

## How the energy market will change water services

Eilard Jacobs

Waternet, po box 94370 Amsterdam. E-mail: Eilard@jacobs@waternet.nl

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### Abstract

In the 20<sup>th</sup> century energy and water services are provided by large centralized systems. The development of renewable energy sources, especially solar energy, however generates a transition towards more decentralized services in the 21<sup>st</sup> century. The development of green buildings and other off the grid solutions facilitates a growing demand for these decentralized solutions, not only for energy but also for water services. It is the challenge for water utilities to be a player this development.

**Keywords:** decentralized systems, energy from wastewater, green buildings, renewable energy.

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### CENTRALIZED AND DECENTRALIZED SYSTEMS

The first water supply systems and the first sanitation systems were implemented on a household scale. The Romans already started with a water supply system on a residential scale, but in the 19<sup>th</sup> century many cities in Europe and elsewhere got large central water supply systems and wastewater collection systems. In the second half of the 20<sup>th</sup> century also a lot of the rural area was connected to centralized systems.

Looking at energy supply the same development can be seen. At first heating and lighting of a house was done individually. But with the introduction of city gas in the beginning of the 19<sup>th</sup> century centralisation of energy supply began. In the 20<sup>st</sup> century almost the whole developed world and the urban areas of the developing world were connected to a centralized energy supply.

Although there is a worldwide movement towards reliable centralized systems for water and energy services, there always has been a development of small scale local systems for water and energy services as well. This has proven to be especially useful for remote locations, where a connection to the central system is too expensive.

So in spite of the increasing centralisation, the market provides many decentralized solutions as well, but the price of these facilities is not competitive when a centralized system is available.

For water services there is a special concern about decentralized solutions: a main reason to introduce centralized water supply and wastewater collection was to fight the epidemics of cholera in the 19<sup>th</sup> century and other public health issues. With a centralized system this public health aim is much more easy to maintain than with decentralized equipment. For this reason the policy in most countries in the developed world is to use centralized systems (on a municipal scale or higher) when possible.

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### THE DEVELOPMENT OF SUSTAINABLE ENERGY SOURCES

The awareness of (un)sustainability which became a common issue in 1972 with the publication of the club of Rome report "limits of growth", has been the driver to develop energy sources from renewable energy. The concern about the increasing green house effect on the earth has reinforced this development. Especially solar- and wind energy have gained a tremendous interest (see figure 1 and 2). Nowadays the market provides all kind of equipment to raise your own energy, from sun, wind but also from other sources like biomass. In the 21<sup>st</sup> century the consumer has a choice

between using the centralized energy supply on the one hand and generating his own energy from a renewable source on the other. At the moment many consumers choose for both because they want a back up (like the first steamboats still had sails as a back up). The more reliable the decentralized sources become the less there will be a need for a back up in future.

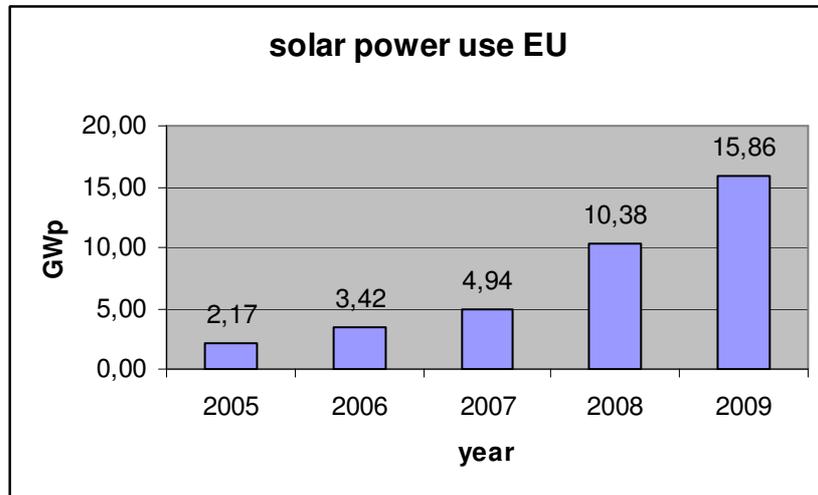


Figure 1 | increase of solar power use in the EU (source Eurostat).

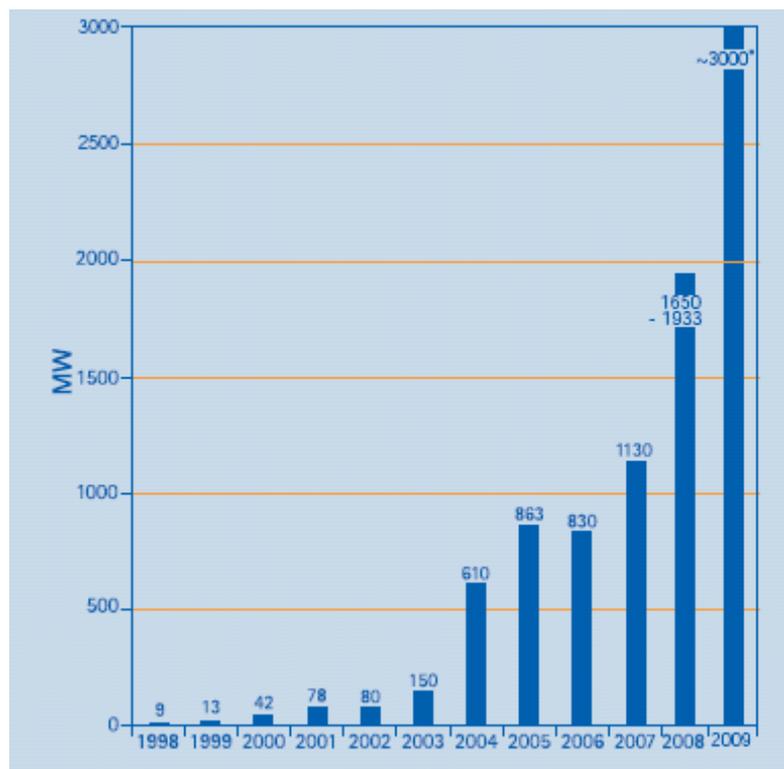


Figure 2 | Photo voltaic capacity in Germany (Source IEA annual report 2009).

### Towards more decentralized energy supply

Renewable energy sources like solar energy, wind energy have another scale. Solar energy requires space. This space can be found in urban areas on building roofs or sometimes gardens. High capacity solar energy power plants require very much space. This probably only is available and profitable in

low dense populated areas with maximal sunshine conditions. Projects on this scale are developed among others in Spain (for example the ANDASOL project near Granada). The optimum scale for wind energy is different, but more important is that wind energy generation meets more opposition from the people living in the neighbourhood. In practice this leads to bigger windmills at places with optimal wind conditions (hill summits, sea, lakes etc.). The optimal scale for the use of biomass as a renewable energy source still developing, at the moment it is often implemented on a pilot scale.

But over all there is a tendency: the transition towards renewable energy use generates also an transition from huge centralized energy production to a more scattered decentralized energy production. It is not probable that decentralized power supply will replace the existing centralized system on the short term. The grid will still be useful for energy exchange because some renewable energy sources have a discontinue production, so there will be a need for back up (until good storage capacity will be available)

### The energy producing house

So far houses where energy consumers but a combination of energy efficiency and techniques on insulation, energy production and storage makes an energy producing house possible. The first pilots (see figure 3) are realised and it is expected to become standard in the future.



Figure 3 | Powerhouse at Leusden, the Netherlands.

## THE EFFECT ON WATER

Until now the thinking of energy neutral or even energy producing houses almost neglected the role of water and water services. In the energy balance the energy effects by transport of wastewater is not mentioned or even completely neglected. However a substantial part of the energy losses are caused by the water services mainly because the cold incoming drinking water is heated (for use as hot water but also because the in house temperature is higher) and discharged as a higher temperature wastewater (the exact figure is very dependant on the climate situation, in the Netherlands this loss is calculated on 30%, Blom 2010).

The total water services contain a serious part of energy. Two kinds of energy are especially interesting on a household scale, the thermal energy of the outgoing wastewater flow and the chemical energy from the organics in the wastewater flow. The thermal energy is easy to recover by using a heat exchanger. Only a heat exchanger at the shower drain can already recover 42 % of the heat losses through the sewer discharge. (Blom, 2010).

At the moment the chemical energy is mainly harvested by using the biogas from the sludge digestion process at the sewage treatment plant as a fuel for generating electricity and heat. But in this way about only 30% of the theoretical potential energy is used. More efficient techniques are possible (like a fuel cell) even at a home scale.

## The house of the future

It is to be expected that within a short time self supporting houses for energy are not only possible but even will become quite common. Already complete “off the grid” solutions are available, although it is also likely that in urban areas a grid connection as a back up will be maintained. But overall the focus in these cases will change from centralized to decentralized energy supply.

For water supply and wastewater treatment the techniques for complete off the grid solutions are already available as well. But here especially public health aspects, but also control costs are an important factor that prevents decentralisation. Also the investments in a centralized infrastructure are high and are done for the next 5 decades or so. This causes that new decentralized solutions cannot be implemented profitable on a short term.

However, there is a lot of energy put into the water services on a household scale (see figure 4). Especially heat can the best be extracted from the system as close to the source as possible and the techniques to do so are available already.

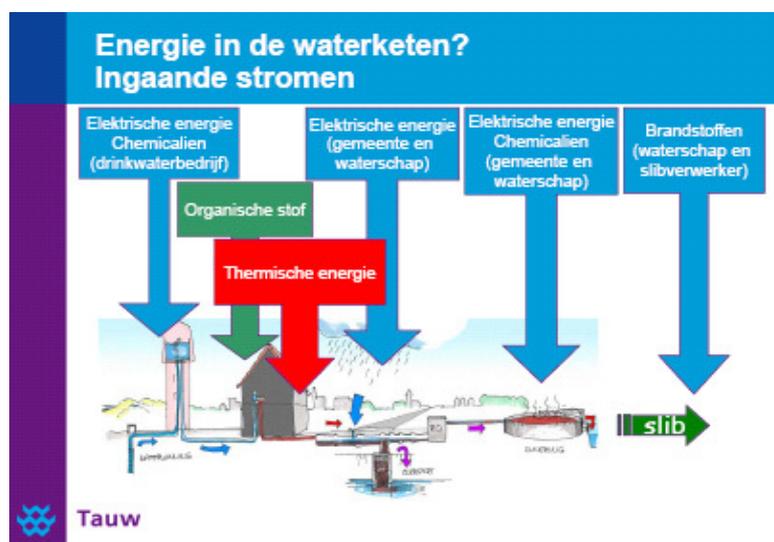


Figure 4 | Energy input in water services.

Recovering the chemical energy is a more complicated process. At the moment a part of the chemical energy in wastewater is recovered by the methane collection from sludge digestion. With an anaerobic treatment like it is implemented in Sneek (Meulman, 2010) this energy can also be extracted on a small scale (see figure 5).

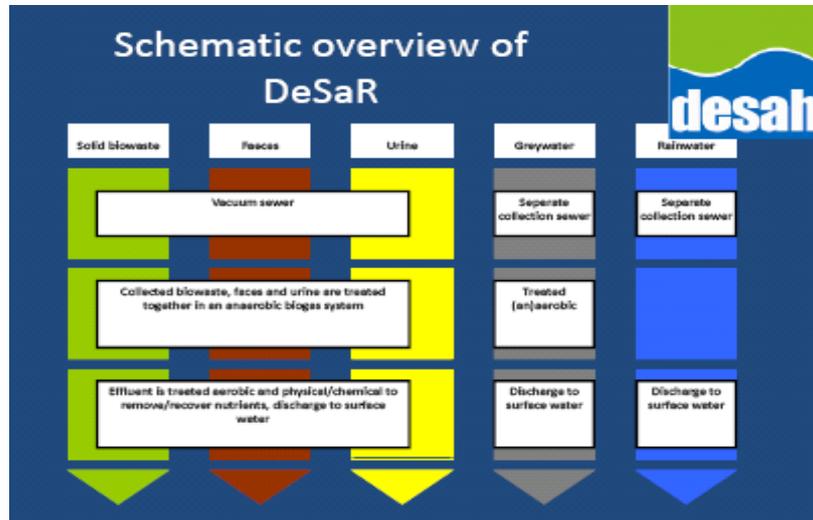


Figure 5 | Schedule of the Desar concept for decentral anaerobic treatment.

## Green buildings

An important movement is the development of green buildings. All over the world every year new green buildings are build. So far the focus in green building is on low energy and low green house gas emissions. But more and more water reuse is an issue. The use of collected rainwater for toilet flushing is already rather common (for example at the head office of Waternet in Amsterdam). But also reuse of grey water is possible, like it is implemented in the Bank of America Tower, Manhattan, New York.

In New York in Battery Park City (figure 6) many green buildings are developed. Here also complete reuse of waste water is implemented for example using Membrane Bio reactors.

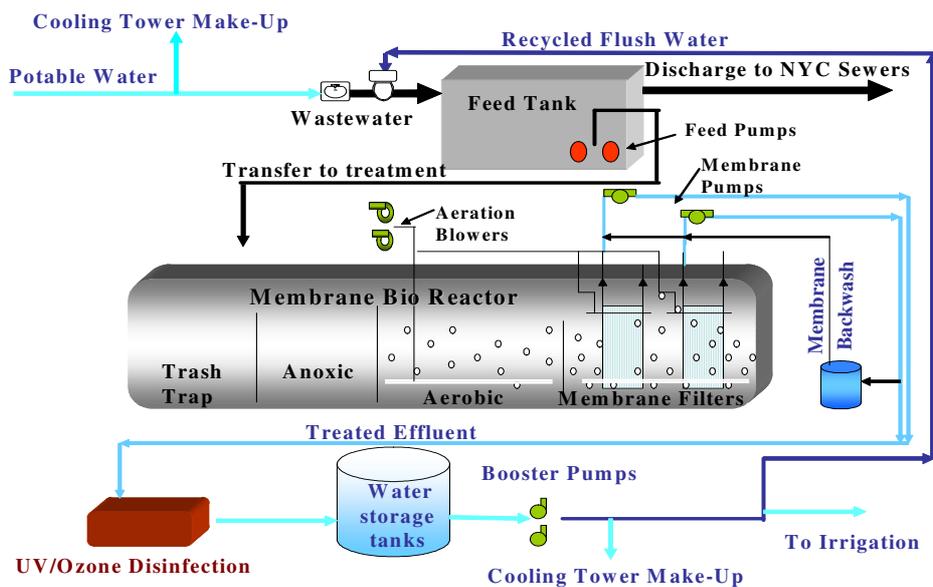


Figure 6 | Wastewater reuse for a building in Battery Park city, New York.

So there is a movement going on for buildings to become more and more independent on the grid, not only for energy but also for water services.

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## **HYPOTHESIS**

“The development of small scale renewable energy sources will create independency of external services. This independency applies to the tendency of individualism and will influence the demand for off the grid water solutions as well”

At the moment a process of individualisation can be recognized in many parts of the developed world. The development of individual energy supply by the use of renewable sources very well connect with this process. It is clear that there is a market for green buildings already. It is very well possible that this market will develop to a critical mass for transition within a decade. Then it is not longer a matter of cause that buildings are connected to a central system, not for energy nor for water services. There will be a demand then for a choice between full connection or self supply (or a combination). Because there is a serious market by then, there are already solutions offered by industry for “in home energy recovery” from wastewater and for reuse of grey water or waste water. This marked may grow.

## **The consequences for the water utilities**

Although there is more and more attention for decentralized water treatment, the implementation is still very limited. In many cases the centralized solution is, on a short term anyway, the cheapest solution. Also still a defensive approach to decentralized solutions can be recognized amongst water utilities and municipalities. It is not likely that persisting this attitude will delay the demand of development of decentralized solutions very much. It is more probable that there will be an independent market development and the water utilities have to develop new business which include decentralized solutions as well.

The challenge for the water services will be to join the green buildings development and to co-develop new small scale solutions especially on the field of reuse of wastewater in combination with recovery of energy from the water use.

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## **CONCLUSIONS**

The introduction of renewable energy sources, especially solar energy is causing a transition to more decentralized power supply

The development of green buildings stimulates not only decentralized power solutions but also decentralized water management solutions

This development generates a demand for “off the grid solutions” for energy supply as well as water services

Water utilities should join the development of off the grid solutions and develop new business models to be sure not to miss a part of the market.

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