International Journal of Sustainable Energy Planning and Management

RESEARCH and EXPERIMENTATION

Solutions and services for smart sustainable districts: innovative Key Performance Indicators to support transition

Carola Clemente[*a], Paolo Civiero[b] and Marilisa Cellurale[a]

[a]*Sapienza University of Rome, PDTA Department – Via Flaminia 72, 00196 Roma (IT)*
[b] *IREC Catalonia Institute for Energy Research, Jardins de les Dones de Negre, 1, 08930 Sant Adrià de Besòs, Barcelona (Spain)*

ABSTRACT

The European Strategic Energy Technology Plan (SET Plan) supports the Energy Union's policies by setting the strategies for the European Union energy sector. In 2018, the Implementation Plan traced the pathway in planning, deployment and replication of 100 Positive Energy Districts (PED) by 2025. This article presents innovative research on models, methodologies planning tools and technology solutions for the short-medium term implementation of PEDs.

The approach and methodology behind the research is based on an operational framework set up to identify gaps and sharing for urban services' implementation and to support life improvements for citizens, consumers, and prosumers.

The main output of this research report is a framework to facilitate a synthetic evaluation of the positioning and improvement of each smart city solution considered in the study. These are referring to engagement phase (planning, design, construction, management) and engagement scale (functional unit, building, blocks of building, infrastructures, environment). Furthermore, the framework improves the identification of strategies and stakeholders' commitment to promote Smart Urban District or PEDs transition.

This research contribution stems from the project *SCC solutions for Positive Energy Districts – Research of Electric System/Annual Implementation Plan 2018/41* between Sapienza University of Rome and ENEA Energy Technology Dept. – Sustainable Energy Network. The broader aim of that project has been to design a set of strategies to facilitate the transition of the built environment towards e.g. Smart Energy Districts.

Keywords:

Positive Energy Districts;
Transitions and Dilemmas;
Key Performance Indicators;
Smart Cities and Communities solutions

URL: http://doi.org/10.5278/ijsepm.3350

1. ntroduction

In in the context of a decade of deep economic suffering, the transition from the EU Horizon 2020 to the EU Horizon Europe programme marks an important landmark in analysis and evaluation about the climate and energy policies. The energy issue, no longer confined to the resource-consumption binomial, has been recognized by the international scientific community [1–5] as a pervasive issue, linked to the economy of scale, information, interoperability of systems, and the quality of citizens' behaviour. Over the last ten years, the European Energy Research Alliance (EERA) through the Joint Programme Initiatives (JPI) has provided the scientific and operational basis to realise the full potential of energy efficiency in urban areas [6].

The rapid technological advancement, especially in the big data management and IoT field, supported the commitment of the JPI Urban Europe in getting ahead

*Corresponding author - e-mail: marilisa.cellurale@uniroma1.it

Acknowledgement of value

The added value of the research "SCC solutions for positive Energy District – RdS/PAR2018/041" is the setting up of a framework which support synthetic evaluation and facilitate public officers within a Municipality to recognize which alternatives would support the transition to PEDs according to Italian rules and regulation. The idea is that this framework could facilitate their deployment and replication to each local context as for instance, Taranto.

I believe that PEDs must be not only efficient from the energetic point of view, but also they must integrate functional, technological and social aspects, with an overall improvement of services for citizens to support transition towards urban sustainability.

That is why the main outputs and results of the research project could facilitate Municipal Council Representatives in the comprehension and laying out of strategies which can be effective to enable urban regeneration. This is the main objective for Taranto City where it is necessary to develop an integrative approach which includes technological, spatial, regulatory, financial, environmental, social and economic perspective driven by City in cooperation with industry and investors, research and citizen organization.

Ubaldo Occhinegro , Council Representative for Urban Planning - Construction, Mobility and Strategic Plans, Municipality of Taranto, Italy

"a purely techno-centric vision that reduced smartness to a driver for the economic development of those companies that in various way operate in the ICT" [7].

In 2018, the Implementation Plan traced the pathway in planning, deployment and replication of 100 Positive Energy Districts (PEDs) by 2025, defined as follows: *"PEDs require interaction and integration between buildings, the users and the regional energy, mobility and ICT systems, as well as an integrative approach including technology, spatial, regulatory, financial legal, social and economic perspectives. Ideally, PEDs will be developed in an open innovation framework, driven by cities in cooperation with industry and investors, research and citizen organisations"* [8].

The research project "SCC solutions for positive Energy District — Research of Electric System (RdS)/ Annual Implementation Plan (PAR) 2018/41" - a collaboration between Sapienza University of Rome PDTA and ENEA Energy Technology Department Sustainable Energy Network - moves from vision and understanding highlighted in the SET Plan Implementation Plan Action 3.2 Smart Cities, which aims to support the planning, deployment and replication of 100 Positive Energy District by 2025 for a sustainable urbanization.

The research project aims to create a support to facilitate cities towards a positive energy transition identifying properties of PED, priorities for planning/deployment of PED and an innovative Key Performance Indicators (KPIs) system to promote transition.

The main outcomes could be based on:

- PED conceptual framing as a transition from Smart Urban District model highlighting gaps and commonalities;
- PED conceptual framing according to "new" urban dilemmas able to highlight which Smart Cities and Communities (SCC) solutions better allow the transition towards PED;
- an innovative framework and KPIs system for identifying SCC solutions enabling transition towards PED.

The research project is therefore focused on the systematization (a) of the main implementation domains for PED transition, (b) the products and solutions according to the different dilemmas in PED, (c) the scales and phases, and (d) the relevant stakeholders for planning and deployment of PED supporting development of a set of SCC solutions.

The final result is a framework and an innovative KPI evaluation system to identify for each SCC solution (technologies, sensors, products, apps, ICT, etc.) the level of technology readiness level(TRL), the stakeholder type which is necessary to involve to support planning and deployment of SCC solutions as well as the engagement phase (planning, design, construction and management) and the engagement scale (functional unit, building, blocks of building, infrastructure, environment). The framework allows to identify gaps and commonalities for implementing urban services which support a high quality of life for the consumers/ prosumers.

An added value of the research project is an innovative way to create a repertoire of technological solutions, which includes a defined quantity of devices, products and tools within a wide range of solutions available on the market and/or ready for the test-bed phase as well as a KPI metrics to identify engagement scale and engagement phase as well as the potential stakeholders to involve in.

2. Smart Urban District priorities and dilemmas facilitating PED transition.

This research project follows the previous one, namely "RdS/PAR2017/075" which aim was underline the technological solutions already available on the market to support the transition towards Smart Urban District and highlighted that it is necessary to integrate the regulated model of city transformation - for discrete stadiums and sectors as prescribed by the regulatory framework[†]- with an holistic approach to stimulate the optimization of resources through the application of SCC solutions, thus promoting a high interoperability degree. The reasoning refinement and the tools developed within the Smart Urban District, both on a technical and epistemological level, require a continuous evaluation, revision and implementation of the adopted solutions.

† We are referring to the European and national regulatory framework for energy, which has the strength of defining a minimum level of energy performance of built environment but does not promote an integrated vision regarding the optimization of energy systems

It is therefore a question of constructing a scalable methodological and operational framework, aimed at responding to two orders of preliminary considerations, referred to the national level (Italian case study):

1. the structural characteristics of Italian urban realities [9] qualify the dilemmas with respect to the consistency of the built heritage and to the dimensional and evolutionary parameter of the urban application field;
2. to correspond, where useful, to the objectives of SET - Plan on Action 3.2, it is necessary to set up the instrumental framework for implementing and governing the transition to PEDs for progressive steps of immediate implementation.

According to this, a logical (computer) tool has been designed for the recognition and systematization of the SCC resources and solutions already operational and implementable within the Smart Urban District.

In the next step, there are two conceptual evolutions able to orientate the transition to the PED.

The first concerns the measurement of the effectiveness of the solutions identified: we intend to measure the smart quality not only with reference to the objective performance indicators but based on the field of application, then interoperability with other solutions, at different scales; the second concerns degree of gain that the combination itself generates, referred to the sum of the KPIs of the individual instruments. In other words, measuring quality on applications means evaluating the effectiveness of an interoperable system, such as the ratio between the sum of the expected (project) performance of a solution and the plus value (positive KPI)

Table 1: Analysis Model for implementation of the SCC solutions in areas of Urban Dilemmas

Areas	Key Tools/ Technologies answer in areas	Implementation domains	Engagement phase	Engagement scale	Stakeholder
1. Safety & Security, 2. Health, 3. Education, 4. Mobility, 5. Energy, 6. Water, 7. Waste, 8. Economic development, Housing and Community.	*Ref. to all* Areas (1,2,3, …)	1. Technologies in built environment 2. Energy supply system, 3. Water disposal system, 4. Waste disposal system, 5. Mobility system, 6. Public space, 7. Regulatory framework.	1. Planning, 2. Design, 3. Construction, 4. Management.	1. Functional unit, 2. Building, 3. Block of buildings, 4. Infrastructures (material/ immaterial), 5. Environment (physical/social).	1. Government, 2. R&I, 3. Financial/Funding, 4. Analyst, IT project and Big Data, 5. BPM, 6. Urban Services, 7. Real Estate, 8. Design/ Construction, 9. Social/Civil Society, 10. eCommerce.

Table 2: SCC Solutions areas of Urban Dilemmas. Implementation of solutions/services according to [11,12]

			Key tools/technologies answer in areas
	Areas	**Class of solutions**	**Solutions**
1	**Safety & Security**		real time crime mapping smart surveillance body worn cameras disaster early warning systems predictive policing emergency response optimization crowd management building security and safety system personal alert applications gunshot detection data driven building inspections
2	**Health**		telemedicine online care search and scheduling real time air quality information infectious disease surveillance lifestyles wearables remote monitoring applications and medication adherence tools data based population health interventions first aid alerts integrated patient flow management system
3	**Education**		e-learning platform augmented reality tools building automation simulator Education&Training platforms energy management awareness real time behavioral impact personalized education applications open data/data management platform
4	**Mobility**	sharing/ e-hailing/ autonomous driving	private e-hailing bike sharing car sharing autonomous vehicle pooled e-hailing demand-based micro transit traffic management and data services real time road navigation
		traffic management and data sharing	real time road navigation integrated multimodal info digital payment in public transit intelligent traffic signals and vehicle preemption real time public transit info smart parking predictive maintenance of transit infrastructure congestion pricing
		urban cargo	smart parcel lockers parcel load pooling and urban consolidation centers

Table 2: SCC Solutions areas of Urban Dilemmas. Implementation of solutions/services according to [11,12]

			Key tools/technologies answer in areas
	Areas	**Class of solutions**	**Solutions**
5	**Energy**		distribution automation system dynamic electricity pricing building energy consumption tracking smart streetlights building automation systems building energy automation systems
6	**Water**		leakage detection and control water consumption tracking water quality monitoring smart irrigation
7	**Waste**		waste collection route optimization digital tracking and payment for waste disposal
8	**Economic Development Housing and Community**		local connection platforms peer to peer accommodation platforms digital administrative citizen services local civic engagement application local e-career center online retraining programmes

generated by an optimized combination of solutions different, in response to urban dilemmas‡, as it will be explained later in this article.

3. Transition towards Positive Energy Districts: dilemmas and solutions

The transition to an energy surplus goes through the domains already identified for the Smart Urban District, which are specified in urban dilemmas to which SCC technologies and solutions respond. The table below shows the correspondences between the urban domains involved in the transformation, identified by the World Economic Forum [10] and the eight transition contexts, identified as areas for defining "dilemmas" [11].

In the operative matrix the dilemmas categorize the relative answers in terms of technologies.

In accordance with the ontology drawn by the SET Plan ACTION 3.2, the solutions to the dilemmas are implementable and not unambiguous. A first survey conducted by McKinsey & Company [12] was adopted as a coherent trace to the previously stated objectives, susceptible of subsequent implementations dictated by the expression of future urban dilemmas and consequent technical responses of research and innovation.

Key Tools & Technologies become the enabling factors that, conveniently combined with business models and system stakeholders, allow the development of SCC solutions which facilitate transition towards PED [8].

4. Implementation domain

Taking into account the formulation of the SET Plan ACTION 3.2 Implementation Plan, the Positive Energy District should involve the optimization of three dimensions:

- Energy efficiency in buildings;
- Energy flexibility within the districts;
- Supply, at the regional or local level, of energy from renewable sources.

The actions have an impact on urban physiology, recognized in six classes of physical components and one of a disciplinary nature (Table 3).

Furthermore, the listed classes constitute domains of systems and relationships in which the dilemmas originate. The effectiveness of the combined and integrated application of SCC solutions is linked to the ability to

‡ The contents of the document, therefore, adhere to the purposes of Module 4 - Replication and Mainstreaming of PED, specifically the "Activity No 4 - Identify analyze policies mixes and initiatives for PED transition, and enable to transfer from research into practice, as well as co-creation with industry and city partners" programmed in the implementation of SET-Plan ACTION.

Table 3: Implementation domains of the SCC solutions

Implementation domains of key tools/technologies answer in areas

Technologies in Built Environment			**Energy Supply System**	**Water Disposal System**	**Waste Disposal System**	**Mobility System**	**Public Space**	**Regulatory Framework**
Building	Infrastructures							
	Material Infrastructures	*Immaterial Infrastructures*						

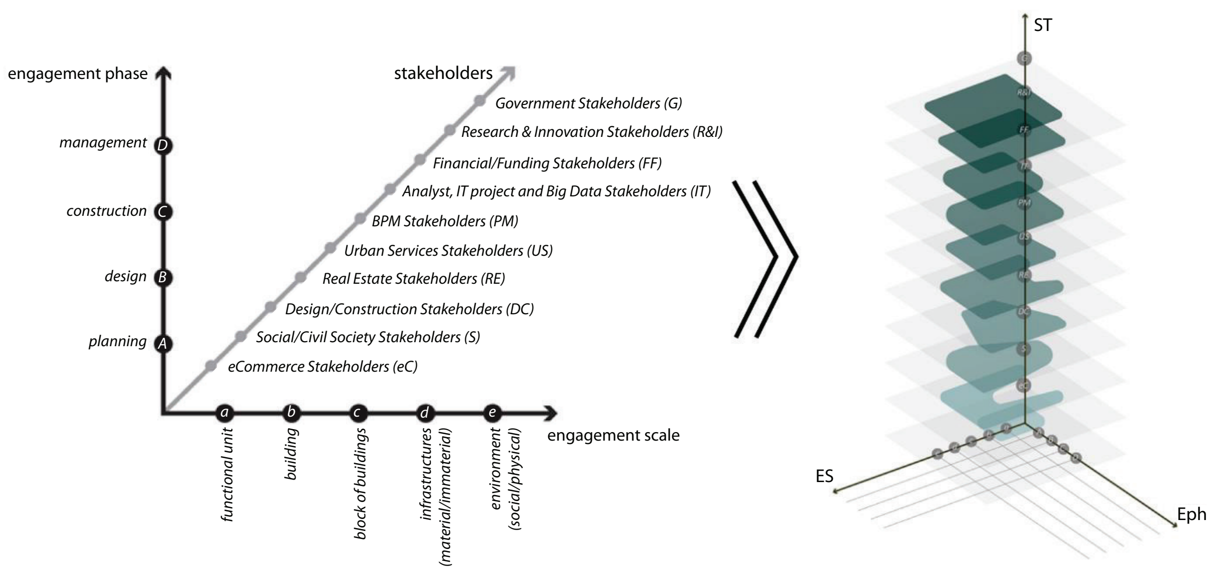


Figure 1: On the left side, the dimensions of the transformation and implementation of the SCC solutions: engagement phase/scale with stakeholders. On the right, Logical framework applied to the "motion sensor" technology for the evaluation of its effectiveness and potential

recognize the connections between domains, the subjects involved in proposing and discussing dilemmas and designing, therefore, the implementation of systems and components. The synoptic framework qualifies as a tool for the positioning of existing ICT products, for the identification of gaps, for the possible development of unpublished fields of application or for the enhancement of existing solutions. In fact, it is believed that the first transition to PEDs is knowledge and organization of existing resources, a sort of accelerator and generator of plus-valence on what we already have in our hands.

5. Transitions towards PED: step towards and engagement

As already mentioned, we consider the physical dimension of urban reality as an indispensable factor in the evaluation of solutions and potential value generation. For this reason, a further coordination effort is required for positioning different solutions within the matrix.

The left side of Figure 1 shows the dimensions of the transformation in terms of time as phases - that characterize the transformation processes of the built environment - and dimension of the action triggered by the solution or the integrated solution system in the relative implementation domain, from the functional unit, in which the individual prosumer acts, to the environmental dimension, as the sphere of physical and social relations, to which the highest degree of complexity is attributed. The third dimension, the system stakeholders, links the effectiveness of the tools themselves to the ability of the actors of the supply chain to play the role of accelerators (RdS / PAR2016 / 033) of the implementation of SCC solutions and to express the potentials of use unpublished.

On the right side, Figure 1 shows, through a three-dimensional representation, the functioning of the logical framework applied to the "motion sensor" technology, described in detail below.

The impact of the adoption of the motion sensor is not assessed in itself but with respect to its ability to affect the different scales of the urban environment and to involve stakeholders in the interaction with technology.

Thanks to the given framework, the ability of the stakeholders to activate and promote the implementation in the two engagement dimensions (phase and scale) is able to shape differently the specific weight of the SCC solution. It appears clear that overlap and consolidation of stakeholder interests accelerate and amplify the effectiveness of the process.

6. Analysis of SSC solutions and specific implementations towards energy services to support PED.

Market demand analysis as well as experimentation of innovative products/ solutions in the RD&I areas (i.e.: ICT., robotics and industrial automation) could highlight possible ingenious scenarios in the perspective of the Smart City to come. In this perspective, PEDs are an integral part of this process, in line with the SET-Plan ACTION n.3.2, in line with the strategies of sustainability and energy efficiency in the environment built at different scales (from the building to the district, to urban space), according to synergistic actions defined among the Member States of the European Union.

Among the solutions deriving for RD&I actions, integrated solutions are potentially the most useful for the diffusion of PEDs, thanks to the interoperability that is established between technologies, infrastructural networks and systems as well as the improved ability to manage a large amount of data [13-16]: the dialogue among systems, technologies and components allows the transition from single architectures to an ecosystem which enable new services that interact each other in a collaborative approach, favoring the automatic interaction between applications and their reuse.

Thanks to interoperability it is possible to share and use information promptly, and thus overcome the traditional subdivision into vertical silos to achieve communication between horizontal silos. The classification of solutions according to certain areas of interest is therefore useful for defining the field of action of each individual solution and the level of technological innovation achieved, in order to promote an adequate integration between energy and urban services through the inclusion of additional services (not only energy services) useful to promote a higher level of quality of life for the citizen, consumer and prosumers.

By processing the data, it is therefore possible to implement software applications capable of carrying out specific functions and activating potential services aimed at certain user categories, according to specific thresholds set by the system. The communication of data and information is made possible to the end user and accessible to service providers, through the use of mobile devices (SD - Smart Devices – e.g. smartphones, tablets and other dedicated systems): this process of transmission of information and communication with end users and stakeholders makes it possible to create new management tools for buildings and the city and to define new scenarios for the use of the built environment condition.

According to the given premises it is possible to distinguish: devices and products, communication interfaces, energy management platforms and urban planning, web tools and interactive apps, whose purpose - as mentioned - is on the one hand improving the performance of the built system and, on the other, to raise the quality of life of the person, enabling a range of innovative services to the citizen, according to specific areas of action and intervention.

Thanks to the research it has been possible to create an analysis tool for the identification of potential products which need to be implemented for PED transition, according to the Italian situation and with respect to certain domains of interest, defining priorities and level of TRL.

Through the systematization of information, it is therefore possible to identify areas, products, stakeholders and the relative level of TRL maturity achieved by each solution, in order to verify the effective implementation and applicability to the national context.

The research activity was therefore aimed at identifying the specific functions of the products and the type of service that they are able to provide, with reference to the scope of the main "dilemmas" previously defined (Economic development housing and community; Health, Mobility, Safety & Security, Waste, Water) as determined in SET-Plan ACTION n.3.2 and in the framework of the respective "domains" of the implementation, in order to recognize gaps to solve in the future, according specific areas and lines of action .

The following type of solutions has been defined (A - Actuator, B - Bus connectivity, G - Gateway, SD - Smart Device, SM - Smart Meter, SO - Smart Object, SS - Smart Sensor (in the case of technologies and devices); IC - Communication Interfaces, IP - Interactive Platforms (apps), UP - Urban energy management platforms) as well as functioning and performance (i.e.: systems activation, communication with the end user and system stakeholders, control, monitoring, collection and transmission of info or services).

The specific functionalities, the quantity and quality of the parameters that the individual solutions are able to manage or the type of service they are able to supply in an integrated way have also been determined - AAL - Assisted Living, COM - Comfort, NRG - Energy, SAE - Safety & Security. While Assisted Living's solutions (AAL - Ambient Assisted Living) are mainly aimed at fragile user categories - such as disabled or elderly people - the other devices refer to generic users, is able to offer diversified services, such as control of the environmental conditions to guarantee the wellbeing of the occupants (COM - Comfort), or adequate safety conditions (SAE - Safety & Security) to ensure the safety of the users with respect to external agents or the occurrence of dangerous situations for the person , the management of energy consumption (NRG - Energy) aimed to reduce polluting emissions and the consequent economic savings.

It is indeed possible that the same device is able to enable multiple services and can be effective for different and multiple levels of user satisfaction, embracing distinct features or parameters.

In order to verify solutions interoperability, the communication protocol (e.g. wireless or wired) to which the individual solutions refer has been identified as well as location in the physical space (i.e. indoor or outdoor) according to the radius of action that they are able to intercept.

The table presented in this article are part of a selected repertoire of technological solutions, in which a defined quantity of devices, products and tools is included within a wide range of solutions available on the market and/or being tested.

The repertoire of solutions is a sort of catalogue, potentially useful in the project's elaboration phases which could be used as a device for sharing knowledge on these systems. These solutions, despite being widely used in many international contexts, do not yet enjoy regulatory, performance and appropriate use, such as its immediate application on a national scale. The radial graph allows to determine the level of technological progress achieved according to the TRL levels defined. Thanks to the Figures 2 and 3 it possible to identify gaps and missing solutions for the provision of specific services and with a view to achieving higher levels of quality of life for the citizen, consumer/prosumers, within the framework of the "dilemmas" previously established.

7. Conclusion

This paper highlights strengths and weaknesses for the transition towards PED through the "dilemmas" approach.

According to the actual state of art in SCC solutions, it has been possible to identify the area which the single solution/product is able to support, as well as priorities and research perspectives.

The consequent framework which derives is a tool to guide, verify and assess the TRL level (achieved / objective / priority) for each single technology or group of technologies, devices, products, apps and integrated intelligent systems. It is also possible to implement areas for R&DI on solutions able to provide urban services to support PED transition. The given flexible model is effective to recognize functionality and criticism for each solution, and to position research and products in the market as well as stakeholders related to the specific solution.

The table for product/solution illustrated in the article represents a small selection of a wider repertoire, which includes a defined quantity of devices, products and tools within a wide range of solutions available on the market and/or being tested.

The repertoire of solutions is a sort of catalogue, potentially useful in the definition phases of SCC solutions. The information and the radial chart that accompanies each data sheet make it possible to determine the incidence and level of integration for each solution having in mind the 4 dilemmas and the specific areas for urban dilemmas, as well as the technological progress achieved according to the TRL levels.

This representation also makes it possible to identify any gaps and missing solutions for the provision of specific services and with a view to achieving higher levels of quality of life for the citizen / user, within the framework of the "dilemmas" previously established.

Acknowledgement

This article was invited and accepted for publication in the EERA Joint Programme on Smart Cities' Special

Technical features

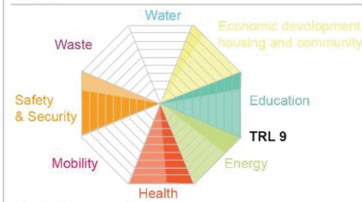
Ultralight, compact, battery powered.
Completely wireless.

Wall mounting h min 2,40 mt / other
Measurement range lux: 0 - 32000 lux
Measurement range ° C: -20 - 100 ° C
Operating temperature ° C: 0-40 ° C
Frequencies: 868.4 or 869.08 MHz (EU)
Distances: up to 50 m (outdoor)
Distances: up to 30 m (indoor)
Dimensions: 46 mm

Dilemmas

- Digital transition in urban context
- From urban resilience to urban robustness
- Sustainable land-use and urban infrastructures
- Inclusive public spaces for urban liveability

Areas



Description

The "motion sensor" is a multifunctional smart sensor, as it is able to perform multiple functions within the same technology.
The motion sensor is, in fact, at the same time able to measure the temperature and intensity of the light present in the home environment, offering a range of additional performances thanks to its ability to detect movements and changes in the position of objects, people and animals.
The motion sensor is a battery-powered device designed to be easily installed on any surface.
The LED indicator signs movement, temperature level, operating mode and can be used to check if the device is inside the Z-Wave network.
A lux sensor allows you to dynamically adjust artificial lighting in relation to the intensity of natural light present outside.
The motion sensor is also able to adjust the light intensity according to the presence of people in the environment and adapting it to the specific user preferences, activating predefined scenarios based on the time of day and the position of the sensor inside or outside the building.
The sensor is also able to intelligently recognize people and animals, useful for the purposes of intrusion safety and can be configured to detect any vibrations in the event of an earthquake, by setting certain parameters.

Requirements

- [x] environmental
  - Artificial lighting monitoring
  - Indoor air temperature monitoring
  - Natural lighting monitoring
  - Motion and external agents presence control
  - Earthquake monitoring and dynamic actions
- [x] technological
  - Emergency operation

Protocol

- [ ] wired
- [x] wireless
  - Z-Wave

Producer

Fibaro

Typology

- [ ] A - actuator
- [ ] B - bus connectivity
- [ ] G - gateway
- [ ] IC - communication interface
- [ ] IP - interactive platform (app)
- [ ] SD - smart device
- [ ] SM - smart meter
- [ ] SO - smart object
- [x] SS - smart sensor

Function

- [ ] activation
- [ ] communication with end-user
- [ ] control
- [ ] data collection
- [x] monitoring
- [ ] transmission of informations

Service

- [x] AAL - Assisted Living
- [x] COM - Comfort
- [x] NRG - Energy
- [x] SAE - Safety & Security

Position

- [x] indoor
- [x] outdoor

Functionalities and parameters

- [x] accelerometer (earthquake)
- [ ] activity
- [ ] air velocity (wind)
- [x] artificial light
- [ ] breath command
- [ ] CO2 concentration, VCO
- [ ] consumptions (water, gas, electricity)
- [x] emergency (building system)
- [x] emergency (user)
- [x] falls
- [ ] fire presence
- [ ] gas & smokes presence
- [ ] humidity
- [ ] incontinence
- [x] movement (users and animals)
- [x] natural light
- [ ] night light paths
- [ ] open / close
- [ ] presence (users and animals)
- [ ] rain
- [ ] rumor / sound
- [ ] sleeping quality
- [x] temperature
- [ ] vital parameters
- [ ] vocal command
- [ ] water leak presence

Keytools answer in Areas

Economic devolopment housing & community

- [ ] digital administrative citizen services
- [ ] local civic engagment application
- [ ] local connection platforms
- [ ] local e-carer center
- [ ] online retraining programmes
- [ ] peer to peer accomodation platforms
- [x] personalized education

Education

- [ ] augmented reality tools
- [x] building automation simulator
- [ ] education & training platforms
- [ ] e-learning platform
- [ ] energy management awareness
- [x] open data / data sharing
- [ ] personalized education
- [ ] real time behavioral impact

Energy

- [x] building automation system
- [x] building energy automation system
- [ ] building energy consumption tracking
- [ ] distribution automation system
- [ ] dynamic electricity pricing
- [x] home energy automation systems
- [ ] home energy consumption tracking
- [ ] smart streetlights

Health

- [ ] medication adherence tools
- [ ] online care search and scheduling
- [x] real time air quality information
- [x] remote monitoring applications
- [ ] telemedicine

Mobility

- [ ] autonomous vehicle
- [ ] bike sharing
- [ ] car sharing
- [ ] congestion pricing
- [ ] demand-based microtransit
- [ ] digital payment in public transit
- [ ] integrated multimodal info
- [ ] intelligent traffic signals and vehicle preemption
- [ ] parcel load pooling & urban consolidation centres
- [ ] pooled e-hailing
- [ ] predictive maintenance of transit infrastructure
- [ ] private e-healing
- [ ] real time public transit info
- [ ] real time road navigation
- [ ] smart parcel lockers
- [ ] smart parking
- [ ] traffic management and data services

Safety and Security

- [x] body worn cameras
- [x] building safety & security system
- [x] crowd management
- [ ] data driven building inspections
- [x] disaster early warning systems
- [x] emergency response optimization
- [ ] gunshot detection
- [x] home security and safety system
- [x] personal alert applications
- [ ] predictive policing
- [ ] real time crime mapping
- [x] smart surveillance

Waste

- [ ] digital tracking and payment for waste disposal
- [ ] waste collection route optimization

Water

- [ ] leakage detection and control
- [ ] smart irrigation
- [ ] water consumption tracking
- [ ] water quality monitoring

Figure 2: Motion Sensor datasheet

App informations

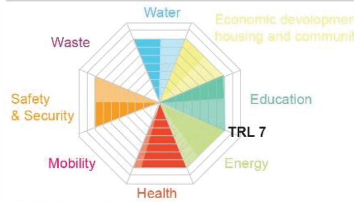
Research project: Your Wellness
Country: Dundalk, Ireland
Year: 2013 - in progress

R&D: Netwell Centre, CASALA
U: Dundalk Institute of Technology
SME: Fujitsu
Others: Dundalk Town Council, Department of Environment and Local Government, Atlantic Philanthropies, Sustainable Energy Authority of Ireland

Dilemmas

- Digital transition in urban context
- From urban resilience to urban robustness
- Sustainable land-use and urban infrastructures
- Inclusive public spaces for urban liveability

Areas



Description

Your Wellness is defined as a smartphone or iPad app, used to detect a series of physiological and behavioral conditions of users, thanks to the possibility of receiving feedback on their wellbeing or health conditions, activating preventive actions. The first phase of the research allowed at the definition of some wellness categories to be monitored through the platform, which mainly concerned the quality of sleep, mood and social interaction. Data from sensors integrated into the building system are useful to obtain additional information such as the history of falls, the feeling of fear due to the insecurity in the environment and the level of user activity as fatigue or cognitive performances. The use of data from motion sensors take informations about the activities daily living and the detection of user's position inside or outside the apartment or building. A localization map verifies the excessive permanence of the elderly in a specific environmental unit that is indicative of a state of health or changes in user's behavior or mood. Interventional therapies exist to act on particular signals of ill health.
Night walking or excessive stay in the bathroom may be symptomatic of sleeping interruption or a sudden illness and may be detected by a bed sensor. The level of user activity is also indicative of a particular emotional state, such as the presence of anxiety or depressive disorders.
The platform also allows the monitoring of vital parameters be measured remotely (blood pressure, weight, blood sugar, ...); within the acceptability threshold set in the IT device, it is possible to activate preventive behavior actions by the various operators in the assistive and health-care sector (doctors, nurses, pharmacists, ..).
This integrated system supports the feedback by end-users, as essential to support the older persons in self-management of their health state and to improve their quality of life as they age.
The platform is able to manage, finally, a series of information on the level of safety and use of energy at home. The control and monitoring of energy consumption or equipment uses give specific information about their uses and make users aware of the potential costs' savings obtainable. User involvement is an essential part of the project's development: the elderly are educated in the use of digital technologies and receive information and guidance to improve their health or mood.

Protocol

- [x] wired
- [ ] wireless

KNX

Producer / Research centre

Fujitsu, Netwelle Centre, Casala

Typology

- [ ] A - actuator
- [ ] B - bus connectivity
- [ ] G - gateway
- [ ] IC - communication interface
- [x] IP - interactive platform (app)
- [ ] SD - smart device
- [ ] SM - smart meter
- [ ] SO - smart object
- [ ] SS - smart sensor

Function

- [ ] activation
- [x] communication with end-user
- [ ] control
- [ ] data collection
- [ ] monitoring
- [ ] transmission of informations

Service

- [x] AAL - Assisted Living
- [x] COM - Comfort
- [x] NRG - Energy
- [x] SAE - Safety & Security

Position

- [x] indoor
- [x] outdoor

Functionalities and parameters

- [ ] accelerometer (earthquake)
- [x] activity
- [x] air velocity (wind)
- [x] artificial light
- [ ] breath command
- [ ] CO2 concentration, VCO
- [x] consumptions (water, gas, electricity)
- [x] emergency (building system)
- [x] emergency (user)
- [x] falls
- [ ] fire presence
- [x] gas & smokes presence
- [x] humidity
- [ ] incontinence
- [x] movement (users and animals)
- [ ] natural light
- [ ] night light paths
- [x] open / close
- [ ] presence (users and animals)
- [ ] rain
- [ ] rumor / sound
- [x] sleeping quality
- [x] temperature
- [x] vital parameters
- [ ] vocal command
- [x] water leak presence

Keytools answer in Areas

Economic devolopment housing & community
- [ ] digital administrative citizen services
- [ ] local civic engagment application
- [x] local connection platforms
- [x] local e-carer center
- [ ] online retraining programmes
- [ ] peer to peer accomodation platforms
- [x] personalized education

Education
- [ ] augmented reality tools
- [ ] building automation simulator
- [ ] education & training platforms
- [ ] e-learning platform
- [x] energy management awareness
- [x] open data / data sharing
- [x] personalized education
- [ ] real time behavioral impact

Energy
- [x] building automation system
- [x] building energy automation system
- [x] building energy consumption tracking
- [ ] distribution automation system
- [x] dynamic electricity pricing
- [x] home energy automation systems
- [x] home energy consumption tracking
- [ ] smart streetlights

Health
- [ ] medication adherence tools
- [x] online care search and scheduling
- [x] real time air quality information
- [x] remote monitoring applications
- [x] telemedicine

Mobility
- [ ] autonomous vehicle
- [ ] bike sharing
- [ ] car sharing
- [ ] congestion pricing
- [ ] demand-based microtransit
- [ ] digital payment in public transit
- [ ] integrated multimodal info
- [ ] intelligent traffic signals and vehicle preemption
- [ ] parcel load pooling & urban consolidation centres
- [ ] pooled e-hailing
- [ ] predictive maintenance of transit infrastructure
- [ ] private e-healing
- [ ] real time public transit info
- [ ] real time road navigation
- [ ] smart parcel lockers
- [ ] smart parking
- [ ] traffic management and data services

Safety and Security
- [x] body worn cameras
- [x] building safety & security system
- [ ] crowd management
- [ ] data driven building inspections
- [ ] disaster early warning systems
- [x] emergency response optimization
- [ ] gunshot detection
- [x] home security and safety system
- [x] personal alert applications
- [ ] predictive policing
- [ ] real time crime mapping
- [x] smart surveillance

Waste
- [ ] digital tracking and payment for waste disposal
- [ ] waste collection route optimization

Water
- [x] leakage detection and control
- [ ] smart irrigation
- [x] water consumption tracking
- [ ] water quality monitoring

Figure 3: App Your Wellness (Great Northern Haven) datasheet

issue on Tools, technologies and systems integration for the Smart and Sustainable Cities to come [16].

References

[1] Good N, Martinez Cesena EA, Mancarella P. Ten questions concerning smart districts. Building and Environment (118) (2017): 362-376. https://doi.org/10.1016/j.buildenv.2017.03.037

[2] Yan D, Hong T, Dong B, Mahdavi A, D'Oca S, Gaetani I, Feng X. IEA EBC Annex 66: Definition and simulation of occupant behavior in buildings. Energy and Buildings 156 (2017): 258-270. https://doi.org/10.1016/j.enbuild.2017.09.084

[3] Frederiks ER, Stenner K, Hobman EV. Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. Renewable and Sustainable Energy Reviews (41) (2015) pages 1385-1394. https://doi.org/10.1016/j.rser.2014.09.026

[4] Tianshu W, Zhu Q, Yu N. Proactive demand participation of smart buildings in smart grid. IEEE Transactions on Computers 65 (5) (2015): 1392-1406. https://doi.org/10.1109/TC.2015.2495244

[5] Palensky P, Dietmar D. Demand side management: Demand response, intelligent energy systems, and smart loads. IEEE transactions on industrial informatics 7 (3) (2011) pages 381-388. https://doi.org/10.1109/TII.2011.2158841

[6] SCIENTIFIC BOARD FOR JPSC SPECIAL ISSUE, Joint Programme on Smart Cities. EERA Joint Programme on Smart Cities: storyline, facts and figures. TECHNE - Journal of Technology for Architecture and Environment, [S.l.] (1) (2018) pages 16-25 https://doi.org/10.13128/Techne-23566

[7] Antonini E, Mussinelli E. Toward the smart city and beyond. TECHNE-Journal of Technology for Architecture and Environment, [S.l.] (1) (2018), pages. 26-27. https://doi:10.13128/Techne-23567.

[8] SET-Plan ACTION n°3.2 Implementation Plan. Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts. (2018). Available online at:https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf [Accessed on 01 Sept 2019].

[9] Pinna R, Costanzo E, Romano S. (2018). Pathways to ZEED. TECHNE-Journal of Technology for Architecture and Environment, (1), pages 40-44. http://dx.doi.org/10.13128/Techne-22736

[10] World Economic Forum (2015). *Inspiring Future Cities & Urban Services. Shaping the Future of Urban Development & Services Initiative, Global Survey on Urban Services.* Available online at: http://www3.weforum.org/docs/WEF_Urban-Services.pdf [Accessed on 01 Sept 2019].

[11] JPI Urban Europe. Strategic Research and Innovation Agenda 2.0. Full Draft. (2018) Available online at https://jpi-urbaneurope.eu/about/sria/

[12] McKinsey Global Institute (2018). *Smart Cities: digital solutions for a more livable future*. Available online at: https://www.mckinsey.com/~/media/mckinsey/industries/capital%20projects%20and%20infrastructure/our%20insights/smart%20cities%20digital%20solutions%20for%20a%20more%20livable%20future/mgi-smart-cities-full-report.ashx [Accessed on 01 Sept 2019].

[13] Ahlgren B, Hidell M, Ngai EC. Internet of things for smart cities: Interoperability and open data. IEEE Internet Computing 20 (6) (2016). pages 52-56. http://dx.doi.org/10.1109/MIC.2016.124

[14] Integrated and Replicable Solutions for Co-Creation in Sustainable Cities. Available online at https://irissmartcities.eu/content/5-iris-transition-tracks [Accessed on 01 Sept 2019].

[15] Maestosi PC, Civiero P, Romano S, Botticelli M. Smart home network for smart social housing: A potential to boost the dignity of mankind. InProceedings of the 42th IAHS World Congress The Housing for the Dignity of Mankind, Naples, Italy 2018 Apr (pp. 10-13). Available online at http://sue.enea.it/wp-content/uploads/2017/11/paper-IAHS2018_-ID014_20180215-ottimizzato.pdf [Accessed on 01 Sept 2019].

[16] Østergaard PA, Maestosi PC. Tools, technologies and systems integration for the Smart and Sustainable Cities to come. Int J Sustain Energy Plan Manag 2019;24 2019. http://dx.doi.org/10.5278/ijsepm.3450