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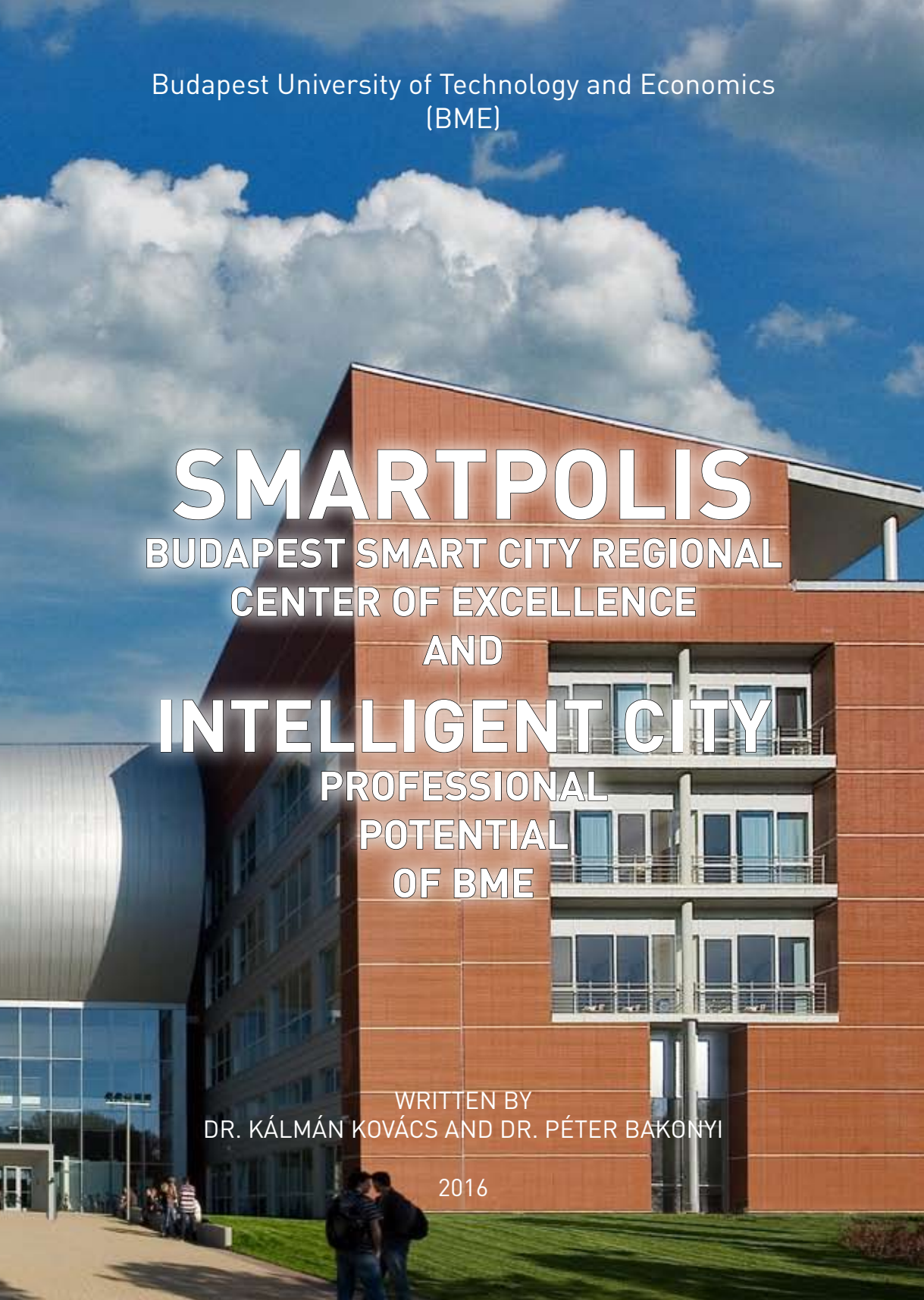

SMARTPOLIS

BUDAPEST SMART CITY REGIONAL CENTER OF EXCELLENCE AND INTELLIGENT CITY PROFESSIONAL POTENTIAL OF BME

WRITTEN BY
DR. KÁLMÁN KOVÁCS AND DR. PÉTER BAKONYI

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I. Introduction

The BME-based Budapest Smart City Centre of Excellence (Smartpolis) with its regional scope will be able to provide high quality support to settlements in planning their Smart City programs, will increase the chance of winning grants and ensure the successful implementation of the projects. As the development of the Hungarian Smart City Strategy is nearing completion, the strategic goals building on the harmonization of the EU initiatives, local needs and conditions, and the recommended implementation methods will significantly accelerate the development processes of becoming a smart city.

Statistics and studies prove our common experience that energy and mineral consumption, depletion of resources, environmental impact of the world are continuously increasing since the opening of the twentieth century; and in parallel with these, the urbanisation process is accelerating – by the exceptionally fast development and spread of expanding community services primarily induced by industrialization, and then newer and newer technological advances. As regards the sustainability of processes, surveys in several fields show we reached a tipping point by early third millennium. In some areas we need to radically change the trends. Such are carbon emission, fossil fuel stock, rain forests, or the area of freshwater reserves, were we need to achieve decrease instead of further increase. And, clearly, there are areas where we are unable to amend the trend. For example, the process of urbanization: more than half of the world's population lives in cities, within that in developed countries this proportion is even higher, and in the case of the European Union, this reaches 75 per cent. Moreover, energy consumption (and environmental impact) increases most dynamically in cities, because besides the mass service problems raised by increasing concentration, the society-wide demand for and personalized services satisfying individual needs is rapidly growing. It is therefore in the urban environment where we primarily need to find solutions that may provide for long-term sustainability. There are several points of conflicts in cities. Such are public works (e.g. power and water supply, traffic), environments of everyday life (e.g. residential buildings, institutions, workplaces), industrial and service areas and green areas. We need to find intelligent or so-called smart solutions that besides being very efficient and sustainable, promote economic prosperity and the increasingly comfortable and safe ways of life. This can be the most efficiently achieved by mobilizing the totality of urban resources and creating a development strategy in coordinated manner, using new technologies. The intelligent city (also known as 'smart city" or 'Smart City') specifically affects the development of these areas: government, way of life, mobility, economy, environmental protection and energy supply.

The Smartpolis - Budapest Smart City Regional Center of Excellence is happy to welcome investors, research partners and experienced suppliers of smart cities.

II. The European Initiative on Smart Cities

II.1. Social and Professional Challenges

Cities have become priority players of economy and society, primarily due to urbanisation and the rise of knowledge intensive economy, as well as because of the ever-increasing consumption and pollutant emissions [1]. The fulfilment of EU 20-20-20 objectives (20% pollutant emission decrease, 20% renewable energy and 20% energy efficiency increase) means that dynamic change is necessary in the areas of energy consumption, transport and infrastructure, and cities hold key roles in this. In the EU, 75% of the population lives in cities and uses 70% of the utilized energy, and the proportion is the same in the area of pollutant emission. Along these conditions, considering a tight budget, there is need for changes, but differently than previously. Fig. 1 shows how forecasts of EU energy consumption changed after 2005.

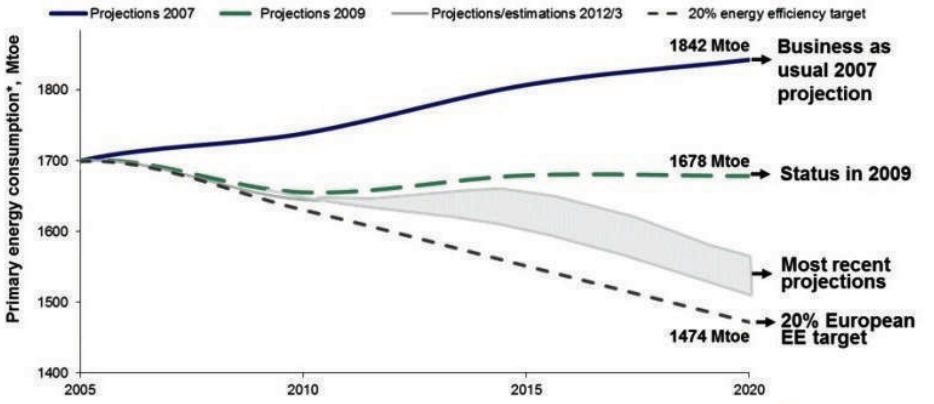

Fig. 1: EU primary energy consumption scenarios for 2020 [2]

The figure clearly shows (dashed green line) that the initial positive effects of the 2005 energy consumption reduction actions after 2009 did not prevail, and the system was restored in 2013 to essentially the same growth path gradient [2]. Analysts saw the reasons among others in that the independent industrial solutions did not become to an integrated, synergic system, the initiatives did not concentrate on the most critical area, the cities, and the long term business model of the solutions was not created, either.

[1] EU Energy, Transport and GHG Emissions Trends to 2050, Reference Scenario (2013), http://ec.europa.eu/energy/sites/ener/files/documents/trends_to_2050_update_2013.pdf

[2] EU primary energy consumption scenarios for 2020 (2013): http://ec.europa.eu/eip/smartcities/files/sip_final_en.pdf, pp 5

II.2. Intelligent answers: EU Smart City initiative

To tackle these problems, the so-called Smart City (or Intelligent City) initiative was launched , together with setting up a strategy and implementation plan. These gives intelligent or so-called smart solutions that besides being very efficient and sustainable, promote economic prosperity and the increasingly comfortable and safe ways of life. This can be the most efficiently achieved by mobilizing the totality of urban resources and creating a development strategy in a coordinated manner, using new technologies. The grey bar in the figure shows the expected impact of this, which approaches the original ambitious plan of 20% decrease.
According to the Cohen vision (Fig. 2), the most important components of smart cities are smart economy, environment, government, living, mobility and people.

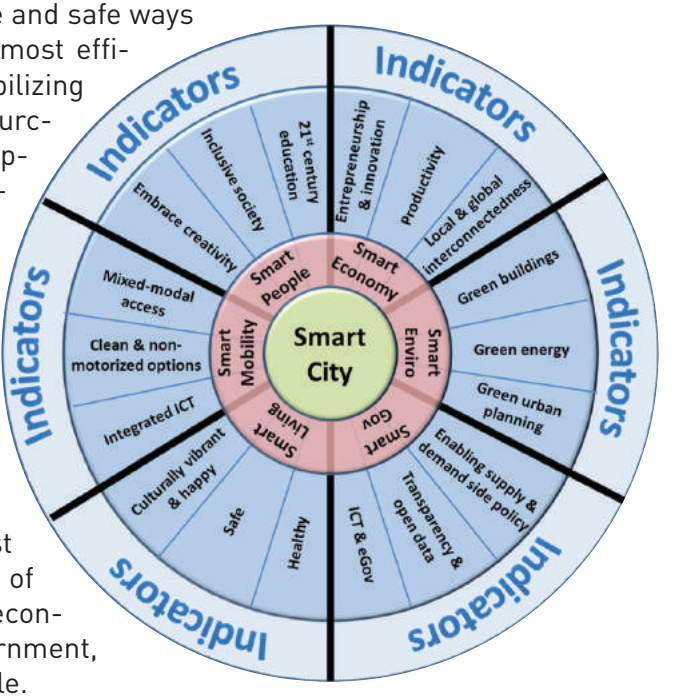

Fig. 2: Key components for the smart cities [3]

The essence of the new initiative, learning from the failure of the early measures introduced in 2005, the European Union considers drastic changes closely related to each other necessary in the following areas:

- energy production and energy utilization,
- transport and delivery systems,
- infrastructure (build environment – building, public utility), and
- information technology and communication technologies.

[3] Cohen, B. (2012): http://www.ubmfuturecities.com/author.asp?section_id=219&doc_id=524053

Therefore, we can only attain these objectives, if widespread, comprehensive, integrated, sustainable 'smart city' solutions are developed in the areas of energetics (buildings and services), mobility (transport) and infocommunications technology (ICT). These solutions are common and transposable from city to city. Various solutions have already been developed[4] [4], but the larger scale industrial rollout is missing yet.

II.3. Elements of EU Smart City strategy

The EU Smart City strategy aims at developing three key areas:

1. Sustainable urban mobility using alternative energies and smart solutions:
   a) in public transport, logistics,
   b) areas of planning and operational management.
2. Sustainable energy efficient buildings and areas:
   a) increasing the energy efficiency of buildings and areas,
   b) increase the proportion of renewable energy utilization,
   c) enhancing the quality of life of the community.
3. Establishing integrated infrastructure:
   a) to connect energetics, transport and ICT,
   b) to increase efficiency and sustainability.

Societal-economic objectives of the EU Smart City program:

1. Accelerate innovation and investments to improve societal, economic and environmental conditions.
2. Take significant step forward in the areas of quality of life, sustainability and competitiveness:
   - quality of life of city dwellers improves,
   - efficiency of utilization of resources,
   - reduction of pollutant emission (by min. 30%),
   - energy efficiency of buildings,
   - dynamic disaster management,
   - sustainability of business models for smart city solutions,
   - efficiency and competitiveness on local and EU level.
3. Building up co-operation in the Danube region to speed up the Smart City developments and deployments.
4. The Smart City program appears as a new paradigm in the technological, economic and societal developments of cities.

[4] BALTHASAR, A. et al. (ed.) (2015): Central and Eastern European e-Dem and e-Gov Days 2015, Conference Proceedings, Austrian Computer Society, 2015

II.4. Business plans for Smart Cities

EU considers necessary for sustainable and widely feasible solutions that for the involved area integrated new business model and financial viability should be created, with the key cornerstones:

- traditional solutions (interests) are not sustainable;
- new approach is necessary, which is:
  - market oriented and sustainable in the long run,
  based on individual-community (public-private cooperation) strategy,
  - a unification of complex urban needs and industrial, service industry interests.

Elements of a business model related to Smart Cities:

- modular approach,
- adaptability of local (operating) ecosystems, and
- creates the European market of solutions, technologies and products-services designed for smart cities.

II.5. ICT development for Smart Cities

ICT (Infocommunication Technology) is the key technology that is able to manage these challenges and Smart City concept offer solutions utilizing ICT to the above listed problems. ICT, and its key element, Internet of Things (IoT) strengthens man-to-man, man-to-machine and machine-to-machine relations, promotes their expansion, the development of infrastructure and business operations. This is how the interdependence of ICT and society is building up and their future development is interweaving. Future Internet is the critical element on the ICT side of this, that is, the establishment of a communication-technology platform capable of meeting the exploding needs.

This way the research and development of Future Internet and the application-research and service-development activities of Smart City are closely linked. As when developing the Intelligent City services for the next decades, we need to consider the changing Internet technology environment (Future Internet) on which it will have to be implemented. And vice versa, in the course of researching Future Internet, it is important to consider those comprehensive development and service trends for which we intend to create tools that are capable of servicing them in the long run (tools that are quick, secure and last but not least, energy efficient).

II.6. Implementation of EU Smart City strategy

The EU listed eleven inter-dependent priority areas in the Operational Implementation Plan [5] of the European Innovation Partnership on Smart Cities and Communities:

1. Citizen focus – engaging of citizens in the change processes
2. Policy and Regulation – creating a supportive environment for development
3. Integrated planning and management – solutions arching over sectors and administrative limits
4. Knowledge Sharing – dissemination of solutions, changing the innovation capability
5. Baselines, Performance Indicators and Metrics – definition and metering development (change) parameters
6. Open data governance – freedom of information and protection of privacy
7. Standards – ensuring the consistence of development (applicability)
8. Business models, Procurement and Funding – integrated solutions at EU and world market level
9. Sustainable Urban Mobility (transport)
10. Sustainable Districts and Built Environment
11. Integrated Infrastructures and processes across Energy, ICT and Transport

Examining the interactions of these, the various priorities can be grouped in accordance with the category they belong to: the decision making process, inside information and knowledge sharing strengthening social cohesion, or financing, that is, financial sustainable of operation. The last three priorities are in fact the comprehensive professional areas of implementation. The first eight priorities appear horizontally on all three professional priority areas.

Figure 3 shows this interaction and the inner processes of strategy implementation.

[5] Strategic Implementation Plan (2007): in "An Energy Policy for Europe" [COM(2007) 1 final] for the 20/20/20 energy and climate targets, p. 3.

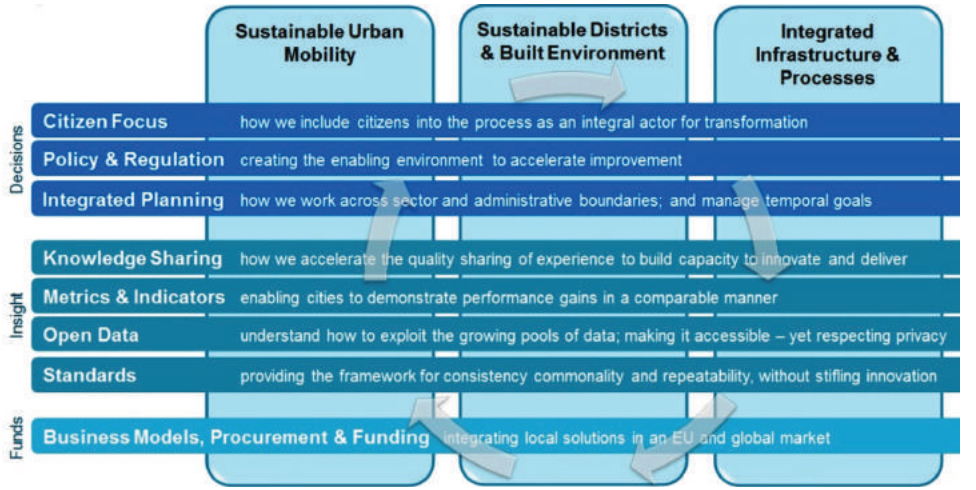

Fig. 3: Implementation of Smart City Strategy [6]

The successful implementation of the plan requires significant technological developments and intelligent integrated solutions in all involved areas. We show the innovation processes of 'Intelligent City' in Figure 4.

← Horizontal research programs and market considerations for SCC oriented information →			
R+D and viable SCC ideas validation	SCC ideas initial demonstration in urban environment	SCC ideas demonstration in large scale urban areas	Market based general introduction in urban environment
Direction of innovation process →			
R+D budget, e.g. EU FP7 and H2020		H2020 and other sources	Technical support programs, structural funds, risk capital

Fig. 4: Innovation processes of 'Intelligent City' SCC = Smart Cities and Communities

[6] Operational Implementation Plan of the European Innovation Partnership on Smart Cities and Communities (2010), http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf p.5

II.7. Some elements of Smart City tender application opportunities

EU Smart City landscape

In the EU countries, among cities with a population between at least 100 and 200 thousand 51% implemented smart city solutions, while 90% of cities with a population above 500 thousand regard themselves smart cities and implements significant scale Intelligent City projects, primarily in the area of services. This indicates that smaller cities are in the planning phase, but this proportion is changing.

The following EU Member States have the most smart cities: Austria, Italy, United Kingdom, Denmark, Estonia, Slovenia, Sweden, Spain, and France.

According to the EU Smart City strategy preparatory documentation, the 6 most successful EU smart cities are: Amsterdam, Barcelona, Copenhagen, Helsinki, Manchester and Vienna. The 'starting eleven' includes: Paris, Stockholm, London, Hamburg and Berlin.

In the course of preparing the Horizon 2020 strategy, to determine the new objectives and the viability of their implementation, the EU the considered - besides the global trends of the past decades – the changes and new challenges that emerged in Europe, and within that in the whole European Union that was enlarged several times in the past two decades and in the Member States. Two from among these explicitly supported the claim for the community that it should seek complex, efficient and long-term sustainable solutions for the problems of the cities.

1) Cities have become priority players of economy and society, primarily due to urbanisation and the rise of knowledge intensive economy, as well as because of the ever-increasing consumption and pollutant emissions. The fulfilment of EU 20-20-20 objectives means that dynamic change is necessary in the areas of energy consumption, transport and infrastructure, and cities hold key roles in this.
2) The trend of urbanisation goes on, dynamically and globally, meanwhile the risks of sustainability are also on the rise, almost endangering the liveability of the cities, undermine competitiveness and heavily impact upon quality of life.

This is why the EU moved Smart City development objectives into the focus of its strategy, and this is why it intends to support the development, implementation of wide ranging, comprehensive, integrated and economically sustainable 'smart city' solutions and the dissemination of successful solutions. Various solutions have already been developed, but the larger scale industrial rollout is missing yet.

Smart City tender application opportunities and criteria – Horizon 2020

H2020 Societal Challenges:

1. Health, Demographic Change and Wellbeing
2. Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy
3. Secure, Clean and Efficient Energy
4. Smart, Green and Integrated Transport
5. Climate Action, Environment, Resource Efficiency and Raw Materials
6. Europe in a changing world - Inclusive, innovative and reflective societies
7. Secure societies – Protecting freedom and security of Europe and its citizens

All 7 areas of intervention in the EU Horizon 2020 strategy require full-scale intelligent solutions for efficient developments. Therefore EU handles the Smart City theme as top priority, and the Horizon 2020 program includes several grant schemes with significant funding amounts. The first H2020 call for applications supporting the realization of the EU Smart City development strategy heavily impacted these areas.

Basic requirements of the first EU tenders

EU heavily funds the realization of the Smart (Intelligent) City strategy with calls for applications. For example, in the frame of the already started Horizon 2020 program, the SCC1 Smart Cities and Communities call for applications. The basic requirement is the integrated and holistic approach, therefore each 'implementing city' will take a pledge in each area listed here:

- energy efficient district (energy efficient residential buildings 50 kWh/m^2/year)
- integrated infrastructure
- urban mobility
- local team (local government, energy provider, organisation of real estate, ICT network provider, street lighting company, traffic management, university, SMEs)
- business model and financial viability (public-private cooperation).

Fig. 5: H2020-SCC1-2014-15 winning applications implementing and follower cities

III. Smart City development in Hungary

The Hungarian Smart City strategy aligns to the Digital Nation Development Program (DNFP) approved by the Hungarian government. DNFP, on the other hand, closely aligns the EU Digital Agenda for Europe and the objectives of the National (Hungarian) Infocommunication Strategy. As a first step of strategy development, the SC Professional Platform and Planning Environment were formed. Then followed the definition and categorization (state, community, business) of relevant intelligent city services, the establishment of the joint technological platform; and the elaboration of complex business models (economies of scale, local characteristics, financing). Parallel to this, the establishment of supportive environment (calls for proposals and regulation) to integrated solutions and continuous monitoring and application development environment takes place.
One of the key players of the professional background is the Budapest Smart City Centre of Excellence.

III.1. Planning frameworks and professional forums

National Digital Development Programme

The Hungarian strategy for Intelligent City is not yet finalized. Government, however, recognizing the social, economic and national policy benefits stemming from the widespread, purposeful use of infocommunications and digital tools – approved the National Digital Development Programme (DNFP) aimed at the increased spread of access to infocommunication services and tools. To implement DNFP, the government decided it is necessary to secure 30 Mbps bandwidth Internet access on the whole territory of the country by 2018. These resolutions provide the framework for commencing strategy development on government level.

National Infocommunication Strategy 2014-2020

The development of the digital infrastructure belongs to the Prime Minister's Office and the Ministry of National Economy. This strategy framework is shown in Table 1.

Strategic frames for Smart City developments		
EU Digital Agenda	National Infocommunication Strategy 2014-2020	National Digital Development Programme 2014-2020
EU-wide broadband coverage by 2013	Reaching all domestic settlements with optical cable by 2016	
EU-wide min. 30Mbps broadband coverage by 2020	All domestic households with min. 30Mbps broadband access by 2020	All domestic households with min. 30Mbps broadband access by 2018
Min. 50% of EU households with min. 100Mbps broadband Internet subscription by 2020	Min. 50% of households with min. 100Mbps broadband Internet access by 2020	Min. 50% of households with min. 100Mbps broadband Internet access by 2020

Table 1: Strategic frames for Smart City developments

Future Internet National Technology Platform

Simultaneously, several professional organisations were formed aiming to assist the development and to contribute to the operationalization of this strategy. Most prominent among these are the Future Internet National Technology Platform (JINTP or JI Platform in short) established in on May 3, 2011 which, by way of its members, covers the whole competence area. Its membership includes the Ministry of National Development, Ministry of National Economy, National Innovation Office on the government side; all significant technical and science universities of the country and the relevant Academy institutes on the research side; and all significant telecommunications and IT firms, professional association and society on the industrial service side.

The JI National Platform is chaired by Dr. Péter Bakonyi, senior specialist at BME EIT, who also leads the subproject implementing the establishment and operation of the Future Internet Research Coordination Centre.

Smart City Section

Under the framework of Future Internet National Technology Platform, a professional initiative established the Smart City Section in 2014 to enable more efficient preparations for European Union Horizon 2020 and domestic Union tenders. The Section aims at promoting the dissemination of ICT RDI activities and applications related to Smart City strategic objectives and

implementation programmes, and the cooperation of involved professional participants.

In accordance with the objectives, the Smart City Section welcomes municipalities and representatives of municipality associations key to the success of implementation, and institutions and businesses interested in Smart City development, regardless of their membership in the Future Internet NTP. The Section also has it among their aims that they support the development and implementation of the domestic concept and strategy plan of intelligent city (Smart City) with professional concepts, strategy papers created together with government and civil organisations, service providers and EU partner organisations. Besides this, to promote successful bidding and project implementation, the Section provides forum for the dialogue between municipalities and service providers.

The Smart City Section was formed at the October 3, 2014 Future Internet National Technology Platform session held in the National Innovation Office, its leader is Dr. Kálmán Kovács, director of BME EIT.

III.2. Conceptual elements of Hungarian Smart City Strategy

The professional history of domestic Smart City (or previously known as Intelligent City) strategies and conceptual ideas span a remarkable nearly two decades. A first such professional document was created at the Budapest University of Technology and Economics (BME) in the cooperation of the Telecommunication and Telematics and the Department of Telecommunications departments of the Faculty of Electrical Engineering and Informatics, on behalf of National IIF Coordination Office in early 1996.

The Smart City strategy under preparation also has significant groundwork literature. In then frame of present study we do not elaborate these, just provide a recapitulation of those major elements and implementation framework of the latest domestic Smart City strategy that are expected to be included in the final version.

Other topics, covering primarily the domestic Smart City situation, the tender opportunities opening in the near future, as well as the expected regulation, operation and sustainability conditions will be discussed in the last chapter.

Strategic frames for Smart City developments

The Smart City strategy needs to be aligned with the National Digital Development Programme (DNFP) adopted by government. DNFP closely aligns with the Digital Agenda for Europe and the 2014-2020 objectives of the Hungarian National Infocommunication Strategy.

Digital community and economic development (and especially the Smart City services) belongs to Prime Minister's Office, the Ministry of National Development and the Ministry of Interior. Coordinated by Lechner Knowledge Centre of MeH.

The digital public services (the Digital State included) belong to the Ministry of Interior in collaboration with Prime Minister's Office. Digital competences belongs to the Ministry of Human Resources and the Ministry of Economy. These strategic frames are shown in Table 1.

The place for Smart City developments in DNFP implementation process

The implementation of the National Digital Development Programme is based on four closely interdependent development pillars, and coordinated action plan and activities within and among the pillars as per Government Resolution 1631/2014 (XI.6.) on the Implementation of DNFP.

Four pillars of DNFP: Digital infrastructure, Digital community and economic development, Digital public services and Digital competences involve developments that are building on each other, but are also in a significant part implemented in parallel.

Relationships are shown in Table 2. The focus location of Smart City developments within the Digital community and economic development pillar is clearly visible and interpreted.

The place for Smart City developments in DNFP implementation process			
Digital infrastructure	Digital community and economic development	Digital public services	Digital competences
All domestic households with min. 30Mbps broadband access by 2018	Provision of free devices among population (neediness)	New, digital customer points (approx. 270 government windows)	Introduction of new, IT based public education program
Connecting local public institutions to broadband internet network	**Intelligent City (Smart City) services**	Every service available electronically by 2020	Strengthening digital literacy
Financing: Cooperation of market and government	Economic development: - Regional programs - development of IT background of SME-s	Compulsory use of electronic services for businesses	Incentives for adult education programs

Table 2: Place for Smart City developments in DNFP implementation pillars

Direction and complexity of Smart City developments

On the basis of the practice of EU and isolated domestic Smart City developments, the characteristic intelligent (smart) services are as follows (without attempting to be comprehensive):

- business area (e.g.: electronic ticket, smart metering, information portal, tourism, e-buying, digital library, remote monitoring, intelligent transport, e-parking, etc.)
- administration, municipal, government area (e.g.: e-administration, digital city consultation, electronic registers, etc.)
- general and intermediate areas (e.g.: e-security, e-education, healthcare smart services, etc.)

At the same time, on the basis of the strategy, the funding of developments will go towards primarily complex, integrated solutions. Such as:

- 'smart card' (which is suitable for using a wide variety of services and receiving funds, verifies authorizations and discounts, etc.)
- integrated city energy management (includes smart metering, intelligent energy network development, intelligent transport, renewable energy usage, etc.)

- digital education structures (integrated digital education platform, adult education, digital library, special education of persons with disabilities, etc.)
- city complex (Smart) e-administration (integrated digital city card, online portal, digital consultation, e-administration, etc.)
- and complex developments supporting the improvement of digital security and data protection

Smart City Platform

Key prerequisite to the efficient dissemination of Smart City solutions is the definition of certain common elements, characteristics, on this basis the evaluation of recipient communities (settlements), and the grouping of communities, the development of typical solutions and the support of their adaptation.

A possible frame for this is offered by the ICT network basic infrastructure (broadband network access) to be implemented by the DNFP, and the Smart City Technical-Technological-Service Platform, or Smart City Platform in short, which is formed over this infrastructure. A number of business solutions would be connected to, based on and performed over this platform, and on the other hand, this platform would ensure that the services are implemented in a single integrated system.

As a starting point, depending on the endowments of the city, fully or partially community services would be built on the Smart City Platform.

These services

- a part of these (e.g. security /data, property, service/, monitoring /public areas, public safety/, city card) should be established in every settlement (Smart City Basic Services),
- other part of these would be created on partly community, partly business base (e.g. digital education, intelligent transport, e-Health Care, Smart energy, e-administration, etc.), and the operation of these can also be mixed (Smart City Community Services).

And finally, business smart solutions are connected to the unified or at least typed Smart City Platform. This would increase the efficiency, utilization of the platform and simplify implementation and operation.

III.3. Smart City Hungarian concept

We provide here a short overview of the Hungarian concept for smart cities, organized in the following chapters (Please mark that the relevant services are for illustration only, do not contain the full proposed smart city service list.).

Determination of relevant Smart City services

The full smart city services palette includes seven groups of services, out of which three groups have direct equivalents in the frames of the Digital Nation Development Program (DNFP). Intelligent Management from the palette has a relevant counterpart as 'Development of IT background of local SME's' in the frame of DNFP. Intelligent governance and Intelligent infrastructure are mirrored in the 'Digital Public Services' and 'Digital Infrastructure', respectively, of DNFP.

The rest of the smart city service palette includes four other services groups, such as smart mobility, smart environment, smart population, and intelligent way of life.

Smart mobility includes service categories that cover intelligent community transport (such as digital passenger information, electronic pass), intelligent transport management (like intelligent traffic light system, traffic routing), or intelligent logistics solutions (services as intelligent transport planning, fleet management).
The smart environment group covers the utilization of renewable energies (e.g.: solar cells), energy efficiency (e.g.: energy efficient buildings, optimization of street lighting) and intelligent environmental protection (e.g.: intelligent waste management, electric car charger).
The smart population palette group contains the integrated school card system, and electronic register services for schools.
Finally, the smart way of life intelligent city service group can be made up of intelligent healthcare (e.g.: digital patient systems), digital culture and entertainment (e.g.: digitizing cultural values, applications), security, smart home solutions (e.g.: surveillance cameras, safe nightclubs), and city card (e.g.: intelligent community card system, electronic payment solutions).

Categories of Smart City services

These smart city services can be categorized by the type of the service provider, let it be the state, the municipality or the market. We need to determine the state services giving consideration to economies of scale, investment

and operation, and public policy. Municipal services provide added value to the given settlement, distinguish. And finally, market services ensure long-term sustainable development.

Currently we see that state services would include from all four intelligent city palette groups the electronic pass, electronic register for schools, and digital health card, surveillance camera system, city card, and electronic payment solutions.
Likewise, municipal services include digital, real time passenger information, energy efficient buildings and optimizing street lighting, and integrated school card system.
Market services would have the smallest share in the aspect: Healthcare and social monitoring systems.

Smart City central technology platforms

The technology platform has three operational entities: the Central Intelligent Card Management Platform, the Central GIS System Platform, and the Central Payment and Clearing System Platform.

Evaluation of Smart City services

The services of the various smart city service groups are categorized here as regards their cost-benefit evaluation (an economic assessment on economies of scale and local endowments) at local level. Some do not need this evaluation, as they generate social benefits for local community and fall in the 'Amenities' category, and those services that besides generating social benefits are important to have the capability of generating income are provided by market players and thus placed in the 'Recoverable' bracket.

Cost-benefit evaluation is needed for services like the electronic pass, and energy efficient buildings, optimizing street lighting, and digital health card, surveillance camera system, City card and electronic payment solutions. Amenities include digital, real time passenger information, the electronic register and integrated school card system. The recoverable bracket has the healthcare and social monitoring systems.

Considering local specifics

The steps of developing a concept that integrates local needs:
- Explore local needs with market research
- Fact finding on the basis of city audit

- Drafting strategic objectives
- Development of business, financing models on the basis of local specifics
- Implementation of city monitoring system

Considerations for economies of scale

Considerations for the classification of cities on the basis of economies of scale:

- settlement size (population, size, rank)
- infrastructure facilities (airport, railways, highways, water transport)
- settlement endowments, opportunities (economic characteristics of settlement, tourism, economic performance)

Possible solutions for investment and operation

Financing investment and operation is a divisive issue. Here we counter the already established three engaged providers (state, municipality and the market) with the various options they have as regards financing sources, operation and management, and technological platform.

- Level of engagement: state, municipal, and local government and market players.
- As regards investment, financing, state has domestic and EU sources, municipalities have domestic, EU, municipality or market investor sources; and joint municipal and market players besides domestic, EU sources have market investor sources as well.
- Operation, management: can be done by four players: state, municipality, market or societal communities.
- Platform: When state is the provider, this tends to be a Closed system, where applications are predefined. In the case of municipalities, it is a closed system, but applications are freely uploadable at the municipal platform. Finally, in the case of joint platforms between municipality and market players, the platform is freely interoperable and developable.

Smart City technical platform and monitoring system

The central smart city technical platform will develop and operate an integrated funding system and financing construction. It will also seek opportunities, coordinate developments. With its international relationships, it will determine the development trends.

The professional platform will have members from tertiary education, BME EIT, Hungarian research institutes on the Research side; from ministries, municipalities and government professional bodies from the State side, and companies and involved clusters will represent the market side.

The tasks of city level professional leadership include:

- the assessment of local endowments (city audit, evaluation of results from previous initiatives)
- the elaboration of Intelligent city individual strategies considering local specifics
- to set up Project Organisation
- to set up project schedule aligned to central requirements and urban development strategies

The next step is to set up smart city professional platform organisation and detailed development of operational mechanism, and to set up and operate central and city level professional platform organisations.

III.4. Hungarian Smart City landscape in the light of a survey

Organized by BME EIT, supported by BME VIKING funding, a comprehensive research (survey) was completed covering 13 Hungarian cities and a Budapest district with the aim to provide a view of the domestic Smart City initiatives, at the same time to offer a technical background for the possible cooperation opportunities in the area of Intelligent City projects. The survey covered such national programs that may promote, complement the successful establishment, operation of settlement Smart City projects or may serve as example.

Subsequently two more settlements were included in the survey, the complete list is as follows:

Baja	Dunaújváros	Miskolc	Székesfehérvár
Budapest	Eger	Nyíregyháza	Szolnok
Budapest, 11th distr.	Gödöllő	Pécs	Szombathely
Debrecen	Győr	Sopron	Veszprém

Figure 6 shows the SWOT of the survey:

Strengths	Weaknesses
• Government ICT decisions • Excellent professionals • Significant available know-how • Municipal communication commenced	• Hungary is lagging behind in EU comparisons • Not considered in sector strategies (and OPs) • Lack of operation (sustainability) business models
Opportunities	**Threats**
• Professional organisational background underway • Significant EU grant funding for Smart City developments • Significant rural development domestic EU funding	• Smart city is not included in area, urban and sector development plans • Low level of international consortium experience at municipalities

Fig. 6: SWOT of the Hungarian Smart City survey (by BME EIT, 2015)

Key findings of the survey:

- A number of national programs were implemented in the past years that show in the direction of implementing intelligent environment.
- In county-cities and other larger cities of the country the basic conditions of Intelligent City development are available, greater or lesser successful pilot projects, and opportunities for systematic development. Furthermore, their bonding is also visible to EU (and within that EU Danube Region) cities, to the west and the east alike.
- The current level of intelligent city development displays great differences among the various Hungarian cities. Better results are achieved by cities that elaborate and commence implementation with a strategic (mostly energy or telecommunications) provider the sustainable and intelligent development program - mainly with tender funding – of the city.
- Several Hungarian cities have built professional connections on the basis of which they can receive experiences from foreign cities ahead of them.

Overall, we can conclude that Hungary is ripe for the accommodation and application of the intelligent environment and intelligent city concepts. Any of the surveyed cities may be suitable to elaborate such applications, if such a municipal intention is formed.

III.5. Sources for Smart City development programs

Depending on the development aim, it is foreseen that various financing models will be created for the Smart City developments.

- ICT base infrastructure (national broadband Internet coverage), being priority EU and Hungarian objective, is expected to be realized in a significant part from EU and Hungarian government development funding sources.
- The implementation of the basic services of Smart City Platform is also a strategic objective that is expected to have a significant share from the operative programs.
- For the development and operation of further Smart City services, appropriate, long-term sustainable business models need to be elaborated as a prerequisite to grant financing. These services will be realized on the basis of local needs and investor interests, mostly not from community sources.

Hungarian operative programs of the 2014-2020 period:

1. Human Resources Development Operative Program (EFOP)
2. Operative Program supporting the Deprived (RSZTOP)
3. Economic Development and Innovation Operative Program (GINOP)
4. Public Administration and Public Services Development Operative Program (KÖFOP)
5. Intelligent Transport Development Operative Program (KOP)
6. Environmental and Energy Efficiency Operative Program (KEHOP)
7. Competitive Central Hungary Operative Program (VEKOP)
8. Regional and Settlement Development Operative Program (TOP)
9. Rural Development Program (VP) - EMVA

The new Operative Programs are linked to ministries, and there is some permeability among them. The projects to be implemented in the frame of the Smart City strategy touch upon nearly every walks of life, share a basic characteristics of being interdisciplinary, that is, they are based on research-development activity realized in the cooperation of several professional areas (and accordingly several disciplines) and ICT. Therefore, nearly all Operative Programs are expected to include calls for applications where intelligent settlement service-development projects can be submitted.

Table 3 contains a summary of most relevant funding sources and expected funding areas for financing Smart City developments.

EU and 'Hungarian EU' funding programs and Smart City funding areas	
Horizon 2020 **H2020**	Excellence programs: Integrated intelligent infrastructure (ICT, energetics, transport), Innovation and sustainability
Economic Development and Innovation Operative Program **GINOP**	Incentives for R+D+I activity, Development of ICT sector, SME competitiveness with the development of ICT capabilities
Regional and Settlement Development Operative Program **TOP**	Economic development building on regional sources, Improvement of settlement quality of life Regional knowledge centres
Environmental and Energy Efficiency Operative Program **KEHOP**	Intelligent and green energetics, Intelligent adaptation to climate change effects, Complex water management

Table 3: Funding sources for Smart City developments

III.6. Professional background for Smart City development programs

In harmony with EU implementation concepts, Hungarian universities and other research institutions - in cooperation with similar EU organisations - play significant roles in developing domestic smart city programs and technological developments.

The formation of a competence network is underway which will be capable to provide a high quality professional background. The most significant initiative is "Smartpolis", the regional Budapest Smart City Centre of Excellence on the basis of the Budapest University of Technology and Economics (BME). The next chapter will provide a detailed introduction.

IV. Smartpolis - Budapest Centre of Excellence for Smart Cities

IV.1. Smartpolis project – The frameworks

The overall and general goal of the proposed project is the utilization of the innovation capacity, knowledge creation and knowledge transfer in the Central Eastern European region for reaching the European goals defined by Horizon 2020.

Preliminary studies have shown that, in the Central Eastern European region, people would like to accelerate the closing up of their regional economy and prosperity to Western European levels. Sustainability is important for economy and society, too. It is also important in the development of the smart activity, working and living conditions.

The consortium organized for this proposal has defined the overall goal to establish the Budapest Centre of Excellence for Smart Cities for strengthening the research and innovation capabilities of the Budapest University of Technology and Economics (BME) in this promising multidisciplinary scientific and technological field. The Centre will become an incubator of smart city concepts and solutions in the region through its high level theoretical research, system and technology developments, accelerated deployment, as well as its educational and consulting activities. The core of this objective is the integration of new and smarter technologies, like smart energy support, smart building, sustainable transport and ICT into the smart city programs.

BME has strong education and research capabilities in all required fields. It is especially strong in infocommunication technology, control theory, modeling of large systems, development of green buildings, and dynamically controlled mobility. And the Federated Innovation and Knowledge Centre of BME which manages the Smartpolis project at BME, has successful experiences in establishing centres of excellence.

All these capabilities combined with excellent economic solutions and high-level innovation management will make the University a perfect candidate to become a multi-disciplinary knowledge centre for supporting the development of smart cities.
The Smartpolis project is based on the needs and targets of the 'stakeholders' (the EU and the governments, city leaders and citizens, service provid-

ers and SMEs, universities and professionals) of the Smart City intention and implementation.

Therefore, the proposal is consistent with the Horizon 2020 strategy goal: developing a new, excellent science and technology centre for supporting the regional leadership in the given area and offering positive answer on society requirements in creating intelligent, sustainable cities.

The consortium is also aiming to follow the concept of the study commissioned by the European Parliament on Knowledge Transfer from Public Research Organizations [7], because the establishment of the new facility as a centre of excellence will be an important tool for realizing cross and intra-regional knowledge transfer.

Activities of the new centre of excellence – we call this organization SMARTPOLIS – will be organized and performed within the organizational framework and premises of the Faculty of Electrical Engineering and Informatics of the Budapest University of Technology and Economics.

The coordinator Hungarian Intellectual Property Office plays a very important role in Hungary and also in the broader region in respect of innovation management and the facilitation of communication between industry and academia. Based on this expertise and track record, the organization will be a leading force for the establishment and introduction of the framework conditions of efficient and successful knowledge transfer.

The Western European partners – the 'brains' - Fraunhofer FOKUS and the Urban Institute will support BME in the establishment and initial operation of the centre primarily by sharing their experience and know-how in launching and running such operations and by providing best practices, benchmarks, as well as by sharing partner relationships and participating joint industrial and research projects.

Though the cooperation of the parties the long term goal of establishing a centre of excellence for smart city technologies and their implementation with regional reach in Central Eastern Europe, and with solid reputation and stable financing is ambitious, but fully achievable already within the timeframe of the second phase of the Smartpolis project (Fig. 7).

[7] http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf pp5

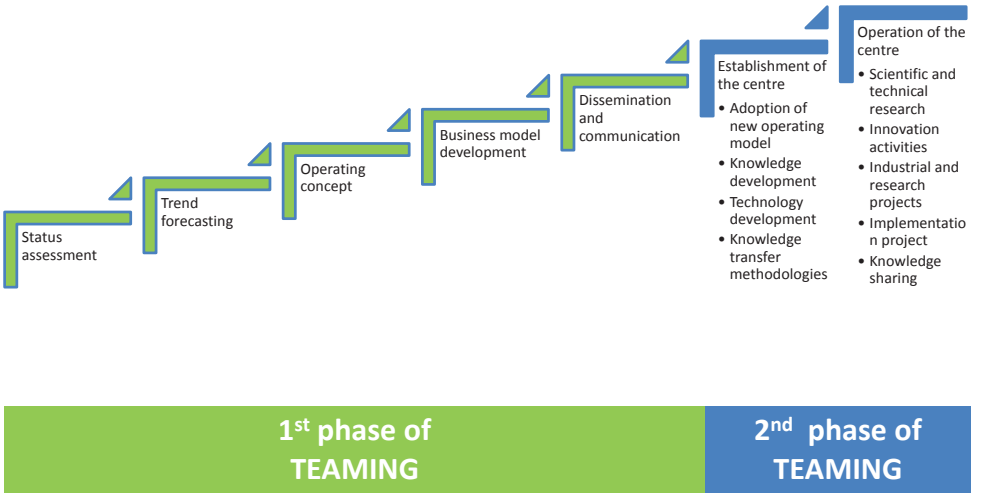

Fig. 7: Smartpolis project road map: 1st – 2nd phases

The establishment of a successful new operation is achieved through the realization of short and medium term goals and targets.

IV.2. Smartpolis - Short term goals

Short term goals satisfy the requirements of the first phase of the TEAMING project by elaborating a concept and associated business plan for the establishment and operating principles of the new centre of excellence, while the long term goal is the successful launch and operation of this new centre.

To realize the short term goals, the following activities will be performed in the first phase of the TEAMING project:

- Status assessment - comprising definition and evaluation of the smart city concept and development strategies; research of best practices; analysis of the Eastern European reality and impact assessment of the social, environmental, safety, security, etc., aspects.
- Forecasting of future trends - including the evolution of smart city concepts; society requirements and acceptance; theory of large system modeling and control; development of the required technologies, like distributed sensor systems, management of large systems, mobility solutions, energy efficient technologies, etc.).
- Elaboration of the operating concept of the centre, including its scientific

program and administrative model. This work will encompass the definition of main focus points of the activities with associated benchmarks and the necessary organizational structure. The work will place special emphasis on the adoption of best practices of the project partners transferring their know-how.

- Development of the business model of the centre for the initial 5-year period - evaluation of the required infrastructure and human resources for meeting the established targets. The multi-year financial strategy and plan, with P&L, BS, cash flow projections and ROI calculation will be based on the successful realization of the elaborated work program. External financing sources and schedule will also be described assuring the long term viability of the centre.
- Establishment and implementation of a proper framework for communication and dissemination of the project objectives, results and the introduction of SMARTPOLIS to all relevant stakeholders, including the municipalities, industry, academia and the general public both locally and in the target region of Central Eastern Europe.

Objectives:

- Establish the Budapest Centre of Excellence for Smart Cities
  - organized and performed within the organizational framework and premises of BME;
- Strengthening the research and innovation capabilities of BME
  - communication technologies, building development, sustainable and green energy supply, urban transport, and city administration;
- Centre will become an incubator of smart city concepts and solutions in the region
  - high level theoretical research, system and technology developments, accelerated deployment, as well as its educational and consulting activities;
- After the 2nd year of operation will have considerable influence on local smart city programs
  - developing new solutions, new technologies, new knowledge,
  - developing the knowledge transfer policy and strategy based on the concept of open innovation
  - supporting smart city developments;
- The subsequent part of the business plan will elaborate the extension of the centre:
  - broadening its scope of activities, realizing a regional reach, increasing the number of employees, having substantial revenues from industrial cooperation and from local and international grants;

  - projects initiated by the Centre like innovation activities, publications and research projects as well as new patent applications.
- Measurable impact.

Workplan:

Commitments in the proposal – **internal**

- SMARTPOLIS will become a successful, respected smart city centre of excellence in the Central Eastern European region.
- The Centre will have 25+ researchers and experts after the first three years, including at least 5 PhD students, and quest scientists from partner universities of the region.
- The Centre will organize an international conference each year.
- The Centre will participate in at least 3 international and 5 local projects in the initial five-year period.
- Experts of the Centre will make at least 10 presentations annually at major international conferences.
- Research results will be published in at least 2 peer reviewed journals.
- Training courses will be introduced to disseminate smart city know-how in the region.
- The Centre will submit 8-10 patent applications in the initial 5 years.
- SMARTPOLIS will establish industrial cooperation with at least 10 major multinational companies active in the region.
- The centre will become an incubator for at least 5 SMEs to facilitate their involvement in smart city development projects.
- Extensive cooperation will be established with municipalities in the region supporting their smart city development programs.
- By the end of the 5th year the Centre will cover 30% of its expenses by revenues generated from industrial-commercial assignments and projects.

Commitments in the proposal – **external**

- Centre is to establish the scientific and technological background of the integrated solutions for Smart Cities taking the strategic implementation plan of the (EIP-SCC) as a master plan.
- The Centre should be actively engaged in the Smart City Stakeholder Platform & Community.
- The Centre should cooperate with national initiatives of EU member states.

- The Centre will act as a catalyst for the introduction of EIP-SCC in the region which brings together cities, industry and citizens to improve urban life through more sustainable integrated solutions.
- The activity of the Centre will have a potential effect on the life of more than 5 million inhabitants of the region in the cities where SMARTPOLIS will have active cooperation and/or projects.
- The activity of the Centre will decrease energy consumption, and increase transport efficiency by at least 20% in all its respective projects.
- Through the cooperation with the Centre, cities aiming to become 'smarter' will have access to at least EUR 100 million from the EU cohesion fund.
- New technologies, not used before in the region, will be deployed through the knowledge transfer facilitated by the Centre.
- Higher education will develop new bachelor and master courses in the smart cities domain.
- The region will be integrated into the European cooperation in the fields of smart cities.
- The Centre should help establish national initiatives in Central Eastern European Member States.
- Research of successful smart city projects, smart city activities, smart city planning.
- Impact analysis of smart city development on the economy, societies, sustainability, environment, costs, safety and security - use of simulation techniques.
- Use of the Morgenstadt: City Insights compatibility analysis.
- Evaluating the best smart city solutions and best methods applied in smart city solution developments (selection of up to five best practice smart city solutions).
- Technology map of the successful implementations.
- Analysis of the financial models and business models.
- Evaluation of the Governance structure: city boards, round tables, and other multi-stakeholders.
- Analysis of the Eastern European smart city developments.
- Define the needs and requirements in establishing the regional centre of excellence in the Eastern European region.

IV.3. Smartpolis Center - Long term goals

Long term objectives and activities will be defined in the operating concept and associated business model of the centre comprising the following key issues in the second phase of the TEAMING project:

- knowledge development - managing a multidisciplinary large system, controlled as distributed but coordinated sub-systems, reflecting the dynamically changing environment and requirements
- technology development - including micro-sensing, micro or smart actuators, infocommunication, situation awareness, multi criteria decision support, and other relevant state of the art technologies
- knowledge transfer - strategy and policy for transferring knowledge to smart city developers, to industry actors, municipalities, academia as well as the general public
- implementation and deployment projects – contributing to smart city development programs

The project proposal will describe a plan to develop a centre of excellence which already after the second year of operation will have considerable influence on local smart city programs by (i) developing new solutions, new technologies, new knowledge, (ii) developing the knowledge transfer policy and strategy based on the concept of open innovation systems, and (iii) supporting smart city developments.

The subsequent part of the business plan will elaborate the extension of the centre, namely broadening its scope of activities, realizing a regional reach, increasing the number of employees, and having already substantial revenues from industrial cooperation, contracts as well as from local and international grants. In terms of innovation activities, publications and research projects as well as the first new patent applications will already prove the success of Smartpolis.

The formed consortium intends to work as joint venture with a long term horizon of cooperation among the relevant partners from both the Western European leading and the Eastern European follower organizations. The team will manage the planned activities to achieve the defined goals, establishing and operating a successful, well-known, respected new centre of excellence for smart cities in the Central Eastern European region.

IV.4. Smartpolis - BME Smart City competence areas (coordinated by BME EIT)

In cooperation with the faculties, BME EIT compiled a proposal and competence collection for a Smart City implementation meeting EU requirements. BME Smart City competence areas are the following:

- Smart energetics
- Intelligent urban and rural development
- Intelligent transport
- Climate change
- Environmental protection
- Quality of life – Healthcare
- Community participation in urban development
- Water quality and water management
- Integrated infocommunication (ICT) systems
- Systems integration.

Short description of the various subsystems:

A) ENERGETICS

Smart Microgrids, Smart Grid of Regions

There are already several small area microgrid pilot projects (Salzburg, NetLabs: Freiamt im Breisgau; Sonderbuch, Fót, and a number of others), in other cities similar systems are planned (e.g.: MEE statement).

Smart energy efficient grids

- coordination of electrical power distribution management, renewables, energy storage, control, consumer influencing at metropolitan level (eg.: FŐTÁV – MAVIR – MVM Partner)
- cooperation of metropolitan (BKK, including possibly water transport), long-distance transport and the power system to implement storage functions
- implementing a BUeCAR pilot on the model of BUBI: P+eR parking garages renting electric cars at drive-in zone boundaries flattening the load curve with overnight charge
- involving heat pumps (and cartridge heaters) in electric power system control (primarily to balance weather-dependent renewable supply)
- connecting various energy transport infrastructures for energy storage (Power2Gas, Power2Methanol)
- smart public lightning system: current pilot project in Budapest in a consortium led by GE: http://geforcee.geblogs.com/self-sustaining-intelligent-lighting/

It is advisable to initiate pilot projects on the above areas that will further a part of the above solutions to physical implementation. In the course of this, special attention is to be paid to local endowments, and additional benefits should be exploited to the largest possible degree, e.g.:

- heating of public institutions and farms in disadvantaged microregions with heat pumps, or establishing biogas plant
- increasing employment
- promoting the cooperation of urban rail transit and long-distance railways (heavy rail) with the electric power network:
  - energy saving with regenerative braking;
  - charging accumulators of electric powertrain public transport vehicles considering the system level interests of the electric power grid
  - connecting energy storage and e-mobility in metropolitan environment, promoting the involvement of further renewable energy resources

Collecting measurement and status data generated during already operating and future pilot projects to a common platform:

- this way, by using data from operating 'small physical samples', applying the variable data in probability models, the benefits of joint coordination could be demonstrated in offering and using system level control reserves
- on such a hybrid (physical/simulation) model, principles and rules of joint coordination could be worked out, considering network characteristics, aligning to the needs of energy markets interconnecting on the macroregion level, as well
- On the basis of the simulations, in a further integration step, these autonomous microgrids could be factually placed under joint management control, which would make the validation of the computerized simulations shown in the previous point and the microgrid – smart grid transition feasible
- The concept, naturally, requires the cooperative involvement of regional providers (Distribution System Operator, DSO) and the affected macroregional providers (Transmission System Operator, TSO)

For EU Member States, this project would demonstrate the potential of coordinated electric power trade and regulation functions on a previously nonexistent level. Indeed, at present primarily the interconnection of day ahead markets (DAM) on increasing regional levels (making energy production more transparent and competitive) is on the agenda, but there exist effective

methods for coordinating regulatory reserves (International Grid Control Cooperation - IGCC) that results in further cost savings. In the next step, the integration of electric power and reserve markets (in Hungary, a GOP project was started in November 2013), the involvement of small power plants in system regulations (Virtual Power Plant – VPP), then the promotion of the participation of household size small power plants and customer (demand response programs), with special view on customer control.

Online Building Energetics Decision Making System with Building Typology (Smart Building as Microgrids):

- ICT Pilot Project with identical type buildings, but varied geographical coordinates. Ensuring international measurability and comparability in EU Member States.
- Measurement and monitoring of heat and electric power consumption of building portfolio with remote monitoring, error reports and analyses.
- Creation and optimization of intervention options considering the aspects of energy supply systems.
- Development of building energetics smart online software (Business Intelligence Online SW) for building reconstruction and small-scale utilization of renewable energy.
- Area Cost Optimal methods and synchronizing legal regulations with existing Lifecycle methodologies (LCA).
- Holding, organizing and arranging multilevel and multi target group building energetics trainings (training and coaching) for public servants (ministry, university, municipality).
- Legal, administrative, financial and technical issues in the topic by country, region, settlement, building type, user, etc.

B) INTELLIGENT URBAN AND RURAL DEVELOPMENT

Objective

To refresh and 'recycle' knowledge amassed and experienced during centuries and millennia for intelligent – that is, protected, safe, close-to nature, cost effective, therefore sustainable – built urban environment.

Tools

Creating balanced situations

- city and nature in intensive and harmonic balance (green, water)
- (even extreme) natural endowments managed as opportunity and not threat
- by minimising the effects of weather extremities (puffers in water, energy)
- in intensive but harmonic balance with nature
- in complementary harmonic balance of buildings and public spaces (sizes and proportions)

Energy management

- prudently managing available local energies (solar, water, wind, geothermic, bio)
- minimizing 'motorized' locomotion (especially in private transport)
- expanding opportunities for gentle (human powered) transport (on land and water)

Sustainable construction

- with seeking and strengthening the regional character of city architecture and architecture matured over the centuries
- ensuring natural (comfortable and healthy) living conditions
- ensuring sustainable, partially self-sufficient workplaces
- with the functional change, reuse, rehabilitation of existing, abandoned or amortized buildings
- building with local (obtainable within reasonable distance) and recycled materials
- with minimal waste and recycling it
- passive (increasingly relying on the physical laws of nature) load-bearing structure, building construction, and building engineering solutions (span, structure, shading, heat trap, light trap, cellar, etc.)

Sustainable communities

- continuously activating the population (participation)
- organizing grassroots urban communities
- thinking in several generations, planning for the long run
- making the players of developments (builder, developer and contractor) stakeholders in accepting and supporting the above

In the above approach, ICT is primarily a tool and not an objective to decrease 'transport' needs and distances, to seek optimum solutions and to continuously monitor.

R&D method:

- Elaboration of the exact methodology of research on the basis of the above outline (definitions, correlations, conclusions)
- Working out the necessary course of action according to the methodology, that is, the method of tests and interventions.
- Applying the methods of tests and interventions as necessary by the methodology

C) INTELLIGENT TRANSPORT

Possible elements of intelligent transport system:

Track:

- regenerative systems: eg. when the tram brakes, it regenerates energy to the system.

Vehicle:

- smart micro car renting system: just as with bicycles, with several docking points in the city, I get in one at my home, and leave it at the arrival point,
- smart car sharing software: collects who goes where, and organizes traffic on the principle of car sharing so vehicle utilization is better, the number of vehicles in traffic and pollutant emission is lower,
- analysis of the introduction of e-car systems (where to install charger stations, with how many chargers, the possible amount in pollutant decrease
- underground buses,
- suspension railway tram,
- amphibian public waterway vehicles,
- concept of cruiser feeders for Danube or mass transportation.

Control:

- dynamic traffic control, information exchange of transport branches, optimizing peaks to prevent and minimize traffic congestions.
- control of road traffic generated by airport: on the basis of air traffic and road traffic characteristics, e.g. priority for airport-bound traffic when air traffic generates daily peaks: with this, the extent of road congestions caused by significant traffic to and from the airport can be minimized

(which, by increasing efficiency, decreases pollutant emission),
- dynamic article and departure path (so-called SID/STEAR) optimising SW for airports on the basis of geographical (e.g. location of the serviced city, elevation of its parts), demographical (e.g. population, population density of districts under the flight paths), meteorological (e.g. wind force, direction, temperature, humidity) data to decrease noise and/or emission of aircraft above the serviced city,
- group control.

Service:
- routing advisory system; how to get from A to B, what course, what vehicle, when to depart to arrive at x hours to my workplace, meeting, etc. (it is necessary to know the traffic situation, the location of congestions, etc.),
- unified communications network among vehicles: information exchange about traffic, where vehicles are headed, in order to be able to dynamically plan, control traffic,
- active and passive conflict management systems: vehicles communicate to evade accidents, to increase traffic safety.

D) CLIMATE CHANGE

Climatic extremes in urban environment.
Urban build-up - among others with heat island effect - increases the unpleasant effects of climate change. Heat waves are getting several degrees warmer, which necessitates increasing the cooling capacity of residential and office buildings. Sustainability principles should be enforced at various planning levels – development, regulation, strategy, building and environment planning.

This includes (among others):
- enforcing pedestrian and community transport priority, in pursuit of a car-independent way of life,
- sustainable transport – development of community networks, decrease of necessity for mobility, support for bicycle transport,
- development of green space system,
- energy efficiency (compact building mass, natural lighting and ventilation, etc.), use of renewable energy,
- selective waste collection, waste management,
- cycling in water usage / rainwater and wastewater recovery.

Urban air quality
The variation in the frequency and intensity of extremities related to climate change is detectable in this field, either (e.g. the increase of the duration and severity of winter and summer smog situations). Local air quality is determined by the density, intensity and location of transport, energetics and industrial air pollutant sources. In the case of certain air pollutant materials (e.g. PM10, PM2.5, O_3), long-range atmospheric transport originated outside the cities may play a part. The sustainability planning and measures listed above – especially in the areas of transport and energy efficiency - facilitate the improvement of urban air and by way of this of quality of life.

E) ENVIRONMENTAL PROTECTION

Risk reduction of urban polluted industrial sites
The objective is to clean (remediate) urban polluted areas with environmentally friendly biotechnologies. To increase the efficiency of remediation based on biodegradation by using environmentally friendly additives in areas long polluted with organic contaminants. Instead of soil replacement, we develop and apply innovative cost efficient biotechnologies with which soil quality can be maintained in the long run. The foundation and application of a soil treatment technology that serves carbon emission to atmosphere and holding organic carbon in the soil, and the improvement of degraded and contaminated soil.

Risk-free utilization of waste for soil improvement and creation of growing medium in order to increase urban green areas.
The objective is to cost effectively utilize industrial and household waste, create products instead of placing them in landfills. Working out innovative technological solutions to utilize organic and inorganic, non-hazardous waste, by-products to create growing media. With growing media, we plan to increase urban green areas, create green rooftops for better air quality and less CO_2 emission.

Increasing wastewater treatment efficiency with special filter systems.
The efficient and targeted removal of micropollutants in treated wastewaters posing risk to environment and humans with special cyclodextrin-based filter systems. Targeted treatment of hospital and industrial wastewater.
Verification of developed innovative environmental technologies: technology efficiency, environmental efficiency, cost effectiveness survey, SWOT analysis and Life Cycle Assessment.

F) QUALITY OF LIFE - HEALTHCARE

The aim of R&D is to apply technologies with the aid of which the quality of life of the elderly can be improved, their sense of security can be enhanced in their homes and familiar environment. By this it can be achieved that people do not at all or only later get into various care institutions With the use of remote patient monitoring systems, a large proportion of rehabilitation processes previously done only in hospital can be performed in controlled environments in our own homes. Another benefit of these systems is that by monitoring the appropriate physiological parameters, behaviour patterns and mental abilities diseases can be detected sooner and become more easily curable.
Such assistive systems are quite multidisciplinary and combine solutions applies in varied areas. BME EIT Healthcare Technologies Knowledge Centre has semi-finished or close-to-prototype solutions in the following areas that may prove useful in 'smart city' solutions:

- Development of human motion recognition, tracking and analysis programs based on 3D camera (Kinect and Xtion). With the aid of these, various rehabilitation physical exercises can be performed at home, or can be used as special controller of computerized programs, games that makes us move or make control possible with natural gestures.
- Use of a communication tool (YoooM) implementing virtual being together (replicating presence): Persons distant from each other can perform various activities together. With the aid of these, people who have difficulties or can not at all leave their home are able to develop social relationships.
- Data collecting and analysing, and sharing, displaying on web portal or (Android based) mobile devices. Monitoring physiological parameters (measurement of blood pressure, ECG, pulse oximeter, sleep monitoring, etc.). On the basis of information from passive sensors (consumption meters, motion sensors, contact sensors, temperature/humidity sensors, light sensors, etc.), detecting and monitoring home activities.
- Application of serious games. The change in the mental abilities of the players can be monitored on the basis of information from our web-based games. On of its attractions, although not fully proven, is that these games – to a certain level – can maintain or improve our mental capabilities. It should be interesting to further develop the games in a direction where people could play against each other, creating a community holding mental freshness important.

G) COMMUNITY PARTICIPATION IN URBAN DEVELOPMENT

Objective of the subsystem
Smart, built-up city and technologies cannot exist without the people living in it and using these technologies, social communities, that is, the city, (science) and its technologies are with and for society.

Therefore, in the 'smart communities' subsystem, urban people, communities, municipalities and community institutions upholding these are in the center; we would test from their perspective and with their participation the use and effect of various energy and water saving 'green' urban development innovations and technologies with the use of the latest research achievements of economic and social sciences. For example, our previous researches showed that it is not enough to energy efficiently renovate, equip with the latest devices a panel house or school if the individual and the communities are not yet energy- or 'future-conscious', their habits and behaviour changes slowly, the interest of the individual is in conflict with that of the community (social traps) or the regulatory, economic, legal environment is not encouraging.

Target area and short program of the subsystem
It is very important in positive change to involve the active participation of the affected communities in urban development, to use 'smart governance', education, information and effective communication with state-of-the-art ICT techniques.

In our R&D activity such urban groups, social strata would have prioritized roles that have EU (or global) problems, as aging city dwellers, among whom many have 'low energy level'. How and using what societal-economic tools could this be redressed?

Another test target group and research area could be mapping the city (energy, transport, space and building) use, community media habits of the generation of the future, the ICT native Generation Z people, in this context measuring their cultural and social capital and utilizing the sustainable urban development potential lying in it.

H) WATER QUALITY AND WATER MANAGEMENT

Current situation

Elements of the current urban water infrastructure (focusing on households): water extraction, water treatment, drinking water supply; domestic water use (flushing toilets, kitchen, bathroom, garden, etc.); mixed waste, sewage network, transport, waste water treatment; rain water drainage; sludge handling, transportation and disposal. Urban infrastructures today are primarily centralized, and allows open water and material flow. The infrastructure consists of a system of hierarchic levels: household, residential building, block, city, watershed, etc. In case of changes, the levels are paired with time scales. Current infrastructure is characterized by a concept that proved wrong by today: the system is not sustainable, cost and energy effectiveness is not observed, resource management and closing the circulation (water and materials – P and N, heavy metals, etc.) are missing. etc.

Smart solutions directions

- Consumption reduction, pricing and smart metering, grey water, rainwater, flush toilets, contaminant separation, source control, decentralization, etc.
- Decentralized systems depending on the conditions, yellow and black water.
- Wastewater treatment in the sewer, closure and substitution of certain sections
- Moving to decentralized anaerobic treatment.
- N and P recovery.

Program element details

Smart building – urban water

Limiting water use besides maintaining appropriate personal and household hygiene, the use of water-saving fixtures and replacing uses not requiring drinking water quality with rainwater and/or use of grey water (re-use).
The precondition to this is the separated drainage of waste water that are significantly differently contaminated and generated by various uses of water. The wastewater (grey water) of washing and laundry is less contaminated, it is perfectly suitable for toilet flushing and cleaning after minor treatment. Water consumption can be read without entering the apartments, or can be queried centrally via a data transmission system. The heat of hot water used in instantaneous water heater system can be partly recovered (as part of the passive house energy saving system).

Environmental protection – urban water

The transformation of the current rainwater only-drainage system to enable the above, domestic and irrigation uses, and the utilization supporting the city's green (ground water replacement) (SUDS - Sustainable Urban Drainage System). The richer and healthier urban greenery significantly improves microclimate (prevents the formation of heat islands: Climate subsystem), at the same time positively impacts the Energetics subsystem. It contributes to improving air quality, primarily to decreasing dust (PM2.5, PM10) concentration: favourable effect at Healthcare subsystem.

Urban water and energetics

Our goal/tool is the decrease of transported water quantities and the energy demand of the system, and the utilization of waters and sludge as renewable energy resources and in energy production, either directly or indirectly. As a list:
Drinking water

- Decreased energy use drinking water systems; drinking water plant.
- Installation of drinking water heat exchangers for building cooling (also inside the building).

Sewage, sewage sludge:

- Minimizing energy usage + maximizing energy recovery.
- Decreasing the energy use of sewage drain (optimizing distance and quantity) and wastewater treatment.
- Utilization of wastewater heat energy to heat and to cool neighbouring buildings.
- Zero-energy treatment plants. Sewage treatment plant as an energy producer.

- Digesting sewage sludge – biogas utilization (fuel for gas engines, microturbines, gas cleaning - city gas system, biogas-fuelled gas vehicles).

Urban river sections, streams

- Mini hydropower plants.
- Bringing urban streams to the surface from the canal network, connecting rivers and streams into the everyday life of cities (formation of aesthetic, natural stream sections, decreasing the water quantity transported in the sewer system and loaded into wastewater treatment plants.)

Community participation – urban water

The intelligent building-urban water connection cannot be implemented without the information, persuasion and involvement of individuals and communities.

Various solutions of Environmental protection – Urban water also requires the information, persuasion and involvement of the population.

I) INTEGRATED INFOCOMMUNICATION (ICT) SYSTEMS

Objectives

The vision is that all the smart-city areas have to be integrated around ICT that allows exchanging all the necessary information between all different areas, all different applications as well as between all the players of the Smart City. Confidentiality, Privacy, Security, Personality Rights and similar aspects are to be strictly obeyed.

- Providing the latest telecommunication, IT and content services for pilot purposes.
- Introduction of possible future ICT services with the interactive participation of local population and businesses.
- Familiarization of modern ICT services which make the life of the clients easier
- Testing the operability and usability, of ICT services.
- ICT training, education of the population in schools, study groups and publicly advertised further trainings.

Topics and programs

Learning, education

Virtual community space - Space for users to have conversations, share and watch films, video, photos among themselves. Beyond entertainment, however, it is an exciting and useful educational tool, as e.g. in case of illness, the student can be part of the teaching hours from home.

Culture, entertainment, tourism

Introduction of services in sports halls with ip-based broadcast systems - With ICT systems installed in sports halls, cultural events, congresses can be accessed and viewed via the internet or mobile devices.

Virtual tour guide - Virtual tour guide is a mobile application presenting the touristic offerings of a city, a real-time and full-value tour guide making the latest city programs available.

Comfortability

City card - Users in the test can use modern community services with Smart City Card with photo ID. Participating local small and medium enterprises may secure an effective marketing tool.

Smart shop - Mobile payment, mobile coupons, customized recommendation system, digital shelf labels.

New generation network - Over an optical network, clients are able to access information on the internet in real-time, and D-quality television is made possible with IPTV service.

Corporate services

IP-based business communication - Symmetric broadband internet connection, telephony, customer relationships, audio and video options, interactive conferences and telepresence and mobility solutions.

Hosting and colocation services - Tasks related to servers from area or server based location through server rental to replacement server and value-added services.

Cloud based services - Cloud based replacement for server, data storage and services (e.g. Mail, database, document management).

Ipsound - Voice, data and internet service provision. It includes ip-pbx, it-security and wlan functions. The service is targeted at small and medium-sized companies, with ip technology.

Security

Where's my car - Building on fleet tracking and smart phone options, we can continuously track the position of the car, its current and previous route and a number of its parameters.

School student identification access control system - Based on RFID technology, the student identification access control system excludes unauthorized entry.

Settlement monitoring system - The system monitors entry and exit roads of the settlement. May play priority role in enhancing the public safety situation of settlements, the subjective sense of security of the local population.

IV.5. Smartpolis - BME EIT Smart City coordination activities

The Smart City coordination activity of BME is in practice performed by the Federated Innovation and Knowledge Centre of the Faculty of Electrical Engineering and Informatics of BME-n (BME EIT).

BME EIT was established in 2009. A BME EIT includes 13 member organisations from various areas of specialisation. EIT's mission is to prepare and elaborate complex international and domestic tender projects, forming international consortia with research organisations and industrial partners.

Essential elements of BME EIT Smart City activities:

- The successful cultivation of the Smart City topic requires the participation and cooperation of nearly all BME faculties.
  - Similar initiatives: FuturICT, Danube Strategy, Space activities, etc.
- Formation of joint BME Smart City concept .
- Joint applications:
  - BME (BME EIT) submitted bid to the Horizon 2020 Teaming tender
  - BME (BME EIT) commenced the organisation of the participation in the Horizon 2020 SCC1-Smart City tender.
- We initiated the establishment of the Smart City Section in the framework of the Future Internet National Technology Platform.
  - In this, we intend to call for rural cities, the academic sphere, professional organisations, and interested industrial partners.
- We offer consultation and development services for those cities that are planning Smart City developments in the TOP Operative Program opening next year.
- We assist to cooperation with foreign partners, the transfer of know-how.
- Enhancing tender proposal infrastructure efficiency at BME with EU cooperating partners.

V. Summary

The development of the Hungarian Smart City Strategy is nearing completion. The strategic goals building on the harmonization of the EU initiatives, local needs and conditions, and the recommended implementation methods, will significantly accelerate the development processes of becoming a smart city. The applications of the elaborated common urban technology platforms and sample solutions will make implementation more efficient. We are confident, that the created professional organisations and the participating research institutions, among them especially the BME-based Budapest Smart City Centre of Excellence (Smartpolis) with regional scope, will be able to provide high quality support to settlements in planning their programs, will increase the chance of winning grants and ensure the successful implementation of the projects.
The Smartpolis - Budapest Smart City Regional Center of Excellence is happy to welcome investors, research partners and experienced suppliers of smart cities

Budapest University of Technology and Economics - Central Building

Budapest University of Technology and Economics - Central Building by night

Budapest University of Technology and Economics - Building Ch

Budapest University of Technology and Economics - Library Building

Budapest University of Technology and Economics - Library Building reading room

Budapest University of Technology and Economics - Buildings I and Q

Budapest University of Technology and Economics - Building Q

Budapest University of Technology and Economics - University Open Day

CONTENT


MŰEGYETEM 1782
smartpolis
Smart City Centre of Excellence