



# Addressing Behavioral Change towards Energy Efficiency in European Educational Buildings

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# Green Awareness In Action

- Affect the behavioral characteristics of the citizens inside buildings where they live and work.
- Focus on a particular target group: essential for designing a successful behavioral-change strategy
- Educational buildings constitute 17% of the non-residential building stock in the EU
- Educational community – students, educators, parents, researchers

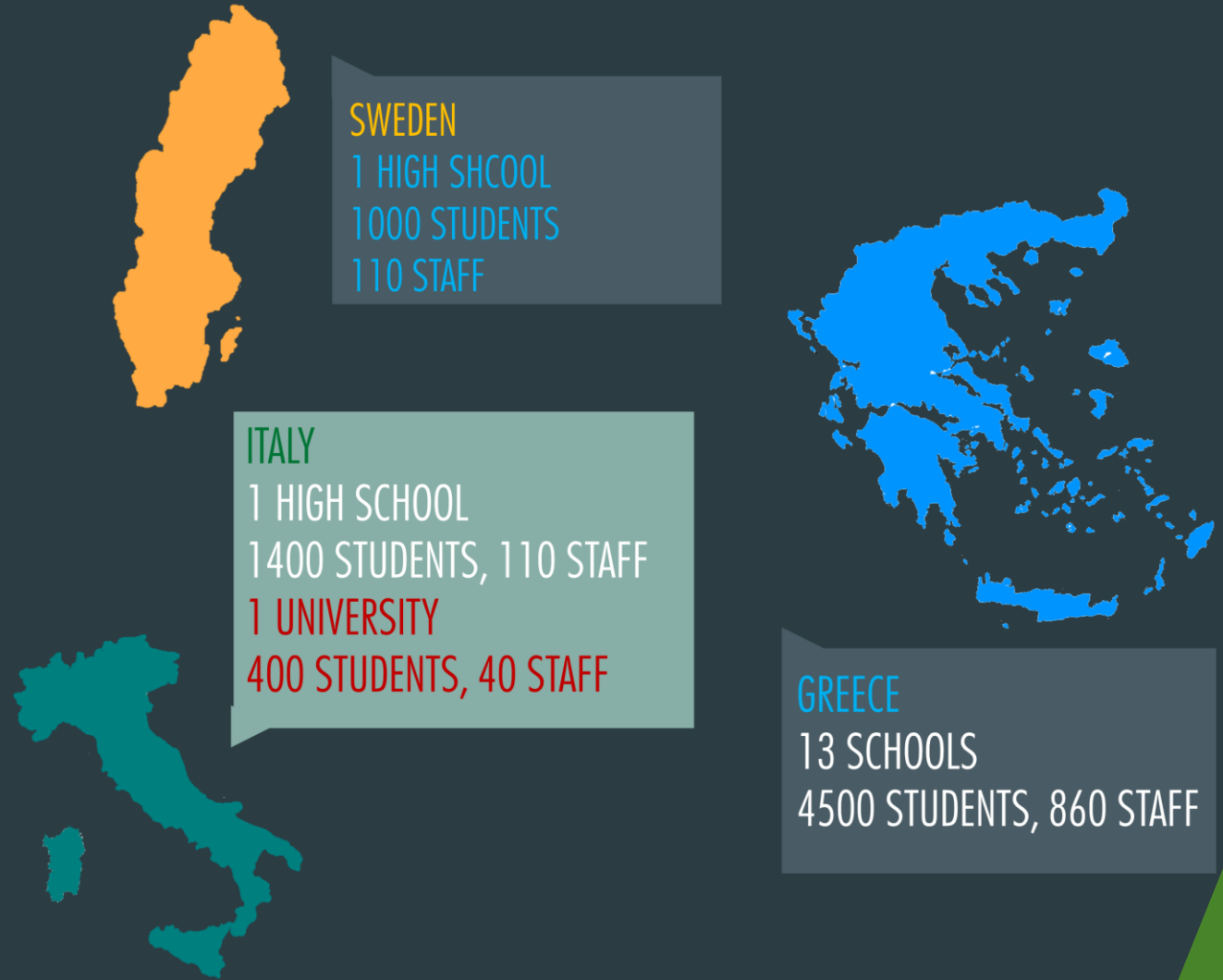
# Behavioral change towards energy efficiency and sustainability

Educational approach combined with a set of applications.

- (a) educating children and young people to embrace energy-efficient habits has sustainable results on energy consumption, as these people are highly unlikely to abolish their habits in the future
- (b) focusing on students will also affect their immediate family environment. Several studies document the ability of students to influence choices made by their families related to environmental issues

# GAIA at a glance

- 3 countries
- 15 schools
  - Primary schools
  - Secondary schools
  - Technical high schools
  - 1 university building
- ~6000 students
- ~1100 educators

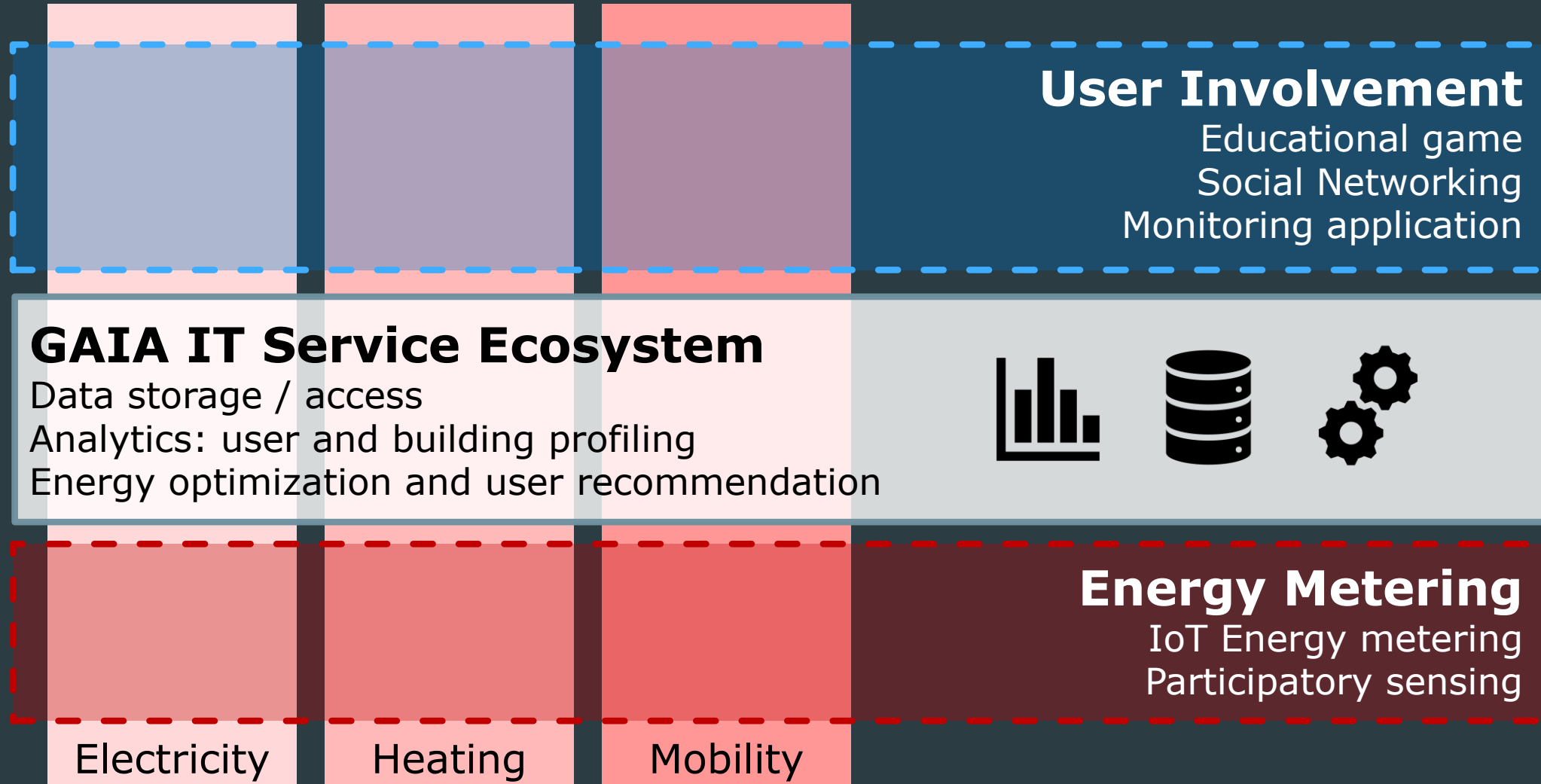


## However...

- Different education levels, age, culture etc.
- Customization and localization of the applications
- Language but also according to the roles and availability of staff to implement energy efficiency campaigns

Lots of differences in practice among countries and schools

# GAIA overall design



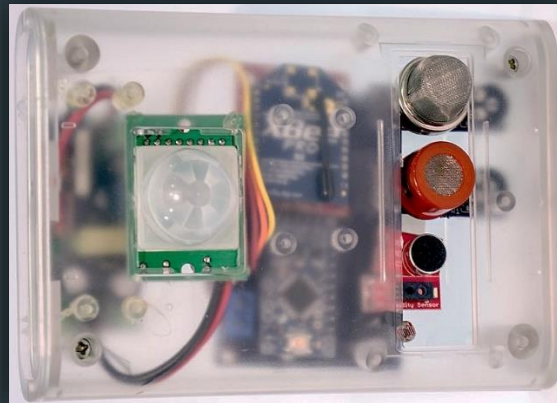
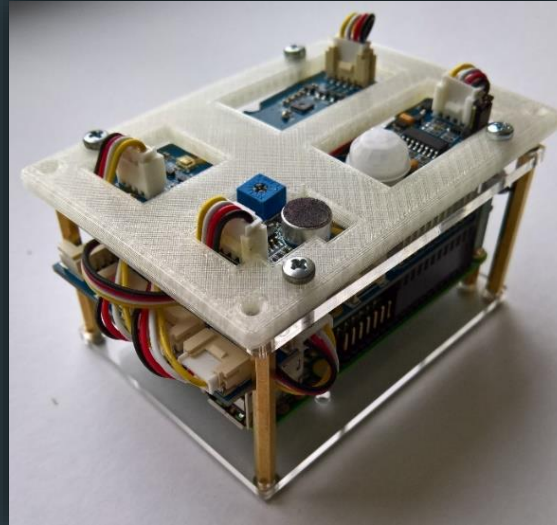
# Infrastructure used inside buildings

- IoT nodes installed to monitor the power consumption of the building as a whole, or specific floors/sectors.
- IoT nodes installed in classrooms and other supporting rooms to monitor a set of environmental parameters such as temperature, humidity, activity and noise levels.
- IoT gateway nodes installed in central points of the building to bridge the IoT nodes that communicate using IEEE 802.15.4 with the Internet, while gateways communicate directly with GAIA cloud services

# GAIA IoT devices

Large part open-source  
and open-hardware  
approach

- Arduino
- Raspberry Pi



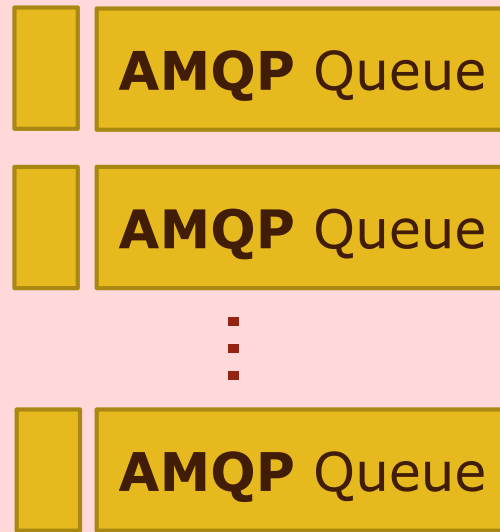


# GAIA Service – Data Storage & Access

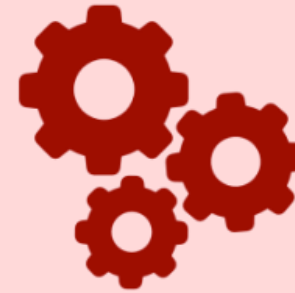
## Sensors



## GAIA Platform



## Aggregation



## Storage



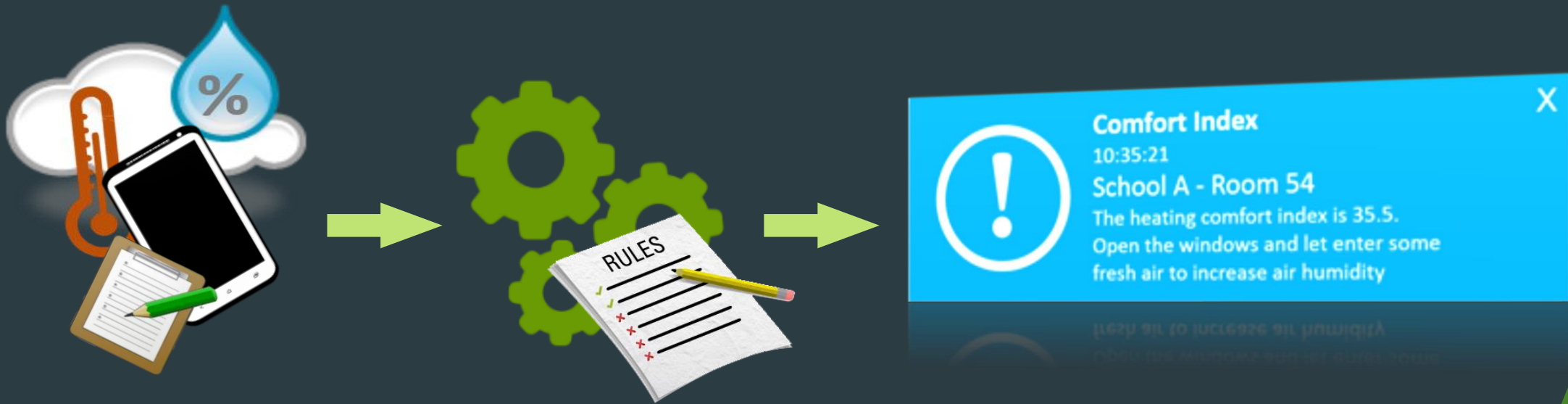
## Applications

HTTP REST API



# Recommendation Engine

The aim of the Recommendation Engine is to generate appropriate recommendations for energy savings, according to the occurrence of some specific conditions in the building/area of interest.



# GAIA Applications

Raise awareness, support action and foster engagement

- **Competition** which is implemented in the online challenge game: the communities of different educational facilities compete among each other.
- **Social networking** where the communities compete to respond to the challenge announced
- **Continuous monitoring** of energy consumption.

# Educational Serious Game

## **Web-based online “quests” game**

Utilizes gamification mechanics to motivate players to engage in energy saving topics supporting classroom education:

- experience impact on the facilities' energy consumption over the course of the challenge by
  - Monitoring data
  - Gaining points
- compete and compare against other classes
- share their experiences with their peer group

# Students interface

- Classic board game logic
- Students move through the board by answering questions from “challenges”
- Gradually the game board becomes more “alive”
- Students can see the progress of other schools

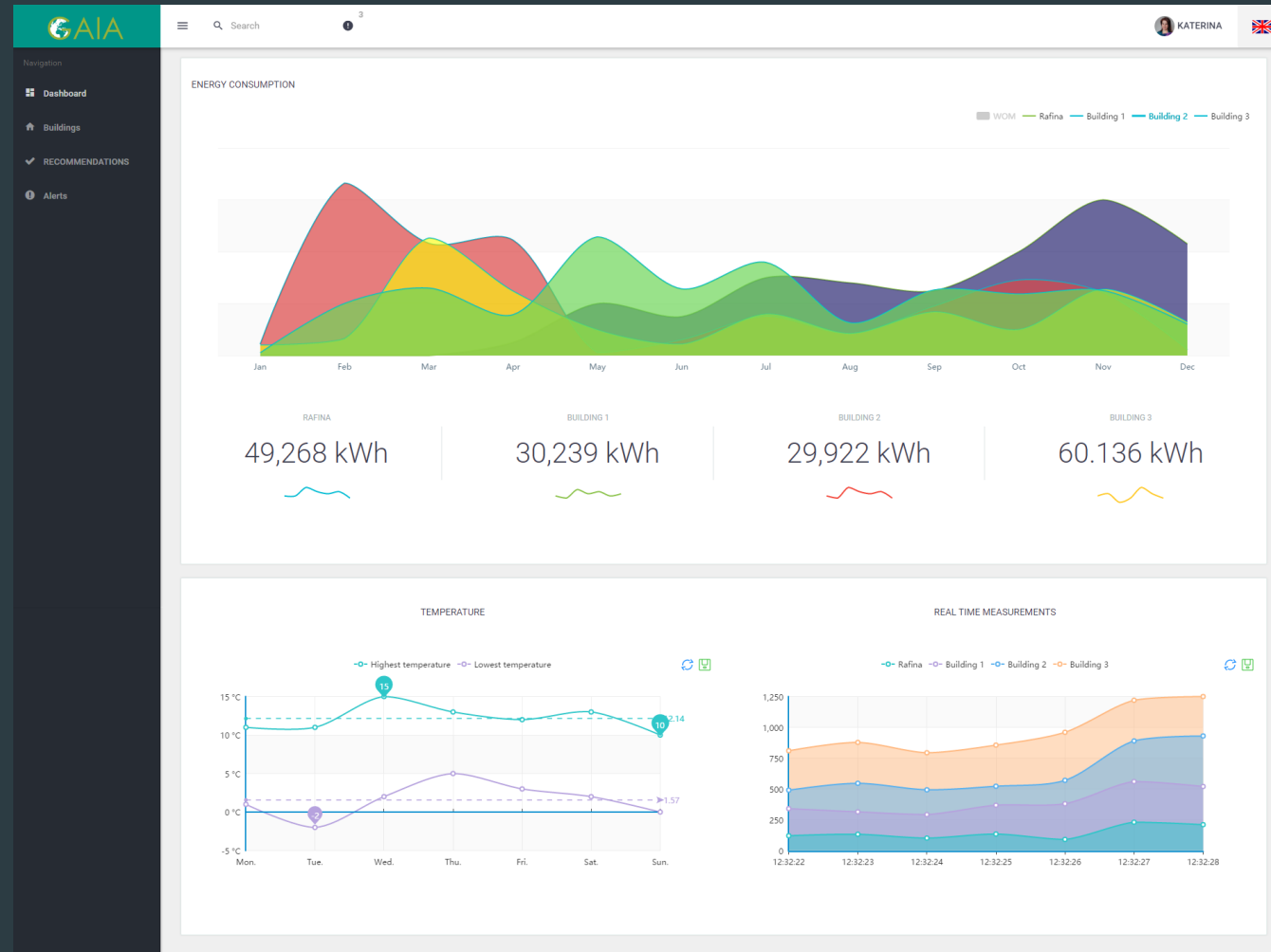


# Community Engagement: Social networks

- Provide an additional means to interact with the community and promote return/continued visits
- **Weekly goals** for the participating school communities towards fostering engagement and awareness.
- **Web scavenger hunt**, using #hashtags for tracking purposes
- **Student-created content** from the educational serious game can be shared here

# Monitoring application

- Continuous monitoring
- Building comparison
- Real-time suggestion



# The value of GAIA

The value of GAIA's approach lies in:

1. the variety of applications addressing all the actors of the school community
2. the flexibility of the applications, customizable to suit the specific facilities and communities
3. the openness in integrating additional applications in the future



# Validation of GAIA - Trials

- A set of trials is currently being planned in a number of educational facilities across Europe
- Different climate zones, building age categories and socio-economic criteria.
- Evaluate the different kinds of feedback developed, assessing which is the better way for each user category (and age) to perceive energy amounts or its energy spending profile.
- All the pilot buildings are continuously collecting energy consumption and environmental data, gradually gathering a detailed profile in terms of energy consumption and other characteristics

# Conclusion – Future work

## Data-driven behavior change

- Prototypes of applications are available
- Mini trials for evaluation already underway
- Already collecting data to build a baseline
- Test our approach during next school year 2017/2018 in more than 15 European educational buildings

# Thank you for your attention

Project website: <http://gaia-project.eu>

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