BELMONT FORUM URBAN EUROPE

Project no. 730254

Sustainable Urbanisation Global Initiative

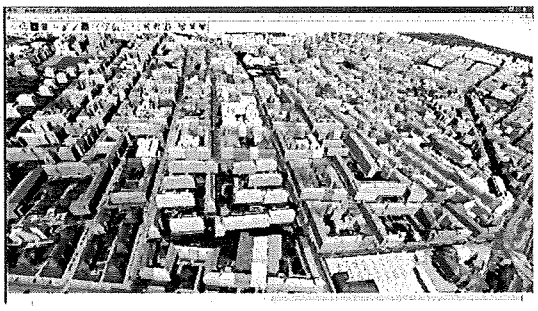
Food-Water-Energy Nexus

Joint Call for Proposals

Pre-Proposal: Consortium, General and Financial Information

1. Project Overview

Project Short Title/Acronym: **IN-SOURCE**			
Project Full Title: **IN**tegrated analysis and modelling for the management of sustainable urban FWE Re**SOURCE**s			
Project Coordinator/Main Applicant: University of Applied Sciences Stuttgart (HFT) – Centre for Sustainable Energy Technology Research / Prof. Dr. habil. Ursula Eicker			
Themes: (tick the relevant theme(s)) ☒ Theme 1. Robust Knowledge, Indicators and Assessments ☒ Theme 2. Multi-level Governance and Management of the Food-Water-Energy Nexus ☐ Theme 3. Managing Potential Strategies and Solutions to Address Emerging Risk and Tradeoffs at the Intersection of Sustainable Urbanisation and the FWE Nexus			
Keyword 1: Co-designed scenarios for sustainable, green and energy efficient cities of the future Keyword 2: Urban data modeling for new design tools of urban scenarios Keyword 3: System analysis of decentral urban energy systems for resilient and efficient food and water supply and waste treatment			
Overall project type:			
X Fundamental research	XX Applied research	X Innovation and implementation	
Total Project Costs in EUR:	1.858.968 €	Requested funds in EUR:	1.708.372 €
Duration of the Project in months (max. 36):	36	Expected start:	01.2018
Total Effort in Person Months:	206	Expected end:	12.2020



2. Abstract

As cities across the globe confront rapid change, they face common metabolic challenges to provide food, water and energy (FWE) supplies and to ensure healthy, socially balanced and economically productive communities. In this context, government, utilities, developers, investors, and other decision-makers need tools to identify, quantify and visualize cross-sectoral and cross-media impacts to FWE systems from various decisions – from urban development strategies to CO_2 mitigation/-adaptation plans to FWE infrastructure investments.

The proposed IN-SOURCE project will develop a shared urban data and modeling framework to help cities analyze and characterize FWE systems and nexus interrelationships. Shaped by city stakeholder requirements, this framework will utilize a common urban 3D data model applicable to regions and cities in Europe and the United States.

The IN-SOURCE modeling framework will: (a) simulate impacts of land use, climate change and decentralization of FWE supply infrastructure in cities with different densities and under multiple constraints in order to ensure adequate energy, water and food distribution and storage capacity; (b) configure alternative urban and regional scenarios toward integrated carbon neutral and sustainable infrastructure, based upon decentralized and increasingly autonomous FWE supply; and (c) analyze scalability and transferability of prototype solutions to other cities.

3. Project Consortium

	Organisation	Type of organi-sation	Country / Funding agency	Contact Person (first name and family name)
Main Applicant HFT	University of Applied Sciences Stuttgart (HFT) - Centre for sustainable energy technology research http://www.zafh.net	RO	Germany/ BMBF	Prof. Dr. habil. Ursula Eicker
Co-Applicant Partner 2 LKR	Landkreis Ludwigsburg http://www.landkreis-ludwigsburg.de/english/	OTH (public body)	Germany/ BMBF	Dennis Fricken
Partner 3 BWE	bw engineers http://bw-engineers.com	SE	Germany/ BMBF	Alfred Helble
Partner 4 AIT	AIT - Austrian Institute of Technology GmbH - Center for Energy http://www.ait.ac.at/ueber-das-ait/center/center-for-energy/	RO	Austria/FFG	Dr. Ernst Gebetsroither-Geringer
Partner 5 UNI-KLU	Alpen-Adria Universität Klagenfurt - Institute of Social Ecology (SEC) http://www.uni-klu.ac.at/socec/eng/inhalt/1.htm	RO	Austria/FFG	Prof. Dr. Karlheinz Erb
Partner 6 CUNY	City University of New York – CUNY Institute of Urban Systems and CUNY Energy Institute http://cunyurbansystems.org/	RO	USA/NSF	Prof. Ahmed Mohamed, PhD
Partner 7 NYIT	New York Institute of Technology http://www.nyit.edu	RO	USA/NSF	Prof. Ziqian Dong, PhD

4. Quality of Work, Project Objectives and Targets

4.1 Project objectives and targets

In their Sustainable Development Goals the United Nations have set ambitious targets for cities, climate action, clean energy and water, good health and food security until 2030. However, it is difficult to translate these targets into concrete local urban infrastructure development strategies that can be monitored, regularly assessed and in turn, reported back to national and global decision makers.
The main strength of IN-SOURCE is to contribute closing this knowledge gap by

- Using a **bottom up approach** to model urban system development towards a stable renewable energy system, secure and energy efficient water supply and abundant green spaces for food production and leisure. IN-SOURCE will then combine the aggregated results with larger scale (mainly regional, up to national) system models
- **Involving urban stakeholders** in the whole process: developing indicators, including data, developing tools to model and visualize the impacts and help developing strategies
- Considering common urban problems in three very different case studies and thus improving the **transferability of the local results to global urban areas**.

The main objective of IN-SOURCE is to develop tools and apply them to case studies in order to quantitatively assess the predicted impact of changes in urban land use due to population, climate change, the energy transition and the challenges of providing a truly resilient infrastructure. The project will combine urban big data with emerging urban modeling tools in order to assess urban transformation strategies. The main result will be a shared urban data and modeling framework, integrating 3D visualization tools for stakeholders.
The IN-SOURCE project is based on the assumption that the FWE and infrastructure problems that **cities world-wide currently face similar challenges** and differ mainly by density, climatic boundary conditions and local resource availability. Thus, a global research agenda to address these common urban problems seems possible. Trade-offs and synergies for climate-compatible development can be evaluated through scenario analysis exploring complex cross-linkages.
IN-SOURCE will use indicators to analyze interactions at multiple scales. The indicator CO_2 emissions will be used to assess, for example, the role of smart (micro)grids for renewable energy generation and efficient water and food supply, wastewater treatment and reuse as well as waste utilization. Land use and ecosystem service indicators such as the urban ecological footprint allow us to analyze the role of urban farming with its impact on total urban energy consumption, traffic volume, water requirements and the local climate conditions and to compare the economic potentials based on urban centrality and compactness with food production in the hinterland. Resilience is an important indicator for the (electrical) energy infrastructure and for the relationship between water supply security and food supply and distribution logistics. This includes the resilience of the transport sector to natural disasters or blackouts and its impact on food availability and the food cooling and refrigeration chain. A rational food, water and energy management system increasingly requires these carefully selected and validated indicators to reflect not only emissions standards, but also the impact of FWE on ecosystem services in addition to economic stability at various scales.
In order to achieve our purpose, the **relevant urban stakeholders** (municipalities, energy and water supply companies, food producers and logistics companies, citizens and their associations) must co-identify and co-produce knowledge on inherent joint features and variability of urban systems, their predictability, and the human dimensions. We expect reciprocal benefits when considering local-to-global scales (bottom-up approach). Thus, a global viewpoint offers context to local-scale phenomena and in many cases, defines what happens over the smallest of domains. In turn, the local scale offers critical ground-truthing opportunities for global concepts and is crucial to develop actionable solutions for a sustainable urban infrastructure.

IN-SOURCE will address the FWE challenges at the local and regional levels. Cities and regions of different size and density in Europe and the US will be directly involved in order to implement and validate the approach and to scale up results in order to connect local action with macro-scale targets:

Low density region: The region of Ludwigsburg is a Southern German region with small to medium sized cities in Germany, where a 3D CityGML model for 39 communities is available to model scenarios, develop measures and work with the regional governance to speed up implementation of sustainable infrastructure such as maximum renewable supply, efficient wastewater treatment with sewage sludge to energy projects, treated effluent reuse for irrigation in agriculture or a high regional food production ratio including food and forest waste to energy concepts.

Medium density urban area: The city of Vienna is a medium dense and growing European city, where also a 3D CityGML model is available and already in use for energy-related analyses. The model will be combined with regional ecosystem models to analyze the consequences of land use change for food generation, renewable integration, climate change adaptation and water quality/quantity issues.

High density urban area: The expanding and very dense city of New York faces challenges of a limited capacity urban infrastructure, particularly the electricity grid, and increasing needs to provide a resilient infrastructure for water and food supply. The close relation of decentral microgrids with integrated renewables in energy efficient districts with green and secure food logistics and water treatment is a major focus. As in the European case studies, a common data model based on the CityGML standard is already available for the integrated modeling approach.

The main indicators and NEXUS question addressed in the IN-SOURCE project are summarized below:

FOOD *Indicators:* Quality, sustainable production, security of supply, land use, energy footprint, CO_2 footprint	**FOOD → WATER** • Impact of food production and food waste treatment on water quality • Climate change impact on food production and water demand	**FOOD → ENERGY** • Use of waste food for energy production • Impact of urban farming on transport and processing energy
WATER → FOOD • Water treatment for irrigation • Water treatment for food process water • Water treatment for potable water	**WATER** *Indicators:* Water quality, water quantity and long term sustainability, resilience, land use, water footprint	**WATER → ENERGY** • Energy requirements in wastewater treatment for different water quality and possible reuse • Wastewater sewage sludge treatment for thermal energy generation, phosphorous recovery
ENERGY → FOOD • Smart micro grids for resilient food refrigeration chain and food logistics • Demand side management potential of food chain refrigeration (supermarkets) • Energy efficiency of food production	**ENERGY → WATER** • Smart grids and renewables for resilient water supply and treat-ment • Wastewater plant efficiency and de-mand side management (DSM), reuse • Energy efficiency of water supply	**ENERGY** *Indicators:* CO_2 emissions, reliability and resilience, land use footprint

4.2 Overall project type

Based on the partners previous work with emerging urban data model standards such as CityGML, the project aims to connect multi-scale modeling methods from the different domains of the FWE Nexus to create robust knowledge, indicators and assessment (Theme 1). The goal is to determine which planning strategies result in a resource-efficient and socially balanced urban infrastructure while

providing ample scope for citizen participation and while guaranteeing resilient food and water supply. Fundamental research questions are addressed, for example how cities function on fluctuating renewable energies and whether the waste water treatment plants or food refrigeration chains can be used for demand side management. By testing the models and methodology in three case study areas in Germany, Austria and New York, multi-level governance and management topics of the urban systems are covered (Theme 2). Involving the municipal stakeholders addresses applied research questions on decision support methods and the engineering company´s feasibility studies pave the way for implementation and innovation actions in the regions.

5. Key activities

To develop solutions for innovative urban infrastructures in sustainable, green and livable cities, we divide the work in six work packages (WP). WP1 will develop scenarios and visions jointly with all major stakeholders. WP2 will specify and flesh out the urban data model based on 3D GIS. In WP 3 qualitative analyses and system interactions will be identified and studied. In WP4 important FWE Nexus questions will be analyzed for each case study by combining various simulation models which are already part of the toolset of the consortium partners. The results will be analyzed jointly with all stakeholders of the urban case studies (WP5) in an iterative feedback process. By a series of international workshops the results will be disseminated to further cities and regions (WP 6). The project leader HFT will coordinate all work packages and the Data Management Plan.

WP 1 Vision building, scenario and KPI definition (Lead LKR)

***Objectives**: Stakeholder mapping and workshop design; Vision building and co-produced scenarios for FWE in future cities; Indicator development*

Relevant urban stakeholders are convened in workshops to iteratively develop co-designed scenarios of preferred future urban infrastructure under identified constraints. The goal is to develop a vision of how the different stakeholders want to live in future cities, how much green spaces and local food production is desired, how renewables can be best integrated and how land use changes are envisaged for future urban developments. Global key performance indicators (KPI) e.g. CO_2, costs, land use, water quality, resilience, specific energy use and others will be developed and applied.

Outcome/milestones: Local workshops (Months 3-10); Scenarios defined, Indicators identified and agreed upon with stakeholders (M 12)

WP 2 Urban data modeling (Lead HFT)

***Objectives:** Harmonize and extend the partners common data model; Investigate data availability, data security and strategies to enrich and complete the data repository.*

Given the heterogeneity of territorial and temporal entities and scales involved in the project, the adoption of a common, shared and open urban data model is crucial. CityGML will be used as the only currently available open urban data model that allows spatial modeling with semantically different objects at multiple scales and urban thematic areas such as energy or utility networks. CityGML will be extended in the project to the application domains food and water. The urban model will then be filled with data such as water quantity and quality, energy usage and outages, food consumption and production, transportation and disposal from a range of US and European data sources (municipalities, private utilities, regional vehicle travel infos and many others). Challenges of incomplete data and data integrity will be addressed through various data recovery and interpolation methods. Data from innovative sensing technologies and sensor networks also will be included for real time measurements.

Outcome and milestones: Urban data model with CityGML application domain extensions for food and water specified and implemented (M24)

WP 3 System analysis and feedback interactions (Lead AIT)

***Objectives:** Understand system interactions and feedbacks in the entire FWE system; obtain a joint vision of the project partner of system interactions to be transported to the stakeholders; define and develop tools how to visualize the system interactions within the stakeholder workshops*

A common method to map different systems (e.g. urban water management, energy or food supply system) by a qualitative system analysis approach will be developed using for example Causal Loop Diagrams, integrated biophysical Stock Flow analyses such as socioecological metabolism or the "human appropriation of Net Primary Production", as well as sensitivity analyses. The key nexus topics for each case study region will be determined taking into account different stakeholder visions. This can include for example the role of distributed renewable generation and microgrids to provide stable and resilient food and water supply systems with low CO_2 emissions, efficiency potentials in the water treatment sector combined with energy generation from sewage sludges or the impact of urban farming on land use, irrigation needs and local climate conditions while reducing transport energy.
Outcome and milestones: Main Nexus topics assessed qualitatively in all case studies (M20)

WP 4 Software tools and case study application (Lead CUNY)

***Objectives**: Analyze suitability, usability, performance and interoperability of tools for the FWE Nexus, Design and implementation of data exchange interfaces, Prepare top down and bottom up system models to simulate case study scenarios; Case study simulations; Develop visualization tools for different stakeholder groups*

Based on the stakeholder scenarios, the partners will use and combine their different urban modeling tools to answer Nexus questions on a range of scales such as the impact of the visions regarding CO_2 mitigation and climate adaptation, renewable energy integration for the water and food system or population development scenarios and the resulting trends of land use change and the impact on renewable energy production. This includes for example the energy efficiency of water supply and wastewater treatment plants as a function of water quality and use for food production and the demand response potentials in the water and food logistics and storage sector.
Outcome and milestones: Interfaces between sets of modeling tools documented (M12), web based import/export to urban data models and result visualization of the case studies (M24)

WP 5: Evaluation of system analysis and modeling results (Lead UNI-KLU)

***Objectives**: Analyze benefits of combining bottom up and top down approaches and determine missing tools and methods for FWE analysis; Discuss suitability and usability of tools and results for stakeholders from different domains and give feedback*

In a participatory process key areas of conflict and of interest or promising strategies resulting from the visions (WP1) and results (WP4) will be identified and contextualized (co-design). Qualitative and quantitative results will be discussed with the relevant stakeholders to obtain their feedback and to develop strategies for future action (co-production). The participatory process will be used to evaluate the suitability and usability of both indicators and tool sets for the planning of concrete measures in the municipalities and regions of the case study areas. A critical assessment of inputs and assumptions in the various tools will allow to evaluate the uncertainties of the scenarios.
Outcome and milestones: local workshops (M24-30); Stakeholder evaluation and feedback completed and documented (M34)

WP 6: Scalability, dissemination and communication (Lead NYIT)

***Objectives**: : Use interactive visualisation tools to show interdependencies of FWE systems to engage stakeholders and communities; Effective communication to disseminate results to the general public; Develop frame conditions and guidelines for scalability/replicability of results*

WP 6 delivers strategies, guidelines and uses interactive visualization methods to transfer the results to the most innovative urban areas worldwide. A series of workshops for different stakeholders will be organized in New York, Stuttgart and Vienna to address NGOs, FAO, UNIDO and practitioners in Urban Water and Energy Management. NYIT will organize specific local 3D scenario workshops with the American Institute of Architects Planning & Urban Design Committee as an excellent platform for public engagement and dissemination. IN-SOURCE will connect to networks such as JPI Urban Europe Stakeholders Involvement Platform, the Global Covenant of Mayors, the Under2MOU regions, the

Future Earth urban knowledge action network, the European Energy Research Alliance (EERA) and others.

Outcome/milestones: 6 international workshops in 3 participating countries (M24-M36); dissemination and transfer of IN-SOURCE methods and tools to at least 5 further major urban areas (M36)

6. Data Management

IN-SOURCE will ensure that research data developed during the project will be shared (by default) through open data as described hereunder. In accordance with the Data Management requirements of Belmont Forum and JPI Urban Europe, a detailed Data Management Plan (DMP) will be made within the first 6 months of the project. The DMP will be drafted according to the template on the "Guidelines on FAIR Data Management" developed by the European Commission (for H2020 projects). The Lead Partner HFT will back-up all results and provide non-confidential data to be published on the Project Website. In addition CUNY will set-up a research/education program website for its 500.000 students with electronic downloadable versions of course and lecture material produced with the IN-SOURCE results. The research/education web site will be set up with an open domain to post research results and announcements as well as a password protected domain to discuss open and yet-to-be-resolved research issues and problems.

NON- OPEN ACCESS DATA, such as **Personal data, Confidential project information or research data** with legitimate reasons to constrain access (e.g. with personally identifiable data) will be put in a platform accessible only to the project beneficiaries and password-protected. The beneficiaries are bound by an obligation of confidentiality.

OPEN ACCESS RESEARCH DATA includes **digital research data and related metadata validating the results** such as description of geographic information scheme, CityGML Energy ADE extensions, monitoring data, developed algorithms etc. The partner NYIT has access to a robust data repository as part of the TBLS advanced server farm TBLShare. The open source D-Space platform as the most widely used institutional repository software in the world enables the open sharing of content with stakeholders and constituencies throughout the world. A repository at NYIT will be implemented during the course of this project. In addition the www.re3data.org research engine supported by the European Commission will be used to find the most relevant data repositories for the FWE IN-SOURCE project.

As **IN-SOURCE** aims to raise the overall knowledge and awareness of a broad range of stakeholders, **scientific publications** will be open access and available for all on the Project website, on relevant open repositories and potentially other websites.

7. Added value of international co-operation

International efforts are necessary to bring together the disperse scientific community involved in urban infrastructure modeling under the common goal of developing and testing strategies for sustainable cities with decentral energy generation, local food production and safe and clean water supply. Enhanced communication and better data flow are necessary to establish how global decision-making can be broken down to national and local urban system transformation strategies. On the other hand, understanding the impact of local decision- making on the achievement of global targets is crucial, be it on a building scale, a city quarter, an entire city or a metropolitan region.

The IN-SOURCE project partners will work beyond the project lifetime on a global **Future FWE Research Agenda**, similar in spirit to the emerging Future Earth initiative, relying on a similar call to the global change community to expand its mission to one that co-produces actionable scientific knowledge within the environmental planning, policy, and management communities. The goal is to extent Global Sustainability Science by providing a **shared urban data and modeling framework** for the FWE questions and to develop an international research agenda to guide engineering, urban planning and social scientists working around the world.

One immediate and tangible opportunity to pursue this objective involves the post-2015 phase of the Millennium Development Goals (MDGs), now collectively referred to as the Sustainable Development

Goals (SDG). The SDG process has initiated complex member-state negotiations with the aim of setting targets and tracking progress toward sustainability.
The IN-SOURCE proposal directly supports several of the SDGs such as food security (goal 2), clean water and sanitation (goal 6), the access to affordable, reliable, sustainable and modern energy for all (goal 7), the achievement of sustainable and resilient cities and communities (goal 11) and actions to combat climate change (goal 13). Within each goal several targets are covered, for example the universal access to affordable, reliable and modern energy service, increasing substantially the share of renewable energy in the global energy mix, doubling the global rate of improvement in energy efficiency by 2030, and enhancing international cooperation to facilitate access to clean energy research and technology. These targets are addressed by the partnership from Europe and the US through improved simulation capacity at various scales derived from improved data quality, quantity, web services, and model integration techniques. By analyzing FWE nexus questions in cities and regions of different size, density and climatic conditions, scalable and transferable knowledge will be generated to be widely used in international networks of sustainable cities.

8. Relevance – Contribution of the project to the goals of the call

In the IN-SOURCE project a global research agenda on urban systems and related data and modeling frameworks is suggested to bring together the fragmented research expertise. The research and planning questions that can be addressed range from city quarter, community and regional level with scenarios for decision-support and policy-making, the analysis of infrastructure needs over time, zoning rules and impact-analysis up to micro-climate predictions and alert systems for critical energy, water or food logistics. Such questions and planning issues are expected to be seen consistently across cities, albeit with starting points, details and outcomes varying based on local context. The shared urban data and modeling framework proposed by the partnership would greatly facilitate learning and sharing between cities. Such urban data sets and a range of representative case studies are essential to demonstrate potential solutions for an energy efficient urban infrastructure with high resilience for local food and water supply. The data as a basis for advanced indicators and the use of 3D modeling tools to assess the energy efficiency of a resilient food and water infrastructure directly support the main goal of the call to **rapidly evolve the knowledge base and understanding of the urban FWE nexus**.
The three case studies proposed will set best practice examples in Europe and the US. The participating municipal and regional governments are highly motivated to **develop practical new solutions to the FWE challenge** – another ultimate goal of the call. The analysis results of the interconnections between decentral energy generation in growing cities with limited space and distribution capacity, efficient waste water treatment and its use for agriculture will be widely disseminated to global sustainable cities networks to support the world´s Sustainable Development Goals.

9. Impact of the project

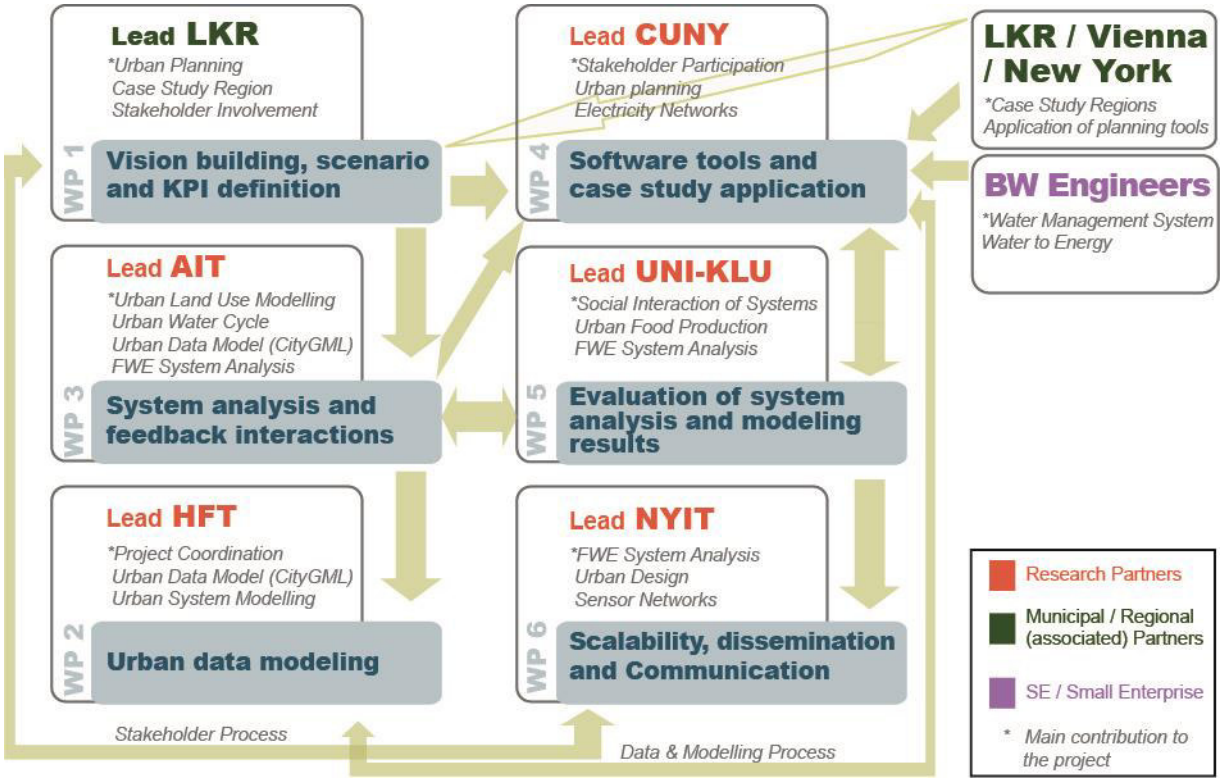
The project creates a shared urban data and modeling framework with interactive modeling tools for diverse applications in the food, energy and water sector with data from different countries and regions. The 3D modeling and visualization tools provide policy holders and decision makers with evidence and scientific projections before implementing a strategy and identify urgency of intervention needed to sustain a community. The indicators and stressors to FWE systems at different regional levels will be compared to find disparate and common elements in different regions and communities. This will aid the customization of the models across different areas of the world
An extension of the urban data model based on the open CityGML standard to the food, water and energy topics is crucial for the harmonization of worldwide modeling efforts. The developed CityGML Application Domain Extension (ADE) will be published and made available as open specification. This will allow every interested institution to adopt and further extend it, thus avoiding technology lock-ins at end of the project and, finally, guaranteeing a sustainable and fair (re)use of the developed IP beyond the project IN-SOURCE. By disseminating the data models and software in a series of international

workshops, the goal is to reach out to at least 5 major cities or regions during the project duration willing to use and implement the data and modeling framework.
The visualization tools will provide a powerful way to engage the general public in information dissemination of scientific discoveries and in behavioral change actions related to the conservation of food and water, the reduction of waste or recycling. There will be an **immediate value to the user community of municipalities, energy providers, engineering companies and citizens at the local level** of the three regional case studies with many concrete solutions and practices for a cleaner, greener, sustainable and resilient FWE infrastructure. Local workshops in each partner country are designed to reach out directly to at least 100 participants annually. By the end of the project, the sustainability and urban planning offices of Vienna, New York and the region Landkreis Ludwigsburg will have the capability to use the data models and visualization tools within their local planning.
The generalization of the local solutions will be studied as a function of urban density, climatic boundaries and resource availability, so that the **results can be directly transferred to cities with a similar typology**. A clear methodology and software tool set will be made available for analysis for further cities and regions. This validated and evaluated toolset allows to analyze different strategies e.g. to reduce CO_2 emissions and increase energy efficiency with the FWE system. It serves different stakeholders for fast assessment of urban planning strategies or urban infrastructure choices. Recommendations and guidelines for an integrated FWE resource management will show what regions can do for sustainable FWE management under different constraints. By the end of the project it is expected that at least 20 cities or regions work with the guidelines with at least five of them directly implementing data models and software tools. A strong communication effort to global networks such as Future Earth, JPI Urban Europe Stakeholders Involvement Platform, the Global Covenant of Mayors, the Under2MOU regions and others will support and ease the **translation and spread of methods to many regions world-wide**, contributing to the promotion of open tools for open sustainable societies.

10. Project consortium, multi-actor and trans-disciplinary collaboration, co-creation

The IN-SOURCE consortium addresses the complex FWE challenges with a multi-disciplinary research partnership from Europe and the US including engineering, geography, computational and geoinformation science (**HFT, CUNY, NYIT, AIT**) as well as social and behavioral science (**UNI-KLU** Austria and HFT psychology research).
The lead partner HFT with the experienced project coordinator Prof. Dr. habil. Ursula Eicker is a leading University of Applied Sciences in the building sector and carries out research in urban energy systems and smart city modeling. HFT Stuttgart brings in its competences in 3D urban modelling of the building stock and renewables. **CUNY** provides science-based policy support for local governments and is actively engaged with multiple NYC government agencies, especially the Mayor´s office of sustainability and companies such as the energy distributor ConEdison, providing particular strength for the New York case study. **ConEdison** operates one of the world's largest energy delivery systems with 10 million customers in New York City and Westchester County. The proposed demand response research within the waste water treatment and food cold chain is of paramount interest to them. The **New York Mayor´s office of sustainability** is responsible for the overall citywide sustainability policy development and implementation in the relevant city agencies and is highly interested in planning and decision support tools for the 2030 and 2050 strategy development. Both are associated partners to the project, providing data and analysis results. **NYIT** is actively engaged in increasing the understanding of sustainability, energy, climate change, FWE nexus and has actively convened scientists from across the globe for the FWE research agenda with the NYIT's 2010 Think Green Global Forum, the 2014 Water-Energy Nexus Conference or the 2015 FWE Nexus in Sustainable Cities Workshop. NYIT also leads the way in designing climate resilient and sustainable cities at its Urban Climate Lab. **AIT** is the largest non-university research organization in Austria and has generated the CityGML-based 3D city model of Vienna and together with HFT contributed in the development of CityGML extensions. The AIT Smart

Cities and Regions Research Group has a long experience in System Analysis, Stock-Flow modelling, GIS-based modelling and urban development simulations. **UNI-KLU** with its Institute of Social Ecology (SEC) focuses on the interactions of social and natural systems in the context of sustainable development. SEC has a rich experience in the development of concepts and indicators for monitoring biophysical aspects of economic development. It has been involved in Material and Energy Flow Accounting (MEFA) since the early nineties and contributed to develop international methodological standards at OECD and EUROSTAT. Municipal and regional stakeholders such as the project partner **Landkreis Ludwigsburg** and the associated partners Vienna and New York were chosen as major case study regions with very ambitious climate protection goals. 3D CityGML models are available in all three cities and regions for energy scenarios and will now be extended to include the water infrastructure and agricultural land use information. In an iterative co-creation workshop process, the social scientists from UNI-KLU, HFT and CUNY will moderate the vision building of the municipal stakeholders. The company partner and SME **bw-engineers GmbH** will carry out feasibility studies and develop solutions for an energy efficient water infrastructure including treated effluent reuse for irrigation in the agricultural sector with the goal to protect fresh and ground water sources.



Main roles and competences of the partners in the IN-SOURCE work program

The stakeholder co-creation process ranges from the trans-disciplinary vision building in WP 1 to large scale replication and dissemination in WP6. The case study cities and regions Vienna, New York and Landkreis Ludwigsburg will be strongly involved. The urban data modeling process with AIT and HFT´s main competences directly feeds into the software tool development and application led by CUNY. UNI-KLU´s work on social interactions has direct relevance for system analysis and feedback, case study applications and scalability of results. BW engineers´ main work relates to emerging techniques and innovation actions in the water and waste to energy and water quality for reuse (food, process water) and will have direct impact in the case studies.

11. Approximate Projected Costs and Efforts

Organisation	Country / Funding agency	Project type of partner contribution	Costs (EUR; *including overhead costs according to the applicable funding agency's rules*)						Cost share per partner (in %)	Total effort in person months per partner	Partner contribution in EUR	Requested funding in EUR	Funding rate requested (in %)
			Personnel[1]	*R&D infra-structure use*	*Costs of materials*	*Third-party costs*[2]	*Travel costs*	Total					
HFT	Germany/ BMBF	IF	411.204 €		24.000 €	15.000 €	30.720 €	480.924 €	25,87%	61		480.924 €	100%
LKR	Germany/ BMBF	I	90.300 €		15.000 €[3]	19.000 €	12.800 €	137.100 €	7,38%	18	41.130 €	95.970 €	70%
BWE	Germany/ BMBF	I	110.000 €		3.000 €		6.400 €	119.400 €	6,42%	9	47.760 €	71.640 €	60%
AIT	Austria/ FFG	IA	200.000 €		1.500 €	10.000 €	24.000 €	235.500 €	12,67%	25	35.325 €	200.175 €	85%
UNI-KLU	Austria/ FFG	IA	136.875 €		7.500 €	7.500 €	24.000 €	175.875 €	9,46%	18	26.381 €	149.494 €	85%
CUNY	USA/ NSF	IAF	284.320 €		6.839 €	10.023 €	53.922 €	355.104 €	19,10%	55[4]		355.104 €	100%
NYIT	USA/ NSF	IAF	249.023 €		44.815 €[5]	22.444 €	38.783 €	355.065 €	19,10%	20		355.065 €	100%
TOTAL			1.481.722 €		102.654 €	83.966 €	190.626 €	1.858.968 €	100%	206	150.596 €	1.708.372 €	

[1] "Personnel", "R&D infrastructure use" "Material" and "Travel": including overhead for HFT (20%), AIT and UNI-KLU (25%), CUNY (57%) and NYIT (42,2%)
[2] Including costs for the organisation of local and international workshops
[3] Licence costs for 3D urban data model
[4] Including person months for two students (graduate and undergraduate)
[5] Including costs for sensor networks and communication infrastructure

12. References

HFT has been very active in numerous national and international projects on energy and resource efficient cities (ENsource project with five large Southern German urban energy case studies, http://www.ensource.de/, **coordinator**), on demand side management of blocks of buildings (H2020 Sim4Blocks http://www.sim4blocks.eu/, **coordinator**) or on resource efficient food production (GREENFOODS http://www.green-foods.eu/). HFT new industry co-financed 5 mill. Euro project on intelligent cities covers the whole range of urban resource efficiency from urban planning, new building technology components, IT and communication infrastructure up to new mobility concepts.

CUNY has carried out numerous projects on energy and environmental engineering. The CUNY Building Performance Lab has developed energy models of NYC municipal buildings, which serve as the basis for measurement and verification of the city's retrofit program for its 4,000 building portfolio (http://www.cunybpl.org/). CUNY has also performed detailed transient modeling of the New York City Transit (NYCT) power distribution network to optimize utilization of regenerative braking energy and explores a novel communication-based power distribution paradigm https://nsf.gov/awardsearch/-showAward?AWD_ID=1640715&HistoricalAwards=false. CUNY has also researched on global urban greenhouse gas emissions and the distribution of emissions through the urban-to-rural gradient[6].

NYIT´s research ranges from its Long Island Carbon Footprint Project (2013 to NYIT's GreenPrint transportation Solutions as well the 2015 Summary for City Leaders at COP21 Climate Summit[7] and the upcoming book Climate Change and Cities (2017)[8]. NYIT has been building a collaborative sustainability research platform with partners, such as our Eco-Partnership on Water Monitoring, Protection and raining with Peking University or the "Pathways to Cleaner Production" partnership with seven universities in Latin America. (https://ecopartnerships.lbl.gov/partnership/nyit-pku)

AIT has a long experience in GIS-based modelling, urban planning and energy planning, developing and providing tools for "Smart Cities and Regions Research Field" in various projects (http://www.ait.ac.at/en/research-fields/smart-cities-and-regions/projects). In the "Urban Infrastructure Development Simulator" project (UIDS-URBANICA) a tool was developed able to perform urban growth simulation and related infrastructure cost estimations ((http://www.ait.ac.at/en/research-fields/smart-cities-and-regions/projects/UD_InfraSim/). In the Austrian Carbon Balance Model (ACBM) a comprehensive description and analysis of all carbon stocks and flows was developed with the five main parts Agriculture, Forestry, Energy, Production and Waste.

bw engineers organizes and coordinates a consortium of consulting engineers in Germany and has carried out numerous projects in water and environments engineering, such as the Design-Build of Improvements to the Airport-1 Wastewater Treatment Plant (Airport-1 WWTP) in Jeddah City, 2015-2016, Comprehensive stormwater drainage and flood protection masterplan including hydrologic and hydraulic model and design work for the city of Riyadh, 2010-2013 or KWISS – the Waste Water Treatment plants information system of Stuttgart, 2003-2012.

UNI-KLU (SEC) works in interdisciplinary projects on the conceptualization and quantification of land use intensity analysing socioeconomic constraints, feedbacks, and thresholds, from top-down macro perspectives as well as applying bottom-up approaches, spanning a wide range of spatio-temporal scales (projects LUISE, BACI and Global HANPP http://www.uni-klu.ac.at/socec/eng/inhalt/1170.htm, http://baci-h2020.eu/index.php/) Sustainable urban development is further focus where a more sustainable resource use on city level is addressed (projects UTE https://www.aau.at/ute/, SUME https://campus.aau.at/cris/project/-0f4dc44845ae29440145b1a5c53230ae?lang=en).

[6] Marcotullio, Peter, Andrea Sarzynski, Jochen Albercht, Niels Schulz and Jake Garcia 2013 "The geography of global urban greenhouse gas emissions: An exploratory analysis", Climatic Change 22(4): 944-958

[7] Nada M. Anid and Marta Panero;" NSF FEW Workshop Food, Energy, and Water Nexus in Sustainable Cities" Synthesis Report to the National Science Foundation. http://www.nyit.edu/files/special_events/FEW_WorkshopSynthesisReport.pdf

[8] Available online at: http://www.cambridge.org/gb/academic/subjects/earth-and-environmental-science/climatology-and-climate-change/climate-change-and-cities-second-assessment-report-urban-climate-change-research-network?format=PB&isbn=9781316603338