House Comprehensive IoT Energy Management Solution

Girds prepaid monitoring&billing&control, Solar PV monitoring&billing, PCS&BMS discharge&charge monitoring, IoT based, Cloud based

Ver. Date: March, 14th 2024

Acrel Co., Ltd.

No.253 Yulv Road,Jiading District,Shanghai,China

2024/03/14 Ver.

Acrel Energy Management Solution

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1. Scenario Preset

(1) This solution request a IoT based cloud monitoring for 8000 residential houses power system with solar PV and energy storage system [BMS&PCS] so that we could realize online&remote monitoring&billing&control for all 8000 houses centralizedly via IoT system.

(2) For each house, there are 3 monitoring points:

Grids side monitoring [also need prepaid billing and control]

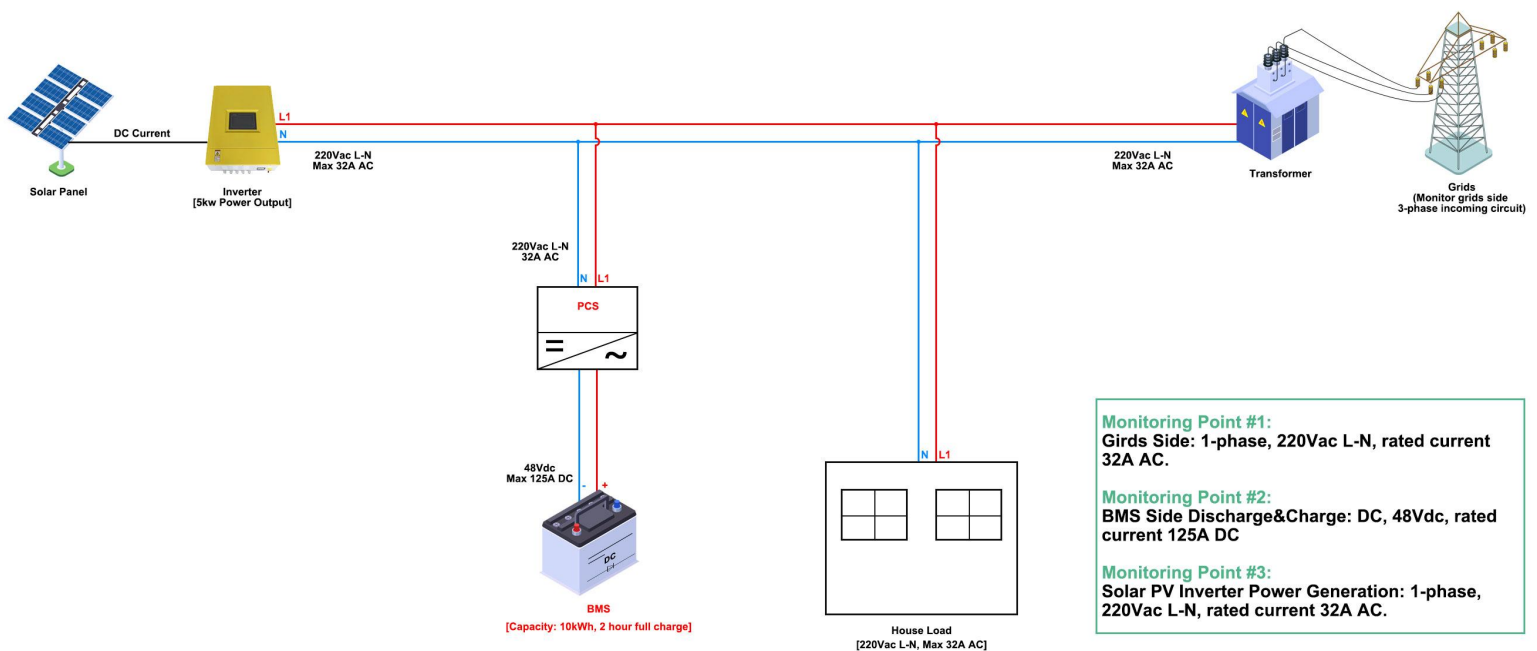Rated Current: Max 32A AC; Rated Voltage: 220Vac L-N, Type: 1-phase Circuit

② Solar PV inverter energy Generation Monitoringÿ

Rated Current: Max 32A AC; Rated Voltage: 220Vac L-N, Type: 1-phase Circuit

BMS system charger&discharge energy monitoring

Rated Current: Max 125A AC; Rated Voltage: 48Vdc, Type: DC Circuit

(3) For the places that we gonna install IoT gateway, it's covered by stable 4G signal.

Monitoring Point #1:
Girds Side: 1-phase, 220Vac L-N, rated current 32A AC.

Monitoring Point #2:
BMS Side Discharge&Charge: DC, 48Vdc, rated current 125A DC

Monitoring Point #3:
Solar PV Inverter Power Generation: 1-phase, 220Vac L-N, rated current 32A AC.

(1) Scenario Preset

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2. Devices Deployment Plan [Take 1 House for example]

House#1 - Overall Communications #1-1:
- **1* ANET-1E2S-4G 4G IoT Gateway** [For communicate with ADL100-EYNK energy meter and Solar &PCS inverter and further interact with upsteam Acrel IoT Energy Management System and Inverter Operation Maintanance System]
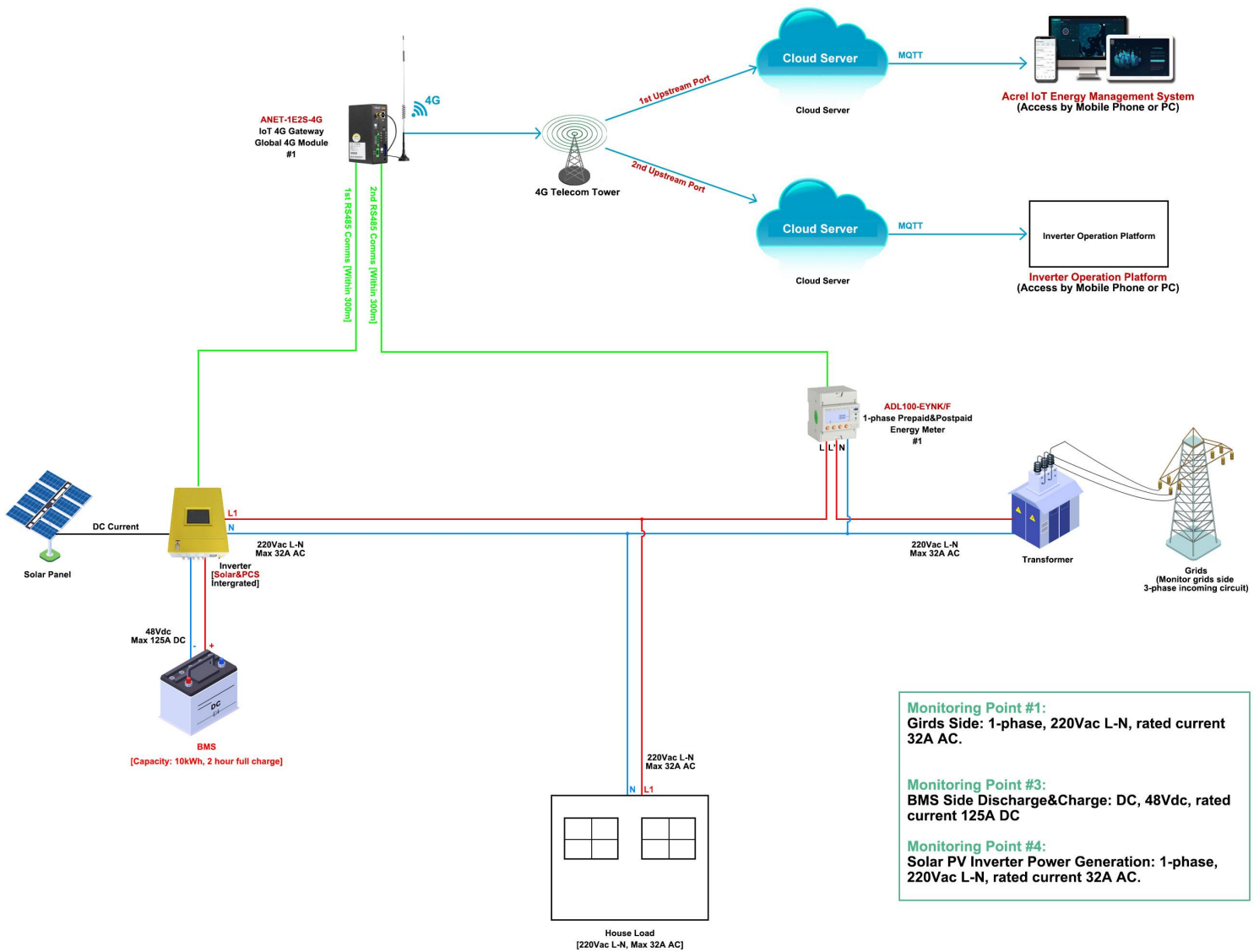
House#1 - Grids Side #1-1:
- **1* ADL100-EYNK/F 1-phase Prepaid&Postpaid Energy Meter** [For monitoring&billing&control the power consumption of house's loads sourced from grids]

House#1 - Solar PV Inverter Side #1-2:
- Data collected by Inverter

House#1 - BMS System Side #1-3:
- Data collected by inverter

(1) Device Deployment Plan

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3. Communication Structure&Logic [Both Acrel Hardware&Software]

(1) 4G Communication could be served as one of the final data upstream methods by sending the data to cloud server deployed in Internet so that Acrel IoT System could be interact with these data collected by bottom metering devices like Energy Meter

(2) Between ANET-1E2S-4G and ADL100-EYNK prepaid&postpaid energy meter and 3rd party Solar&PCS inverter we are using RS485 Comms. within 300m [via RS485 Port & MODBUS-RTU protocol].

(3) Between ANET-1E2S-4G IoT 4G Gateway and Acrel IoT Energy Management System or Inverter Operation&Maintanence System, we are using 4G Communications based on MQTT protocol.

System

Acrel IoT Energy Management System

Inverter Operation Platform

Server

Cloud Server

MQTT **Cloud Server** MQTT

Cloud Server

MQTT **Cloud Server** MQTT

4G

4G Telecom Tower

4G **MODBUS-TCP**
MQTT

Smart Gateway

ANET-1E2S-4G
4G IoT Smart Gateway

RS485 MODBUS-RTU

Metering Devices

ADL100-EYNK
1-phase Prepaid&Postpaid Energy Meter

Inverter
Solar&PCS Integrated

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4. Hardware Devices Overview

Model 1: ADL100-EYNK/F 1-phase Prepaid& Postpaid Energy Meter

- Communicaiton: RS485[MODBUS-RTU]

- Monitoring: Up to 1 circuits [AC Metering]

- Control Mode: Prepaid&Postpaid Control Model

- Multi-tariff/TOU Function [optional]: 4 tariff rates and etc.

- Rated Voltage: 220~264Vac L-N

- Rated Current: 10(60)A AC

- Certificate&Standard: CE

1-phase **Remote Control**
Prepaid&Postpaid **MODBUS-RTU**

Model 1: ANET-1E2S-4G IoT 4G Gateway

- Upstream Comms.: 4G [MQTT protocol]

- Downstream Comms: 2 -way RS485 [MODBUS-RTU protocol]

- Data Storage: Supports SD/MMC memory cards of not less than 512 M

- Power Supply: 85~265Vac [<10W]

- Certificate&Standard: CE

IoT Gateway **4G/WiFi/Ethernet**
MQTT&MODBUS **RS485 Downstream**

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5. GIS Analyzing

(1) Customer side could manage all the project room/buildings position all over the country.

(2) Customer side could manage all devices that connected to Acrel Cloud Prepaid&Postpaid System to know where these devices are located & which room/buidling was monitored by this devices.

(3) Customer side could receive all kinds of alarm including devices off-line alarm for example for checking the working status of the devices in countrywide project.
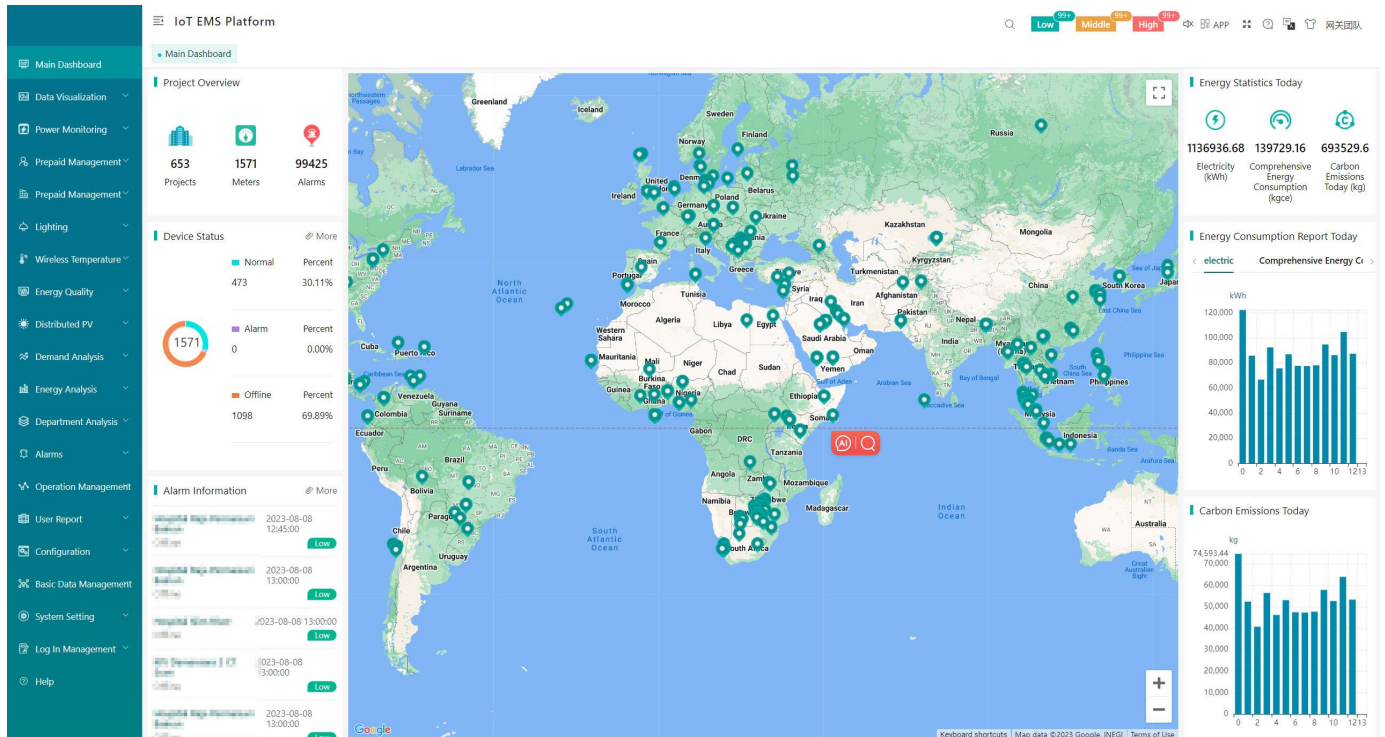
(1) GIS Analysing and Command Interface

(2) Write in Project/Building Logistic Location Information

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Acrel®	Management Solution	E-mail: loki@acrel.cn
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5. Role setting and Sub account creation

(1) Operator could set the system permission level of each role [administrator, end power user for example]

(2) Sub Account Creation: Administrator could create sub account for their end power user and allow them to only check the energy and billing data of their own house. Also, could ban the permission of end power user for changing everything.
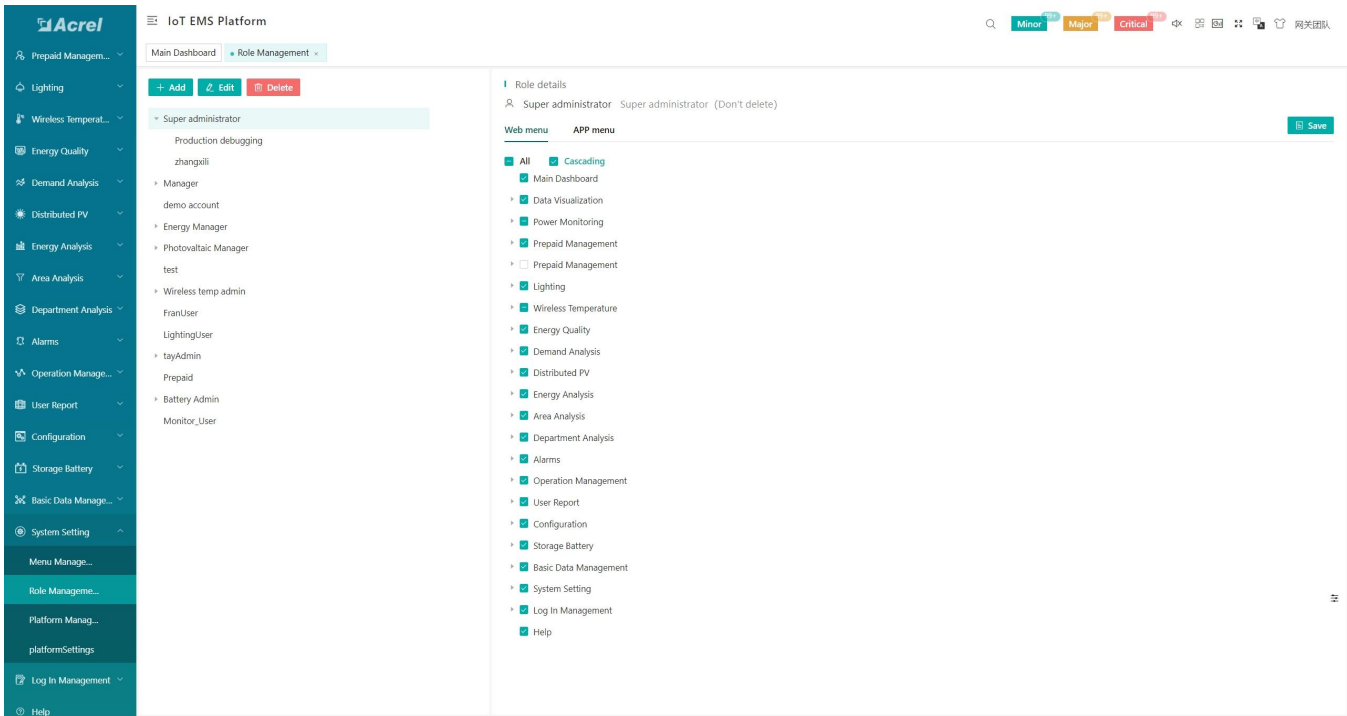
(1) Role and Permission setting
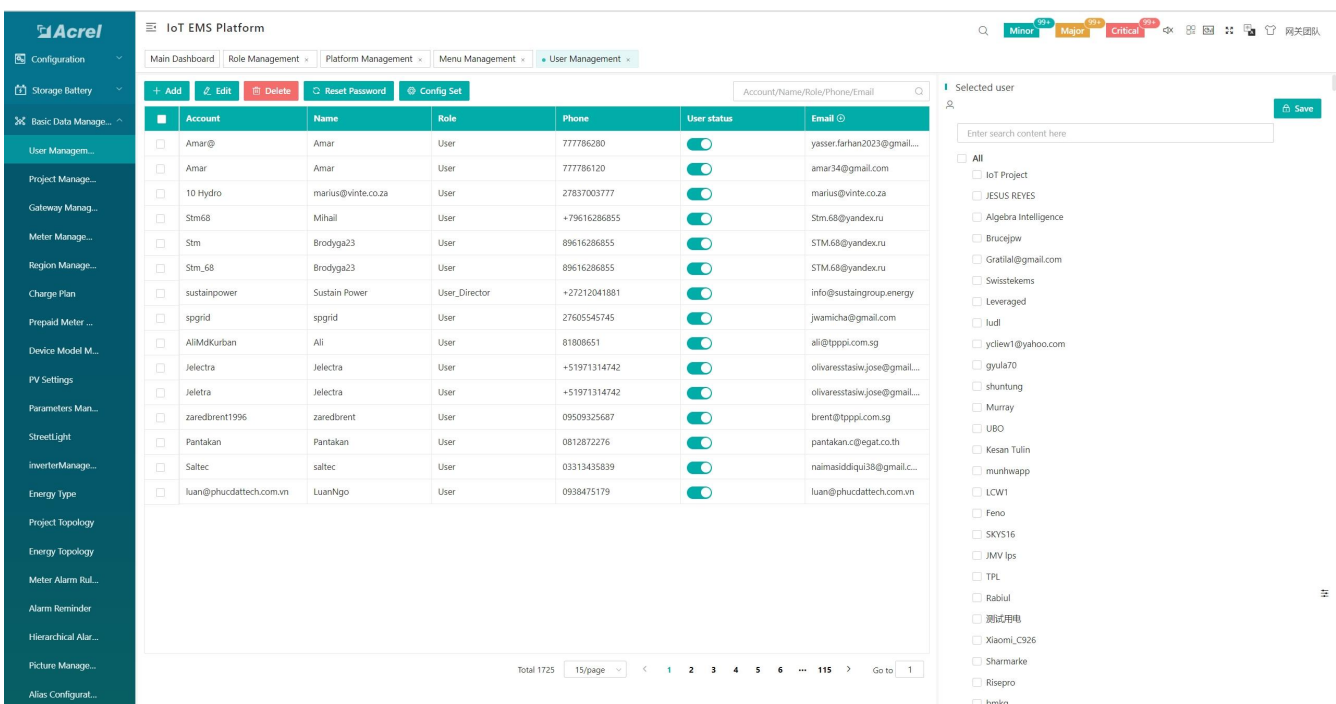
(2) Sub account creation and management

6. Solar PV Monitoring Part

(1) Solar PV project overview: For checking the overall power generation, benefit anc etc of Solar PV deployed all over the country. [Solar Power Generation data will be collected by Solar Invertere and further issued to ANET-1E2S-4G gateway for a further 4G upstreaming]

(2) Solar PV monitoring: For checking the solar power generation, house loads overall power consumption sourced from both Solar PV/BMS and Grids, house loads partial power consumption sourced from Grids.
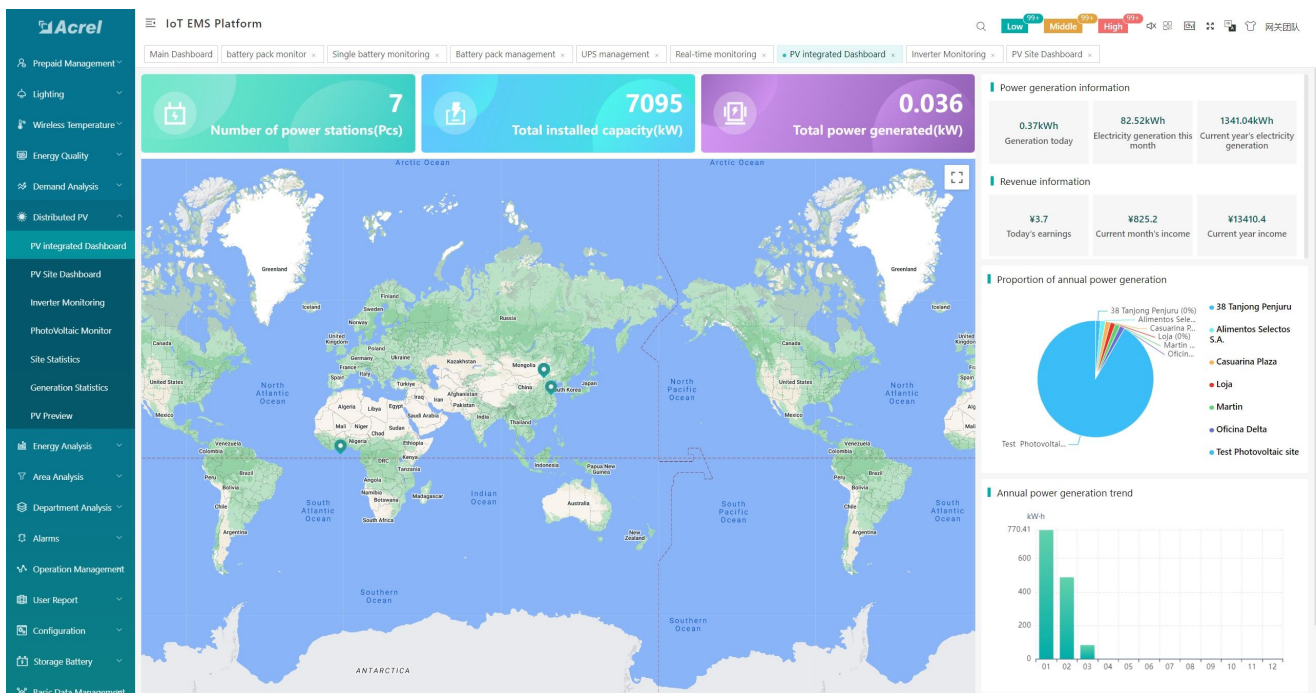
(1) Solar PV Project Overview

(2) Solar Site Monitoring Overview

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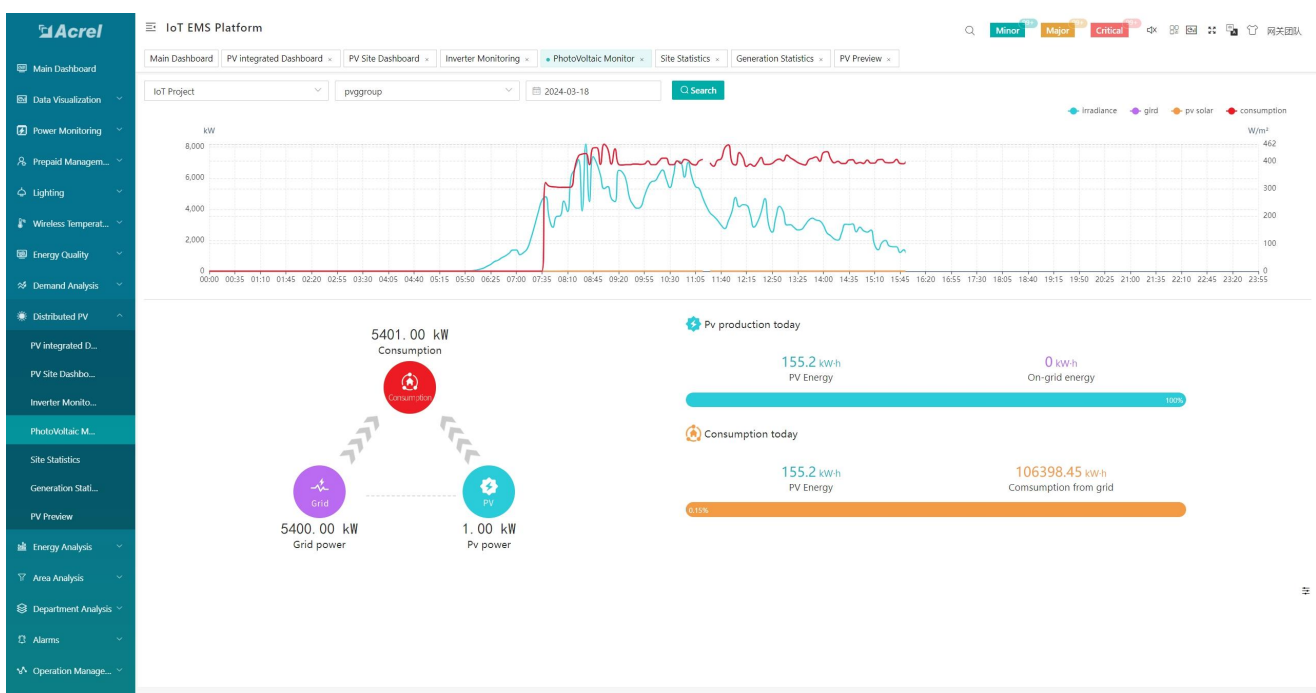
6. Solar PV Monitoring Part

(3) Solar PV inverter overview: For checking the overall solar PV devices list, model, daily power generation, real-time power generation and etc.

(4) Solar PV inverter detail monitoring: For checking the solar inverter power generation [daily, monthly, yearly, life circle], annual utilization hours, basic electricity parameter [voltage, current, power, frequency and etc], power generation trend and curves, etc.
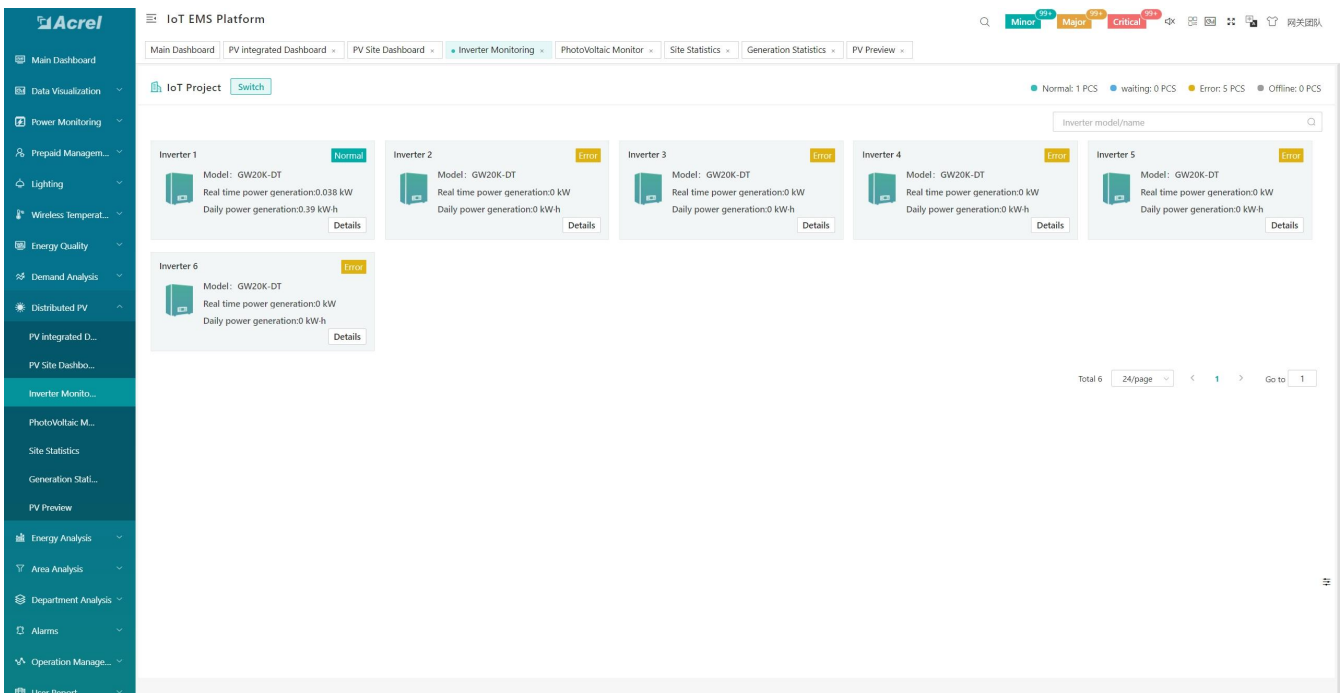
(3) Solar PV Inverter List

(4) Solar Site Monitoring Overview

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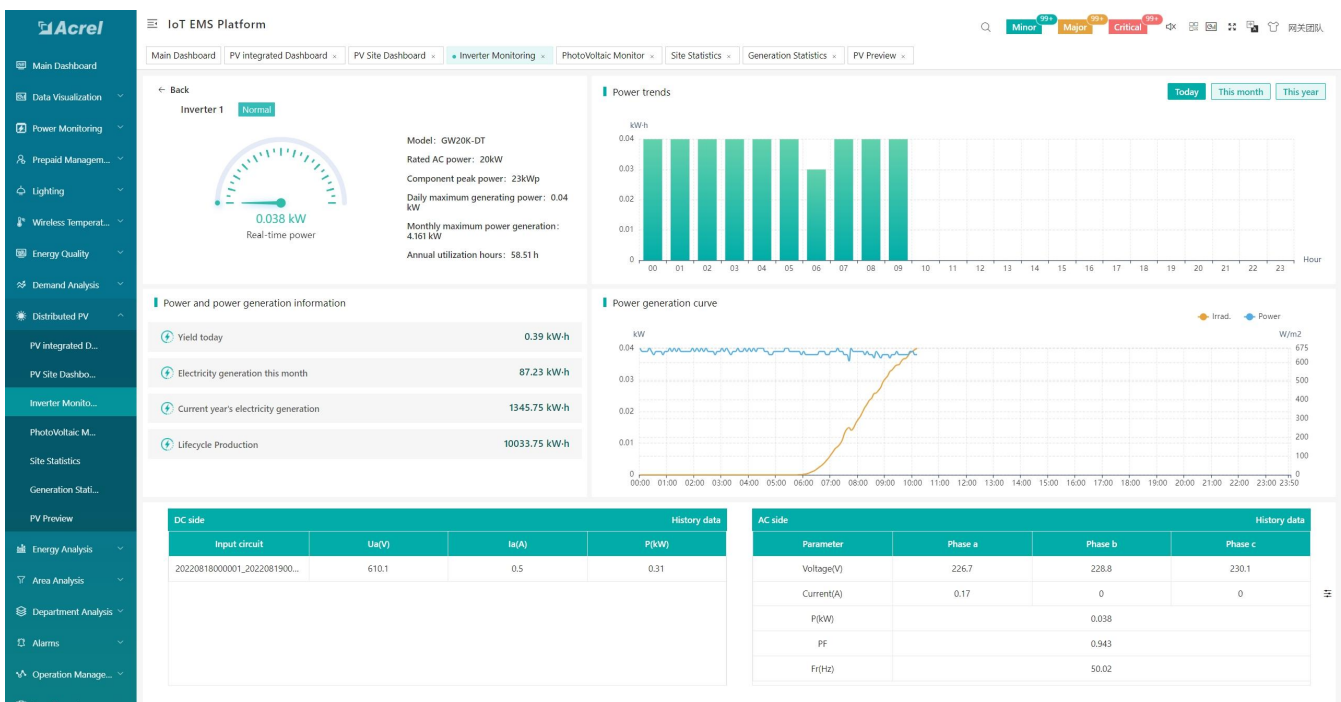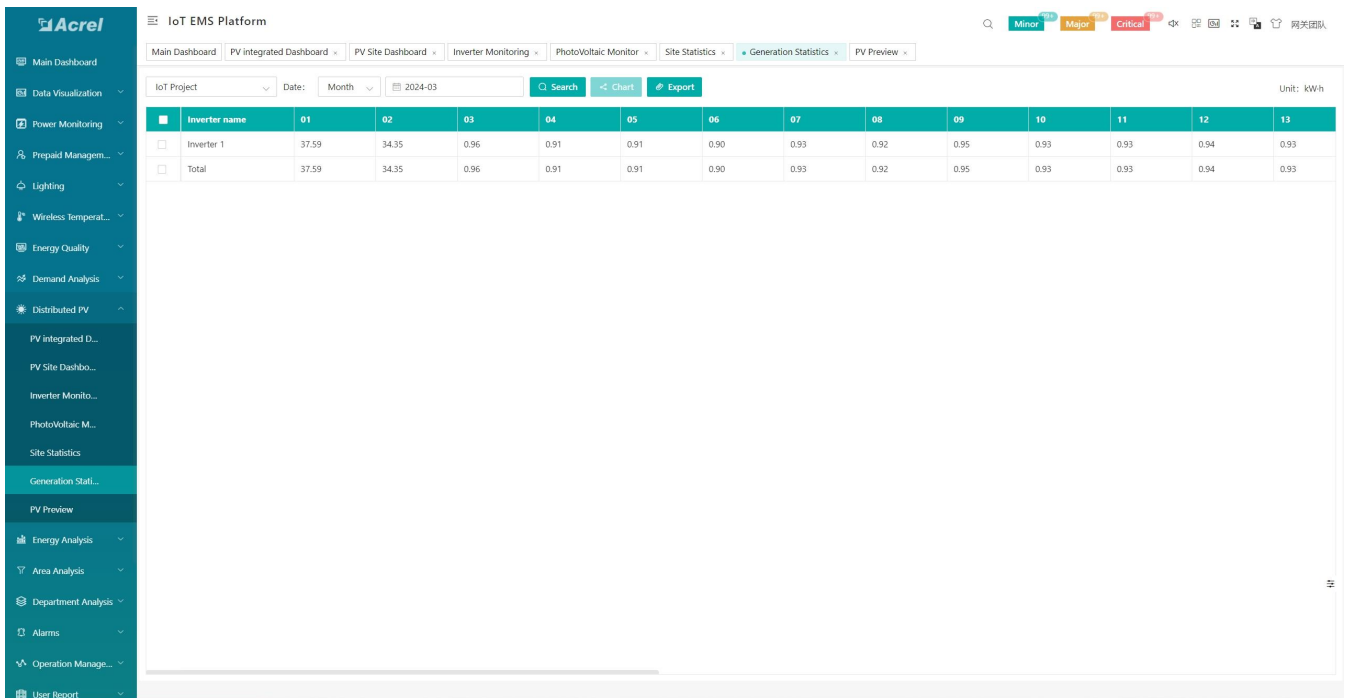
6. Solar PV Monitoring Part

(5) Solar PV inverter Power Generation Report: For checking the daily, monthly, yearly power generation report of certain/all inverters.
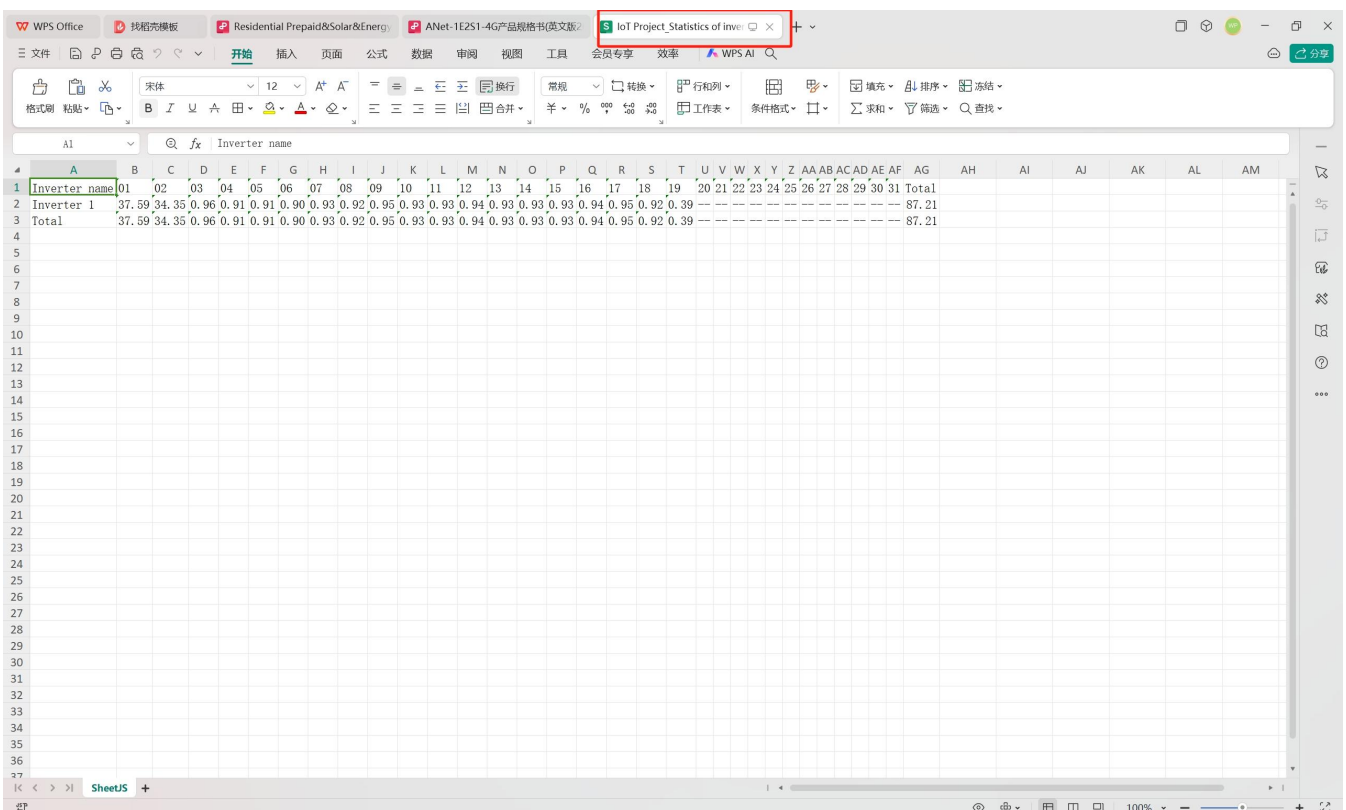
(6) Solar PV inverter Power Generation Report Export: The power generation report of solar PV inverter could be exported into Excel format file for further analyzing and storage.
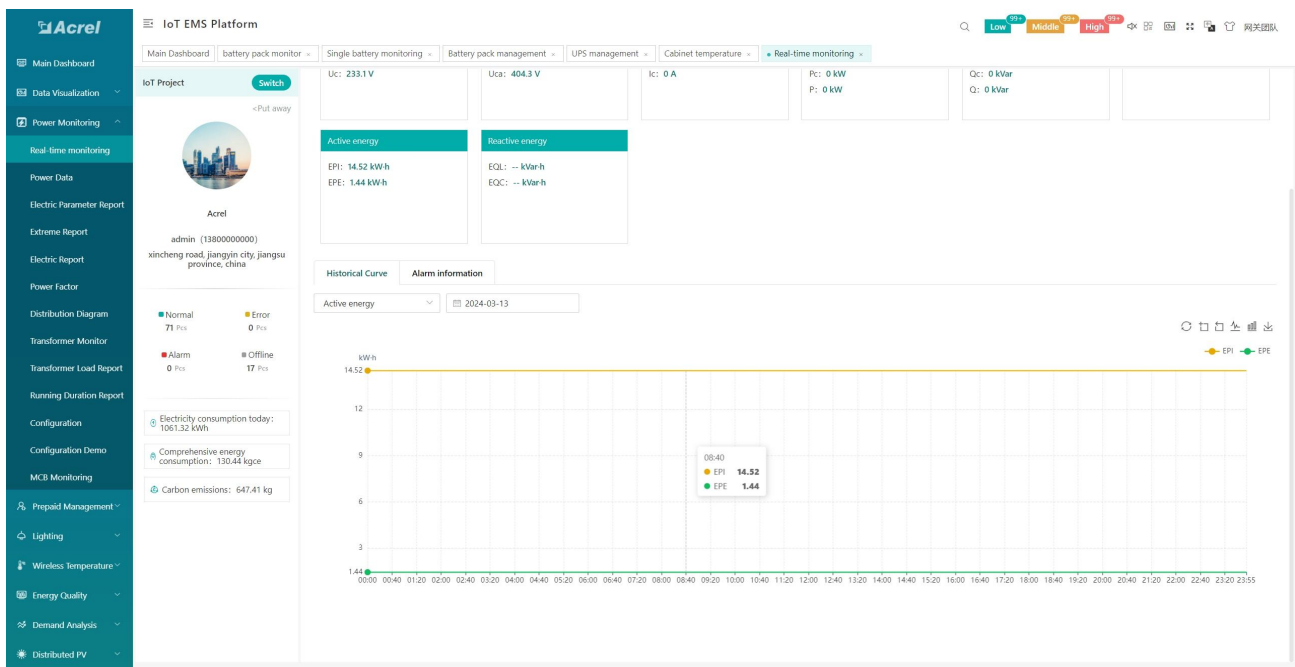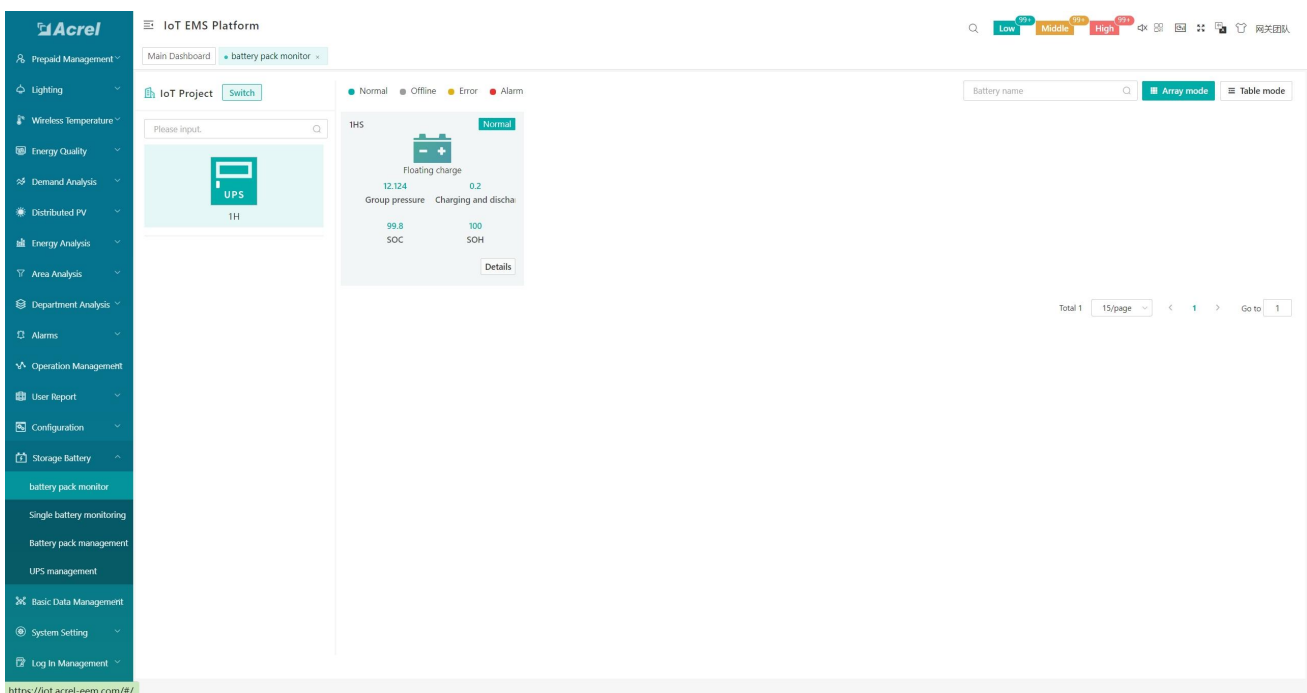

(5) Solar PV Inverter Power Generation Report

(6) Solar PV Inverter Power Generation Report Export [Excel format]

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6. Solar PV Monitoring Part

(7) Solar PV inverter Power Generation Analysis Report: Check DoD [day over day], MoM [month over month], YoY [year over year], power generation analysis of certain/all inverters.

(8) Solar PV inverter Power Generation Report Export: The power generation analysis report of solar PV inverter could be exported into Excel format file for further analyzing and storage.
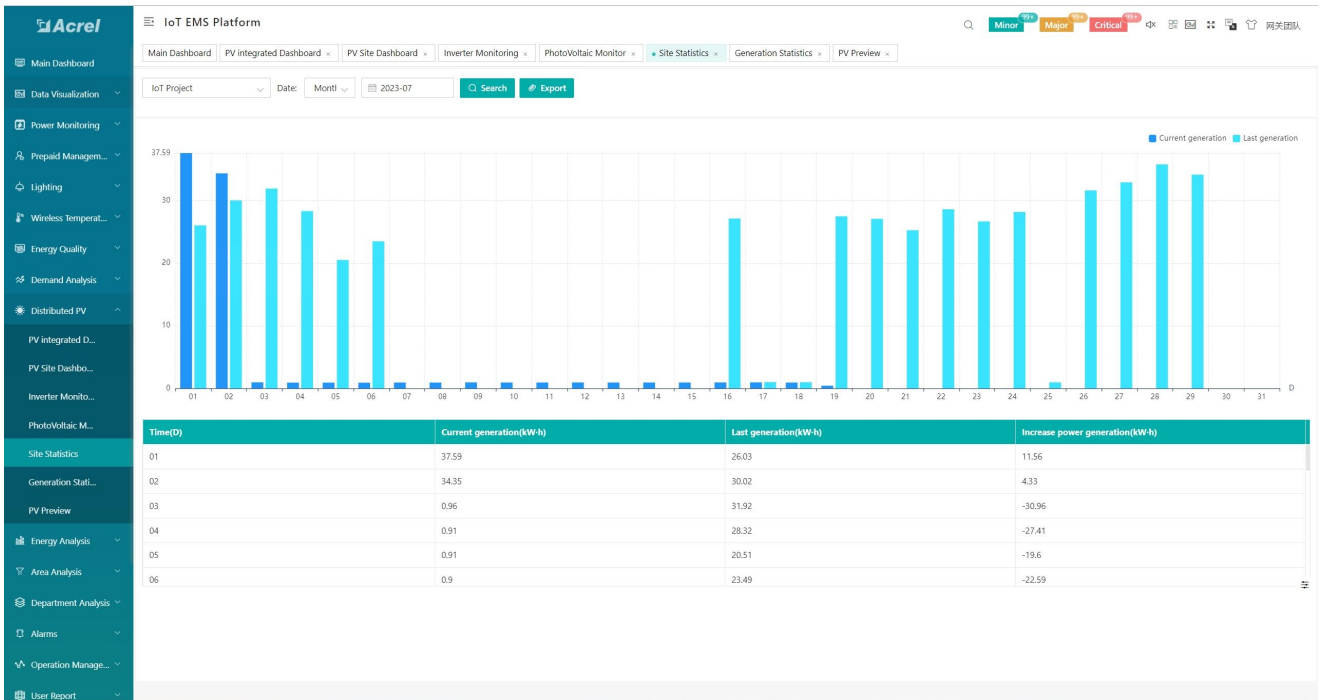
(7) Solar PV Inverter Power Generation Analysis Report
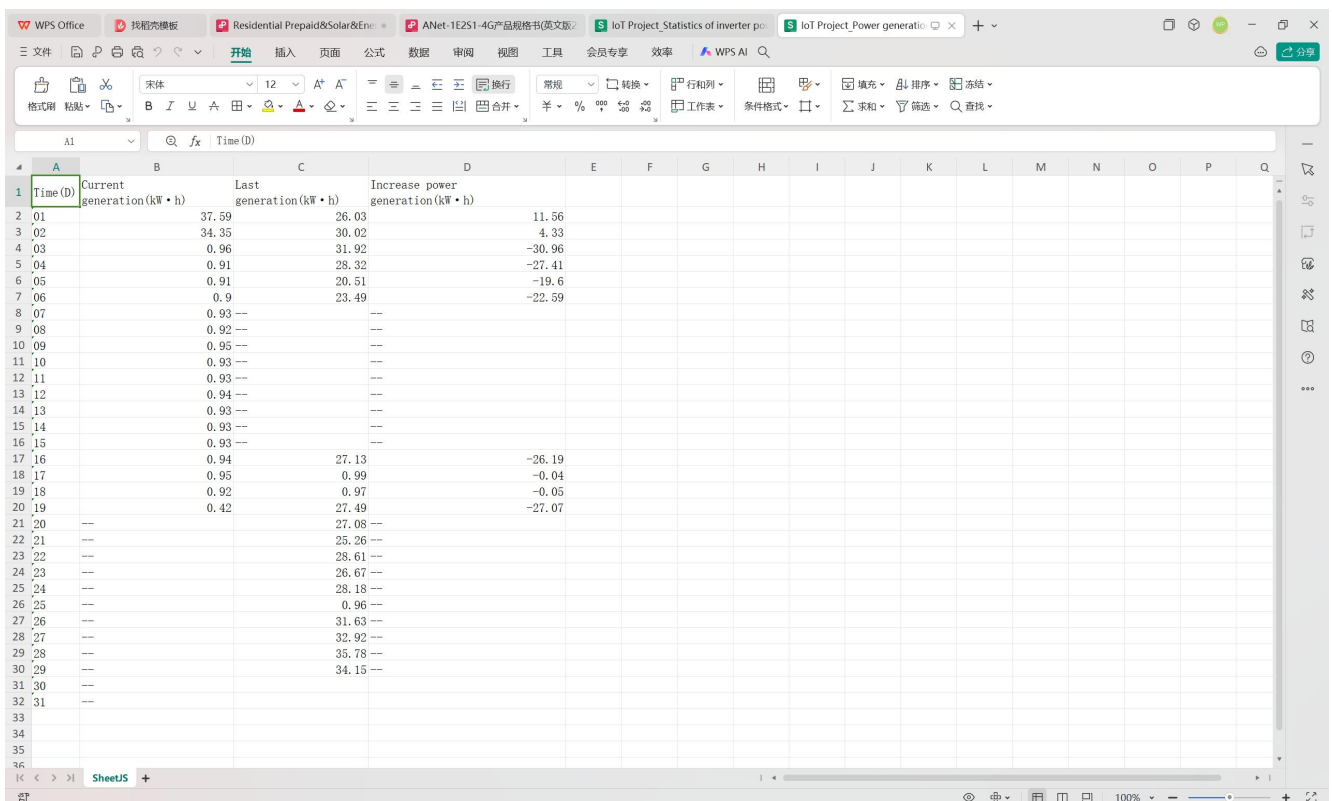
(8) Solar PV Inverter Power Generation Analysis Report Export [Excel format]

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7. DC Energy Storage Monitoring

(1) ANET-1E2S will collect the BMS&PCS data from inverter and further upstream to Acrel IoT Energy Management System for a centralized or separate data analyzing and display.

(2) Necessary data will be discharge&charging energy of BMS and the SOC, SOH status of battery packs.

(3) A autogenerated discharging&charging energy report was avaible and could be export in Excel format for further overview.

(1) BMS&PCS discharge&charging overview

(2) BMS battery pack monitoring [SOH, SOC, etc.]

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8. Electricity Prepaid&Postpaid Part - Vendor&Topping up Logic

(0) Operator Side set administrator office for certain region to do the Online Electricity Vending by using WEB based system platfomr.

(1) Administrator create "User Account" for a unique End Power User of certain building/room.

(2) Administrator bond "User Account" to a certain building/room and then bind to a certain postpaid energy meter.

(3) End Power User of certain building/room contact administrator office, do the payment according to their monthly electricity bills. [monthly electricity bills will be issued to end power user via SMS, E-mail, mobile Application and etc.]

(4) Administrator operate Acrel Cloud Prepaid&Postpaid System to recharging the certain "User Account" after receiving the payment from End Power User which already bound to certain "User Account".

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6. Electricity Prepaid&Postpaid Part - Room/House bound to Energy Meter and User Account Creation

(1) Bind certain room/house with certain prepaid&postpaid energy meter identified by unique Meter SN code. [Prepaid Management - Account Management - Room Information]

(2) Create User Account for certain room/house. And bind this user account with certain room/house

Thus create a "Prepaid&Postpaid Energy Meter with unique SN - Certain Room/House - Certain User Account" binding relationship [Prepaid Management - Account Management - User Information]
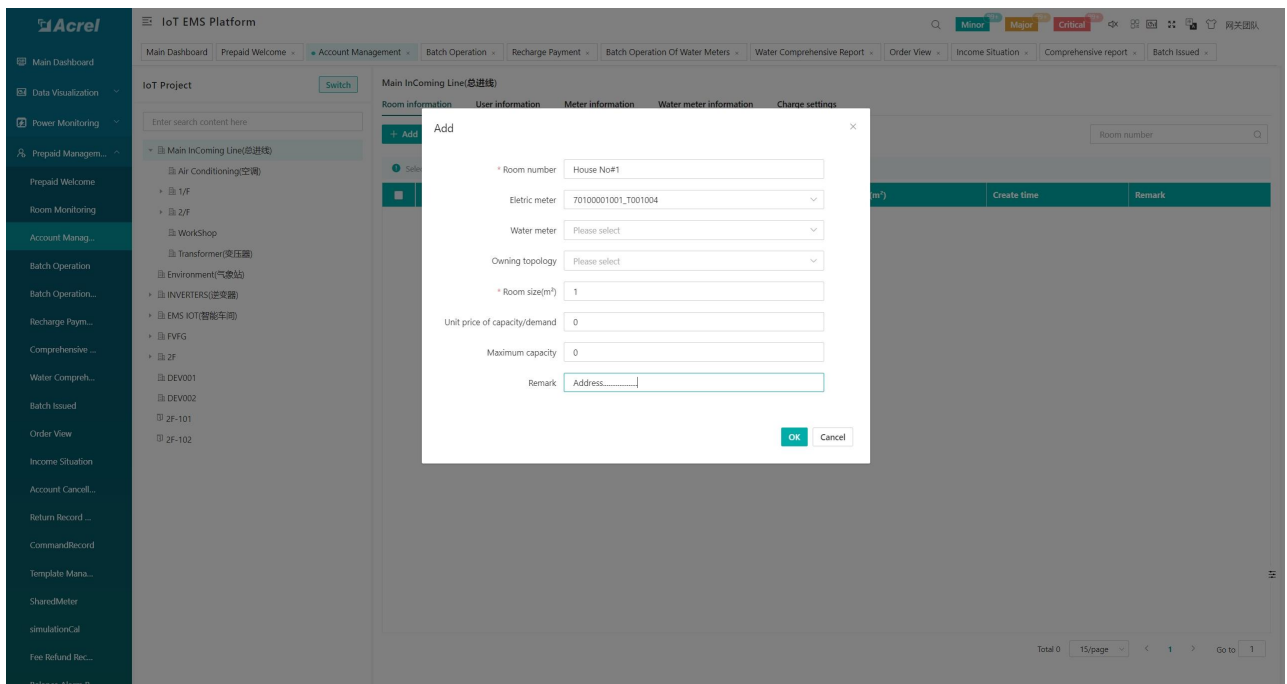
(1) Room/House bound with certain Prepaid&Postpaid Energy Meter
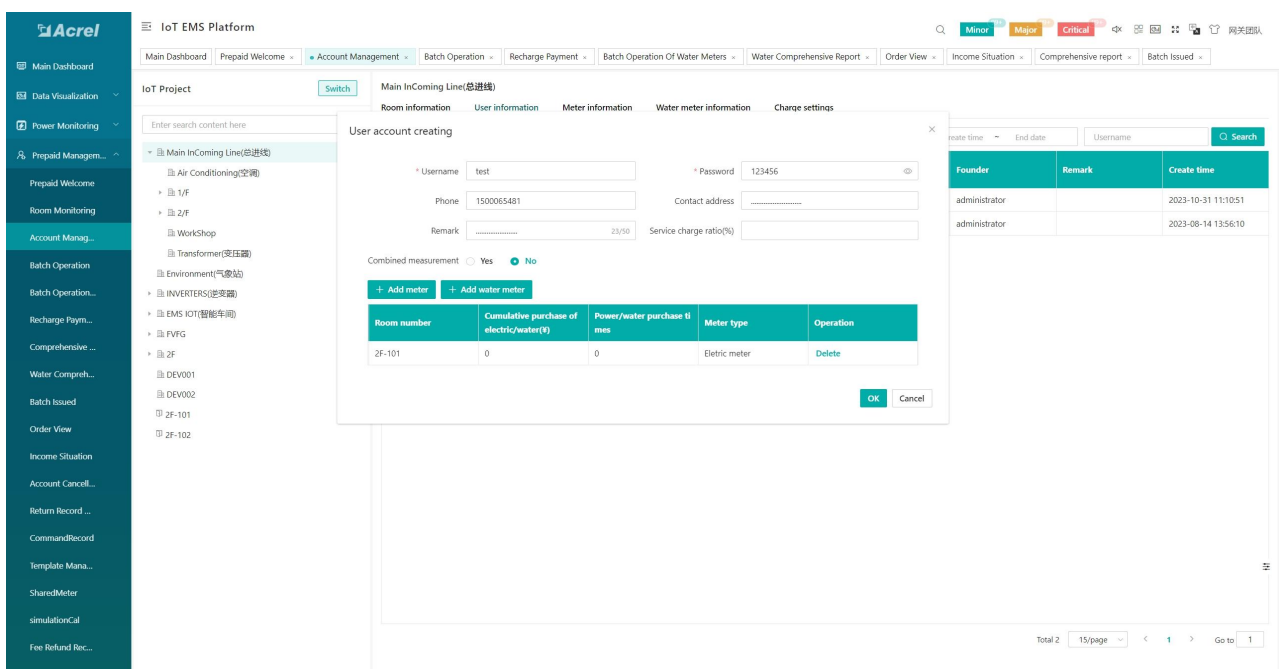
(2) Create User Account and bind it with certain Room/House

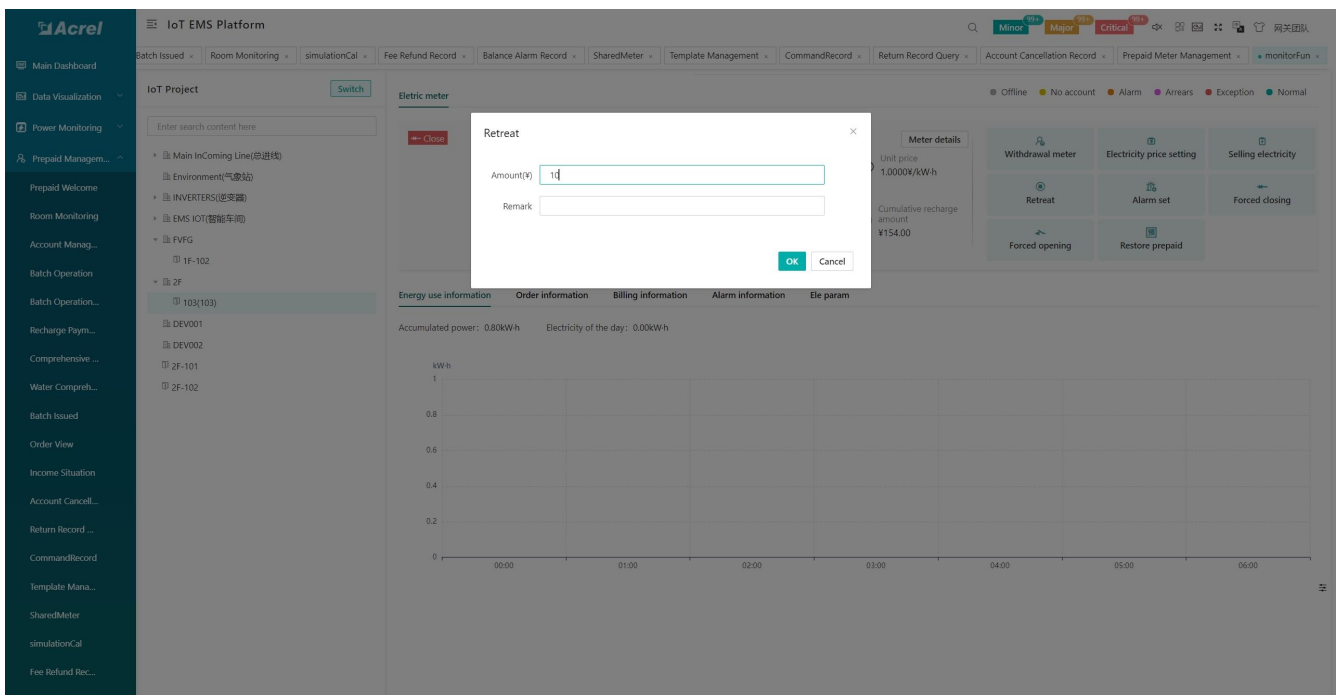Acrel Energy Management Solution

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6. Electricity Prepaid&Postpaid Part - Open Account for formal billing and control of certain Room/House

(3) Find room/house information in room monitoring. [Prepaid Management - Room Monitoring]

(4) Click Open account to formally initiate billing and control function to this certain room/house. Set electricity price [either multi-tariff or flat tariff], click zero clear if no balance remaining in initial balance credit.
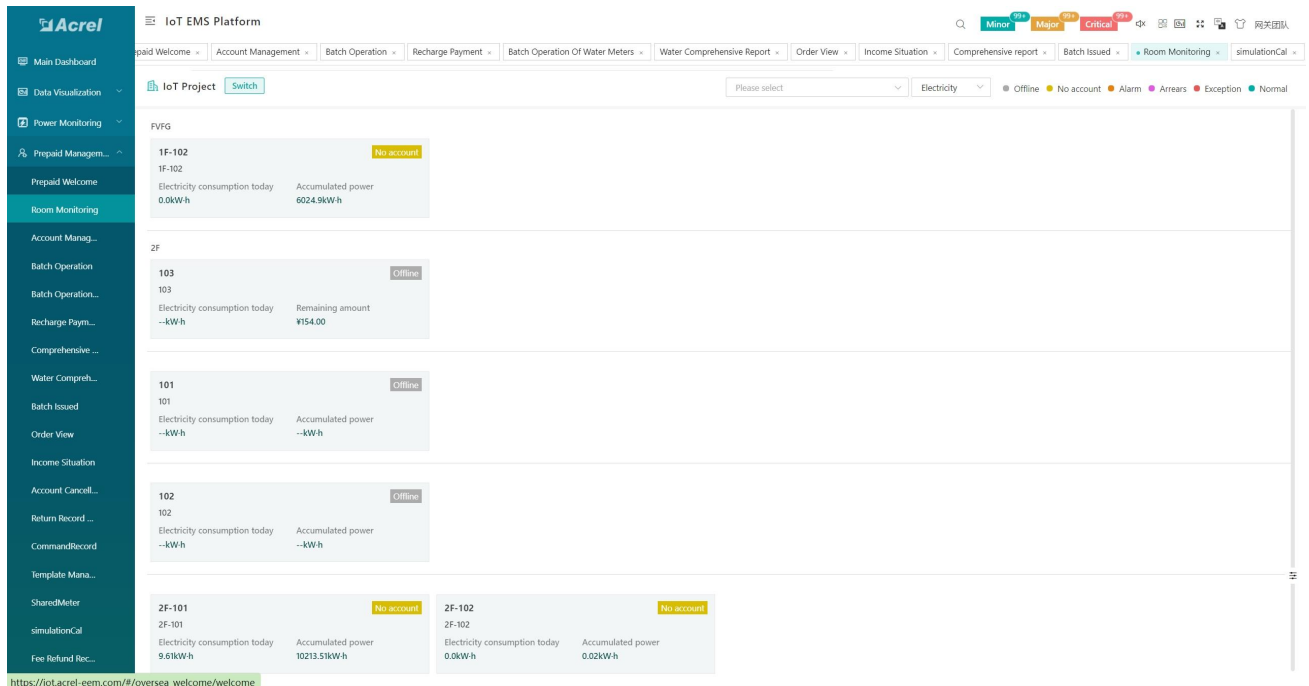
(3) Room/House bound with certain Prepaid&Postpaid Energy Meter
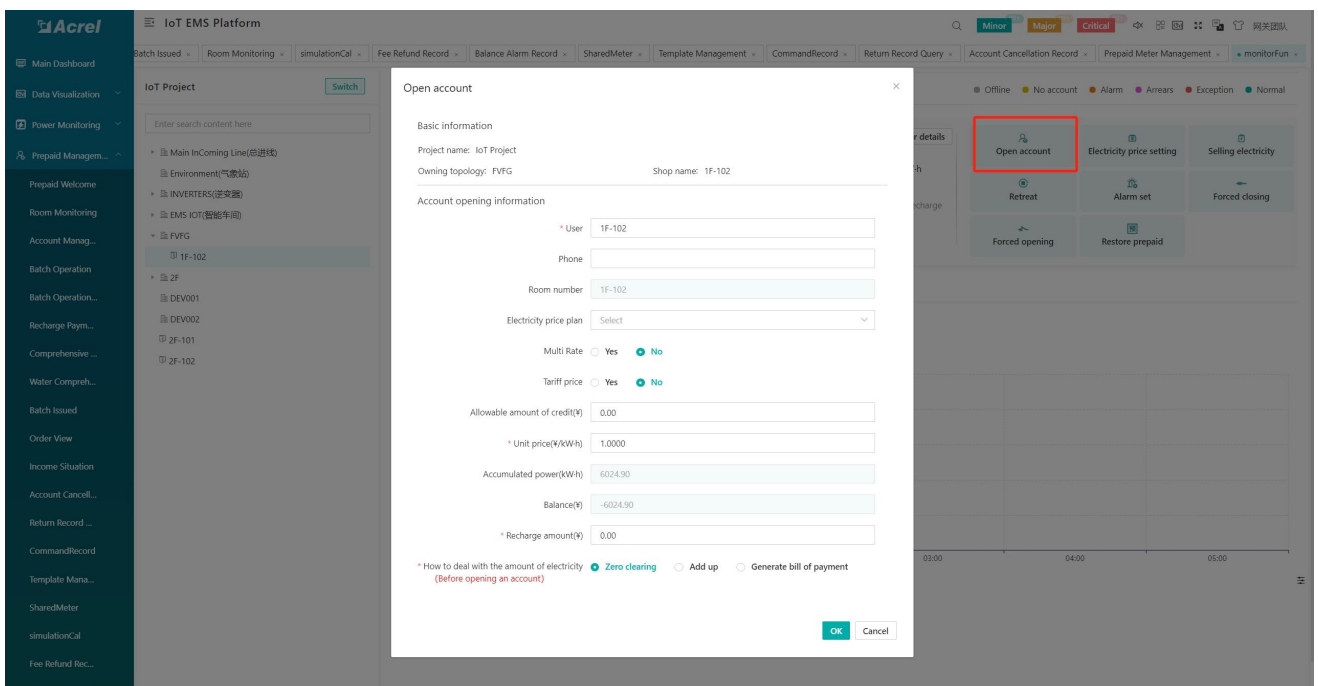
(4) Create User Account and bind it with certain Room/House

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6. Electricity Prepaid&Postpaid Part - Selling Electricity and Retreat Electricity

(5) Selling Electricity: Operator enter certain room/house interface, click selling electricity button to sell electricity to this house/room [Prepaid Management - Room Monitoring - Click Room]

(6) Retreat Electricity: Enter certain room/house interface, click retreat electricity button to retreat electricity to this certain house/room [Prepaid Management - Room Monitoring - Click Room]
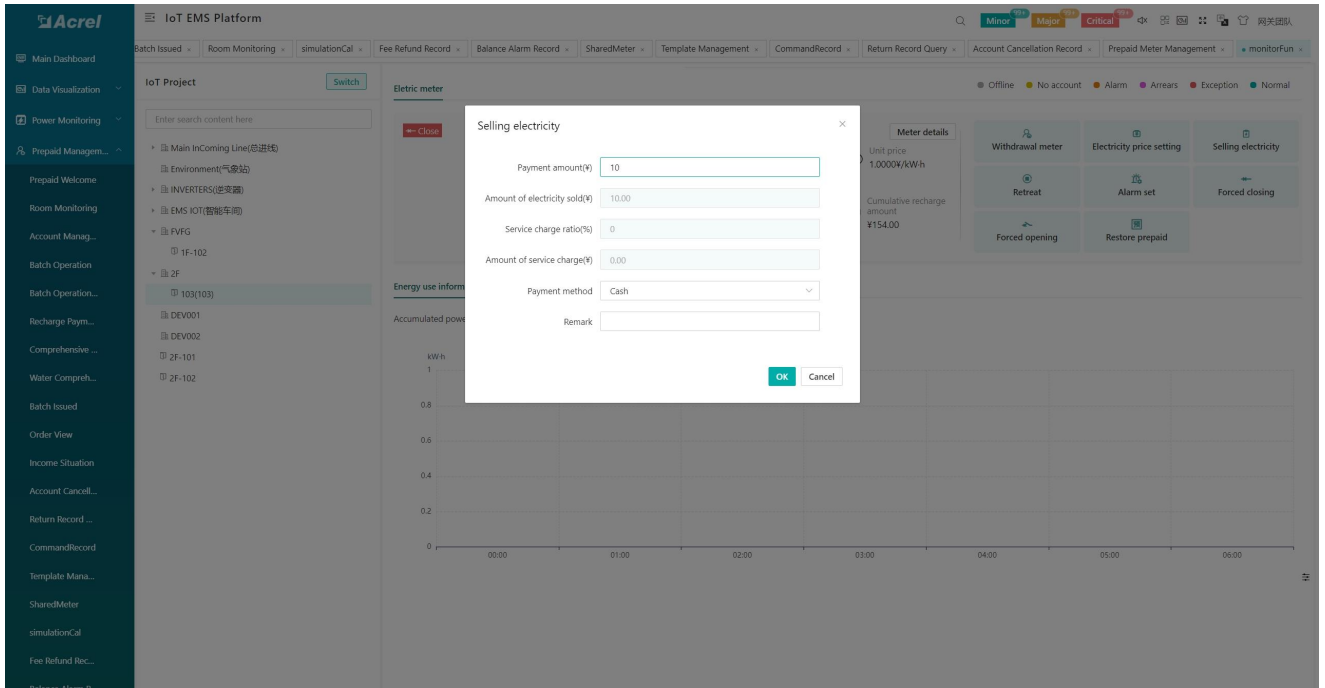
(5) Electricity Selling and Topping up
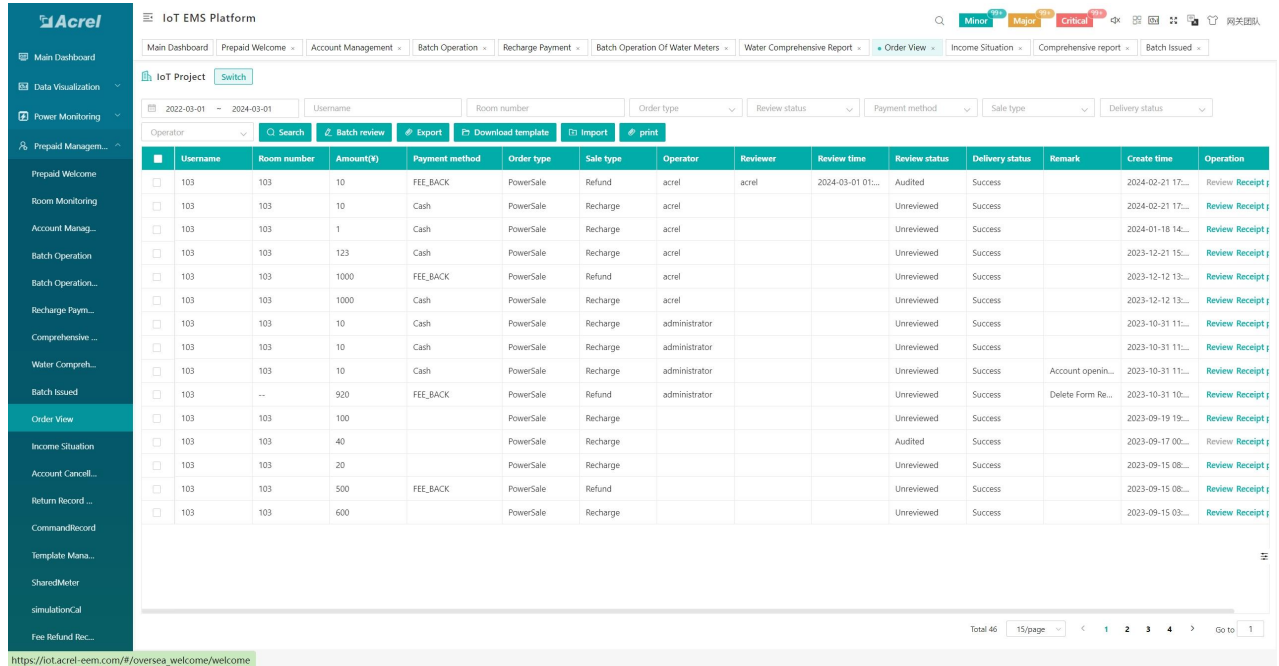
(6) Create User Account and bind it with certain Room/House

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6. Electricity Prepaid&Postpaid Part - Selling Electricity and Retreat Electricity

(7) Electricity Selling Order Checking: Operator could check their electricity selling&retreat history of all of their customers. [Prepaid Management - Order View]

(8) Export Electricity Selling Order Invoice: Operator could export Electricity Selling Order Invoice separately or in batch to end power user

(7) Electricity Selling Order Checking

预付电费收款收据
Electricity Bill Payment Reception

| 用户姓名 User Name	103	开票日期 Date of Invoice	2024-03-19 03:41:24	票据号 Invoice Number	17602322283748569088
收费项目 Charging Item	房间号 Room Number	收款方式 Payment Reception Method	收款金额 Payment Reception Amount	备注 Note	
Refund	103	Fee Back	10.00		
合计金额（大写） Total Amount	101			小写	10.00
所属项目	IoT Project	项目联系人 Contact Person	admin	联系电话 Tel	13800000000
收费员 Payee	acrel	缴款人 Payer	103	开票单位 Invoice Party	(Stamp)
备注 Note	请现场核对金额，并妥善保管收据，本收据作为缴费唯一有效凭证 Please check the payment amount and keep the invoice safely for sole valid				

(8) Electricity Selling Order Invoice

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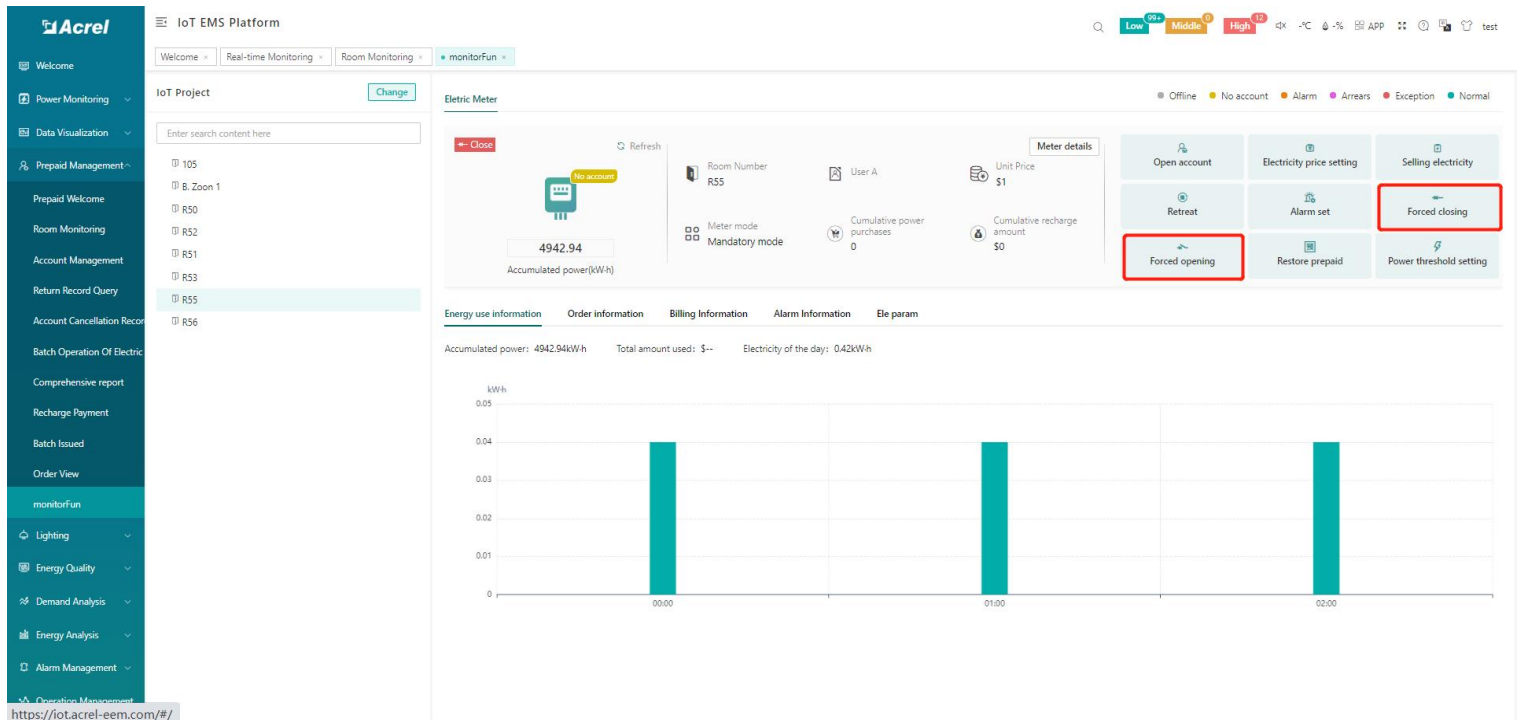Website: www.acrel-electric.fr

7. Electricity Prepaid&Postpaid Part - Remote Control Logic

For remote switch on/off control of circuit's CB (circuit breaker), basic control logic was as below [pic 6.1]:

(1) Postpaid Control Logic: Administrator use Acrel Cloud Prepaid&Postpaid System, enter the "room mangement" interface, and issue "force closing/switch on" or "force opening/switch off" command to control the on or off status of circuit's Circuit. [in prepaid control logic, the balance credit >0, or <0 will automatically trigger switch on or switch off command respectively]

(2) ANET-1E2S-4G gateway receive the control command via 4G communication. And further issue this control command to downstream ADL100-EYNK energy meter.

(3) ADL100-EYNK/F energy meter has built-in magnetic holding relay. Once the energy meter receive the "switch on" or "switch off" control command, this will trigger its magnetic holding relay to switch on or switch off the circuit's CB respectively.
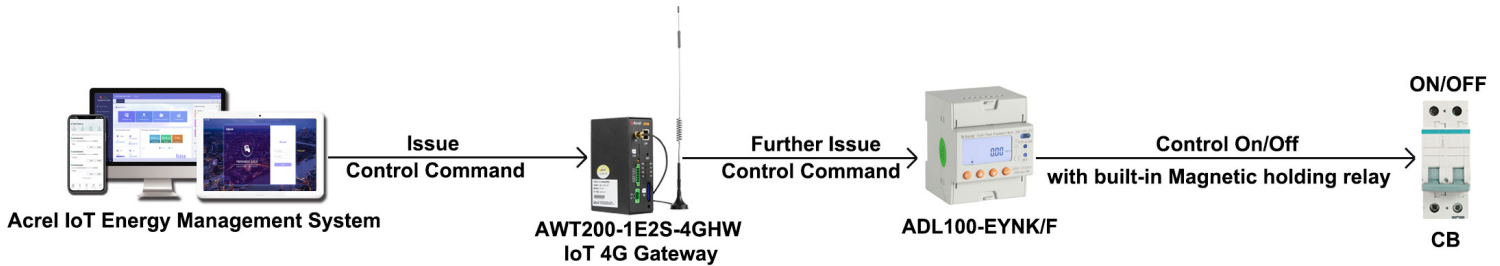

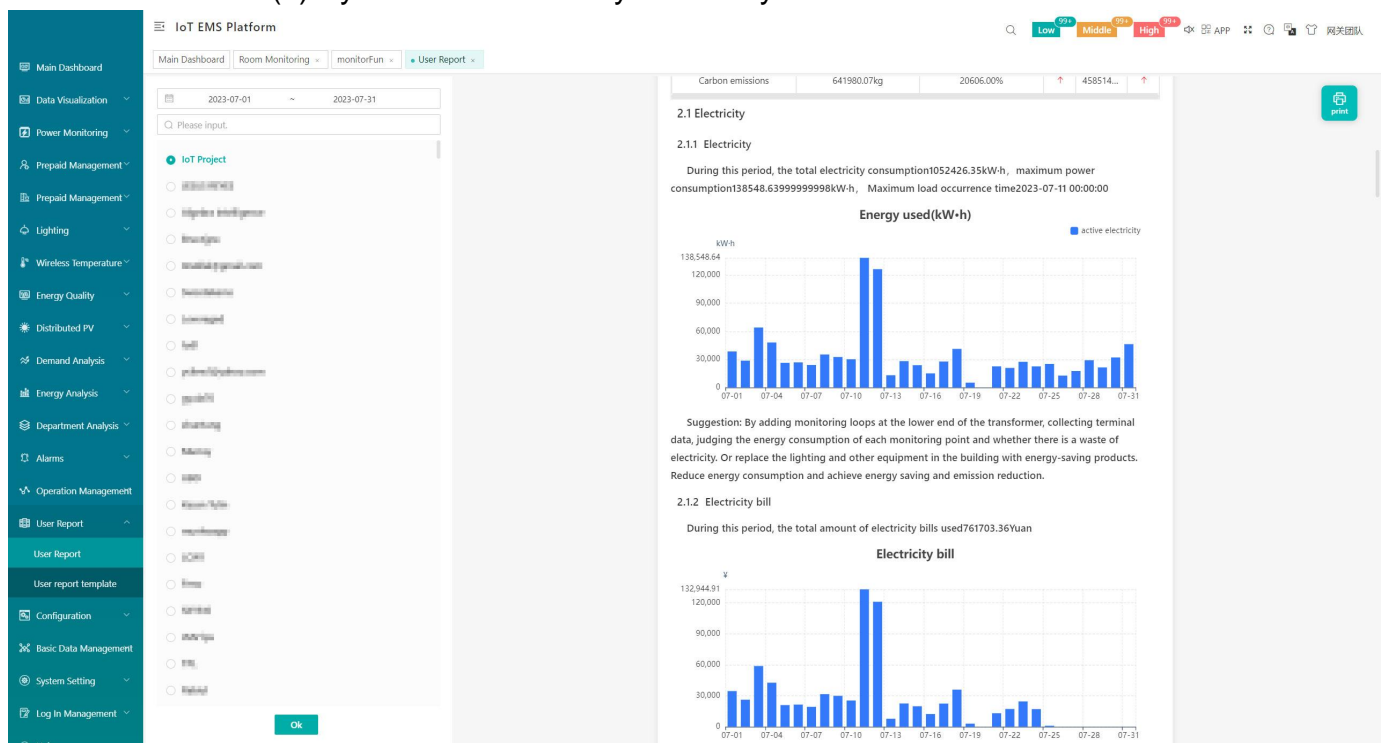(1) Illustration of Remote Control Logic

(2) Administrator use Acrel Cloud Prepaid&Postpaid System to issue "Control Command"

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8. Auto-generated & Auto-issueing Customizable User Report and Electricity Bill

(1) Acrel Cloud Prepaid&Postpaid System could automactically generate a monthly electricity bills and energy report while issueing down to end power user via E-mail, SMS, APP, etc.

(2) Monthly electricity bills will be based on flat rates or step rates accordingly.

(3) End power user could also check their energy consumption or electricity bills on their Prepaid& Postpaid APP.

(4) Customizable User Report was possible according to the customer request.

Noted: Utility side could customize the format of monthly electricity bill&energy report.
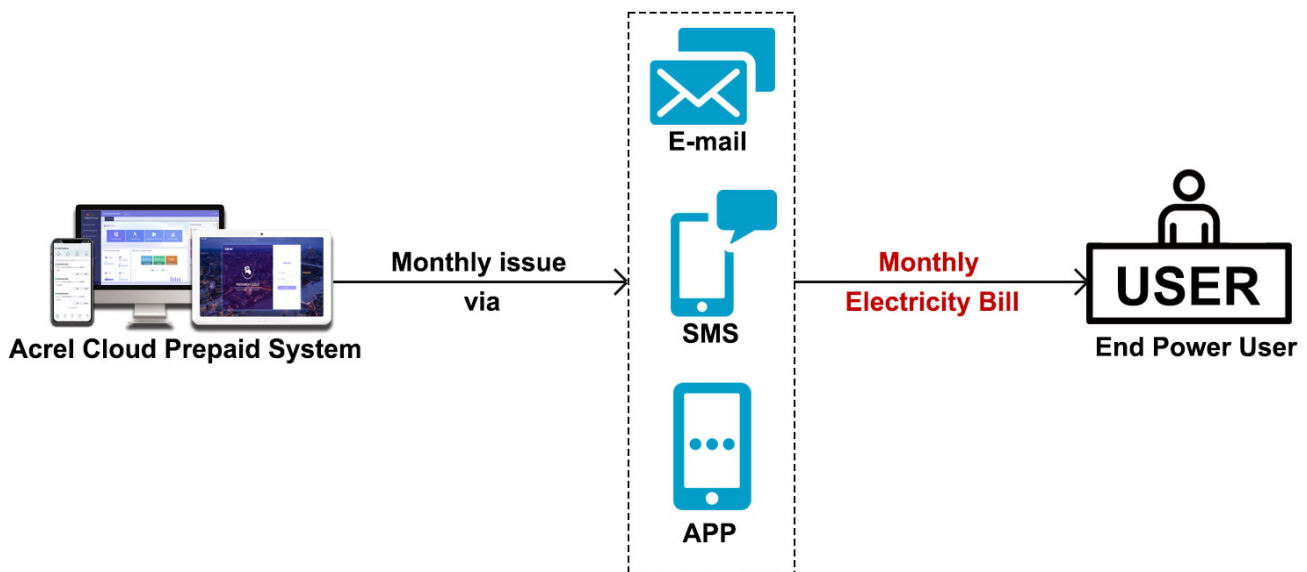
(1) System issue Monthly Electricity Bills to End Power User

(2) Customized Monthly Electricity Bills

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11. System Platform Security

(1) Acrel Cloud Prepaid&Postpaid System got a IEC 27001:2013 certification for approving the system security level on information security management of design, developement of electrical meters and etc.

(2) For safety of data transmission between Acrel ANET Gateway and Acrel Cloud IoT Energy Mangement System. Normally use the AES, SSL or other types of data encrption methods.

(3) Cloud Server recommend to use private cloud server for safe and stable data storage.

(4) For other information about data security, kindly contact Acrel Software Department for more information.

(1) IEC 27001:2013 Certification
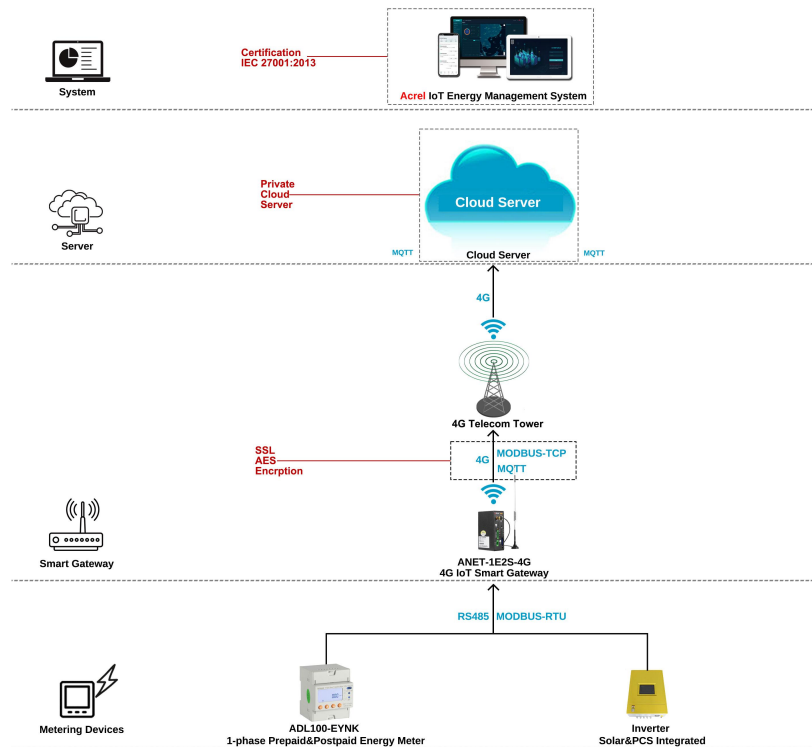
(2) Data Transmission Encrption

12. Acrel IoT Energy Management System General Introduction

Acrel IoT Energy Monitoring System could be access in 2 different ways:

(1) Access through WEB on your computer.

Access port: https://iot.acrel-eem.com/

(2) Access through APP on your mobile phone

Download Link: https://play.google.com/store/apps/details?id=com.acrel.iotems

(1) WEB Accesss (Computer):

Access Port: https://iot.acrel-eem.com/

Test Account Name: acrel

Test Account Password: 123456
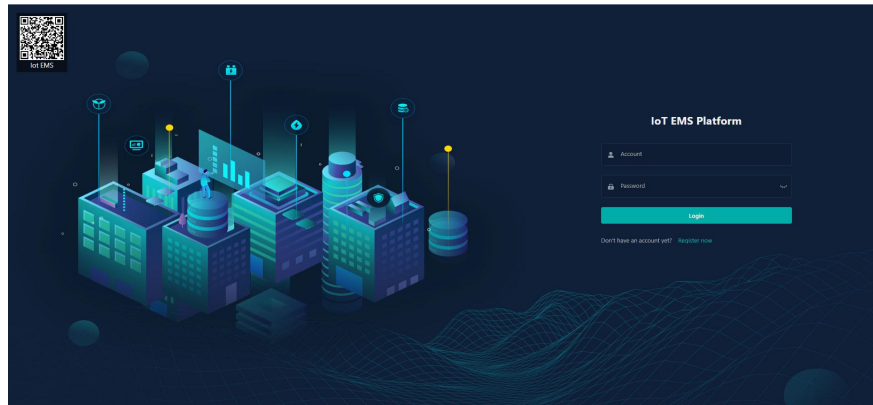
(2) APP Accesss (Mobile):

Download Link: https://play.google.
com/store/apps/details?id=com.acrel.
iotems
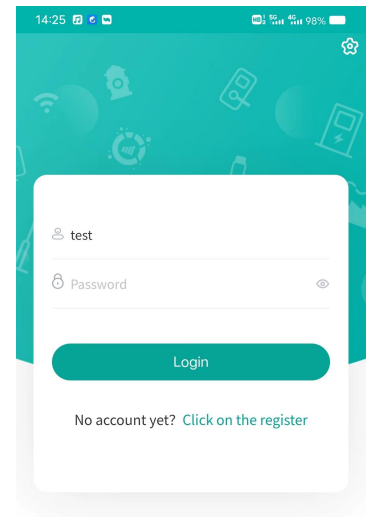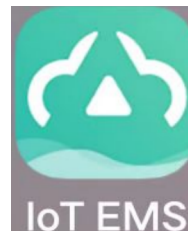
Test Account Name: acrel

Test Account Password: 123456

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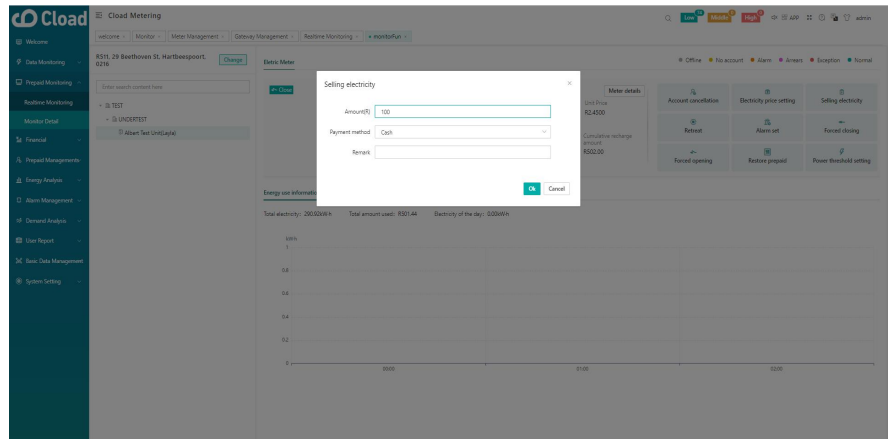E-mail: loki@acrel.cn
Website: www.acrel-electric.fr

12. Acrel IoT Energy Management System General Introduction

Main Function of WEB side System:

(0) Prepaid Interface (1) Devices List (2) History Curve (3) Electricity Parameters Report (4) Energy Consumption Report (Daily, Monthly, Yearly) (5) User Report

(0) Prepaid Interface-Overview: All basic function of prepaid operation could be seen here.Also, a overview of room balance credit and power consumption was available
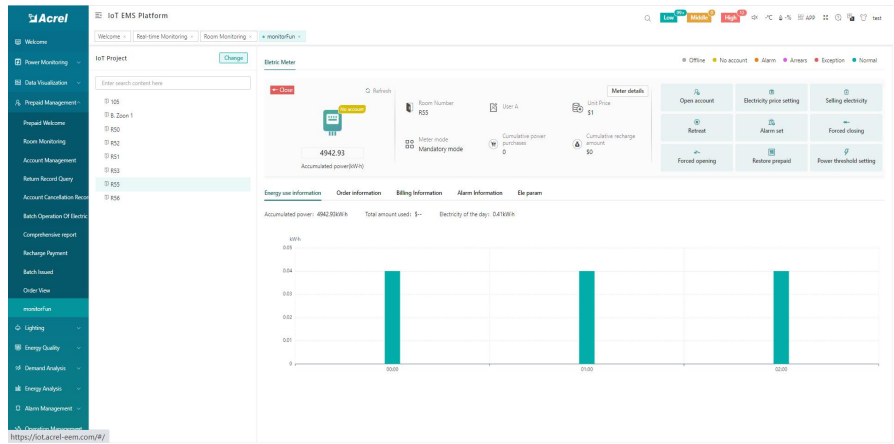
(0) Prepaid Interface-Open Account: A prepaid energy meter will formally serve its prepaid billing and control function only after binding a "room" and "user" with it and open account for this certain "room".
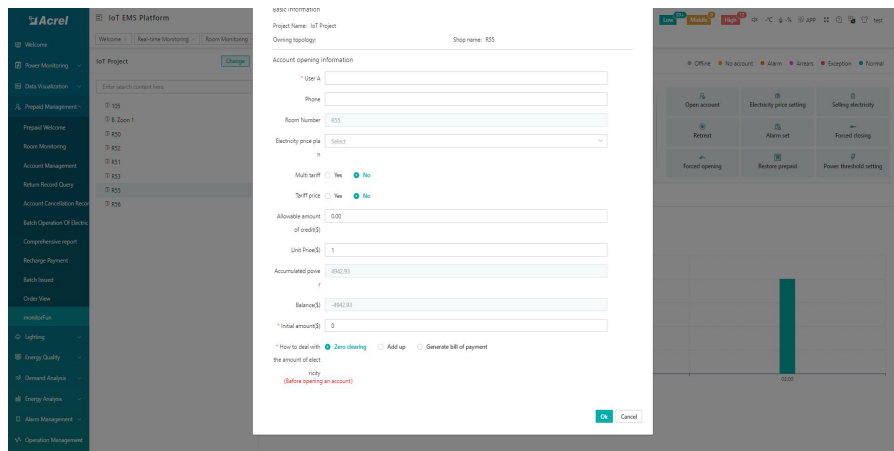
(0) Prepaid Interface-Topping Up: Enter amount to issue topping up command to certain "prepaid energy meter" bound with certain "room/user".
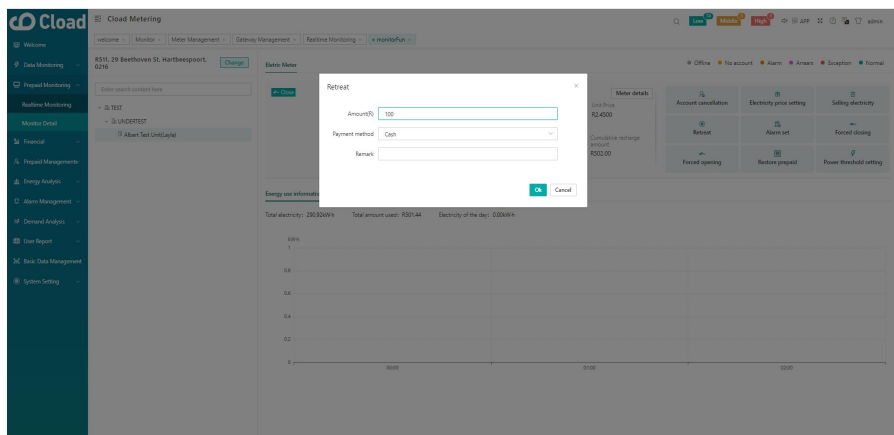
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(0) Prepaid Interface (1) Devices List (2) History Curve (3) Electricity Parameters Report (4) Energy Consumption Report (Daily, Monthly, Yearly) (5) User Report

(0) Prepaid Interface-Retreat:

Retreat certain amount from credit balance. Designed for revising the possible false operation

(0) Prepaid Interface - Control - Prepaid Mode: In Prepaid Mode, when the credit balance below 0, prepaid energy meter will automatically shut down loads power. and when balance above 0, will immediate resume loads power
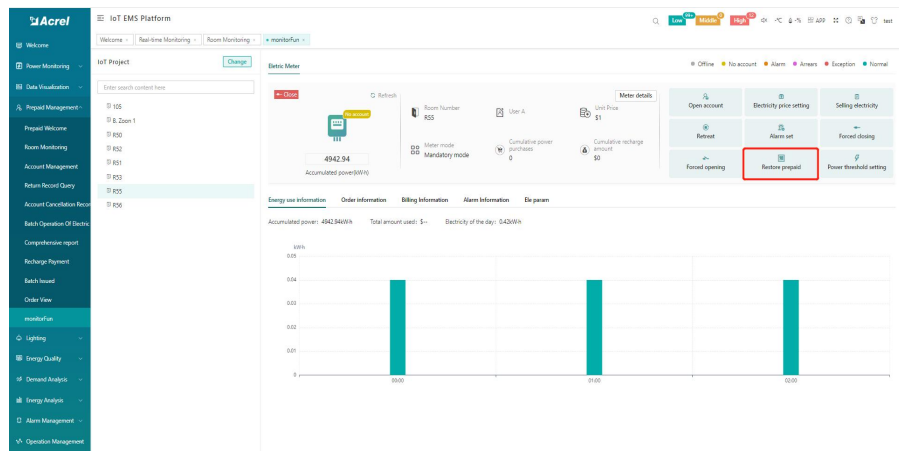
(0) Prepaid Interface - Control - Postpaid Mode: In postpaid mode, load's off-on switch control will be fully manually control by platform. Balance credite whether below or above 0 won't influence the load's switch on/off status automatically
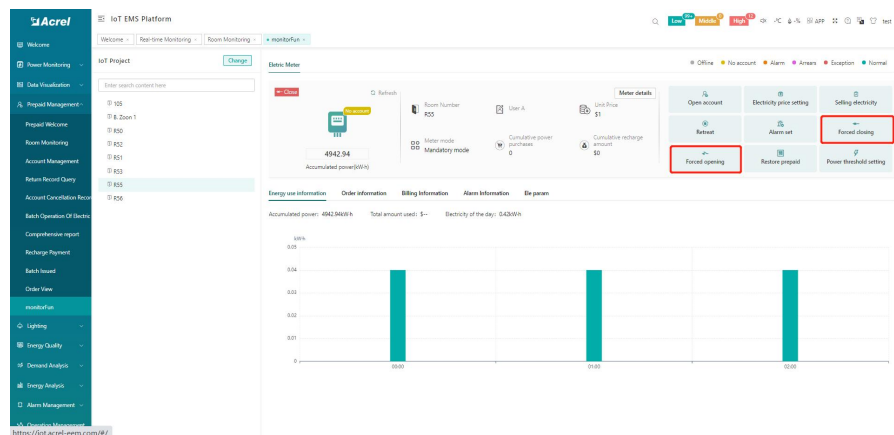
12. Acrel IoT Energy Management System General Introduction

Main Function of WEB side System:

(0) Prepaid Interface (1) Devices List (2) History Curve (3) Electricity Parameters Report (4) Energy Consumption Report (Daily, Monthly, Yearly) (5) User Report


(1) Devices List: Showing the overall devices connected to Acrel System and were bond to certain project. SN code, Online-Offline status, devices model and other necessary information will be shown here.
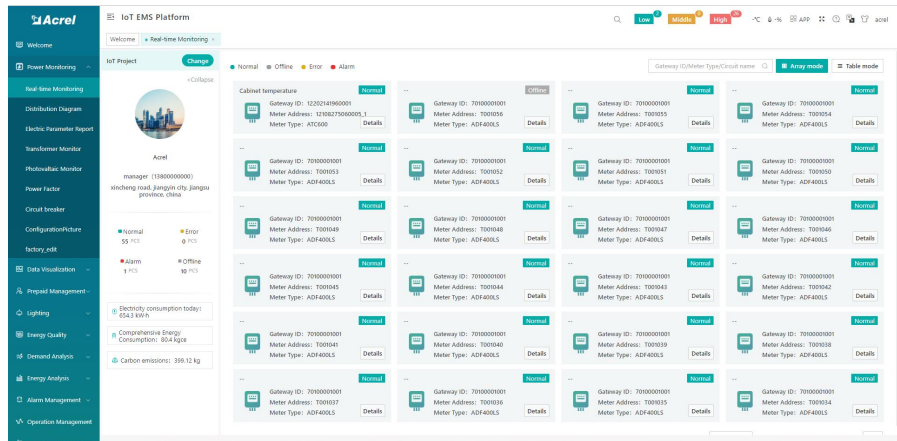
(2) History Curve: Showing the daily history data curve of all the data that could be collected and upload by energy meter or other basic metering devices.
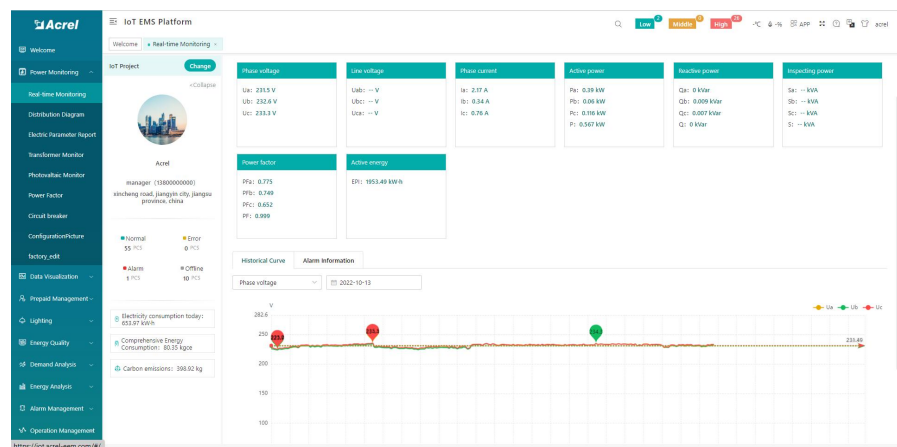
(2) History Curve: By selecting the items of "data" and "electricity parameter", platform can show the history curve of different data and date.
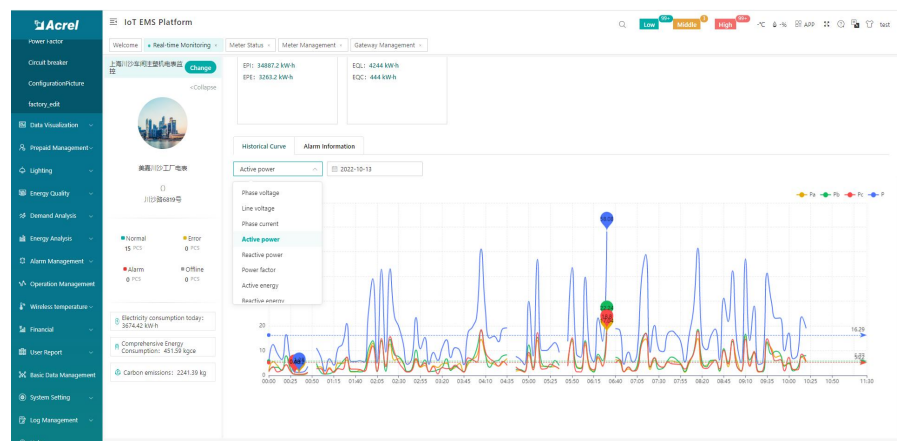
Acrel Energy
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(4) Energy Report (Daily): This Interface show the daily energy consumtion report (calculated by forward active energy)

(4) Energy Report (Daily): This daily energy report could be also export to computer in "Excel" format

(4) Energy Report (Monthly& Yearly): Same as daily energy report, monthly and yearly energy report could be also checked on platform and exported in "Excel" format.

| Acrel® | Acrel Energy Management Solution | Author: Loki Elfin
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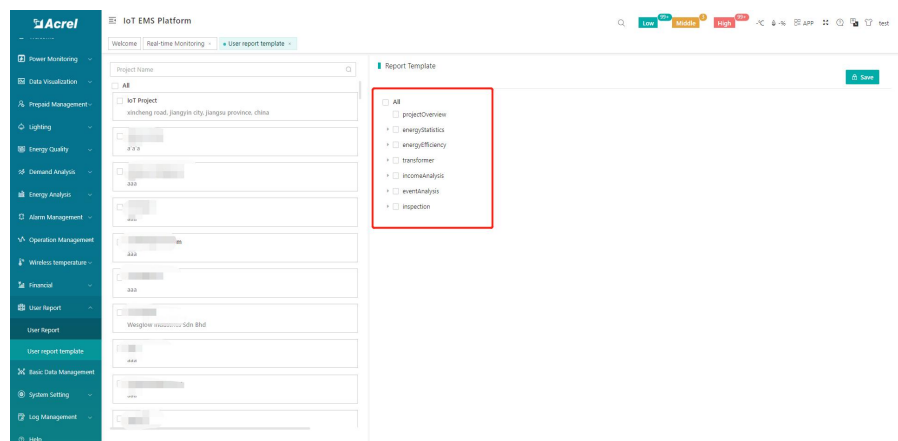
(5) User Report: A comprehensive user report including project overview, energy report, energy analysis and etc could be check on platform
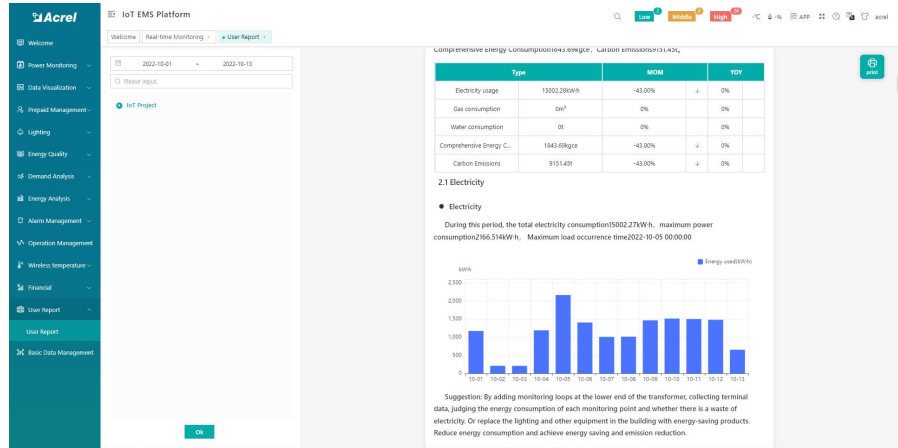
(5) User Report: User report could be exported in "PDF" format into your PC for convenient check and storage.
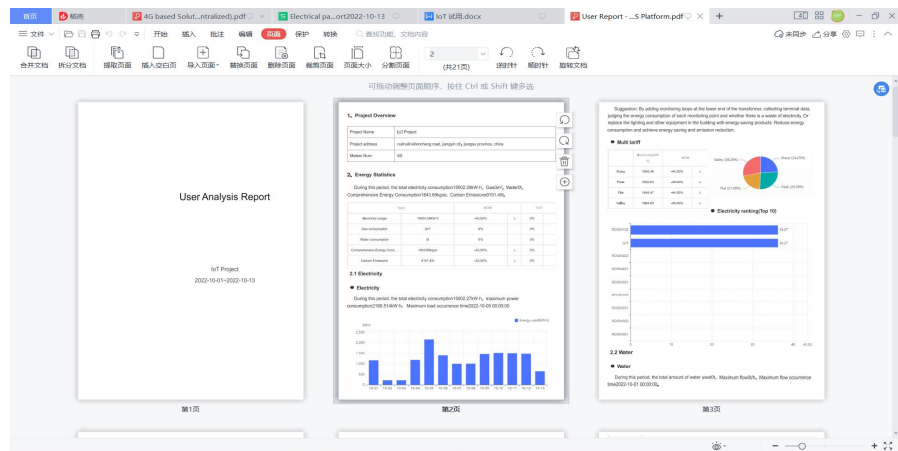
(5) User Report: User report support template customization in buy-out service of Acrel IoT Energy Monitoirng System.

Acrel Energy Management Solution

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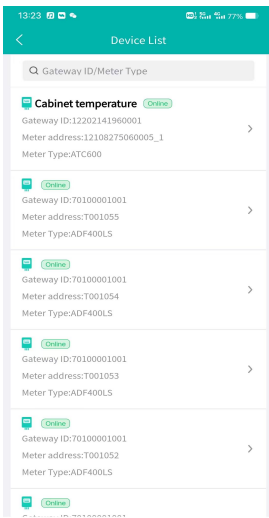Website: www.acrel-electric.fr

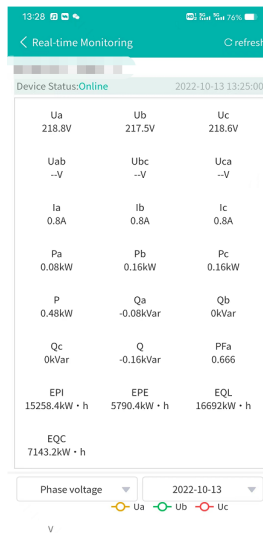## 12. Acrel IoT Energy Management System General Introduction

Main Function of APP side System:

(1) Devices List (2) History Curve (3) Electricity Parameters Report (4) Energy Trend (5) Energy Consumption Report (Daily, Monthly, Yearly)
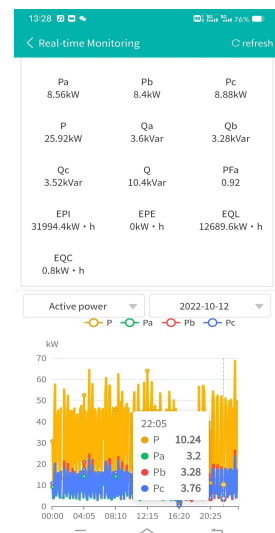
Noted: Since APP side and WEB side of Acrel IoT Energy Monitoring System share the same data, normally recommend our user to add the devices to their account using APP and check the data using WEB platform.

(1) Device List

(2) History Curve

(2) History Curve

(3) Parameter Report

(4) Energy Trend

(5) Energy Report