

THE FRESH RESEARCH PLATFORM



- 1 *Controlling a residential thermostat using a sensor hub and remote wireless node.*
- 2 *Mobile devices can be used to control and obtain data from FRESH components.*

Fraunhofer Center for Sustainable Energy Systems CSE

Massachusetts Office
5 Channel Center Street
Boston, MA 02210

New Mexico Office
5600 University Boulevard SE
Albuquerque, NM 87123

Contact



Kurt Roth, Ph.D.
Director
Phone: 617-575-7256
kroth@fraunhofer.org

cse.fraunhofer.org

Challenge and Opportunity

Home energy displays (HEDs) and home energy management (HEM) systems support energy efficiency in residential buildings. These approaches are complementary: HEDs provide information on energy consumption in the home, while HEM systems make it easier to reduce consumption by automating control of building systems such as HVAC, lighting, and plug loads.

There is still significant scope to improve the effectiveness of these technologies, as well as user acceptance and adoption. The **Fraunhofer Experimental Smart Home (FRESH)** research platform provides a framework for designing, prototyping, deploying, and testing novel HED and HEM solutions. FRESH consists of deployable, customizable hardware components and flexible software modules to evaluate innovative technologies and usage models.

Combined with Fraunhofer CSE's expertise in usability research, building energy analytics, and field evaluation, FRESH enables valuable insights into how HED and HEM solutions work in the real world.

Industry Benefits

- Field evaluation of behavioral interventions and home energy management systems for acceptance, comfort, and energy savings
- Supports the development of algorithms for activity modeling, such as non-intrusive load monitoring (NILM)
- Targeted field and lab usability, as well as user-acceptance evaluation of technical and usability challenges within a customizable, complete end-to-end test framework
- Evaluation of strategies to increase adoption of residential energy management technologies
- Energy modeling to rigorously quantify the impact of HED and HEM solutions on whole-home energy consumption and peak electric demand



The FRESH Platform

FRESH is a collection of **field-deployable, customizable sensing, control, display, and feedback components** that are wirelessly networked. Its distributed wireless hardware facilitates data acquisition from different sensor types across multiple rooms in a home or building, and can control a variety of appliances and systems.

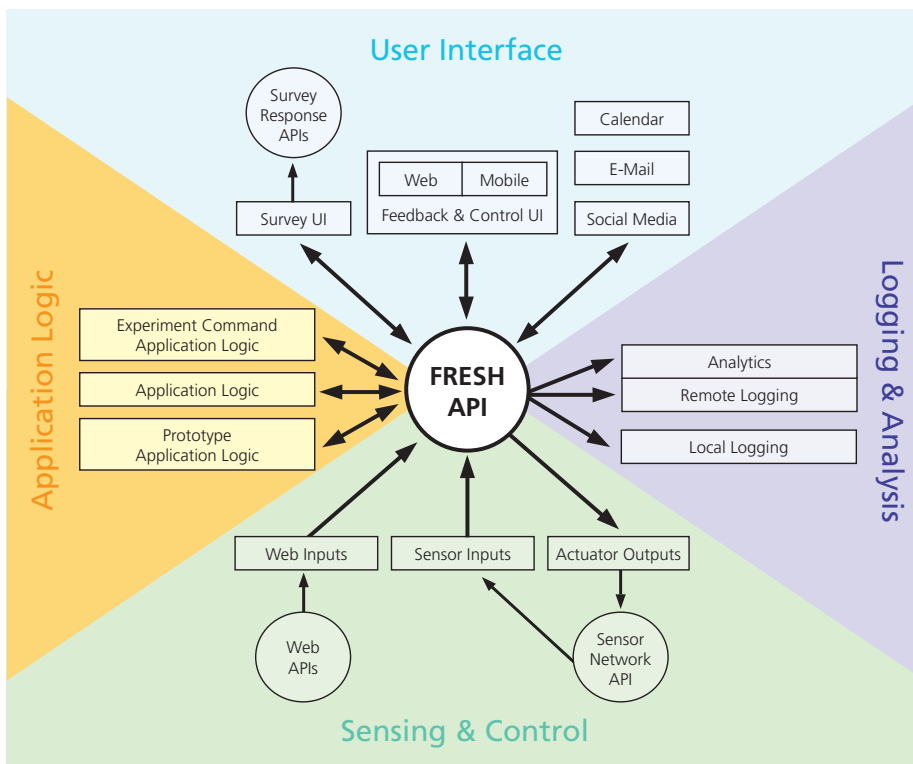
FRESH supports software customization with its modular design. Given the increasing sophistication of smart thermostats and other HEM products, FRESH contains a **machine learning module** that supports the testing of various algorithms. Data collected from hardware sensors can be applied to improve prediction accuracy for home occupancy and households' target temperature preference.

Flexible **web and mobile user interface modules** implemented in HTML/Javascript and Android allow CSE researchers to implement and assess behavioral science features such as salient messaging and social comparison. FRESH can even be configured to automatically send **context-aware surveys, alerts and messages** to users when certain conditions are met – for instance, if the system detects that a window is open even though the air conditioning is running.

IMPLEMENTED FEATURES

- Distributed sensing through wireless sensor nodes
- Control of HVAC and plug loads via wires in the wall or wireless control
- Remote control via Android mobile phone / tablet
- Automated survey delivery to mobile devices
- Occupancy prediction through a third-party machine learning algorithm
- Temperature set point schedule syncing through web calendars
- Has been tested continuously in deployments of up to 5 months

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3 A web-based interface allows researchers to access and analyze real-time or historic data from any individual sensor node.

4 Customized components can be assembled and set up at Fraunhofer CSE's Data Acquisition Laboratory.