# Towards a Resilient Community

## A Study of Decentralized Technical Service Provision

*Simon Fast*

*Sweden*

## Introduction

This essay is about alternative ways to provide people with the basic services needed for a productive life in an urban context. With rapid urbanization and neglected infrastructure in lots of megacities in the global South, major problems with service provision is a reality. The text highlights alternative ways to provide services by shifting perspectives from centralized big infrastructure that provides for millions of people to decentralized systems which might be better suited for today's challenges. The services that will be analyzed are water management, sanitation and electricity. These are chosen of two reasons; they are essential to human development, and they are part of the built infrastructure.

Right now we can see an unprecedented growth of the human population. Every week the global population increases with around 1.5 million people (worldometers.info). To put that in perspective, the global population grows with one Munich  per week. The ever increasing population, together with migration are the main causes for the rapid urbanization we currently experience around the planet. This phenomenon is at its strongest in the global South, where recent financial opportunities, as well as environmental changes brings people from the countryside to the cities. Urbanization as such is not a bad thing since it is closely related to economic growth and an increase in human capital, but the way it is occurring right now is unsustainable for the future development of human kind and planet Earth. Joan Clos, Under-Secretary-General at the UN states that "the current urbanization model is unsustainable in many respects, puts many people at

risk, creates unnecessary costs, negatively affects the environment, and is intrinsically unfair" (UN-Habitat, 2016).

Rural to urban migration are due to a complex mix of reasons, which either forces or encourages people to move to cities. The forced reasons can be conflicts, natural disasters or environmental change which makes agricultural work unprofitable or even impossible. Factors that promote urban migration are the work possibilities, alongside with educational possibilities and access to healthcare. The UN-Habitat Report (2016) exemplifies the complexity of migration in a paragraph:

> Although the African economy has witnessed relatively high levels of growth, and is the second fastest the world, high unemployment especially among the youth, inequality, poverty, lack of opportunities and a sense of hopelessness are driving migrants to make this perilous journey in unworthy and overcrowded boats to Europe.

When cities grow in an unprecedented pace they have to face the challenge of providing basic services like transport networks, sanitation, water, electricity, healthcare and education to the ever increasing population. If cities cannot provide adequate services "the basic productivity of all citizens will be compromised" (UN-Habitat, 2016). The alleviation of poverty and human development is therefore dependent on the provision of basic services to the people. The problems with service provision are most urgent in poor countries where the urbanization pace is at its peak. These cities have not had the resources to keep up with the ever increasing demand for services. (ibid).

To tackle these challenges we might have to change our perspective when it comes to service provision. The already under-dimensioned (or sometimes non-existent) centralized infrastructural systems that have been standard since the industrialization might have to give in for other types of small scale infrastructure that are more adaptive to the ever changing fabric of the modern city (Bieker, et.al, 2010).

The research presented in this paper is analysed with Manila in the Philippines as a focal point, since the course Urban Shelter took us there for a three weeks study trip. There, we visited a social housing project adjacent Smokey Mountain, which

triggered my thoughts regarding society and development. The poor contitions for the most voulnerable in society was a striking sight which triggered thoughts about what is needed for human development. The visit functioned as a starting point for my interest in technical service provision and the fragility of the megacity. Manila also experiences many of the above mentioned phenomenons; urbanization, poverty, fragility etc, which are of interest for the text. To have focus on Manila is interesting on a personal level, since our design task parallel to this paper was to develop a housing project within Manila. The research done for this paper can to a great extent be integrated into the design proposal.

# Decentralized Systems

This section will look into the different systems available for local service provision. There is a richness in different systems and technologies available that could be analyzed and integrated in this research but the paper can not cover all of them. The selection has been made trying to find modern and sustainable alternative solutions which are suitable for a community in the size of 500 to 2000 people in an urban context. The focus will be within three fields; electricity, freshwater and wastewater management. A community can get electricity from solar cells and through extended wastewater treatment, water from rainwater harvesting and wastewater treatment, and small scale sanitation systems that could be integrated in the urban fabric.

## Wastewater Management / Sanitation

The standard system for handling wastewater in an urban context is to collect and transport it from households through long sewage systems to a treatment plant outside the city. This giant piece of infrastructure then cleans the water before disposing it to the adjacent waterbody. This is usually the ocean, a lake or a river (Bodnar, 2013). In today's world when water scarcity is a major problem in many places on the planet, this system could be considered outdated since we are not recycling the water. One other argument against it is that it is a huge investment to build those facilities and all the piping required to transport the wastewater to the treatment plant. A lot of cities in the global South do not have the resources necessary for an investment of that scale (Schreff and Wilderer, 2000). A third

and major reason to reconsider the current way of approaching wastewater management is that those huge infrastructural systems are sensitive to natural disasters like earth quakes as well as to man-made attacks like terrorism or war (Avezzù et.al, 2012).

There are available alternatives to the centralized wastewater management system we usually use in cities. One proven way can be found in Toarps Ekoby outside Malmö which has a decentralized closed wastewater management system for its residents. Toarps Ekoby was developed by the architect Krister Wiberg who has invested most of his career in sustainability. The water cycle in the village is as following; the water to the household comes from a well and passes through a purification process before it appears in the taps in the house. When used, the water passes a sludge tank which collects the solid waste before the natural

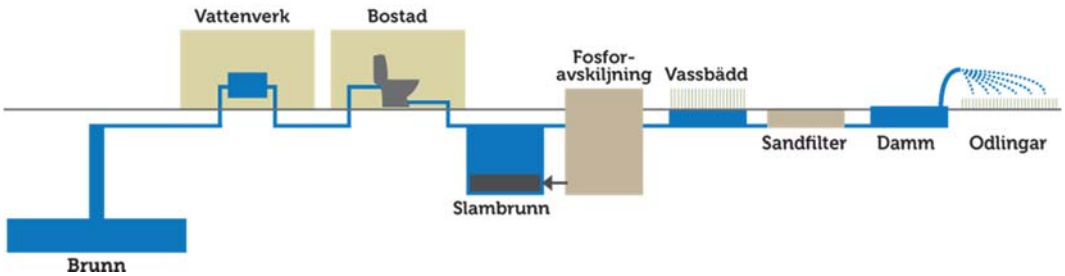

Figure 1. Toarps Ekoby's wastewater treatment cycle (toarpsekoby.se)

cleansing through a reed bed and a sand filter. After this process the water is good for irrigation of farmland or other non potable uses. Over time the water finds its way back to the groundwater and into the well (toarpsekoby.se). This system handles all the requirements necessary to not pollute the surrounding environment. According to Michael Cimbritz (2018), professor in water supply and waste technology at LTH, this system requires a big area to achieve an acceptable end product (about 10 square meters per person) which makes it less suitable for an urban contexts. It is a good system for holiday resorts or villages on the countryside but it simply cannot work in the city because of the necessity of horizontal space (Cimbritz, 2018).

There are other actors who have specialized in wastewater treatment in an urban context. The company Organica, co-founded by the architect Attila Bodnar, have

further developed the standard techniques used in centralized wastewater treatment facilites and made it four times more effective, mainly by increasing the density of bacteria which feeds on the organic matter in the water and in that way cleans it. With a system that much more effective the size of the treatment plant can be reduced a lot (Bodnar, 2013).

Organica have managed to shrink the size of the treatment plant to an extent where the price of land no longer is an issue. However, there are still a lot of complications with wastewater treatment in an urban context. The reduction of estate value close to the facilities as well as the odour from treating wastewater are both reasons why people are sceptical of urban wastewater treatment (ibid).

The solution that Organica has developed to deal with these issues is pioneering and architecturally interesting. They have developed a concept where the surface of the cleansing tank is covered in vegetation in a way so that their root system provides space for the bacteria to fiest in the water, while the top looks like a green house or a botanical garden. The effects of this are that it looks pleasant to the eye, that it is odour free, and that it could be used in recreational and educational purposes (Organicawater.com).

When it comes to scale they have developed small prefabricated treatment plans, treating from 100 to 400 cubic meters of influent wastewater per day (Organicawater.com). A Danish person produces about 80 liters of wastewater (wte-ltd.co.uk) which means that the treatment plant could cover the needs for 1250 to 5000 people.

## Rainwater Harvesting

To collect rainwater and store it for later use has been a way for humans to survive and to cultivate land for a long time. Now, with rapid urbanization and increased water scarcity in many places all over the globe, the interest for alternative water sources have greatly increased. It is also proven that human development, economic prosperity and poverty alleviation is dependent on the access to water. Lijun Liao and Linus Zhang (2003) writes:

> Water has often been a bottle-neck in the development of the agricultural, industrial and social-economical sectors of the region. In a global perspective, due to the accelerating pace of population pressure it is expected that by the end of this century one third of Earths arable lands will be lost due to desertification and 14 % of the human population living in arid zones in the world will be directly threatened.

Water is not only a necessity for humans to prosper but the scarcity of water can cause mass migrations and despair. The water scarcity is noticeable in many developing countries all over the globe which also makes their struggle to "catch up" with the developed world even harder. Zhang and Liao state that "water shortage is a major obstacle for local economic development and a crucial factor causing severe poverty".

There is a huge potential in rainwater harvesting because of its accessability and reliability. It is not, however, just to connect the gutters to a container and let the seasons to do their job. This might be fine if it's only for non-potable uses, like watering flowers or flushing the toilet, but to counteract water scarcity the water needs to reach a drinkable quality. The water collected from rainfall requires treatment to reach the WHO drinking water standards. There are problems with the current low-tech rainwater harvesting systems in several ways. Poor maintenance can cause leakage as well as lowering the water quality (Liao and Zhang, 2003).There are, however, cheap and reliable ways to purify the rainwater within the small scale of the current systems.

First, the system should have a sedimentation tank immediately after the water is collected. Here the bigger particles will descend to the bottom. After this step the water will enter a the CFS (coagulation-flocculation-sedimentation) facility where chemical coagulants are added to aggregate the contaminants to big clusters to easier remove them. The next step is to catch all the pollution-clusters through a filtering process, where the water is led through a pipe filled with sand or other filtering material. Lastly the water goes through a disinfection process, preferably using UV-light or chlorine, before the finished product is clean and drinkable. The materials and chemicals used are not expensive, but the UV-light needs electricity (Liao and Zhang, 2003).

With a simple installation of an above described rainwater treatment facility one can get an end product which is fully consumable. It is only the size of the facility and the time the water has to pass through that decides how much drinkable water the system can produce. If there is a big water collection tank in the beginning of the system, the natural rainwater could be stored there when heavy rains fall and then later proceed through the treatment steps and guarantee drinking water for the people far after the rainy season is over. So the system does not require great space, but it do require a well dimensioned collection tank.

## Electricity

Since industrialization our power has been provided through ever increasing centralized macrogrids which have developed along cities as they grow. With today's population increase and urbanization there are reasons to believe that the macrogrid as energy provider is limited and cannot cope with the increasing demand (Marnay and Venkataramanan, 2006). If the system would manage to meet the ever increasing demands, it is not clear if it can do it on time and in a planned and organized way because of the size and complexity of the macrogrid. Other reasons to question the current consensus about energy delivery would be the fragility of the macrogrid. It could be a target for sabotage and terrorism which then would have severe consequenses on large areas (ibid). There are alternative ways to deliver electricity through independent microgrids. "Microgrids are self-contained electric grids that can operate as an "island," independently of the central power grid" (Environment America, 2017). Today it is not a common way to build but it has been tested and proven to provide decent quality power.

To create a small scale microgrid for a block in a city is not a very complicated task. At some places, especially in the developing world, it could even be preferable due to the poor conditions of the existing macrogrid. The problem with a microgrid, especially in an urban context, is how to get the electricity in there and to keep it reliable over time. The ideal would be to have a city block that produces renewable energy at a constant rate which then would provide stable power to the microgrid within the block. This block would then be energy independent with a zero energy footprint. Due to the heterogeneity of renewable power plants (wind speeds for wind turbines or sun for photovoltaic cells) the

energy sources must be complemented with power generators or batteries to handle the different outer conditions (Bhattacharyya and Sen, 2013).

An experiment with a closed microgrid with local renewable energy are being tested in the small village Simris outside Simrishamn in southern Sweden. The village gets all its energy from a wind turbine and a small photovoltaic park just outside the village, and it produces enough to cover all inhabitants energy consumtion over one year (eon.com). They have solved the storage by using the different energy storage units that already exist within the buildings; electric cars, water heaters, etc, and combined that with a big battery adjacent to the power park. A high tech computed system distributes the power through the different storage units and makes sure that the voltage in the grid is on the right level (ibid). This experiment in Simris has shown that decentralized microgrids powered by renewable sources can work really well, but the projects initial cost was high, 35 million SEK. One can argue that a system like this will eventually pay off since the power is produced automatically just around the corner, but for now it is bold to suggest this as a solution everywhere, even though it would be the best for a sustainable future without compromising the modern living standards.

Since there is no really cost effective way of storing electricity yet, Sen and Bhattacharyya (2013) studied how to supply a remote Indian village, disconnected from the macrogrid, with reliable power through a combination of different energy sources. While the sources (in this case hydropower, photovoltaic systems, wind turbines and bio-diesel generators) are non-reliable by themselves the study concluded that it was fully possible, and cost effective to apply this hybrid technology for electricity provision rather then to extend the macrogrid to the village (Bhattacharyya and Sen, 2013). Here, as in the Simris experiment, the most important feature of the power system is a smart software that can regulate the different power souces to make sure that the electricity is constant and of good quality.

To design a city block to be as self supporting as possible regarding electricity, one would need to dimension a photovoltaic roof, possibly combined with a few wind turbines depending on the site conditions, and store the energy produced during active hours of production for times when the hybrid system is

nonproductive. Since batteries are still expensive, at least for that scale of energy storage, other possible solutions would be to sell the extensive power back to the surrounding macrogrid. In that case the block needs a fuel driven power generator for the days or hours when the renewable energy sources are unproductive. At least if the block is intended to create the required amount of power on site. Another alternative would be to buy power from the grid during the hours when electricity production is down. In a block with its own water treatment facility one can excavate biogas from the sludge which then could power a generator when its needed.

# Discussion

To house the ever increasing urban population is a huge challenge for today's world. A lot is being built to upgrade peoples living standards from informal to formal settlements. In Manila huge projects all over the city are being built trying to provide adequate housing for the poorer part of the population. Unfortunately these projects are designed with the sole interest in housing as many as possible as cheap as possible which leads to a design that is in no way helping its already exploited inhabitants to develop economically or as human beings. With high prices on water and electricity these factors are major expenses in a poor Manila household. Steps must be taken to consider not only the present situation of housing crisis, but also the future of the city and its inhabitants. The existing infrastructure needs to be considered and questioned to better meet peoples' needs. As mentioned before, basic services are crucial for a productive population. That, together with the high pressure human kind puts on the environment, should be strong arguments for a larger initial investment in infrastructure to make especially the poor communities more resilient when it comes to service provision.

In today's urban shelter discourse the basic services provided are the most primitive solutions to the people with least opportunities as it is. A consequence of prioritizing initial price over lasting quality and resilience is that human development and alleviation of poverty becomes increasingly hard for the already most vulnerable in society. The financial shift of focus have to change in order for inclusive growth to happen, which in the long run will be the most productive

economical development model for any country. A population that is healthier, and with a higher degree of skills can provide more for the economy as a whole.

A developing country does not have the same quality of centralized extensive and well functioning service provision as the developed world. With the pace of urbanization, these cities need to consider other ways to provide for their citizens instead of copying an old concept from the global North. With the disaster prone location of the Philippines, small scale, decentralized service provision would be a much more resilient solution and that would decrease the affect humans have on the environment.

Yet another argument for a decentralized approach regarding basic service provision is that the systems can be specified and customized for the needs of the specific unit. If you have space you can treat the wastewater in a very natural way with reed beds and sand filters while that would be unthinkable within an urban fabric. Some decentralized systems; office blocks, stores, might only need electricity during the day and could easily use solar panels without any extra battery for their energy use. A housing situation on the other hand would need some capacity of energy storage or alternative energy sources to cope with the residents' needs during evenings and night time.

# Urban Shelter Design

To clearify the discussion and conclude what the research has shown, this part is meant to demonstrate an example of how one can incorporate alternative ways of service provision when designing housing for the poor in an urban context. As mentioned in the introduction, this application is located in Manila and is therefore designed for a tropical climate and an urban context. With rainwater harvesting connected to a treatment facility one can produce drinking water for the community. This would greatly reduce the use of plastic bottles in countries like the Philippines where the water quality in the tap is low. Except for the initial cost of installation this system would also provide free water which is, as above mentioned, a vital resource for human development. To handle urban wastewater there are interesting new approaches of creating smaller treatment plants within the city fabric. This is a financially interesting alternative since no major

investment in grand piping infrastructure is needed to transport the blackwater back and forth to a distant location outside the city. These treatment facilities might need to be in a bigger scale than just one single city block to be preferable but just by connecting a few adjacent blocks they can get the quantity required for a desirable solution. If the treatment facility also extracts biogas from the biproduct of the water treatment, the sludge, the plant could be energy positive and support its surroundings with power. This system, together with photovoltaic cells or windpower would make the decentralized approach for basic service provision possible. The scale of these systems might need to vary in scale to be as productive as possible, but they are no the less disconnected from the centralized systems within the city. The treatment plant might need wastewater from a cluster of a few housing blocks while the electricity could be produced within each building. Rainwater harvesting might need to be subdivided even more to be available and close to all residents, and to make sure that everyone gets their fair share. Of corse all of these systems mentioned above require initial investments, but they are a more resilient and environmentally friendly approach to future development. Figure 1 explains the hybrid service provision in small scale in a diagrammatic way.

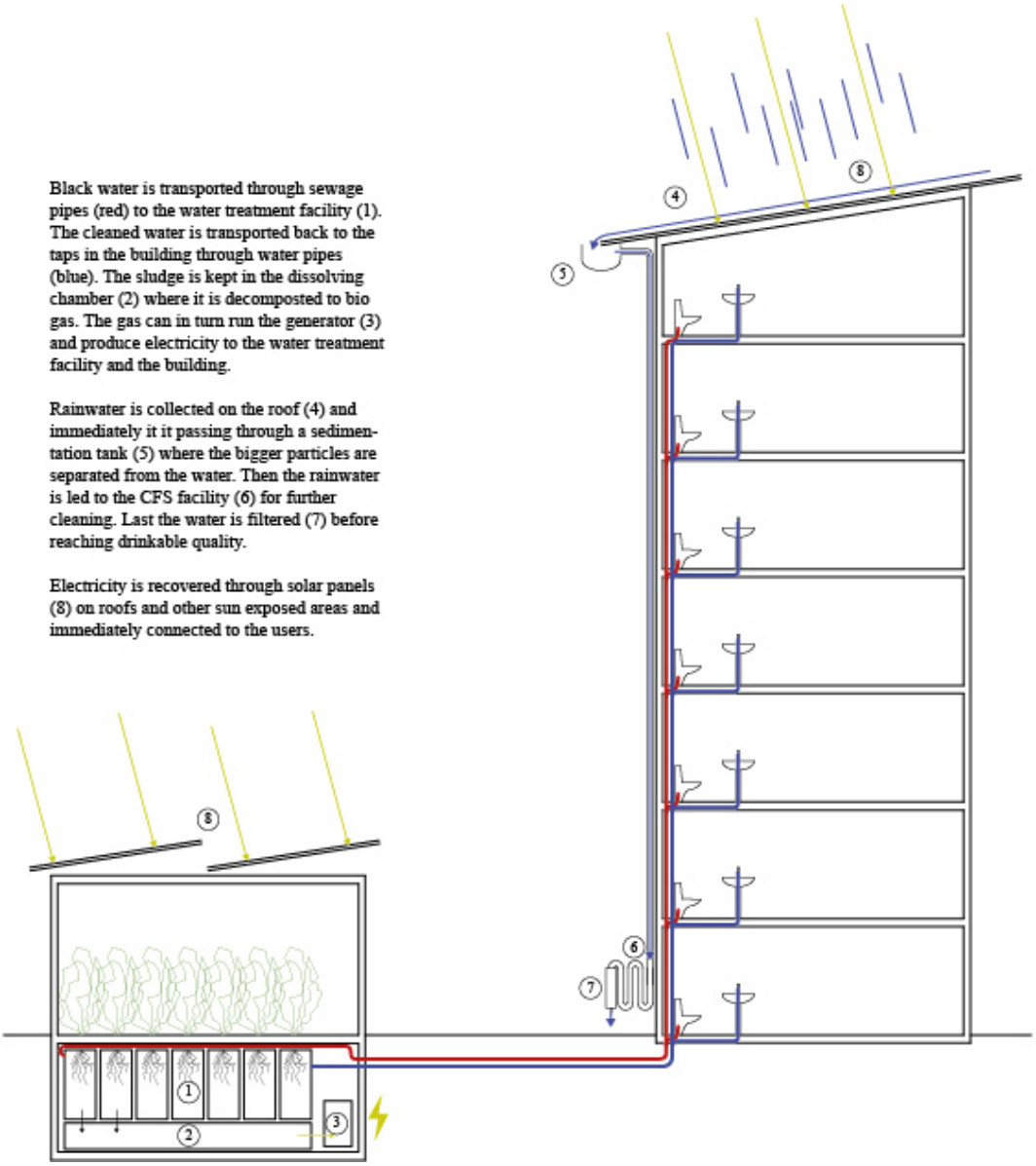


Figure 1 presents the author's proposal for small scale hybrid service provision in a diagrammatic way. A resilient system that experience a minimal impact of surrounding changes. It makes sure to supply the inhabitants with the basic services required for a modern life in the city.

# The Role of Architects

Within the big process of designing and constructing a building, with all its complexity, the architects role should be a link between all the different actors of the building project. Architects should mediate the different wills from all actors but still never loose track of the building as a whole; as a piece of the urban landscape, as a future home for people, as a disruption in the existing

environment. This essay has only focused on infrastructure and alternative ways to think about service provision, but to introduce a new way of building, to break the norm, architects need to understand the specific requirements and involve that in the design. In the text, two architects namely Krister Wiberg and Attila Bodnar are mentioned to highlight the important connection between technical service provision and the architect profession. Since a building is a complex network of systems one cannot simply add or subtract parts independently. The system of service provision has to be included from an early stage as well as the quality of life for the inhabitants and the durability of the building.

Architects should have a key role in developing the built environment. They should function as a middle part between the power and the inhabitants. Even in the case of housing the poorest, architects should be involved in the design. Who, if not architects, can consider the human values within the built environment that are required for a livable and hopefully prosperous neighbourhood? At a time when we are facing a mass urbanization in a faster pace than ever before, new creative solutions are urgent. If we exclude architects from working with this quest for new effective and humane ways of fast pace urban development, no one would work with it. In a collaboration with economists, politicians, engineers and end-users, architects could get the knowledge required to find new approaches to deal with the urgent need of housing. Architects have to be a part of the construction of one new Munich every week.

One other reason why architects should be included is the quality of the space they create. Even if the situation forces us to build fast and to build a lot, the buildings will stand there for 50 or even 100 years. If minimal thought is paid to the design of these buildings and they are just an effective way to get people off the streets, they have no chance of surviving for even closely as long as a building is supposed to. When visiting the social housing site adjacent Smokey Mountain, it is clear that architecture is of great importance in the long run. The area was severly run down and looked more like a prison or a camp than a place where people lived their lives. The poor quality in the architecture, in the materials and in the maintenance gave the area a sense of hopelessness which was striking. How can this be a place for the most voulnerable in society? In this case, architects have designed the buildings but they have not had any political or financial power

to question the way social housing is done. So, the inclusion of architects in the process is not a sole solution, but one of the requrements for a decent housing production. One of architects' main roles is to get involved in the public debate, and to get involved in the policymaking in order to change the course of the discussion regarding urban shelter. From there architects, together with politicians and economists, can design new strategies for social housing.

# Bibliography

Avezzù F. Ghirardini A.V. and Libralato G., 2012, *To Centralise or to Decentralise: An Overview of the Most Recent Trands in Wastewater Treatment Management.* Journal of Environmental Management, 94, Venice: University Cà Foscari Venice.

Bhattacharyya S. C. and Sen R., 2014, *Off-grid Electricity Generation with Renewable Energy Technologies in India: An Application of HOMER.* Renewable Energy, 62. Leicester: De Montfort University.

Bieker S. Cornel P. and Wagner M., 2010, *Semicentralised Supply and Treatment Systems: Integrated Infrastructure Solutions for Fast Growing Urban Areas.* Water Science and Technology, 61:11, IWA Publishing.

Bodnar A., 2013, *Water Alchemy* [video]. TEDxDanubia. https://www.youtube.com/watch?v=InNArv2h4m0 [2018-04-17]

Cimbritz M., 2018, *Professor in Water Supply and Waste Technology at LTH.* Interview [2018-04-11]

Environment America, 2017, https://environmentamericacenter.org/page/amc/renewable-energy-101-ten-tools-moving-your-campus-100-clean-energy [2018-04-18]

Eon.com, 2018, https://www.eon.se/om-e-on/innovation/lokala-energisystem/vi-pa-simris.html [2018-04-16]

Liao L. and Zhang L., 2003, *A Moveable Combined Water Treatment Facility for Rainwater Harvesting.* Agu Fall Meeting. Lund: Lund University.

Marnay C. and Venkataramanan G., 2006, *Microgrids in the Evolving Electricity Generation and Delivery Infrastructure.* IEEE.

Organicawater.com, 2018, https://www.organicawater.com/the-organica-solution/ [2018-04-17]

Schreff D. and Wilderer P.A., 2000, *Decentralized and Centralized Wastewater Management: a Challenge for Technology Developers.* Water Science and Technology, 41:1, IWA Publishing.

Toarpsekoby.se, 2018, http://toarpsekoby.se/teknik/ [2018-04-16]

UN-Habitat, 2016, *Urbanization and Development: Emerging Futures.* First Edition. Nairobi: United Nations Human Settlements Programme.

Worldometers.info, 2018, http://www.worldometers.info/world-population/ [2018-04-16]

Wte-ltd.co.uk, 2018, https://www.wte-ltd.co.uk/wastewater-amounts-in-the-home.html [2018-04-16]