TRANSITIONS TO THE URBAN WATER SERVICES OF TOMORROW

Final Report

Executive Summary

Project Context and Main Objectives

Main S&T Results

Potential Impact, Dissemination and Exploitation of Results

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Final Report

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Preface and a note to the reader

After 48 months of collaborative work, TRUST has delivered outputs as per the Description of Work (DoW), thanks to the fact that collaboration among the project partners is both widespread and meaningful, and thanks to our partners in the cities / utilities who have provided data and engaged with the project's ambitions.

This report gives a comprehensive overview of the project context and objectives, its main S&T achievements, the potential impact and our activities and plans for dissemination and exploitation of results. Throughout the text there are references to actual outputs of the TRUST project in terms of contractual deliverables. In addition to the contractual deliverables, there are much more results and reports available that have been delivered by the TRUST project. The following note explains where this material can be found (e.g. for reviewers or members of the Project Advisory Committee).

NOTE:

In addition to the official deliverables, TRUST has produced a number of reports and results related to specific tasks or milestones of the project. Documents classified as "public" in the Grant Agreement are published at the project website. (www.trust-i.net).

A complete repository of results and reports stemming from Deliverables (D), Tasks (T) and Milestones (MS) of the project can be found at the Intranet of the TRUST project. The intranet contains a browsable structure of the project with all its work packages, tasks, deliverables and milestones (http://project.trust-i.net)

This intranet repository is accessible for (i) project partners ,(ii) commission services, (iii) reviewers appointed by the commission, and (iv) members of the Project Advisory Committee (registration procedure required).

For registration and access to the TRUST intranet, please contact info@trust-i.net.

EXECUTIVE SUMMARY

Supplies of clean drinking water and safe water sanitation are at risk from a number of different factors. Climate change, pollution, demographic change and ageing infrastructure are putting strain on urban water services. Sustainable solutions to these challenges must take into account rising energy prices and the pressing need to reduce emissions, as well as consider long-term investment scenarios, while securing adequate levels of service to users The TRUST project was aiming to support the transition of urban water services and their management to provide utilities with new confidence to draw up and introduce innovative and sustainable solutions.

Transition to more sustainable urban water services requires a couple of elements. First, it is key to develop a clear understanding how sustainability of urban water services can be defined and assessed. Second, the actual transition planning involves several steps such as diagnosis (where are we now?), vision (where do we want to go?), analysis (what is needed to get there?), technology & management options (what can be done?), prediction (what happens if?), decision-support (which option is the best one?) and finally the acceptance by decision-makers and stakeholders.

TRUST has developed a portfolio of solutions, tools, guidelines, software and training material for all of these steps, and has demonstrated their feasibility and usability in ten participating city utilities across Europe.

As one of the first steps, a definition and comprehensive assessment framework for sustainability of urban water services has been developed. This has been transformed also into tools for diagnosis of the current and future status, ranging from tools for a very quick scan ("Blue-City-Index®") to more complex web-based self-assessment tools for sustainability in general and financial sustainability in particular. To support the development of a clear vision and strategic planning, a roadmap methodology and guideline have been developed and applied with the city utilities. They also considered stakeholder involvement and an analysis of public perception and forms of governance. Innovative modelling tools (e.g. a "metabolism model" WaterMet^2) were developed that enable an assessment of the impact of interventions on the overall performance and sustainability gains of an urban water system. TRUST also assessed and demonstrated emerging technologies for, among others, optimised water treatment, water reclamation schemes for non-potable-use, sustainable water demand management, storm water disconnection, energy-saving options and water-energy interventions.

Another focus area of TRUST has been the development of improved tools and guidance for infrastructure asset management. This has been addressed by (i) development and demonstration of mobile technologies to support asset maintenance & repair and demonstration of a new technology for pipe-scanning, (ii) software modules and tools for asset management, complementing an existing portfolio of tools delivered by a previous award-winning project (Aware-P).

Finally, a range of integrated tools and guidelines have been developed that put the different management and technology solutions into a common framework and provide guidance to different user groups (policy makers, management and technical staff of the water sector) how to plan and start the transition process by using the TRUST portfolio.

To ensure a proper dissemination and impact of TRUST results, the main results have also been transformed into manuals of best practice for different target groups, e-learning materials (online available for free) and the basis for a one-year post graduate curriculum on sustainable management of urban water services.

In summary, TRUST has provided participating cities with clear individual roadmap towards more sustainable and effective urban water systems, and delivered a supporting portfolio of demonstrated technology and management interventions and tools.

1. PROJECT CONTEXT AND MAIN OBJECTIVES

The central objective of TRUST was to deliver co-produced knowledge to support TRansitions to the Urban Water Services of Tomorrow, enabling communities to achieve a sustainable, low-carbon water future without compromising service quality. TRUST aims to deliver this ambition through research driven innovations in governance, modelling concepts, technologies, decision support tools, and novel approaches to integrated water, energy, and infrastructure asset management. Figure 1 illustrates the main objectives and primary features of the TRUST strategy.

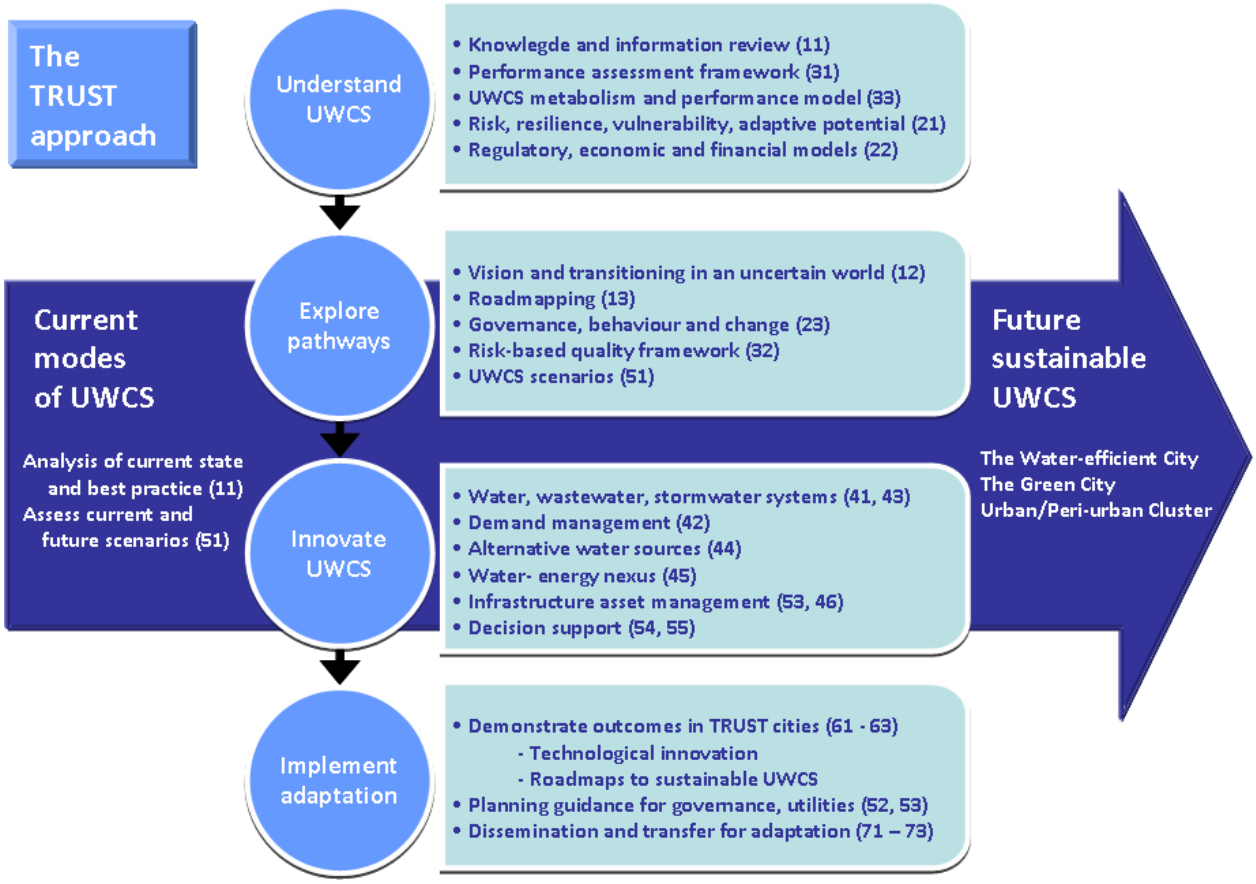

Figure 1 The TRUST approach. Numbers in parentheses refer to TRUST Work Packages

The first step was to provide a consolidated description of the state of the art in Urban Water Cycle Services (UWCS), develop a clear understanding how sustainability of urban water services can be defined and assessed, and to present a roadmap methodology enabling UWCS to plan and realize a future vision of resource-efficient, high-performing, and resilient UWCS. The development and articulation of these pathways and the exploitation of opportunities for near future interventions were the core elements of TRUST, as illustrated

in the vertical structure in Figure 1. To achieve this, TRUST delivers an extended understanding of the performance of contemporary urban water services, providing a platform for defining bottlenecks and potentials for improvement – the pathways. This comprised comprehensive analysis tools to assess the impact of measures on the overall performance of UWCS and in particular on their sustainability. A number of emerging technologies as well as new models and concepts were analysed to assess their capability to support sustainable, low-carbon urban water futures. The most promising interventions were implemented and tested in the urban water system of one or more participating end users. In order to facilitate the selection, implementation and dissemination of promising new management and technology options, TRUST also aimed to deliver integrated guidelines, sector-specific education materials and software tools (e.g. decision support systems) to be used by decision makers ranging from national and regional policy-makers to utility CEO, asset managers and UWCS operators.

The detailed objectives of TRUST were as follows

Work Area 1 – Diagnosis and Vision

The main objectives of WA 1 were to enable and perform an initial assessment of the urban water situation in Europe, to provide methodologies and tools to enable water utilities to develop a specific vision for their more sustainable future, and to develop a roadmap methodology that enables water utilities to carry out the necessary strategic planning.

Work Area 2 – Policy, Financing and Society

The objective of Work Area 2 during the TRUST project was to support the development and assessment of adaptive potential in the governance and socio-economic regimes that shape urban water provision. Existing physical and institutional infrastructures are, by their very nature, conservative and resist change. A step change is urgently required in the capacity of the water sector to respond to contemporary challenges, one which requires a deeper understanding of how innovative solutions are generated, evaluated and embedded in existing systems. In practical terms, the contractual objectives of WA2 were to deliver policy briefs for water management practitioners, a Financial Sustainability Rating Tool (FSRT), a Self-Audit Adaptive Potential Tool (APSA), 'advice to water management practitioners on competition, efficiency and new business opportunities', and a conceptual 'model of sustainable and stable water governance arrangements' – to help improve the resilience of water distribution agreements. The overarching purpose of these objectives was to offer water sector organisations a way to understand and prove their capacity to be adaptive - so they can learn more from their experiences and adjust management practices as a result of what is learned.

Work Area 3 - Analysis Tools

The objective of this work area was to develop, according to state-of–the-art systems analysis approaches, tools for metabolism analysis and systems performance evaluation of the urban water cycle services (UWCS). This was done by taking into account the economic, social and environmental boundary conditions of the urban water systems, and examining in detail the technical functions of the water services, including the physical assets and key activities and technologies of each subsystem of the urban water service system This forms the basis for quantifying resource consumption inputs, waste and emission outputs, and risk issues, in order to document the present and possible future overall system sustainability performance (economic, environmental, society). Such and understanding is essential in order to establish sustainable future policy for UWCS.

Within this general objective, the aim was to develop and deliver comprehensive analytical tools for metabolism analysis and system performance evaluation, which can be used to assess the impact of technology or operational measures on performance of the urban water cycle services (UWCS) in terms of sustainability.

This needed to be built on the definition and evaluation framework for 'sustainability of UWCS' developed in close interaction between WA 1 and WA 3. The scope of the analytical tools was to cover economic, social and environmental boundary conditions of the urban water systems, and examining in detail the technical functions of the water services, including the physical assets and the key activities and technologies for each subsystem of the urban water service system. This should enable decision makers to test the effect of alternative 'possible' and 'realistic' options on the metabolism of a certain UWCS.

The current state as well as any changes in a given UWCS also entail certain risks (e.g. of failing to achieve sustainability targets) and therefore the development of a risk-based framework as a complementary module for the metabolism model was also among the objectives of WA 3. Finally, an additional objective of WA 3 was to carry out a first test of the analytical tools by a 'model' city, inspired by city of Oslo.

Work Area 4 - Technologies and Operational Options

The main objective of WA 4 was to develop technologies and operational options to enhance urban water systems by providing new tools, methods and models for the planning, implementation and operation of enhanced urban water systems. The investigated intervention options were to cover the entire urban water cycle from water supply via water use to wastewater disposal and water reuse, also considering cross-cutting issues such as the energy-water nexus and the aspect of integrated infrastructure asset management. And they will address challenges driven by climate change impacts, ageing infrastructure and efficiency ambitions. All these had to be carried out with a strong focus on the actual needs of the TRUST pilot cities and the end-users involved in the project.

Work Area 5 - Water Policies and Integrated Tools

During the first reporting period, WA 5 had developed the framework for later integration of results from other Work Areas into a coherent suite of TRUST products (guidance and decision-support tools, manuals of best practice, integrated software and training courses).

During the second reporting period (after other Work Areas started to actually deliver first results for further processing), the objective of WA 5 was to develop general-use integrated approaches and planning support tools aimed at the transition from current status to the desired sustainable urban water cycle services of tomorrow. The integrated approaches developed both at the regional / national level and at the utility level, will seek a long-term asset management (AM) view that balances performance, risk and cost, and takes into account social and political acceptance. The development work aims at empowering policy makers and water utilities, in the widest possible range of contexts, with access to a comprehensive, integrated portfolio of guidance and decision support tools, including manuals of best-practice, software, curriculum for postgraduate a course and e-learning materials.

During the third reporting period, a broad number of products were developed or finalized: (i) A web-based tool to support roadmapping of urban water services – a tool that is at the same time an ideal means to navigate within the whole of TRUST deliverables. This tool is accompanied by a detailed report; (2) a series of manuals of best practice to support planning of urban water services, covering a broad spectrum of topics, including general guidance, guidance on UWCS planning and management for policy-makers, guidance on strategic planning for utility managers and tactical planning for utility managers and other decision makers; (3) a decision support tool based on a metabolism model; (4) an e-learning course on infrastructure asset management; (5) the curriculum of a post graduate course on urban water cycle services; (6) final polishing of the TRUST/AWARE-P software platform and preparation of user guidance materials ("How to" and tools "Quick start"s).

Work Area 6 - Demonstration and Implementation

Work Area 6 was established to make and sustain connections between knowledge institutes and water utilities and between researchers and professionals around Europe. Throughout the project, it successfully deployed three instruments towards this aim. Firstly, it set up and ran roadmapping processes with each of the ten city utilities participating in TRUST. These processes were designed following the TRUST roadmap guidelines, which in turn were adapted to the specific needs of cities and regions in mind. Where possible and desired, TRUST tools were tested and/or demonstrated in situ as part of these processes. They have resulted in strategic roadmaps that support city utilities in realizing their long terms visions of UWCSs. Secondly, several Cities Platform Events and Regional Workshops were organized, in places such as Athens and the Algarve. Whereas the roadmapping

processes were meant to develop individual and contextualized roadmaps towards sustainable UWCSs, these events stimulated the exchange of insights and learning between city utilities participating in TRUST. Lastly, the Train4TRUST initiative enabled city utilities to be trained in some of the tools and instruments developed in the project. This helped translating generic outputs from TRUST into outcomes 'on the ground', in cities.

Work Area 7 - Dissemination and knowledge transfer

The main objective of WA7 was to produce and develop the most adequate tools and channels for an effective project communication. In order to achieve these broad objectives, it was envisioned that all project results should be post-produced to convey a sense of quality in their appearance that would match the scientific quality of the research that led to the results being presented. As a result, a professional and recognizable brand had to be developed, a very comprehensive website with both public and private sections to be tailor-made for the project and each deliverable was post-produced to make its communication more effective and appealing.

In addition to these project-wide tasks, WA7 was in charge of individual communication actions in which it targeted through events the communication with collaborating cities and the technical community through the final project conference.

2. MAIN S&T RESULTS/FOREGROUNDS OF THE PROJECT

2.1. Work Area 1 – Diagnosis and Vision

WA 1 intended to provide an overall snapshot assessment on current UWCS in Europe. The main objectives were to understand the current status of UWCS, defining a future vision for UWCS, designing a path towards the vision and ensuring a successful transition pathway. In order to achieve these objectives, the planning process should incorporate a roadmap to guide current actions towards a more sustainable future.

Over the curse of the first 18 months of the project, the activities planned for WA 1 were successfully completed. During this period, several outputs were achieved, such as, the "Baseline assessment of the sustainability of the urban water cycle services (UWCS) in cities" (D11.1c) based on a questionnaire (D11.1b) involving a set of cities including the pilot utilities that are project partners, or a roadmap template and guideline developed to be used in WA 6 (D13.1). An important progress was the debate around a practical definition of sustainability for UWCS and how it can be assessed. This joint activity of WA1 and WA3 resulted in a consensus document defining a framework on how to define and assess sustainability of UWCS (included in D31.1, cf. WA 3). We consider this as a valuable output of the TRUST project, which also helped to shape further activities of the project and beyond.

Key results of this work area include:

- A state of the art review publication of UWCS - 'what works', preferred options and best practice, with a specific focus on the topics of demand management, reuse & recycling, water & energy and leakage and loss reduction (D11.1a).
- A questionnaire for a quick-scan to make a first assessment of the sustainability of urban water services. (D11.1b)
- An application of this quick scan to the city utilities that are partners in TRUST (D11.1c). This application and the analysis of the results provided an important starting point for many subsequent activities in TRUST.
- An analysis of major urban change pressures and future trends in urban water services, and how they affect in particular the TRUST pilot cities (report T12.1).
- A review on flexible UWCS and transitional pathways (report T12.2).
- Guidelines for urban water strategic planning, based on the best European practices (D12.1)
- The Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems (D13.1). This provides a description of how transition planning efforts in Urban Water Cycle Systems (UWCS) can be organised by a roadmap approach, it offers guidance throughout the whole process and offers templates to support the roadmap working process. This roadmap guideline illustrates diverse aspects in water supply and waste water management in terms of the five TRUST sustainability dimensions: social, environment, economic, governance and assets. This manual has been designed for direct practical use in TRUST and for organising sustainable UWCS planning in general. This result has been instrumental for shaping the demonstration activities in TRUST, because it has been applied in all TRUST city utilities throughout the demonstration activities carried out by Work Area 6. In fact, the individual roadmaps developed for each TRUST city utility defined the framework for most of the actual demonstration activities within TRUST, but also provided the TRUST city utilities with a long term strategic roadmap that goes beyond the lifetime of the TRUST project. The roadmap guideline is the first manual developed for practitioners taking into account the roadmap methodology, and provides a generic understanding of the roadmapping process and structure. The manual offers users the opportunity to apply qualitative and quantitative information from different sources. If performance indicators are applied, selected IWA performance indicators for drinking water and wastewater will be integrated in the TRUST roadmap approach. The guideline also discloses a creative process for an interdisciplinary planning procedure.

2.2. Work Area 2 – Policy, Financing and Society

Much of our early work in WA 2 was concerned with developing and communicating a solid theoretical foundation for understanding the social, political and economic governance of urban water systems – both the existing frameworks and their potential for change. Our chief accomplishment in the first 18 months of the project was the organisation and execution of stakeholder consultation workshops in Oslo, Lisbon, Edinburgh and Hamburg. These events were both well attended and valued by a range of stakeholders. Whilst each event explored a different, but locally important, agenda, the workshop outputs provide a fascinating glimpse of the challenges being faced in each region and the opinions and preferences of the major stakeholder groups. The evidence emerging from the workshops together with our report on 'Contemporary Thinking on Risk, Resilience and Vulnerability' was shared with other TRUST WAs and used to inform subsequent WA2 deliverables.

The other highlight from the first 18 months of the project was a suite of industry focused reports which the WA team authored. Our reports on 'Carbon Sensitive Urban Water Futures' and 'Contemporary Water Market Structures and Regulatory Frameworks' address topics of immediate concern to water providers. They draw on a mixture of literature, informed expert opinion, and comparative analyses to create a detailed picture of not only the current state-of-the-art but also the options for future intervention, innovation, and change. These reports were positively received by the European water community, providing a thoughtful but practice oriented overview of two important concerns for water utilities. Finally, with the ambition of informing the development of messaging around proposed water management interventions, we delivered a set of policy briefs for water management practitioners, which highlighted reactions to and views on specific water management interventions in different contexts. These early contributions were highlighted on both the TRUST website and disseminated through other routes (e.g. the IWA waterwiki and the edie environmental web site), creating interest and enquiries from utilities across Europe.

In the next stages of the project, much of our work was concerned with synthesising the theoretical foundation for understanding the social, political and economic governance of urban water systems, developed during the work detailed above, in order to provide practical, informed and valuable recommendations for urban water systems. A key result in this regard was the production of practical tools: the (1) Financial Sustainability Rating Tool (FSRT) for urban water systems; and the (2) Adaptive Potential Self Assessment (APSA) Tool for urban water stakeholders. Whilst each tool provides a different function, both tools were produced in response to the challenges being faced in urban water systems and the opinions and preferences of the major stakeholder groups that were consulted during their development. The FSRT offers water supply and/or wastewater removal companies an opportunity to rate the utility's financial sustainability. The APSA tool offers water sector organisations a way to understand and improve their capacity to be adaptive so that they can learn more from their experiences and adjust management practices as a result of what is learned. The APSA tool was presented at the TRUST Cities Platform Event in Athens, Greece in November 2013 and was well received. As a result, we made the tool publically available. The user output from both of the tools was collated and used to inform subsequent WA 2 activities.

Another outcome at this second stage of the project for WA 2 was the industry-focused report that the WA 2 team authored, titled 'Risk, vulnerability, resilience and adaptive management in the water sector'. This is now available externally (at the public project website). The report addresses topics of immediate concern to water providers. It presents a synopsis of current thinking in the literature and the models, tools and techniques used in the application of the concepts of risk, vulnerability and resilience. This report was not initially planned for disseminating to an external audience but feedback from a previous task in Work Package 21 led us to its production. Such WA 2 contributions were highlighted on both the TRUST website and disseminated through other routes (e.g. the TRUST Cities Platform Event and the 2014 IWA biennial Conference & Exhibition). In addition, a large dissemination package of a TRUST suite of tools (encompassing the: (1) FSRT for urban water systems; (2) APSA tool for urban water stakeholders; and (3) Self-Assessment Tool Based on UWCS Performance Measures) was created in collaboration with Work Area 7 as all three tools are assessment tools available for the same target audience.

In the final stages of the TRUST project, WA 2 completed major activities and delivered several significant outputs. An important result was the production of two publically available deliverables. The first deliverable (D22.2), 'Advice to water management practitioners on competition, efficiency, and new business opportunities', sets out to help identify the current level of efficiency within utilities as well as provide concrete measures for efficiency improvement. Special focus is placed on the role of business niches as well as on the possibilities of implementing business innovations. The second deliverable (D23.2), 'Improving the resilience of water distribution agreements', sought to develop a conceptual model of stable water governance arrangements, allowing water service companies and regulators to improve the resilience of water distribution agreements. This output was driven through a formal analysis of competing theories and informed by relevant historical case studies, which allowed us to develop and stress test a conceptual model of stable water governance arrangements. A concept to help water managers and regulators develop fit for purpose water governance arrangements where (i) resource availability is highly variable, and (ii) there is rapid change in the nature of demand (uses, qualities etc.) is proposed.

During this time, WA 2 also produced a conference paper on 'Risk, Vulnerability, Resilience and Adaptive Management in the Water Sector' (based on Task 21.1) for the 2014 IWA biennial Conference & Exhibition in Lisbon, Portugal, This was well received at the event and generated much interest from parties external to TRUST. Additionally, a seminar on 'Understanding and Improving Organisational Adaptive Capacity in the Water Sector' (based on D21.2) was given at the 2014 Royal Geographical Society (RGS)-IBG Annual International Conference in London, UK. A further presentation, 'Lessons Learned in Designing Web-Based Support Tools for Urban Water Management' (based on D22.1 and D21.2), was delivered at the 2015 IWA Cities of the Future Conference in Mulheim, Germany. Finally, a Train for TRUST workshop and Brokerage Event on the Adaptive Potential Self Assessment (APSA) tool were held at the 2015 IWA Cities of the Future Conference in Mulheim, Germany on April 28th 2015.

2.3. Work Area 3 – Analysis Tools

This work area has been set up to support the ultimate outcome of TRUST with respect to planning tools to reach more sustainable urban water cycle systems. As a starting point for the development of analysis tools and for the main activities in TRUST in general, a comprehensive definition of sustainability has been worked out in a co-operation between researches of WA1 and WA3. This definition counts on the three traditional dimensions of sustainability, namely the social, environmental and economic. In the TRUST definition, this is extended by including the main resources that are crucial for water services, namely physical and organizational assets and governance systems. A set of criteria and indicators corresponding to the dimensions have been defined. This definition forms the foundation of all activities in TRUST that by the end leads to the decision support system (in WA5). Thus the definition and the DSS frame the other activities in WA3 and in the rest of TRUST.

UWCS performance assessment framework

The goal of WP 3.1 was the development of criteria for performance assessment to be used in the succeeding WP 32-34 and TRUST in general. In particular a very simple online self-assessment tool were brought forward to help determine whether a certain service/utility/city was in line with the 2040 objective defined by TRUST main vision.

To some extent, the self-assessment tool was conceived as an entry point to the project for stakeholders (mainly service providers) outside TRUST. Its key ambition was to be a simple tool that utilities could use to perform an initial diagnostic on their sustainability as a whole with a simple and relatively short process. As a result, the self-assessment tool is considered as much a technical tool for a preliminary diagnosis as a communication tool to present the TRUST concept and results to interested stakeholders. Further, it enables users to make a quick scan of their current situation as a basis for more extensive analysis by for example the metabolism models.

Early in the TRUST project it was identified that there would be the need to measure performance and assess sustainability across the different project work packages. In order to ensure coherency between the works developed in the different packages, it was agreed that the team from WP31 should play a fundamental role in developing two tasks that differed from the works envisioned in the DoW. The team developed a comprehensive framework to assess sustainability within TRUST that should be used by all other teams in the project to develop the performance measures necessary for their specific tasks.

The development of a project-wide performance assessment framework that is designed to assess the sustainability challenges of UWCS is a significant result that can certainly be used beyond the scope of TRUST.

Risk-based quality management of the water service functions

Risk assessment is applied to control risks related to a change to a given system and in a given period of time. The risk has been identified as those circumstances that impact on sustainability objectives as set in WP31. The specific objectives are as follows:

- Define the system and associated hazards
- Develop the conceptual risk framework for the generic city and connected to the conceptual urban metabolism model
- Develop the quantitative risk framework for the generic city and associated to the quantitative urban metabolism model to be tested in WA 6.

The basis for the conceptual risk assessment in the urban water cycle was presented in the milestone document MS25 *Conceptual metabolism risk-controlled model as a basis for quantitative computing*, and finally in deliverable D32.1 *Metabolism risk-controlled model*. It explains the concept of risk as developed in the context of sustainability analysis and introduces the most appropriate risk assessment techniques for risks of not being sustainable in the urban water cycle. The study required a new risk conceptual development due to the characteristics of the analysis that has to be done at the strategic, macro level, using an integrated systems approach. Therefore the methodology presented differs from the traditional one. Instead of working with events (for instance an "accident" or a "failure"), the proposal to analyze risk is to use a set of scenarios, each set corresponding to a type of circumstances influencing the sustainability criteria. Fault tree are developed for that purpose. The focus is on estimating the probability of the hazardous event identified that has the potential to impact on the set objectives. A hazard identification database in excel format has been developed to accommodate all identified risk events and facilitate the dialogue with the metabolism models (WP3) to identify the data, input/output flow between the metabolism and the risk analysis; secondary to establish a connection with the multicriteria analysis that forms the basis for the TRUST DSS (WP54). The work was linked to the case study of Oslo.

Development of the metabolism-based UWCS performance model

The objective of this WP is to develop metabolism-based models for assessing the performance of an urban water system with focus on sustainability related issues under existing and a range of possible future conditions and scenarios. The principal model was named the WaterMet^2 model (where 'Met' stands for both metabolism and metropolitan hence '2'). The WaterMet^2 model enables analysis of principal flows of water, energy and materials in the UWCS in the past, present and future. All this, in turn, enable quantifying a number of different indicators such as operational and maintenance costs, any risk and intervention assessment over some planning horizon.

The development of WaterMet^2 included several steps

1. Scoping the problem of a metabolism in a generic city (task 33.1)

This task introduced the system definition and scoping of the UWS metabolism model which is treated as input for later tasks. The UWS includes five subsystems: 1) the water supply subsystem, 2) the water demand subsystem, 3) the wastewater subsystem, 4) the cyclic water recovery subsystem, and 5) the resources recovery subsystem. The metabolism model covers all three aspects of sustainability (social, economic and environmental) upon physical metabolism performance indicators. Aspects of technology, management and information are seen as elements of today's system, or elements of future sets of interventions. The metabolism model does not deal with operational level decision-making. It aims to support strategic decision-making, with the time horizon towards year-2040. The tactical planning horizon (4-5 years) will of course influence the choice of interventions in the near future, on the basis of today's external and internal boundary conditions.

2. Conceptual UWCS metabolism model (task 33.2)

This task developed the conceptual UWS metabolism model for a generic city by using the information scoped in the previous task. The main components and processes considered in the UWS are: (1) water supply and distribution; (2) water demand; (3) wastewater and (4) cyclic water recovery and resource recovery. The elements that are modelled in the water supply and distribution system are: (1) raw water sources; (2) WTWs, (3) service reservoirs; (4) principal flow 'routes'. The key elements modelled in the wastewater system are: (1) principal wastewater/storm water flow 'routes'; (2) CSOs (and storm tank overflows), (3) WWTWs and (4) recipient, i.e. receiving water (only as a 'sink' point). In addition, the UWS is characterised using four different spatial scales together: (1) indoor area; (2) local area; (3) subcatchment area; and (4) city area.

3. Conceptual UWCS performance model (task 33.3)

This task developed the WaterMet^2 model as the conceptual UWS performance model for a generic city by extending the conceptual metabolism model developed in the previous task with the relevant performance criteria. WaterMet^2 is also used for the development of risk assessment models (WP32) and it was part of the decision support system for the long-term planning of UWCS (WP54). The WaterMet^2 model simulates the urban water flows using a simplified, mass balance approach, starting from the water resources and ending to the receiving water bodies. The WaterMet^2 model uses daily time step (or aggregated steps as defined by the user) to simulate the UWS performance for a period of N years. Both aspects of water quantity and quality modelling are quantified by the WaterMet^2. The WaterMet^2 model analyses several principal flows in the UWS components as: (1) water flows, (2) energy flows; (3) greenhouse gas emission (GHG) flows; (4) material flows; (5) chemical fluxes; (6) pollutant flows. These flows are modelled whenever generated, rehabilitated, consumed, replaced and are aggregated temporally and spatially within components, subsystems and city area.

4. WaterMet^2 data acquisition and metabolism model in parallel (task 33.4)

The aim of this task was to carry out in-depth UWCS metabolism and performance model analysis of one city as a model city as an integrated and iterative research and development process with task 33.3. Oslo was chosen as pilot for this purpose.

Data collection started already by project upstart. A series of meetings were held with Oslo municipality. A significant part of data needed to populate the model has been achieved from Oslo.

In parallel, NTNU has designed a an Excel based model – the Dynamic Metabolism Model (DMM) - to document the flows and stocks of materials and chemicals, energy consumption and the environmental impacts associated with the operational phases of the different sub-systems of the water utility. It is proposed that this is amenable for use along with WaterMet2.

UWCS performance analysis and evaluation of Oslo as model city

The objective of WP34 in the third period was to use models to understand the impact of interventions in a perspective towards year 2040 for the pilot city Oslo. The two metabolism models, WaterMet2 and DMM were enablers of the investigation. They are both mass-balanced based with some differences in structure and outputs. They use recorded data and convert them into suitable metrics or indicators.

Several combinations of four upstream and two downstream interventions were tested. The upstream interventions comprise reduction in per-capita demand, leakage reduction, installation of micro-turbines and introduction of a new water source. The downstream interventions included upgrading and changes to the wastewater transport system and upgrading of investments at BEVAS WWTP (one of the two main wastewater treatment plants in Oslo).

The impact was calculated as changes in GHG emissions per capita for different combinations of interventions, and further as change in capital expenditure per capita, fraction of water demand fulfilled in Oslo and effect of rehabilitation of water network on water demand.

The authors received feedback from Oslo water and wastewater utility about their experiences with using and opinions about the two models. Both WM2 and DMM models were used to evaluate the sustainability for various alternative strategies for water supply in the city in the future.

2.4. Work Area 4 – Technologies and Operational Options^

The WA4 activities delivered a number of new insights into scheme operation and advice for their optimised operation with respect to improved sustainability scores. The achievements for the different parts and aspects of the urban water cycle are summarised below.

WP41 was devoted to the optimization of **water supply systems** and development of diagnostic tools and methods for optimal management and operation procedures in terms of safety and sustainability/resource-efficiency. Based on work on the ground at three water utilities an **optimization framework** was proposed encompassing:

- Mapping operational performance status that includes initial performance evaluation and comparison to model predictions.
- Utilizing diagnostic tools, *e.g.* for water quality characterization that also helps identification of variations in the performance.
- Utilizing curative tools that includes performing experiments and trials without compromising the water quality produced.
- Utilizing decision support systems to highlight some other aspects *e.g.* economic and environmental issues that are not covered by the diagnostic and curative tools.
- Identifying performance optimization potentials and possible benefits.
- Implementing selected operation conditions based on overall assessments of potential advantages and disadvantages for both treatment and distribution systems.

The results demonstrate the applicability and benefits of the applied diagnostic tools, including treatment process assessments, optimization efforts, NOM fractionation, BDOC, and LCA. The results support the fact that LCA that are not based on local conditions can provide misleading results. The results also show the benefits of applying local optimization trials and internal, rather than conventional, benchmarking procedures that are well adapted to the site-specific nature of source waters, treatment facilities, distribution systems and operator staff.

In the area of **water demand management** we were aiming at developing novel techniques for the effective and efficient reduction of water consumption within WP42. A core output is the "Guidance on evaluation and selection of sustainable water demand management technologies" based on reviews of different WDM technologies and methodologies developed in the project. The WDM interventions considered in the report have been evaluated largely based on the their overall water saving potential, cost-effectiveness, water-related energy use as well as impact on the reliability of supply/demand balance of Water Distribution Systems (WDSs).

The **problem of leakage reduction** was addressed by the application of a new methodology based on integrated energy and pressure management optimization. The applied methodology demonstrated how the integrated process results in both leakage reduction

and direct and indirect energy savings as a consequence of the optimal pump scheduling and valve actuation delivering pressure reductions across the network.

In lowering the environmental impact of **wastewater as well as storm water collection and treatment** we performed a comparative benchmarking between wastewater treatment plants using the PAST tool developed by a partner. This way optimisation potential for special treatment process steps could be identified.

Combined sewer spills during heavy rainfall events cause detrimental effects on the quality of receiving waters. Managing such overflows by appropriate infrastructure, such as storage and treatment, is both challenging and potentially costly. The application of **two kinds of modelling methodologies and tools** aimed at facilitating this process:

- estimating the disconnection potential of stormwater from sewers using a suite of GIS based info and the hydrological model STORM. A core measure in this approach are Sustainable Urban Drainage Systems (SUDS) that help to retain and treat stormwater decentrally.
  The model was fully adapted and applied for the case of the Hoffselva catchment (Oslo, Norway) where we were able to identify spatial distribution of SUDS in a catchment and to quantify the effects of such disconnection on the behaviour of combined sewer overflows (CSO).

An assessment of the measures with respect to their sustainability dimensions was performed by the modelling tool ADAPT

- The effect of incorporating SUDS in urban drainage was assessed by another tool developed in the project: **ADAPT (A Drainage Analysis and Planning Tool).** which offers the possibility of a multi-objective optimisation having regard to asset size optimisation and cost analysis. The tool is based on the use of optimisation of a range of possible options to achieve a stated set of performance criteria. Improvements to the drainage system can be effected by either making changes to the network assets (pipes and storage tanks), and removal or modification of the runoff from paved surfaces .
  The tool has been applied to the small steep catchment of Hoffselva in Oslo. The catchment has problems associated with both flooding (58 known basement locations) and pollution in the two small watercourses from 21 overflows from the combined sewer system. An Infoworks CS model has been built (10km2 and 2200 pipes) and verified, before being used to analyse the system behaviour and evaluate options for meeting performance requirements. The results demonstrate how the performance requirements might be achieved and confirms the capabilities and effectiveness of the tool.

Exploring the potential of alternative water resources to contribute to more sustainable urban water cycle systems, we focused on pilot city studies. Experimental and conceptual work was carried out particularly in the water scarcity cluster cities, Madrid, Athens and Lisbon, encompassing

- Plant audit for inland desalination plant in the pilot city Madrid pointing out potential for optimized energy regime and a perspective for zero liquid discharge operation
- More than one year pilot-testing of ceramic membranes for post treatment of treated effluent for reuse at different wastewater treatment plants in Lisbon using microfiltration as well as ultrafiltration membranes
- Research programme on water recycling roadmap for Athens quantifying the scope of additional water resources availability under different development scenarios. Suggested options haven been taken up by the utility to be investigated in an additional internal study on alternative sources of water vs different uses for the existing water resources.
- Definition of key performance indicators and development of a framework to assess sustainability gains of various options compared to conventional solutions or no acting, and their summary in as Good practice recommendations.

Exploring the **Water-Energy Nexus** was a key endeavour of WP45. The work was successful in delivering intervention concepts for energy saving, recovery and power generation from the urban water cycle system (D45.1). We identified numerous options for energy measures in the water sector ranging from water conservation and process efficiency improvements to new technologies and redesigning water systems. Next to energy efficiency improvements, there is a need for new concepts in which water is viewed as a carrier of energy. Municipal wastewater is a potential source of chemical energy, i.e. organic carbon that can be recovered as biogas in sludge digestion. Even more so, domestic (waste)water is a source of thermal energy. And in areas with altitude differences, installing micro-hydro technologies in water distribution systems can convert energy from the pressure and flow into electricity. At 9 case studies, intervention concepts for energy saving, recovery and generation from the urban water system have been researched. Summarised, the main outcomes of the research are:

- Algarve and Alcoy water supply system: by performing an energy audit, the most energy efficient operating scheme can be determined.
- Oslo and Amsterdam water cycle: the thermal energy recovery potential from wastewater is large, and it is in particular feasible if coupled to aquifer thermal energy storage systems.
- Schiphol and Athens wastewater treatment: the energy generation at wastewater treatment plants through biogas can be enhanced by co-digestion and thermophilic digestion.

- Langhirano (Reggio Emilia), Athens and Algarve water supply system: in a water distribution system, water and energy can be saved by integrating pressure and energy management., i.e. by installing micro-turbines.

Further a support tool for the evaluation of water energy interventions focussing on the optimisation of energy demand in distribution networks (D45.2) was developed. It serves as a diagnostic efficiency tool for the evaluation of water energy interventions, here for pressurized system transport and distribution phases. The first step to improve efficiency is being aware that there is potential for large improvement margins. Lack of awareness is a key impediment and can be quickly solved with a simple and accurate system diagnostic, which is the first phase of the process. The diagnostic, presented for the water pressurized system transport and distribution phases, is based on a new metric. If the improved margin estimated is important, then in the analysis stage the weakest points (energetically speaking) of the system can be identified. Last, with the corresponding cost – benefit analysis, the identified improvements that are economically worthy should be implemented.

Infrastructure Asset Management is deemed a crucial activity of water utilities. The TRUST WP46 activities elaborated supportive tools for this by delivering and proving the concept of different technologies, such as.

- a mobile technology to support asset assessment, repair and maintenance. It was designed to explore technological options to capture and visualize multimedia data in mobile contexts. It supports (e.g.) the user to create multimedia archive of the operations with richer data records and facilitates data sharing among co-workers.
- a pipe-scanning method for enhanced assessment of the condition of water. Extensive testing provided info for an extended database and thus enabled better assessment of the pipe conditions. The tool helps utilities to perform a targeted rehabilitation of the right pipe, at the right time, with the right method.

2.5. Work Area 5 – Water Policies and Integrated Tools

The objective of Work Area 5 was to develop general-use integrated approaches and planning support tools aimed at the transition from current status to the desired sustainable urban water cycle services of tomorrow. The integrated approaches, developed both at the regional/national level and at the utility level, seek a balanced long-term asset management view between performance, risk and cost, and will take into account social and political acceptance. The life cycle assessment paradigm will be incorporated whenever appropriate and feasible. The proposed development work aims at empowering policy makers and water utilities.

Strategic asset management (AM) of urban water infrastructures faces the challenge of dealing with expensive and long lasting assets of very diverse nature, useful lives and costs. Typically, utility managers inherit an infrastructure with assets in assorted conditions and stages in their lifecycle. They are expected to manage their value in order to ensure a service of adequate quality, and make sure that what they pass on to their successors is capable of continuing to do so. Long-term vision is most definitely needed, and sound transition paths must be adopted in order to ensure that urban water services are sustainable, without jeopardizing the quality of the service provided during the transition. Focusing on the transition for more sustainable services, the approaches and integrated tools developed in WA5 adopted the TRUST concept of sustainability (WA3), took into account pressures and drivers (WA1), and generalised the roadmapping methodology developed in WA1 and tested in WA4, embedded governance and economic learnings from WA2, took into account technical and technological learnings from WA4, in order to cope with the implementation of disruptive solutions.

GUIDELINES TO ASSESS CURRENT SITUATION AND LAY OUT FUTURE SCENARIOS FOR UWCS

These guidelines are a useful tool developed with the purpose of logically assisting a UWCS utility in characterizing and evaluating its current status and defining possible scenarios and tracks that can be useful for utilities to manage a transition for a more sustainable UWCS. The main idea is that the guidelines were designed to drive anyone (water professionals, decision makers, stakeholders) in the use of TRUST deliverables, or other available approaches identified as useful tools or best practices to assess the UWCS current state and possible tracks. The guidelines are made of a portfolio of Situation Analysis Factsheets (SAF) developed for each TRUST deliverable or other available tools or approach from the literature to assess the UWCS current state and possible tracks. Each Situation Analysis Factsheet includes synthetic information on: Framework scheme of the tool; purpose and output; objectives and main output; inputs and resources; data, human resources and time needed; methodology; a synthetic description of the methodology or the approach; disadvantages and limitations reported; links to additional information. This information is available as a report and as web-based software application (Figure 2), organised by road mapping step, pointing out the covered sustainability dimensions and the capability for analyzing current and/or future situation, as well as the relationship of each TRUST tool with the TRUST criteria and objective, as summarized in the Situation Analysis Factsheet.

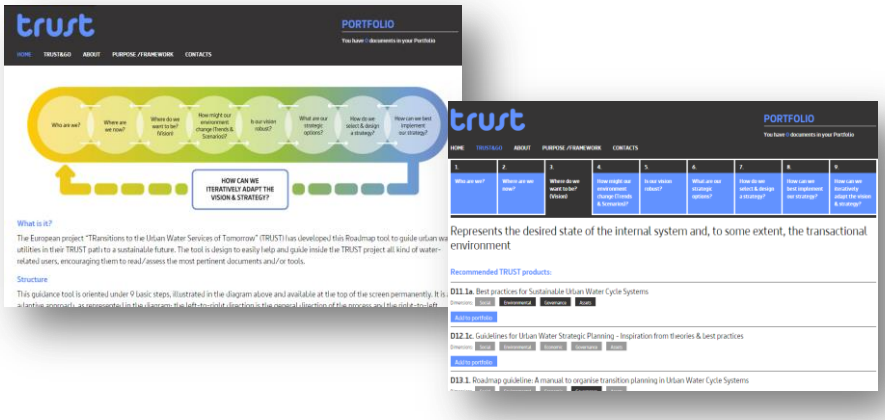

Figure 2. Snapshots of the web-based tool

THE POLICY GUIDANCE MATERIAL

The Policy Guidance Material (PGM) of TRUST is intended to provide policy makers with information and assistance for shaping the transition towards sustainable urban water services of tomorrow. TRUST PGM assists policy makers in designing and refining strategic plans for sustainable urban water management. Statements of relevant government, ministry and regulator representatives across Europe, collected in a set of structured interviews, provide insights into current thinking around desirable urban water futures and remaining institutional barriers. One of the key outputs of this activity was Vol 2 of the manuals of best practice mentioned below. This guide highlights aspects of effective institutional frameworks, TRUST sustainability assessment framework, financial sustainability and the general principles of resilience, flexibility and additivity in terms of urban water systems to support decisions on the selection of appropriate technology options and network configurations.

THE TRUST APPROACH AND TOOLS FOR INFRASTRUCTURE ASSET MANAGEMENT

The TRUST approach for infrastructure asset management, in the core of WA5 work, addresses strategic, tactical and operational planning, is supported by professional-grade software and is complemented with scientific developments materialised in a Decision Support System and a Decision-Theatre software (developed at a prototype level). It inherited from a number of previous R&D efforts. The foundations were the CARE-W and CARE-S EU 5th FP research projects, which evolved into a coherent and professional approach and software suite developed under the AWARE-P project (aware-p.org), that gave the name to this IAM approach. Developments TRUST allowed for achieving a much higher lever on maturity and sophistication, giving place to the TRUST/AWARE-P IAM approach. This approach is a broad management process that addresses the need for a fundamental plan-do-check-act cycle at a utility's various decisional levels – strategic, tactical, operational – aiming at the alignment of objectives, metrics and targets, as well as

effective feedback across levels. “Infrastructure” is meant to embrace all the physical assets of the urban water systems, and not only the buried components.

The TRUST built on the AWARE-P results and further developed them by:

- incorporating the TRUST concept of sustainability (Brattebø et al., 2013);
- consolidating the process of building a sound assessment system, resulting from stakeholders consensus on the key objectives, criteria, metrics and reference values; leading-edge distributed software to support decision theatres was developed at a prototype level within TRUST (Ydreams & LNEC);
- developing, at a prototype level, a decision support system based on a metabolism model (University of Exeter & Addition);
- producing manuals of best practice at policy makers, for utility strategic managers and for utility mid-managers and other decision makers (under finalization at the time of writing this paper; LNEC & IST);
- producing new modules of the AWARE-P software at a professional grade and enhancing the whole platform (Addition & LNEC).

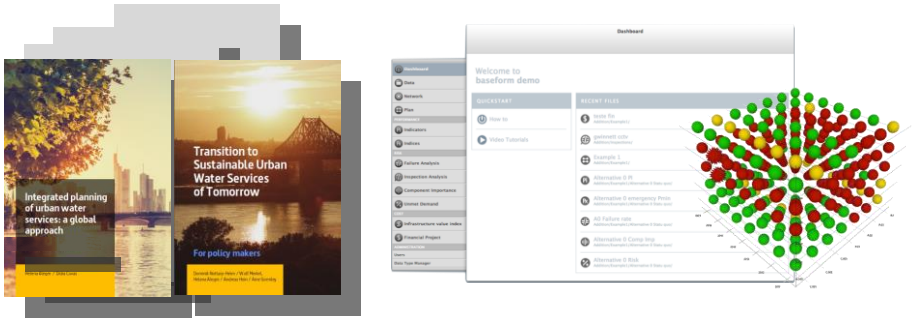

Figure 3. Manuals of best practice and software

The TRUST / AWARE-PO approach

- Is driven by service, objectives, and for this it has functional units in the core - not individual assets, not asset types
- Looks at long term time windows , not “infrastructure life cycles” because urban water infrastructures have indefinite lives
- Addresses performance, risk an costIs driven by service, o

SOFTWARE OVERVIEW: GENERAL OUTLINE

The TRUST software is a visual suite of tools for infrastructure asset management and planning, supporting the quantifiable impact assessment of AM interventions and promoting the best trade-offs between performance, economics and risk.

It is a non-intrusive, web-based, collaborative environment where objectives and metrics drive IAM planning. It was designed for water supply, wastewater and stormwater systems and services, and is aimed at industry professionals and managers, as well as at the consultants and technical experts that support them. The main tools developed within TRUST are PLAN (to support diagnosis and alternative comparing, ranking and selection) and FIN (to assess the main economic indicators of any given project, such as net present value).

Using available data (asset registry, geo-databases, kPIs , financial, operational), the TRUST software comprises a modular tool portfolio for AM planning, spatial analysis, and asset system diagnosis and prediction. The software has been designed following a modular paradigm in an open arrangement that allows for its usage with multiple workflows. The tools may be used individually or in combination.

GUIDANCE AND EDUCATIONAL MATERIALS

The guidance and educational materials developed include a series of manuals of best practice, an e-learning course and a curriculum for a post-graduate course.

The series of manuals of best practice on integrated planning of urban water services focuses on Infrastructure Asset Management (IAM). IAM aims at ensuring that infrastructures are managed in such a way that sustainability of the service is ensured by maximizing service performance at a minimum cost and with acceptable risk levels, in the long term. Urban water services include water supply and wastewater and storm water management. Vol 1 introduces a global framework, key principles and concepts and the main challenges and opportunities. Volume 2 is the manual produced in WP52. Volumes 3 and 4 include specific guidelines for strategic and tactical planning at the utility level, as well as a portfolio of rehabilitation techniques using in supply pipes and storage tanks and drainage systems.

Given the importance of post-graduate education, a curriculum for a one-year post-graduate course on sustainable management of urban water cycle services (UWCS) has been prepared. The aim of the curriculum is to provide a reference that may be adapted or adopted by any European university or network of universities. Although the curriculum and courses presented are hypothetical, for the descriptions actual course contents of several European universities are used. TRUST deliverables are presented as course reading. The target groups of this curriculum are: (i) Education planners through Europe, which can incorporate (parts of) this curriculum in their education on the sustainable management of UWCS; (ii) Professors and teachers, to enrol their course in the wide amount of offered courses regarding UWCS; (iii) Students, in order to get acquainted with UWCS and explore their possibilities in the European Union.

E-LEARNING COURSE

TRUST e-learning course on "introduction to infrastructure asset management of urban water services" has been produced. It is composed of a comprehensive set of videos, based on supporting slides, software demonstrations and direct speech presentations. It covers the main IAM principles, covers both strategic and tactical planning, combines theory and practical cases, includes do's and don'ts regarding data management, and provides a general overview of who is who in world of IAM. The main target public of this course is utility CEOs, middle managers and other decision makers. However, it is also thought of university students, consultants and water professional at broad, interested in this thematic.

DECISION SUPPORT SYSTEM

The DSS developed implements a tool which is able to quantify the impact of different sets of interventions/technologies on the performance of the UWS, including associated risks and costs by evaluating a wide variety of sustainability performance metrics under different scenarios. The metabolism model WaterMet2, developed in WA3, which undertakes the simulation of the integrated modelling of UWS, is employed in the DSS.

There are two parallel, complementary implementations of the DSS in two different software systems and platforms (i.e. web-based and desktop tools), with feature sets that take advantage of those platforms' specific contexts and target slightly diverse user groups.

The web-based tool is one of the modules available in Baseform's software deployment for the TRUST Project, alongside the AWARE-P IAM planning software portfolio. It shares the Baseform platform's visually-oriented interface and usage language, creating a degree of commonality with the available portfolio of tools, namely those developed under TRUST such as the PLAN comparison & decision tool, aiming specifically at managerial and technical roles in urban water services where decisions impact a number of stakeholders and interests.

The desktop DSS tool is designed to run under a Windows™ operating system. It is a stand-alone software tool, however it will use other deliverables in the TRUST project as the input file. More specifically, the WaterMet2 model developed in WP33 can be used in DSS as a simulation model to support the assessment of intervention strategies in an UWS for the long-term planning of UWS. The desktop tool enables additional functionality over and above that available in the web-based tool. In particular, whereas the web-based tool requires that Intervention Strategies (Alternatives) be predefined in the WaterMet2 input data, the desktop tool allows the end-user to interactively construct and evaluate their own Alternatives using any combination of the Interventions that are published by the WaterMet2 model.

DECISION THEATRE

As part of the scientific developments within WA5, new visualization tools for collaborative decision-making, performed by multiple users at the same location and same time were designed, specified and developed. The software tool developed at a proof of concept level

explored new interfaces enhancing collaboration between diverse stakeholders and supplying visualization methods to support their decisions. Software design strictly follows the single steps of the decision making process, starting with the mission, the vision, the objectives and corresponding criteria and ending with the weighted metrics. In each step, the achieved results are displayed and the final result is visualized in a weighted pie chart, providing a clear overview of the discussion results. The software functionality allows the moderator to control the process effectively at any step of the decision making process, proceeding or stepping back according to the actual discussion needs of the group. The group member as an individual user has the flexibility to use his own screen independently, to either take part in the actual stage of the process or to review preceding steps to recap the decision-maker pathway. The decision maker process is designed for a group gathering in the same room, but also remote users are likely to be included in the process.

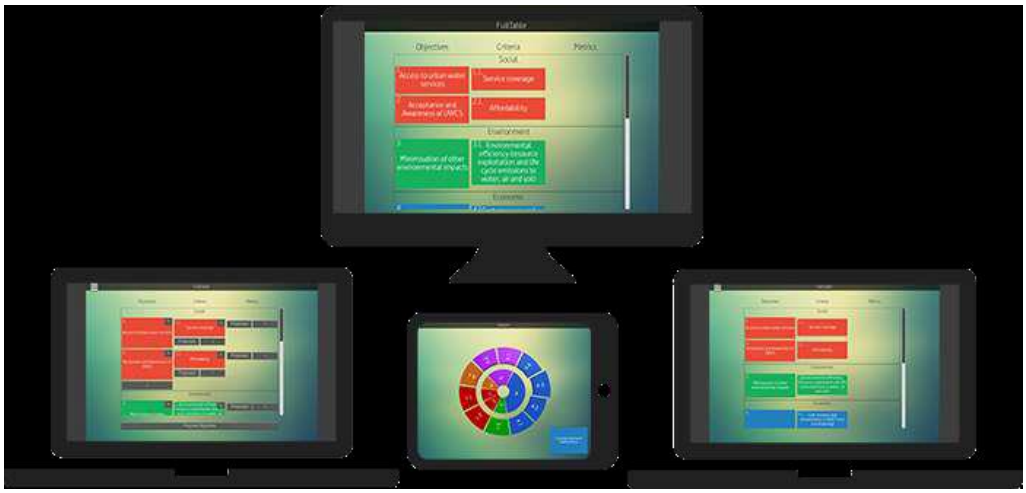

Figure 4. Decision theatre: example of coordinated screens the different stakeholders may see at a time.

2.6. Work Area 6 – Implementation and Demonstration

TRUST was designed with and for city utilities, to support their quests for improved sustainability in delivering urban water services. Reaching out to and working closely with these end-users has therefore been essential from the moment the project started. Work Area 6 was established to make and sustain such connections, between knowledge institutes and water utilities and between researchers and professionals around Europe. It successfully deployed three instruments towards this aim.

Firstly, it set up and ran roadmapping processes with each of the ten city utilities participating in TRUST. These processes were designed following the TRUST roadmap guidelines, which in turn were adapted to the specific needs of cities and regions in mind. Where possible and desired, TRUST tools were tested and/or demonstrated in situ as part of these processes. They have resulted in strategic roadmaps that support city utilities in realizing their long terms visions of UWCSs.

Secondly, several Cities Platform Events and Regional Workshops were organized, in places such as Athens and the Algarve. Whereas the roadmapping processes were meant to develop individual and contextualized roadmaps towards sustainable UWCSs, these events stimulated the exchange of insights and learning between city utilities participating in TRUST.

Lastly, the Train4TRUST initiative enabled city utilities to be trained in some of the tools and instruments developed in the project. This helped translating generic outputs from TRUST into outcomes 'on the ground', in cities. These three activities will be further elaborated upon below.

Developing roadmaps for sustainable UWCSs

The cities participating in TRUST have engaged in a roadmapping process throughout the duration of the project. Roadmapping has been a central activity in Work Area 6, which sought to promote and implement the TRUST outputs. A roadmap, following Deliverable 13.1, "enables decision makers to plan and implement a pathway to achieve desired objectives" (see a visual of the process in Figure 5. Such objectives are specific to each city and hence, their definition and accomplishment must occur within and by the city (utilities) themselves.

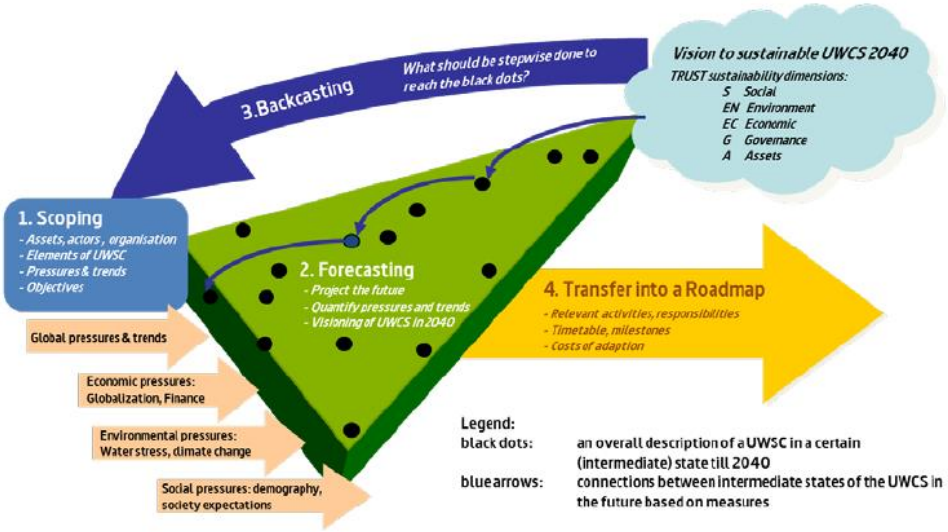

Figure 5 TRUST roadmap process visualised

The goal of Work Packages (WP) 6.1, 6.2 and 6.3 was to set up such a roadmap process and create and implement a roadmap for the cities in three City Clusters:

- Water Scarcity City Cluster – Algarve (Portugal), Athens (Greece), Reggio Emilia (Italy)
- Green City Cluster – Hamburg (Germany), Amsterdam, Schiphol (both the Netherlands)
- Urban – Peri-urban City Cluster – Oslo (Norway), Bucharest (Romania), Scotland (UK)

Water Scarcity City Cluster (WP 61)

The roadmap process in the Algarve region has been a broad one, with the involvement of multiple, highly motivated stakeholders, including water services and other competitive water users (golf courses, agriculture and ecosystems water dependent). They took this opportunity to sit around the same table and plan ahead for a sustainable water future for the region. Although a full-fledged roadmap could not be accomplished in the time available, the sketch developed provides a solid basis for further development for the strategic urban water topics in the Algarve region. The roadmaps of Athens and Reggio Emilia both focused on their respective water services. The Athens approach was an elaborate process supported by the strong commitment of the Athens Water Utility. The process exploited work undertaken in WA4 and based on that, three individual roadmaps were developed linked to urban water demand management, water reuse and strengthening the water energy nexus in urban water systems. Reggio Emilia City developed their roadmap with a particular concern given to the reduction of water withdrawals from groundwater, and the service reliability/resilience due to the tree shaped water supply system layout. Both of them can be exacerbated by climate change foreseen in the next decades. During the road mapping

process, a subset of measures have been selected and successively tested with the use of a metabolism model.

Green City Cluster (WP 62)

The roadmaps for the cities in the Green City Cluster cover very different topics and hence, resulted in, tailor made strategies to adapt the unique parts of the UWCS to the identified needs of the future. HAMBURG WASSER focused on two related topics, namely water metering and tariffing. The topic central in the roadmapping process of Waternet Amsterdam was Clean Capital, the working name for innovative projects on the water-energy-waste nexus. Lastly, Schiphol was mainly interested in the water-energy nexus and practical projects aligned to this theme. Their respective roadmapping processes differed quite a bit, from a very elaborate, but intimate process at HAMBURG WASSER to a broader, multi-stakeholder process at Waternet and a brief, experimental and practical one at Schiphol.

Urban – Peri-urban City Cluster (WP 63)

The roadmap developed in and for Oslo has been extensive and focused on three key sustainability issues, namely how to plan ahead for some key trends such as population growth, increasing urbanisation, ageing infrastructure and climate change, water demand management and the effectiveness of water governance. During the roadmap process it was concluded that it is desirable to maintain (and not increase) the current total water use until 2030. The population of Oslo is expected to increase with more than 150 000 through 2030 meaning that the water use per person must be reduced. New technologies, leakage reduction, renewal of water networks etc. will help to maintain a stable water demand. "Low hanging fruits" will first be exploited to reduce current total water demand. The Oslo roadmap will be linked to the greater master plan of the city. ApaNova of Bucharest followed a more basic roadmap process with a focus on defining the state of the present system and qualitatively projecting the changes at the 2040 horizon. A list of potential interventions to integrate in the ApaNova master plan is extracted from these analyses. Topics that were identified as crucial in Bucharest were water demand, impacts of climate change and optimal network efficiency, with focus on drinking water systems. Bucharest has made a list of interventions, which will further be evaluated by ApaNova and potentially integrated in their master plan. Scottish Water, lastly, focused on improving the sustainability of their rural services. The roadmap focused on furthering an initiative called the Sustainable Rural Communities Initiative, and it developed a strategy for research under this program. Future work should focus on meeting the communities' specific needs, as it turned out what they perceived as most sustainable differed significantly between them.

Cities platform events: mutual learning and exchange between city utilities

A second major activity in WA6 has been the organization of Cities platform events, meant to stimulate learning and exchange between the different city utilities participating in TRUST. Three such events have been organised.

A first City Platform Event took place in Faro, in the Algarve (Portugal). This event focused mainly (but not exclusively) on the water scarcity city cluster, and more specifically, on the theme of alternative water sources. The workshop provided an overview and facilitated exchange of water recycling practices and desalination techniques. It pointed out options to integrate them in UWCS in a more sustainable way. A major intention was to learn about the current activities in this field in the TRUST pilot cities of the water scarcity cluster.

Basel, Switzerland, hosted the second City Platform Event, preceded by a workshop on the baseline sustainability assessment. The objective of this event was to familiarize the cities with the roadmapping process and to select a suitable roadmap process to be implemented by each city, thereby taking into consideration the various socio-economic tools that are in the making (e.g. metabolism model, decision-support system). During the event city representatives discussed their preference for how to do their roadmapping process (basic, advanced or a mix) and the related follow up activities.

The third Cities Platform Event took place in Athens, Greece, and achieved two aims. One was the exchange of practices and insights between cities regarding their roadmap processes, which by then, were already quite advanced. Day one of the event thus involved presentations of city representatives on their roadmap themes and insights, followed by subgroup discussions. The second aim was to increase knowledge on the TRUST tools and instruments. Day two was therefore mainly set up to exchange knowledge on the tools by TRUST researchers to the end-users from city utilities, either in the form of presentations or by simple demonstrations.

Instead of organizing a fourth event (which was foreseen, but proved hard due to travel constraints of potential participants) it was decided to pay TRUST utilities personal visits. During such visits, the project features and needs were shared and collected. Such visits, although not initially foreseen, have been pivotal in translating seemingly abstract project results into concrete actions and outcomes for city utilities.

TRAIN4TRUST: training city utility professionals in TRUST tools

A major objective of the TRUST project was not only to develop impressive tools and instruments by researchers, but also the active promotion and demonstration of those to end-users. Thus a training program has been developed under the name of Train4TRUST, and implemented in the later stages of the project. In essence, this activity of WA 6 involved two main stages.

One was the development of a training portfolio, outlining what tools and instruments end-users from city utilities could be trained on and what the program of potential training workshops would entail. Nine TRUST tools and instruments have been included in this portfolio, such as the Dynamic Metabolism Mode, the energy and leakage management tool PaVLOS, the strategic infrastructure management tool AWARE-P and techniques for demand management. At the same time of developing this portfolio, a screening of demand of potential trainees at city utilities took place, followed by a prioritization of the training workshops with most potential.

The second stage of this activity involved the actual organization of training and promotion events. Four such events have taken place. The first workshop was on the water infrastructure tool AWARE-P. It took place in Hamburg and was attended by twelve participants from around Europe. This workshop was followed up by a webinar, to deal with questions after participants practiced a bit with the software linked to AWARE-P. A second training workshop on AWARE-P was organized in Maputo, Mozambique. This was attended by over thirty people from Mozambique's main water entities. The third training workshop in Reggio Emilia focused on the Watermet^2 tool. The first day involved the explanation of the TRUST DSS and sustainability framework, while the second discussed the impact of this and other tools within TRUST. Finally, tools were promoted in a 'tool stand' during the final conference in Mülheim an der Ruhr. Conference attendants were informed about or could experience a demonstration on the TRUST adaptive Potential Self-Assessment tool, the STORM model, the Energy Assessment of Pressurized Water Systems and the AWARE-P software.

2.7. Work Area 7 – Dissemination and Knowledge Transfer

Work Area 7 of TRUST has been setting up the scene, creating the communication vehicles, opening the communication channels and developing the foundations for an effective project communication. This included creating a strong and recognizable TRUST brand, determining the target audiences and exploitation strategy of the project deliverables, and developing formats and tools like the TRUST magazine, the website a newsletter by subscription and other communication materials.

WA7 has developed a brand that is easily recognizable and consistently present in all project results and communication about TRUST, ranging from website design, newsletters, deliverables, reports and any product and information material that was produced. Harmonization is extremely high and a quick overview of project materials reveals that the approach originally conceived to establish a TRUST look and feel has been successful.

A news section of the website was deployed using blog technology to facilitate constant updates and improve search engine placement. The project was also made visible in the social networks, including facebook, linkedin and twitter.

The website became a dynamic space (especially considering traditional websites of research projects). New content was uploaded every month and project news were published periodically. Additionally, all contents were profiled for specific target audiences and website visitors are enquired about their own profile and presented with the project information more suitable to their needs.

All public deliverables of TRUST are accessible through the project website, and categorized according to target groups and topics. In accordance to the exploitation strategy also developed within WA7, each deliverable was characterized specifying its target audience, its tone and a 300-word summary to aid with search engine indexing.

The eight issues of the TRUST Magazine (also attached to this final report) followed a much more ambitious approach than originally planned. What was supposed to be a newsletter turned out to be a professionally written and formatted magazine that although designed for its dissemination in electronic form also permitted a printed version and saw the physical distribution of its first two issues in key events like the World Water Forum Marseille, France) and the IWA World Water Congress (Busan, South Korea), and of its last issue at the final TRUST event, the IWA Cities of the Future – TRUST Conference April 28-30 2015 in Germany.

The magazine did not prevent TRUST from also distributing a monthly electronic newsletter by subscription, which saw its first issue in October 2012 (once the project deliverables and events began to justify such a communication vehicle). The newsletter was automatically generated from website contents and informed subscribers about the latest TRUST products, events and news.

The results of the dissemination and exploitation activities of TRUST can be measured in terms of the many tools and guidance documents that have been prepared and are now ready to be used for all upcoming deliverables. Dissemination papers have also been distributed to a wide audience (+10.000 readers) and thousands of potential visitors have been exposed to TRUST in key events.

TRUST has been mentioned in different newsletters (STREAM, the Centre for Water Systems at the University of Exeter, AdP – Aguas de Portugal, WssTP) as well as some online organs such as urban waters daily and Edie.net. TRUST had two guest posts at IWA Water Wiki and was mentioned in IWA Water Wiki TV, Episode 1. Articles about TRUST have been published in journals of the International Water Association Water 21 and the Water Utility Management International (wumi), 3R international (a specialist piping and pipe engineering journal), Water Worldwide by the American Water Works Association and online at CORDIS (the Community Research and Development Information Service of the European Commission) and Eugris (Portal for soil and water management in Europe).

A more comprehensive overview on publications and dissemination activities of TRUST is provided via the scientific reporting tool at the EC participant portal.

A series of short videos was produced in a professional video studio at the premises of the WA7 work area leader in Valencia during the M36 project meeting. For a selection of about a dozen key deliverables and outputs, these short video clips (usually staging the main author of the deliverable) explain the basic idea and application of the TRUST result, and should be a suitable tool (teaser) to raise interest and drive traffic to the actual deliverables. The website visitor can therefore get a 5 minute summary of the deliverable that can be downloaded in that same page. These videos are available at the TRUST project website for each of the selected deliverables and can be browsed by choosing “videos” on the side menu.

Regarding event organization, WA7 successfully organized a series of face to face events from which the final project conference needs to be highlighted. To this respect, a key achievement was the inclusion of the final TRUST conference within the IWA Cities of the Future program (http://www.iwahq.org/3p/themes/cities-of-the-future.html). This is one of the thematic programs set by the International Water Association, with deep impact in the industry, and a successful series of conferences that saw its fourth edition in Istanbul in September 2013. The TRUST final conference, held in Mülheim an der Ruhr (Germany) was one of the two Cities of the Future conferences scheduled for 2015 (one in Australia, another in Europe) a proof of the impact and demand for the program.

The conference attracted more than 120 participants from more than 20 countries. Two thirds of the conference participants were not related to TRUST. The same ration (1/3 TRUST, 2/3 external) applied to the authorship of conference contributions (45 oral presentations and 25 posters). The professionals from outside the TRUST project were able to gain further insight on TRUST findings and products, and were also able to engage in discussions on the path that cities need to evolve sustainably to their future vision.

For this conference, an independent conference website was developed, all paper submission and selection were handled by WA7 through a project online platform as was the design of the communication elements.

In addition to the conference, a number of workshops and training events (to train interested end-users in the application of TRUST results and tools) were held, some of them even in countries outside Europe (Mozambique, Uganda). Details on the regional events organization can be found in deliverable 73.1.

The actual success of the TRUST communication strategy will only be determined in the future. The project website, which will remain online for at least five years as its legacy, will continue to improve its ranking in the search engines as the pages become more visited and it is established as a reliable source of quality information. After all, a significant amount of its contents were added in the later stages of the project and are just beginning to attract attention of the water sector.

3. POTENTIAL IMPACT, DISSEMINATION ACTIVITIES & EXPLOITATION OF RESULTS

As requested in the FP7 work plan and call TRUST was answering to, the expected impact of the project is to "*assist water authorities and utilities in formulating and implementing appropriate urban water polices and levels of service criteria. The understanding of urban water-energy relationship should be increased and tools and techniques should be developed to implement urban integrated water and energy resource management*".

To achieve this impact was the main driver and criterion for the way the TRUST project was designed and carried out. The "Transition to more sustainable urban water cycle services of Tomorrow" was the storyline the project has used in its internal and external communication to convey it main intentions, and the concept of "sustainability" has been used as a framework to have a quantifiable indicator of the impact the project work and results will have on the urban water service providers that are applying the tools and solutions developed within TRUST.

Supplies of fresh clean drinking water and safe water sanitation are at risk from a number of different factors. Climate change, pollution, demographic change and ageing infrastructure are all putting strain on urban water supplies. Sustainable solutions to these challenges must take into account rising energy prices and the pressing need to reduce emissions, as well as consider long-term investment scenarios. The TRUST project was aiming to support the transition of urban water services and their management to provide utilities with new confidence to draw up and introduce innovative and sustainable solutions.

Transition to more sustainable urban water services requires a couple of elements. First, it is key to develop a clear understanding how sustainability of urban water services can be defined and assessed. Second, the actual transition planning involves several steps such as diagnosis (where are we now?), vision (where do we want to go?), analysis (what is needed to get there?), technology & management options (what can be done?), prediction (what happens if?), decision-support (which option is the best one?) and finally the acceptance by decision-makers and stakeholders.

TRUST has developed a portfolio of solutions, tools, guidelines, software and training material for all of these steps, and has demonstrated their feasibility and usability in ten participating city utilities across Europe.

As one of the first steps, a definition and comprehensive assessment framework for sustainability of urban water services has been developed. This has been transformed also into tools for diagnosis of the current and future status, ranging from tools for a very quick scan ("City Blue Print") to more complex web-based self-assessment tools for sustainability in general and financial sustainability in particular. As an example of impact and exploitation of TRUST results, the "City Blue Print" developed in TRUST has been developed further within the context of an Action Group of the European Innovation Partnership for Water (EIP

Water), and has been transformed into a registered trademark "Blue-City-Index®". This methodology of a quick scan to assess the overall performance and assessment of the urban water system has now developed a life outside the TRUST project and has been applied to more than 45 cities worldwide.

To support the development of a clear vision and strategic planning, a roadmap methodology and guideline have been developed and applied with the ten TRUST city utilities. They also considered stakeholder involvement and an analysis of public perception and forms of governance. Innovative modelling tools (e.g. a "metabolism model" WaterMet^2) were developed that enable an assessment of the impact of interventions on the overall performance and sustainability gains of an urban water system. TRUST also assessed and demonstrated emerging technologies for, among others, optimised water treatment, water reclamation schemes for non-potable-use, sustainable water demand management, storm water disconnection, energy-saving options and water-energy interventions.

Another focus area of TRUST has been the development of improved tools and guidance for infrastructure asset management. This has been addressed by (i) development and demonstration of mobile technologies to support asset maintenance & repair and demonstration of a new technology for pipe-scanning, (ii) software modules and tools for asset management, complementing an existing portfolio of tools delivered by previous projects. An additional example of further impact, dissemination and exploitation of these tools is the integration of the TRUST asset management software tools into the Aware-P platform (www.baseform.org), a software suite for infrastructure asset management with hundreds of users worldwide, and even the recent winner of two prestigious awards in the water sector (IWA project award and Muelheim water award).

Finally, a range of integrated tools and guidelines have been developed that put the different management and technology solutions into a common framework and provide guidance to different user groups (policy makers, management and technical staff of the water sector) how to plan and start the transition process by using the TRUST portfolio.

To ensure a proper dissemination and impact of TRUST results, the main results have also been transformed into manuals of best practice for different target groups, e-learning materials (online available for free) and the basis for a one-year post graduate curriculum on sustainable management of urban water services. For key outcomes of TRUST, short video sequences have been produced as teasers, usually staging the main developer of the tool explaining background, application and performance of the tools. All public deliverables and teaser videos are available through the project website which will remain online for at least five years after the end of the project.

In summary, TRUST has provided participating cities with clear individual roadmap towards more sustainable and effective urban water systems, and delivered a supporting portfolio of demonstrated technology and management interventions and tools.

Thus, TRUST will have a very specific impact on the ten participating utilities by means of the individual roadmaps that also include the long-term implementation of, among others,

solutions developed by TRUST. See below (section on Work Area 6) for examples of individual roadmaps and their impact on urban water utilities.

Just as one example of impact and follow-up activities, the Emilia-Romagna Region Territorial Agency for Water Services and Solid Wastes (acronym ATERSIR in Italian) has developed an interest in the TRUST approach and tools, following the participation of the Agency Director in the working group for the roadmapping procedure of the town of Reggio Emilia. A first contract was signed in 2013 (Euro 13,000, for a grantee). Being responsible for monitoring and checking the companies providing the water service in each of the 8 provinces, ATERSIR is looking for approaches and tools to evaluate the sustainability of the integrated water cycle in Regione Emilia Romagna from an environmental, economic, and performance approach. To this end, the Agency has signed a contract with TRUST beneficiary University of Bologna, supporting part-time a post-doc grantee (initially for one year, contract worth Euro 15,500) to study the applicability of some TRUST tools for their needs. A larger contract (Euro 70,000) is under negotiation with one of the largest water suppliers of the Region (IREN Acqua Gas, also a TRUST beneficiary) to support fully a post-doc researcher for 2 years using TRUST tools in Reggio Emilia.

In the following, the impact, exploitation and dissemination of TRUST results are described in more detail along the Work Areas of TRUST.

Work Area 1 – Diagnosis and Vision

The impact of key outputs of Work Area 1 (City Blueprint®, Roadmapping methodology and guideline) has already been outlined above. Whereas the City Blueprint, also known as Blue City Index, already has a successful afterlife outside of TRUST as a key feature of a dedicated EIP Action Group on this topic (and currently applied to more than 45 cities worldwide), the roadmap methodology has up to date primarily been used internally within the TRUST project. Here, however, it has been instrumental in shaping the collaboration with the end-users. Applying the methodology and its templates, individual roadmaps towards more sustainable urban water services have been developed for each TRUST water utility. After successful demonstration of the roadmap tools in TRUST, the beneficiaries mainly involved in development of the roadmap concept will apply it in their consulting business for the water sector.

Work Area 2 – Policy, Financing and Society

Work Area 2 during the TRUST project has generated a significant number of exploitable results. Of great potential is practical tools that have been produced by WA 2: the (1) Financial Sustainability Rating Tool (FSRT) for urban water systems; and the (2) Adaptive Potential Self Assessment (APSA) Tool for urban water stakeholders. Whilst each tool provides a different function, both tools were produced in response to the challenges being faced in urban water systems and the opinions and preferences of the major stakeholder groups that were consulted during their development. The FSRT offers water supply and/or

wastewater removal companies an opportunity to rate the utility's financial sustainability. The APSA tool offers water sector organisations a way to understand and improve their capacity to be adaptive so that they can learn more from their experiences and adjust management practices as a result of what is learned. The APSA tool was presented at the TRUST Cities Platform Event in Athens, Greece in November 2013 and was well received. As a result, we made the tool publically available. The user output from both of the tools was collated and used to inform subsequent WA 2 activities. In addition, a large dissemination package of a TRUST suite of tools (encompassing the: (1) FSRT for urban water systems; (2) APSA tool for urban water stakeholders; and (3) Self-Assessment Tool Based on UWCS Performance Measures) was created in collaboration with Work Area 7 as all three tools are assessment tools available for the same target audience. Furthermore, a seminar on 'Understanding and Improving Organizational Adaptive Capacity in the Water Sector' (based on the APSA tool) was given at the 2014 Royal Geographical Society (RGS)-IBG Annual International Conference in London, UK and a presentation on 'Lessons Learned in Designing Web-Based Support Tools for Urban Water Management' (based on the APSA and FSRT), was delivered at the 2015 IWA Cities of the Future Conference in Mulheim, Germany. Finally, a Train for TRUST workshop and Brokerage Event on the APSA Tool were held at the 2015 IWA Cities of the Future Conference in Mulheim, Germany on April 28th 2015.

Dissemination activities, in addition to those relating to the TRUST suite of tools, have been of central importance to WA 2. Our Policy Briefs were highlighted via the IWA waterwiki and the edie environmental web site, creating interest and enquiries from utilities across Europe. We presented a conference paper on the 'Risk, Vulnerability, Resilience and Adaptive Management in the Water Sector' at the 2014 IWA biennial Conference & Exhibition in Lisbon, Portugal. At the 2013 'Catchment Management: Impact of climate change on delivery and investment.' ESKTN Conference in Oxford, WA 2 delivered a seminar on 'Contributions from the TRUST project on Catchment Management under Climate Change.' We have also led multiple meetings with UK water companies – Anglian Water, Yorkshire Water, Thames Water, Scottish Water, Severn Trent Water, to discuss TRUST project outputs and exploitation potential.

Work Area 3 – Analysis Tools

Two model prototypes have been developed within WA3, based on metabolistic principles, namely WaterMet2 (WM2) and Dynamic metabolism Model (DMM). Whereas WM2 is a fully developed analytical models built on water and resource balances in sections of a system and with a high spatial and temporal resolution, the DMM is an excel-based aggregated calculation model with monthly/yearly time resolution inspired by general resource flow analysis. Both provide important information to support decisions in a sustainability context. They provide supplementary information and it is recommended to use both models. The two models represent a significant potential as tools to support a sustainable development, They are presented in a large number of journal articles and at conferences world-wide. A risk based methodology for assessment of sustainability is connected to the metabolism model. It represents a novel thinking of risk analysis and is already presented at conferences and in journals. The fact that these tools are used already in a pilot city (Oslo), where support on strategic decision is an important outcome, may pave the way for further use in several

cities. Courses have already been conducted in one more city (Reggio Emilia) and it is expected that more will come. The models are included in high-level teaching at NTNU, Norway and it is recommended that also other universities include it in their curriculum.

For more extensive exploitation in near future, it would be advisable that major consulting companies adopted the models for their strategic advices to the customers.

Work Area 4 – Technologies and Operational Options

The different activities within WA4 have already achieved a significant impact and more potential impact can be induced through further utilisation and exploitation of the obtained results. In all work packages of the work area intensive collaborations with water utilities in the TRUST cities have taken place and new tools have been developed for direct application and further use. Just to name a few examples: on the water supply side new characterisation tools for organics have been developed which can be utilised by water utilities in Scotland and Norway and have led already to process improvements. A new tool to assess water demand management options has been developed and is available for further utilisation. Progress has been made with water utilities to improved network design. A new pipe scanning system has been tested under field conditions and new exploitation options have been developed. A particular highlight are the intensive tool developments and application studies for disconnection potential and sustainable urban drainage systems carried out but SMEs in connection with the Oslo water utility. These tools have great exploitation potential for the companies involved. Different studies on improved utilisation of alternative water resources have led better assessment of options available for the utilities. Concrete examples for energy savings in both water distribution and wastewater treatment systems have been developed and implementation plans are available for the utilities for further impact. An SME has developed a new tool to support infrastructure asset management and this can be linked to the overall TRUST set of tools in this domain. Based on the prototype testing the new tool can be further developed for commercialisation.

Work Area 5 – Water Policies and Integrated Tools

The integrated tools developed within TRUST (WA5) were developed with – not just for – the utilities, looking at the outside of the project, i.e., to maximise the implementation of the TRUST approaches by utilities in Europe and elsewhere, to influence the academia and to capacitate water professionals.

The impact, dissemination and exploitation of results is a process already under way. The TRUST / AWARE-P approach and software are already an international reference cited in multiple reviews. The software system has been publicly available since 2012 and has gathered over 1200 registered users worldwide. 30 utilities in Portugal (representing aprox. 25% of the Portuguese population) have prepared their own strategic and tactical plans in the scope of the 1st edition of the National Initiative for Infrastructure Asset Management (iGPI Collaborative project). These plans started to be implemented in 2013. 2/3 of these utilities, together with 9 new ones from Portugal and Spain are now participating in the 2nd edition of iGPI (Nov. 2014-Dec 2015). Other utilities in Europe, USA and Australia have also

used this approach in their planning processes. The IAM approach developed in the AWARE-P project and TRUST — together with their roll-out stages, the iGPI and PGPI projects — was the winner of the 2014 Europe and West Asia Project Innovation Award in the Planning category (PIA 2014, awarded by the International Water Association) and of the Mulheim Water Award 2014 (www.muelheim-water-award.com).

During TRUST and under the TRUST umbrella, short training courses were carried out for the TRUST cities (Basel 2012 and Hamburg 2015), for high level policy-makers and utility decision makers in Mozambique (Maputo, 2015) and for 90 attendees of a Continuous Professional Development (Cpd) Training, Uganda Institution for Professional Engineers. Many other training courses and dissemination activities were carried out during the course of TRUST in Europe, Africa, Latin America, North America, Asia and Australia. New courses are scheduled for 2015 in Portugal, Spain, Brazil and Jordan.

LNEC, ITA, Addition and IWW, SINTEF, NTNU and IWA are committed in, jointly or individually, promoting a growing implementation of the TRUST / AWARE-P approach. These partners will follow up with projects with the utilities in the several countries, with the formal university courses and professional training, and with dissemination activities as opportunities arise.

On the top of that and more importantly, some innovative strategies are agreed. The aim is to better coordinate efforts among R&D, utilities and consultants at the European and international levels, scalling up the successful experience of the National IAM initiatives in Portugal. This requires also the promotion of synergetic work with consultants, promoting a new style of consultancy work. This has been very recently successfully explored in a project in Portugal regarding the capacitation of 11 municipalities in implementing IAM based approach to water losses management.

Work Area 6 Implementation and Demonstration

WA6 was to demonstrate and implement the outcomes of WA1-WA5 in the city utilities linked to TRUST through roadmaps of interventions with the purpose to achieve sustainable watercycle services. As such the project had an impact for these utilities, which is summarized below.

In the Algarve TRUST enabled to bring a large number of stakeholders together to discuss and agree on priorities in the roadmap to address future water challenges and implement solutions. The opinion of the stakeholders was that the roadmapping process was of great relevance for the Algarve region. The TRUST&GO tool was considered a good way to have a quick tour of the TRUST deliverables highlighting promising topics, tools and technologies to discover and track new pathways for the water utilities sustainability challenges.

In Athens individual roadmaps were created and assessed for three identified topics of interest to the Athens water company EYDAP, namely water demand management, water reuse and the water-energy nexus. The TRUST project and associated activities and tasks have served as an incubator of new ideas and opportunities and have laid the foundations for EYDAP to

discover new pathways. The analysis carried out throughout the project highlighted promising topics and new technologies. In fact, some of the concepts and technologies investigated and analysed within the TRUST roadmapping activities have already passed into the demonstration phase in which actual technologies are being tested in EYDAP and Athens through new pilot projects.

At HAMBURG WASSER the roadmapping focused on water metering and tariffs as critical issues for strategic decision making. First ideas have been developed as a basis for further elaboration in 2015.

At Waternet (Amsterdam) the roadmapping exercise gave input to its main strategic priorities on sustainable and market-driven 'innovations' and 'solutions' at the interface of water, energy, waste, resources and raw materials. In this exercise water, waste and energy entities as well as the port of Amsterdam worked together to develop innovative concepts on the edge of water, energy and possible other resources.

Schiphol has the ambition to become a climate resistant and carbon neutral airport and metropolitan area and is particularly interested in the reuse of materials and resources. The roadmap for Schiphol Airport focused on interventions for energy optimization and resource recovery. These interventions are currently implemented as part of other projects.

The Oslo roadmapping focused on reducing water demand and leakages. Both technical and non-technical interventions have been developed. Pressure reduction is currently assessed for short term implementation.

For Bucharest the focus was on water demand and efficiency of the network. Various interventions have been identified in the roadmap including a more cost-effective design of distribution network. This new design concept is considered for piloting in a newly to be developed area.

At Scottish Water the roadmapping process contributed to improving the services to rural communities, for which purpose the company had launched the Sustainable Rural Communities Initiative.

At all TRUST utilities the roadmapping was embedded in company specific strategy developments, which promotes the exploitation of the TRUST outcomes and will ensure an impact far beyond the lifetime of the TRUST project.

Work Area 7 – Dissemination and Knowledge Transfer

Work Area 7 was instrumental in disseminating project results and maximizing outreach and impact of TRUST, - but it doesn't have outputs of its own that can be described here, apart from a range of events that have been carried out through the project, in collaboration with other work areas, such as the city platform events, regional workshops, training events and last but not least the final event of TRUST which was organised as an international conference (as part of the IWA Conference Series "Cities of the Future" 28-20 April in Muelheim an der Ruhr, Germany), with more than 120 international participants. Two

sessions with in total 12 presentations were dedicated to the presentation of key results from TRUST, whereas the remaining 7 sessions were open for contributions from other experts from the field. This combination ensured a high attendance of external participants at this event, and contributed to the international dissemination of TRUST results.

TRANSITIONS TO THE URBAN WATER SERVICES OF TOMORROW

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