Best practices in urban planning and management technologies: Netherlands best practice

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B3 Draft Report

Best Practices in Urban Planning and Management Technologies

NSUS network for the application of science technology and innovation to the urban sector

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1. Introduction

This report is part of the EU-sponsored *NSUS network for the application of science technology and innovation to the urban sector*.[i] Its findings are complementary to the reports C2 and C3 that are prepared for the same project. While these related reports discuss best practices in STI policy (C2) and Caribbean innovation trends in urban water and energy management (C3) respectively, the report at hand presents a Dutch perspective on STI developments in the field of urban water and energy management. It includes a review of existing urban technologies (section 4) and looks at the drivers underpinning these innovations and the uptake thereof (section 5). It further assesses the potential applicability of these innovations in the Caribbean context (section 6). Section 8 presents the conclusion of the presented findings. The following sections explain the used methodology (section 2) and the typology developed for this research project (section 3). It is important to note that the given definition of 'technology' is particularly broad and includes purely technical innovations as well as organisational tools and policy instruments.

In order to keep this report within a reasonable volume, the research team from the University of Amsterdam decided to narrow the focus of the research activities, based on a) the original ToR as formulated in the EU-ACP project documentation; and b) the priority themes as identified in the recent publication 'Towards a Caribbean Urban Agenda' (Verrest, Mohammed & Moorcroft 2011). As a consequence, this report includes (and is limited to) three major themes that are all considered highly relevant to the Caribbean context: *energy efficiency*, *water supply*[ii] and *flood response management*. Furthermore, the report puts emphasis on retrofitting. This entails that technologies needed for new developments are only included if there is a proven applicability in similar contexts. In order to link this report to the expertise available during the NSUS technical meeting in Amsterdam, the listed technologies only feature those technologies that are applied in the Netherlands.

2. Methodology

This report is based on publicly available sources such as reports, academic publications and related technology listings. It does not aim to present new findings regarding the current thinking of innovation policy. Instead, the added value of this exercise lies in a new, theme-specific compilation of relevant documents that together present a compact overview of the major developments in energy efficiency, water supply and flood response management.

We translated the research problem as stated in the original NSUS Terms of Reference (see Annex 1) into four research questions, which served as a guideline for the research activities.

1) What are possible categories of urban issues in energy efficiency, water supply and flood response management?
2) A) What are matured technologies (in the broader sense) for each category?
   B) Which factors influence the uptake of these innovative technologies?
3) Which of the technologies identified in 2A are applicable to the Caribbean context?
4) A) What are the strengths and weaknesses in the Caribbean setting to implementing these technologies?
   B) Based on the analysis in 4A, what could be done in order to facilitate further implementation of these technologies?

For question 2A (section 4) we used a variety of sources. In order to make the best use of existing expertise in the fields of energy efficiency, water supply and flood management across the Netherlands, the research activities included both expert interviews and online desktop research. The findings for 2B (section 5) draw on information gathered from various policy reports as well as the Dutch patent registry and its *escapenet* database. We then used a score system to answer question 3 (section 6). The definition for 'applicability' in the Caribbean context included 1) small-scale (decentral management possible & applicable for small markets); and 2) low cost (no high-tech solutions).

Annex 2 includes the detailed research plan for this report, including the operationalization as it is defined for each sub-question. The draft report at hand only includes the data required for questions 1-3. Questions 4A and 4B depend on input from the B3 report. Data and findings for these two questions will therefore be added after the technical meeting.

3. Typology & Classification

For each of the three themes, we looked at two dimensions of urban innovations: *scope* and *type* of a given innovation. For each dimension we identified three categories. For each of these categories, we then created an icon to indicate scope and type of the presented technology. The icons are intended to help the reader when assessing and comparing the different technologies – and to facilitate the applicability analysis presented in section 5. Figure 1 below introduces these icons.

The *scope* dimension differentiates between the household level, community level and the city level. Some innovations are relevant to all three levels, others might have a particularly value for only one of them. For example, LED lighting can be applied on household, community and city level, while desalination technologies would be relevant only on city-level. By using this dimension to categorize each of the selected technologies, it is easy to judge whether a technology is applicable in a certain urban setting. In some cases, we marked technologies relevant for both the household and city level. This is the case when a certain innovation is implemented across the entire city, but targets individual households (such as an energy consult).

The *type* dimension makes a distinction between the three major types of innovation. This definition was taken from the report *Measuring Environmental Innovation*, which was done for the European Union in 2008. The three categories include 1) environmental technologies, 2) organisational innovation and 3) appliances & products.[iii] For example, an LED light bulb is a product that is available for purchase. In contrast, certain desalination processes are not a product as such, and therefore belong to the environmental technology category. Organisational innovation covers new ways to set standards, regulate or organise people and institutions through i.e. committees, train-the-trainer programmes.

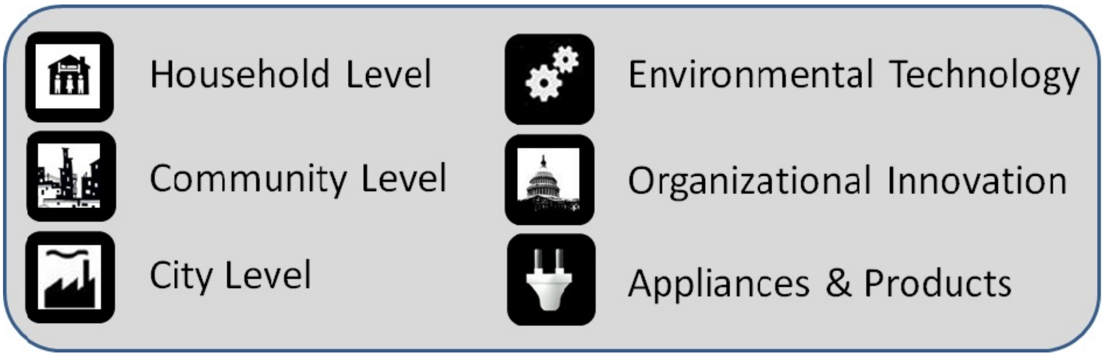

Figure 1: 3 icons for innovation scope (left) | 3 icons for innovation type (right)

Further, we identified several aspects within each of the three themes. Water supply for example includes technologies that are related to water quantity, water quality and watershed management. Each of these can again be sub-divided into more detailed sub-aspects (in the case of water quantity: surface catchment, rain- and groundwater catchment, wastewater treatment and desalination). Because some categories overlap, we listed several technologies under more than one category. Green roof catchment systems, for example, both serve to enhance the ground water supply and also acts as a water filter. This technology therefore features both under ´ground water catchment´ and ´water treatment´. Figure 2 below presents an overview of the 18 sub-aspects used for this report.

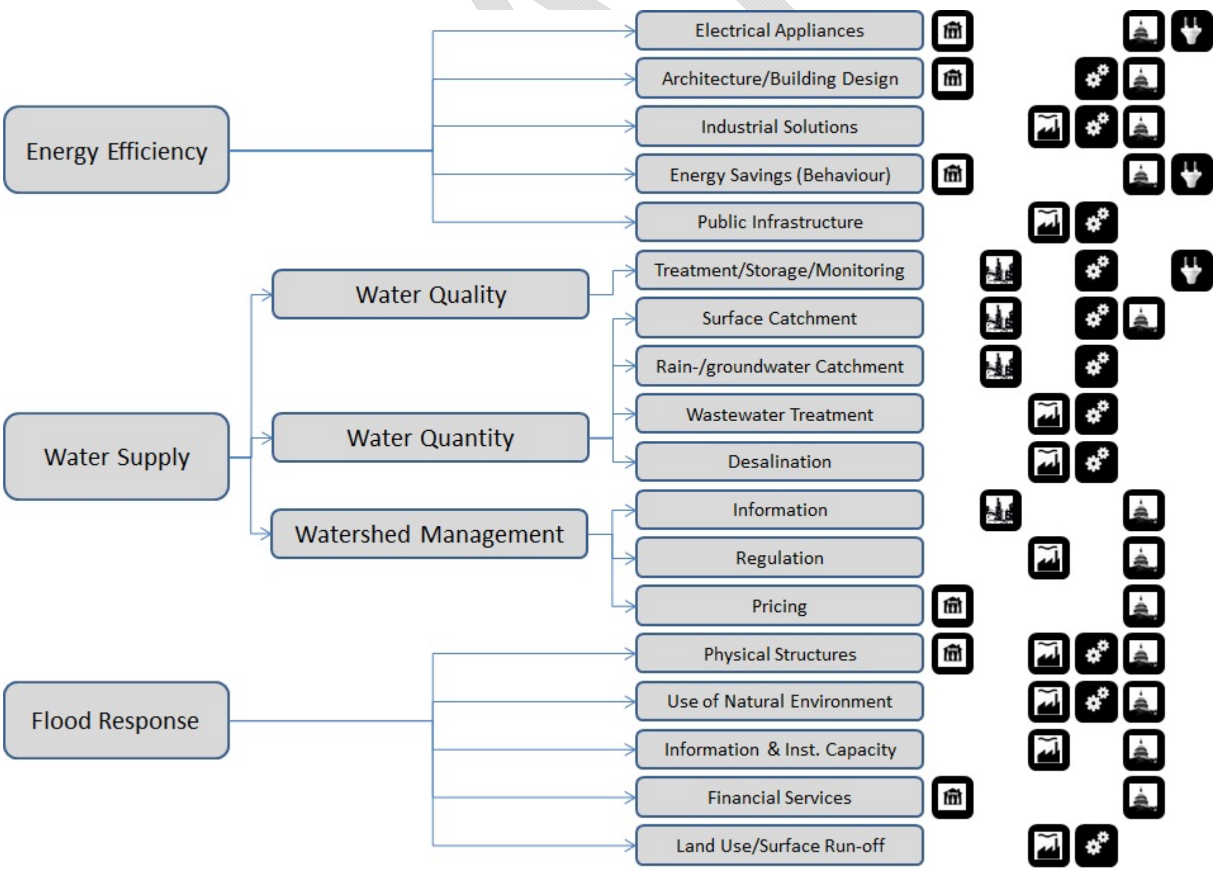

Figure 2: overview of the 18 different sub-aspects across the 3 themes. Each can be linked to one or more of the introduced scope and type categories (see black/white icons on the right)

In general, we have attempted to limit the selected technologies to those that are within the jurisdiction of municipal authorities. Only in exceptional cases have we also included technologies that are designed and implemented on the national level. The idea is that the underlying principle could also serve as an inspiration for the city, community or household level.

4. List of Technologies:

It is impossible to present a comprehensive overview of all relevant innovations in energy efficiency, water supply and flood response. Instead, we aimed to provide an illustrative sample of a total of 77 urban technologies that are documented, tested and applied in the Netherlands.[iv] It should be noted that at the time of writing, not all of them are internationally utilized. The following pages include tables with selected technologies, covering each of the 18 sub-aspects defined in section 3. For some of the more technologically-driven examples, we have included a separate document with visual illustrations. These technologies are marked as such in the text.

It is important to note that the summaries listed in each of the following tables have been largely drawn from the respective reference, and in many cases it was not possible to cross-check claims with additional sources (see Annex 4).

Theme I: Energy Efficiency

1. Electric Appliances

Nr	Title	Description	Scope	Type
1.1	Energy box and energy saving consult for low-income households (see also 4.1)	A Municipal project which provided 12,000 low-income households in Utrecht with a free energy consult and **energy saving box**, with unemployed residents trained to act as energy-saving consultants.		
1.2	HR107 combiketel	The HR107 combiketel is a high efficiency boiler used both for heating and hot tap water.		
1.3	Energy saving box for low-income households (See separate document for illustration)	A municipal project where free energy saving boxes were distributed to 2,400 low-income households. The energy box contains 3 energy efficient light bulbs, a stand-by killer, radiator insolation, water savers and a brochure with energy saving tips. With these tools, each household has the potential to save 250 kWh electricity, 56m3 gas and 16m 3 water, with a total value/savings potential of €104 per year		
1.4	Solar hot water heaters (See separate document for illustration of Solesta System)	The solar thermal market in the Netherlands has been growing at an annual rate of 20 – 30% since 2006. Solar water heaters, such as that by Solesta, can produce hot water 30-50% cheaper than gas/oil/electricity. The systems are also small; Solesta boasts the world's most compact.		
1.5	Energy labels (beyond city)	Since 1996 retailers have been required to place energy labels on various appliances to help customers choose more efficient units. By law new domestic refrigerators and freezers, washing machines and electric tumble dryers, combined		

		washers and tumble dryers, dishwashers, lighting and stoves must include an energy label. Boilers and hot water heaters may also be included in the future. The label includes the logo, manufacturer, type number, and energy efficiency class (A-G).		

2. Architecture / Building Design

Nr	Title	Description	Scope	Type
2.1	Municipal energy efficiency requirements	The city of Apeldoorn set high energy efficiency standards as a requirement for land development. Since the city owned the undeveloped land they could set terms of development for companies, and consequently ensure greater local energy efficiency.		
2.2	Self-adjusting ventilation grate (See separate document for illustration)	These innovative aluminum ventilation grates for windows have an actuator (flap) that responds to the airstream. When the wind is strong, the opening is reduced, thereby reducing the airflow. When there is no wind, the actuator is completely open. This reduces draughts and saves energy for the user. The units have built-in insect protection and are rainproof.		
2.3	Energy Performance Standards for new buildings (beyond city)	Since 1995, the Netherlands has had Energy Performance Standards for new buildings and non-residential buildings. This is meant to reduce energy consumption by 15% and 20%.		
2.4	Subsidy scheme for window glazing (beyond city)	Window glazing improves insulation and improves energy efficiency. To encourage glazing, the Dutch government instituted for a limited time a subsidy of 35 euros/m2 for double glazing for windows in 2009. This was applied for both new purchases and retroactively for recent renovations.		
2.5	Providing rebates to households that buy energy efficient appliances and installations (beyond city)	The Dutch government and the energy companies, have an agreement that the latter should use a portion of the energy tax they collect to give rebates to those customers who buy very energy efficient appliances or install insulation in their homes. This has succeeded in increasing sales of energy efficient appliances, which in turn lowers the price for them. Around 30% of Dutch households have received rebates.		

3. Industrial Solutions

Nr	Title	Description	Scope	Type
3.1	Cogeneration of energy (CHP) for industry	Cogeneration is the generation of both heat and electricity in one plant using the same fuel. It works by reusing heat energy which normally is simply released. Combined heat and power (CHP) plants significantly reduce energy losses		

4. Energy Savings (Behavioural Change)

Nr	**Title**	**Description**	**Scope**	**Type**

4.1	Energy box and energy saving consult for low-income households	A Municipal project which provided 12,000 low-income households in Utrecht with a **free energy consult** and energy saving box, with unemployed residents trained to act as energy-saving consultants.		
4.2	Smart meters with energy feedback display units	Smart meters record detailed information about energy consumption and this is displayed on the feedback display units, allowing customers to become more aware about their consumption patterns. An initial project in Geuzenveld in Amsterdam has shown that households with such units are more environmentally-friendly and aware about their energy usage.		
4.3	Climate Street Party Competition (klimaatstraatfeest)	A kind of competition in which residents of a particular street win a prize by proving that they collaborated to reduce energy consumption.		
4.4	Training local women to be Eco-coaches	A local NGO recruited minority women and trained them to be an eco-coach. In turn, these coaches trained a group of approximately eight friends and neighbours about environmental topics such as energy savings, water saving and waste recycling. Participants met four times to exchange ideas on improving their environment and to be trained. The local NGO provided learning materials and assistance. All participants received an energy saving box which contained various simple tools such as energy efficient light bulbs. In total there were 800 participants and 1000 tons of CO_2 saved/yr with the project.		

5. Public Infrastructure

Nr	Title	Description	Scope	Type
5.1	Switching streetlights to LED lights	As done in Eindhoven, the base of international and LED lighting industry leader Philips, municipalities can switch street lighting to more efficient LED lighting. By replacing 94 luminaires with mercury bulbs 80W and 50 luminaires with HPS bulbs 50W on existing poles, Eindhoven saved energy and reduced CO_2 emissions.		
5.2	Heatsavr liquid pool cover	Heatsavr™ is an effective liquid pool cover that greatly reduces heat loss and evaporation from the surface of a pool. Heatsavr™ is made of biodegradable ingredients which reduce the rate of heat evaporation and humidity, reducing heating costs. The city of Amsterdam has partnered with Heatsavr to introduce the sustainable technology in the city's public pools.		

Theme II: Water Supply

6. Water Quality – Treatment, Storage & Monitoring

Nr	Title	Description	Scope	Type
6.1	Green Accounting	Green accounting sheds light on the value of environmental resources, by incorporating costs to the natural environment into traditional		

		calculations, such as domestic product or national product. At the national level, green accounts usually are composed of “natural resource asset accounts; pollutant and material flow (energy and resources) accounts; environmental protection and resource management expenditures; and environmentally adjusted macroeconomics aggregates (including indicators of sustainability).” Green accounting reports are prepared in addition to the traditional ones.
6.2	Vegetated swales (see also 7.2)	Vegetated swales can be used to treat and store polluted run-off from roofs, streets, or other surfaces. The soil helps to filter out phosphates and heavy metals, and organically treat the water. Excess water can also be stored in boxes below the swale. They can withstand normal storms, and otherwise the water simply overflows into the surface water.
6.3	Vertical reed bed filters (See separate document for illustration)	Vertical reed bed filters can be used to remove phosphate from water. The vertical reed bed filters are made up of sand and iron partical filters that are then covered by broken stones and reeds. The reeds growing over the sand serve to keep the filter open for water to flow in and out. The top layer of broken stones prevents the water flowing in from washing out the sand filter at the inlet. It is possible to cover the filter with parkland, thereby enabling the use of the land for multiple functions.
6.4	Infiltration Transport (IT) drains (see also 8.5)	IT drains are porous drains that are located above the groundwater level. Stormwater run-off is collected by street gullies and discharged to the drains. From the IT drains, water drains into the soil. The benefit of IT drains is that they compare with vegetated swales in terms of water treatment efficiency, but they use less space.
6.5	Green or vegetation roof (see also 8.6)	Roofs covered with vegetation can assist in rainwater collection and storage, while also acting as a natural filter for the water. Since July 2008, the municipality of Rotterdam has had a subsidy scheme for green roofs falling under the Rotterdam climate adaptation programme, Rotterdam Climate Proof. People who want to construct a green roof can request a subsidy of up to € 30.00/m2: € 25.00 of which comes from the City of Rotterdam and € 5.00 from the water boards.
6.6	Perfector-e (emergency) portable water purification unit (See separate document for illustration)	Designed by a Dutch company and since applied around the world in various disaster situations, the Perfector-e is a self-contained mobile water purifier. Although not designed for desalination, it can treat any type of polluted surface water to produce high-quality potable water. The system runs on a mobile generator, and it can produce 2000 liters per hour of water. The Perfector-E relies on membrane filtration technology and disinfection by ultraviolet light. It is low-cost and easy to maintain..
6.7	SolarDew water purification systems (experimental)	SolarDew is a new technology for producing potable water from almost any source of polluted,

	(See separate document for illustration)	contaminated or saline water. SolarDew relies on a patented new membrane technology, evaporation and condensation, and runs on solar energy. It is simple to install, maintain and apparently affordable for families, households, or small communities.		

7. Water Quantity – Surface Catchment

Nr	Title	Description	Scope	Type
7.1	Vegetated swales	Vegetated swales can be used to treat and store polluted run-off from roofs, streets, or other surfaces. The soil helps to filter out phosphates and heavy metals, and organically treat the water. Excess water can also be stored in boxes below the swale. They can withstand normal storms, and otherwise the water simply overflows into the surface water.		
7.2	Disconnection of paved surface from sewer system	Instead of directing storm water to the sewers, it can be locally treated and retained. Different technologies can be combined to achieve this, such as permeable pavement, vegetated swales, reed filters, etc.		

8. Water Quantity – Rain- & Groundwater Catchment

Nr	Title	Description	Scope	Type
8.1	Rain and storm water use in agriculture (see also 16.1)	In Maasbree, the Netherlands, rain and storm water is used for watering the plants in this largely horticultural area, as opposed to drinking water. Storm water can be stored in buffer areas underground. Aquifer Storage and Recovery (ASR), where water is stored in a layer below the ground, is one technology that can be used. This can cut costs too, because it is no longer necessary to build huge and costly surface reservoirs.		
8.2	Private cisterns to collect rainwater instead of sewers, regulations for where residents can wash cars (see also 12.1)	In the residential ares of De Vliert In Den Bosch, the Netherlands, the city opted to update the sewer system to improve water management. Where previously storm water and sewage had been collected in one system, the two are now separated. Rainwater is collected locally in private cisterns, where it then filters into the ground, and only sewage goes to the waste treatment plant. This improves the plants efficiency, since they no longer have to deal with rainwater, and the groundwater is constantly being renewed by the rain. The project sought participation and collaboration by the city, local water board, and residents themselves.		
8.3	Aquifer storage and recovery wells	Aquifer Storage and Recovery involves the pumping of extra water down into an aquifer, and then pumping it back out when necessary. In the western part of the Netherlands this method is used to irrigate greenhouse vegetables and flowers. This is particularly helpful since surface water in this region is too saline to use. In this case ASR wells are filled 15-50 m deep with rainwater, which is collected from the roofs of the greenhouses. In the last 20 years, over 100 of these ASRs have been successfully constructed.		

8.4	Permeable pavement with gravel water storage (see also 19.9)	Permeable pavement with just gravel, no cloths. In this construction, a bed of gravel is laid under the permeable pavement, providing a foundation for the street and a significant area for water storage. The joints in the pavement allow storm water to flow down into the gravel. The different layers act as filters, with the top layer of “finely broken” stones helping to eliminating “heavy metals and hydrocarbons (PAHs)”, and below it more cours stones enable organic bacterial water treatment. In the Netherlands permeable pavement can be cheaper (40 EUR/m2 vs 45 EUR/m2) than traditional pavement.		
8.5	Green or vegetation roof	Roofs covered with vegetation can assist in rainwater collection and storage, while also acting as a natural filter for the water. Since July 2008, the municipality of Rotterdam has had a subsidy scheme for green roofs falling under the Rotterdam climate adaptation programme, Rotterdam Climate Proof. People who want to construct a green roof can request a subsidy of up to € 30.00/m2: € 25.00 of which comes from the City of Rotterdam and € 5.00 from the water boards.		
8.6	Wadis (See separate document for illustration)	A wadi is a ditch or grass field that is used to store water. A storage trench made of gravel and a drainage pipe is constructed below the ditch or field. Water can be stored here while it is gradually released into the surface water.		

9. Wastewater Treatment

Nr	Title	Description	Scope	Type
9.1	SHARON Nitrogen removal from wastewater (See separate document for illustration)	SHARON is a system for the removal of nitrogen from wastewater. More specifically the SHARON system is used to treat “high strength ammonia liquors such as sludge dewatering liquors and the liquid fraction of pig manure.” Where as most nitrification/denitrification systems produce nitrate, SHARON results in nitrite, which is more cost-effective. The SHARON system does not retain sludge, so ostensibly less operator oversight is necessary, and necessary initial equipment investments are lower. Moreover, the system uses ANAMMOX bacteria, which convert ammonia into nitrogen gas using 60% less energy than conventional nitrogen removal systems. The process was developed by a Dutch technology supplier and consultant, in cooperation with two Dutch universities. SHARON-ANAMMOX® is currently used at the Rotterdam wastewater treatment plant.		
9.2	DEMON sustainable nitrogen removal with deammoniazition (See separate document for illustration)	The DEMON process is a nitrification/deammonification process in which ammonia and nitrite are simultaneously converted to nitrogen gas, without the use of organic carbon. The process is controlled through small variations in pH, which is efficient and can help to cut costs. In comparison to conventional nitrification-		

		denitrification systems, the DEMON boasts 50 % energy savings for nitrification and 100 % on carbon source. The full-scale DEMON system has already been installed 9 times, and 6 more are either under construction or in the initial stages. The DEMON system at Apeldoorn WWTP, the Netherlands, has an ammonia removal capacity of 1500 kg/day.		
9.3	Nereda Wastewater Treatment Technology (See separate document for illustration)	The Nereda system was first developed at Delft University, and it is now internationally applied. It is a cost-effective easy to use technology marketed by DHV engineering company. It treats water by means of an aerobic granular sludge.		
9.4	Carrousel cost-effective aerobic wastewater treatment technology (See separate document for illustration)	Carrousel® is a proven, reliable and cost-effective technology for the biological treatment of municipal and industrial wastewater. For example, the n carrousel®1000 system is used for smaller villages and industries.		
9.5	the Norit Airlift MBR for Municipal Wastewater	The Norit Airlift MBR is a compact water purification system. It brings together biological degradation and membrane separation. It is superior to traditional activated sludge systems because it produces a "higher biomass concentration and less sludge carry-over", which in turn reduces the size of the system and post-treatment needs. The system consumes the same or even less energy than submerged membrane systems because of "efficient use of process conditions for flux enhancement."		

10. Desalination

Nr	Title	Description	Scope	Type
10.1	Reverse osmosis desalination plants (ProMinent) (See separate document for illustration)	Reverse osmosis desalination plants by ProMinent use low pressure membranes, which can reduce operation costs up to 50%. They also use the latest energy recovery systems, high-quality components, and microprocessor control.		
10.2	CapDi (Capacitive deionization) Desalination Technology (See separate document for illustration)	System that desalinates brackish water at a lower economic and environmental cost than any other available technology. CapDI removes dissolved salts from water, helping to reduce water usage and save money. CapDI can recover between 80% and 90% of the water treated, compared to 50-70% for reverse osmosis. CapDI takes advantage of the energy stored in the electrodes during desalination, helping to improve energy efficiency. The system does not require additional chemicals as other systems do.		
10.3	Delft University Reverse Osmosis desalination plant using renewable energy sources	Delft University of Technology is developing a stand-alone reverse osmosis desalination plant powered by renewable energy sources. The first prototype relies on wind energy to power high pressure pumps. The plant has proven strong, easy to maintain and operate, and sustainable.		
10.4	Dutch Rainmaker (See separate document for illustration)	Dutch Rainmaker uses windmill technology to produce drinking water from air (Air to Water product range). It can also be used for desalination of seawater (Water to Water		

product range). Desalinisation is achieved through the "principles of mechanical vapour recompression". The system can operate at high efficiency even without access to the power grid. This technology could be used in areas with brackish or briny water problems to produce drinking water. The output is greater for the Water to Water line than the Air to Water line.

11. Watershed Management – Information

Nr	Title	Description	Scope	Type
11.1	Educational Groundwater level recorders	In Tilburg a project was begun in 2002 to install 15 educational groundwater level recorders in areas frequented by cyclists and pedestrians. The recorders, which were designed by an artist, are meant to highlight the importance of groundwater levels to residents. A sign with information about the importance of groundwater levels to soil moisture and the local area was placed next to each recorder. The project was expanded in 2005 elsewhere.		
11.2	Use of road signs to indicate groundwater protection areas	Protected groundwater areas can be demarcated with roadside signs. These should make people more aware of the areas and what they can and cannot do there.		
11.3	Using maps to ensure most cost-effective remediation interventions	In the Netherlands, the Harbour Company Rotterdam and TNO are using the WELCOME-strategy to address contaminated areas. The WELCOME-strategy is attempting to improve groundwater quality in the most cost-effective way. As part of the strategy, maps are created to show where pollution is coming from, and its impact on water areas. This in turn is used to set priorities. Soil and groundwater models are also used to determine the spread of pollutants and measures taken accordingly.		
11.4	Educational game about water use	The Chain consultancy company developed a game about water that was used to educate people about water uses and how the use of water in one sector affects another.		
11.5	Involving important figures in publicity campaigns	The Crown Prince of the Netherlands presided over the Second World Water Forum held in The Hague in March 2000. This attracted a lot of attention in the Dutch media. This raised media attention to the Forum and to the issues of water.		

12. Watershed Management – Regulation

Nr	Title	Description	Scope	Type
12.1	Private cisterns to collect rainwater instead of sewers, regulations for where residents can wash cars	Car washing in the streets of Den Bosch/De Vliert is now banned. Instead, they can use designated car-wash spots, which drain to the sewage system rather than infiltrating the soil.		
12.2	Defining Groundwater Protection Zones	In the Netherlands groundwater protection zones are defined according to the following principles: Water abstraction areas are jointly held by the water supply companies, ranging from 0.25-7 hectares. The depth of abstraction depends on		

Nr	Title	Description	Scope	Type
		the quality and flow of the groundwater. Groundwater protection zones are sometimes set around abstraction areas. Hydrogeological data is used to determine the area in which groundwater is likely to reach the point of abstraction between 25 and 100 years. This area is then protected from any well drilling. On average in the Netherlands, a protection area is 1-3 km wide.		
12.3	Water Assessments for all structure and land use plans (beyond city)	Since 2003, all land use and structure plans have been subject to a water assessment that determines the impact of spatial developments on the water system. In this way by incorporating water issues into planning from the early stages negative effects on the water system can be limited or compensated for.		

13. Watershed Management – Pricing

Nr	Title	Description	Scope	Type
13.1	Approval of water plan and budget by users	In the Netherlands, water boards are governed by councils, with the council members representing the various categories of water users. Representation is based on the amount of water charge paid by the user category. The councils meet to discuss and approve the annual plan and budget of their water board.		
13.2	Tax on ground water (beyond city)	The tax on water supply is part of the Dutch government's policy to reform the fiscal system, restructuring it and making it more green. The tax also aims to motivate water conservation and reduce the use of groundwater vis-à-vis surface water. However, groundwater is normally cheaper to extract than surface water, so the tax aims to reduce this difference in price. At its current rate, the tax is rarely enough to make surface water more cost-efficient.		
13.3	Tax on tab water (beyond city)	The tax on tap water is levied on the delivery of (drinking) water to a maximum of 300 m3 per connection per year. The water companies themselves pay the tax, but they can pass on the cost to consumers. Tax Rates: The rate is Euro 0.146 per m3 (VROM, 2006). Exemptions: The supply of water for emergency provisions, like fire taps and sprinkler installations, are exempted from the tax.		

Theme III: Flood Response Management

14. Physical Structures

Nr	Title	Description	Scope	Type
14.1	Groyne design	Groynes in rivers can be designed in certain ways to help regulate the flood waters.		
14.2	Inflatable Dam in Kampen	The unique, inflatable storm-surge barrier at Ramspol is made of three large bellows made of		

		rubberized cloth, which fill with water and air when flooding is expected. Under normal conditions the bellows are deflated and lay on a foundation in the lake. Each one is 8 m in diameter, making them the world's largest. While elsewhere such inflatable barriers are used for normal flood control, the Ramspol Dam should withstand serious storms. This type of barrier provides effective protection from high tide, does not compromise navigation and is relatively cheap.		
14.3	Temporary Reparation of dikes with sheet wall and sand	After a dike of the Rotte River near the village of Wilnis breached, the spilling water was blocked with a temporary waterproof sheet pile wall and the dike was strengthened with sand. After this was done, the local Water Board prepared plans for reinforcement and permanent restoration of the dike along 1.5 km.		

15. Use of Natural Environment

Nr	Title	Description	Scope	Type
15.1	Storm water use in agriculture	In Maasbree, the Netherlands, rain and storm water is used for watering the plants in this largely horticultural area, as opposed to drinking water. Storm water can be stored in buffer areas underground. Aquifer Storage and Recovery (ASR), where water is stored in a layer below the ground, is one technology that can be used. This can cut costs too, because it is no longer necessary to build huge and costly surface reservoirs.		
15.2	Reactivation of flood plains	After a major threat of flooding in 1995, the Netherlands reconsidered its water management policy in the Netherlands. One of the new concepts to emerge was the idea of creating additional space for the rivers, which would improve their ability to absorb flooding. Some smaller dikes were therefore removed, additional channels and trenches constructed, and the original flood plains restored. This not only improved flood management, but also had the potential to improved groundwater replacement.		

16. Information & Institutional Capacity

Nr	Title	Description	Scope	Type
16.1	Flood Control Dashboard (See separate document for illustration)	Developed by HKV as part of the Floodcontrol 2015 project, the Flood Control Dashboard streamlines and aggregates available information about flood risks and real-time data from various sources (such as weather satellites, GPS, social media) into one user-friendly, customizable platform. Designed to make information clear to decision-makers. It has been implemented in Kampen, Noordwaard, the waterboard Groot Salland) as well as Jakarta.		

16.2	Floodex preparation exercise	The Floodex exercise (September 2009) was held to practice managing a major international response in the case of a major flooding disaster. Severity was based on the Worst Credible Flood Scenario for the NL. Preparing for and conducting the exercise was very useful for determining what factors have to be considered in an international rescue effort, including legal barriers, communication, oversight, etc. that were not previously considered. Conclusion: if procedures for receiving international assistance are streamlined response efforts are much more efficient.
16.3	Using Volunteers for Emergency inspection of embankments	In the Netherlands, it is the responsibility of local Water Boards to conduct quality checks on embankments and take precautionary measures when needed. In extreme conditions, when water levels are high, volunteers can be deployed to guard some of the embankments.
16.4	Water Awareness Campaign	The government started an awareness campaign – “The Netherlands lives with water” – to explain its policy of “giving water more room” and obtain support for it. Well-known Dutch weather expert served as the government’s spokesperson in the awareness campaign to explain the policy in simple terms to the public. The expert taught people about the different measures taken by national and local authorities to keep the country safe from the threat of flooding.
16.5	Extendable Hazard Mapping System	As part of its national safety policy, the Dutch Government has developed a Flood Management System that helps to assess the possibility of a flood to occur at a given place and the damage it could cause. The system also provides information on what action can be taken to minimize risks; thereby helping in the construction of evacuation plans as well as for spatial planning. The system has been designed as a set of modules, making it flexible and easy to develop as it can be expanded by attaching new modules.
16.6	Disaster Warning Sirens	An information campaign by the Dutch government with the goal of educating and guiding citizens on how to prepare for disasters. It includes suggestions for making a disaster kit and a website (crisis.nl) where information would be posted in a disaster situation. It also includes a pilot project for an NL-alarm system which would send out warning text messages to all mobile phones in the affected area.
16.7	Denk Vooruit or "Think ahead" Information Campaign	Information campaign by the Dutch government with the goal of educating and guiding citizens on how to prepare for disasters. Includes suggestions for making a disaster kit and a website (crisis.nl) where information would be posted in a disaster situation. It also includes a pilot project for an NL-alarm system which would send out warning text

		messages to all mobile phones in the affected area.		
16.8	Flood Risk Zoning (See separate document for illustration)	Involves the mapping of what areas will be submerged and what areas dry in a flooding scenario. They can help to reduce the number of victims in a flood. This should represent the worst case scenario, or Worst Credible Flood Scenario. Cities can for example be divided into safe areas, warning areas, and unsafe areas and colour coded accordingly. in red: unsafe zones with more than 3 meters of water, in orange (warning) zones with on average 1-3 meter and dry (safe) areas nevertheless with chain effects of the flood (no electricity, no sanitation, no food, no water).		
16.9	Risicokaart.nl	A website that allows individuals to access their own risk to flooding based on their postcode or city.		

17. Financial Services

Nr	Title	Description	Scope	Type
17.1	Subsidy for diverting run-off from impermeable surfaces to the sewage system	In Nijmegen the local government together with the Rivierenland Water Board provides a subsidy of 4.55 Euro for each m2 of impermeable surface.		

18. Land Use & Surface Run-off

Nr	Title	Description	Scope	Type
18.1	Enlarging river beds	In the city of Zutphen there are plans to expand the Ijssel river bed in order to prevent flooding. The higher areas are developed and the lower areas used as water storage.		
18.2	Dyqualizer (See separate document for illustration)	A platform that aims to initiate dialogue between diverse stakeholders in water management and flood control, such as urban planners, waterboards, and city officials. It allows these different stakeholders to each provide their opinion (by "tuning" the dyqualizer on various properties of water defences, for example what they think the safety level of the dike is. It consists of three spatial planning and three flood safety criteria, each of which can be allowed to weigh more or less heavily in a particular design. The criteria are technical design, manageability, extensibility, land use, barrier effect and functions. By modifying the weight given to these criteria, proposals can be 'fine-tuned' to take account of different interests.		
18.3	Water Assessments for all structure and land use plans (beyond city)	Since 2003, all land use and structure plans in the Netherlands have been subject to a water assessment that determines the impact of spatial developments on the water system. In this way, by incorporating water issues into planning from the early stages negative effects on the water system can be limited or compensated for.		

18.4	Sustainable urban drainage systems	The FLOWS (Floodplain Land Use Optimizing Workable Sustainability) project aims to implement Sustainable Urban Drainage Systems (SUDS) in several countries in Europe. These SUDS have as their goal reducing the risk of flooding, improving water quality, replacing groundwater and improving biodiversity. SUDS techniques include filter strips, filter drains, permeable surfaces, infiltration devices and basins and wetlands. These strategies improve groundwater infiltration and long-term storage.
18.5	System to divert storm water from the sewage system	In urban environments storm water often flows directly in the sewerage system, preventing groundwater renewal and increasing the chance that water treatment facilities become overburdened. In "De Vliert" in Den Bosch a separate "infiltration system" was put in place to remove the storm water. Storm water is captured and slowly released into the soil.
18.6	Impermeable layer constructed under porous asphalt to prevent pollution	In the Netherlands porous asphalt is used in 60% of the highways. Porous asphalt reduces noise pollution and avoids bad visibility during heavy rainfall. When it rains, pollutants in run-off water can enter the groundwater. The pores in the asphalt allow rainwater to filter through the road. Beneath the asphalt an impermeable layer can be placed, retaining the pollutants and oil in the asphalt, where it is removed regularly.
18.7	Integrating land and water management	After the village of Rijssen experienced severe flooding in 2002 because the drainage system could not handle excess rainfall, the local government decided to improve land and water management. They chose to install larger storm water discharge pipes, and also improve storage basins and groundwater infiltration of rainwater. Additional strategies were presented at a public meeting, including low-level retention sites (i.e.parks in low-lying areas).
18.8	Infiltration Transport (IT) drains	IT drains are porous drains that are located above the groundwater level. Storm water run-off is collected by street gullies and discharged to the drains. From the IT drains, the water infiltrates into the soil (sand). IT drains require less space than vegetated swales and their treatment efficiency is similar.
18.9	Permeable pavement with gravel water storage (See separate document for illustration of Aquaflow system)	Permeable pavement with just gravel, no cloths. In this construction, a bed of gravel is laid under the permeable pavement, providing a foundation for the street and a significant area for water storage. The joints in the pavement allow storm water to flow down into the gravel. The different layers act as filters, with the top layer of "finely broken" stones helping to eliminating "heavy metals and hydrocarbons (PAHs)", and below it more cours stones enable organic bacterial water treatment. In the Netherlands permeable pavement can be cheaper (40 EUR/m2 vs 45 EUR/m2) than traditional pavement.

5. Trends in Dutch Innovation Policy:

There are a variety of factors, which influence whether, and if so to what extent, innovative technologies are being taken up in a society. In the case of the Netherlands, it is useful to look at Dutch innovation policy in general, to identify the main characteristics of the country´s innovation system, and to then assess the most important factors influencing innovation uptake in the field of urban energy- and water management.

5.1 Innovation Policy in the Netherlands

In international comparison, the Netherlands scores high on innovation policy. According to the Global Innovation Index (GII)[v], the Netherlands ranked 10th in the world in 2009. This ranking is based on eight pillars (five for inputs and three for outputs). The measured inputs include 1) institutions and policies; 2) human capacity; 3) infrastructure; 4) market sophistication; and 5) business sophistication. Outputs include 1) knowledge; 2) competitiveness and 3) wealth. While the Netherlands only ranks 12th on the input pillars, it ranks 8th in terms of output. This positive input-output ratio positions the Netherlands 3rd in the world when it comes to innovation effectiveness. The GII states that countries with a good input-output ratio are "in spite of a relatively poor environment, […] able to deliver in terms of output"[vi].

Several factors explain why the Netherlands, comparatively, has a relatively poor supportive environment for innovation. The 2008 European Innovation Scoreboard termed the Netherlands as an 'innovation follower' – i.e. the country has a strong position regarding human resources and innovation support, but has a lower score regarding corporate investments (below the EU 27 average).[vii] However, Dutch innovation policy has gradually succeeded in improving the challenges of its innovation environment. The 2009 INNO Innovation Policy Progress Report for the Netherlands states that structural problems have been addressed, including the lack of coordination between various involved parties, the small number of operational objectives to increase innovative SMEs, and the need for more structural funding of R&D and innovation investments.[viii]

Zooming in on the actual policies, Dutch innovation support has over the last five years become more focused on selected priority areas. In general terms, innovation policy in the period 2007-2011 was guided by ten objectives aimed at improving the country's overall innovation position. In 2007 the Dutch further renewed the so-called Innovation Platform, which had originally been set up as a temporary entity. Its objective was to "especially focus on the development of new innovation programmes in health care, sustainable energy and water management". This platform was also part of the much broader initiative 'Netherlands Entrepreneurial Innovation Country Project', which focused on creating a long-term strategy for innovation and entrepreneurship.

In 2008, the Dutch established the 'Knowledge & Innovation' programme department (K&I). Since then, the K&I acts a forum for all ministries associated with the innovation sector and stimulates these to work together on policies related to innovation. Furthermore, the K&I is responsible for 1) developing agendas for prioritised societal themes[ix] and 2) create synergies between the policies for knowledge, innovation and entrepreneurship of the various ministries. Particularly the latter, the INNO 2009 report argues, has improved the Dutch innovation system.

The economic crisis in 2009 had a negative effect on the Dutch innovation performance. New challenges became a priority, such as:

- The need to raise the number of innovative SMEs, not only in industries, but also in the country's relatively large services sector
- The need to create a more stimulating environment for innovative entrepreneurship (e.g. by reducing bottlenecks and improving access to capital)
- The need to improve the attractiveness of the Netherlands as a location for knowledge-intensive activities and innovation, particularly for foreign R&D companies
- The need to create an excellent climate for both learning and research to secure a sufficient supply of new (doctorate) graduates

The most recent developments in Dutch innovation policy have led to a much greater emphasis on a number of selected priority sectors. The newly established Ministry of Economic Affairs, Agriculture and Innovation aims to make the Netherlands one of the five leading knowledge economies. Nine so called 'top areas' (including water and energy)[x] will receive € 1.5 billion in a bid to increase the competitiveness of these sectors. The 2011 INNO report states that "this approach can be seen as an unexpected break with the egalitarian Dutch tradition of non-discrimination".

This recent shift towards a selected group of sectors does not mean that Dutch innovation policy is strictly focused on technological R&D. Since 2006, the Netherlands established, under the auspices of the Innovation Platform, the Centre for Social Innovation. Its work emphasizes the need to bridge the gap between what is technologically feasible and socially acceptable. Such a broker function can act as a catalyst for technology uptake.

5.2 Factors influencing innovative technology uptake in the Netherlands

The Netherlands has a relatively fragmented science and research community. It includes 13 universities, 18 KNAW institutes, six NWO institutes, five large technological institutes (GTIs), four technological top institutes (TTIs), 14 TNO institutes, and a number of state owned research and advisory centres.

For the purpose of this report, we focus on four separate factors that are considered key to innovation and the uptake thereof. This selection is based on a review of relevant academic and policy documents on innovation policy in the Netherlands. We distinguish between human and organisational factors respectively, and look at innovation on the one hand, and innovation uptake on the other (as factors influencing innovation are closely interrelated). Figure 3 below presents a schematic overview of these four selected factors. It should be noted that all of these factors are in one way or another dependent on adequate funding. In the case of the Netherlands, the financial resources available for the various aspects of innovation-related polices are too diverse to summarise in this report. These are highly context-specific and would not necessarily serve as a best practice for other innovation systems. It is recommended to identify financial limits and opportunities for the country- or region-specific contexts as part of a follow-up activity to this report. When doing so, it would be useful to pay particular attention to public procurement as a driver for innovative technology uptake.

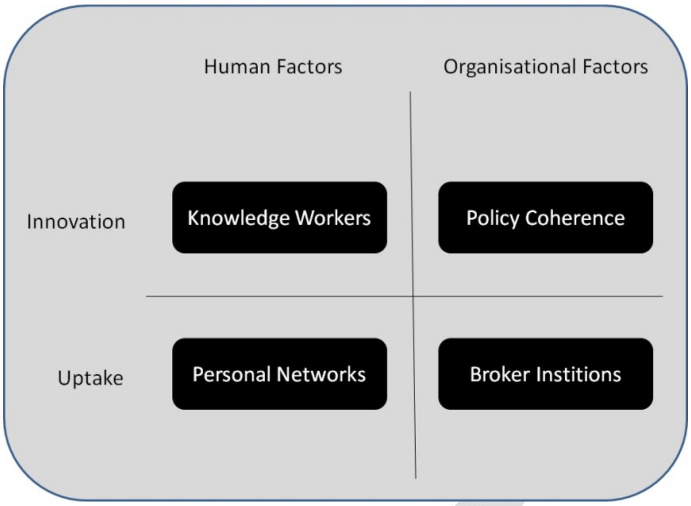

Figure 3: Four selected factors that influence innovation and the uptake thereof

Knowledge workers: it is difficult to create a knowledge-intensive economy without an adequate pool of human resources. In the Netherlands, challenges include the university level, where overall numbers in science are low and drop-out rates are relatively high. In addition, career opportunities are limited for those who have chosen a scientific profession, which limits the creative competition. In addition, there is limited knowledge creation due to the fact that it is difficult for knowledge workers from abroad to enter the Dutch labour market.

Policy coherence: the Dutch innovation system is marked by "a strong division of labour between science on the one hand and technology and innovation on the other hand"[xi]. Each level within the innovation system has its own standards, working cultures and funding regulations. While there has been a trend towards more cooperation over the last couple of years, the lack of policy coherence still acts as a major barrier to innovation.

Personal networks: knowledge workers in the Netherlands are often connected through informal routes, and communicate with all relevant actors throughout the system. This circumvents the problems attached to the highly complex system of formal institutions across the country. The case of the Netherlands shows that a well-developed network amongst key people has a crucial function in innovation uptake.

Broker institutions: one of the biggest challenges for the Netherlands lies in the diffusion and valorisation of relevant innovation. In particular, there is a need to bridge the gap between what is technologically feasible and socially acceptable. Recent years have led to public initiatives such as the NL Centre for Social Innovation, which sole aim is to facilitate this process of ´societal immersion´. Similar initiatives are placed within existing public institutions, such as theme-specific knowledge platforms chaired by a ministry. However, innovation experts consider this alone insufficient to enhance the level of innovation uptake.

The example of the Netherlands shows that both human and organisational factors play an important role in the Dutch innovation system as a whole. This is also the case when looking at the technology uptake specifically in the field of urban energy- and water management. The overview presented below lists some of the key broker institutions in the Netherlands and their function within the water- and energy-specific Dutch innovation network.

Name	Thematic focus	Main function	Website
Deltares	Water / Living	…to develop, acquire, apply and disseminate integral, multidisciplinary knowledge and knowledge products related to living and working in delta (coastal, estuarine, riverine) areas, on an internationally leading level.	www.deltares.nl
Netherlands Water Partnership	Water / General	…to unite Dutch water expertise among its members from private, governmental, research and NGO players.	www.nwp.nl
WETSUS	Water / Treatment	…to create a unique environment and strategic cooperation for development of profitable and sustainable state of the art water treatment technology.	www.wetsus.nl
KWR Water Recycle Institute	Water / Treatment	…to assist society in optimally organising and managing the water cycle by creating knowledge, building bridges between science, business and society and promoting societal innovation.	www.kwrwater.nl
HeliXER	Water / Quality	…to bring together public entities, private companies and research institutes to work on the development of water-related consumer products, with a strong emphasis on the "water experience" and health, and a short "time to market" for products.	www.helixer.nl
RIONED	Water / Drainage	…to function as a centre of expertise and promoter of the interests of sewerage and the urban water management sector.	www.rioned.net
STOWA	Water / General	…to coordinate and commission research on behalf of a large number of local, provincial and national water authorities.	www.stowa.nl
Utrecht Sustainability Institute	Water / Energy	…to work together with the business community, the government, and other social partners in order to integrate and apply knowledge.	www.usi-urban.nl
TNO Applied Research	Water / Energy	…to connect people and knowledge to create innovations that boost the sustainable competitive strength of industry and well-being of society.	www.tno.nl
Agency NL	Energy	…to support the excellent implementation of international, innovation and sustainability policy.	www.agentschapnl.nl
NIBRA Institute for Safety	Flood Response	…to gather and enhance knowledge for subsequent dissemination. And this includes the compiling of knowledge in written form for course purposes.	www.nifv.nl
ENW Expertise Network for Flood Protection	Flood Response	…to bring together expertise for flood protection in its widest sense. Its activities cover both physical water management and social aspects, both for primary and regional flood defence systems.	www.enwinfo.nl

The Dutch water sector is particularly interesting. Water being a major priority for the Netherlands, there is a great variety of semi-public broker institutions for water-related issues (see table above). Despite this complex network of intermediaries, it is still difficult to match demand and supply for innovative water technologies. The major dilemma lies in finding the right balance between streamlining the various broker roles (top-down) on the one hand, and to build on more informal, personal networks in order to foster a (bottom-up) exchange between science and practitioners. In other words, the Dutch experience in using broker institutions for technology uptake shows that the mere existence of these intermediaries is not a guarantee for a greater valorisation of scientific innovation. Research often remains too abstract for practitioners, and practitioners often lack the time to wait for research results. Instead, it might be useful to facilitate a more intensive dialogue between individuals – facilitated by intermediaries – and to bring them together for solving specific problems that can be dealt with in a shorter time-span.[xii]

Whereas this might be a promising approach, it is only one possible solution. The list of technologies presented in section 5 shows many different types of innovation, and it remains a difficult task to assess whether one particular factor could be considered instrumental in supporting the uptake of a given technology. For a more detailed analysis, it would be worthwhile to gather survey data from those stakeholders that were involved in a particular technology uptake, and to identify the role of personal networks on the one hand and broker institutions on the other.

6. Analysis: Low-cost/small scale

The table below scores each of the selected 77 technologies for the two categories low-cost and small-scale. It uses a scale from one to three asterisks. One asterisk stands for NOT low-cost or NOT small-scale, whereas three asterisks stand for VERY low-cost or VERY small-scale. Those technologies that are rated with three asterisks in either of the two categories are highlighted grey.

Theme I: Energy Efficiency

Nr	Title	Low-cost	Small-scale
	Electric Appliances		
1.1	Energy box and energy saving consult for low-income households (see also 4.1)	***	**
1.2	HR107 combiketel	*	***
1.3	Energy saving box for low-income households	**	***
1.4	Solar hot water heaters	*	**
1.5	Energy labels (beyond city)	***	*
	Architecture / Building Design		
2.1	Municipal energy efficiency requirements	***	*
2.2	Self-adjusting ventilation grate	**	***
2.3	Energy Performance Standards for new buildings (beyond city)	***	*
2.4	Subsidy scheme for window glazing (beyond city)	*	*
2.5	Providing rebates to households that buy energy efficient appliances and installations (beyond city)	*	*
	Industrial Solutions		
3.1	Cogeneration of energy (CHP) for industry	*	**
	Energy Savings (Behavioural Change)		
4.1	Energy box and energy saving consult for low-income households	***	***
4.2	Smart meters with energy feedback display units	**	***
4.3	Climate Street Party Competition (klimaatstraatfeest)	***	***
4.4	Training local women to be Eco-coaches	***	***
	Public Infrastructure		
5.1	Switching streetlights to LED lights	**	**
5.2	Heatsavr liquid pool cover	*	**

Theme II: Water Supply

Nr	Title	Low-cost	Small-scale
	Water Quality – Treatment, Storage & Monitoring		
6.1	Green Accounting	**	*
6.2	Vegetated swales (see also 7.1)	**	*
6.3	Vertical reed bed filters	**	***
6.4	Infiltration Transport (IT) drains (see also 8.5)	**	**
6.5	Green or vegetation roof (see also 8.6)	***	***
6.6	Perfector-e (emergency) portable water purification unit	**	***
6.7	SolarDew water purification systems (expertimental)	*	***
	Water Quantity – Surface Catchment		
7.1	Vegetated swales	**	*
7.2	Disconnection of paved surface from sewer system	*	*
	Water Quantity – Rain- & Groundwater Catchment		
8.1	Rain and storm water use in agriculture (see also 16.1)	**	**
8.2	Private cisterns to collect rainwater instead of sewers	**	***
8.3	Aquifer storage and recovery wells	*	**
8.4	Permeable pavement with gravel water storage (see also 19.9)	*	*
8.5	Green or vegetation roof	***	***
8.6	Wadis	**	*
	Wastewater Treatment		
9.1	SHARON Nitrogen removal from wastewater	**	*
9.2	DEMON sustainable nitrogen removal with deammoniazition	**	*
9.3	Nereda Wastewater Treatment Technology	***	*
9.4	Carrousel cost-effective aerobic wastewater treatment technology	**	**
9.5	The Norit Airlif MBR for Municipal Wastewater	**	**
	Desalination		

10.1	Reverse osmosis desalination plants (ProMinent)	*	*
10.2	Capdi (Capacitive deionization) Desalination Technology	*	*
10.3	Delft University Reverse Osmosis desalination plant using renewable energy sources	*	**
10.4	Dutch Rainmaker	**	**
	Watershed Management – Information		
11.1	Educational Groundwater level recorders	**	**
11.2	Use of road signs to indicate groundwater protection areas	**	*
11.3	Using maps to ensure most cost-effective remediation interventions	**	*
11.4	Educational game about water use	**	***
11.5	Involving important figures in publicity campaigns	***	**
	Watershed Management – Regulation		
12.1	Regulations for where residents can wash cars	***	***
12.2	Defining Groundwater Protection Zones	**	**
12.3	Water Assessments for all structure and land use plans (beyond city)	**	*
	Watershed Management – Pricing		
13.1	Approval of water plan and budget by users	*	*
13.2	Tax on ground water (beyond city)	**	*
13.3	Tax on tab water (beyond city)	**	**

Theme III: Flood Response Management

Nr	Title	Low-cost	Small-scale
	Physical Structures		
14.1	Groyne design	*	*
14.2	Inflatable Dam in Kampen	**	**
14.3	Temporary Reparation of dikes with sheet wall and sand	***	**
	Use of Natural Environment		
15.1	Storm water use in agriculture	***	**
15.2	Reactivation of flood plains	**	*

	Information & Institutional Capacity		
16.1	Flood Control Dashboard	*	*
16.2	Floodex preparation exercise	**	*
16.3	Using Volunteers for Emergency inspection of embankments	***	***
16.4	Water Awareness Campaign	**	**
16.5	Extendable Hazard Mapping System	*	*
16.6	Disaster Warning Sirens	**	*
16.7	Denk Vooruit or "Think ahead" Information Campaign	**	*
16.8	Flood Risk Zoning	**	*
16.9	Risicokaart.nl	**	*
	Financial Services		
17.1	Subsidy for diverting run-off from impermeable surfaces to the sewage system	*	*
	Land Use & Surface Run-off		
18.1	Enlarging river beds	**	*
18.2	Dyqualizer	**	**
18.3	Water Assessments for all structure and land use plans (beyond city)	**	*
18.4	Sustainable urban drainage systems	**	*
18.5	System to divert storm water from the sewage system	**	**
18.6	Impermeable layer constructed under porous asphalt to prevent pollution	*	**
18.7	Integrating land and water management	**	*
18.8	Infiltration Transport (IT) drains	**	**
18.9	Permeable pavement with gravel water storage	**	**

What this analysis reveals is that in all three themes there are various low-cost and small-scale technologies that are already being used effectively in the Netherlands. These innovations could be applied in the Caribbean urban context, even with relatively little institutional and financial capacity. There were six technologies that received the maximum of three asterisks in terms of both categories. They were: the energy box and energy saving consult, the Climate Street Party Competition, and the training of local women to be Eco-Coaches, the green or vegetation roofs, regulations for wear residents can wash their cars, and the use of volunteers for emergency inspection of embankments. An additional eleven technologies received three asterisks in one category and two in another, meaning that they were still relatively low-cost and small-scale: Energy box and energy saving consult for low-income households, energy saving box, smart meters with energy feedback display units, self-adjusting ventilation grate, vertical reed bed filters, Perfector-e (emergency) portable water purification unit, private cisterns to collect rainwater instead of sewers , educational game about water use, involving important figures in publicity campaigns, temporary Reparation of dikes with sheet wall and sand, stormwater use in agriculture. During a three-day workshop with the NSUS project partners in Amsterdam, these technologies were presented and discussed. As a whole, the participants found the list of technologies very interesting and useful, and agreed that the low-cost and small-scale technologies were more realistic for application in the Caribbean at a municipal level. However, participants emphasized the necessity of regulatory policies and standard-setting, which would likely be beyond municipal jurisdiction and therefore need to be set at the national level. Thus STI policy must be a combination of a national and municipal action. **7.**

7. Conclusions

The goal of this B3 report, part of the larger NSUS *network for the application of science technology and innovation to the urban sector*, was to showcase best practices in STI policy. To keep the research and report manageable and to make it as relevant as possible to the Caribbean context, the scope of the study was narrowed. Based on this, it was decided to focus on retrofitting, urban technologies related to water management, flood response and energy efficiency that are currently applied in the Netherlands. These three themes were further divided into 18 subaspects, and a sample of 77 Dutch technologies covering all of them identified. Each technology was further classified according to its scope (household level, community level, city level, beyond city) and type (environmental technology, organizational innovation, appliances and products).

This listing was followed by an analysis of Dutch innovation policy. Internationally, the Netherlands scores very high in terms of innovation effectiveness, with a higher output then input. While this suggests that innovation succeeds despite a weaker support system, efforts have been made in recent years to improve policies and prioritize innovation in key sectors. Still, it proves difficult to match supply and demand for innovation in the Netherlands. After researching Dutch innovation policy, four key success factors for technological innovation and uptake are identified, namely: knowledge workers, policy coherence, personal networks, and broker institutions. They can be differentiated according to their focus on organisational vs. human factors, and innovation vs. uptake. Looking specifically at technology uptake, the importance of broker institutions was emphasized, and an illustrative listing of broker institutions related to water- and energy-management in the Netherlands provided. Particularly in the water sector, there are a large number of institutions aiming to bridge the gap between science, policy, and implementation, however, they do not always communicate effectively with all the necessary parties. There is also tension between the need to coordinate these broker roles (top-down), and to stimulate interaction among individuals which are part of personal expert networks (bottom-up).

During the technical meeting with the Caribbean research partners, the role of broker institutions came up repeatedly. It was suggested that this might be a key area for improvement in the Caribbean context. However, drawing from the Dutch example, the mere existence of broker institutions does not guarantee outcomes. Effective communication between relevant parties and individual networks are also critical.

In the last part of this report, the 77 technologies identified in the Netherlands were analysed for applicability to the Caribbean context, defined by a rating of how small-scale and low-cost each innovation is. This definition was validated by the Caribbean partners during the technical meeting. Seven out of the 77 technologies were rated the highest score in both categories, and an additional 11 had the highest score in one category and the second highest score in the other. Thus, there were a number of technologies under each of the three themes in the Netherlands that should be applicable to the Caribbean urban context. While these technologies have the most potential for implementation at the municipal level, other innovations that are beyond the capacity of the city, such as regulations and standards, could also have a great impact on urban sustainability in the Caribbean.

Annex 1: Terms of Reference (deliverables only)

1) Development of a typology (classification system) for issues in water management, with the emphasis on water management as well as energy as it relates to efficient utilization, transportation and pollution in the urban environment. These will be framed by priorities established under the "Caribbean Urban Agenda" as set out in the draft policy working paper: *Verrest H, Mohammed A, Moorcroft S. Towards a Caribbean Urban Agenda. The Caribbean Network for Urban and Land Management*.
2) Review existing internationally utilized urban technologies, according to the above typology, which are documented, tested and working in a global context and the factors which influence the incorporation of these technologies.
3) Identification of the technologies above which may be adaptable to the Caribbean context.
4) Requirements for implementing such technologies in urban planning and management in terms of financial, institutional and human resources will be included in the discussions. This will be guided by findings from a study, running concurrently, which will identify the existing technologies in the Caribbean as well as evaluate the non-technical and cultural factors which may limit implementation of technologies (C3)
5) Produce a draft report for the Technical Advisory Group in the Netherlands
6) Finalization of Technical Working Paper

Annex 2: Research Plan

Nr	Question	Variable	Indicator	Energy Efficiency	Water Supply	Flood Response
				SAME APPROACH FOR ALL THREE SECTORS		
1	What are possible categories of urban issues in the three sectors 1) energy efficiency, 2) water supply and 3) flood response?	Scale of implementation in the urban context	Categories to be defined with 2 dimensions (same for all three sectors)	**2 Scales:** Scale 1 from small to large:[xiii] 2) household, 3) community, 4) city-wide Scale 2 adopted from MEI[xiv] report 2007: 1) environmental technologies, 2) organizational innovation, 3) products and services	See left	See left
2A	What are matured technologies (in the broader sense) for each category?	Documented (!) technologies (including techniques and policy tools) in the three sectors[xv]	Found in relevant policy documents, research publications in the Netherlands, plus interviews with experts	**Table (2 dimensions):** Step 1: make a list with key publications, experts and institutions in NL and elsewhere in EU with relevant expertise (incl. contact details) Step 2: based on all sources and interviews, create a table and add existing (matured!) technologies for each square. Step 3: provide a short summary (10 lines max) for each technology mentioned in the matrix.	See left	See left
2B	Which factors influence the uptake of these innovative technologies?	Policies geared at promoting/facilitating (officially registered) innovation	Regulatory framework for innovation (national NL) / number of innovations & patents in 3 sectors in NL	**Overview:** Step 1: Write max 2000 words on regulatory framework Step 2: Present overview of relevant patents Step 3: identify policies supportive to eco-innovation Sources: Ministry ELI, NL patent registry (techniques only), innovation experts, publications	See left	See left
3	Which of the technologies identified in 2A are applicable in the Caribbean context?	Technologies that are appropriate in similar conditions as present in the Caribbean	Technologies that are small-scale, low-cost	**Table 1:** Step 1: each technology in column 1, small-scale and low-cost resp. in columns 2 and 3. To be marked with asterisks (1 to 3 asterisks,1=low and 3=high) DEFINITIONS: small-scale = decentral management possible & applicable for small markets low cost = no high-tech solutions Step 2: select all technologies that have at least 3 asterisks in one of the columns 2 and 3.	See left	See left
4A	A) What are the strengths and weaknesses in the Caribbean setting to implementing these technologies?	Relevant reasons for high/low uptake of water/energy innovation	From B3 report: identify those resources (or lack thereof) that are relevant to implementing those technologies identified in 3.	**Table 2:** Step 2: add column to table 1 and fill in those resources[xvi] that are required for successful implementation of each technology Step 3: add 2 columns to table (weaknesses and strength in the Caribbean from B3 study) and add Y/N for each technology. Step 4: add column and sum up which exact weaknesses and strengths from B3 study are applicable for each technology.	See left	See left
4B	Based on the analysis in 4A, what needs to be done in order to facilitate further implementation of these technologies?	(New) policies geared at supporting most cost-effective technologies	Identify possible ways to introduce those technologies with low cost-high return	**Table 3:** Step 1: use table 1 and add column. Step 2: fill in asterisks (1-3) for each technology that is cost-effective in the Caribbean context.[xvii] Step 3: identify possible policy initiatives that help to facilitate further implementation of these marked technologies, based on 1) reducing the relevant weaknesses and 2) building on the relevant strengths Step 4: provide short summary of 4B findings	See left	See left

Annex 3: List of experts who were consulted or interviewed for this report

Name	Function	Organisation	Country
André Koelewijn	Specialist R&D	Deltares	Netherlands
Berry Gersonius	Lecturer in Urban Flood Resilience	UNESCO-IHE	Netherlands
Cristiane Machado	PhD Student,	Federal University of Minas Gerais	Brazil
Parisi Jonov	Researcher	UNESCO-IHE	Netherlands
Frank Spruit	Project Leader	Stichting EREA	Netherlands
Johanna von der Weppen	Water Policy Expert	Ecologic Berlin	Germany
Joost van Ettekoven	Junior Researcher	Nyenrode Business University	Netherlands
Lehna Malmkvist	Vegetation & Aquatic Ecologist	Swell Environmental Consulting	Canada
Leo Bruinzeel	Ecologist	Altenburg & Wymenga ecological consultants	Netherlands
Marco Hartman	Advisor GIS and Water Management	HKV Consultants	Netherlands
Martijn van Staveren	PhD Student Project Officer	Wageningen University Nederlands Water Partnership	Netherlands
Maya Sule	Sr. Advisor/Project Manager	Deltares	Netherlands
Natasja Jonckheere	Office Controller and concept developer	Except	Netherlands
Niels Eernink	Flood Planning Project Leader	Deltares	Netherlands
Niels Roode	Senior Advisor	Rijkswaterstaat	Netherlands
Peter Glerum	Project Leader	EU Floodex	Netherlands
Peter Rommens	Specialist in Energy and Sustainable Building	City of Delft	Netherlands
Prof. Dr. Robert Meijer	Coordinator	Urbanflood Project, TNO and University of Amsterdam	Netherlands
Rudy Rooth	Senior Consultant	KEMA	Netherlands
Ruurd Reitsma	Consultant	Rijnconsult	Netherlands
Vincent van Vliet	Senior Researcher and Advisor	Dutch Institute for Safety	Netherlands

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Notes

[i] The major objective of the entire project is "to contribute to poverty alleviation in the urban areas of the Caribbean by placing socially relevant STI at the heart of applied research and policy-making."

[ii] This does not include water demand management (i.e. water conservation and more efficient use)

[iii] The fourth category 'green system innovation' is not included for this research, as it focuses on system-wide (i.e. national) innovations. This is by definition not small-scale and therefore not applicable to the Caribbean urban context (see research question 3)

[iv] Out of these 77 technologies, seven feature in more than one sub-aspect categories.

[v] This index is published by INSEAD and the Confederation of Indian Industries

[vi] Capgemini Consulting, 2009 Benchmarking Study on Innovation Policy, p. 6

[vii] 2009 INNO Report, p. 4-5

[viii] 2009 INNO Report, p. ii – iii

[ix] energy, water, health care, education, sustainable agro-innovation and safety and security

[x] The nine sectors are: life sciences, high-tech materials & systems, agro-food, water, energy, horticulture and propagation materials, chemistry, the creative industry, logistics

[xi] Boekholt et al 2005

[xii] Report Knowledge Arena Meeting, held on 19 May 2010, p.9 and p.14 (Rijkswaterstaat – Waterdienst).

[xiii] Individual level excluded, as limited practical application

[xiv] MEI: Measuring Eco-Innovation, EU funded research project (UNU-MERIT 2007)

[xv] For the purpose of this research, the primary focus rests on retrofitting. This entails that technologies needed for new developments are only included if there is a proven applicability in similar contexts

[xvi] See ToR ref.4: Focus on financial, institutional and human resources only

[xvii] Definition for cost-effectiveness in the Caribbean: low upfront investments, quick impact and short payback period