

## **Integrative Secondary Education Programmes and Research in Smart Cities Context**

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### **1 ABSTRACT**

A smart city can be considered as a specific form of modern city that emphasizes the efficiency of infrastructures by using ICT: many early models equate a smart city with the systemic integration of ICT in e.g. the energy or the mobility sectors – while not considering societal aspects. Innovation is recognized as a key driver in smart city, and thus people, education, learning, research and knowledge gain central importance. This paper sums up the relevant national smart cities activities in Austria and provides an indepth insight into the smart cities activities at the University of Applied Sciences (UAS) Technikum Wien, focusing on gender, diversity and citizen integration in the smart city decision processes. Current steps towards integration of smart cities into research and teaching include recently established smart cities competence team, endowed professorship and the planed smart cities conference in Vienna. Furthermore, the paper is summarizes elaborated educational programs at the UAS Technikum Wien with smart cities focus. Initial base for the smart cities integration in educational and research activities at UAS Technikum Wien has been built within the framework of the European Academic Smart Cities Network (EU-ASCIN) project, with the main goal to establish an Academic Smart Cities Network in cooperation with national and international universities and research institutes. Furthermore, the project allowed to build up professional competence in the area of smart cities oriented education and to expand the training opportunities at the UAS Technikum Wien with smart cities tailored Bachelor's and Master's degree programs. This paper summarizes the project results of the EU-ASCIN project and in particular describes exemplary integration of the proposed educational programs based on practice- and professional field-oriented, diversity-fair approach. Along with the educational approach, UAS Technikum Wien also supports with research and demonstration projects, to guarantee sustainable integration of the smart cities topic at the UAS Technikum Wien. This paper provides information concerning selected, demonstration project “Korneuburg WAY2Smart”. The project “Way2Smart” is driven by the intention to live up to its 2036 Vision Statement and Master Plan. The municipality of Korneuburg intends to rehabilitate two municipality-owned residential buildings, densify them by way of superstructures and annexes and equip them with energy-generating areas, and thus at the same time contribute to covering young tenants' demand for affordable small apartments. This paper shows the endeavors to achieve the ambitious objectives in terms of energy and CO<sub>2</sub> saving in Korneuburg by 2036 and concentration on “social togetherness”.

### **2 INTRODUCTION SMART CITIES TRENDS**

The importance of smart city topic has been stated by the European Energy Research Alliance (EERA) project, Joint Programme on Smart Cities: “As urbanization is progressing worldwide and due to the fact that almost two thirds of our energy is consumed in urban environments, intelligent cities will play a significant role for the complete and successful implementation of the EU Strategic Energy Technology Plan” (Bach, et al., 2014). The subject of smart cities is being broadly discussed not only in the domain-specific mobility, energy and ICT context but also in the educational and research-related fields. Simultaneously in Austria much attention is devoted to the smart cities topic. Cities in Austria are constantly evolving and need to reinvent themselves continuously to maintain the high quality of living. The European framework strategy Europe 2020 defines a roadmap for the economic development across the region, in order to a create smart, sustainable and inclusive economy (Manville, et al., 2014). Since 2010, Austria has been focusing on the support of comprehensive urban demonstration and implementation projects related to the smart city. The Austrian Climate and Energy Fund and the Federal Ministry of Transport, Innovation and Technology (BMVIT) published the technology program "City of the Future", which is striving for the development of new technologies, technological subsystems and urban services for the city of the future (Climate and Energy Fund 2011). In the last few years, the importance of citizen participation and social inclusion has increased.

With a clear message: cities can only be smart if all residents have access to the same degree of participation. This is a key factor playing a central role for urban development. Austria is a leading country with a high degree of social participation, which is endorsed by international rankings and studies in the past. As a smart city, Vienna, the capital of Austria, takes account of the different urban living environments and realities of women and men. Comprehensive equality of a political, social and economic kind is a key element to ensure quality of living. The University of Applied Sciences (UAS) Technikum Wien Austria's largest purely technical university of applied sciences contributes to these goals. UAS Technikum Wien has not only an obligation towards society, industry and business to provide innovative and pioneering instruction, but it also needs to deal with the diversity of the people who work and study at the institution in a responsible manner and must make the resulting potential and opportunities available to all those involved. The UAS Technikum Wien is an educational institution for men and women of different ages, of different origins, nationalities and native languages; with a variety of social backgrounds, family compositions and commitments; with individual needs and opinions, capabilities, skills and potential. In March 2013, UAS Technikum Wien decided to define Gender and Diversity guidelines for research and education activities. In order to derive the greatest possible benefit for students and instructors, everyone who works or studies at the university of applied sciences needs to be familiar with these topics. For this reason, UAS Technikum Wien integrates gender and diversity aspects in the contents and processes of instruction and learning (UAS Technikum Wien, 2015)

### 2.1 Endowed professorship

Described aspects are also considered in the research projects of the UAS Technikum Wien. One example is the endowed professorship. Relating to the subject of Energy Performance of Buildings Directive (EPBD) which requires that all new buildings to be nearly zero-energy by the end of 2020 (EPBD 2014), the user's behaviour and diversity are the main foci, which are not yet integrated in the daily building planning process. A fundamental re-orientation of teaching in the area of buildings and building blocks is required. UAS Technikum Wien has the aim to implement new teaching methods for building and building blocks in the current Master's and Bachelor's degree programmes. Users comfort, user friendliness and internal gender mainstreaming are understood as central features of sustainable buildings. Especially in the areas of comfort-elasticity, usability, dynamic simulation of buildings, facilities and neighbourhoods and life cycle analyses of neighbourhoods run application-oriented research and the results are processed and embedded in teaching.

### 2.2 Smart Cities Competence Team

To support the smart city activities at the UAS Technikum Wien and to support the gender and diversity concepts in education, a proposal for its own smart cities competence team has been submitted and successfully funded by the municipal government of the City of Vienna. The main objective of the competence team for Intelligent Technologies in Smart Cities (KiTSmart) is to develop smart cities related courses and support scientific dissemination in the research community (UAS Technikum Wien 2016) and considering the gender and diversity aspects.

## 3 SMART CITIES IN EDUCATION AT THE UAS TECHNIKUM WIEN

The initial attempt to develop competence at the UAS Technikum Wien in the area of the smart cities was started as the research project, funded by the municipal government of the city of Vienna. The European Academic Smart Cities Network (EU-ASCIN) project had several goals. On one hand to support implementation of the Smart City Wien Framework Strategy through design of the new study programmes and educational concepts, which fill the gap in the area of the citizen activation. On the other hand, to encourage and support the development of an academic dimension of smart cities in central Europe. Within the framework of the project first attempts for integration of the smart cities subject into the existing study programmes has been performed.

In the first step it was decided to build up smart cities using the synergies between existing mobility and energy specific educational programmes (Bululukova und Wahl 2015). However, while the previous approaches e.g. existing Bachelor's degree programmes Transportation and Environment or Renewable Energy Technologies are strongly domain specific, the proposed smart cities educational focus is built on the intersection of these disciplines, providing inter-domain knowledge. The teaching concepts, subjects as well as lecturers from both mobility and energy domains are strongly involved in the design and implementation

of the smart cities specialisation. After choosing the smart cities module within the Bachelor study, the students gain some insight into more general concepts of smart cities. Subsequently, the Master's degree programme in smart cities provides more specific subjects on technical, social and economic aspects of smart cities.

### 3.1 Transport and Environment

The integration of the smart cities topics into the existing Transport and Environment Bachelor Programme is performed as one of the 4 selectable specialisations, which include Smart Cities, Intelligent Transport Systems, Electric Vehicles Technology and Transportation Planning. The smart cities specialisation was designed to meet the requirements of the City of Vienna strategy concerning interdisciplinary education (shown in Table 1).

Specialization Courses	Learning Outcomes
Socio-Technical Aspects of Smart Cities (3 ECTS)	Students are able to point out impacts and benefits of considering gender and diversity aspects within crossover of mobility, energy, and ICT in smart cities
Smart City Influencing Factors (3 ECTS)	Students are able to describe smart cities as a concept, to compare different implementations of smart cities in an international context and to define the interactions between urban planning, mobility, building, industry and energy planning
Big Data in Smart Cities (3 ECTS)	Students are able to analyse and explain challenges posed by Big Data, its sources and its potential impact for specific domain of smart cities, makes use of suitable tools for basic Big Data tools and frameworks
Urban Energy Supply Systems (3 ECTS)	Students are able to define influencing factors on the urban energy demand, to compare energy systems used in urban environments and to work with modelling and scenario development tools

Table 1: Specialization courses and the learning outcomes

### 3.2 Urban Renewable Energy Technologies

The Urban Renewable Energy Technologies provides smart cities specific topics within the 4th and the 5th semester as one of the three specialisation tracks: building energy design, large-scale plants and integrated energy technologies. The subjects within the smart cities specialisation start with a more general overview in the 4th semester, with such topics as integrated design of urban technological energy projects, energy networks design in urban areas and the user behaviour with strong emphasis on diversity. The continuation of the smart cities topic in the 5th semester provides more complex insight into technological concepts, urban administrative frameworks and area specific planning concepts. The courses offer the possibility of hands on learning, including the planning process for small smart city projects, e.g. such as building refurbishment.

### 3.3 Integrative Urban Development - Smart City

The new smart city Master's degree programme is the main step for smart cities integration at the UAS Technikum Wien. Prior to the implementation of the curriculum, an extensive feasibility study of the smart cities domain has been performed. Considering the prospective employment possibilities, several key areas could be identified, including i) infrastructure planning implementation and maintenance ii) management and urban planning such as city administration iii) industry such as technology in mobility and energy domains iv) services such as education and consulting.

Based on the identified employment sectors, the requirements on the educational programme could be elaborated.

According to the UAS Technikum Wien strategy of outcome-oriented learning concepts, several relevant outcome oriented goals have been defined for the new Master's degree programme. After the completion of the Master's programme students should be able:

- To develop inter-domain urban services and business models based on the intersection of mobility, energy, and ICT
- To design integrative urban development objectives in a socio-technical context, to perform current state analysis and to implement required measures
- To analyse urban systems under consideration of social aspects
- To specify and simulate overarching use cases in smart cities
- To develop and implement participatory planning concepts

- To assess regulatory and interface-specific, such as standards and norms at regional, national and EU-wide level.

The technical skills within the new Master's curriculum can be subdivided into introductory modules and selectable tracks (shown in Table 2). The purpose of the introductory modules is to compensate the missing basics for students with few to no smart cities related background, since it is planned to diversify the student groups. To support the inter-domain approach students have the possibility to deepen their interest in one or several hands on projects. The economic and social skills courses round up the curriculum with innovative trends and business models within smart cities context.

The general split in ECTS between the areas of expertise, can be summed up into following core subject clusters: i) smart cities related project work (12 ECTS), ii) scientific Methodology and Tools (36 ECTS), iii) Smart Cities Domain Basics (introductory courses) (6 ECTS), iv) Smart Cities Core Competences (48 ECTS), v) Socio-Technical skills (12 ECTS) vi) Economic, management and legal foundations (6 ECTS).

Selectable Track	Contents
<b>Urban Housing</b>	Densification in urban areas, energy-based renovation
<b>Trends in urban energy supply</b>	Technological trends in the energy supply of modern cities
<b>Physical Measurement-Methods</b>	Measurement technology of physical smart cities characteristics
<b>Embedded Systems</b>	Internet of things, sensor data
<b>Human factors in modern transportation</b>	The human factors and transportation safety
<b>Greenhouse emission reduction</b>	Methods and concepts for reduction of the CHG
<b>Urban logistic systems</b>	Technology in urban logistics and fleet management
<b>Electric vehicles</b>	State of the art in battery technology and electric vehicles
<b>Sensors and Control Theory</b>	Sensor data measurement and usage in control theory, control engineering technology
<b>Distributed and dependable systems</b>	Sensor networks and distributed computing
<b>Urban lighting technology</b>	Lighting technologies for urban lighting
<b>Image-processing</b>	Applied image processing
<b>IT Security in Energy and Mobility</b>	IT security concepts in energy and mobility domains
<b>eHealth</b>	Integration and usage of connected medical IT infrastructures, crowd-sources healthcare
<b>Big Data</b>	Technical concepts in Big Data, semantic knowledge and linked data
<b>Autonomous Driving</b>	Technology for autonomous vehicles and navigation
<b>Cooperative Systems</b>	Car to car, car to infrastructure communication

Table 2: Selectable Track and contents

The described smart cities Master's programme has been approved by the official governmental body and will take place for the first time in winter semester 2016/2017 as part-time Master's Programme in German.

#### Smart Cities Conference

As major outcomes, the results will be continuously presented at the "International Research Conference on New Urban Smart Energy and Mobility Concepts - First User Experiences" which is organised by EU-ASCIN. This conference is aiming to bring together the research community of European smart city experts with focus on already realised concepts in energy and mobility. Researchers from universities and research centres, who are involved in smart city developments and demonstrations, will discuss the experiences of users, the acceptance of the citizens, and further developments. The two days conference will be supported by the City of Vienna and will take place at the Vienna City Hall in winter 2017. The UAS Technikum Wien takes over the scientific lead of the conference. The conference will be completed by an on-site visit to the Aspern Vienna's Urban Lakeside.

## 4 SMART CITIES IN RESEARCH AT THE UAS TECHNIKUM WIEN

In addition to the implementation of the new study programmes UAS Technikum Wien is also working on demonstration projects. One of these projects is in a small town Korneuburg near Vienna, with about 12,000 inhabitants. Until 2036 the forecasts predict at least 50 % increase in population of Korneuburg. To meet the needs of a growing city - citizens, politicians and administration - planned Korneuburg's path to 2036: with ambitious objectives in terms of energy and CO<sub>2</sub>-saving and concentration on "social togetherness". The municipality of the town decided to start a big participation-project in the year 2011 to define a Vision Statement and a Master Plan for its urban development. Driven by the intention to live up to its 2036 Vision Statement and Master Plan, the municipality of Korneuburg intends to rehabilitate two municipality-owned residential buildings (shown in Figure 1), densify them by way of superstructures and annexes and equip them with energy-generating areas, and thus at the same time contribute to covering young tenants' demand for affordable small apartments. Many people, mainly from Vienna, like to come and live here because of the

high quality of lifestyle – the “green area” next to Austrian's capital. But the community area is rather small, densification is the only way to increase housing - so that the small town will become a small city. Ambitious goals need smart people to reach them – „Korneuburgs Way2Smart” is the first step to a smart city. To reach the ambitious goals concerning energy efficiency, carbon-neutrality and affordable housing and living space, as well as eco-efficient mobility Korneuburg needs to inspire the citizens to join that „Way2Smart“ as a step to fossil fuel independence. As accompanying measures, they offer a communications programmes involving the existing and new tenants of the building, as well as further development – because neighbourhood is a big factor for quality of lifestyle. Last, but not least, mobility measures like e-car sharing, a hitch-hiking-station, good cycle-parking etc. create the possibility to be mobile without a private car. Ultimately, the endeavours to achieve the ambitious objectives in terms of energy and CO2 saving in Korneuburg by 2036 are to be documented in a database in such a way as to make the individual measures available as models and stimuli for comparable projects in the town.



Figure 1: The two municipality-owned residential buildings to be rehabilitate (HuB architekten ZT KG 2013)

The three years project is funded by the Austrian Climate and Energy Fund, with a strong consortium composed by grid operators, energy planners, mobility planners and architects, but also the municipality of Korneuburg. The specific goals of the project are the rehabilitation of two municipality-owned residential buildings and the creation of a mobility hub in the area of the rehabilitated objects and thus create alternatives to the use of private cars. In this prototype housing scheme, affordable small apartments are to be provided to young tenants in a targeted manner. In this context, the state-of-the-art of what is currently technically feasible shall be demonstrated. As accompanying measures, (i) communications programmes are to reconcile measures and needs of existing and new tenants on a level-playing field with experts. The main goal here is to achieve acceptance for rehabilitation measures as well as self-organisation. (ii) Tenants and other citizens will be informed of and mobilised for the objective of the energy-self-sufficiency of Korneuburg. (iii) Property developers are involved in the process which is monitored by social scientists. With regard to the town's ambitious objectives in terms of energy and CO2-saving, these exemplary measures will ultimately be prepared and documented in a database in such a way as to make the individual measures available to Korneuburg and other towns and cities as models and stimuli for comparable projects.

## 5 CONCLUSION

This paper provides a deeper insight into the design of the new study programmes and educational concepts of the first smart cities specific practice-oriented education at UAS Technikum Wien. It sums up current status quo of the project with already accomplished milestones, including integration of smart cities into Bachelor degree programmes and development of an independent smart cities oriented Master's programme. Detailed insights into occupation research, as well as gender and diversity sensitive topics are provided. Furthermore, the paper presents the demonstration project “Korneuburgs way2Smart”. The goal of the projects to provide an exemplary fashion of the two buildings that are to be rehabilitated and offer housing for young people, informed and motivated existing and new tenants, enhanced local traffic, documented progress towards achieving the Korneuburg 2036 Vision Statement and Master Plan. In addition guidance will be prepared with the cooperation of property developers, which is to serve as a tangible example for further projects. The next step at the UAS Technikum Wien may be to develop an “Open Energy City

Database”, which combines the data from the surrounding infrastructure environment with energy data in a standardised web-based interface. Another goal is also to demonstrate possibilities for urban planning and urban neighbourhood development with a view to creating a path to a low carbon city with a high quality of life and good resilience, while taking into account existing and proposed buildings, infrastructures and uses. In addition the development of a future-oriented overall concept for housing and mobility near the train stations is also a focus of the UAS Technikum Wien.

## 6 ACKNOWLEDGEMENTS



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