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# What



- **ChArGED (CleAnweb Gamified Energy Disaggregation)**
- **H2020-EE-2015-2, Research and Innovation Action (RIA)**
- 3 Years (Mar 2016 - Mar 2019)
- [www.charged-project.eu/](http://www.charged-project.eu/)



## Objectives

- Address Energy Consumption in Public Buildings
- Motivate and Educate Employees to Save Energy in their work space through a **Gamified Mobile App**.
- Apply **Energy disaggregation** mechanisms that provide energy use and -consequently-wastages at the device, area and end user level.



# Main Motivation

- User Behavior
- **Example:** Poor occupant behavior on electricity consumption during non-occupied hours which are also identified by our measurements
  - 56% of the energy consumed in buildings happens outside working hours
  - lights and equipment are left on at the end of the day
  - poor zoning and controls.
- Behavior change spreads through social networks as a ‘social contagion’,
  - the behavior of friends and others influences choices, often on a subconscious level.



# Pilot sites

## **Greece, City of Athens IT Company**

- 1 Floor/60 Employees
- Typical office layout
- Solar micro-generation



## •**Barcelona, Catalan Institute of energy**

- 1 Floor / 60-80 Employees
- Open space



## •**Luxembourg, National Museum of History and Art**

- 2 Buildings / 60 Employees
- Personnel offices and exhibition rooms
- many Restrictions



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## Key Idea

Offer a mobile, gamified app to the office users towards improving their energy consumption behavior



# Game Design Approach

- **User-Centered** Approach
- Pilot site visits (all sites) -> collection of characteristics & opportunities for gamified energy savings per site
  - interviews (26 participants) with employees
- **Employees survey** (120 completed) -> collection of energy behaviour + personal & game related profiles
- Gamification Design Workshop Athens - Brainstorming on ChArGED gameplay, epics, user stories
- Selection of gamification concept / persona
  - 3 alternative concepts (Iceberg, Tree, Graph-Plain)
  - on-line survey (138 completed)
- Tree concept won





## Game: Main Characteristics

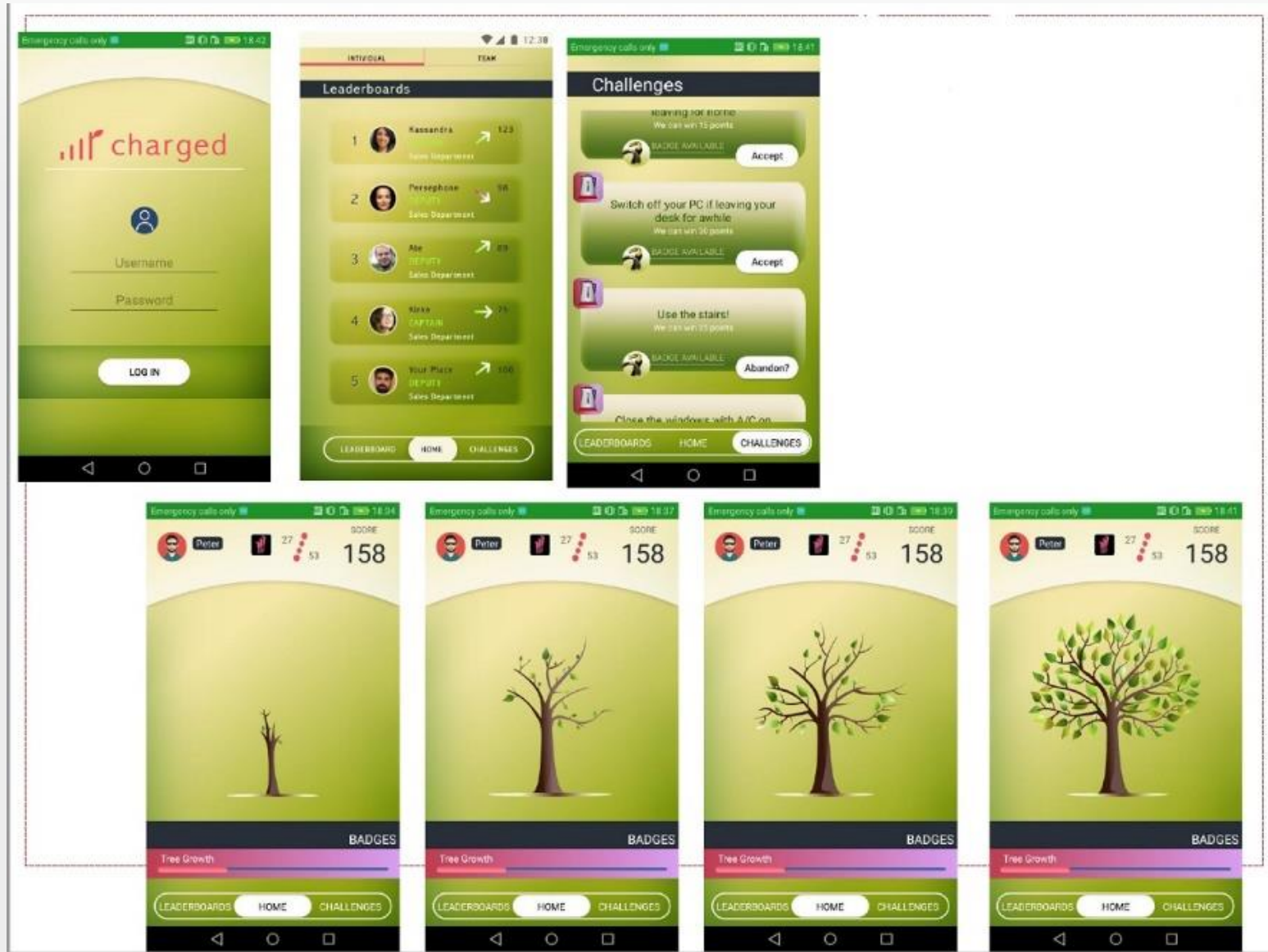
- *Tree persona*
- Team player, Individual player
- Achieve *Challenges*
- *Leaderboards* (team based, individual based)
- *Game elements*: points, levels, badges, roles
- Score, team status, current challenge are included in UI
- Onboarding process
- *Suggested actions* -> actions performed -> *rewards*
- devices/energy are visible -> players see their energy performance per device they interact with







# Game: Overview





# Game: Challenges

- Morning Challenges

e.g. “Lights on”, “elevator up”, “Coffee on” challenge

- Daily Challenges

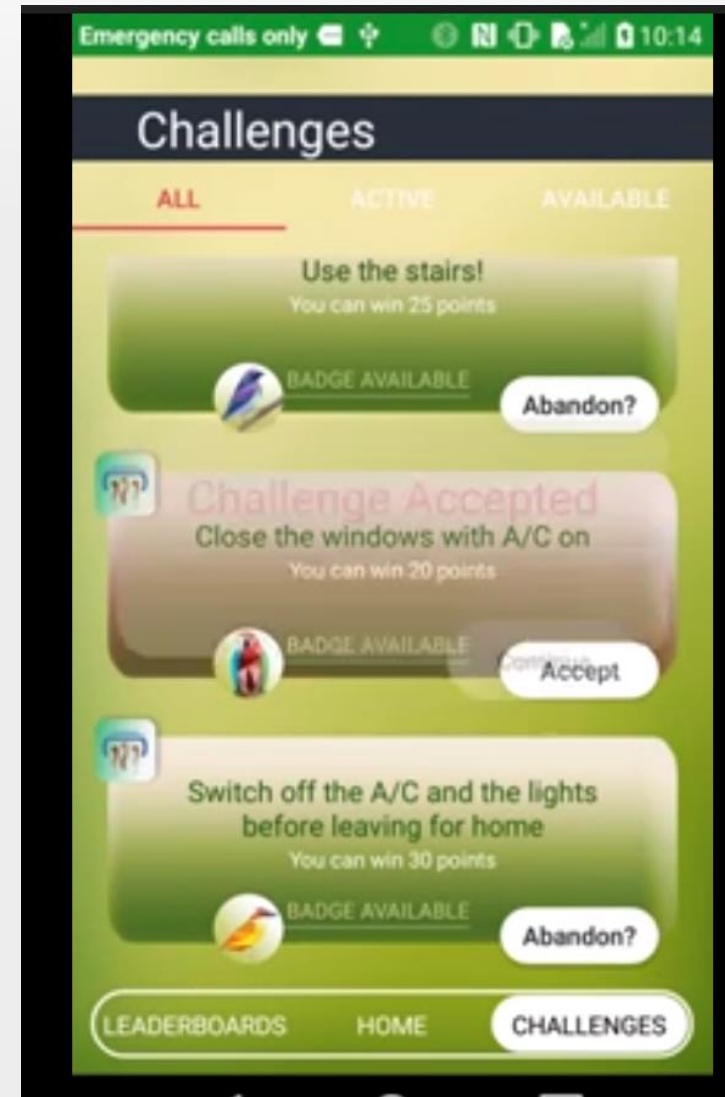
e.g. “Windows” challenge

“Away” challenge: When employees away from office >30 min, they are prompted to switch off unnecessary device. Evening Challenges

- Evening Challenges

e.g. “Lights off”, “elevator down”

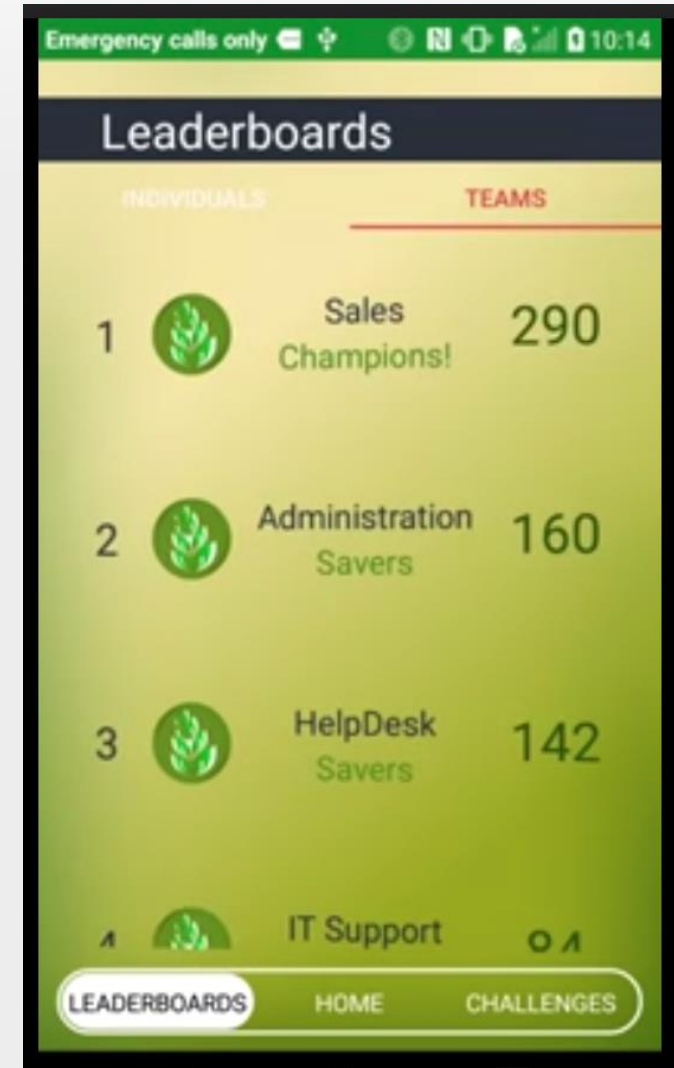
- Weekly/ Monthly/ Yearly Challenges



# Game: Accomplishments



- best performing team -> ChArGED Energy week/month/year **Champion**
- Best performing team member -> ChArGED Energy Week/Month/Year **Captain**
- 2<sup>nd</sup> best performing team member -> ChArGED Energy Week/Month/Year **Deputy**





# Game: Accomplishments & Badges

- Energy Champion/Deputy is earned consecutively → **star** won

- **4 star types:**

- **Bronze:** 2 weeks/months in a row
- **Silver:** 4 weeks/months in a row
- **Gold:** 8 weeks/months in a row
- **Platinum:** 10 Weeks/months in a row



- Players can also win stars by combining lower-rank stars e.g. 4 silver stars > 1 , 4 gold stars-> 1 platinum star
- More badges based on the challenges in the game e.g. check in Badge / Elevator up Badge



# Game: Player Ranking

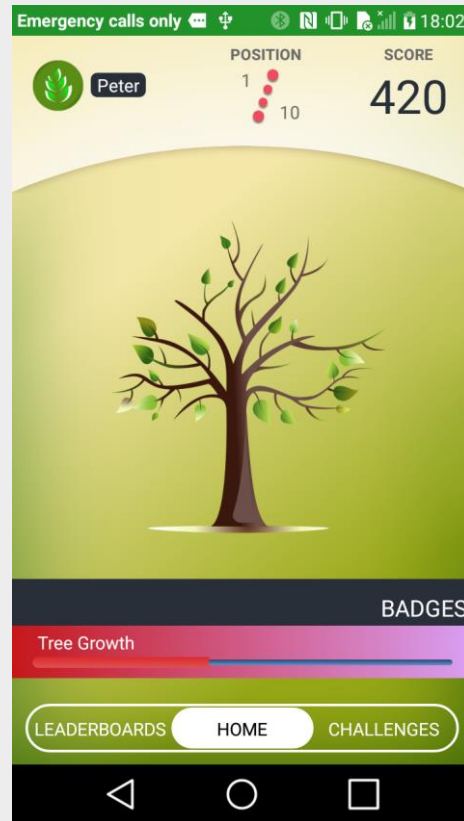


Energy Saving Rank (avatar per rank)	Description	(IND.) Points Threshold
<b>Beginner</b>	Just enrolled in the game, has not performed any actions (rank given with points from on boarding)	50
<b>Amateur</b>	Player earns the first basic bundle of points, becomes more experienced	100
<b>Pro</b>	Player has reached threshold of points that would need a relatively large number of actions	500
<b>Expert</b>	Truly conscious savers, with very large number of actions accrued. Only very active players – nr of points to get it should be challenging, but not unreal	1000



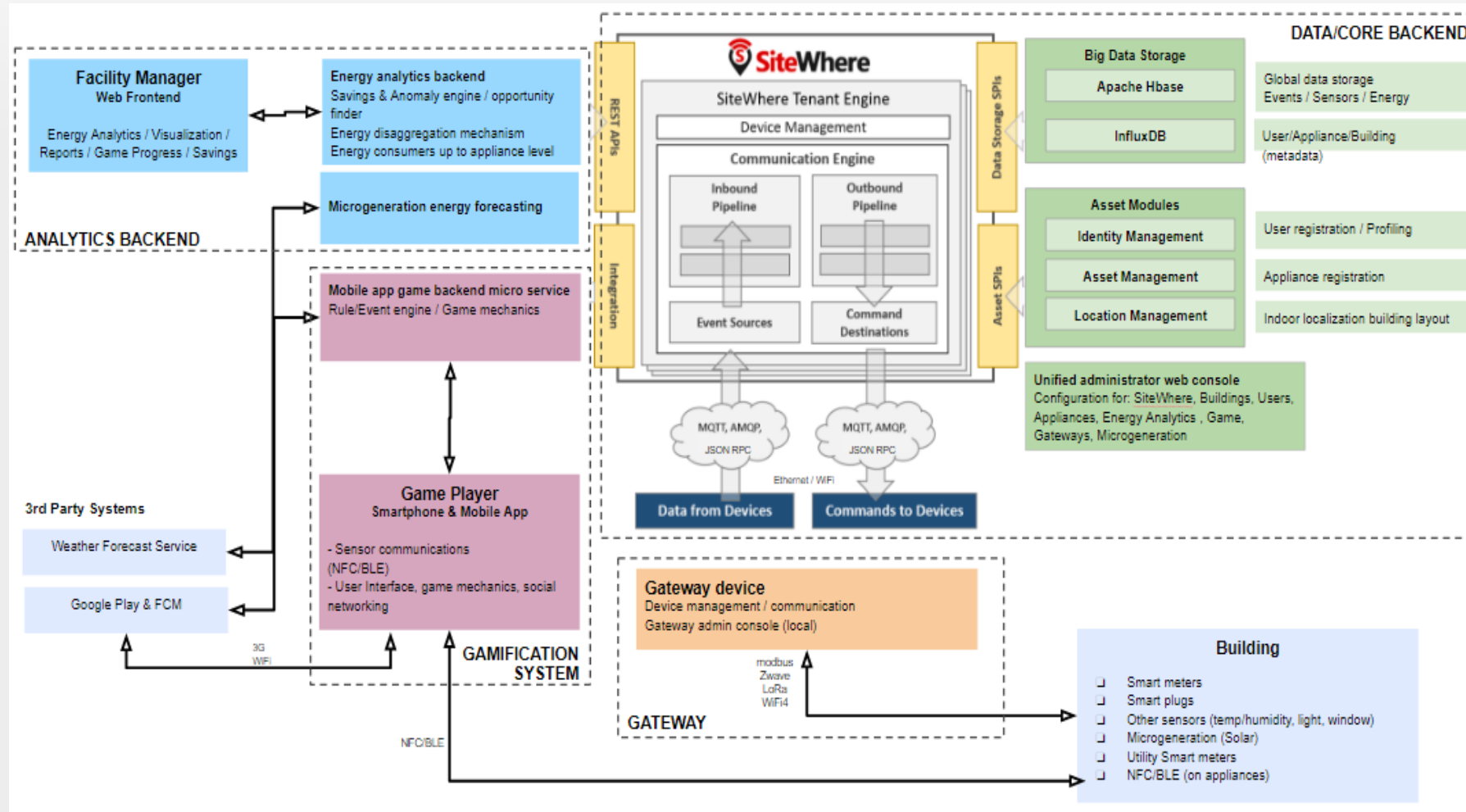
# Game: Tree reflecting Team's Progress

- one Tree per team
- The tree grows proportionally to the challenges won and actions performed.





# IoT-enabled architecture

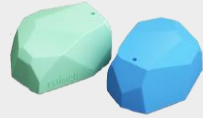


**Internet of Things** low-cost devices (smart plugs, NFC, iBeacons) monitor and record energy usage per room, per user, per device to improve energy disaggregation.





# IoT-enabled Real-time measurements



Inexpensive Devices to support disaggregation at the user/device level

- NFCs
- BLEs
- Fibaro Smart Plugs
- Multi-channel measuring devices
  
- Raspberry Pi 3 with USB Zwave Plus







# Energy Disaggregation and Analytics

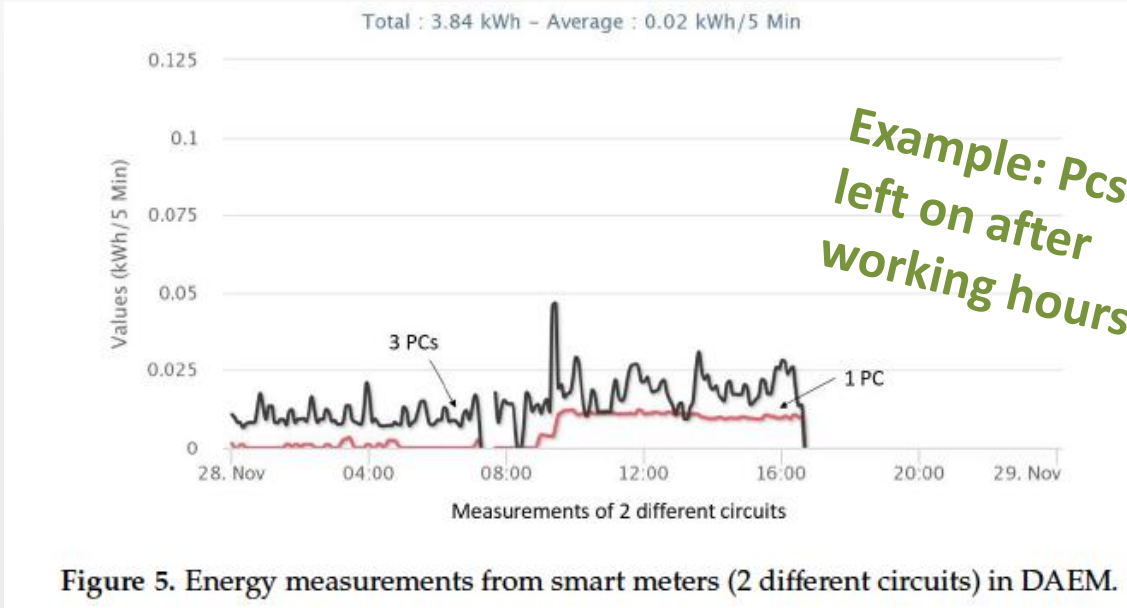
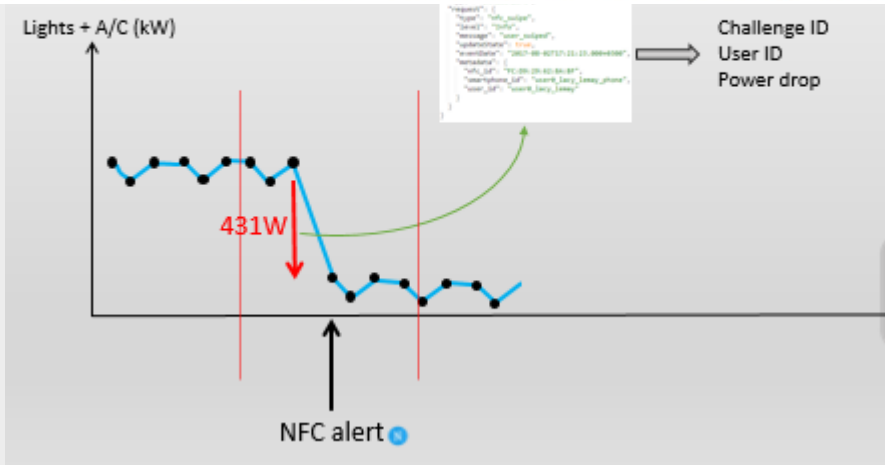


Figure 5. Energy measurements from smart meters (2 different circuits) in DAEM.



- Pre-post event analysis and anomaly detection
- Pre-event analysis: Identify energy wastages to target with behavior change
- Post-event: confirm the users' action and quantify the savings





# Microgeneration Forecasting



- Energy generation forecasting based on daily weather forecasts (hourly) (third party service)
- Solar inverter with rich data communication (Modbus) monitors the generated energy
- Challenges to direct the optimization of energy (e.g. charging your mobile phone)



# Validation Metrics

Energy Related Measures	Electrical consumption reduction
	Carbon footprint reduction
Users Feedback	green knowledge
	energy awareness level
	perceived Energy Usage
	perceived user satisfaction
Users Behavioral change	Perceived user intention to adopt the system (after pilot)
	users with a more green energy behavior (after the pilot)





# Validation Overview

*Goal:* Assessment of ChArGED solutions in terms of the original goals

- 1<sup>st</sup> Validation period
- 2<sup>nd</sup> Validation period
- 3<sup>rd</sup> Validation period

# Validation Instruments



- Pre-pilot questionnaire
- Post-pilot questionnaire
- Monitoring of actual app and web dashboard usage -> usage analytics
- Monitoring of actual energy consumption

# Innovation



- Gamified app with novel design
- Analytics for pre-post event identification
- Energy savings representation in real time (tree concept)
- Team and Personal challenges for engagement



# Contact us



Consortium



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[www.charged-project.eu](http://www.charged-project.eu)



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# Thank you

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