Charging stations – Beckhoff Lummen

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Principle

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As we only have 3x 32A in our parking lot, we designed an automated charging system using:

- standard power measurement
- relays to switch on/off wall mounted power sockets
- RFID readers
- sensor/indicator devices

With this set up we can control when cars can be charged using the standard 230Vac charging cable with a reasonable investment cost.

As we currently only have hybrid cars, the charging speed is sufficient.

Electrical set up

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For each of our 9 parking spaces with charging capabilities, we have installed:

- A switched relay and a 230Vac power socket
- An Aceprox RS485 RFID reader
- A BACnet sensor/LED indicator

For the main power, we measure the current consumption on all 3 fases.

Electrical set up: Power infeed (complete installation)

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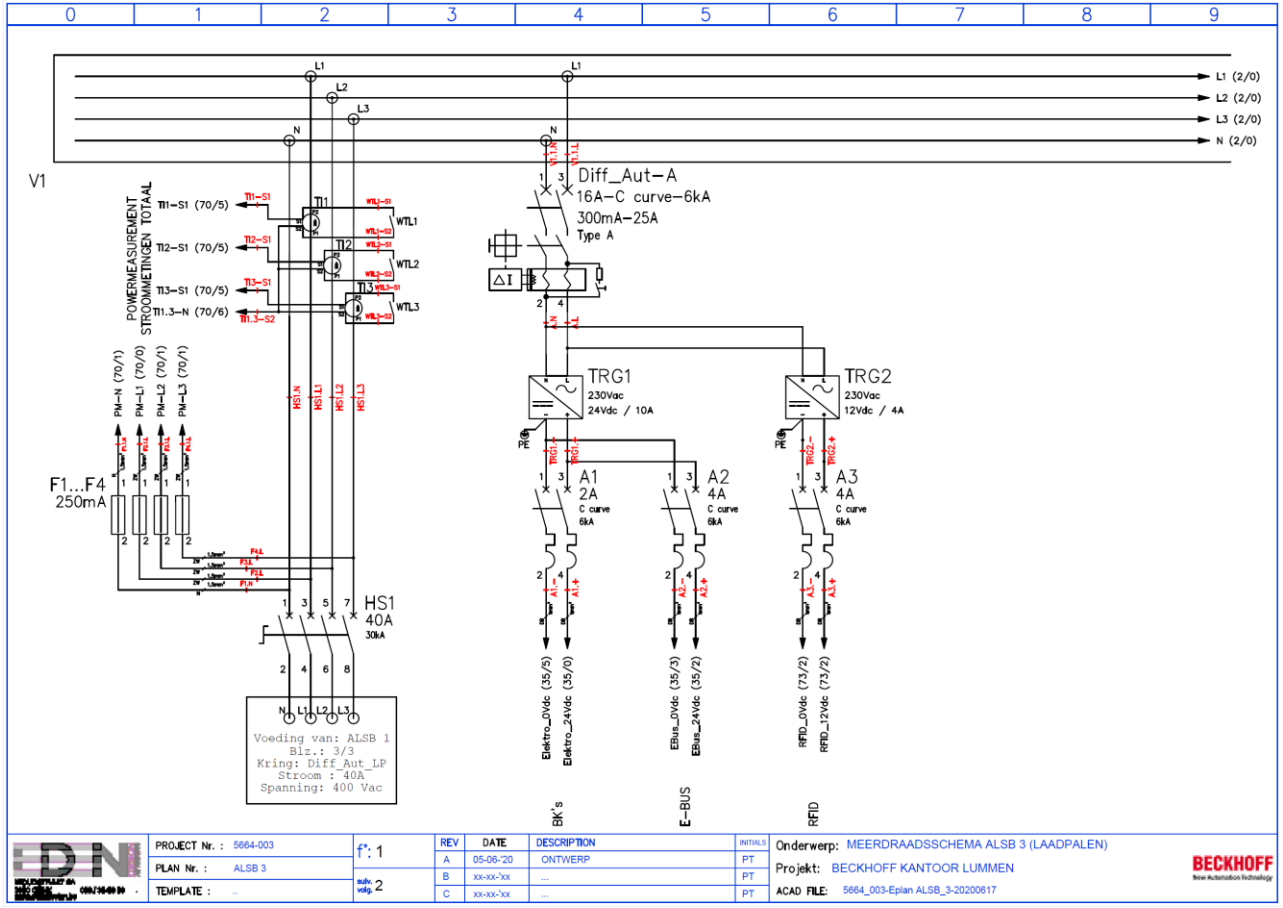
For the power infeed for the complete charging installation, we have installed a 3-fase power measurement system with our own components (IO terminals and TI's).

These measurements are used to measure the complete power consumption (charging and internal components) to enable us to influence the charging as accurate as possible.



Electrical set up: Power measurement per charging station

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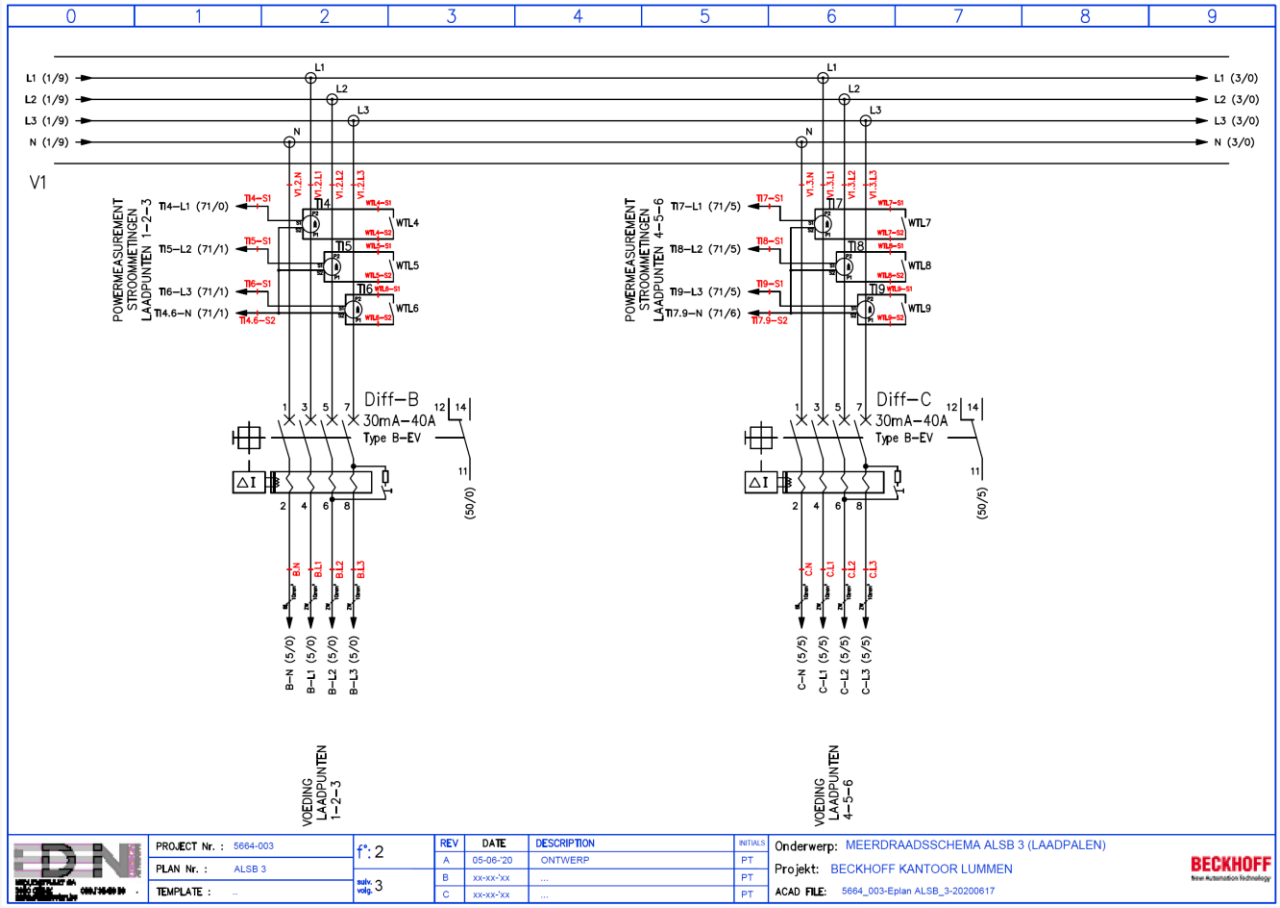
We also measure the power consumption per charging station, each time a single fase 230Vac power socket.

With this measurement, we can not only detect the maximum current a specific car consumes, but also how many kWh's are charged into the car.

The choice for a 230Vac power socket (instead of a 3-fase system), was based on the fact that each hybrid car is delivered with a charging cable for 230Vac.

The 230Vac socket limits the charging speed, but as we mostly can charge the whole day, this is not a problem.
Furthermore, using the standard charging cable saves us a lot of additional investment.



Electrical set up: Sensor and status indication

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We have installed sensors with an integrated multicolor LED that enables us to detect cars and to indicate the status of each charging station.

Status description	Indicator
The parking lot is empty and a car can be charged with a high current consumption (up to 16A maximum). *[Consult your system administrator to find out the maximum power consumption of your car.]*	GREEN 
The parking lot is empty and a car can be charged with a low power consumption (up to 10A maximum). *[Consult your system administrator to find out the maximum power consumption of your car.]*	PINK 
The parking lot is empty but there is currently not enough capacity to charge a car at this station. The station can already be registered, so that charging session will start automatically when the load on the grid has decreased. You can also log in with priority to get priority loading (read chapter badge reader for more information about loading with priority).	YELLOW 
The parking lot is occupied but no registration for a charging session has been made. This may be because the user has never logged in (e.g. because there is no need to charge or because it is not an electric car). This will also occur when the car has only recently been parked and the registration has not yet been made. This status will also occur when a car has not been charging for a certain time because the system will then automatically end the charging session.	ORANGE 
The car is registered on the system but is not currently being loaded. This can occur in two different situations. Or the car itself is no longer charging. In this case, the car will be logged off if it does not charge for a certain period of time. The other situation where this occurs is when the grid is overloaded and the charging session is temporarily paused.	PURPLE 
The car is currently being charged. The car is not charged with priority.	DARK BLUE 
The car is currently being charged. The car is charged with priority.	LIGHT BLUE 

IT set up: Database

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A MySQL database is used to store the badge ID numbers for all colleagues.

This database not only contains the badge ID’s, but also the data for the car linked to the user, like the max charging current.

We use this data to calculate the power consumption that is to be expected for this car.

We use this maximum value because the charging current is different throughout the charging cycle.

As an extension, we also store all charging transactions in the database to be able to generate reports per car, per user, …

Also an error log (f.e. why was a charging session stopped) is integrated to enable diagnostics

Hardware overview

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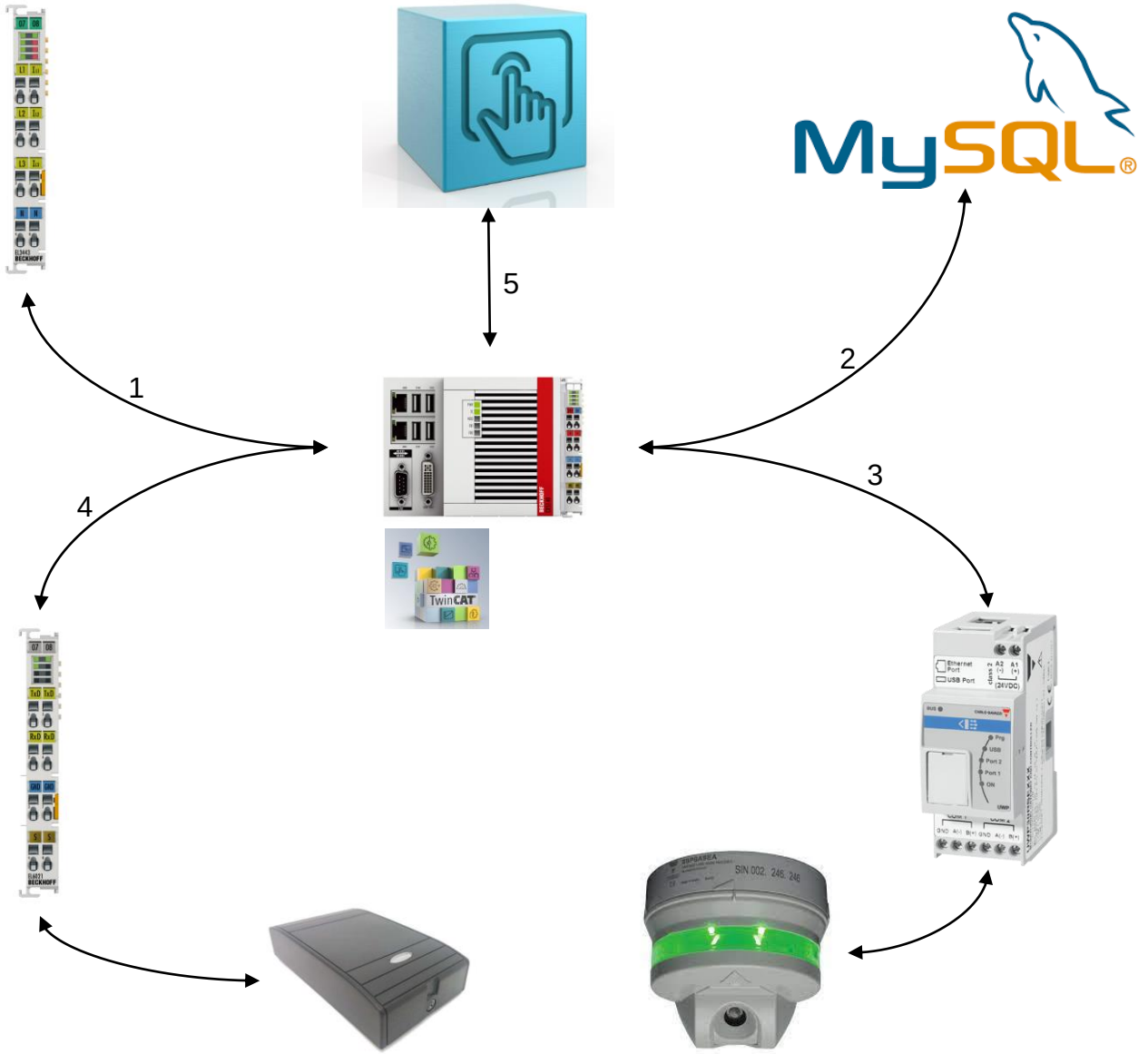
The hart of the system is a CX5140 running TC3, combined with:

1. Distributed power measurement (EL3443/EL3446) with SCT's (Current transformers)
   https://www.beckhoff.com/en-gb/support/webinars/webinar-detail_33546.html
2. TF6420 Database supplement to access (R/W) MySQL database.
   https://www.beckhoff.com/en-gb/products/automation/twincat/tfxxxx-twincat-3-functions/tf6xxx-tc3-connectivity/tf6420.html
3. TF8020 BACnet supplement to communicate with sensor-LED indicator combinations
   https://www.beckhoff.com/en-gb/products/automation/twincat/tfxxxx-twincat-3-functions/tf8xxx-tc3-industry-specific/tf8020.html
4. TF6340 Serial Communication supplement to communicate with RS485 RFID readers
   https://www.beckhoff.com/en-gb/products/automation/twincat/tfxxxx-twincat-3-functions/tf6xxx-tc3-connectivity/tf6340.html
5. TF2000 TcHMI to create a visualization
   https://www.beckhoff.com/en-gb/products/automation/twincat/tfxxxx-twincat-3-functions/tf2xxx-tc3-hmi/tf2000.html



Functionality: Simplified principle for starting a charging session

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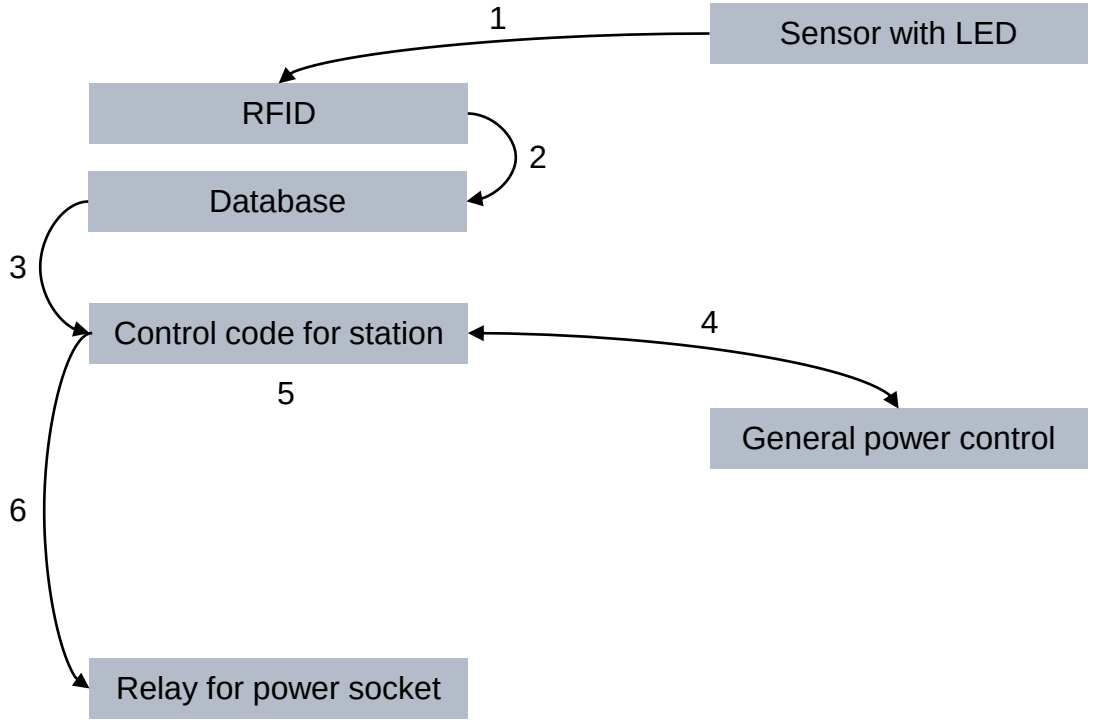
1. Enable RFID when car detected
2. Check if Tag Id is known and enabled
   Get car data (like max charging current)
3. Send relevant data to control code block for the specific charging station
   If tag is read 2 times in 2 seconds, request prioritized charging.
4. Check with general power measurement if enough current is available for this car.
5. Determine what to do:
    1. non-prioritized charging:
        1. If current available: Start charging
        2. If current not available: To wait list
    2. Prioritized charging
        1. If current available: Start charging
        2. If current not available:
            1. When non-prioritized charging sessions are active:
               stop non-prioritized charging sessions and check if additional charging is enough
            2. When no non-prioritized sessions are active:
               To wait list
6. Switch on relay depending on choice in step 5



Functionality : Simplified principle for stopping/pauzing a charging session

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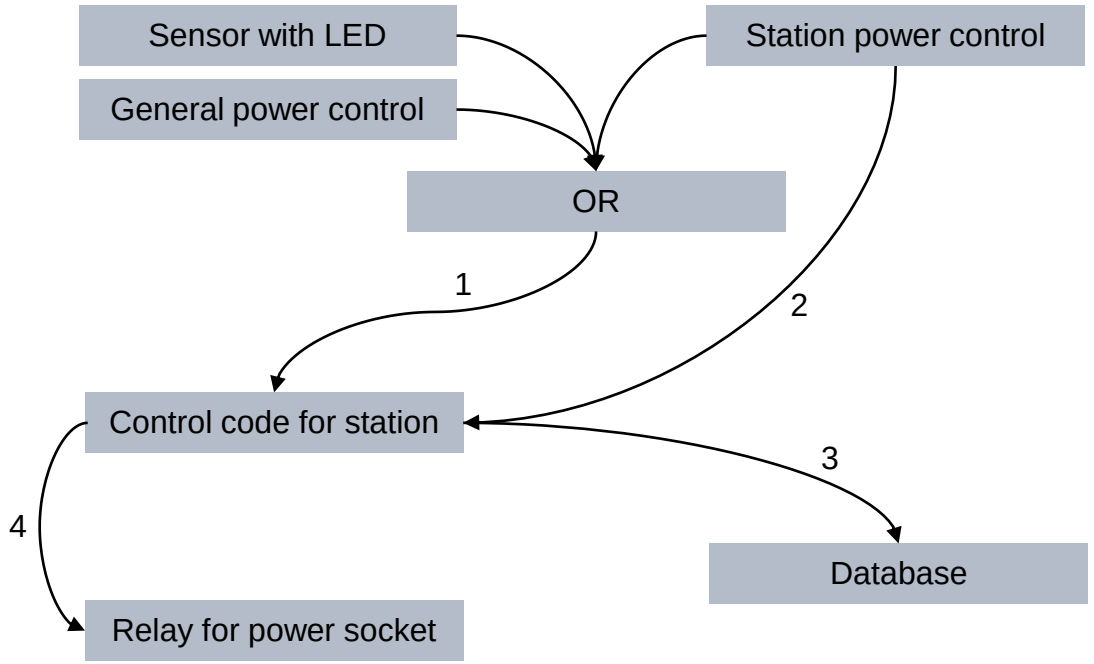
1. The session is stopped when either:
    1. The car is no longer detected
    2. There is an overcurrent on the phase the station is linked to
    3. The consumed current is 0 for a while
2. The charging session is paused when the active session is not prioritized and a prioritized session is requested while the remaining current is insufficient.
3. If a session is stopped, log the session data and the reason for stopping into the correct table in the database
4. Switch on/off relay

When a session is stopped, it needs to be restarted via the RFID reader or the visu to start charging again.

When a session is paused, it will resume as soon as sufficient current is available.

Session that were added to the wait list, are assumed to be paused. This means that they will start as soon as sufficient current is available.



Visualization: Desktop view (Local – HTML5 Website)

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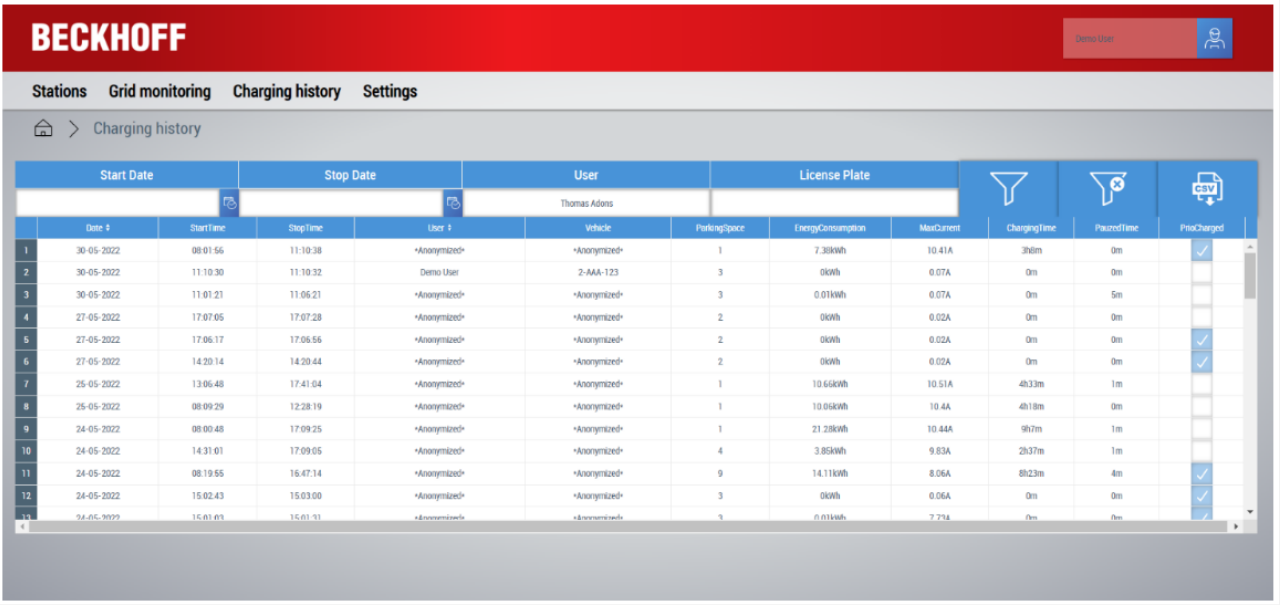

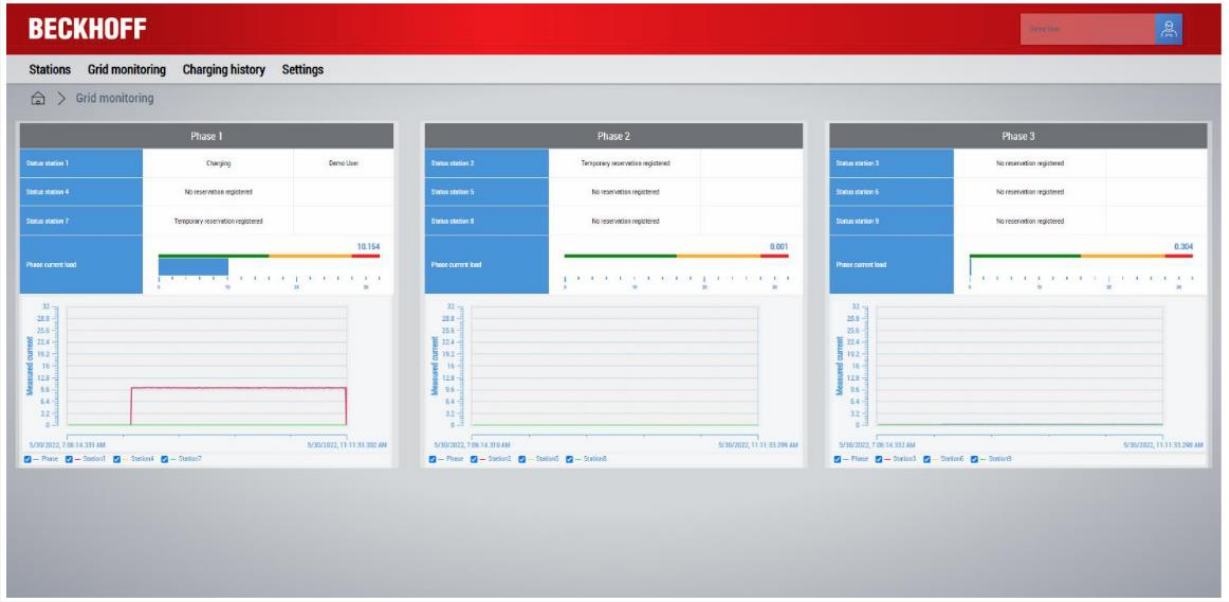

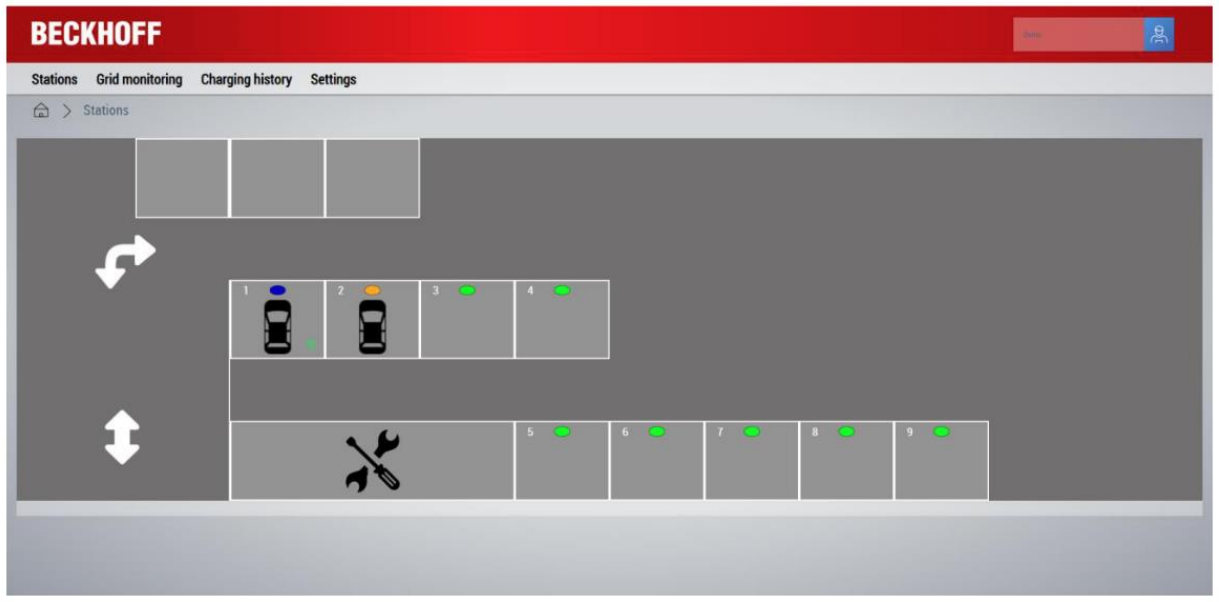

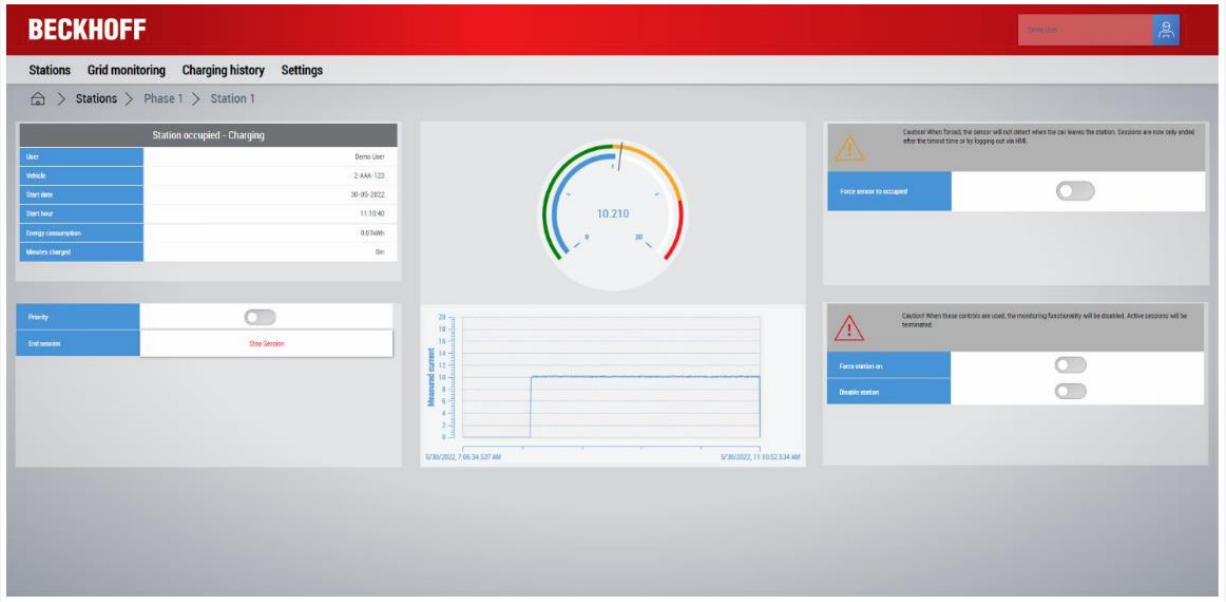

Visualization: Smartphone view (Local – HTML5 Website)

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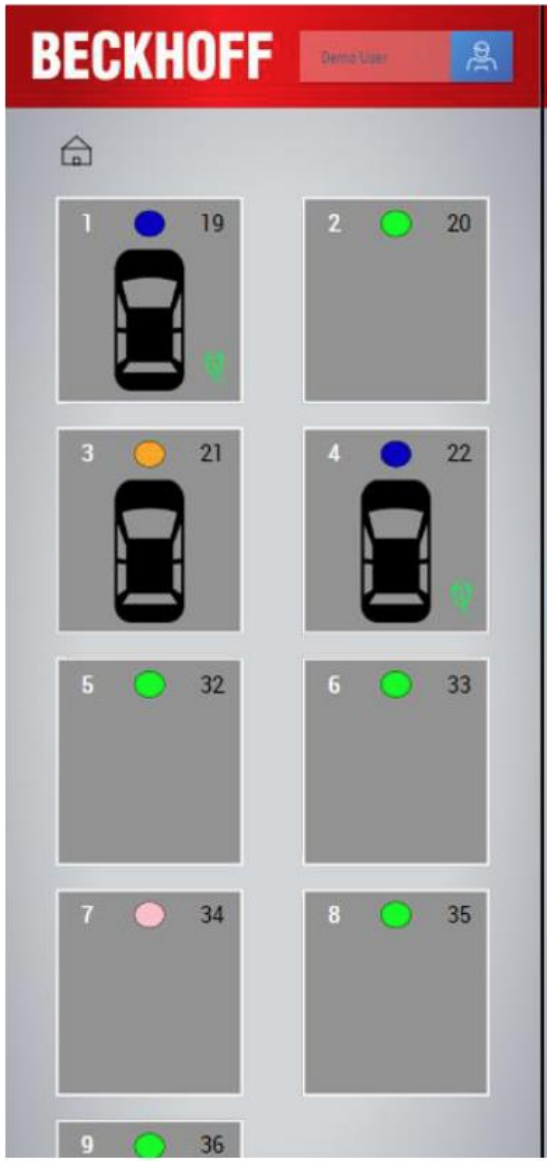

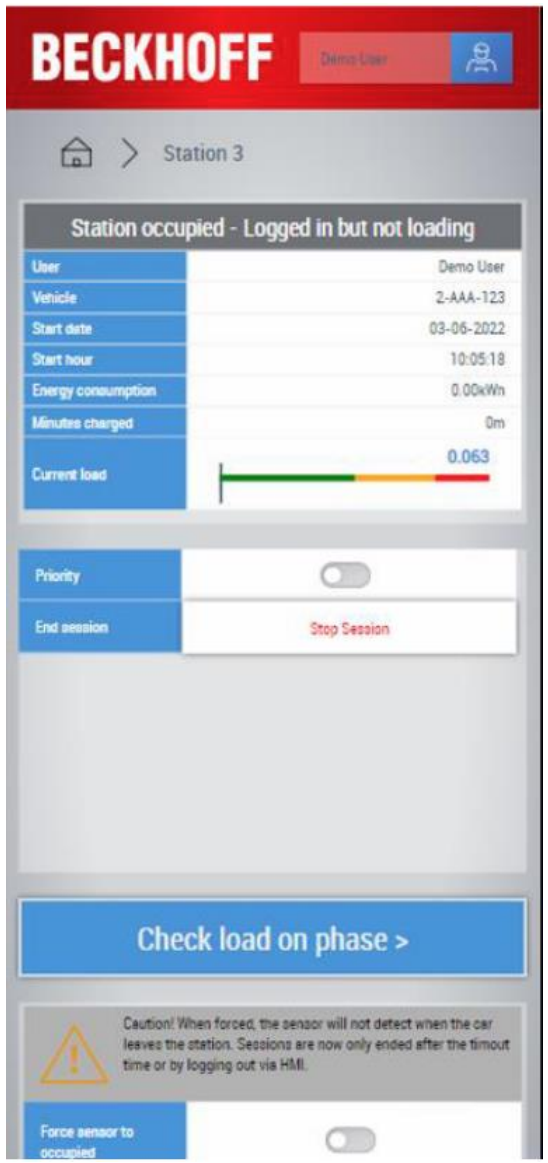

Visualization: Smartphone view (Remote – Communicator App)

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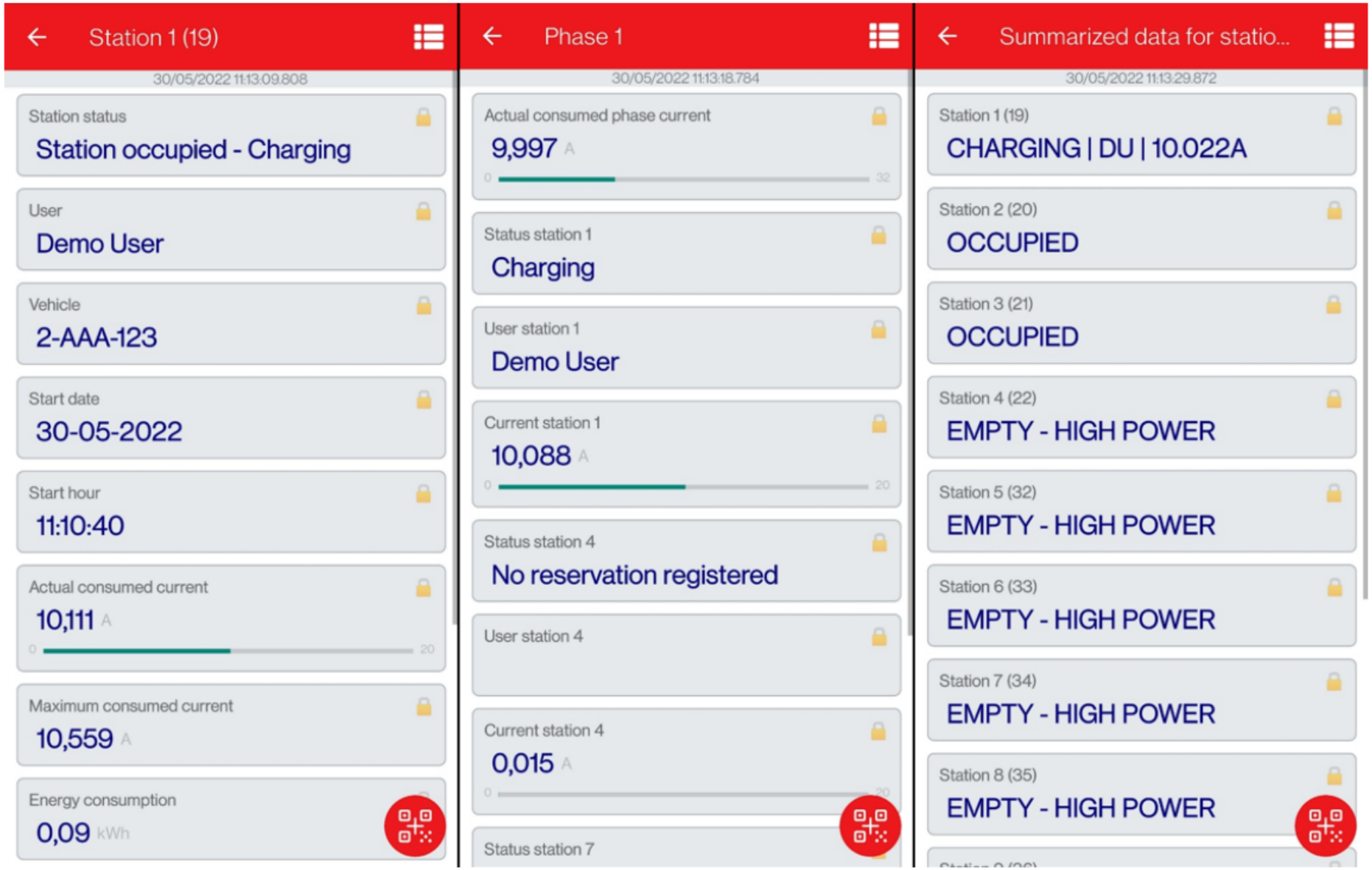

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