INSERT-COIN: TURNING THE HOUSEHOLD INTO A PREPAID BILLING SYSTEM

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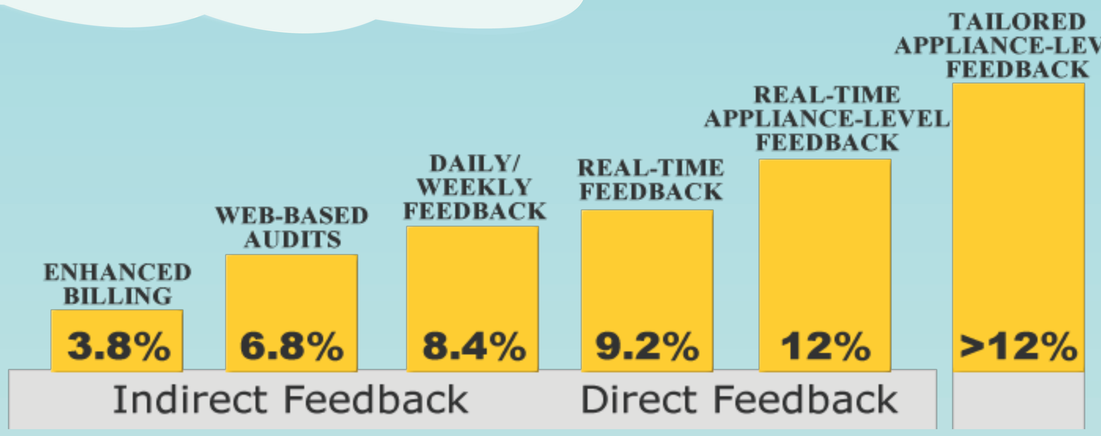
Motivation

Energy awareness is the ability to perceive the effect (monetary, social and environmental) that operating electrical devices has on the environment.

Consumption information is received as consequence to billing
- Too late after consumption occurred
- Scarce awareness of energy usage
- Classic billing is based on estimated consumption

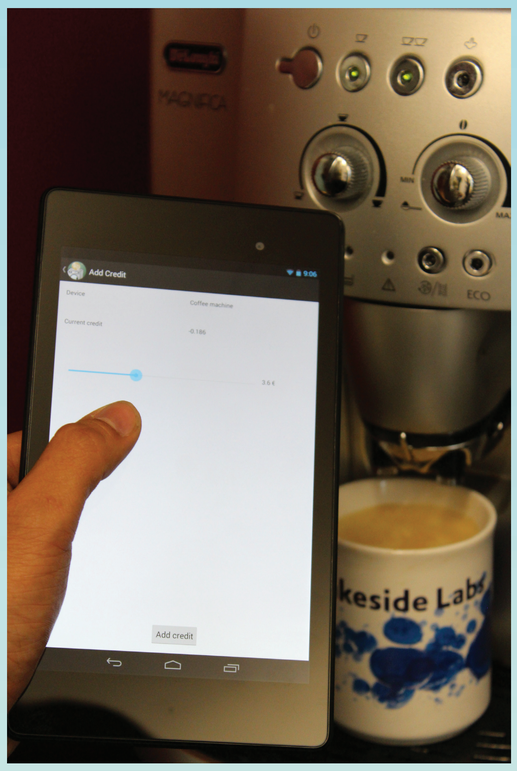
- Energy audits: analyzing energy use to provide tips
- Smart metering: more frequent meter reading and reporting
- Prepaid billing: average savings of 11% in UK
- Adaptive tariff plans: incentiving users to operate in off-peak periods
- Persuasive interfaces: supporting users in understanding energy usage

Existing conservation strategies



Pay-as-you-go devices

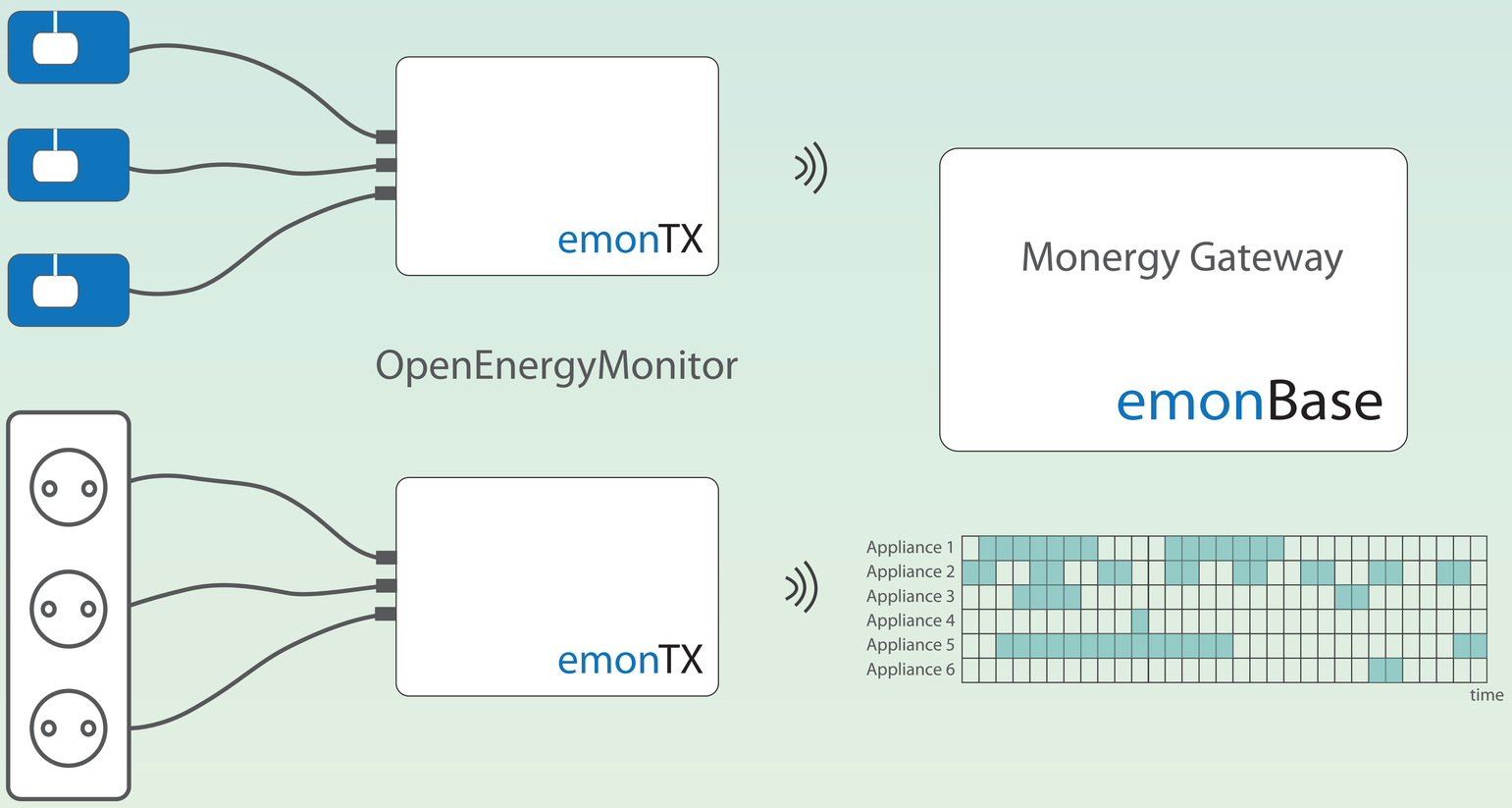
- Combines appliance-level information to prepaid billing
  - Credit is allocated in advance and used to pay when the appliance is operated
  - Operational cost is given by the energy demanded and the current energy cost
- Suits for both regions and can increase users' energy awareness
  - Dynamic pricing as awareness of available energy (locally and in the grid)
  - Demand awareness resulting from operational cost of devices
- Money as non-technical measurement unit for energy and human activities
- Credit as classification metric of electrical devices
  - Can define importance/flexibility for autonomous demand-response
  - Detecting loads connected to each outlet is necessary
- Credit as classification metric of users
  - Individual wallet to track expenses of residents
  - Credit might prevent users from running certain devices (hard vs soft policy)
  - Different awareness levels can be managed using permission categories



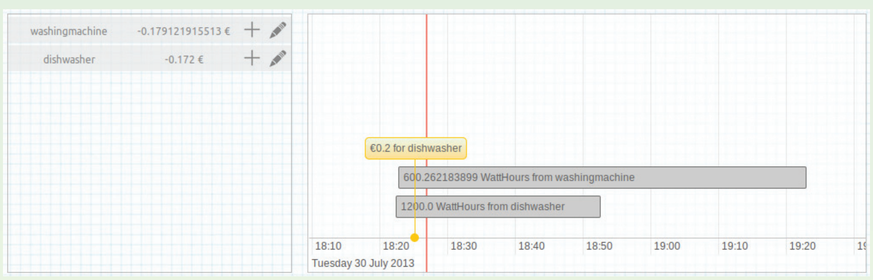
Scenarios in the regions

- Smart metering is already available in Friuli
  - Higher consumption feedback resolution
  - Availability of time-adaptive tariff plans
  - Incentives device shifting
- More developed gas network mitigates electricity use in Friuli
  - Space and water heating, as well as cooking
  - Greater diffusion of air conditioners
- Greater number of greedy devices in Carinthia
  - Water heating, cooking
- Similar consumer electronics and laundry equipment diffusion
- Still scarse knowledge of home automation systems
- Willingness to exploit adaptive prices and interfaces
- Exploitation of renewable energy sources still not diffuse
  - Mostly photovoltaic, though with different sizes

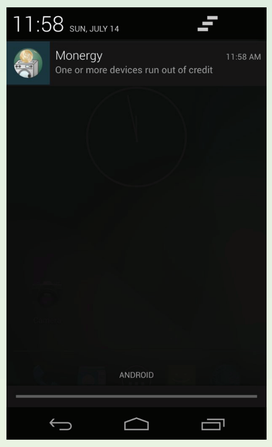
The Monergy advisor



- Active power measurements are sampled and sent to a home gateway
- Events are detected from power measurements and associated to the energy used
- Events are enhanced with situational information, i.e. starting time, duration, energy consumed, current energy cost, and sent to a remote web service running on the Google App Engine
- The cloud-based application keeps track of events and manages a credit for each device, which is decreased according to the energy used and the current cost of energy
- The web service exposes all functionalities through a JSON interface, which makes it interoperable in multiple applications
- The user can manage his account through a web interface and an Android application, which can also receive notification events when the credit is over



- The timeline visualization supports users in understanding cost of their daily activities
- The smart notification system informs all user's devices upon event occurrence, by relying on the Google Cloud Messaging to minimize network and battery usage while keeping devices up to date
- Preliminary evaluations showed the visual notification being a low-intrusive means to the purpose



Conclusions & Future work

- Regional differences should be considered when planning conservation strategies
- Proposed and implemented a strategy that fits for both regions
- Early user tests showed actual perception of cost of activities and credit

- Going to monitor real households in the regions to measure human activities and extract appliance usage models
- Going to test acceptance and effectiveness of pay-as-you-go devices in promoting conservation

MONERGY energy awareness

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