



# WeBike

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November 12, 2014

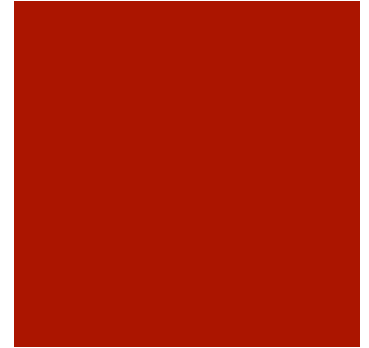
# What?

- A fleet of 31 instrumented eBikes on campus



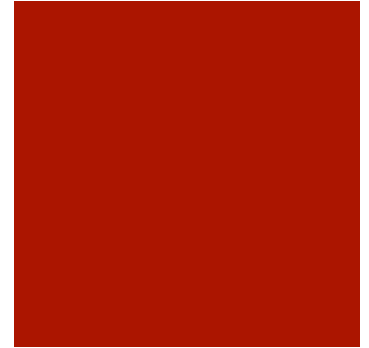
# Who uses them?

- UW faculty, staff, and students
  - Trustworthy
  - Are willing to have usage measured
- Selected using a comprehensive **survey**
  - based on **brain**/behaviour models
  - designed by **Prof. Tobias Schroeder**, U. Potsdam



# Why?

- Scaled down, **cheaper** version of EVs
- With solar charging, is a cost-effective **off-grid transportation** solution
- **Urban transport** alternative
- **Cool!**



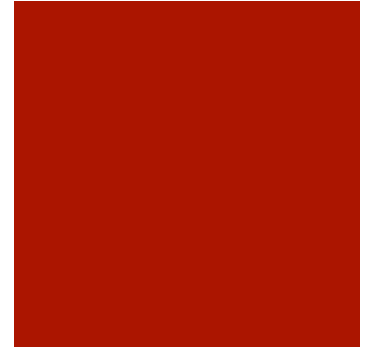
# When?

- Started deployment in July 2014
  - fully deployed in August 2014
  - data collection issues sorted out in mid-October 2014
  - clean data from all 30 bikes since November 7, 2014
- 3-year duration
  - Bikes handed off to users at the end of study



# Sensors

- Galaxy S III (Android)
  - Time
  - GPS location
  - Light (in lumens) for theft
  - Accelerometers
- Voltage
  - to infer battery state of charge
- Charging current
- Temperature sensors
  - inside sensor box
  - inside battery



# Sensors

Temperature sensor  
inside battery casing

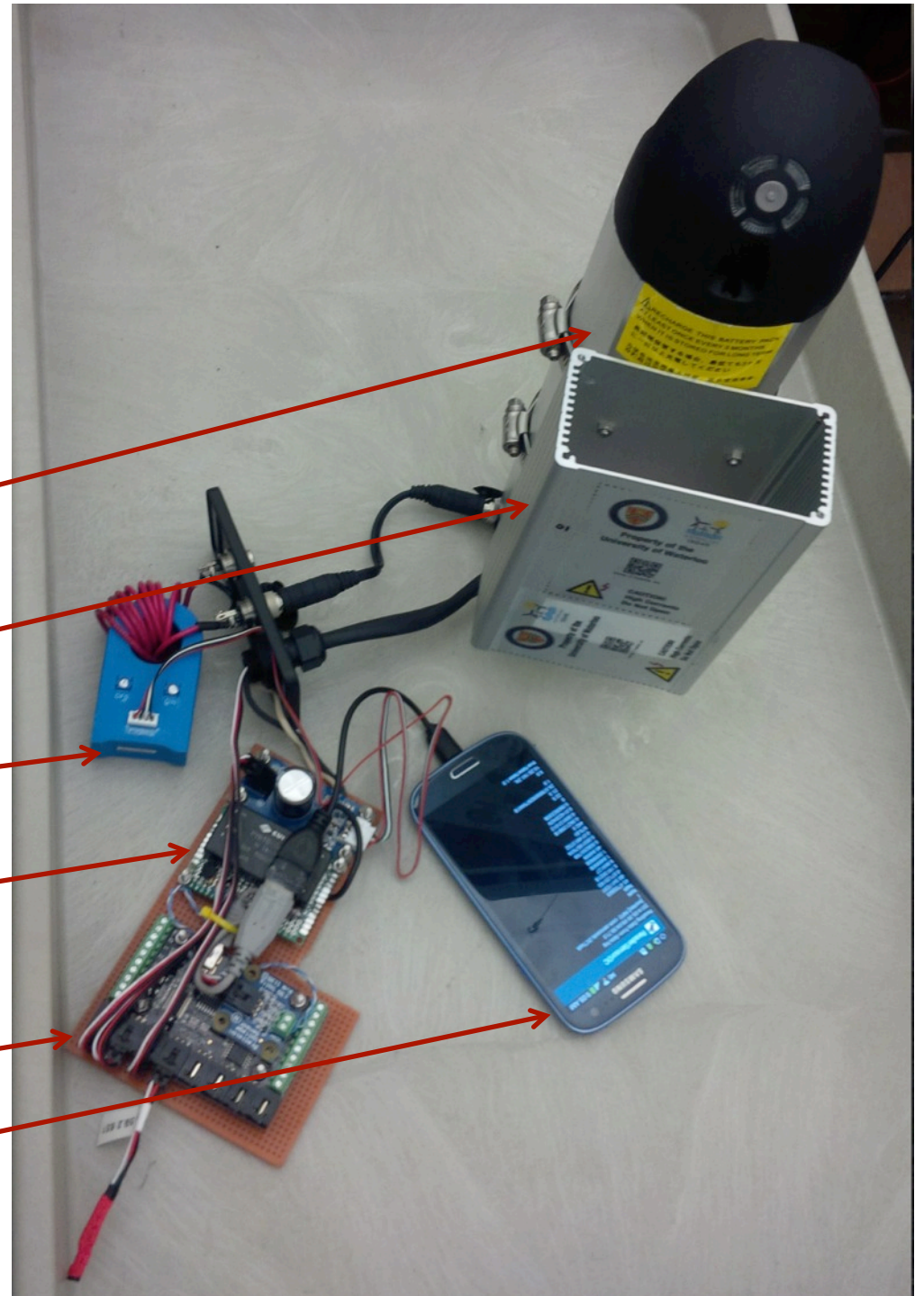
Sensor enclosure

Current sensor

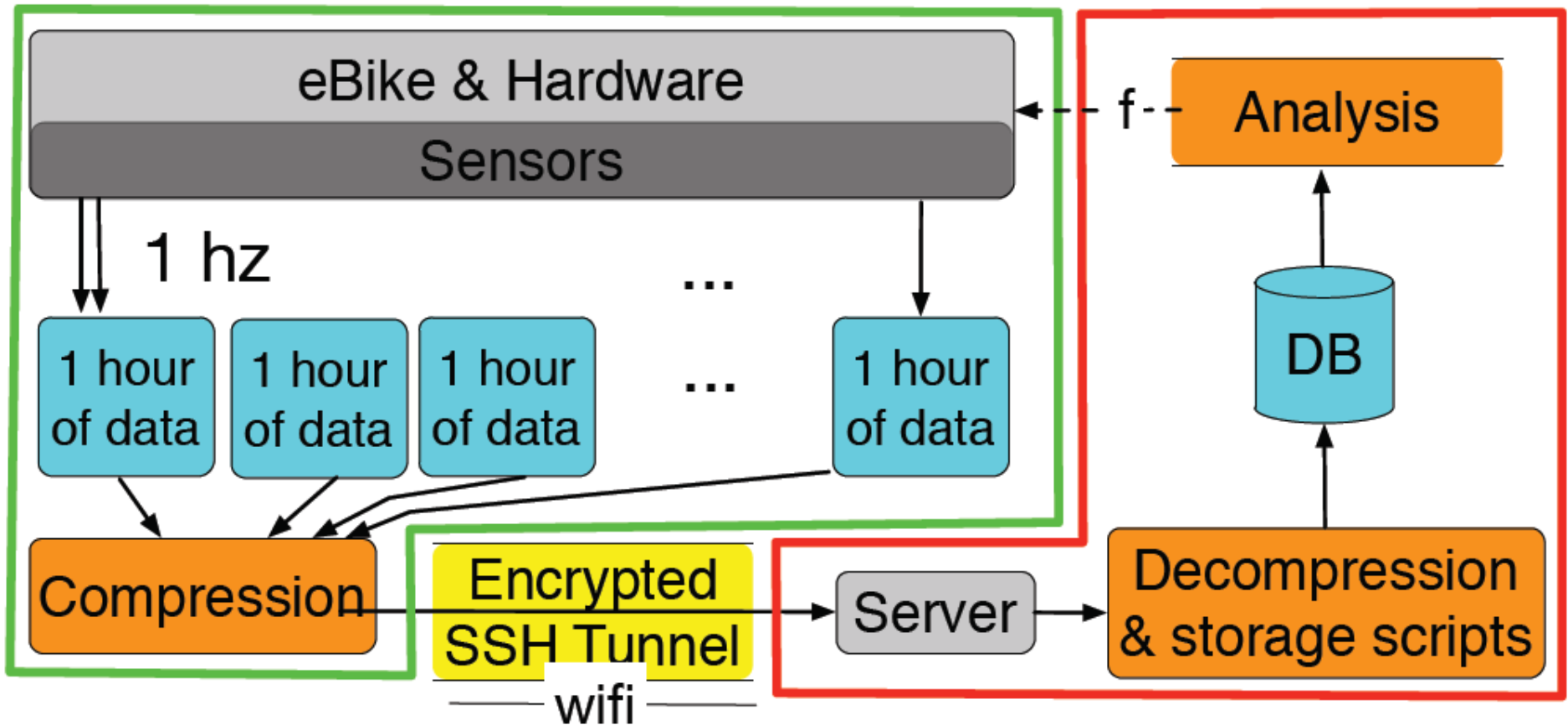
Voltage sensor

Phidget I/O board

Samsung galaxy

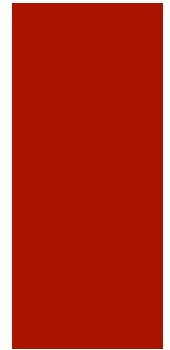


# Software system





# UI



### Trips On Day

mm/dd/yy:

### Biking Per Day

mm/dd/yy:

Num Days:

### Battery Life on Day

mm/dd/yy:

### Trip Distribution

mm/dd/yy:

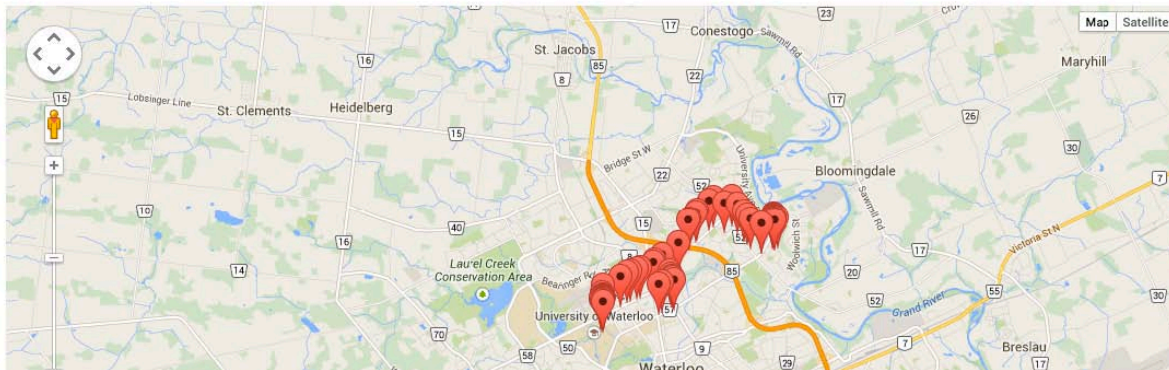
Num Days:

### Speed On Day

mm/dd/yy:

### Google Maps

mm/dd/yy:



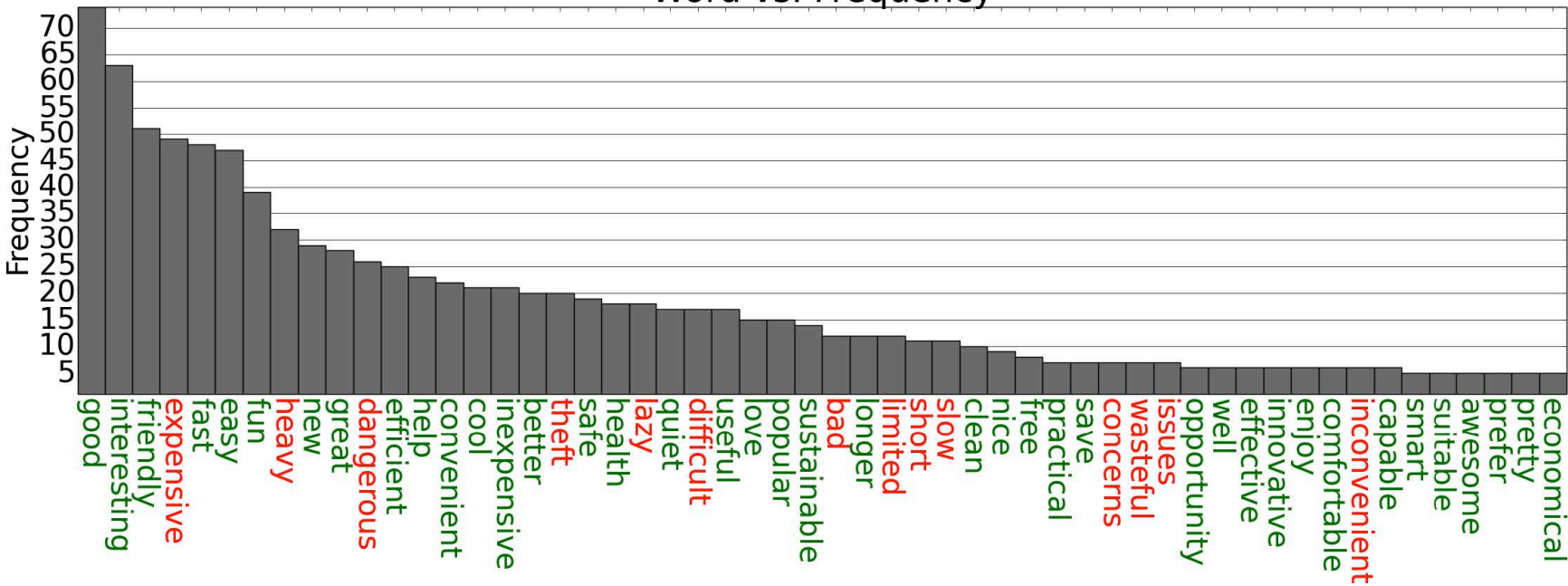
# Results



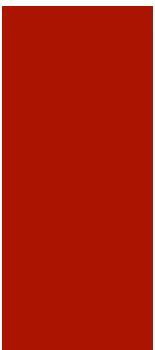
# Sentiment analysis



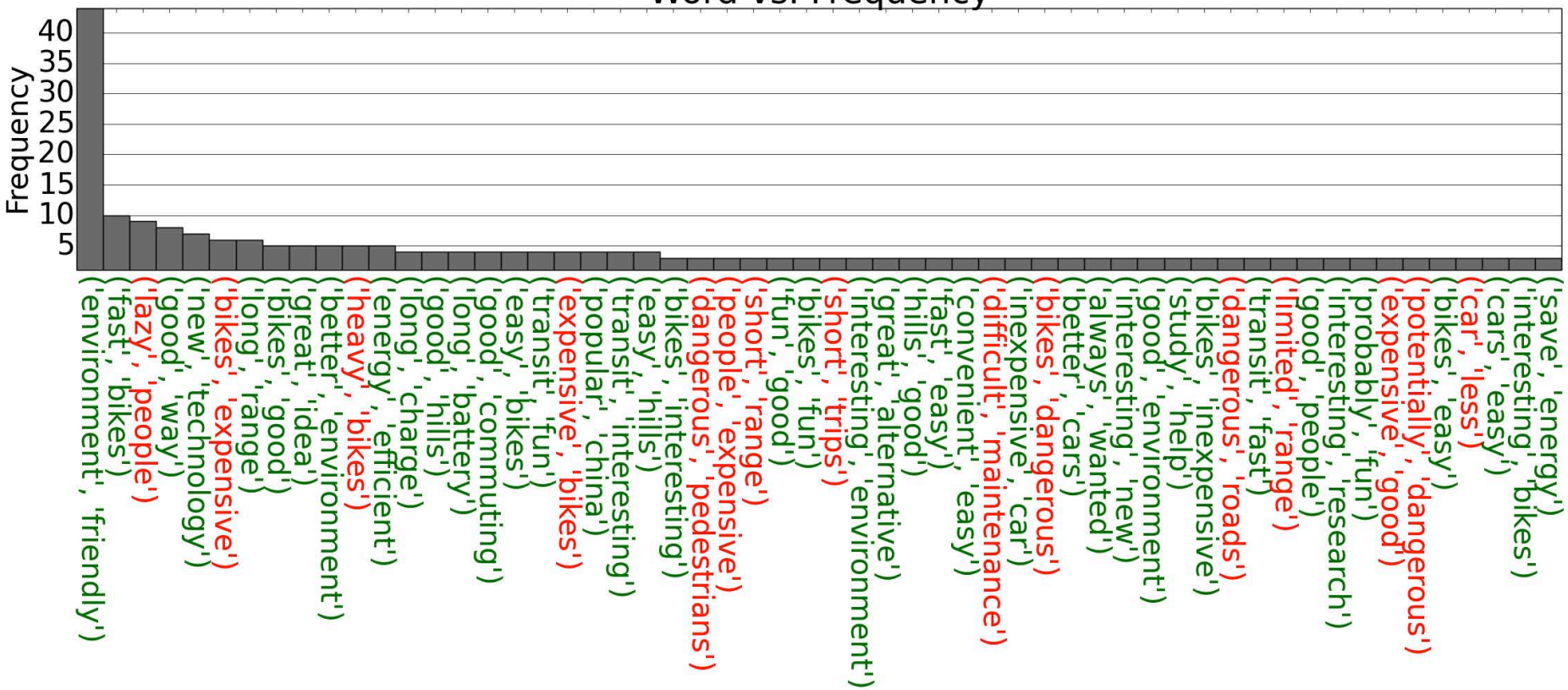
Word vs. Frequency



# Sentiment analysis



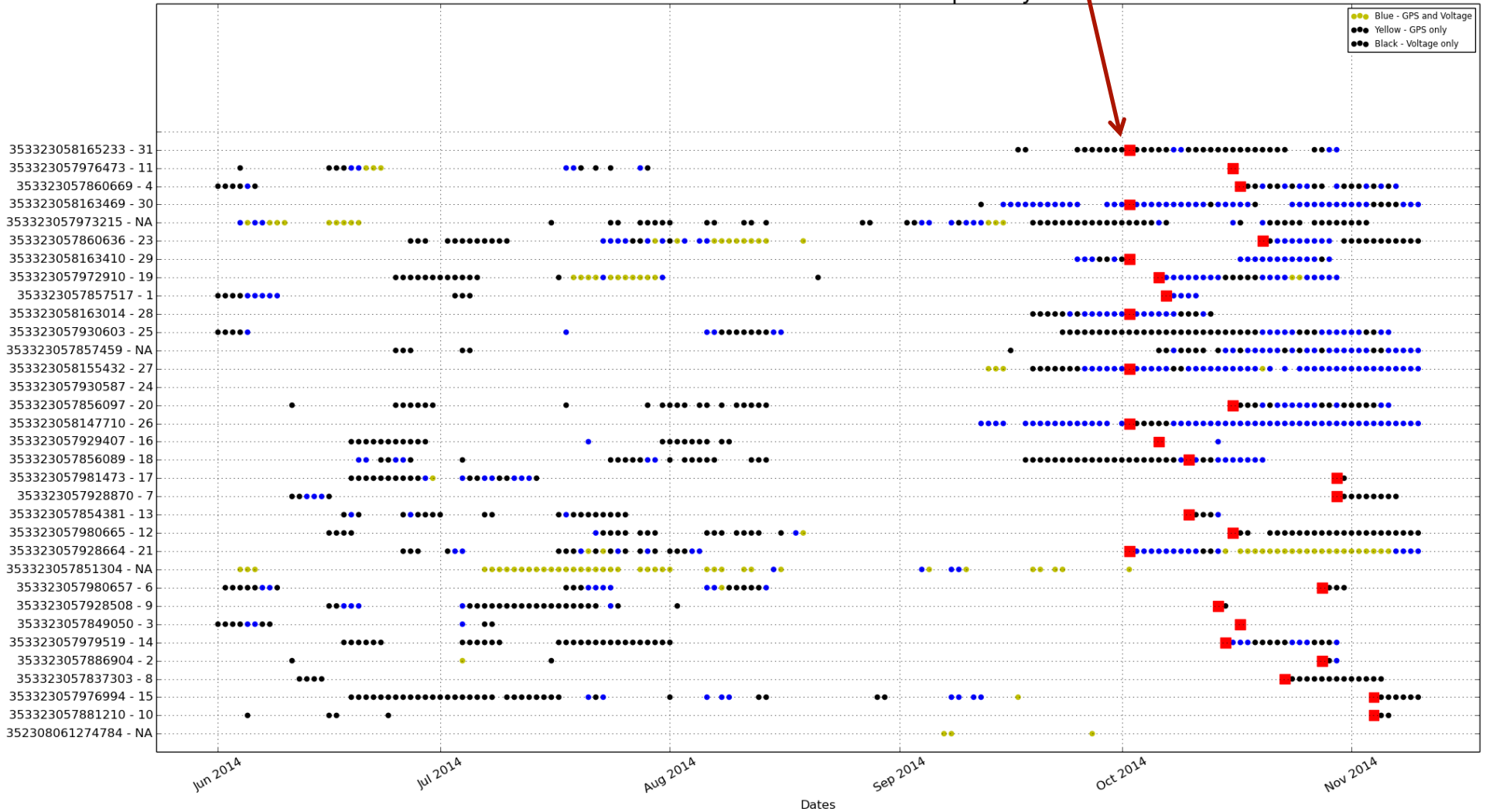
Word vs. Frequency



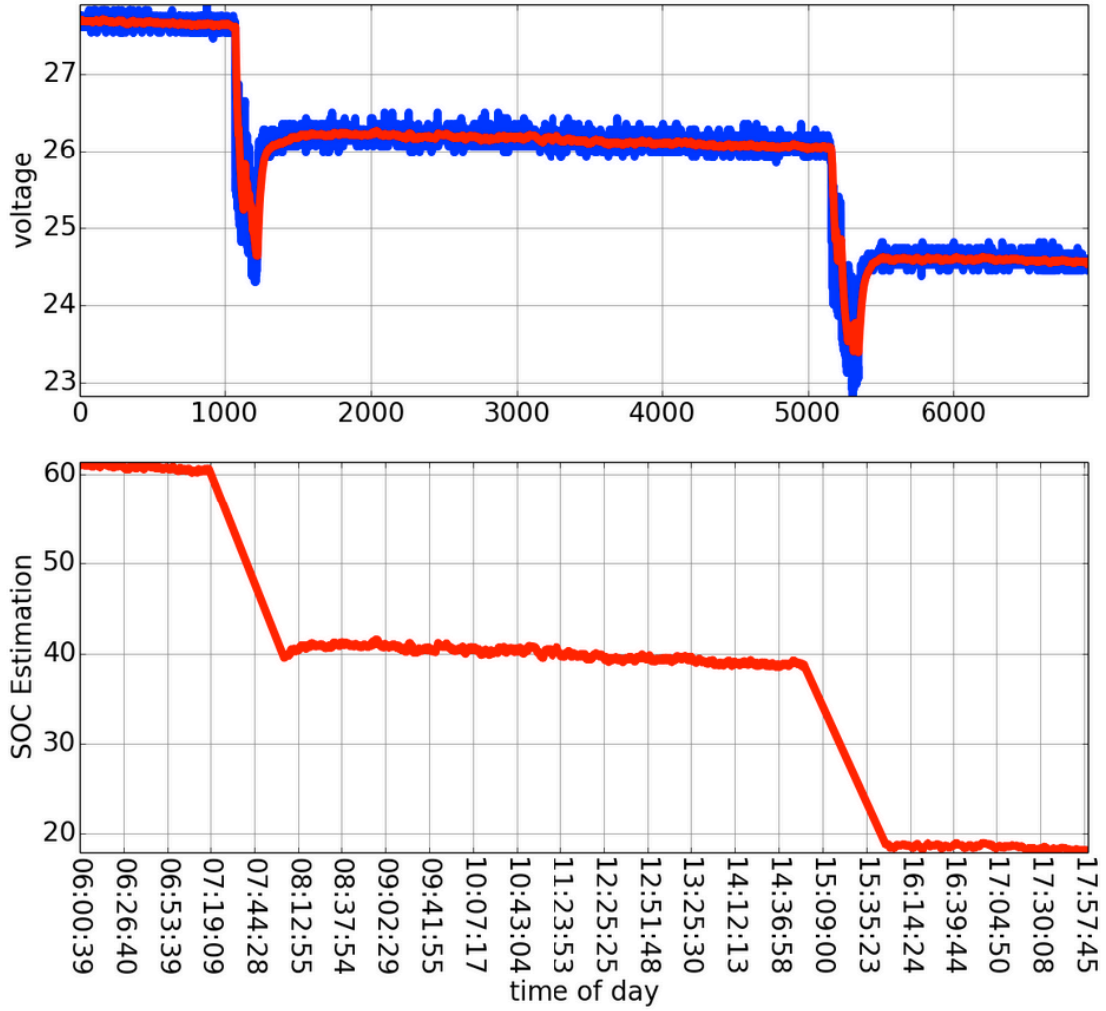
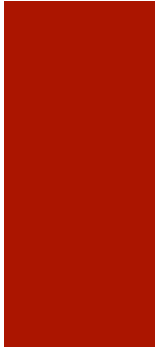
# Data availability

End cap changed

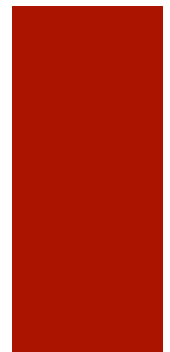
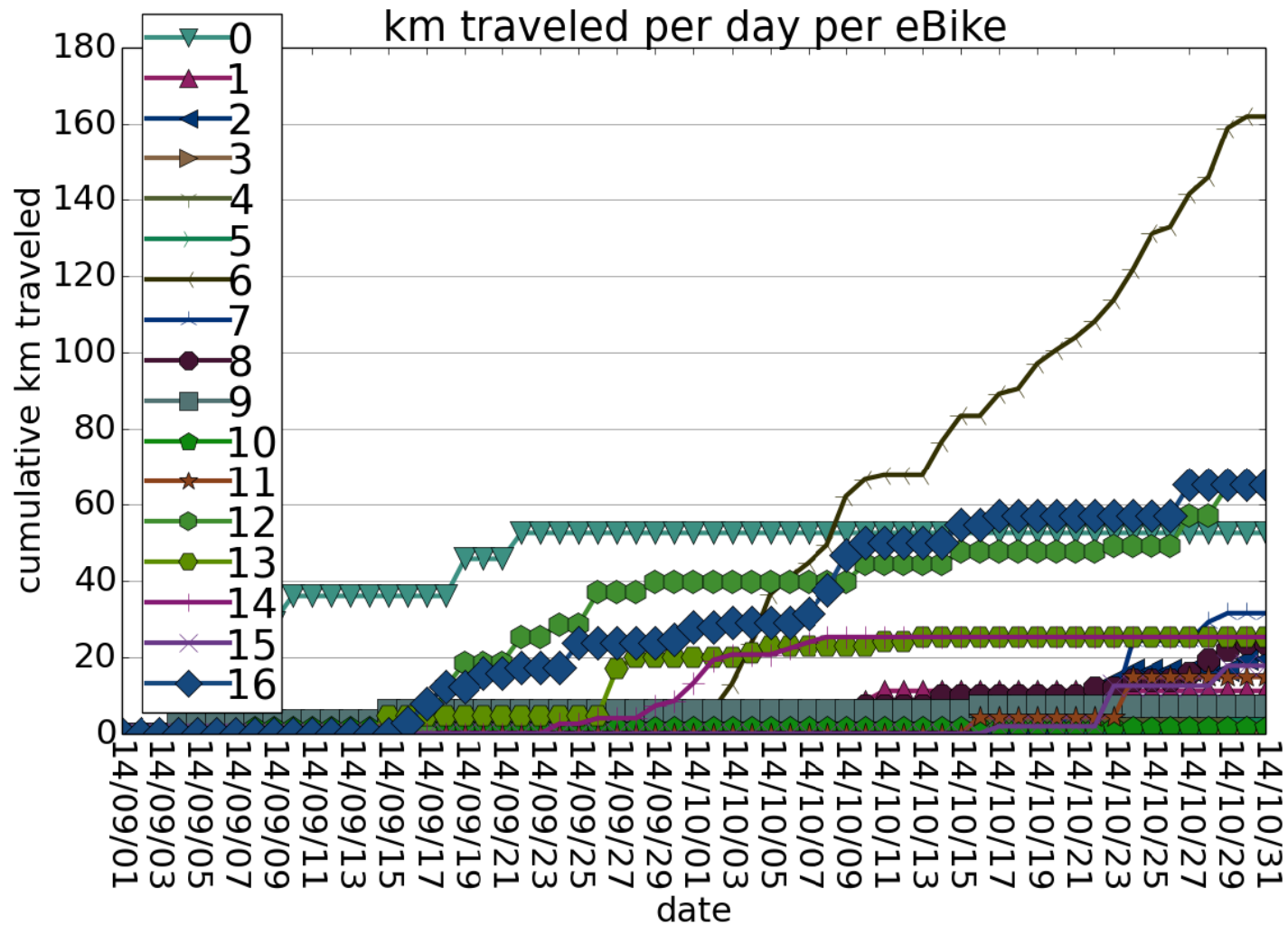
Data Available - At least one trip a day



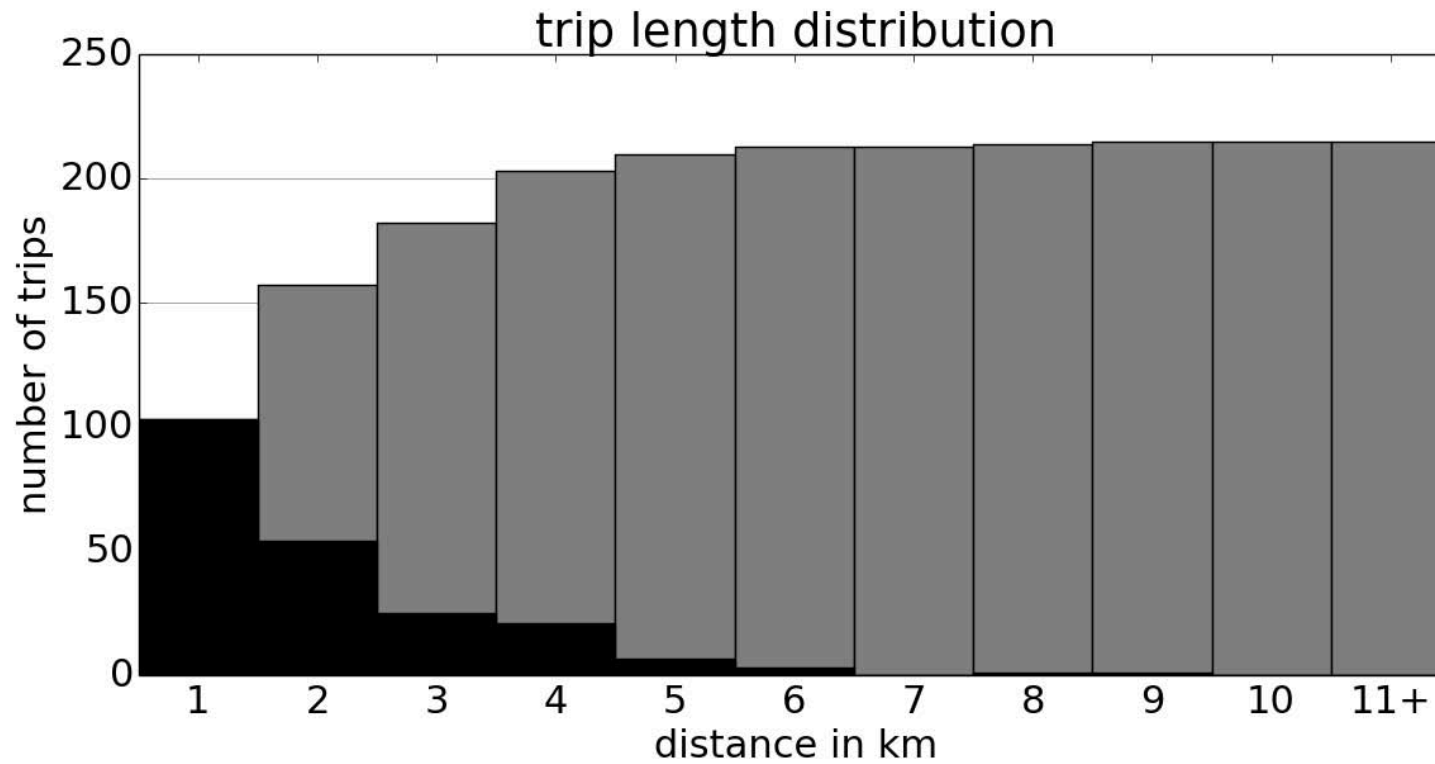
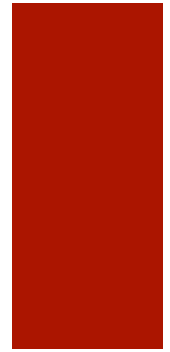
# SOC



# KM per day

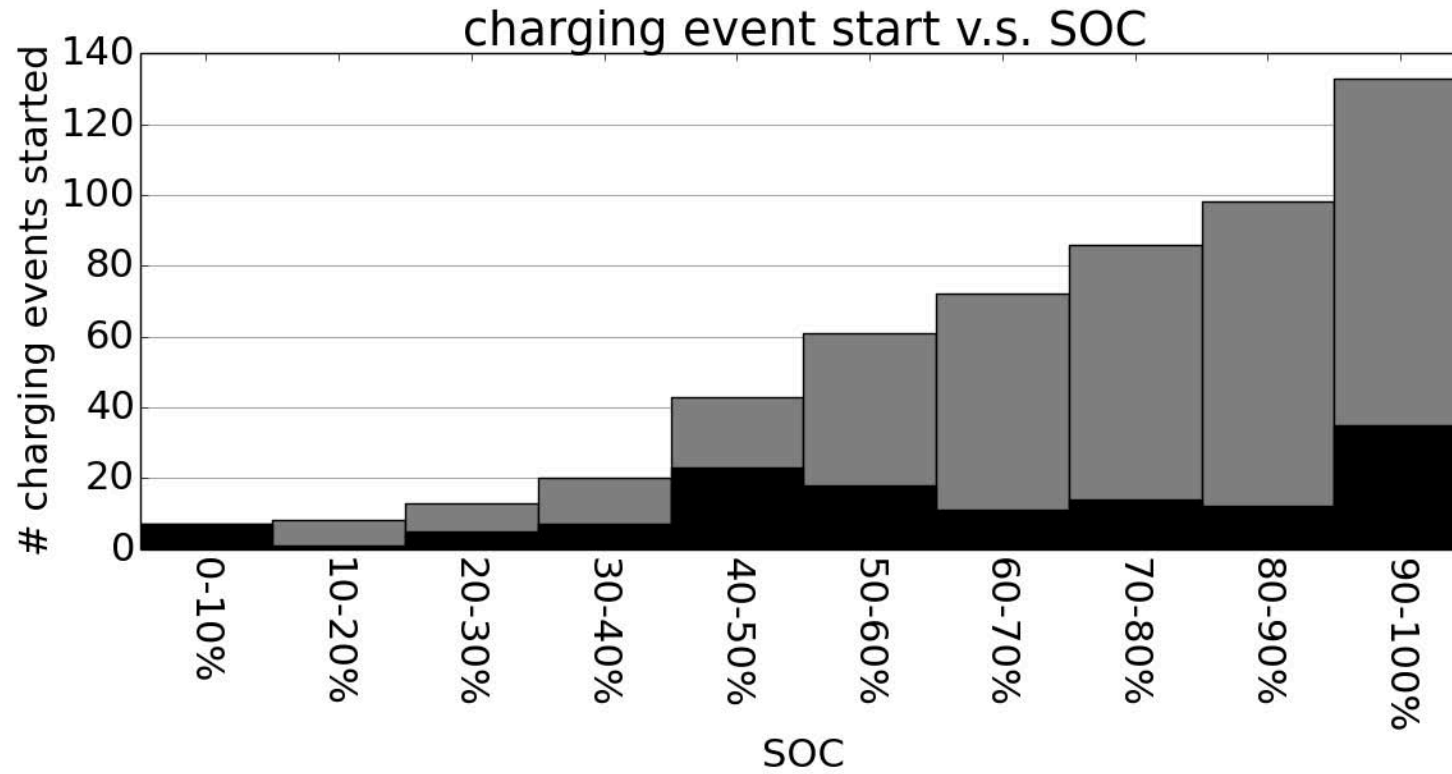
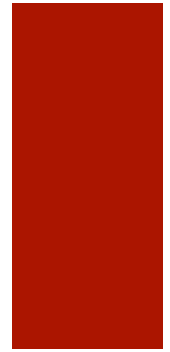


# Trip lengths

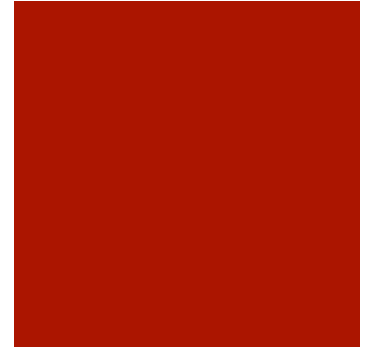




# Range anxiety?



# Potential projects



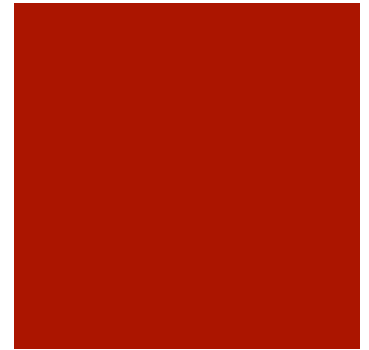
## *Trip information*

- Estimation of **remaining travel time**
  - depends on the driver aggressiveness, state of charge, terrain, and/or temperature.
- Determining **typical driving behaviour**
  - as a function of age, gender, and/or social background of the driver

# Potential projects

## *Range anxiety?*

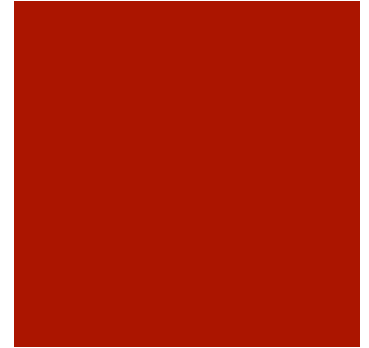
- Determine State of Charge (SOC) **when people normally start charging**
- Determine the **frequency of battery depletion** and the behaviour of participants in response to this situation.



# Potential projects

## *Parking and charging habits*

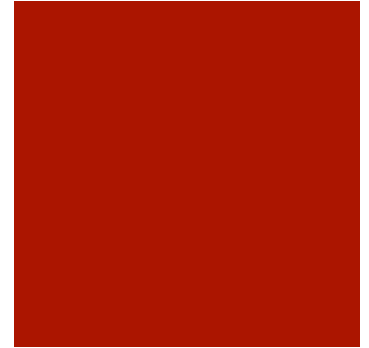
- Spatial and temporal **distribution of parking**/charging events.
- Determine “**hotspots**” for eBikes
  - potential installation of PEVSE (Public electric vehicle supply equipment) at these sites.



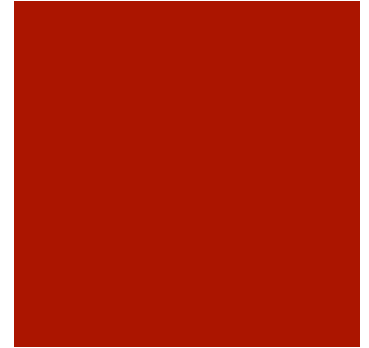
# Potential projects

## *LiON battery properties*

- Estimate **charging losses**
- Estimate the **effects of different drive cycles** and different levels of electric assistance on battery life, and range
- Estimate battery life/range depend on **temperature**
- Estimate the potential for charging EVs using stand-alone **PV**
- Estimate battery capacity **degradation** over time



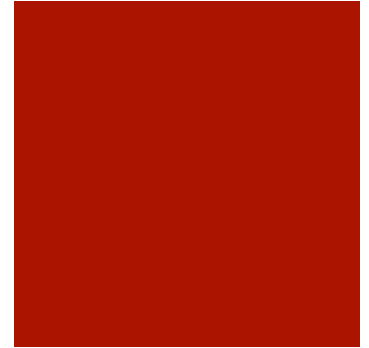
# Potential projects



## *Human Computer Interaction:*

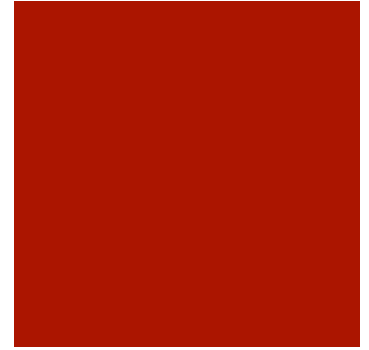
- Determine the **information to be displayed** (either visually or audibly) for the participants.
- Determine if the information displayed should be
  - **health** focused (e.g., calories burned),
  - **environment** focused (e.g., CO2 offset v.s. a car),
  - **logistically** focused (e.g., traffic conditions or route planning).
- Determine the **frequency** at which displayed information should be refreshed.
- Determine the **effect** of displaying information on user's behaviour.

# Multidisciplinarity



- **Chemical** engineering
  - battery performance with temperature and drive cycle
- **Civil** engineering
  - urban transportation
  - pollution sensing
- **Public health**
  - health benefits

# Yet more research problems!



- Batteries to power other things in dev. regions
  - fan, cooler for medicines, cooking, cell phone, tv
- Validate EV adoption model from eBike adoption
- Transfer of power between bikes
  - pooling batteries (P2P energy)



# Conclusions

- WeBike is a unique platform
- Up and running, with 1 GB of data every 3 days
- We are open to collaboration

