



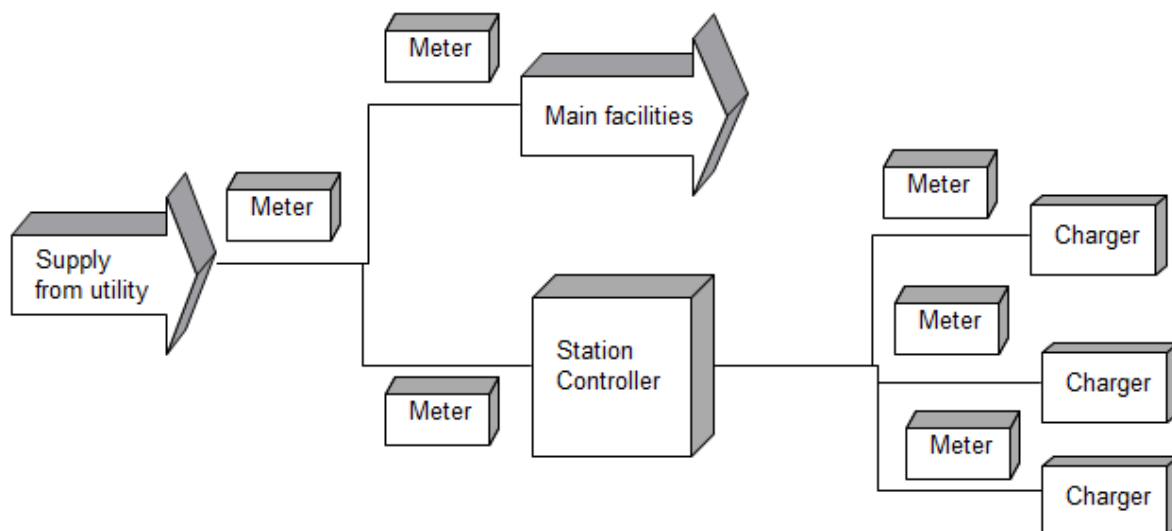
EV Car Charging System

Introduction

The first version of EV Car Charging Station was developed in 2014 for China Light & Power. It was using NEC Quick Charger and deployed in Science Park. It was composed of two components, server installed in CLP for charging station monitoring, meter data usage and payment verification. Each charging station was connected with Elster meter and NEC charger while providing two kinds of payment channel, Octopus and CLP RFID card. Real time data was sent to the server to reflect charger status.

The second generation was developed in collaboration with HKPC in 2017. It was deployed in headquarter of CLP and Heya Crystal Carpark site. The charger was made by Hong Kong based company, Adtronics Technology Co. Unlike previous generation, the charging station was managing up to 32 chargers while it controlled how much power delivered to each charger by providing different kinds of data to a small library provided by HKPC which returned power dedicated to each charger. It then communicated with charger through OCPP (Open Charge Point Protocol) standard protocol to limit the power consumption. The reason of performing this kind of power management is the limited power supply to building or shopping mall as car park and shopping mall shared the supply. The advantage of using this mechanism is to save additional cost on electricity supply.

As HKPC got funding from the government and CLP, the payment channel was not used in first generation. More charger management features were provided from server such as unlocking the charger from the car. Each station communicated with the server over 4G mobile network in real time while all transactional data including meter reading was rebuilt each day in case of mobile network interruption. The meter data for individual charger, other kinds of power consumption and overall power consumption was logged in database. It was being studied by HKPC for further data analysis on charger and EV car.



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Features of the system

Here is the summary of the features.

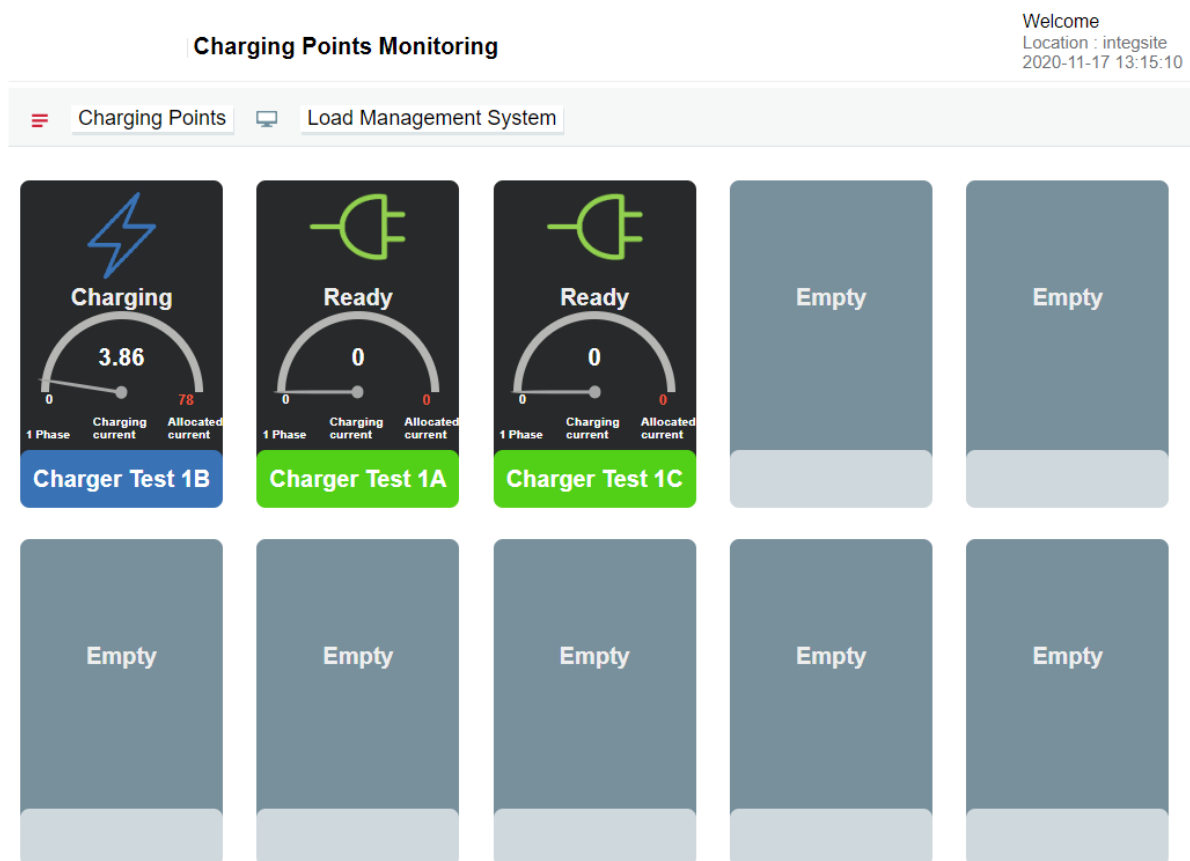
Server

- User management (user role mapping and user data permission setup)
- Site management (site and device setup, site parameter enquiry)
- Data monitoring (station status and control management)
- Historical data (transaction, meter data, charger status)
- Transactional and audit report

Station

- Control flow of charging (using Octopus or RFID over amount of required power consumption in kWh or charging duration) in first generation
- Displaying of charging status, individual power usage and overall power usage in second generation

In second generation, the screen is for information and the customer could not specify the requirement as in the first generation. On the other hand, a small screen on charging would instruct the customer to start, stop and unlock the charger. It is possible to perform the operation in station screen especially when payment channel is introduced.



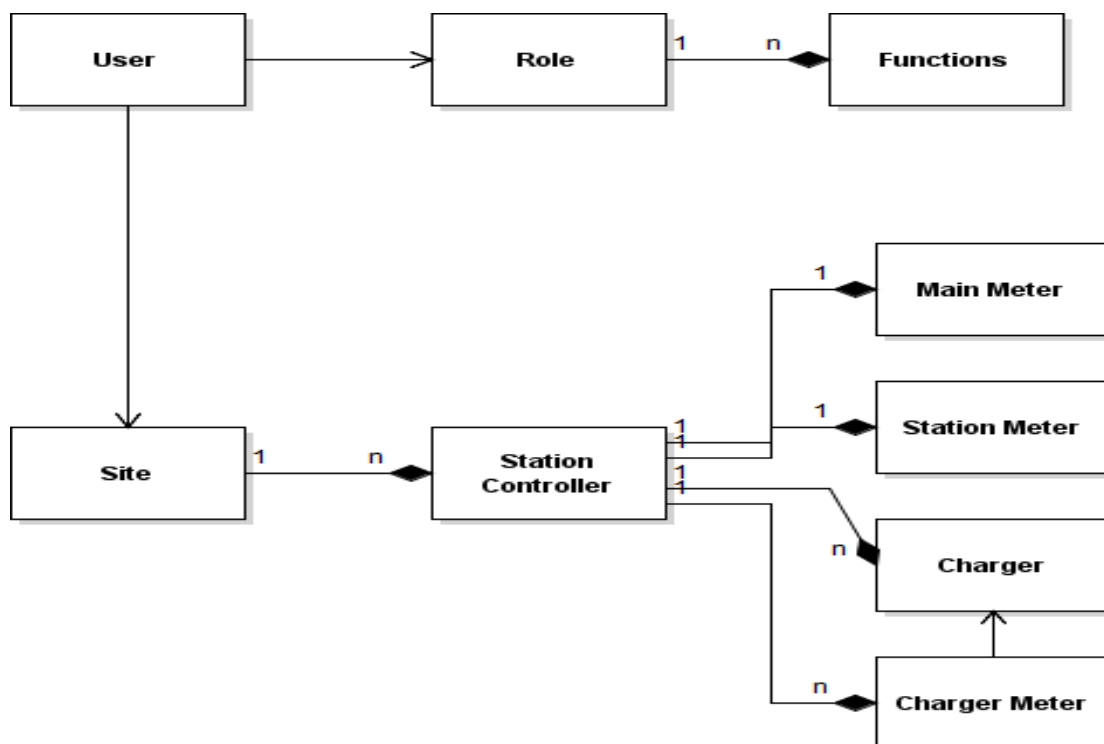
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Description of the system

The system was designed with easy management, scalability and security in mind. After getting user feedback from the first generation, some major improvements were on central management in order that the administration could manage individual charger through the controller. The parameter of load management in individual sites can only be managed through the GUI of the server. Incidentally both the hardware and software were upgraded significantly to manage up to 32 EV chargers. In case of deploying smaller number of EV chargers, the hardware specification can be lowered to save overall initial cost.

Architecture of the system



With reference to the above diagram, the user is assigned with role that a set of functions are allowed. The permission is governed in server side so that even though the user finds out the tricks on accessing non-permitted functions, the server denies the access. Data permission is controlled by the sites allowed for individual user.

In general, OCPP supports meter data transmission where some brands of charger are equipped with built-in meter circuit. In our implementation, industrial standard meter is installed with each charger to fulfill higher data accuracy and standard required by utility. This is especially important when payment is involved such as in the first generation.

Although station meter seems to be redundancy in which its reading can be derived from individual meter reading of the charger, the advantage is to better managing power consumption so as not to overload the overall circuit. In addition, it can overcome any fault arising from the chargers.

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Central Management

The central management is composed of 2 parts, site-based parameter configuration, real time monitoring and control. The first one deals with the tolerance of the consumption in each station of the site.

The screenshot shows the 'SmartEV Station v0.32' interface. On the left is a navigation menu with options like 'Account Management', 'Site Management', 'Data Monitor', 'Historical Data', 'Report', and 'User Profile'. The main area is titled 'Device Management' and contains a table of parameters:

Parameter Key	Parameter Value
percentsupplyuseable	80.00
tolerancechargecurrent	0.50
currentreserve	6.00
tolerancestationcurrent	5.00
numreserve	3

An 'Update System Parameter' dialog is open, showing a 'Controller' dropdown set to 'itestctr001' and a 'currentreserve' input field with the value '6.00'. There are 'No' and 'Yes' buttons at the bottom right of the dialog.

The parameters are queried from the server on individual station and can be updated in real time. Furthermore, individual charger and maximum current allowed through each charger and station meter can also be adjusted from the server. This instruction would be effective immediately to the power management library which then calculates the adjusted value to the station controller to deliver information to charger through OCPP.

The screenshot shows the 'SmartEV Station v0.32' interface with a table of devices. The table has columns for Device, Description, ConnDeviceid, Parent Deviceid, Monitor Deviceid, Location, Maximum current, Maximum kva, Device Type, Status, Site, and Device Parameter. An 'Update Station Parameter' dialog is open over the table, showing a 'Meterid' dropdown set to '63010102' and a 'Max curr' input field with the value '78.00'. There are 'No' and 'Yes' buttons at the bottom right of the dialog.

Device	Description	ConnDeviceid	Parent Deviceid	Monitor Deviceid	Location	Maximum current	Maximum kva	Device Type	Status	Site	Device Parameter
63010101	DevMain for itestctr001	itestctr001	DevStruct001	DevMainTestctr001	Main Trunk	190	--	Meter	inactive	integtest	9.1.0
63010102	DevStation for itestctr001	itestctr001	DevMainTestctr001	SumCharger	Station	78.00	--	Meter	inactive	integtest	9.2.0
63010103	ChargerT1A	itestctr001	DevMainTestctr001	ChargerT1A	Charger Test 1A	6	--	Meter	inactive	integtest	10.3.1
63010104	ChargerT1B									integtest	10.4.2
63010105	ChargerT1C									integtest	10.5.3
ChargerT1A	ChargerT1A									integtest	10001.1.16.1
ChargerT1B	ChargerT1B									integtest	10002.2.32.00.1
ChargerT1C	ChargerT1C	itestctr001	DevMainTestctr001	ChargerT1C	Charger Test 1C	--	--	Charger	inactive	integtest	10003.3.32.00.1
DevStruct001	DevStruct for itestctr001	itestctr001	itestctr001	DevStruct001	Virtual	200	150	Miscellaneous	inactive	integtest	192.168.2.19.6828

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To cater for different types of charger, the server provides the facility to deliver specific parameter in form of key-value pair to individual charger.

SmartEV Station v0.32

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- Account Management
- Site Management
- Data Monitor
- Historical Data
- Report
- User Profile

Site Control

Controller Status

Controller id	Last update	Build date
itestctrl001	2020-11-17 13:22:48	2020-10-16 07:04

Site: Controller:

Change Configuration

Site	Charger	Charger T1A	Charger Test 1A	Key	Value
integtest	ChargerT1A	Charger Test 1A	Charger Test 1A	<input type="text"/>	<input type="text"/>

Now	Last meter update	Last charger update
	2020-11-17 13:17:34	--
	2020-11-17 13:17:34	--

ChargerT1A	Charger Test 1A	63010103	Available	6	6.00	--	--	--	--	2020-11-17 13:12:17
ChargerT1B	Charger Test 1B	63010104	Available	6	73.70	4.64	--	--	--	2020-11-17 13:17:37
ChargerT1C	Charger Test 1C	63010105	Available	6	--	--	--	--	--	2020-11-17 13:10:47

Showing 1 to 5 of 5 entries Previous **1** Next

For real time monitoring and control, the system facilitates data and control command over secure streaming protocol over 4G mobile or LAN network. Electric current and charging status can be viewed per station controller.

SmartEV Station v0.32

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- Account Management
- Site Management
- Data Monitor
- Historical Data
- Report
- User Profile

Site Control

Controller Status

Controller id	Last update	Build date
itestctrl001	2020-11-17 13:57:58	2020-10-16 07:04

Site: Controller:

devstruct: Total current: Total kVA:

Show entries Search:

Parking Slot	Location	Meter id	Charger Status	Max. Current (A)	Now Current (A)	L1 Now (A)	L2 Now (A)	L3 Now (A)	Last meter update	Last charger update
DevMainTestctrl001	Main Trunk	63010101	--	190	--	8.78	5.16	4.22	2020-11-17 14:01:23	--
63010102	Station	63010102	--	78.00	--	2.65	4.16	1.54	2020-11-17 14:01:23	--
ChargerT1A	Charger Test 1A	63010103	Charging	6	3.90	3.10	--	--	2020-11-17 14:01:23	2020-11-17 14:01:18
ChargerT1B	Charger Test 1B	63010104	Available	6	--	--	--	--	--	2020-11-17 14:00:42
ChargerT1C	Charger Test 1C	63010105	Available	6	--	--	--	--	--	2020-11-17 14:00:42

Showing 1 to 5 of 5 entries Previous **1** Next

A set of remote control on individual charger is provided, remote start transaction, remote stop transaction, unlock connector in case of operational issue in the site.

EV Car Charging System



SmartEV Station v0.32

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- Account Management
- Site Management
- Data Monitor
- Historical Data
- Report
- User Profile

Site Control

Controller Status

Controller id	Last update	Build date
itestctrl001	2020-11-17 13:22:48	2020-10-16 07:04

Site: integtest Controller: itestctrl001 Snapshot Update Halt

devstruct: DevStruct001 Total c: 5

Show 5 entries

Start Remote Txn

Site: integtest Charger: ChargerT1B Charger Test 1B
 Result:

No Yes

Parking Slot	Location	Now	L3 Now (A)	Last meter update	Last charger update					
DevMainTestctrl001	Main Trun	2	5.06	2020-11-17 13:17:34	--					
63010102	Station	3	1.82	2020-11-17 13:17:34	--					
ChargerT1A	Charger Test 1A	63010103	Available	6	6.00	--	--	--	2020-11-17 13:12:17	
ChargerT1B	Charger Test 1B	63010104	Available	6	73.70	4.64	--	--	2020-11-17 13:17:34	2020-11-17 13:17:37
ChargerT1C	Charger Test 1C	63010105	Available	6	--	--	--	--	2020-11-17 13:10:47	

Showing 1 to 5 of 5 entries Previous 1 Next

Control Charger Remote Start Txn Remote Stop Txn Unlock Connector Change Charger Availability Get Configuration Change Configuration

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This kind of command can also be integrated with external booking system such as using RFID or Octopus as in the first phase of EV station.

Data Report

Different kinds of data (consumption, charging status or transaction) are stored in the system. As the system employs industrial grade meter which is generally used by utility for bill calculation, two kinds of metering data are historical data stored in meter and snapshot meter data requested by station controller during charging. The system supports two ways of data collection, real time delivery and day-end data upload. This technique has been used since the first generation to include third party data such as Octopus files. In fact, the system in the first generation got information such as blacklist from Octopus headquarter and downloaded to the station controller.

SmartEV Station v0.32

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Account Management
Site Management
Data Monitor
Historical Data
Report
User Profile

Transaction History

Site: Start: End:

Show entries Search:

TxnId	Remote boxid	Position	Meter id	Charger id	Start Time	Start kWh	End Time	End kWh	Pay Channel	Pay id	Charger boxid	Charger Connector id	Charger Start Time	Charger End Time
itestctr001_149160001	--	Charger Test 1A	63010103	ChargerT1A	2020-10-22 13:49:55	38.10	2020-10-22 13:51:56	39.60	5	ChargerT1A	1022200001	10001	2020-10-22 13:49:55	2020-10-22 13:51:56
itestctr001_149160002	--	Charger Test 1B	63010104	ChargerT1B	2020-10-22 14:10:52	26.10	2020-10-22 14:11:50	26.80	5	ChargerT1B	1022200002	10002	2020-10-22 14:10:52	2020-10-22 14:11:50

Showing 1 to 2 of 2 entries Previous Next

To perform preliminary study on the behavior of charger for each transaction, the system provided sufficient information on charger status and consumption.

EV Car Charging System



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Account Management
 Site Management
 Data Monitor
 Historical Data Report
 User Profile

Transaction
 Site:
 Show entries Search:

Txid	Remote txid	Position	Meter id	Charger id	Start Time	Start kWh	End time	End kWh	Pay Channel	Pay id	Charger txid	Charger Connector id	Charger Start Time	Charger End Time
itestchr001_14A110001	--	Charger Test 1B	63010104	ChargerT1B	2020-11-17 13:14:58	35.20	2020-11-17 13:17:36	37.15	5	ChargerT1B	1117200001	10002	2020-11-17 13:14:58	2020-11-17 13:17:36
itestchr001_149160002	--	Charger Test 1B	63010104	ChargerT1B	2020-10-22 14:10:52	26.10	2020-10-22 14:11:50	26.80	5	ChargerT1B	1022200002	10002	2020-10-22 14:10:52	2020-10-22 14:11:50
itestchr001_149160001	--	Charger Test 1C											2020-10-22 13:49:55	2020-10-22 13:51:56
itestchr001_127070001	--	Charger Test 1C											2018-08-07 23:20:40	2018-08-07 23:21:18
itestchr001_126180001	--	Charger Test 1C											2018-07-24 00:00:12	2018-07-24 00:01:57
itestchr001_126170005	--	Charger Test 1C											2018-07-23 23:55:32	2018-07-23 23:56:00
itestchr001_126170004	--	Charger Test 1E											2018-07-23 23:46:17	2018-07-23 23:47:44
itestchr001_126170003	--	Charger Test 1C											2018-07-23 23:33:23	2018-07-23 23:35:02
itestchr001_126170002	--	Charger Test 1C											2018-07-23 23:27:37	--
itestchr001_126170001	--	Charger Test 1C											2018-07-23 22:32:51	2018-07-23 22:34:23
itestchr001_126110001	--	Charger Test 1C											2018-07-17 20:14:32	2018-07-17 20:15:24
itestchr001_1260D0002	--	Charger Test 1A	63010103	ChargerT1A	2018-07-13 01:17:42	26415.80	2018-07-13 01:18:05	26415.90	5	ChargerT1A	713180002	10001	2018-07-13 01:17:41	2018-07-13 01:18:05
itestchr001_1260D0001	--	Charger	63010103	ChargerT1A	2018-07-13	26384.22	2018-07-13	26384.84	5	ChargerT1A	713180001	10001	2018-07-13	2018-07-13

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Account Management
 Site Management
 Data Monitor
 Historical Data Report
 User Profile

Transaction
 Site:
 Show entries Search:

Txid	Remote txid	Position	Meter id	Charger id	Start Time	Start kWh	End time	End kWh	Pay Channel	Pay id	Charger txid	Charger Connector id	Charger Start Time	Charger End Time
itestchr001_14A110001	--	Charger Test 1B			2020-		2020-						2020-11-17 13:14:58	2020-11-17 13:17:36
itestchr001_149160002	--	Charger Test 1B											2020-10-22 14:10:52	2020-10-22 14:11:50
itestchr001_149160001	--	Charger Test 1A											2020-10-22 13:49:55	2020-10-22 13:51:56
itestchr001_127070001	--	Charger Test 1A											2018-08-07 23:20:40	2018-08-07 23:21:18
itestchr001_126180001	--	Charger Test 1A											2018-07-24 00:00:12	2018-07-24 00:01:57
itestchr001_126170005	--	Charger Test 1C											2018-07-23 23:55:32	2018-07-23 23:56:00
itestchr001_126170004	--	Charger Test 1B											2018-07-23 23:46:17	2018-07-23 23:47:44
itestchr001_126170003	--	Charger Test 1A											2018-07-23 23:33:23	2018-07-23 23:35:02
itestchr001_126170002	--	Charger Test 1A											2018-07-23 23:27:37	--
itestchr001_126170001	--	Charger Test 1A	63010103	ChargerT1A	2018-07-23 22:32:50	31094.18	2018-07-23 22:34:22	31094.64	5	ChargerT1A	723180001	10001	2018-07-23 22:32:51	2018-07-23 22:34:23
itestchr001_126110001	--	Charger Test 1A	63010103	ChargerT1A	2018-07-17 20:14:35	28474.84	2018-07-17 20:15:27	28475.10	5	ChargerT1A	717180001	10001	2018-07-17 20:14:32	2018-07-17 20:15:24
itestchr001_1260D0002	--	Charger Test 1A	63010103	ChargerT1A	2018-07-13 01:17:42	26415.80	2018-07-13 01:18:05	26415.90	5	ChargerT1A	713180002	10001	2018-07-13 01:17:41	2018-07-13 01:18:05
itestchr001_1260D0001	--	Charger	63010103	ChargerT1A	2018-07-13	26384.22	2018-07-13	26384.84	5	ChargerT1A	713180001	10001	2018-07-13	2018-07-13

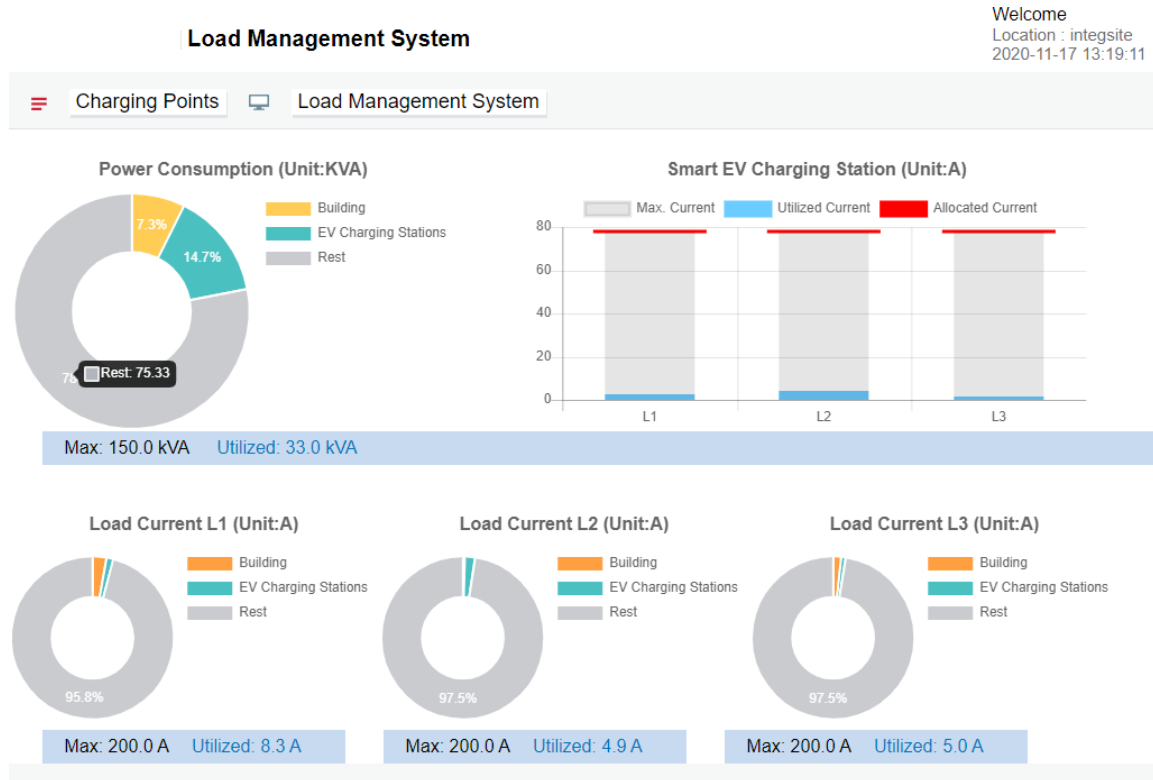
Although only one meter consumption can be displayed, data export provides all metering consumption during transaction. These kinds of information provide background study on how effective the power management module and also as the criteria of upgrading electricity supply.

EV Car Charging System



Station Controller

Additional screen is also provided about the power usage in real time. This screen is also available in separate server page.



EV Car Charging System



Technical Information

Both server and station controller are running on Intel based platform, either Windows or Linux. Its backend database is MSSQL that can either be running on Windows or Linux. The hardware requirement for station controller is Pentium based CPU on Ubuntu subject to number of chargers supported. For those chargers that cannot support OCPP, standalone application which acts as OCPP client with Modbus command can be used.

All the software is written in pure Java with sets of open source software such as Spring Framework, Mybatis, OCPP library, Apache Tiles, JQuery and Web socket.