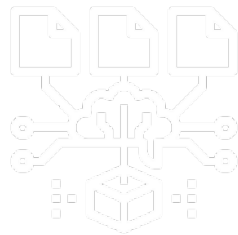


Qbuzz

Smart charging projects at Qbuzz

Content

- » Introduction to smart charging
- » Participation in IRIS project
- » Qbuzz timeline
 - » Past years
 - » Current situation
 - » Future
- » Recap



Introduction to smart charging

- » Smart charging: Not an widely accepted definition yet
- » In the context of Qbuzz: A charging system in which we control the charging pattern of the electric bus at the depots
 - » Power and timing
 - » Total charged remains the same
- » Why smart charging?
 - » Control the peak power
 - » Less impact on the grid
 - » Enables a smaller connection to the grid
 - » Reduced electricity costs
 - » Control timing of consumption
 - » Reduced electricity costs

Participation in the IRIS project

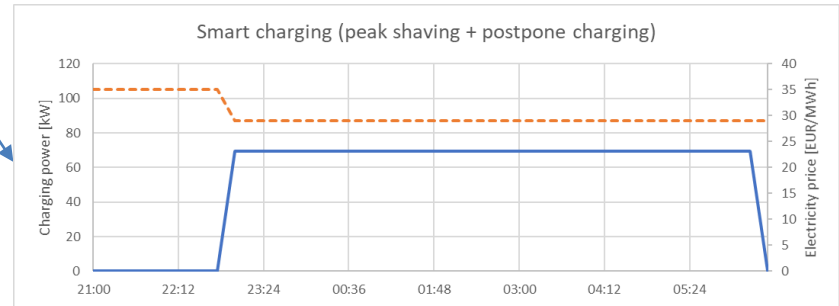
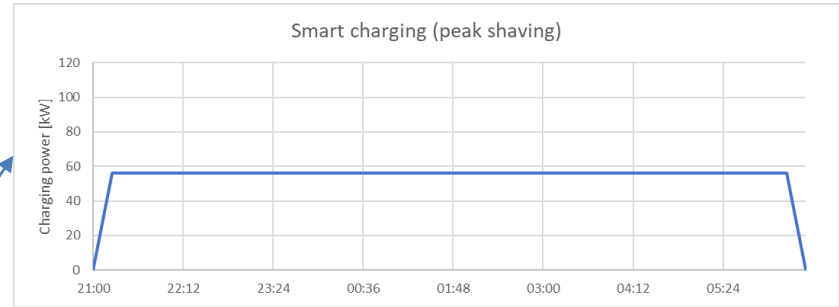
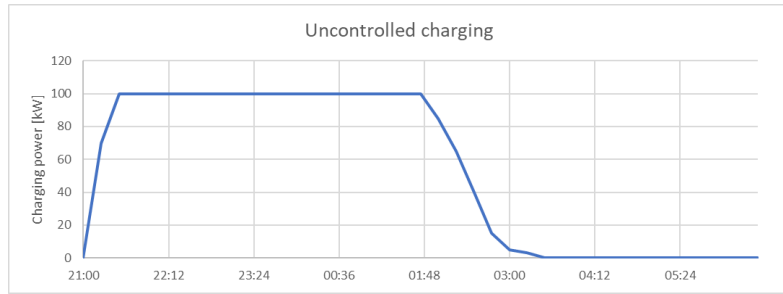
- » Horizon 2020 EU funded project
- » Duration: 5 years (2017-2022)
- » Participants: i.a. Utrecht University, Municipality of Utrecht, Qbuzz
- » Aim: Accelerate the adoption of energy, mobility and ICT initiatives
- » Our contribution: Sharing data for analysis, research etc.



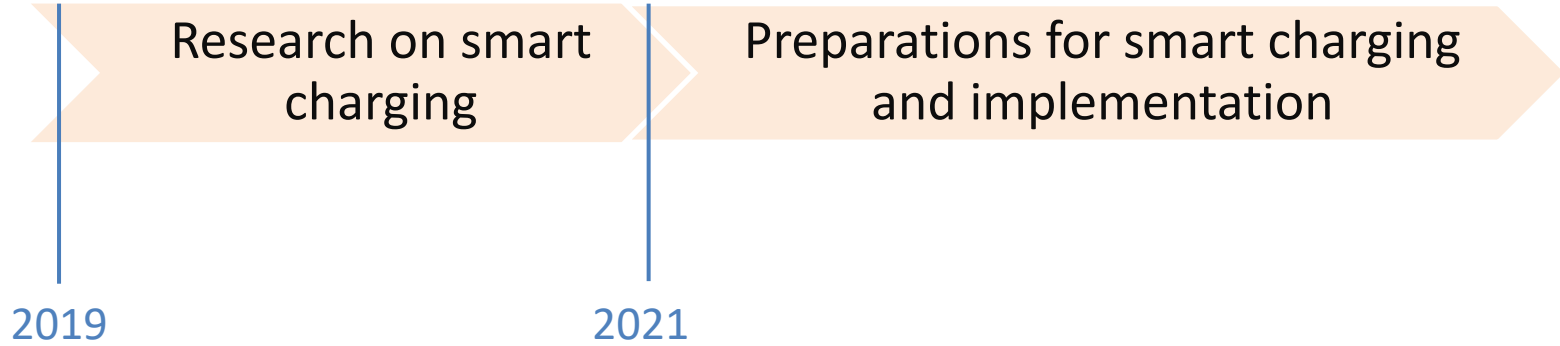
**Utrecht
University**



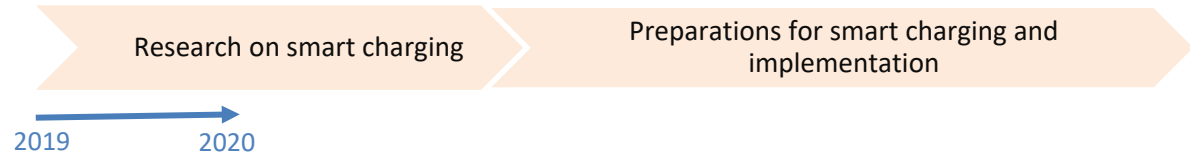
Introduction to smart charging



Timeline



Past years



» Thesis Marle Zijlstra (Energy Science, UU)

» Aim:

» Compare the saving potential of 5 different smart charging strategies

- » Peak shaving
- » Day ahead market (DAM) trading
- » DAM trading + vehicle-2-grid
- » DAM trading + FCR (imbalance market)
- » DAM trading + aFRR (imbalance market)

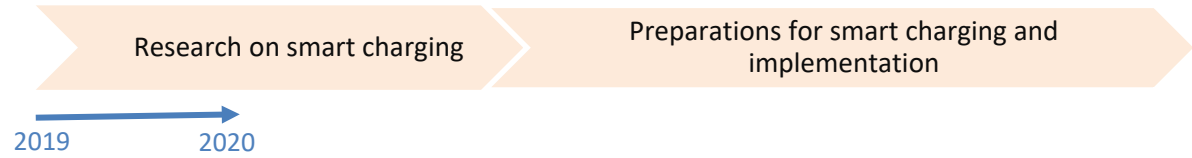
» Concluded most potential for:

- » Peak shaving: electricity cost reduction 16-21%
- » DAM trading: electricity cost reduction 43-48%

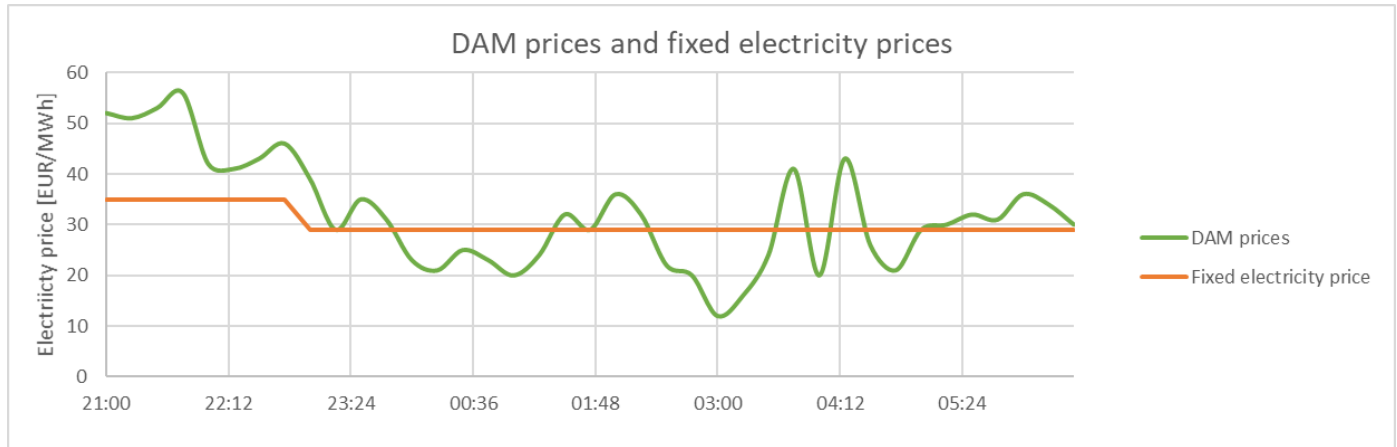
» Limitation:

- » DAM prices as well as electricity consumption were assumed to be given

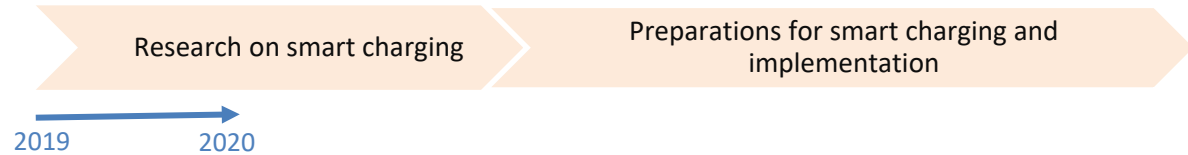
DAM



- » Hourly electricity prices and bigger price fluctuations
 - » Supply and demand based
 - » Higher saving potential



Past years



» Thesis Marle Zijlstra (Energy Science, UU)

» Aim:

» Compare the saving potential of 5 different smart charging strategies

- » Peak shaving
- » Day ahead market (DAM) trading
- » DAM trading + vehicle-2-grid
- » DAM trading + FCR (imbalance market)
- » DAM trading + aFRR (imbalance market)

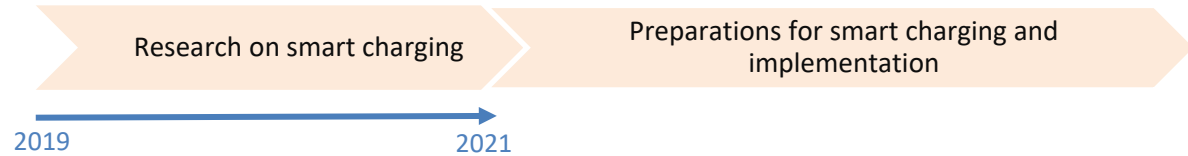
» Concluded most potential for:

- » Peak shaving: electricity cost reduction 16-21%
- » DAM trading: electricity cost reduction 43-48%

» Limitation:

- » DAM prices as well as electricity consumption were assumed to be given

Past years



» Follow-up thesis

» Aim:

- » Compare the saving potential of 3 different smart charging strategies
 - » Peak shaving
 - » Peak shaving + postpone charging (fixed electricity price based)
 - » DAM trading
- » Based on unknown DAM prices and electricity consumption

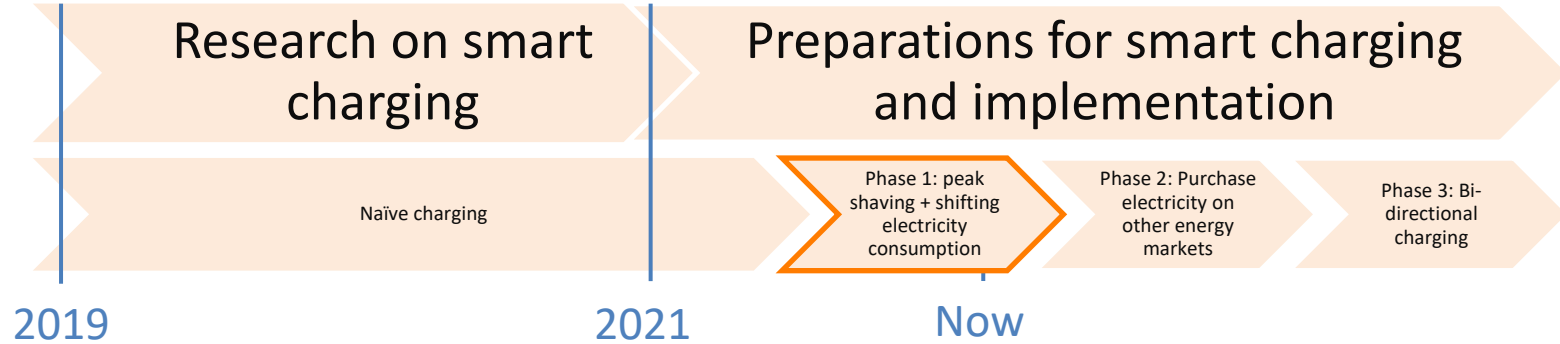
» Conclusion:

- » Peak shaving: electricity cost reduction 7-15%
- » Peak shaving + postpone charging: electricity cost reduction 10-16%
- » DAM trading: electricity cost reduction 7-53%

Timeline and charging strategies



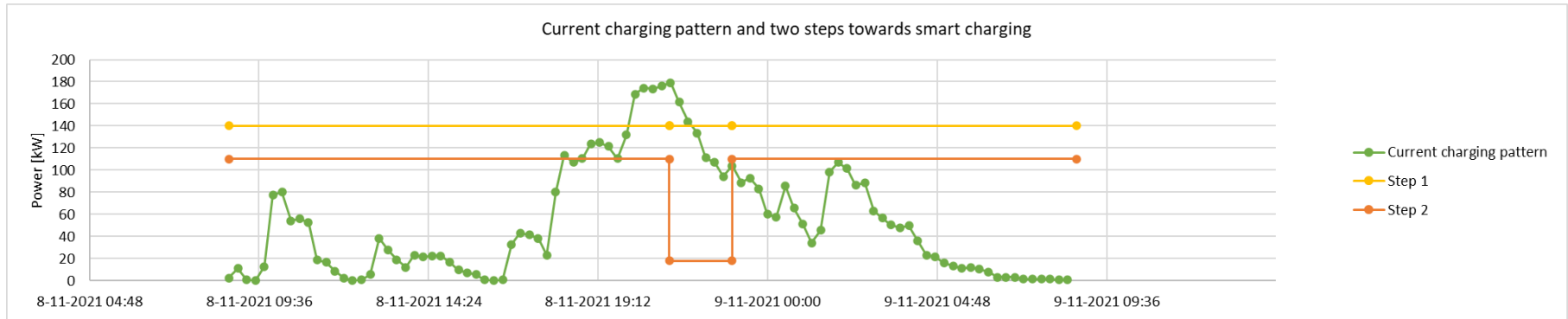
Current situation



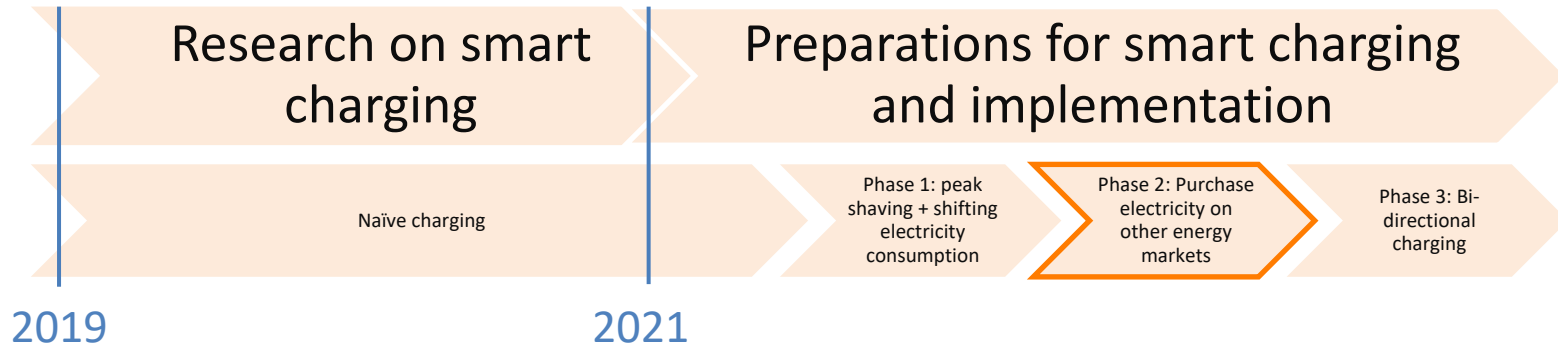
- » Preparation phase 1
 - » Testing hardware (chargers, buses) and software (ViriCiti)
 - » Determine limits using an optimization model
 - » Principle: all buses should be able to charge to 100% if they arrive with a SoC of 20%
- » First six depots in the coming weeks

Smart charging – example

- » Depot Zoutkamp
- » Step 1: Peak shaving
- » Step 2: Peak shaving + postponing charging

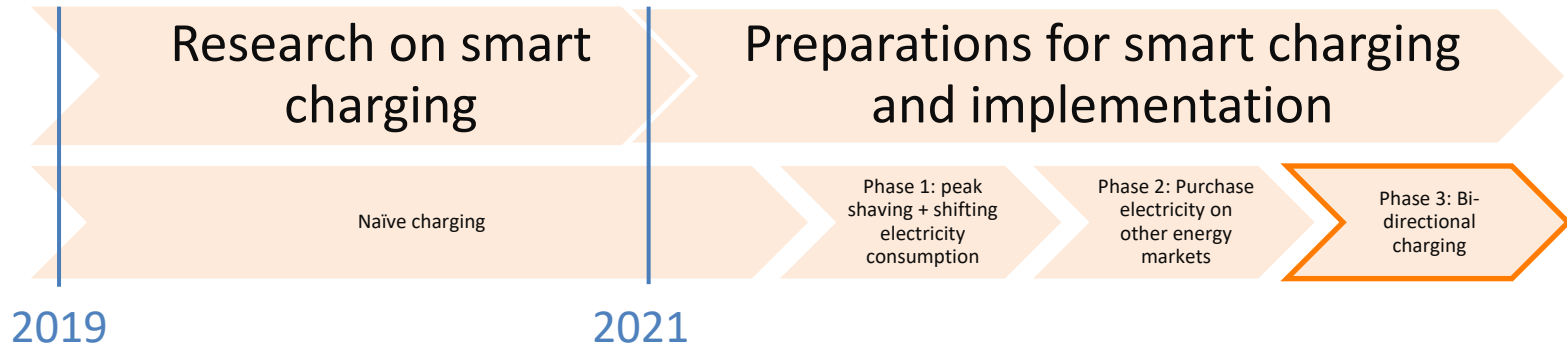


Future - phase 2



- » At the same time: Preparation phase 2
 - » Which energy markets are interesting for Qbuzz?
 - » What does trading at those energy markets involve?
 - » E.g. Hardware, software, third parties
 - » Is the businesscase profitable?

Future - phase 3



- » At the same time: Preparation phase 3
 - » Pilot with refurbished 90 kWh bus battery
 - » Aim: Explore potential for electricity costs reduction with bigger battery packages & practical experience
 - » Approach:
 - » Exploration possible strategies and requirements
 - » Explore businesscases >> GO/NO GO
 - » If GO: Start pilot

Recap

- » Smart charging: “A charging system in which we control the charging pattern of the electric bus at the depots”
- » Research has been conducted
- » Timeline has been set up
 - » Phase 1: Peak shaving and peak shaving + postpone charging
 - » Fixed electricity price based
 - » Phase 2: Purchase electricity on other energy markets
 - » Phase 3: Bi-directional charging
- » Lower our electricity costs

Qbuzz

Programme today

11:05	12:05	Parallel session 1 (Chair: Rien van Stigt) <u>ZOCHER</u> Experiences of ebusses by Keolis <i>Gretha van Velthuisen (Keolis)</i> Charging infra and spatial planning <i>Aart Reurink (Province of Utrecht)</i>
11:05	12:05	Parallel session 2 (Chair: Pascal Ravesteijn) <u>CHAPEL</u> Qdrive programme (Online) <i>Martin Vis (Qbuzz)</i> Monitoring of Zero Emission Buses <i>Martijn Rotteveel (CROW)</i>