UNIVERSITY OF CAMBRIDGE

Computing for the Future of the Planet

Computer Laboratory
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A Global Personal Energy Meter

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Vision

Every day each of us consumes a significant amount of energy either directly through transportation, heating or use of appliances or indirectly from our needs for production of food, manufacture of goods or provision of services. We envisage a Personal Energy Meter (PEM) which can record and apportion an individual's energy usage in order to provide baseline information and incentives for reducing the environmental impact of our lives.

Benefits

PEM data will enable us to identify areas for reducing or optimising our consumption of resources. Projections of consumption will allow us to see the total cost or benefit of a decision to replace an appliance, install insulation or move house. The PEM will also help us identify alternatives to our current activities. For example, the trace of commuting to work might be exploited to highlight any available public transportation or to inform policy for providing future facility.

Deployment and Adoption

We imagine the future generations of mobile phones containing a PEM as an integral part. This will minimise the energy overhead of using a PEM and also provide widescale communication ability. Social networking sites provide an ideal forum for users to share consumption patterns and reduction strategies. The social effects of these communities may well also help provide support for changing lifestyles and impetus for change.

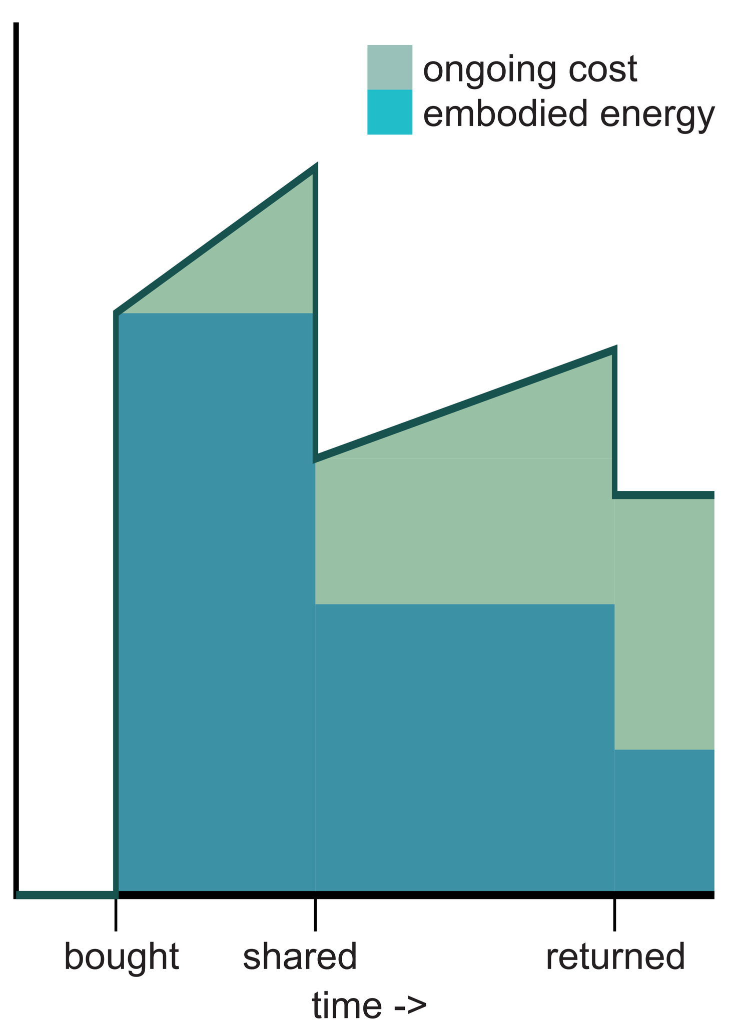
Strategy

It will probably be infeasible to measure all of many ways in which we consume energy. We are therefore beginning our investigation around the most significant areas of consumption as shown in the energy stack (below) for a 'typical moderately-affluent person' [MacKay08]. Our research into the PEM builds on existing efforts for environmental footprinting by considering the technology necessary to apportion these estimates to individuals.

Defence: **4 kWh/d**

Transporting stuff: **12 kWh/d**

Stuff:
48 kWh/d



The energy consumption trace for an appliance consists of a) the embodied energy which is incurred during manufacture; b) energy due to usage; and c) recovered energy from the return or recycling of the device. One model for apportioning usage is apply the direct costs to the current user but to share the indirect energy costs between all possible users of the appliance. This means that an individual's energy bill will reduce as additional users of the appliance are registered and thus take a share of its energy cost.

Food, farming, fertilizer:
15 kWh/d

Gadgets: **5 kWh/d**

Light: **4 kWh/d**

Heating, cooling:
37 kWh/d

Automated recording of the electric and heating costs for a building is increasingly common. However, there are many plausible schemes for apportioning this cost to building users. For example, costs could be divided among those entitled to use the facilities, or split based on physical occupancy time. The PEM must be able to accept building specific allocation policies and must be able to access the contextual information required to implement them.

Jet flights:
30 kWh/d

Air travel is relatively easy to record by monitoring email communication of airline bookings. This technique often forms the basis of the carbon footprinting calculations made by online tools. Increasing the sophistication of these data mining techniques could provide improved estimates by factoring in airline data.

Car:
40 kWh/d

The locations of bus and railway stations can be combined with a GPS location trace of journey start and end points to estimate energy consumption due to transportation. However, distinguishing between travel by foot, bicycle or car is much more difficult in a congested urban environment. Additional data from inertial sensors (now common in many phone handsets) might help with the classification problem.

Context Awareness

Context information will be crucial for apportioning the use and energy costs of resources. In order to obtain this it will be necessary to develop low cost, low infrastructure location systems that can be deployed on a truly global scale.

Policy

Apportionment policies may vary not just in different scenarios but even from institution to institution, building to building and object to object. We need a language for specifying these policies in terms of the contextual information that drives them.

References

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