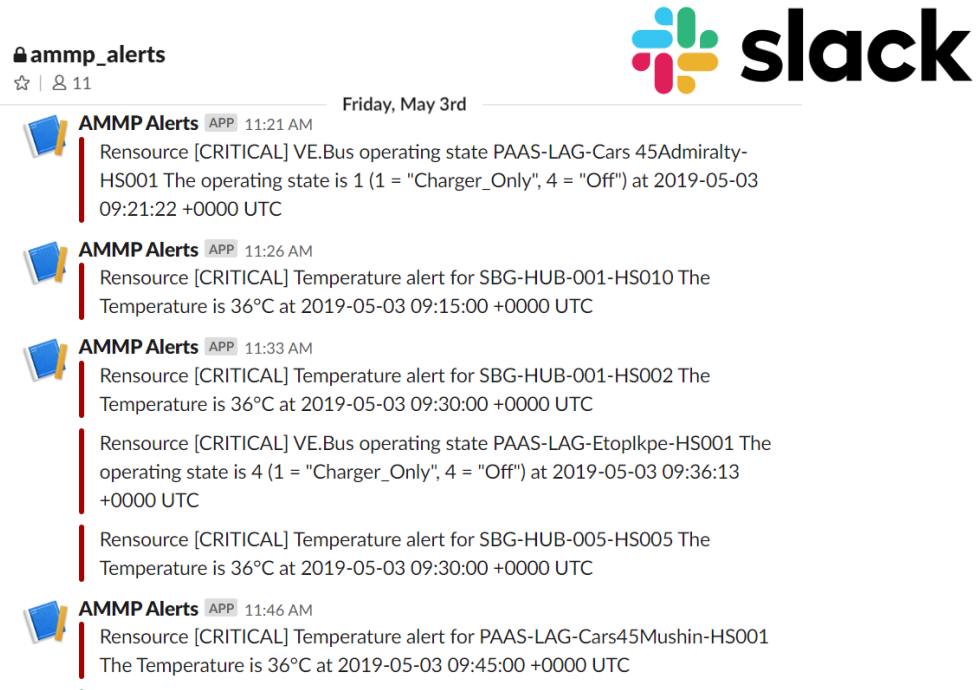
# Example 2


## Multi-channel alerts

Alert management

# Different stakeholders need different alerts

## Every alert across all the systems and meters

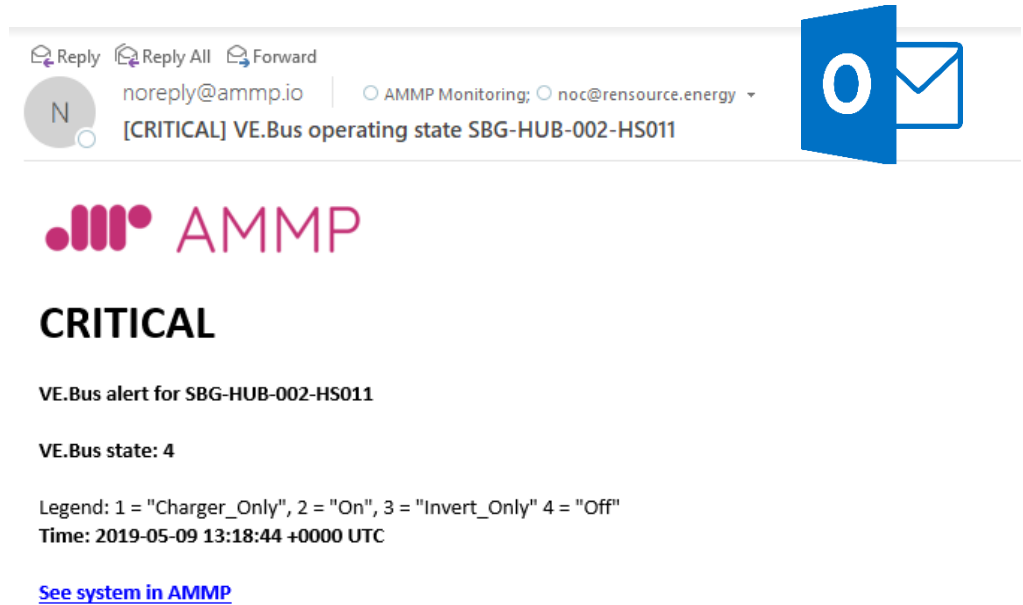


**ammp\_alerts** ☆ | 👤 11 

Friday, May 3rd

- AMMP Alerts** APP 11:21 AM  
Rensource [CRITICAL] VE.Bus operating state PAAS-LAG-Cars 45Admiralty-HS001 The operating state is 1 (1 = "Charger\_Only", 4 = "Off") at 2019-05-03 09:21:22 +0000 UTC
- AMMP Alerts** APP 11:26 AM  
Rensource [CRITICAL] Temperature alert for SBG-HUB-001-HS010 The Temperature is 36°C at 2019-05-03 09:15:00 +0000 UTC
- AMMP Alerts** APP 11:33 AM  
Rensource [CRITICAL] Temperature alert for SBG-HUB-001-HS002 The Temperature is 36°C at 2019-05-03 09:30:00 +0000 UTC  
Rensource [CRITICAL] VE.Bus operating state PAAS-LAG-Etoplkpe-HS001 The operating state is 4 (1 = "Charger\_Only", 4 = "Off") at 2019-05-03 09:36:13 +0000 UTC  
Rensource [CRITICAL] Temperature alert for SBG-HUB-005-HS005 The Temperature is 36°C at 2019-05-03 09:30:00 +0000 UTC
- AMMP Alerts** APP 11:46 AM  
Rensource [CRITICAL] Temperature alert for PAAS-LAG-Cars45Mushin-HS001 The Temperature is 36°C at 2019-05-03 09:45:00 +0000 UTC


## Custom selection of alerts won't spam inbox




Reply Reply All Forward

N noreply@ammp.io | AMMP Monitoring; noc@rensource.energy

**[CRITICAL] VE.Bus operating state SBG-HUB-002-HS011**



 AMMP

**CRITICAL**

**VE.Bus alert for SBG-HUB-002-HS011**

**VE.Bus state: 4**

Legend: 1 = "Charger\_Only", 2 = "On", 3 = "Invert\_Only" 4 = "Off"

**Time: 2019-05-09 13:18:44 +0000 UTC**

[See system in AMMP](#)

Customer operation

Field service engineers

Central operations

Engineering



# Example 3

## System management



# Asset Overview

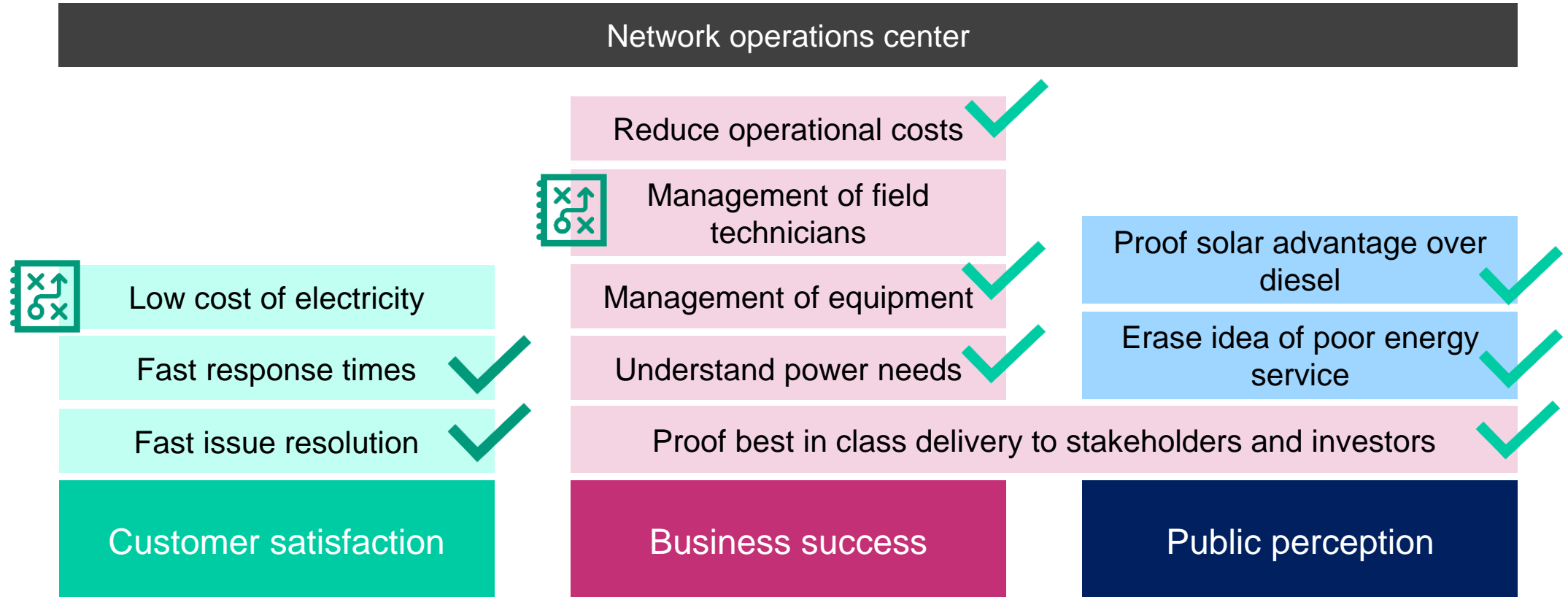
 100

[import from CSV](#) [+ create new asset](#)

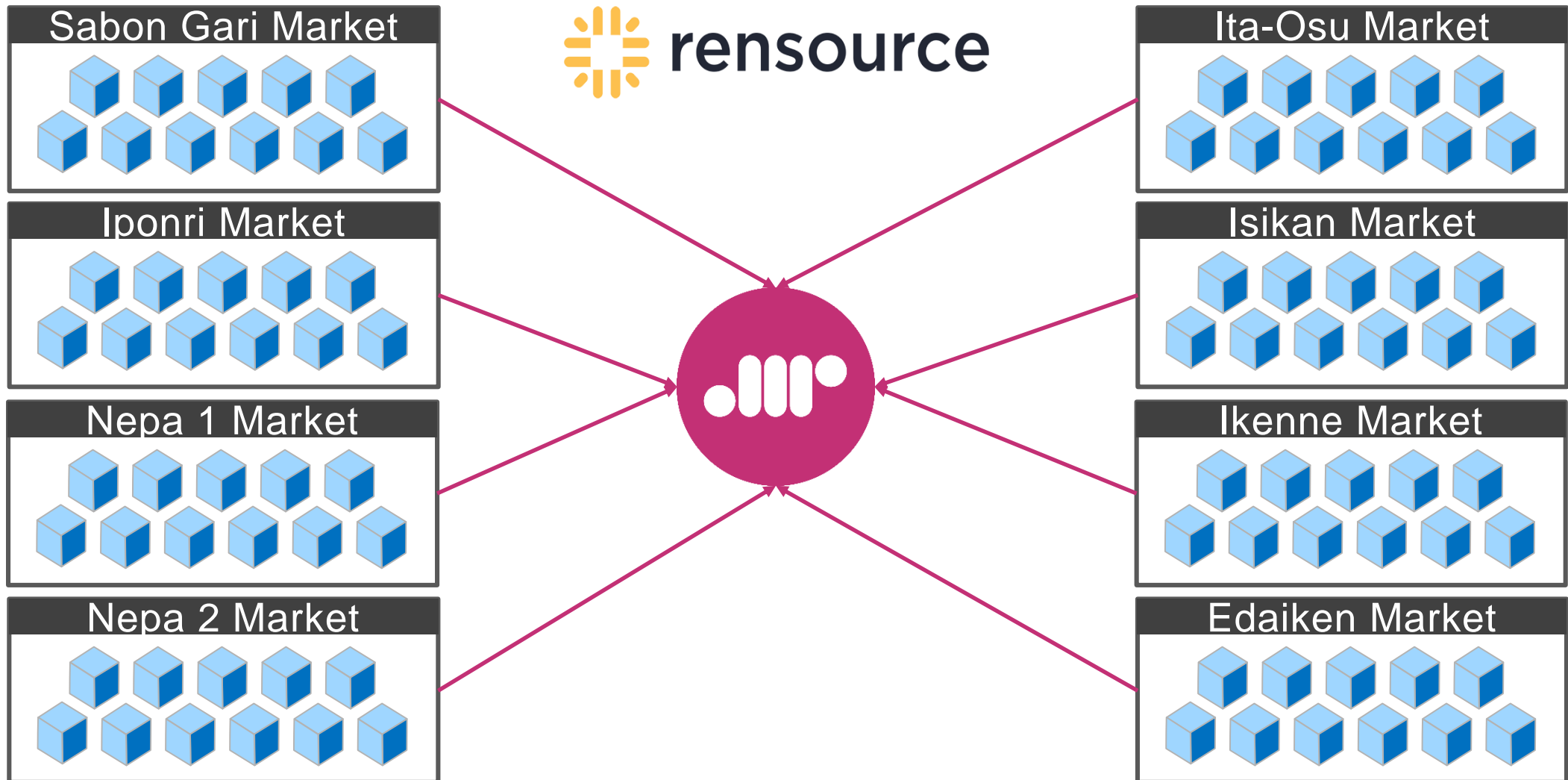
Status	Name	Last updated ↑
✓	Sabon Gari	n/a
✓	Nepa 1	n/a
✓	Gbagi	n/a
✓	Isikan	n/a
✓	Iponri	n/a
✓	Nepa 2	n/a
✓	Edaiken	n/a
✓	Ita Osu	n/a

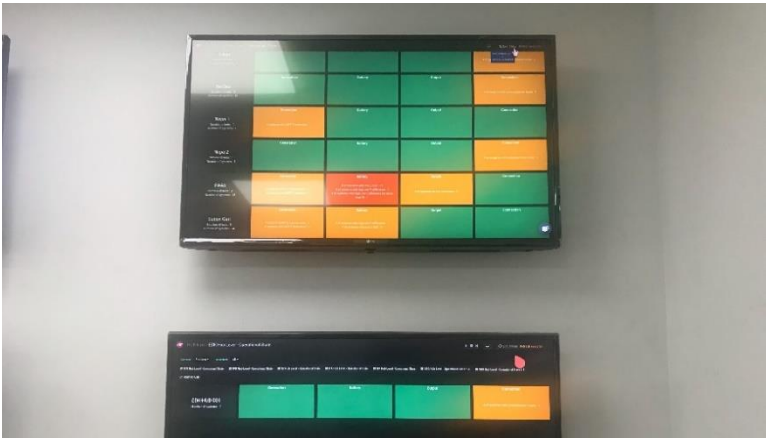


## Direct and indirect impact of network operations center on the business



Besides Sabon Gari Market, there are now in total 8 Rensource industrial clusters managed through the AMMP platform





# Rensource completely transformed Sabon Gari market into a smart solar mini-grid cluster

Before



Now



We are now providing monitoring and management for more than 350 off-grid systems across 5 continents





**Hendrik Broering**

**COO**

Hendrik.broering@ammp.io



**Prince Ojeabulu**

**Head, Network Operations Centre**

Prince.ojeabulu@rensource.energy

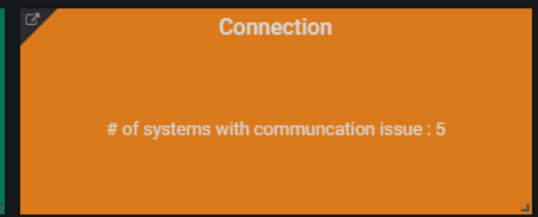
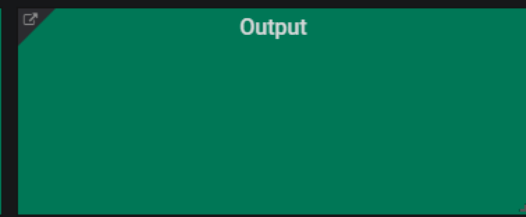
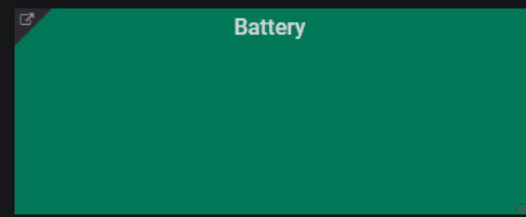
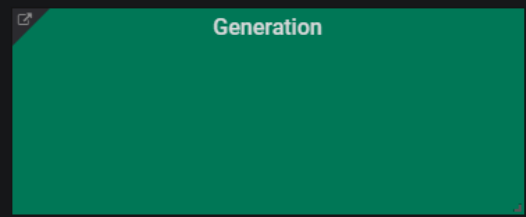
[www.ammp.io](http://www.ammp.io)

[www.rensource.energy](http://www.rensource.energy)

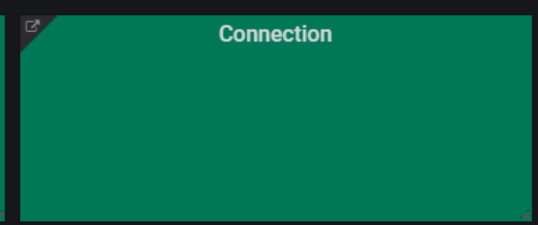
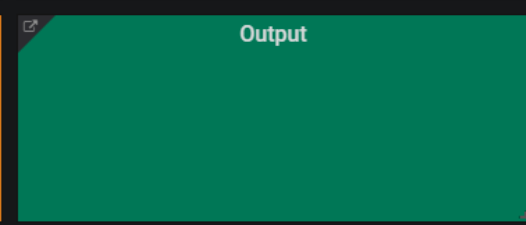
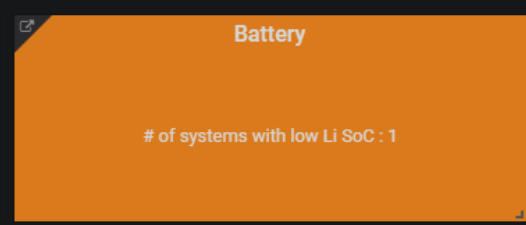
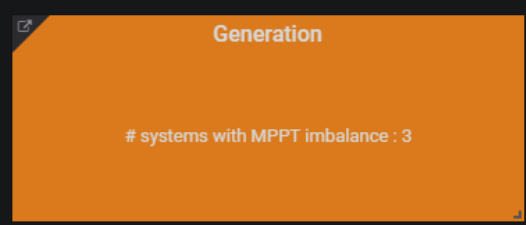
Site filter Ikenne + Iponri + Isikan + PAAS + Sabon Gari

AMMP 1.0 HOW TO USE

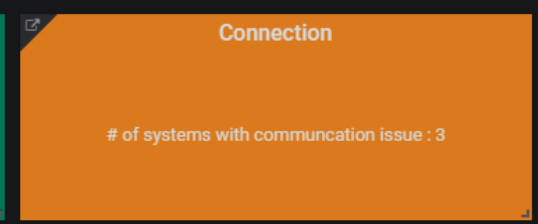
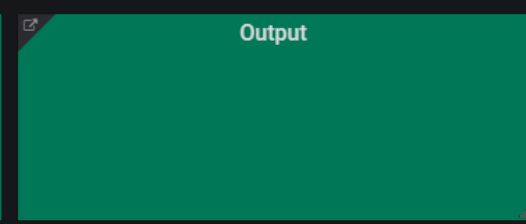
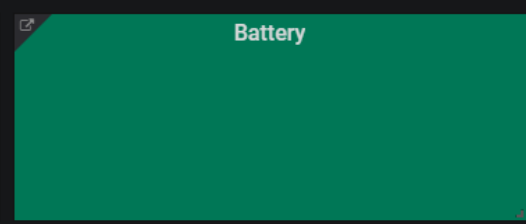
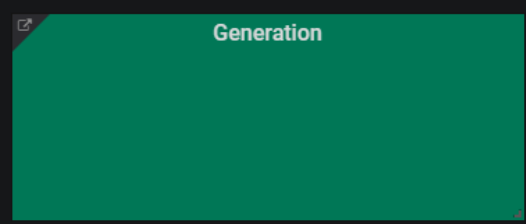
**Ikenne**  
 Number of hubs : 1  
 Number of systems : 5



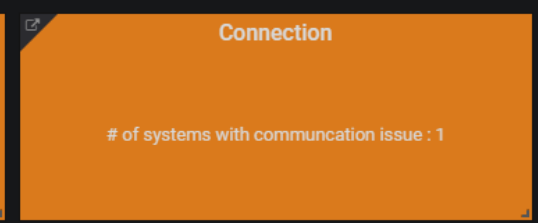
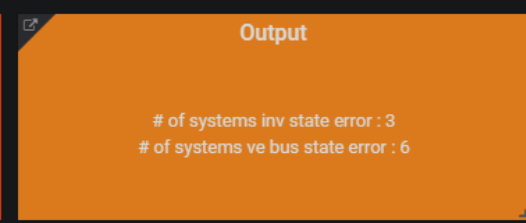
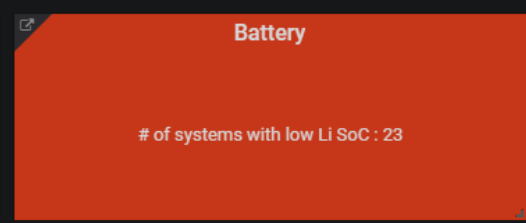
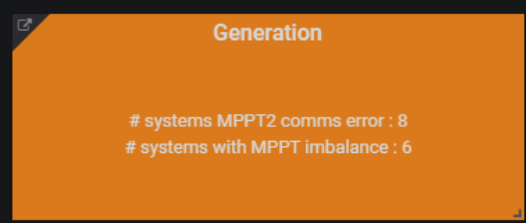
**Iponri**  
 Number of hubs : 2  
 Number of systems : 12



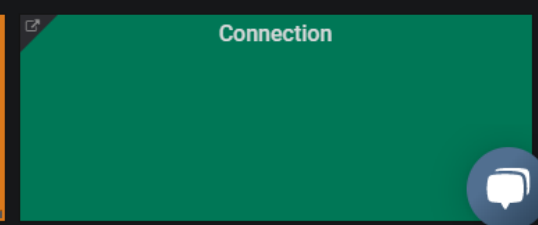
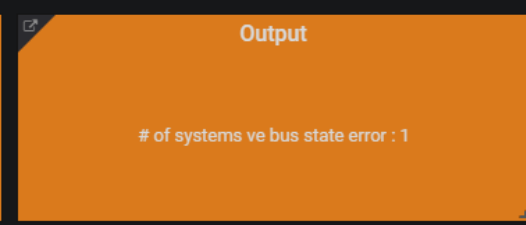
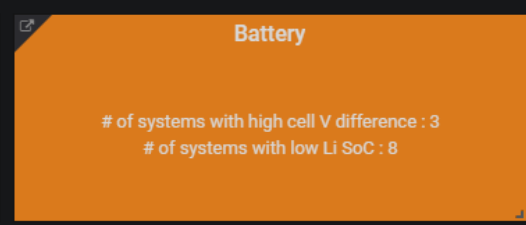
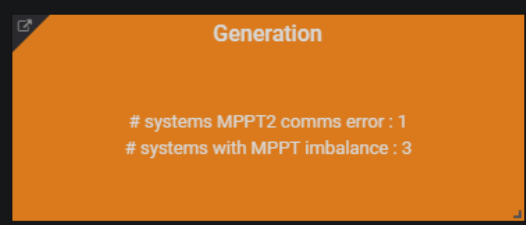
**Isikan**  
 Number of hubs : 3  
 Number of systems : 7



**PAAS**  
 Number of hubs : 3  
 Number of systems : 47



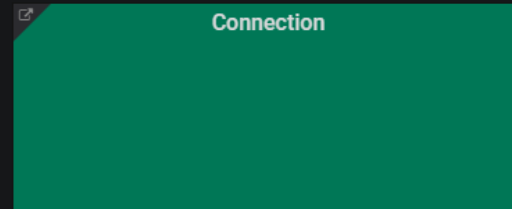
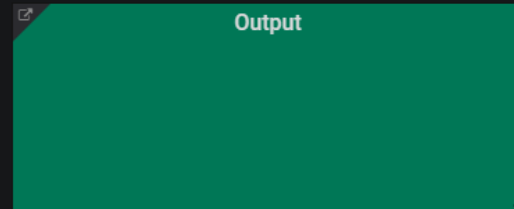
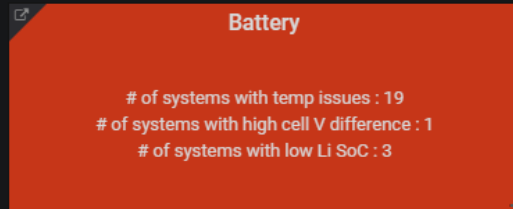
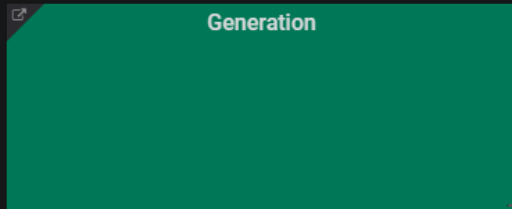
**Sabon Gari**  
 Number of hubs : 8  
 Number of systems : 74



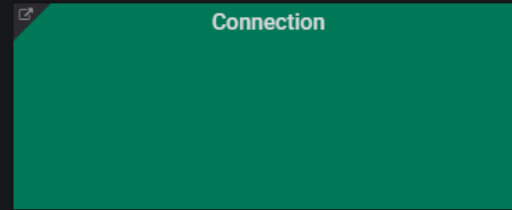
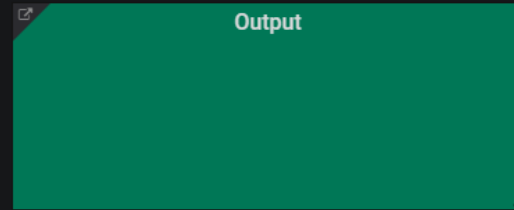
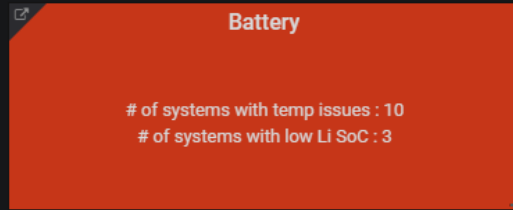
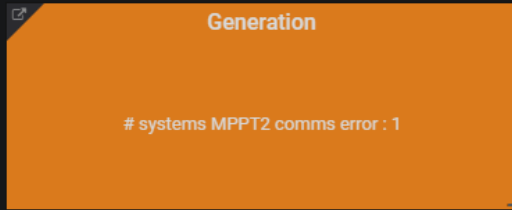
Site filter Sabon Gari Hub filter All

AMMP 1.0 HOW TO USE

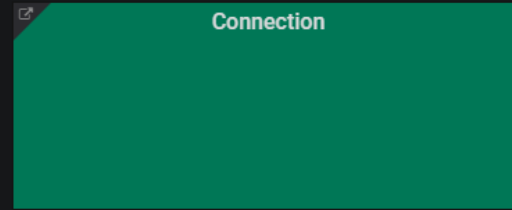
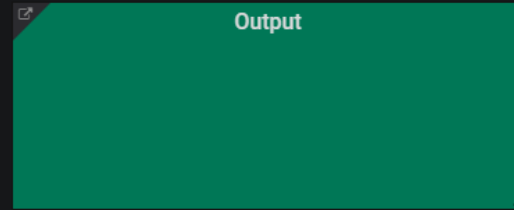
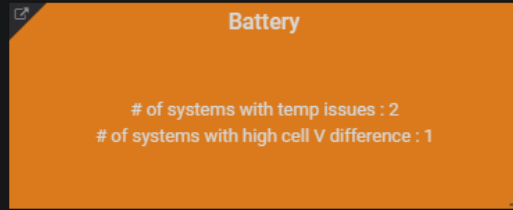
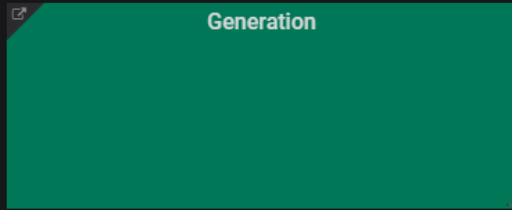
**SBG-HUB-001**  
Number of systems : 19



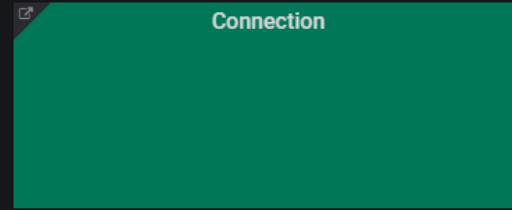
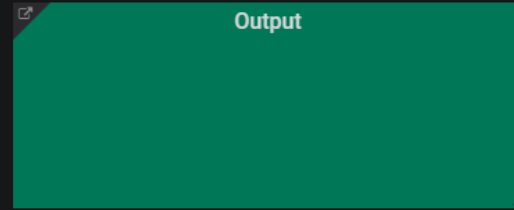
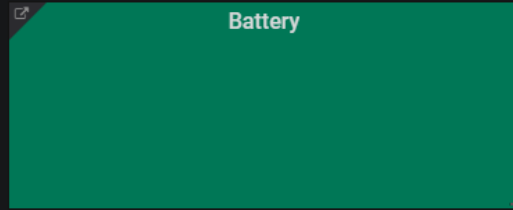
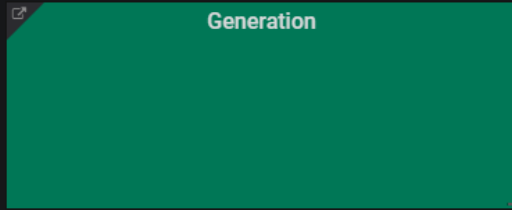
**SBG-HUB-002**  
Number of systems : 15



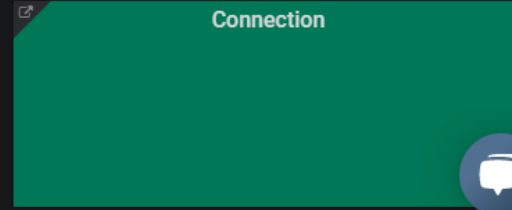
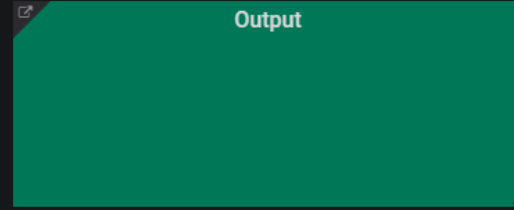
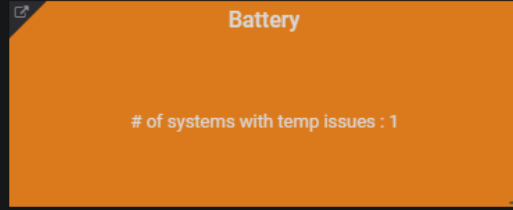
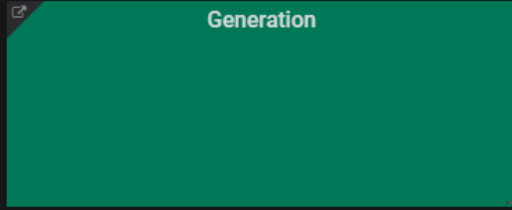
**SBG-HUB-003**  
Number of systems : 6



**SBG-HUB-004**  
Number of systems : 7



**SBG-HUB-005**  
Number of systems : 6





**SBG-HUB-005-HS001**  
IMEI : 865691032302374  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 3

**Battery**  
Current li voltage : 13.12 V  
Temperature too high : 33 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 1.08 min  
Strength last signal (RSSI) : -53 dB

**SBG-HUB-005-HS002**  
IMEI : 865691034348961  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 3

**Battery**  
Current li voltage : 13.12 V  
Temperature too high : 32 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 8.29 min  
Strength last signal (RSSI) : -53 dB

**SBG-HUB-005-HS003**  
IMEI : 865691035519446  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 0

**Battery**  
Current li voltage : 13.18 V  
Temperature too high : 34 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 11.58 min  
Strength last signal (RSSI) : -63 dB

**SBG-HUB-005-HS004**  
IMEI : 865691032302366  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 3

**Battery**  
Current li voltage : 13.16 V  
Temperature too high : 32 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 12.47 min  
Strength last signal (RSSI) : -63 dB

**SBG-HUB-005-HS005**  
IMEI : 865691034403956  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 0

**Battery**  
Current li voltage : 13.15 V  
Temperature too high : 36 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 3.35 min  
Strength last signal (RSSI) : -57 dB

**SBG-HUB-005-HS006**  
IMEI : 865691034384404  
Box type : HS10000

**Generation**  
Current state MPPT1: : 0  
Current state MPPT2: : 3

**Battery**  
Current li voltage : 13.17 V  
Temperature too high : 35 °C

**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 14.01 min  
Strength last signal (RSSI) : -51 dB

**SBG-HUB-006-HS001**  
IMEI : 865691032416489  
Box type : HS10000

**Generation**  
Current state MPPT1: : 3  
Current state MPPT2: : 3

**Battery**  
Current li voltage : 13.13 V  
Temperature too high : 33 °C

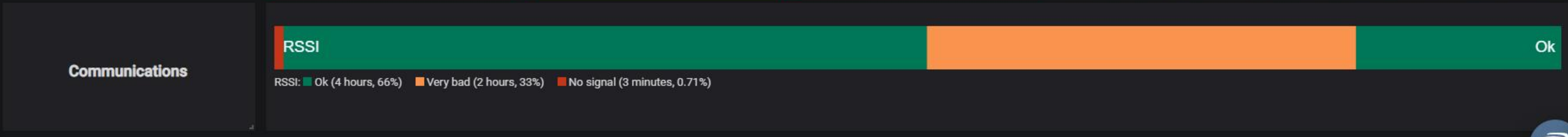
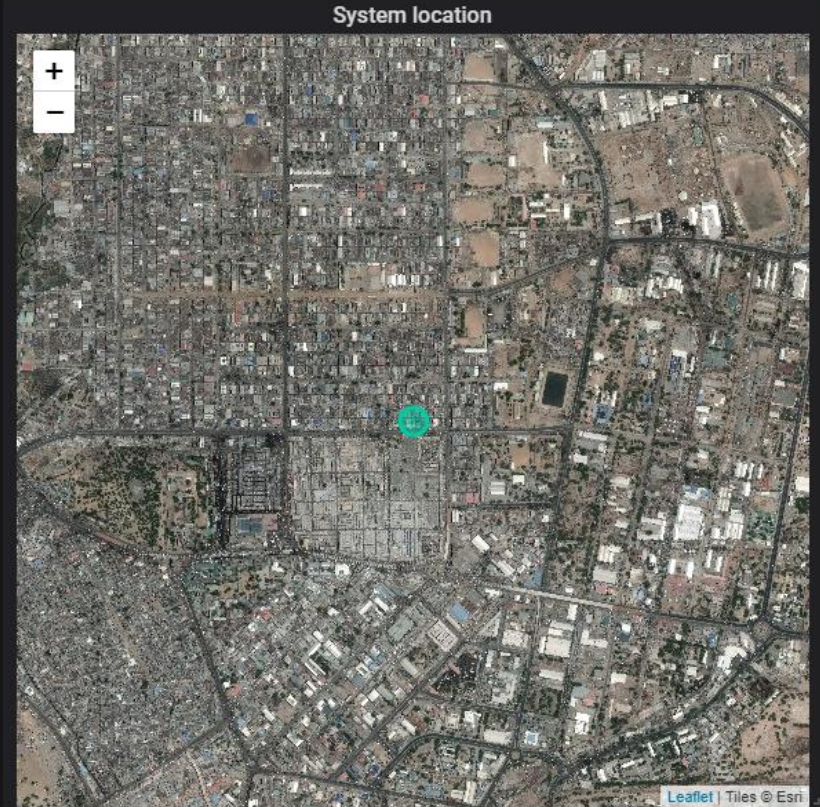
**Output**  
Current inverter state : 40  
Current vebus state : 2

**Connection**  
Last connection : 41.08 s  
Strength last signal (RSSI) : -53 dB

System filter SBG-HUB-004-HS002 ▾

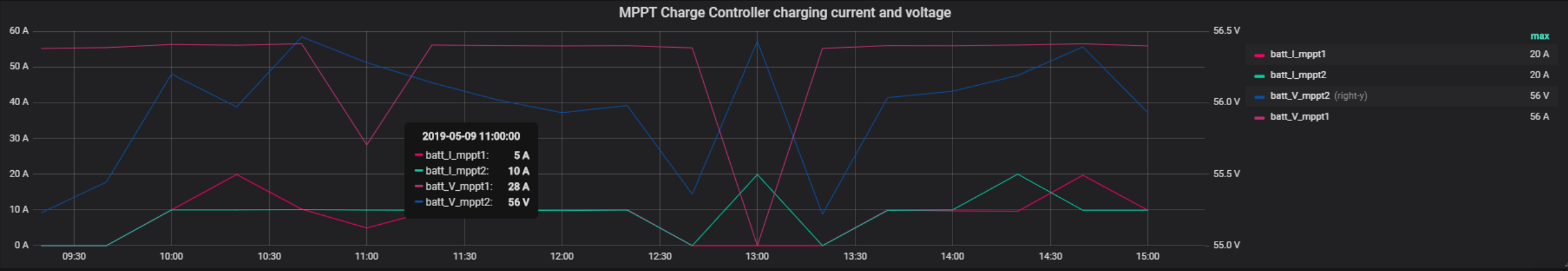
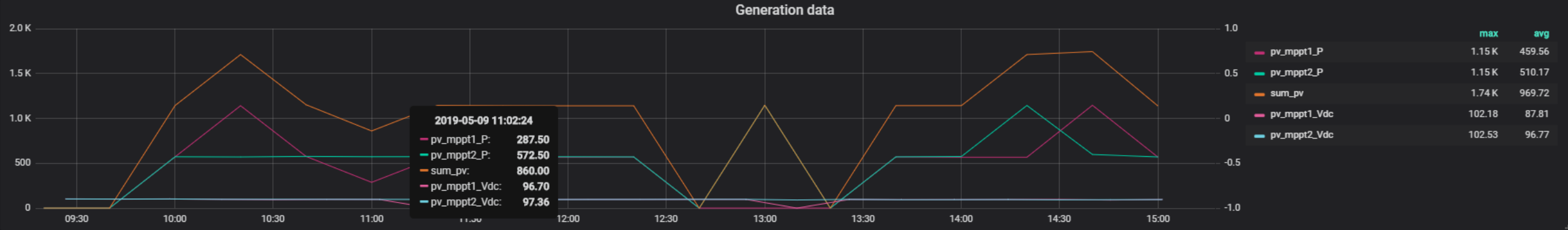
☰ AMMP 1.0 🔗 HOW TO USE

System Info	Generation	Battery	Output
<p>SBG-HUB-004-HS002</p> <p>IMEI : 865691032815524</p>	<p>MPPT communication</p> <p>MPPT 1 last connection : 5 seconds MPPT 2 last connection : 5 seconds</p>	<p>Battery SoC</p> <p>Minimum Lithium SoC : 99%</p>	<p>Battery inverter state</p>
<p>Box type : HS10000</p> <p>BOS Setting : 1-3-1-1-200-0-2-9-0-24</p>	<p>MPPT error state</p>	<p>Battery cell voltage</p> <p>Maximum voltage difference : 0.04 V</p>	<p>VE Bus state</p>
<p>BOS Firmware : 1.05</p> <p>Li Config : 2P4S</p>	<p>MPPT energy balance</p>	<p>Temperature</p> <p>Temperature : 35 °C Temperature too high</p>	<p>Other states</p>



> Weather forecast


















# Asset Overview

Sabon Gari

 100

 import from CSV

 create new asset

Status	Name	Company	Last updated ↓
	SBG-HUB-004-HS001	Rensource	6 months ago
	SBG-HUB-004-HS004	Rensource	6 months ago
	SBG-HUB-004-HS006	Rensource	6 months ago
	SBG-HUB-005-HS006	Rensource	6 months ago
	SBG-HUB-005-HS001	Rensource	6 months ago
	SBG-HUB-005-HS002	Rensource	6 months ago
	SBG-HUB-005-HS003	Rensource	6 months ago
	SBG-HUB-005-HS004	Rensource	6 months ago
	SBG-HUB-005-HS005	Rensource	6 months ago
	SBG-HUB-004-HS003	Rensource	6 months ago



[Assets](#) / SBG-HUB-002-HS009

# SBG-HUB-002-HS009

Asset



### Name

SBG-HUB-002-HS009

### Company

Rensource

### Associated meters

12 [show list](#)



Active

### Coordinates

**12.014600**  
LATITUDE

**8.534200**  
LONGITUDE

[View on Google Maps](#)

### Associated Edge Nodes

1 [hide list](#)  
• 865691035516244

### Created

n/a

### Last Updated

5 months ago

### Tags

- hs\_box\_type** HS500
- hub\_name** SBG-HUB-002
- serial\_no** 170108
- site\_name** Sabon Gari
- site\_ref** SBG

### Attachments

[Files](#) [Upload](#)

None