nextGen
Circular Water Solutions

D6.4 Replication Potential and Outreach in International Markets

AUTHORS: RUPALI DESHMUKH (IVL), ALEXANDRA JAUNET (STRANE), YANJING ZHU (IVL), YOUNG H. LEE (KIST)

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
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Updates from previous version

Comment addressed	Modification
The deliverable is comprehensive and well thought out from a technology point of view. It addresses the replication potential of 3 solutions, i.e. Sewer Mining, Serious Game and AnMBR, especially for India, China and South-Korea. The chosen countries are of high business potential, but also high risk. It well presents information on 3 associated demo cases in those countries, but the specific potential on circular economy solutions to be replicated remains rather generic and links to the mentioned solutions are not sufficiently clear.	The specific potential on circular economy solutions to be replicated will be further assessed in the next steps of NextGen project. Work on business models and value chains is currently being conducted in other tasks. IWA Conference in Copenhagen (2022) will be an opportunity for NextGen partners to organize a Watershare meeting with our partners IVL (China, India) and KIST (South Korea) where this will be further discussed. (section 5.2.4, p.52)
The elaborated plan needs careful business model iterations in order to support the commercialization. It is recommended that the consortium engages with the international outreach partners to present sustainable business models for a successful cooperation	NextGen partners involved in Sewer Mining deployment, Serious Game and AnMBR technology have been contacted to assess their willingness to replicate their activities in associated countries. Their first feedbacks have been incorporated in the deliverable (section 5.2.4, p.51-52).
A chapter on conclusions should be included.	The chapter on conclusion is now included

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Summary

The innovative NextGen project has potential to develop world-class solutions to societal challenges; hence NextGen decided to promote international cooperation in research and innovation by creating a strong European brand and forging relations with key partners from around the globe. NextGen partners identified and included three demo cases of three partners from India, China and South Korea respectively in order to test the replication potential of NextGen circular water solutions outside EU, in a completely different environment.

To support replication and international commercial success of European expertise with in NextGen targets India and China as priority markets. To achieve this, NextGen is building project visibility and sharing ideas through numerous national and international conferences, 'tech festivals', workshops and seminars in India and China. High-level private meetings with Ministries, Urban Local Bodies have been obtained to accelerate roll out in said countries.

NextGen has also engaged with an international audience through Hammarby Sjöstadsverk – a unique facility for research, development and demonstration of wastewater treatment technologies and the Smart City Sweden platform - a state-funded export platform for sustainable city solutions. This platform serves as a broker between technology providers and users around globe interested in investing in smart and sustainable city solutions.

In addition, the international network Watershare acts as a knowledge sharing platform between water institutes across the globe, and in the focus of NextGen particularly engaged with the South Korean partner.

To encourage the water industry in India, China and South Korea to adopt NextGen technologies, models and concepts, a feasibility criterion for middle-lower-income countries was prepared after studying respective market needs and economic conditions presented in replication potential meeting to Indian, Chinese and Korean side. Three NextGen solutions where identified, i.e. Sewer Mining, Serious Game and AnMBR, and the replication potential of these were analysed, identifying conditions for replication in India, China and South-Korea.

This deliverable describes the development of NextGen associate partner's demo cases in India, China and South Korea, summarises all the activities carried out for 'outreach in international markets', and presents the replication potential of NextGen technologies and tools beyond the EU.

Disclaimer

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1. Introduction

Water and wastewater management are global problem; hence it is important to pursue global approach in solving them. The Innovative Nextgen project has potential to develop world-class solutions to societal challenges, create growth and skilled jobs. Hence Nextgen decided to promote international cooperation in research and innovation by creating a strong European brand and forging relations with key partners from around the globe. Nextgen partners identified and included three demo cases of three associate partners from India, China and South Korea respectively in order to test the replication potential of Nextgen outside EU in a completely different environment. This also helped to understand that Nextgen/EU expertise has potential to replicate elsewhere in the world.

The following activities are undertaken, and reported in this deliverable:

- Demonstration of circular water solutions in India, China and South-Korea
- Exchanging international learning experiences through Watershare and Hammarby Sjöstadsverk Smart City Sweden
- Outreach activities in India and China
- Replication potential of NextGen technologies and tools beyond the EU

To support replication and international commercial success of European expertise with in Nextgen, international outreach targets India and China as priority markets - encouraging them to adapt the technologies, models and concepts within Nextgen. To finetune this and increase success, afeasibility criteria for lower-income countries of NextGen technologies was prepared after studying respective market needs and economic condition presented in replication potential meeting to Indian and Chinese side.

The task 'Achieving outreach and commercial success beyond the EU' was led by IVL. NextGen partners STRANE, UNEXE, IPSTAR, ADASA, WE and ESCI were involved in activities under this task through participation in replication potential meeting and by providing inputs for international outreach events. IVL-TSWO, IVL-JIEI, KIST provided the description of the demo cases in India, China and South Korea.

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2. Associated demo cases

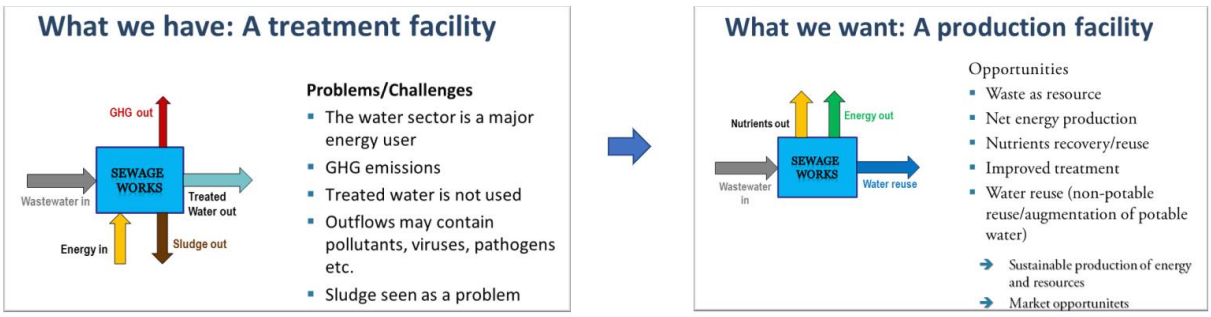
2.1 China: Future Wastewater Treatment Plant

Partner profile:

Jiangsu Yixing Institute of Environmental Industry (JIEI) is a promotion agency of environmental industry. It is planned and finally approved by Jiangsu Science and Technology Department, and its construction and management are in the charge of China Yixing Industrial Park for Environmental Science & Technology. Based on the internal and external resources of the park, the institute keep an open and inclusive service philosophy, aiming to promote the innovation and development for China's environmental protection industry. JIEI is based in Yixing Industrial Park for Environmental Science & Technology. It is one of the first national hi-tech industrial development zone featured in environmental protection industry. It is also an industrial concentration district with the most variety of products and intensive technology for environmental protection enterprises in China. JIEI meanwhile establishes working branch in Beijing—the heart of our country—to set up service communication platform towards the whole industry to promote timely matching of capital, intelligence, policies, talents, information and so on.

Description and objectives

With more than 100 years development, Waste Water Treatment Plants (WWTPs) have been improving people's living conditions and the natural environment. However, with climate change and global population growth, the water shortage is becoming more and more serious and an urgent call to move away from a systematic 'take-make-consume-dispose' behaviour to a circular economy mode in water is gaining traction. In this context, in 2013, 6 well-known Chinese environmental researchers came up with the idea of Future-oriented WWTPs (also called concept WWTPs) and suggested to build a batch of future oriented municipal WWTPs in next 5 years through which, the objectives of below are aimed to achieved. In another word, become the WWTP from a treatment facility to a production facility.



Picture 1: WWTPs to resource production facility (from IVL)

- Sustainable use of water resources -get qualified water resource for different functions and make water reused and recycled.
- Energy recovery-take full advantage of organic matter and achieve energy self-sufficient to WWTPs

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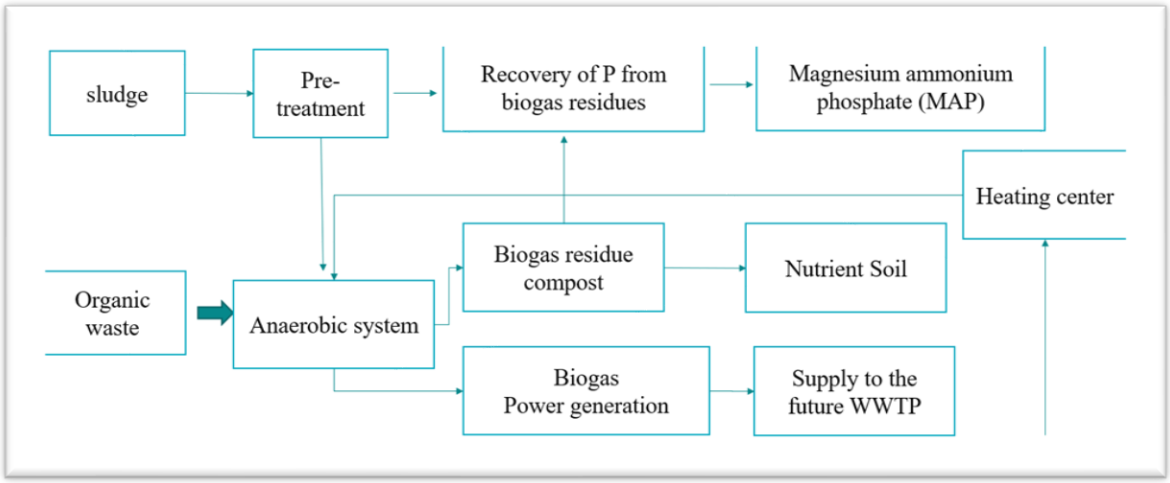
- Resource recovery-recover valuable resource (e.g., N, P) instead of discharge to environment as pollutants, at the same time, decrease the amount of chemicals used during wastewater treatment
- Environmentally friendly - make no harm to the environment.



Picture 2: Organic waste treatment centre of Yixing Concept WWTP

Pilot experience and progress

In 2013, the Experts Committee for the Future-oriented WWTPs in China was set up and in 2015 a kick-off meeting for the Future-oriented WWTPs in China was held. After then, the first demonstration for future oriented WWTP-Yixing Concept WWTP was determined to be built in Yixing City by co-financing from CSD Water Service and Yixing City. In 2018, the cornerstone laying ceremony for Yixing Concept WWTP was hold in Yixing city (Figure 1). Around 120 representatives, including Academician of Chinese Academy of Engineering, local authorities, committee experts of China Municipal Concept WWTP, Yixing Environmental Park and water companies participated the ceremony.

Picture 3: Progress of the construction of the Future WWTP

The Challenges - In the past decades, wastewater treatment in China developed quickly and has achieved substantial progress. However, the current mode is more focusing on the pollutants' removal. But series of problems, e.g., the increased emission of greenhouse gases, high energy and

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chemical consumption, issue of sludge, microplastics, drugs residues are not taken enough attention and considered in a more systematic way.

Solutions – move away from a 'take-make-consume-dispose' behaviour to a circular economy mode in which during the wastewater treatment process, harmful substances removal, valuable resource recovery, energy production and water saving, and recycling are taken into consideration from a systematic perspective. Specifically, through concept WWTP, solutions to solve above challenges are explored, test and even promoted to application in future. Regarding the position of the concept WWTP, it's more than a demonstration for innovative technologies/solutions for wastewater treatment, it is also a pilot of eco-urban space for living, production and ecosystem and a dissemination area for concept and awareness. It's worth mentioning the R&D centre, which has the objectives of conducting research & development of innovative solutions and test & demonstration of technologies. It also has the feature of application-oriented and close connection with promotion and application in market.

Results

Yixing Concept WWTP mainly include 4 parts: 1) wastewater treatment (capacity of 20,000 t/d), sludge and organic waste treatment center (capacity of 100 t/d) and R&D center and pilot area. The total area of the Concept WWTP is 20, 000 m^2.

According to initial planning, the construction should be finished by end of 2019. However, Due to the breakout of novel coronavirus in last quarter of 2019 in China and complete lockdown in the country, the construction restarted until the middle of 2020. By the end of 2020, the construction of facilities for wastewater treatment has been finished and the remaining construction work will be finished in the middle of 2021. The plant should be in operation at the end of 2021.

Investment scheme

The concept WWTP is co-built by CSD Water Service and Yixing City with total investment of 0.5 billion RMB.

Relevance to the circular economy

One main objective of Yixing concept WWTPs is to explore how to achieve material recovery and energy production during wastewater treatment process in China through innovative solutions (e.g., MABR, Annamox in mainstream). The project underlines the UN SDG 6, SDG 10 and SDG 17.

For this case, replicable NextGen results related to material recovery and energy production, stakeholder engagement and market development is adding demonstrable value.

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Picture 4: Design sketch of the Yixing Concept WWTP

Picture 5: Configuration of Yixing Concept WWTP

Refer to the Fig. 3
1: area for wastewater treatment
2: area for biomass treatment
3: area for R&D
4: Multi-function area
5: Bridge
6: Water garden
7: Area for outdoor industrial equipment
8: Exhibition hall
9: Wetland
10: Sports park

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2.2 India: SPONGE irrigation system

Partner profile

Taposya Social Welfare Organization (TSWO) is non-profit organisation and working with social development, through child and women empowerment, entrepreneurship and human rights. TSWO is active in a broad range of developmental fields, including agriculture, environment, forestry and water resources. TSWO worked with UNICEF and performed the responsible duty for the Tribal Labour at the abandoned Tea Garden. TSWO brings expertise in the social and cultural aspects of the SPONGE system. TSWO partner with Sukhani Gram Panchayat (Local Government Rural Body) for the project. Sukhani G.P is in charge of water, waste, and environment subjects in focused area and collaboration with them gave the project a legitimacy with work in the region. Also, experts from Sukhani G.P supported the project in terms of supervision, waste collection, water data capture and others.

Description and objectives

Approximately 2.8 billion people – 40% of the world's population – live in river basins impacted by water scarcity. Of those impacted, 1.2 billion people live in areas of physical water scarcity, where demand is greater than the available supply. Another 1.6 billion people face economic water scarcity, where institutional, financial and human factors limit access to water despite an available natural supply. Between 2000 and 2050, water demand is projected to increase by 55% globally, meaning that the number of people impacted by water scarcity will continue to rise. Furthermore, 70% of all global water use occurs in the food value chain. By 2050, 45% of total GDP ($63 trillion) will be at risk due to water scarcity. We are at a pivotal moment when we face unprecedented challenges to food security and the preservation of our global environment.

SPONGE is an innovative irrigation technology, greatly improving water utilization and supply. Focused on reuse recycle concept, this technology promotes to conserve and reuse of water from fog, rain and dew. It increases reliability in a region with abundant but highly intermittent water availability, improving soil moisture content - while reducing technical maintenance and operation of machinery. It is an easy-to-install, robust water-storing/soil-moisturising system that enables cultivation on marginal lands and provides better opportunities for poor communities and households.

Soil moisture content is increased and kept at optimal levels through a cascading system of buried SPONGEs (foam/cotton units), supplied through fog and dew harvested water. Water is applied in gauged volumes and recycled, minimizing water loss. To ensure sustainability, SPONGE applies a specific selection of plants to control bacteria/fungus in combination with bio-fertilizers, thus forming a techno-biological system. SPONGE is an environmentally friendly and sustainable alternative to the current farming/irrigation practice:

- decreasing dependency of ground and surface water (harvesting fog and dew),
- promoting bio-fertilizer,
- preferring designated supplementary crop choice over pesticides,
- using inert and/or organic materials (foam and cotton),
- reducing machinery operations.

Pilot Experience

SPONGE was successfully piloted in 2018 in in North East India (Rajganj block West Bengal, Bangladesh Border at the Himalayan Foothills) in 4 hectares of land (previously no farming)in North East India

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(Rajganj block West Bengal) as 1st Demonstration site with adoption of 450 farmers with crops like potato, paddy jute and green vegetables.

The Challenge – In the eastern Himalayan Range, the land is mostly sandy/stony soil with poor water capturing capacity and has intermittent/seasonal access to water. Both labour- and cost- intensive processes hamper food production in this area and traditionally exclude women and poor groups from the local economy and gets trapped in extreme poverty and malnutrition with access to very poor health and sanitation facility. Agenda 30 and SDG 6 also underlines these challenges and calls for solutions.

The Solution - SPONGE is an innovative irrigation technology — a techno-biological system — that greatly improves water use and supply. Using water from fog and dew, SPONGE increases reliability in a region with abundant but highly intermittent water availability, improving soil moisture content — while reducing technical maintenance and operation of machinery. It can be applied on existing fields as well as on marginal, rocky or sandy soils unsuited for conventional farming — and even where reliable springs or wells are lacking. Soil moisture content is increased and kept at optimal levels through a cascading system of buried SPONGEs (coco piths/cotton units), supplied through fog and dew harvested water. Water is applied in gauged volumes and recycled, minimizing water loss.
Unique Value Proposition of the project:

- An alternate system for irrigation designed for short-root vegetable crops, growing in difficult terrains (mountainous, water scarce etc.) that helps farmers achieve higher incomes;
- Extended Crop Season, extended income season
- Enhanced soil moisture that enhances quantity and quality of produce
- Reduction in the cost of operations in the long term
- Water savings to support extended agri-allied activities
- System's ease of use facilitates inclusion of women in mainstream agri-activities

Results from the 4-hectare potato field include:

- >50 % reduction of water consumption
- All water harvested from fog, rain and dew.
    - Rain- 14,32,838 liters of water collected
    - Fog- 55,134 liters of water collected
    - Dew- 8,568 liters of water collected
- >50 % reduction of fertilizer cost (comparison with normal situation), due to decreased run-off loss and use of bio-fertilizers.
- Facilitated involvement of 680 women and poor farmers.
- Resulted in 200 tons of mass produce (potato crop)
- Per hectare installation and O&M cost for one years is 3000 USD with production and crop values stands at 8800 USD with 200% secured income level increase due to water collected measures

Sponge Construction

The sponge is positioned layer by layer as shown in figure 3. At the bottom of the soil bed, the aluminium sheeted structure is placed and a sand layer. This aluminium layer will control the slope of the soil bed and the direction of the wastewater flow. The sand will maintain the wet-ness due to continuous supply of water through the sponge. And a thin layer of loose soil will be placed, and the bottom layer of sponge is placed with the guard of foam. These sponges will moisten the soil on it. The foam will help to protect the additional evaporation and store the additional evaporated water within. An additional layer of soil will be placed on top as well as a piece of cotton will be placed arbitrarily in several places to capture the moist water from the

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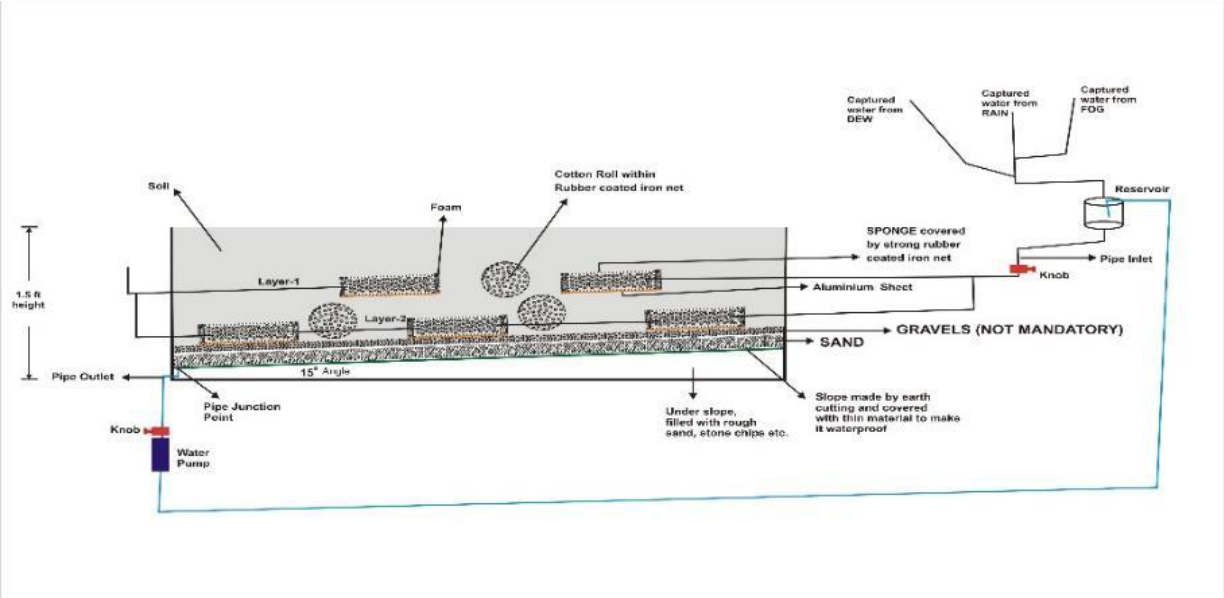
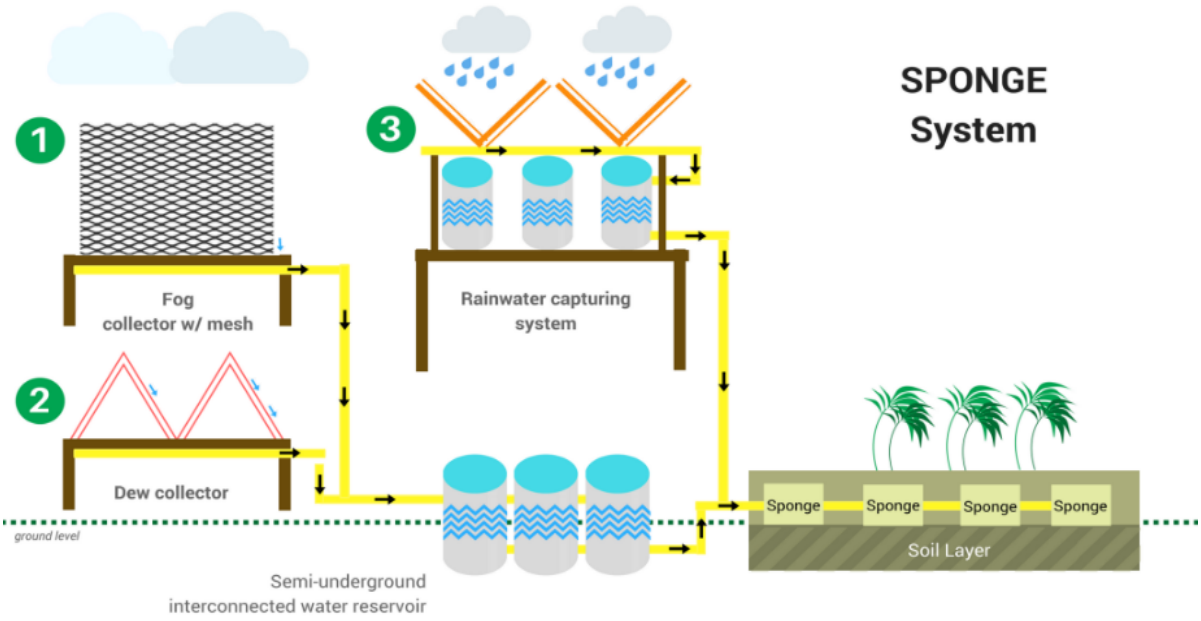
soil for the future use. The water stored on the cotton bulb will be sucked to the soil bed if the soil is be too dry. The pipeline will be placed within the soil layers. The pipelines are again connected with the reservoir as shown in figure 4.



Picture 6: Cross-section of SPONGE construction.

This system will benefit the environment. One of the primary aspects is avoiding soil disturbance. In a traditional system the soil erosion is a big problem; but here it is minimised. Sediment runoff is primarily due to extensive irrigation or another surface water overflow. Since SPONGE is applying water through pipes directly into the porous layers, there will be no overflow and thus considerably less risk for sediment runoff as compared to traditional system. Due to this reason, sedimentation of pollutant and these types of elements is not possible. Here the sedimentation of c micro & macro elements can be stored in the sand layer, foam, cotton.



Picture 7: Design sketch of Sponge system

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Focus on female empowerment

SPONGE empowers women and marginal or resource weak farmers to actively participate in the agricultural sector by de-coupling efficient and sustainable farming from operating heavy machinery. Our innovation will involve the women as employees, as consumer and involve the poor businessman as supplier and dealers and agents and distributors.

Picture 8: Women working on Sponge site

Women are traditionally the water managers. Reliable irrigation water access frees their time which can be spent contributing to the household's economic activities. A survey in our target area shows that women are very interested in participating. Increasing crop yield is an important aspect of the basic security. Tribal communities (Rabha, Santhal and Oraos) will be offered to improve current farming conditions with SPONGE, without changing practice or crops. Including bio-fertilizer into the SPONGE concept both improves working environment and enables alternative incomes from collecting bio-fertilizer material from local markets etc.

Picture 9: Fog collector mesh array on Sponge site

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Investment scheme

The Sponge innovation project participated in secure water for food award- A Grand Challenge for Development and 100,000USD was funded by USAID. The overarching goal of Securing Water for Food is to enable the production of more food with less water and/or make more water available for food production, processing, and distribution.

Relevance to circular economy

Sponge was designed to introduce circular economy solutions "reuse, recycle of water" from fog, dew and rain means closing water loop in focused geographic water stress and poor or less developed areas and addresses socio economic problem and governance challenges at local level. The technology encourages and involve more women and strengthen marginal groups because of its easy usage. It also underlines SDG 1 No poverty, SDG 2, SDG 5, SDG 6, SDG 10 and SDG 17.

For this case, replicable NextGen results related to closing the water cycle, stakeholder engagement and market development are adding value. In the other direction, traditional Indian rainwater harvesting techniques have potential and can easily be implemented in western world. IVL's demo case Gotland Test bed Storsudret is good example where one can see integration of rainwater harvesting techniques from India and advance water reuse techniques from Europe to come over on water issues in area. A highly beneficial exchange.

2.3 South Korea: Recyclable Adsorbent for Nutrient Removal

Partner profile: KIST

The Korea Institute of Science and Technology (KIST) is dedicated to enhancing the prosperity of the entire human race and developing national industries. KIST is founded in 1966 and it is Korea's first government-funded R&D institute. KIST is pursuing world-class research excellence by rearranging its R&D system to effectively address future societal needs and pioneer convergence among industries, academia, and research institutes in order to produce socioeconomic value from public R&D.

Description and objectives

In South-Korea, wastewater plants are now using membrane technology to treat municipal wastewater. However, the membrane technology requires a high amount of energy and it is very expensive to replace and operate the membrane module. Instead, treating the wastewater with special minerals that remove contaminants can be cheaper and require less energy. Typically, water treatment plants use a mineral called zeolite to remove harmful components from the water, such as ammonium and heavy metals. However, powdered zeolite is not very efficient; powdered zeolite can take a long time to settle to the bottom of a treatment tank, making it difficult to recover for recycling. Most of all, the powder tends to agglomerate together, significantly reducing the adsorption sites that can remove the contaminants. KIST is demonstrating a more economically attractive solution, focusing on entrapping micro-sized zeolite particles into porous hydrogels. This allows the zeolite particles to remove contaminants from the water while preventing them from agglomerating together.

Zeolite is a commonly used adsorbent in batch or column adsorption process for the removal of nutrient (ammonium ion) and heavy metal ions. Although zeolite particles (e.g., micro-sized zeolites) have a high

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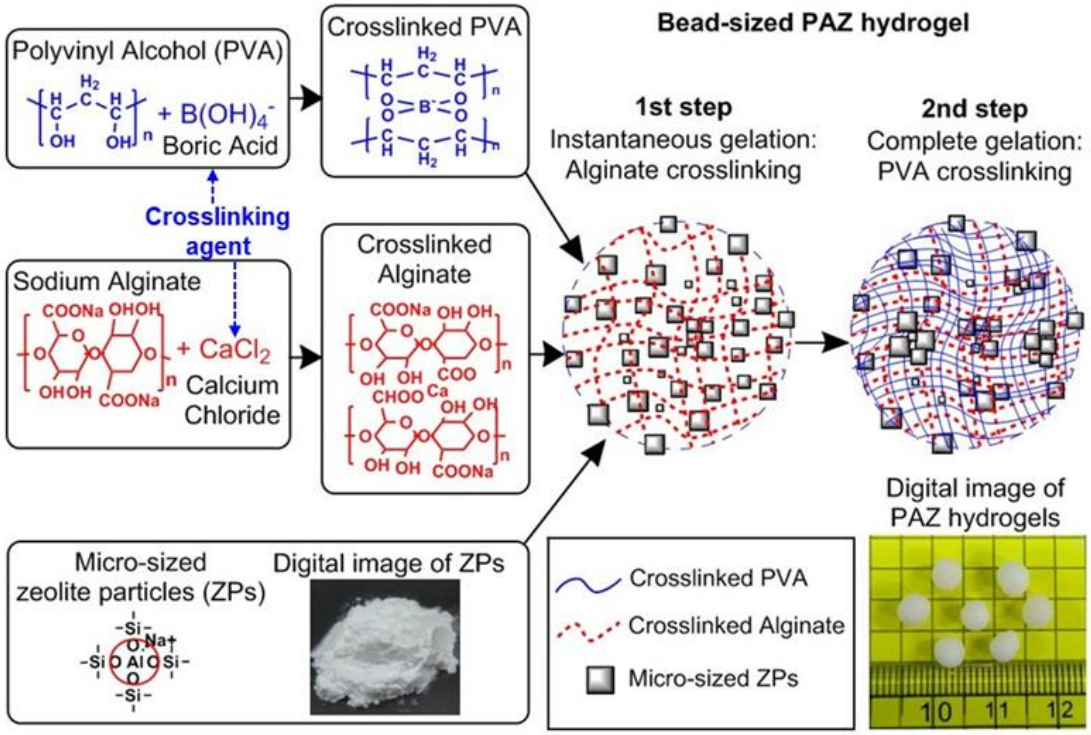
adsorption capacity due to their highly available surface area, the usage of micro-sized zeolite particles (ZPs) has been limited mainly due to long settling time, difficulty to be separated from the solution for recycling, and high-pressure drop in column adsorption process. Moreover, a high dosage of ZPs could impose particle interactions, which resulted in the agglomeration and overcrowding of ZPs. Such agglomeration would lead to a significant decrease in the accessible surface area, lowering the adsorption capacity. Because of these drawbacks of ZPs, granulated zeolite beads (ZBs) commonly shaped using a binder, glue, and filler, have been generally applied in wastewater treatment. One of the most noteworthy drawbacks of ZBs is a significant reduction of the adsorption capacity mainly due to much low accessible surface area, which has prompted a growing research interest in the production of bead-sized zeolite-type adsorbents with less adverse effect on the adsorption capacity.

We have demonstrated that the entrapment of micro-sized ZPs in porous hydrogels is a promising and economical strategy toward overcoming serious drawbacks of ZPs and ZBs for adsorption of ammonium ions (ammonium removal in wastewater). We prepared the polyvinyl alcohol (PVA)-alginate-ZPs (PAZ) composite hydrogel beads with the same size as that of ZBs, by physically entrapping the ZPs via the lattice-type entrapment method. Unlike the ZPs, the PAZ hydrogels had good settleability (good reusability) and showed no significant agglomeration of the entrapped ZPs even under high zeolite dosage conditions.

Due to still high accessible surface area of the entrapped ZPs in the hydrogels, the maximum ammonium adsorption capacity of PAZ hydrogels from Langmuir isotherm was up to 4.3 times higher than that of ZBs. Moreover, the PAZ hydrogels exhibit even and remarkably higher ammonium adsorption capacity than other micro-sized and bead-sized zeolite-type adsorbents in the literature, respectively. Similar to the ZPs and unlike the ZBs, the ammonium adsorption process in the PAZ hydrogels was governed by chemical ion exchange mechanism, and tended to be rate-limited by boundary layer diffusion and mainly intra-particle diffusion. We propose that the entrapment of ZPs in highly porous hydrogel has much less adverse effects on the adsorption capacity and mechanism, compared to the binder commonly used in the synthetic ZBs. Owing to the above-mentioned key features toward overcoming drawbacks of both the ZPs and ZBs, the PAZ hydrogels have great potential as promising and economical alternative zeolite-type adsorbents.



Picture 10: Schematic illustration of the preparation of PAZ composite hydrogel beads

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Investment scheme
This work was funded by the Korea Institute of Science and Technology Institutional Program

Relevance to circular economy
Polyvinyl alcohol-alginate-Zeolite particles (PAZ) composite hydrogel beads have good settleability for further recycling and show no significant agglomeration of the entrapped micro-sized zeolite particles even under high zeolite dosage conditions. That will in turn enhance the reusability of the adsorbent, resulting in improved process economics. We anticipate that this strategy can be expanded to the entrapment of other micro-sized adsorbents in highly porous hydrogels for a broad range of industrial applications in water purification and wastewater treatment.

To conclude, the hydrogels showed a good adsorption capacity to remove ammonium from water. The hydrogel beads entrapping the micro-sized zeolite particles can offer an economical alternative. Other water-purifying compounds could also be added inside the hydrogel beads. Moreover, the hydrogels have a good settleability so they can be easily collected and reused.

For this case, the replicable NextGen results related to the recycle of applied adsorbents for nutrient removal are adding value for all consortium partners.

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3. International learning

NextGen identified high replication potential beyond Europe and introduced replication cases of associate partners from South Korea, India and China in the project and formed an international learning and action alliance under the auspices of Watershare.

To support replication and international commercial success of European expertise with in Nextgen, emphasize to international outreach targeting India and China as priority markets was in focused. To achieve this, Nextgen participated in national and international conferences, 'tech fests', workshops and seminars in India and China. Also connected on private meetings with Ministries, Urban Local Bodies etc. in said countries. To reach international audience beside from EU, India and China, NextGen results and EU expertise within project were communicated and presented to the visitors around the globe to Hammarby Sjöstadsverk and Smart City Sweden Platform. The R&D facility Hammarby Sjöstadsverk is a platform for development and exchange of knowledge and technologies in water treatment and related environmental technology and forms the basis for Sweden Water Innovation Centre - SWIC. Sjöstadsverket promotes cooperation among companies, experts/researchers and municipal sewage works to meet future challenges in the water and wastewater sector and to increase the export. The facility is owned and operated by Nextgen partner IVL together with KTH Royal Institute of Technology. Whereas, Smart City Sweden is a state-funded export platform for sustainable city solutions and having it headquarter at Stockholm Sweden. Nextgen partner IVL is responsible to manage this platform and welcome delegations from all over the world to Smart city Sweden office that are interested in investing in smart & sustainable city solutions.

3.1 Watershare

Watershare is an international knowledge sharing network of water research institutes and water utilities bridging science to practice. Watershare's activities focus on knowledge sharing, exchange and learning, as well as applied research in the (urban) water cycle, with global knowledge trickling down to local impact. Watershare members share their knowledge and expertise, co-defining current trends, new areas of research and the possibility for implementation at the local level, thus spurring innovation for society's most pressing water needs.

Watershare's Objectives

- Share knowledge, resources and expertise across international members leading to innovation and impact on urban water cycle issues at the local level.
- Co-develop new innovative resources (technologies, methodologies and best practices) to share with the global water sector at large.

Key themes for which Watershare tools have been applied are: water scarcity, compounds of emerging concern, future-proof water infrastructure, energy & resource recovery, resilient urban water management.

Currently, Watershare has 25 member organisations world-wide. Within NextGen, the following Watershare members participate: KWR, NTUA, KWB, EUT, UNEXE, UBATH, UCRAN, IVL, and KIST.

Watershare is currently in a transition phase, focusing more on activities and engagement across members that enables and facilitates international knowledge sharing and exchange. Through strategic meetings, webinars, and the five newly launched Regional Hubs across the globe, Watershare

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members are contributing to a water-wise world through learning from each other and applying new insights at the local level.

Picture 11: Overview of Watershare members.

The application of NextGen tools and technologies fits perfectly within the model and approach of Watershare: global knowledge sharing to deliver impact locally. NextGen partners can share their knowledge, resources and technologies during a strategic meeting to international members describing the tool and opportunities this new technology can bring locally. They can then support in disseminating opportunities of the NextGen tools and technologies to local partners and end-users, through either the 5 Regional Hubs of Watershare, or any of the other members who see the potential for interest in their region. During this strategic meeting, networking across Watershare members and NextGen partners can be facilitated to further build relationships in the global water sector, strengthening the outcomes and potential for replication.

At the IWA World Water Conference 2018 in Tokyo, NextGen was presented at a Watershare meeting, to which among others KIST participated. A follow up meeting was planned for the IWA World Water Conference 2020 in Copenhagen, but this event has been postponed till September 2022 due to Covid19.

On 14 April 2021, a Watershare NextGen webinar was organised to exchange experience on circular water solutions with all members. NextGen partners IVL-TSWO (India), IVL-JIEE (China), KIST (South-Korea), and NTUA (Greece) presented their demo cases. More than 50 people participated, both NextGen partners as well as Watershare members and partners from other EU H2020-projects on water in the circular economy. In the discussion, views and experiences were exchanged regarding drivers for the circular economy (such as climate change), conditions for a transition towards circular water solutions (such as supportive regulations), water reuse for a wide range of applications (such as agriculture), and replication potential of AR as a public engagement tool in Asia.

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3.2 Hammarby Sjöstadsverk Smart City Sweden Platform

IVL and Smart city Sweden representative shared experiences from Nextgen Swedish Demo case with a delegation representative from cities in the United States (Picture 1) at Smart city Sweden on February 6, 2020.

Picture 12: A delegation from United States

A delegation led by the Colombian Minister of transport Ms. Angela Maria Orozco (Picture 2) came to Sweden to learn Swedish experiences / expertise in water and wastewater management and visited Hammarby Sjöstadsverk on February 21. 2020. IVL's expert Jesper Karlsson briefed them on NextGen testbed in Sweden and presented them Purest- Beer from recycled water.

Picture 13: A Delegation from Colombia

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A delegation led by the Slovenian Foreign Minister Mr. Miro Cerar (Picture 3) came to Sweden to learn Sweden's work in Sustainable City and visited Smart City Sweden on February 24, 2020. IVL's senior advisor Östen Ekengren discussed importance of eco governance and wastewater management as integral part in city planning with them and briefed them on NextGen circular water solutions.

Picture 14: Slovenia Delegation

On August 24, 2020 Ms. Patrica Godinez Ambassador of El Salvador (Picture 4) in Sweden visited Smart City Sweden to find out sustainable solutions for waste and wastewater handing. Östen Ekengren from IVL presented Swedish Expertise and knowledge in waste and wastewater handing and included Nextgen circular water solutions in his presentation.

Picture 15: Ambassador of El Salvador

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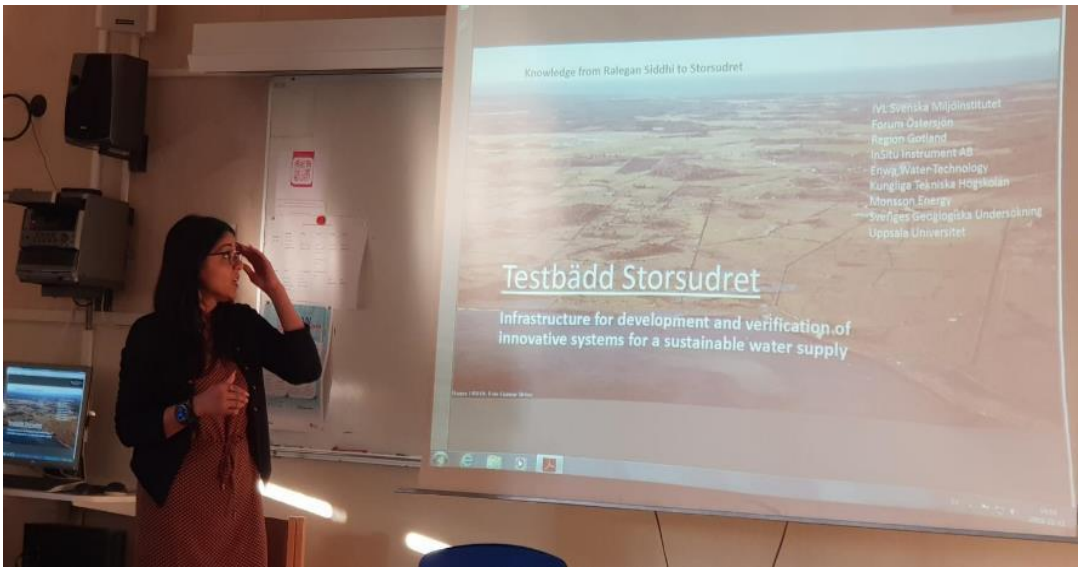
On November 13, 2019 Rupali Deshmukh, IVL was invited to speak on session “Every drop is important” (Picture 5) in Internation Day confernce at Hemse, Sweden. Rupali included NextGen Circular water Solutions and Nextgen Swedish demo case in her speech.



Picture 16: International day conference at Hemse Sweden, The NextGen Gotland case

IVL participated in world water week conference 2019 in Stockholm Sweden. Östen Ekengren, IVL shared experiences from Nextgen’s Swedish Demo case and PU:Rest beer from recycled water (picture 6) with participants around the globe.

Picture 17: The NextGen Gotland Case at the World water week conference 2019

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On March 21, 2019 Rupali Deshmukh, IVL discussed Nextgen circular water solutions with international audience and students from KTH Royal Institute of Technology in Master event for "Energy and Environment" Stockholm Sweden

Picture 18: The NextGen circular water solutions is presented at a master event for Energy and Environment at Sweden

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4. Outreach activities

NextGen emphasized to international outreach targeting India and China as priority markets. Hence, NextGen participated in national conferences, workshops, seminars and participated in meeting with ministries, national research institutes, municipalities etc in India and China.

Due to Covid pandemic, after April 2020 outreach activities were mostly held in virtual mode.

4.1 Outreach activities in India

India is all set to become the most- populous country in the world by 2030, making it home to the biggest and the most under-penetrated market for global -Manufactures and service providers. But poor sanitation in India is surely affecting its economic growth. To address this issue, Prime Minister of India Mr. Modi has launched Clean India mission with huge budget and invited international companies/ experts to explore opportunities under this mission to work in India. Clean India Mission is focusing on management of sludge, wastewater and solid waste.
To introduce NextGen Circular water Solutions in India and explore the opportunities for EU expertise and technologies under Clean India mission Rupali Deshmukh and Östen Ekengren, IVL visited India in January 2019. During this visit, IVL met several important stakeholders from Ministries, local urban bodies, water companies etc (Picture)and discussed EU knowledge in wastewater and sludge management and made presentation on NextGen Circular water solutions.

Picture 19: Meeting with Mr. U P Singh, Secretary, Ministry of water resources, river development and Ganga Rejuvenation, India

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Picture 20: Meeting with with Mr.Durga Shanker Mishra, Ministry of Housing and Urban Affairs Secretary of India and his team

Picture 21: Meeting with Mr. C. K. Mishra, Secretary, Ministry of Environment, forest & climate change, India

Picture 22: Meeting with Mr. R.K. Gupta, Chairman WAPCOS Limited (Ministry of water resources and River development)

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Picture 23: Meeting with Industry minister of Maharashtra Mr. Subhash Desai, Principle Secretary Mr.Nitin Karir and Urban Development Secretary Mrs. Manisha Mhaiskar, Maharashtra

Östen Ekengren, IVL participated in India Sweden Business Day theme Sustainable Development & Innovation (Picture 13) as panellist in February 2019. During discussion, Östen mentioned different innovative technologies and tools within Nextgen project.

Picture 24: India Sweden Business Day "Sustainable Development & Innovation"

Indian Oil Corporation Limited team (Picture 14) came to Sweden to learn Swedish expertise in biofuel and industrial wastewater treatment areas in March 2019. Rupali Deshmukh, IVL presented Circular model in water "Recycle, Recover and Reuse "and briefed them on NextGen circular water solutions.

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Picture 25: Indian Oil Corporation Limited team

Rupali Deshmukh, IVL was invited by Embassy of India in Sweden to a session "Building a New Bio-Circular Economy- The Energy and Water Challenge to share Swedish experiences on the subject at Almedalen week in Visby Gotland in June 2019. Almedalen Week is an annual event taking place in week 27 in and around Almedalen, a park in the city of Visby. All political parties in Sweden, all embassies, representatives of municipalities, organisation, research institute, universities participate in this event. It is the biggest and most important forum in Sweden for seminars on innovative subjects, debates and political speeches on current social issues. IVL used this opportunity to made presentation on Nextgen circular water solutions.

Picture 26: "Building a New Bio-Circular Economy- The Energy and Water Challenge at Almedalen Week

A high level delgation led by Ministry of Jalshakti (Water Resources) India, Minister Mr. Gajendra singh Shekhawat (picture 15) visited IVL and Europe's biggest Wastewater treatment pilot facility Hammarby Sjöstadsverk on August 30, 2019 to learn Swedish knowledge in wastewater handling. IVL included Nextgen Circular water Solutions in discussion with Minister.

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Picture 27: Ministry of Jalshakti (Water Resources) India, Minister Mr. Gajendra singh Shekhawat

IVL Participated in 3 days IFAT India 2019, Mumbai event from October 16- October 18, 2019 (Picture 16). IFAT India is India's Leading Trade Fair for Water, Sewage, Solid Waste and Recycling. It is an ideal platform to network with representatives from municipalities, Local urban bodies, different ministries, industry leaders and business partners in the environmental technology sector from across the globe.

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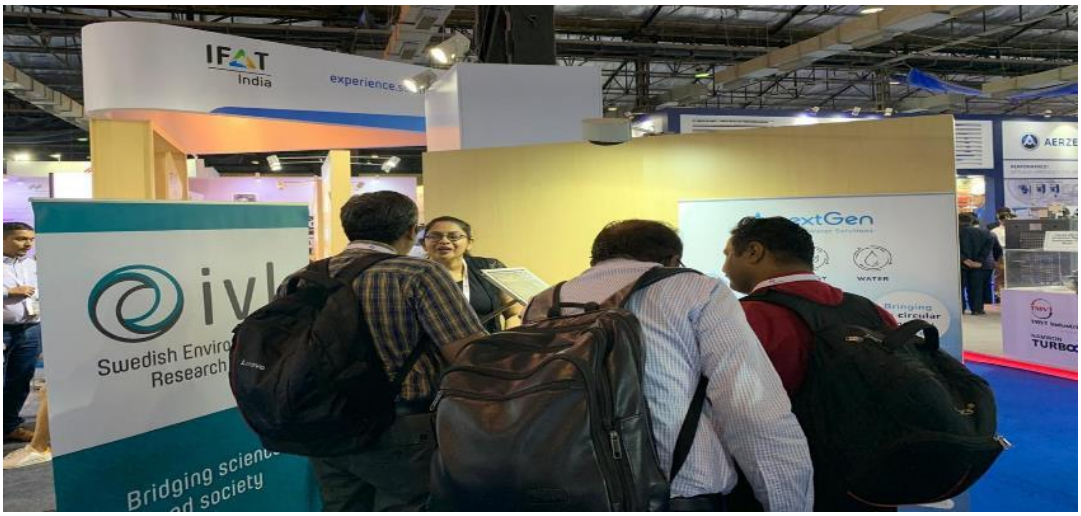
Picture 28: Rupali Deshmukh, IVL Presenting Nextgen Circulate water solution at IFAT INDIA 2019

Circular solutions developed by NextGen have the potential to transform water-stressed areas worldwide. To go close to different stockholders from different deparmants in India interested in Innovative solutions in waste waster mangement, IVL setup the Nextgen booth in IFAT exhibition (Picture 17). IFAT Exhibition gives opportunity to National and international exhibitors showcase the latest innovations and pioneering solutions.



Picture 29: IVL India representatives briefing Visitors on NextGen circular water solutions at NextGen booth at IFAT India 2019 Exhibition

Mr. Vinod Jindal, Joint Secretary Ministry of Urban Development, Government of India has invited IVL in mid-November 2019 for follow up meeting focusing on clean India mission in Delhi. Representatives from Ministry and Central Public Health and Environmental Engineering Organisation (CPHEEO) at ministry of Urban Development were present at this meeting whereas representatives from several states in India such as Chennai, Rajasthan, Goa, Maharashtra, Hyderabad, Madhya Pradesh and representatives of research institutes such as TERI, NEERI joined the meeting via video conference call (Picture 18). In this meeting, IVL highlighted “Water scarcity is biggest global threats, how the future will look like depends largely on how we handle the water issue” and presented NextGen circular water solutions for sustainable water management.

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Picture 30: Follow up meeting “Clean India Mission” at Ministry of Urban Development, India

In January 2020, Minister for Road Transport & Highways, Micro, Small & Medium Enterprises India, Minister Mr. Nitin Gadkari (Picture 19) visited IVL to learn Swedish knowledge in Hydrogen gas from wastewater area. During discussion, IVL shared expertise with NextGen Circular water solutions with Minister.

Picture 31: Minister for Road Transport & Highways India, Minister Mr. Nitin Gadkari

To participate in few important meetings, IVL planed 10 days business trip to India in last week of February 2020. During this visit, IVL met Dr Shailja Gupta, Adviser/scientist at Department of Biotechnology (DBT) Ministry of science and Technology in Delhi, India on February 28, 2020. DBT is Research Funding Agencies, works closely with EU commission. IVL made brief presentation on Nexgen Circular Water solutions. The meeting was concluded with remark from Dr Gupta- “Lots of interest and interesting water solutions to be exchanged between India and Europe.”

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Picture 32: Dr Shailja Gupta, Adviser/scientist at Department of Biotechnology (DBT) Ministry of science and Technology in Delhi, India

To study Mega Sewage treatment projects in Mumbai and introduce European expertise in wastewater in city Mumbai, IVL requested meeting to officials of Municipal Corporation of Greater Mumbai (MCGM). On March 2, 2020 IVL met Municipal Commissioner of Mumbai Mr. Praveen Pardeshi and Additional Municipal Commissioner of Mumbai Mr. P Velarasu. Commissioner showed keen interest in NextGen Circular water Solutions.

Picture 33: Municipal Commissioner of Mumbai Mr. Praveen Pardeshi and Additional Municipal Commissioner of Mumbai Mr. P Velarasu.

The city Indore in India wanted to explore opportunity to collaborate with IVL on Co-digestion project. From last 4 years, Indore is banging clean city in India award. IVL Visited Indore and met Municipal Commissioner of Indore Mr. Asheesh Singh (Picture 21) and discuss ideas on Co-digestion and briefed him on technologies and tool with in NextGen Circular water Solutions.

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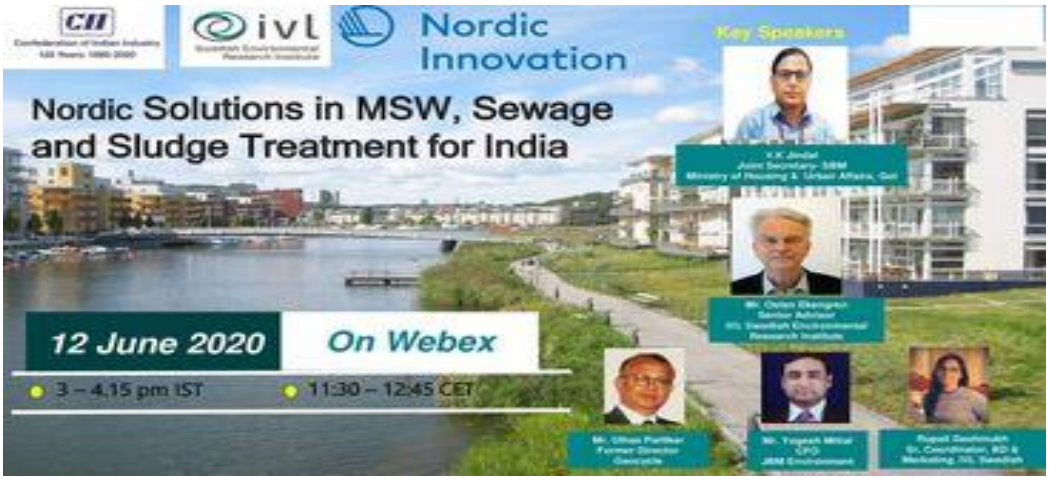
Picture 34: Municipal Commissioner of Indore Mr. Asheesh Singh

Outreach Activities in India after pandemic through Digital platform

IVL in partnership with Confederation of Indian Industry and supported by Nordic Innovation organized webinar on 'Nordic Solutions in Sewage and Sludge Treatment for India' on June 12, 2020. Waste management companies, start-ups and researchers, Ministries from India and Nordic region participated in this webinar. Mr. V.K Jindal, Joint Secretary- SBM, Ministry of Housing and Urban Affairs, India inaugurated this webinar with his keynote speech and put forward India's need in Sewage and Sludge area. Along with Nordic solutions in Sewage and Sludge, IVL presented Nextgen circular water solutions. (Agenda in appendix)



Picture 35: Flyer of 'Nordic Solutions in Sewage and Sludge Treatment for India'

IVL supported and participated Confederation of Indian Industry 's (CII) on 30th October 2020. The conference was also supported by Ministry of Housing and Urban Affair, Government of India. The theme of this conference was "Achieving circular economy through innovative 3R techniques" (Picture 23). This conference brought together Indian industry, technology providers, investors and National & International waste management companies with innovative technological solutions towards keeping India clean in a sustainable manner and to encourage the adoption of 3R practices. The conference was inaugurated with Keynote speech by Prof. K. Vijay Raghavan Principal Scientist Advisor (PSA) Government of India. (Agenda in appendix)

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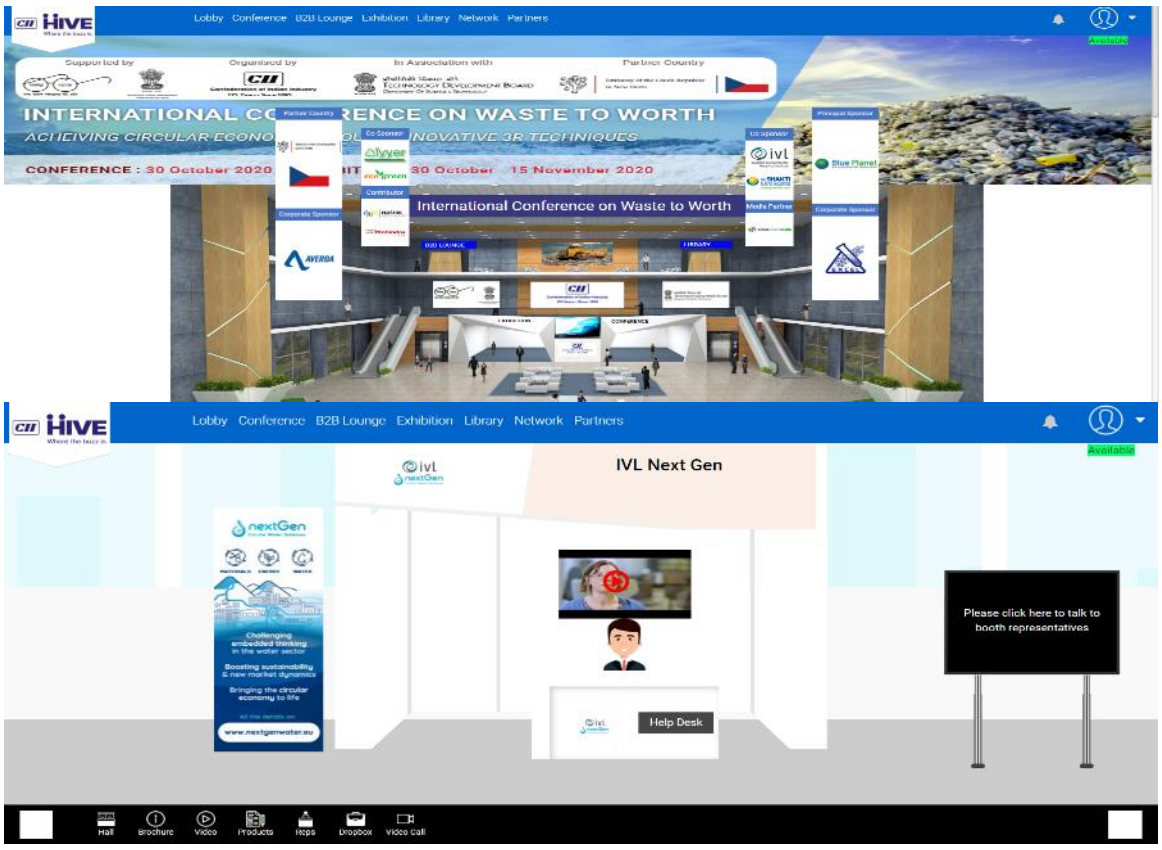
Picture 36: International Conference and exhibition on Waste to Worth

IVL presented NextGen Circular water solutions in session "Global model and Best Practices for waste management" in International Conference and exhibition on Waste to Worth. Curious delegates around the globe visited NextGen Virtual booth in this exhibition to know more about NextGen technologies and tools (Picture 24).



Picture 37: NextGen virtual booth at the international exhibition Waste to Worth

Embassy of India in Sweden Invited IVL to participate in India Nordic-Baltic Conclave 2020 with a theme of "An Innovation-driven Partnership for Growth in a New World". The Concave was inaugurated with key note speeches Dr S Jaishankar Minister for External Affairs, India and other

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Ministers from Nordic and Baltic region, Industry experts & business associations from India and Nordic-Baltic region (Picture 24).

Picture 38: NextGen virtual booth in international exhibition on Waste to Worth

Östen Ekengren, IVL participated (Picture 25) and shared Nordic expertise of energy recovery from organic, nonorganic solid waste, wastewater and sludge in session "Renewable Energy and clean Technology" India Nordic-Baltic Conclave 2020. IVL included Nordic cases within Nextgen project in this presentation.

Picture 39: Session on "Renewable Energy and clean Technology" India Nordic-Baltic Conclave 2020.

The National Mission for Clean Ganga (NMCG), India and the Centre for Ganga River Basin Management and Studies (cGanga) organised the 5th India Water Impact Summit (Picture 25) from 10-15 December 2020 an invited IVL to lead the India-EU Strategic Roundtable (Session D4: International Partnerships: EU) focused on "Water Recycle and Reuse" on December 14, 2020 (Agenda in appendix). During discussion in roundtable, IVL emphasized on Circular water- Closing the loop in water management in specific geographic area and presented NextGen circular water solutions.

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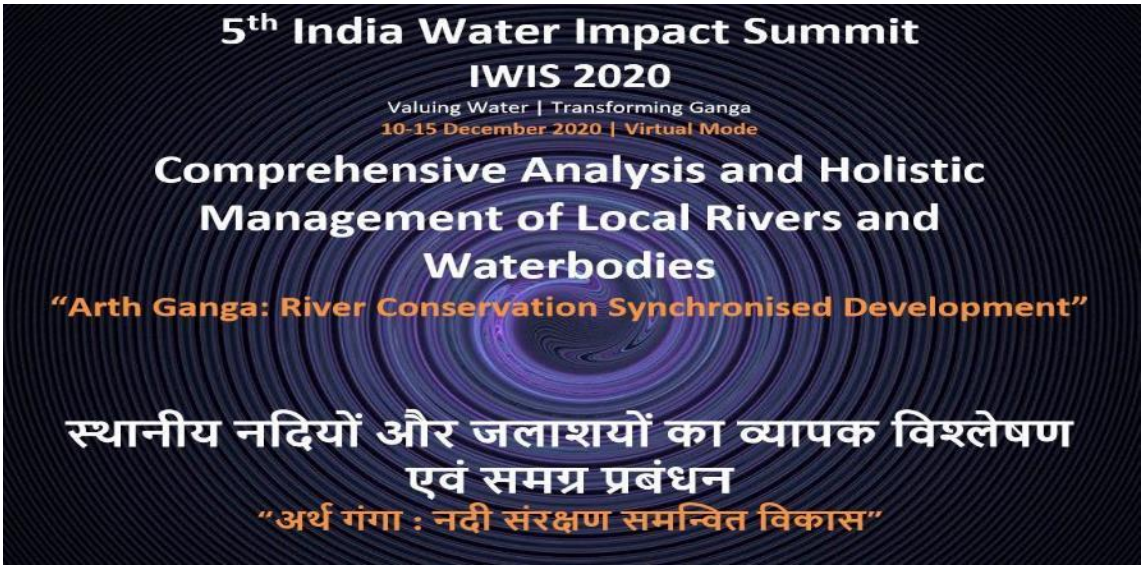
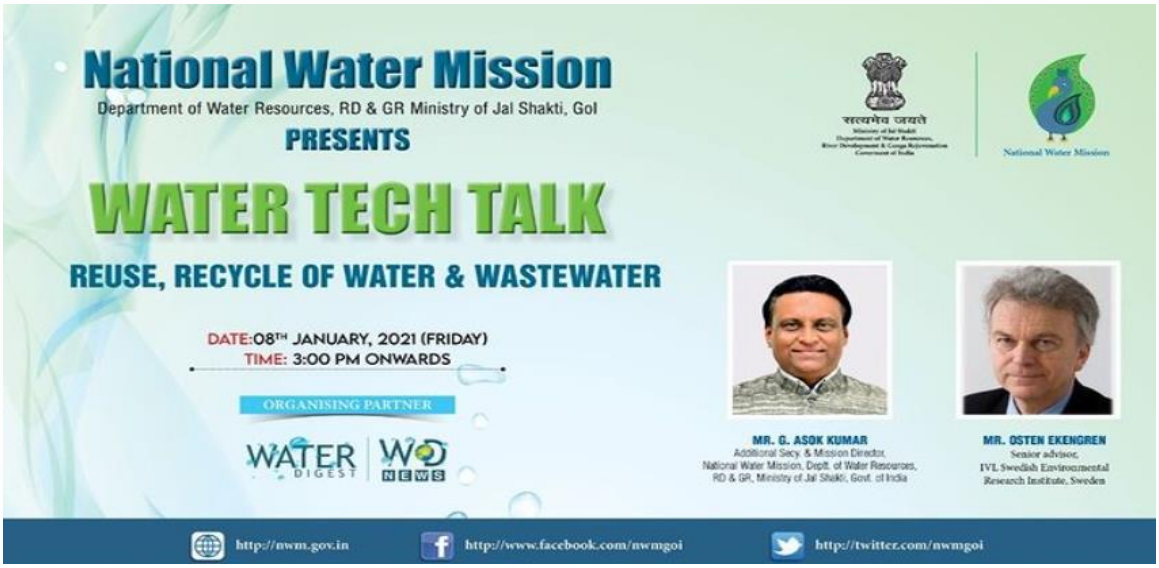


Picture 40: Flyer of the 5th India Water Impact Summit

National Water Mission, Department of Water Resources, RD & GR, Ministry of Jal Shakti, Government of India invited IVL to speak in the 'Water Tech Talk' on the 08th January 2021 (Picture 26). "Water Tech Talk" is a lecture series of National Water Mission, Government of India, intended to promote dialogue and information sharing among participants of water related topics, with an aim to stimulate awareness, build capacities of stakeholders and encourage people to become active participants in conserving water. The talk is live streamed on the Facebook pages of National Water Mission, Department of Water Resources, Ministry Jal Shakti and various other organizations under the Ministry. As per statistic min 100000 people watch this online event every 2nd Friday of month. IVL Included NextGen circular water solutions in this talk show. (Agenda in appendix).



Picture 41: Flyer of Water Tech Talk

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4.2 Outreach activities in China

In April of 2019, the 14th EU-China Partinarent-Water Resource Form was hold in Qingdao China, Yanjing Zhu was invited to give a presentation on Innovative solutions in water sector. NextGen solutions was introduced during the meeting.

Picture 42: 14th EU-China Partinarent-Water Resource Form in Qingdao, China

June 11, 2019 IVL participated in Seminar focused on Large-scale R&D centre for water treatment technology for "Future-oriented water treatment technology R&D and Transformation platform building and practice research" in Beijing China (Picture 27) and together with several researcher from China, Östen Ekengren, IVL brainstormed on best technologies in wastewater area for china and presented Nextgen circular water solutions to all the participants.

Picture 43: Future-oriented water treatment technology R&D and Transformation platform building and practice research" in Beijing China

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A delegation from Tianjin water supply Bureau and Shanghai urban construction Design and Research Institute, China visited IVL and Smart City Sweden (Picture 28) on June 14, 2019 to learn more about Membrane bioreactor and other wastewater treatment technologies. During discussion, Rupali Deshmukh IVL briefed the delegation on technologies and tools within NextGen circular water solutions.

Picture 44: A delegation from Tianjin water supply Bureau and Shanghai urban construction Design and Research Institute, China

June 2019, Staffan Filipsson and Rupali Deshmukh interacted with a delegation from Chongqing Yuelai Investment Group Co. Ltd China (Picture 29) at IVL headquarter, Sweden and discussed potential cases for replication of Nextgen technologies in China.

Picture 45: A delegation from Nankai University Tianjin, China

A delegation from Nankai University Tianjin, China (Picture 30) visited IVL on August 17, 2019 to learn best European wastewater treatment technologies. During discussion Rupali Deshmukh, IVL Presented them with knowledge and expertise from Nextgen.

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Picture 46: A delegation from Nankai University Tianjin, China

In September 2019, Rupali Deshmukh and Ewa Lind participated in Nordic China Smart City conference and presented project Nextgen to high level delegates from China (Picture 31).

Picture 47: Nordic China Smart City Conference

Rupali Deshmukh, IVL discussed circular solutions for water and wastewater management with Beijing ZEHO China delegation (Picture 32) on October 27, 2019 at smart city office. Nextgen circular water solutions were in focused.

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Picture 48: Beijing ZEHO China delegation

In January 2020, Yanjing Zhu IVL China participated the Water Management in the Cold Climate (WMCC-2020) in Harbin China (Picture 33) and delivered presentation on PU:REST Beer from Recycled water and Nextgen circular water solution.

Picture 49: Water Management in Cold Climate 2020 conference at Harbin China

To support the outreach activities in China, Five NextGen Circular water solutions articles were translated in Chinese and circulated through IVL-China's WeChat Official Account, weblog, and website. Also, translation and dissemination of two NextGen circular water solutions introduction videos were done.

Besides, during 2018-2020, IVL has translated and posted NextGen information through IVL China's self-media and gotten more than 1000 clicks.

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Picture 50: Examples of dissemination in China through IVL China's self-media

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5. Replication potential

5.1 Exploring interest and replication potential

To support international outreach activities and evaluate the replication potential of EU Knowledge/ technologies with Nextgen, it was important to build strong association with Stakeholders from India and China. In this respect, IVL involved researchers and experts from India and China and requested them to evaluate potential adoption of Nextgen technologies/ tools for India and China. The experts considered respective market needs and local economic condition in evaluation. Based on this evaluation, feasibility criteria for lower-income countries (India and China) of NextGen technologies was prepared and presented in replication potential webinar for India and Chinese on February 2, 2021 (Picture 34). (Agenda in appendix)

Picture 51: Flyer of Replication Potential Webinar

NextGen associate partners TSWO (India), JIEE (China) and KIST (South-Korea), European partners, important representatives from research institutes, local urban bodies, water companies from India and China were present at this Replication Potential Webinar meeting. (Meeting minutes in appendix) Indian speakers highlighted that India is the biggest and the most under-penetrated market for global -Manufactures and service providers but water crises and poor sanitation are affecting India's economic growth. To overcome on these problems, Government of India has allocated huge budget for sanitation and plan to build infra-structure for wastewater management, also giving emphasis to water reuse; wastewater recycling and reuse. There are 3 drivers for water reuse in India - addressing water scarcity, environmental and health benefits. India still in the initial phases of wastewater reclamation and reuse and needs assistance in their transitions in achieving SDG 6 Clean water Sanitation. There are many challenges such as Social, Institutional, technical etc. associated with the implementation of treated wastewater reuse projects, limiting the growth of wastewater reclamation and reuse in the country.

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Speakers from China were also underling the urgent need of circular water solutions for sustainable future. During the discussion, Indian and Chinese experts showed keen interest in technologies/ tools in NextGen circular water solutions and highlighted few projects in India and China in which NextGen technologies and tool could fit in.

5.2 Replication potential beyond the EU

Within NextGen, the market creation of technologies and tools is explored in WP5. For a number of NextGen technologies and tools for which there is an interest by the NextGen partners in Asia, the replication potential has been assessed. This assessment has been conducted with a short literature review of the three identified areas to better understand the context and the potential drivers and barriers to NextGen solutions implementation. It has been complemented with interviews of the three partners in charge of associated demo-cases in India, China and South Korea. A summary of the characteristics of the studied technologies **Sewer Mining, Serious Game and AnMBR** has been produced and associated with opinions from interviewee on the potential of each technology for each country. Those findings were confronted with NextGen partners to have a first overview of their willingness to engage in further replication activities on the three selected technologies.

1. Circular economy in the water sector outside Europe: the case of China, India and South Korea

a. Context for replication in China

As described in section 2.1, wastewater treatment in China developed quickly and has achieved substantial progress. In 2018, more than 5 000 municipal WWTPs had been built in China, with a daily treatment capacity which is almost twice as large as Europe (200 million m3/d), making China the world's largest municipal wastewater infrastructure (Qu, J., Wang, H., Wang, K. et al., 2019). The wastewater treatment ratio had reached over 90% by 2018, and is usually undertaken by local governments, especially in the urban areas.

Industrial wastewater is usually discharged into the municipal network after a mandatory pre-treatment onsite (treatment in factory or in centralised treatment facilities located within the industrial parks), however, it requires high cost from industrial and water operators.

Furthermore, the wastewater management mode has evolved into a PPP-based system involving both the government and enterprises. This transition from the public operations lessened the financial burden of the government and carried on improvement and innovation in both construction and operation of wastewater facilities.

"The geographical diversity in wastewater properties, environmental conditions and economic development levels in China implies a high necessity for different WWTPs to implement customized, flexible technologies and effluent discharge standards in, instead of the currently prevailing uniform mode. This will be of particular importance for the environmental-sensitive and water-deficient regions where inappropriate

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wastewater management may result in severe ecological, environmental and social consequences." (Qu, J., Wang, H., Wang, K. et al., 2019).

Then, it is necessary to think China as a complex territory that cannot be addressed uniformly. In return, it also provides with opportunities to implement and test several technologies for water reuse.

Water scarcity is a pressing issue at a global scale; however, it is especially strong in China as population and urbanisation continues to grow. Water shortage risks need to be addressed, while wastewater volume will keep increasing.

Strong political support and supporting policies at different scales (local, regional, and national) brought government and researchers together to tackle issues related to wastewater treatment. China is the leading expert on water reuse, as innovation is supported by this favorable context. Incentives for the private sector have also been mobilised to fight water scarcity.

In the 13th FYP (Five Year Plan), China aims to spend around RMB 559 billion or 0.75 percent of its GDP on its water treatment industry (ADB, 2016). This national level spending will account for only about 10-30 percent of the total financing supply in this sector. The financing structure of China's water treatment industry rests on national/provincial/local government funding, and the private sector. Public institutions mostly fund municipal wastewater treatment projects or centralised wastewater treatment facilities located within industrial parks. On-site treatment facilities are usually funded privately.

However, as identified in Section 2.1, the emission increase of greenhouse gases, high energy and chemical consumption, issue of sludge, microplastics, drugs residues are not taken enough attention and considered in a more systematic way.

b. Context for replication in India

India faces pressing challenges concerning water treatment and sanitation. Providing extensive sewerage network and reliable and affordable wastewater treatment comes with a huge cost. (Singh et al., 2018). Due to the growing water demand, the gap (about 60%) in the wastewater generation and treatment (Kakwani, Kalbarn 2020), the lack of infrastructure (wastewater collection network) combined with intermittent water supply systems are challenges that need to be addressed.

India is a continent with diverse climate and frequent weather changes. As such, water is of different quality and quantity. Water scarcity is an issue pressing for water reuse solutions, but not every solution is adapted to every climate and regional context. As described in section 2.2, in the eastern Himalayan Range, the land is mostly sandy/stony soil with poor water capturing capacity and has intermittent/seasonal access to water.

The difference between rural and urban areas in terms of wastewater treatment should also be assessed as centralised sewerage and wastewater treatment systems cover only a portion of larger urban areas. Furthermore, the hypothesis of collecting all wastewater

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and its treatment at a centralised treatment facility at a national scale sets the problematic of the economic feasibility (Singh et al., 2018). Sustainable alternatives need to be implemented considering the cost of the sophisticated treatment technology that requires high technical expertise for its operation and maintenance. Solutions should then focus on the necessity to fit with regional climates, available skills and funds.

The Indian government has funded several investment programs on clean water and sanitation. The phase 2 of the Clean India Mission focuses especially on water reuse promotion: it aims to raise awareness about water reuse in local government and water management ecosystem. Water reuse in a new challenge for India, with 1.3 billion people and many political parties, it might take a long time to raise awareness on this specific subject.

c. Context for replication in South Korea

In 2012, the ministry of Environment in South Korea evaluated at 7.1 billion m3/yr the total of effluent discharged from WWTPs, including 9.3% of the total available water resources from precipitation (Jeong et al., 2016).

South Korea faces four main challenges for sustainable water governance and management (Choi et al., 2017):

- Damage to Water Quality and Ecosystems of River Basins: climate change aggravates seasonal oscillation between floods and droughts; and dense population inhabits limited land space.
- Regional Water Use Conflict: non-point source pollution in highland versus lowland areas creating regional conflict over water rights.
- Economic Growth: the population shift from rural to urban areas and the multiplication of activities (development of industrial areas for example) using water combine to aggravate water consumption.
- Inadequate Water pricing mechanism: water is priced without considering neither a full cost recovery principle or environmental externalities. On average, water charges are low and incite excessive water use without covering maintenance costs in full.

Wastewater reclamation projects for agricultural land have been implemented by the Korean government since 2005, and the reused amount reached 45 million m3 in 2011 (Jeong et al., 2016). This amount is low when it is compared with the water abstracted (around 7,2 billion m3). The perception of recycled water is still strongly negative in South Korea. Few policies support funding for wastewater reuse and it limits the application of technologies and willingness to research the topic.

Human resources are critical to carry water reuse projects and highly skilled engineers are needed. As such, it is necessary to raise awareness on water reuse and promote reused materials instead of new ones. The perception of recycled materials is also negative, compared to new materials, including concerning fertilizers.

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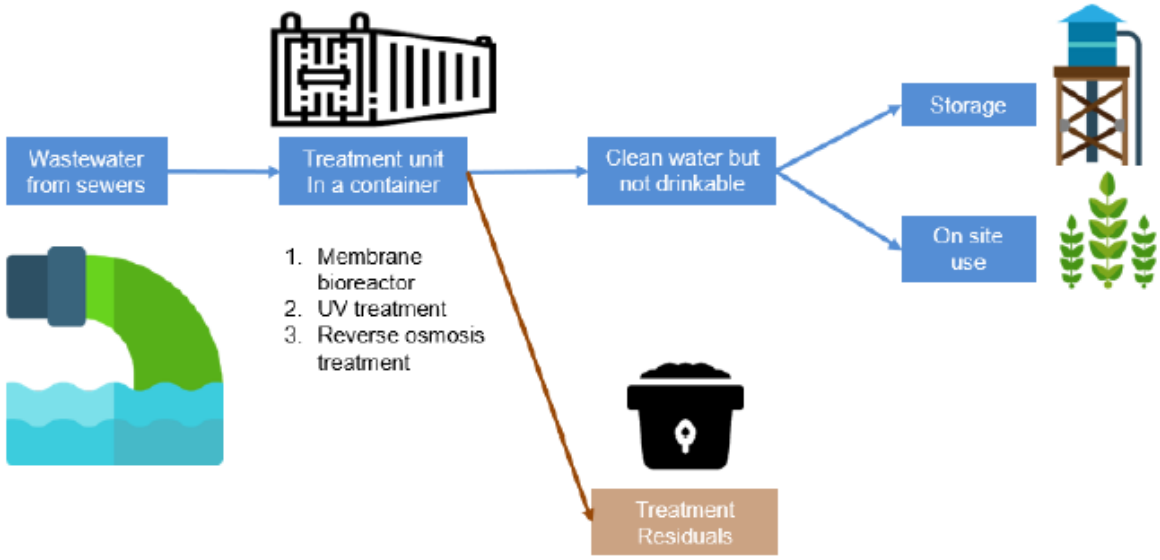
2. Return of experience

- **Sewer Mining: water reuse from sewage network**

The Sewer Mining concept at the NextGen demo case Athens (Plevri et al, 2020) consist in extracting wastewater from sewers, treating it directly on site and reusing it directly at the point of demand or stock it (Strane, 2020). The treatment residuals could go back to the sewer to be treated by a regular wastewater treatment plant or could be collected to either treat them or to transform them (compost, methanisation, etc.), when merged with green waste.



Picture 52: Scheme of the sewer mining process (Source: Barret et al., 2020)

This concept provides opportunities for synergy creations and potential savings on water transportation costs. The potential accessibility of new water source for irrigation provides social benefits for local farmers as well.

The sewer mining process is a solution of reuse aiming for decentralised water treatment to produce usable water for activities not requiring drinkable water. In areas where water is scarce and irrigation takes an important part of the water resource, it is a good alternative for agriculture.

Sewer mining brings added values to water reuse, considering the current overuse of natural water. It saves resources with:

- Access to the reused water on site and limitation of the transportation
- A small footprint unit for the water treatment and minor landscaping and construction work
- Reduction of pressure on the natural water resource both in terms of quality and quantity

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- A use of water secured within offering a minimal ecosystem impact.

And bring further benefits:

- Local valorisation of the treatment residuals (agriculture fertilizers, methanisation, etc.) and possible synergies with local stakeholders.
- Longer lifetime of water in the urban water cycle
- New forms of multi-used consumption

Reuse water (or reclaimed water) for specific usages which do not require drinkable water (irrigation, washing, etc.) instead of using drinkable or underground water (up to 100 m3 per day) (Barret et al., 2020). In urban or semi-rural areas with an operational sewage network, the priority targets of the solution would be irrigation, especially for the following spaces: agriculture, sport fields, public parks.

- **Serious Game: raising awareness for circular technology in water sector**

"Serious Games (or "Games of utilitarian purposes") are informatics applications under the form of video games adapting gamification techniques to train, educate, communicate, advertise, inform or animate specific target audiences while playing. Serous Games have emerged as an effective means of engaging stakeholders, also in the water sector (Khoury et al. 2018).

In the NextGen project, a Serious Game on circular water solutions has been developed for a virtual toy town, and hence could be used world-wide. The serious game answers the need to raise awareness on water reuse solutions for a broader audience. The promotion of recycled water is necessary to change the negative perception of reused water. It is also a training tool for water management stakeholders to support decision-making. The main goal of gamification is to raise awareness and motivation for participants. Here, it is used to promote the implementation of water reuse solutions. The Serious Game will fill the gap in information about water reuse while supporting decision-making in the water sector.

Serious Games have positive repercussions to their users: it may improve their self-monitoring, problem recognition and solving abilities. It also promotes collaboration, negotiation, and decision-making (Vallee et al, 2020).

The benefits of Serious Games are the following (Routledge, 2016 in Vallee et al. 2020):

- Engagement stimulation
- Linking knowledge and practical application in a safe environment
- Optimising on pedagogical techniques and knowledge retention
- Reusability
- Rolling specialist knowledge out to wider audience.

Serious Games address a population relatively familiar with online gaming, in particular the young adults who have a gamer profile and are the biggest consumers of training and coaching. Smartphones and tablets are expanding, and solutions should adapt to this evolution in the access to formation and training opportunities. Furthermore, in countries

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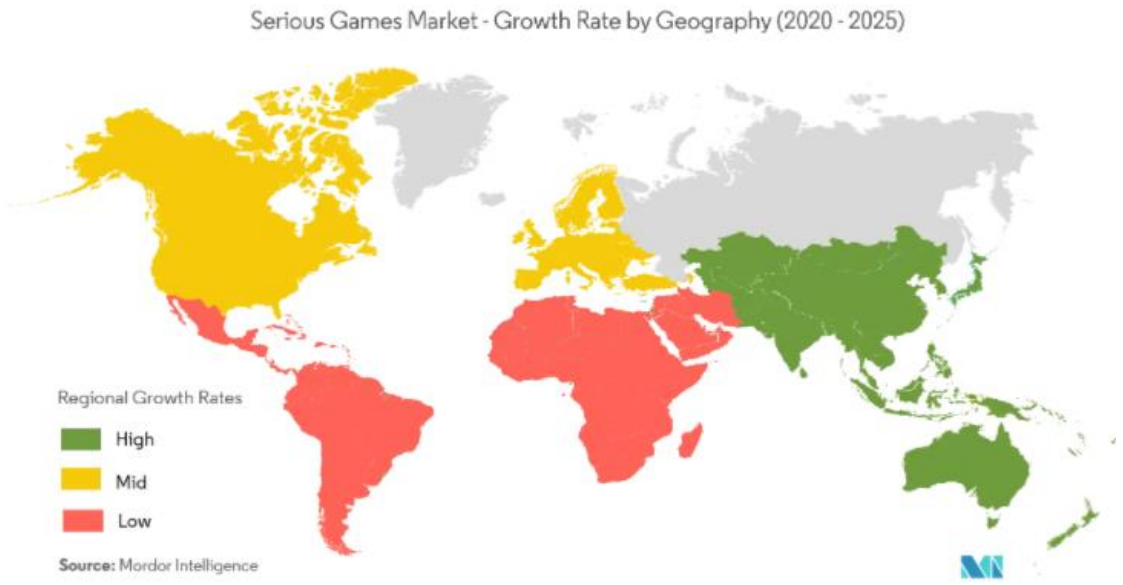
with low computer access, mobile devices are much more widespread and represent a high potential target for serious gaming.

The serious games market is expected to register a CAGR of 20% during the forecast period, 2021 - 2026. The Asian continent has been identified as a high potential area for serious game promotion (Mordor Intelligence, 2021).



Picture 53: Growth rate of Serious Game market by geography (2020-2025) (Mordor Intelligence)

- **AnMBR: seperator, ultrafiltration and degassing membrane**

The Anaerobic Membrane Bioreactor (AnMBR) of the NextGen Spernal demo case uses a membrane bioreactor for the anaerobic treatment of wastewater. The sewage is filtered and separated leaving the effluent and sludge apart (Umble, 2015). This sludge is then treated anaerobically by mesophilic bacteria which release methane as a by-product. The biogas can later be combusted to generate heat or electricity. This technology allows for a positive energy balanced process and promotes the creation of synergies.

AnMBR technology is an attractive alternative for sewage treatment and is especially fit for treating industrial wastewaters at extreme conditions (high salinity, high temperature, high SS concentrations, presence of toxicity) (van Lier et al., 2015).

AnMBR saves both energy and space:

- The methane rich biogas produced can be used as a renewable, storable source of supplemental energy for the production of heat or power. This energy that can be generated by the methane combustion can then exceed the energy required for maintaining the process.
- The process produces low excess sludge and therefore, saves space in WWTP.

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Furthermore, AnMBR produces high quality effluents free of solids and can be used to retain special microbial communities that can degrade specific pollutants in the wastewater.

"Operational costs related to energy requirements for gas/liquid recirculation for membrane fouling control and chemical costs required for membrane cleaning are still heavy burdens on the economic feasibility of AnMBRs. However, membrane acquisition and/or replacement costs have decreased significantly due to a decline in membrane module costs (Ozgun et al. 2013 in van Lier et al., 2015)."

AnMBR is a solution especially adapted to warm climate and concentrated wastewater but operating and maintenance costs still operate as a barrier that needs to be addressed for further implementation.

3. Drivers and barriers for replication of circular water solutions outside Europe

The SDG6 "ensure availability and sustainable management of water and sanitation for all" has set ambitious targets for reuse to be reached by 2030. Countries and cities all over the world are facing an increase of freshwater demand due to urban growth and economic development. Water scarcity is a pressing issue, both due to climate change (reduction of available water resource, change in the seasonal cycles), and to an increase of pollution due to human activities (Tortajada, 2020). To prevent pollution of source waters, the amount of untreated wastewater discharge needs to decrease: finding value in wastewater streams might be one of its solution (IWA, 2018).

Replication activities require a case-to-case basis evaluation as it depends on the social, political and economic factors described in Picture 54. Replication potential needs to be carefully assessed both qualitatively and quantitatively to make sure that the solution is relevant to the context and will effectively benefits to local stakeholders. Motivations and available resources would then be clearly identified and support a sustainable replication process.

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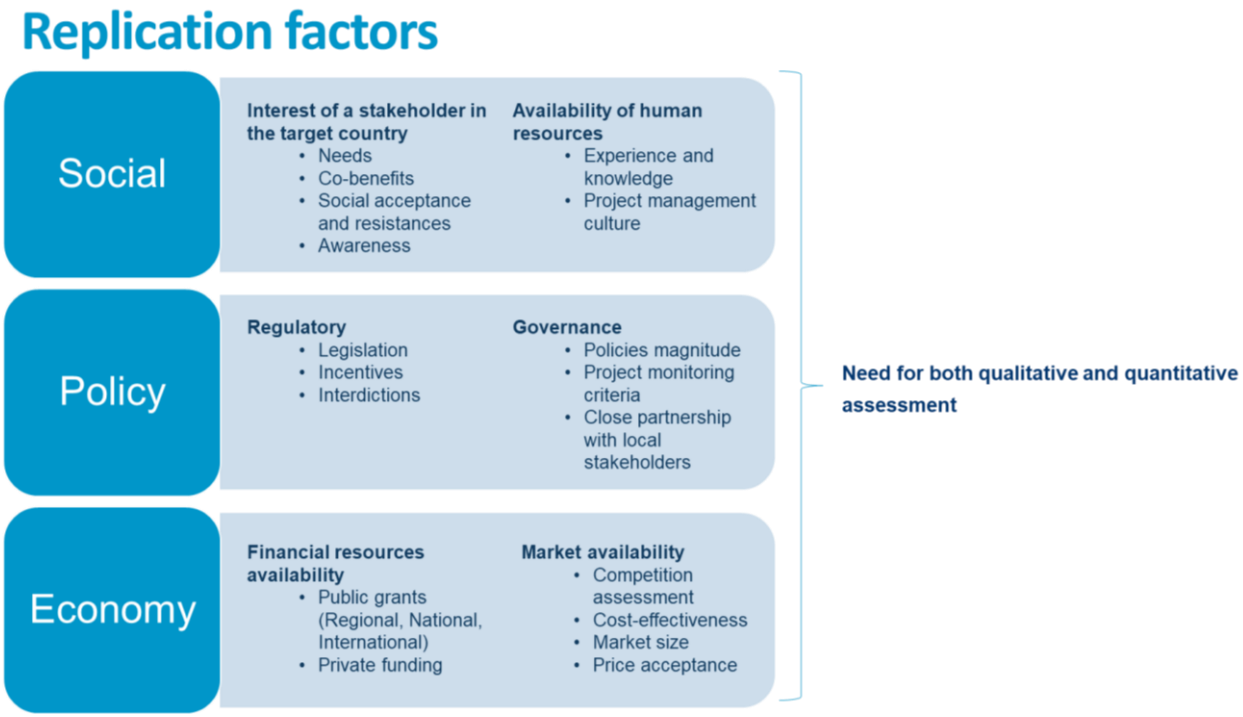

Picture 54: Replication factor for circular water solutions outside of Europe (Source: Strane)

The IWA WasteWater Report 2018 on reuse opportunity describes drivers and barriers faced by cities for water reuse. The case of Chennai (India) and Beijing (China) were especially relevant to better understand challenges met by water reuse projects outside Europe. This analysis have been complemented with the work of Nikita S. Kakwani and Pradip P. Kalbar on challenges and opportunities for circular economy in urban water sector in India. Interviews inputs were also added to Table 1 that lists all those factors.

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Table 1 - Drivers and Barriers for the implementation of water reuse solutions in India and China (Source: Strane)

	Categorisation of factors	Drivers	Barriers
Economic	Economic Impact	• Extraction of resources (water, energy and material) generating new revenue • Saving on water resources used for agriculture • Reduction of energy dependancy	Using recyled water in agricultural activities may lower the market value of crops
	Economic incentives	Freshwater tariff will increase for industrial use in coming years	Low pollution discharge fees
	Water Price	Freshwater tariff will increase for industrial use in coming years	• Availability of freshwater at a low price • Lack of competitiveness of recycled water
	Investment	*Funds available (hyp)*	• High technology and energy costs leading to wastewater recycling plants been unable to scale up • No stable market for recycled water • Substantial cost of energy for treatment • Additional costs of transportation and distribution of reclaimed water
Regulation	Policies and Legislations	• Mandatory wastewater recycling • Mandatory for industries and manufacturers to achieve zero liquid discharge in their operations • Comprehensive procedure/guidelines for the use of recycled water and recovered resources	• Lack of supporting policies • Incentives or benefits of using recovered resources from wastewater unadequately defined
	High standards for reclaimed and reuse water	*Funds available (hyp)*	Reclaimed and reused water standards are more stringent than the wastewater discharge standards
Governance	Political willingness	• Strict application of regulations promoting water reuse • Permits for all new developments will only be awarded with wastewater recycling planned into the design	• Weak enforcement of pollution-related regulations • No control on extraction of • groundwater
	Availability of external funding	*Funds availability*	Reliance on external funding for implementing and operating the facilities related to the water sector : no skill building or skill transmission to local staff
	Public Private Partnerships	Implementing innovations in close partnership with the private sector and inter-governmental agencies	

Some drivers and barriers described in the figure above are expert judgements generated by Strane expertise.

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4. Recommendations for replication and further uptake

The NextGen circular water solutions Sewer Mining, Serious Games and AnMBR has interest from, and replication potential in India, China and South Korea. For each geography, the recommendations for replication of each technology have been summarised using data gathered throughout literature review and interviews with the NextGen partners in Asia as well as feedbacks from NextGen technical partners.

- **Sewer Mining**

The Sewer Mining concept is interesting for decentralization. However, the interviews did not show a high interest for the solution. The costs were high, and the volume of wastewater treated does not fit with local need. As such, it is not a priority for neither associated demo-case. Furthermore, the negative perception of reused water, especially in South Korea, makes it difficult to ensure local motivation.

Recommendations: As such, the Sewer Mining would be replicable with lower costs and increased treatment capacity

Target: Isolated and rural areas could be targeted to deploy the solution if funds (from international donors for example) could be solicited, and motivation is confirmed.

As the partner currently working on the deployment of a sewer mining solution, Strane (in collaboration with NTUA and Chemitec) is still at the experimental phase. The business model and the technology are not yet ready to be implemented. Considering the constraints of implementation in France, as well as the lack of interest for sewer mining of associated demo-cases, Strane does not yet consider deploying the solution in countries outside Europe. A strong interest in sewer mining, as well as a motivated partner would support replication activities. Available financial resources would also be needed to lower the costs of the technology in associated countries.

- **Serious Game**

According to the studies, the serious game has a high potential in Asia, especially in South Korea where the gaming culture is widespread. The interest for its awareness raising functionalities was raised by both India and China, especially targeting regional governments.

Recommendations: As smartphones are much more widespread than laptops and computers, one of the recommendations for the serious game would be to make it compatible with smartphones (the NextGen SG will be compatible with smartphones). Furthermore, it needs to fit with the local context: state of infrastructures, stakeholders' ecosystem, etc.

Target: The main targets would be local governments and universities.

The University of Exeter is currently developing the Serious Game with a "generic" model that can fit any country. Adapting the underlying model to specific characteristics of one

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country/case study would require a small effort/investment because it is modular, and therefore would only require adding a small extra module e.g. a desalinisation plant and corresponding model testing... As the technology can be deployed anywhere, it would only need a willing partner to develop the corresponding version of the serious game. University of Exeter would be willing to discuss with such a partner to deploy the Serious Game in associated countries.

- **AnMBR technology**

The AnMBR technology rose a high interest both in India and China. The high concentrated industrial water and hot weather makes India compatible with this technology. However, the costs efficiency is a challenge: AnMBR technology is expensive, and upscaling would then be an issue in India. China has a high willingness to study and implement AnMBR technology for wastewater treatment. As industrial and municipal wastewater are merged after pre-treatment, wastewater usually have a higher concentration than in Europe. South Korea is interested by the technology but is developing an alternative solution (described in section 2.3).

Recommendations: To replicate AnMBR technology in India, it is necessary to lower the costs or find alternative sources of funding for upscaling (public/international funds).
No barriers for the replication have been noticed so far in China, technical interviews should be considered.

Target: The main target are industrial WWTPs.

Anaerobic treatment of municipal wastewater is successfully deployed in tropical and sub-tropical areas already, most notably South America. To successfully deploy the technology in more temperate climates the process needs intensifying hence coupling the anaerobic reactor with an ultra-filtration membrane (AnMBR). In addition, it is very likely that the greater amount of dissolved methane, a consequence of the colder temperatures, requires some form of methane recovery. In principle Severn Trent would be open to deploy its solution in other parts of the world including India, South Korea and China once the technology is proven. The commercial / IP arrangements of the technology need resolving, a suitable commercial arrangement with technology partners in those countries is necessary to deploy. Areas of China and South Korea that have climates more similar to Northern Europe would probably be targeted first, as simpler anaerobic solutions may be more appropriate for warmer regions of India and China. For now, the main barrier identified that could hinder replication activities is the cost of the technology.

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6. Conclusion

The innovative European solutions in water sector have leading position in the international market and contribute globally to safer drinking water, sustainable storm water solutions and resource efficient water and wastewater management for better environment. To strengthen international collaboration and to test replication potential of NextGen circular water solutions outside EU, three demo cases of associate partners from India, China and South Korea respectively were included and studied in the Nextgen project. Demo cases of the associate partners are unique and creating or will create substantial impact at local level. Through numerous outreach activities in India and China, and through networking alliances with European partners, we have been able to exchange experiences and achieve cross-fertilisation on the potential of circular water solutions.

India, China and South Korea are still in the initial phases of wastewater reclamation and reuse but there is high business potential. Circular business models are being studied in the NextGen project and a methodology for value chains assessment is being developed as well in D5.1 and D5.2. A survey on business model improvement, especially considering other non-economic parameters has also been developed. Overall, those findings will contribute to the incorporation of circular (such as: nutrient recovered rate, materials, and product life extension, etc) and/or environmental and social (job creation, carbon footprint, etc) indicators. Those new business models will allow to have long-term vision in cases where business cases are not yet economically viable. They also highlight policy recommendations that would favour circular business solutions by identifying drivers to use and barriers to overcome. Those topics, as well as the potential for replication with associated countries will be discussed at the IWA Conference in Copenhagen (2022) where NextGen will organize a Watershare meeting with our partners IVL (China, India) and KIST (South Korea).

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Bibliography

Alexandre Barret, Victor Faraut, Mouldi Hammadi, George Karavokiros, Klio Monokrousou, Clara Plata, Vassilis Psaltopoulos, Erzsebet Pocsi, Charles-Xavier Sockeel, “D5.3 Market and competition assessment”, 2020, NextGen project

Ik-Chang Choi, Hio-Jung Shin, Trung Thanh Nguyen, John Tenhunen, “Water Policy Reforms in South Korea: A Historical Review and Ongoing Challenges for Sustainable Water Governance and Management”, 2017

Ho-Sik Chon, Huncheol Im, SeJin An, “Adaptation Technologies in Water Sector Demanded by Developing Countries and the Potential of Technology Transfer of SMEs in South Korea”, 2018

Hanseok Jeong, Chounghyun Seong, Taeil Jang, Seungwoo Park, “Classification of wastewater reuse for agriculture: a case study in South Korea”, 2016, *Irrig. And Drain.*

Nikita S. Kakwani, Pradip P. Kalbar, “Review of Circular Economy in urban water sector: Challenges and opportunities in India”, 2020, Journal of Environmental Management

Khoury, M.; Gibson, M.J.; Savic, D.; Chen, A.S.; Vamvakeridou-Lyroudia, L.; Langford, H.; Wigley, S. A Serious Game Designed to Explore and Understand the Complexities of Flood Mitigation Options in Urban–Rural Catchments. Water 2018, 10, 1885.

J.B. van Lier, F.P. van der Zee, C.T.MJ. Frijters, M.E. Ersahin, “Celebrating 40 years anaerobic sludge bed reactors for industrial wastewater treatment”, 2015, Rev Environ Sci Biotechnol,

Plevri, Argyro, Lytras, Efthymios, Samios, Stylianos, Lioumis, Christos, Monokrousou, Klio and Makropoulos, Christos, 2020, Sewer Mining as A Basis for Technological, Business and Governance Solutions for Water in the Circular Economy: The NextGen Athens Demo”, Environmental Sciences Proceedings 2(1), 54

Qu, J., Wang, H., Wang, K. et al. Municipal wastewater treatment in China: Development history and future perspectives. Front. Environ. Sci. Eng. 13, 88 (2019).

Anju Singh, Megha Sawant, Sheetal Jaisingh Kamble, Mihir Herlekar Markus Starkl, Enrique Aymerich, Absar Kazmi, “Performance evaluation of a decentralized wastewater treatment system in India”, 2018

Tortajada, C. Contributions of recycled wastewater to clean water and sanitation Sustainable Development Goals. *npj Clean Water* **3,** 22 (2020)

Umble, Art "Anaerobic MBR: Challenges & Opportunities", 2015, Hydrogen, Hydrocarbons, and Bioproduct Precursors from Wastewaters. Washington, DC: National Renewable Energy Laboratory

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N°776541

N. Vallee, A. Bredimas, A. Lourantou-paris, K. Dahmani, A. Reidon, C. Chew, « D6.2 : SIM4NEXUS Final Market and Competition Study", 2020, Sim4Nexus project funded by the EU Horizon 2020 research and innovation programme under grant agreement No. 689150

IWA WasteWater Report 2018 – The Reuse Opportunity

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Appendix

I. Agenda- Nordic Solutions Sewage and Sludge Treatment for India webinar

CII Confederation of Indian Industry 125 Years: 1895-2020

ivl Swedish Environmental Research Institute

Nordic Innovation

WEBINAR ON
NORDIC SOLUTIONS IN MSW, SEWAGE AND SLUDGE TREATMENT FOR INDIA
June 12, 2020 15:00- 16:15 (IST) / 11:30- 12:45 (CET)

1500- 1505 Hrs	**Opening Remark and Moderator by** • **Mr. Ulhas Parlikar** Former Director, Geocycle- ACC Global Consultant- Waste Management, Circular Economy, Policy Advocacy, AFR & Co-processing
1500- 1515 Hrs	**Keynote Address** ***'India's current situation in Sewage, Sludge and MSW areas'*** • **Shri V.K Jindal** Joint Secretary- SBM Ministry of Housing and Urban Affairs Government of India
1515- 1545 Hrs	**Presentation** ***'Innovative solutions by Nordic in Sewage, Sludge and MSW treatment'*** • **Mr. Osten Ekengren** Senior Advisor IVL Swedish Environmental Research Institute
1545- 1555 Hrs	**Emerging Business Models in Waste Management and Policy Initiatives in India** • **Mr. Yogesh Mittal** CFO JBM Environment
1555- 1600 Hrs	**Closing remarks** • **Ms. Rupali Deshmukh** Senior Coordinator, Business Development & Marketing IVL Swedish Environmental Research Institute
1555- 1615 Hrs	**Questions & Answers**

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II. Agenda- International conference on Waste to Worth

International Conference on Waste to Worth

'Achieving Circular economy through Innovative 3R techniques'

30 October 2020 I 1000 Hrs- 1730 Hrs I Over Virtual Platform

15 Days Virtual Exhibition: 30 Oct 2020 – 15 November 2020

[Session – 1]

1200 – 1315 Hrs Glocal Models and Best Practices for Waste Management

Urban India generates 62 million tons (MMT) of waste annually with an average annual growth rate of 4%. Out of this, 55 MMT is municipal solid waste and 5.6 MMT is plastic waste (Source: CPCB). One of the major challenges lies to manage these wastes not only in a boost of the quantity of wastes but also in the increasing complexity of handling the wastes' streams due to the diversity and composition of the waste generated by the urban India. Therefore, it is imperative to minimize the waste going to landfills and water stream through efficient recycling, processing and scientific management methods as well.

The session would focus on existing waste management systems, models, best practices across the country and World to address the issues of management of waste in a holistic way, suggest best possible technological solutions to mitigate the solid waste problem, financial models, government supports etc

1200 – 1205 Hrs	Opening Remarks by Chair	**Masood Mallick** Joint Managing Director Ramky Enviro Engineers Limited
1205 – 1215 Hrs	Best Practices in Waste Management in Abu Dhabi and Tangiers	**Rabih Jawad** Vice-President Operations AVERDA, Dubai
1215 – 1225 Hrs	Decentralized Waste Management for maximum resource recovery and decent livelihood - Case studies from small cities and towns in India	**Wilma Rodrigues** CEO Saahas Zero Waste
1225 – 1235 Hrs	Best Practices from Western World in Waste and Wastewater management	**Osten Ekengren** Senior Advisor IVL Swedish Environmental Research Institute, Sweden
1235 – 1245 Hrs	How and what need to be done for technologies to be successful in India	**Yashas Bhand** Director, Organic Recycling Director, Yasasu EMS Pvt Ltd.
1245 – 1255 Hrs	Waste management in The Czech Republic in the Age of Industry 4.0	**Michael Rada** Founder and Leader & Industrial Upcycling - Designer and Leader The Czech Republic
1255 – 1305 Hrs	What can be learnt from countries (a.i. China) which were successfully in developing their WtE infrastructure	**Nicolas Maertens** Business Development Manager Keppel Seghers
1305 – 1310 Hrs	Closing Remarks by Chair	

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III. Agenda- 5th India Water Impact Summit

TRACK D – INTERNATIONAL PARTNERSHIP	
Session D1 Day 1: Thursday, December 10, 2020 18:00 – 19:00 hrs	**UK** Recently cGanga signed a MOU with British Water to create a bridge for UK industry to pair up with its Indian counterparts to build 21st century infrastructure in water and environment sector. UK is also becoming a major partner to help India tap into global capital base to finance its green growth agenda. The session will put a spotlight on how the partnership is being put into action.
Session D2 Day 2: Friday, December 11, 2020 18:00 – 19:00 hrs	**USA** From artificial intelligence to state-of-the-art infrastructure development approaches, US companies are aiming to partner with their Indian peers to accelerate innovative technologies and solutions into the Indian market. The session will highlight various initiatives and partnerships that have been formed or are forming.
Session D3 Day 3: Saturday, December 12, 2020 18:00 – 19:00 hrs	**Norway** Norway will be a key partner to India's growth particularly bringing in the circular economy principles. As a world leader in energy systems, Norway can help India usher in advanced energy and resource recovery solutions and commercial models into India. A crucial alliance has already formed with Norway on how India will manage sludge from its wastewater treatment plants and many others are in play.
Session D4 Day 5: Monday, December 14, 2020 18:00 – 19:00 hrs	**Europe** From developing hydrogen from waste to satellite remote sensing, European companies are already partnered with India in its sustainable development agenda. Nations from across Europe will present new innovations and discuss with Indian counterparts approaches to partner up and develop impact projects particularly at the intersection of energy, water and land.
Session D5 Day 6: Tuesday, December 15, 2020 18:00 – 19:00 hrs	**Lower Mekong Nations** The Ganga Mekong partnership has already established a base for India's support for the growth of Lower Mekong nations – Cambodia, Laos, Myanmar, Thailand and Vietnam. Throughout this new partnership India will share its experiences and expertise of managing river Basin with its peers in the Lower Mekong.

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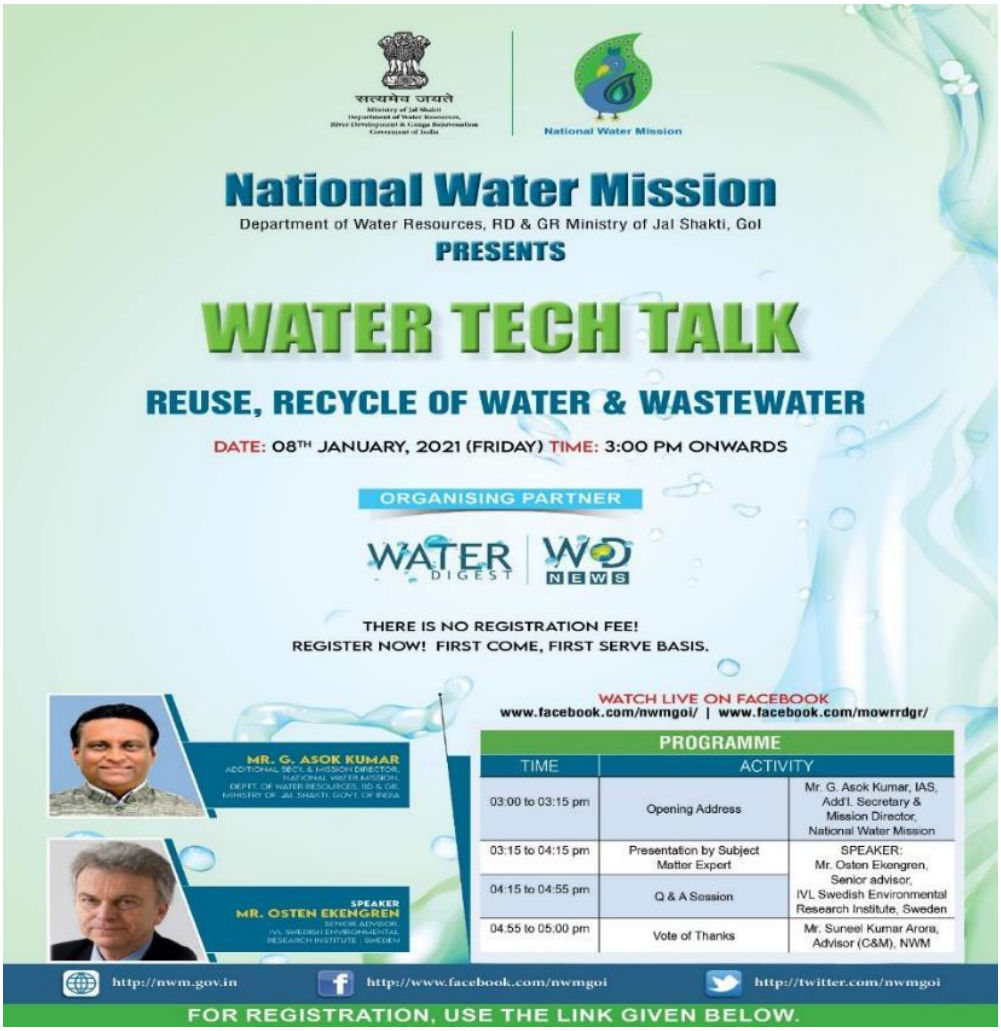
IV. Agenda- Water Tech Talk



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V. Agenda of Replication potential meeting

nextGen
Circular Water Solutions

Replication Potential Webinar EU Expertise
On Tuesday February 2nd, 2021 at 0800-1100 CET/ /1230-1530 IST/ /1500-1800 CST

Time	Topic	Speaker
0800-0802 CET / 1500-1502 CST / 1230-1232 IST	Opening Remark	Moderator Rupali Deshmukh, IVL Sweden
0802–0820 CET / 1502–1520 CST / 1232–1250 IST	Keynote Speeches:	• Dr Sunil Kumar National Environmental Engineering research institute (NEERI) India. (India's current situation in Sewage, Sludge and MSW areas Research Challenges & opportunities in wastewater Management in India) (10min) • Mr. Gao Song Jiangsu Yixing Institute of Environmental Industry. (7 Min)
0820-0840 CET / 1520-1540 CST / 1250-1310 IST	Speech on Challenges and opportunities in wastewater Management & Future-oriented WWTPs in China	• Dr. Gong Hui, Tongji University
0840-0855 CET / 1540-1555 CST / 1310-1325 IST	Mega Sewage treatment plant (STP) Projects with plan of Reuse of wastewater	• Mr. Ajit Salvi, The Municipal Corporation of Greater Mumbai, India. (10Min)
0855-0915 CET / 1555-1615 CST / 1325-1345 IST	Nextgen-case study 1- Costa Brava (Spain)	Sandra Casas Garriga, Eurecat
0915-0935 CET / 1615-1635 CST / 1345-1405 IST	Nextgen-case study 2- Spernal (UASB/AnMBR) (United Kingdom)	Peter Vale, Severn Trent
0935-0955 CET / 1635-1655 CST / 1405-1425 IST	Nextgen-case study 3- Serious games	Khoury, Mehdi & Evans, Barry, University of Exeter
0955-1000 CET / 1655-1700 CST / 1425-1430 IST	Break	leg stretch
1000-1015 CET / 1700-1715 CST / 1430-1445 IST	Overview of market potential and feasibility criteria for China and India of NextGen (STRANE)	Charles-Xavier Sockeel
1015-1100 CST / 1715-1800 CST / 1445- 1530 IST	Round table discussion with Q/A	Open discussion- All Participant
1100-1145 CET / 1800-1845 CST / 1530-1615 IST	VAT-Digital twins project	Erik U Lindblom & Oscar Samuelsson, IVL Sweden

Join zoom meeting- https://ivl-se.zoom.us/j/88412011845?pwd=MjJPa0ZpV1NJOXVveGorM01scmxYdz09

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VI. Meeting Minutes: Replication potential Webinar

20210202 NextGen Replication Potential Webinar：EU Expertise

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Participants from European, UK, India and China

1. **Opening Remark by Rupali, IVL, Sweden [15.00-15.03]**

Greetings. Introduction about the meeting and participants.

2. **Keynote speeches [15.03-15.20]**

2.1 **Dr. Sunil, NEERI, India [15.03-15.13]**

Focus on wastewater, solid waste, also carbon, plastic, and other aspects
Wastewater & solid waste management would provide job opportunity
Only 29% water treated across the country
Many challenges of wastewater treatment
Only 75-80% of the MSW are collected and 22-28% are treated
Swachh Bharat Mission Project

2.2 **Mr. Gao, JIEI [15.14-15.18]**

Greetings and introduction
Presentation: Next Generation water treatment
10 model.
China has the biggest market.
Water treatment, low carbon, green economy.

3. **Speech by Dr. Gong, Tongji University, China [15.19-15.38]**
Challenges and opportunities in wastewater management & future oriented WWTPs in China

(1) Brief introduction.

In the past 20 years, the development of WWTP is increasing rapidly.
China is under the fast urbanisation

(2) WWTP problems

WWTP consume high level energy consumption
WWTP led to several problems and were unsustainable.

(3) To build the future WWTPs in China and innovative cases in China

A. Beijing:

The distance between houses and on the ground WWTP could influence the house price
In the future, the plant could be transferred as underground plant so the ground space can be used
Now about 90 underground WWTPs in China (and become more and more)
From negative asset to positive asset

B. Eco-complex in suburb

Combine the WWTP and Eco park
Municipal wastewater treatment in China: development history and future perspectives

4. **Speech by** Dr. Salvi**, The Municipal Corporation of Greater Mumbai, India [15.38-15.52]**
Research challenges and opportunities in wastewater management in India

(1) Background of sewerage system of Mumbai

More than 30% area is unsewered in Mumbai
Some parts of the sewerage system have been used over 30 years

(2) Future plans– approaches with recycle & reuse plan

New discharge standards, open technology, DBO contract

(3) Challenges of implementation of new projects

Inadequate land, removal of mangroves, sludge disposal

(4) Challenges of implementation of recycle and reuse policy

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Maintenance of tertiary treatment facilities, provision of distribution network, public awareness, restriction on reuse and recycle water

(5) Model of Bandra WWTP

60% green cover, public space, knowledge center, many public buildings, interconnecting skywalks

(6) Conclusion

Every plant has its own situation, case by case

5. **Nextgen Case study [15.53-16.41]**

5.1 **Costra Brava by Sandra, Eurecat, Spain [15.53-16.05]**

Costa Brava Demo Case

(1) Background

Touristic region, seasonal population changes

A pilot plant integrated by UF and NF

(2) Nextgen solutions

Use OR. UF NF.

Use LCA to analyse the environmental impacts

(3) Results

Remove more than 90% contaminants

5.2 **Spernal (UASB/AnMBR) by Peter, Severn Trent, UK [16.07-16.28]**

Spernal WWTP UK - Anaerobic membrane bioreactor (AnMBR)

(1) Background

Produce bio-gas. Low sludge production

Application for agricultural land in some countries (such as nations in cold climate)

(2) NextGen solutions

No aeration required, huge saving in electricity consumption and associated CO2 emissions

Extra biogas, recovery of nutrition

(3) Results

High remove rate

5.3 **Serious games by Khoury et al., University of Exeter, UK [16.28-16.41]**

It's a system dynamic model for designing the water and wastewater management related to circular economy, including reservoir, river, house, WWTP, etc.

You can change the parameters in the model to get higher scores of circular economy

SDM based on Julia language

6. **Overview of market potential factors for NextGen technologies in China, India, and South Korea by Charles-Xavier & Alexandra [16.49-17.03]**

Selecting projects (1-2 out of 27 technologies)

Analyse replication factors (e.g., social policy economy)

Sewer mining miner

7. **Roundtable discussion with Q/A [17.03-17.45]**

Comments from CN side:

Comments from India side:

EU technologies are good. The possibility to replicate it in India? (

A: timeline- now the tech. is not validated, validation in 3-5 years and start the market application and transaction.

Q1 from Jos: which of the replication factors are most important for potential application of AnMBR in India and China?

- **China, Economic factors (especially for the price and lifetime of the membrane) are the most important**

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factors

- **Comments from Pete Vale: It's expensive but the price is much less than before. Not sure the lifetime of membrane in AnMBR process. Need to think about you really need membrane or you can use another way to treat the water.**

Q2 from Derek Pan: How to evaluate the recovery efficiency of ammonia and why chose 3M membrane and what is most challenge part?

- **Answers: I rely on data from Cranfield University. About 10 years cooperation on research on membrane context in the system. It is a proven technology, but unproven application in this field. We selected this technology based on experience from Cranfield University and we got good ammonia recovery efficiency.**

Difficulty is to change the gas quality.

AnMBR maybe could be used for sludge plant.

Q3 from Derek Pan: are Severn Trent comparing the AnMBR and MABR in Spernal testbed to see which is more available for municipal wastewater?

Answers from Pete: No. AnMBR and MABR filling different needs. We are interested in AnMBR to see if it can upgrade the existing active sludge to removal more ammonie, for example, because population growth, without having to build concret tanks or put more energy in. It is a good chance for low whole life cost solution for grading existing system.

Q4 Jos Frijns: Is serious games interest to you for engaging the public?

- **Ajit: we are willing to try that. Would trying to add the game in the project in the future. Could improve the public awareness.**
- **Dr. Gong: I think the public engagement will interest the game.**
- **Dr. Pan: Chinese people welcome new ideas… if the game could be designed as mobile APP, it may be popular. To attract younger generation is important.**
- **Mehdi: Currently the game is designed as desktop or laptop version, hopefully it could have the mobile version. Previously, we were focus on the model, and now we need to try to how to tell a good story.**

Q5 from Chen Jun: How to remove mass from liquid line with low temperature?

- **Pete: MBR has good performance in South America. Cold temperature may be more difficult. Use longer time (?) and other steps to enhance the performance in cold climate.**

Jos: What's the strengths… opportunities of China and other Europe countries

- **Charles: First need to start what do you need. Then to see what to corporate.**

Yanjing: How to combine the serious games with environmental education? Any cost?

- **Mehdi: interested person can contact us.**

8. **VAT-Digital twins project by Erik & Oscar, IVL, Sweden [17.46-18.10]**

(1) What have we developed?

An application (digital twin) for training and test of WWTP

(2) Use digital twin to simulate the reality

VAT-test

Q&A: why not use other software?

- **In Sweden we have many simulation models**

Q&A: The inlet of wastewater is very complicated in China, could this model be used in China?

- **You need to do some work in China, it's possible to use the model in China. The model needs to be modified by monitoring data.**

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VII. Agenda Watershare webinar: NextGen Circular Water Solutions from Across the Globe

In the transition towards the circular economy, the water sector worldwide is taking initiatives to close the water cycle further, reuse water, and recover energy and nutrients from wastewater. Within the EU H2020-project NextGen, several Watershare partners demonstrate circular water solutions within Europe and China, India, and South Korea. In this webinar, Watershare partners present their NextGen activities such as IVL-TSWO on sponge irrigation in India, IVL-JIEI on high efficiency and energy-saving wastewater treatment in China, KIST on advanced materials for water purification in South Korea, and NTUA on sewer mining in Greece. An excellent opportunity to learn from each other.

Agenda:

Intro – Lisa Andrews, KWR & Watershare: welcome, intro Watershare

Intro – Jos Frijns, KWR: NextGen, programme webinar

Speakers:
1- Rupali Deshmukh, IVL - Taposya India: sponge irrigation system
2- Yanjing Zhu, IVL - JIEI (Jiangsu) China - concept WWTP of Yixing
3- Young H. Lee, KIST South Korea - advanced materials for water purification
4- Klio Monokrousou, NTUA Greece – sewer mining at Athens urban tree nursery

Q&A with speakers (and poll)

Closing – Jos Frijns, KWR

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