



Sustainable and affordable home for everyman



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WATER NARRATIVE

University of applied sciences Utrecht
Solar Decathlon 2017





Sustainable and affordable home for everyman

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1. HOT AND COLD WATER

Selficient's water systems has been chosen based on the choices made during the design phase. We describe the start from source to the end, the user.

The water systems starts with the tanks. The tanks are divided in water source and black water. Both tanks have a volume of 2000L (528 gallon). The water transports through a pump to the iCEM energy module. This module provides the house from electricity, hot and cold water and heating. Figure 1 shows a simplified model of water circuits in the house.

The pump creates a pressurized system, this happens in the boiler as well. In the boiler the water is heated by an electric coil, driven by the energy of the solar panels. We used a coil because of the efficiency rate of almost 100%.

Hot water has the characteristics to rise. Because of the pressurized system we tap the water on top, which is the hottest water. This gives the system the benefit of using the hottest upper layer of water in the system. From iCEM the hot and cold water is distributed to the bathroom and the kitchen. To prevent the system from Legionella, the boiler automatically heats the system to 70 degrees Celsius once a week.

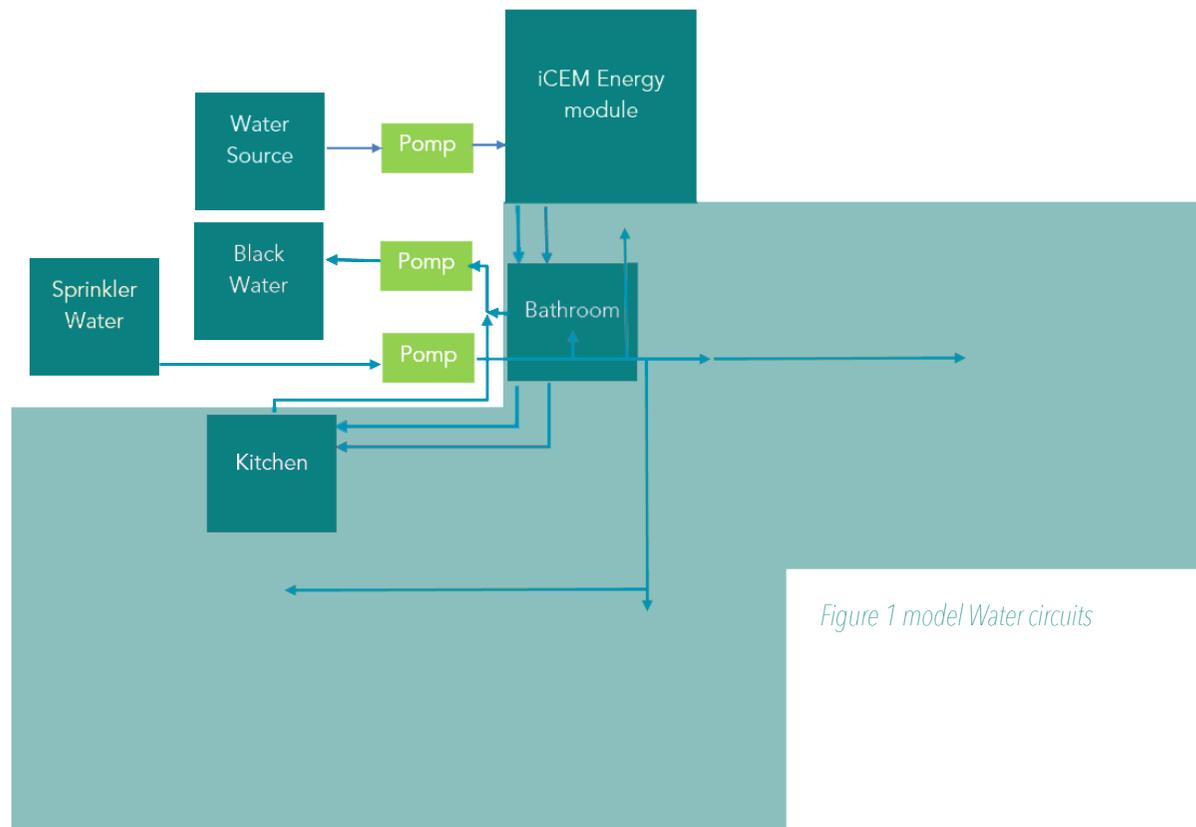


Figure 1 model Water circuits

2. TRANSPORTATION

2.1 GEBERIT PUSH FIT SYSTEM

With the Geberit Push Fit system, the water flows throughout the whole house. The system uses semi flexible piping with fittings to connect different pipes. We connect the pipe and fitting by hand. The connections are permanent. Still, this system is easy to use in a house that can increase and decrease in size.



Figure 2 connector



Figure 3 Geberit Push Fit system

2.1.1 MODULARITY IN THE PUSH FIT SYSTEM

Relocating, extending or diminish your piping is done easily. You can cut the pipes right behind the fitting and attach a different fitting, a valve or a stop. The water systems can be arranged for an adapting house without any difficult adjustments. The fittings are made of reusable plastics, so the waste production is minimized.

Due to the rules of the competition, we cannot reuse water from the sky. Solar Decathlon states that water from the sky has to go back to the soil. In our opinion, rain water could have been used for washing dishes and clothes, toilet-usage and even the shower. If we had implemented these ideas, we would pollute the soil with faeces, soap and other chemicals. Thus, we will not use rain water.

Another reason for not implementing reusable water, is because of our phrase 'Selficient is the house for everyman'. At the competition we are sure that there will be usage no hazardous fluids (e.g. drain and sink unblockers), so that could have been reused. But if we look further than the competition (which we do), we have to take others in account too. It is not a given that everyone would use ecofriendly fluids, which is a risk we do not want to take.

Furthermore, we did not implemented filters in the drainage system because of high costs and strict safety rules in the Netherlands. Instead, our engineers chose to connect our drainage directly to our black water system to simulate a sewer which leads it to a central water purification installation in the city. It makes it a lot cheaper and reduces the possibility of circulating polluted water in your system or the possibility of releasing it into the soils. With this in mind, we created a house that is prepared for a real life living situation by potential customers in all segments of society. It is not focused on a house that is inhabited for just one week. To make the house more sustainable, we still want to reduce water usage.

3.1 WATER EFFICIENT APPLIANCES

Selficient does not use a main water reusing system, it focusses on reducing water on appliances scale. Table 1 shows a research about which appliances has the biggest impact on the water budget.

| Segment | Usage in Liter | Usage in % |
|---------------|---------------------|------------|
| Cooking | 1,4 | 1,2 |
| Drinking | 1,8 | 1,5 |
| Dishes | 6,1 | 5,2 |
| Washing | 15,4(4Gallons) | 12,8 |
| Toilet | 33,7(9 Gallons) | 28,3 |
| Washing hands | 5,0 | 4,2 |
| Shower | 48,5(12,94 Gallons) | 41 |
| Bathtub | 2,8 | 2,3 |
| Rest | 5,3 | 4,4 |
| Total | 120 | 100 |

It shows the average water budget of a person. The total of the water use is 120 liters a day. The three largest consumers are:

- Shower 48.5L, 41%
- Toilet 33.7L, 28.3%
- Washing 15.4L, 12.8%

This a total of 82,1% of the total water budget. The shower has the biggest share.

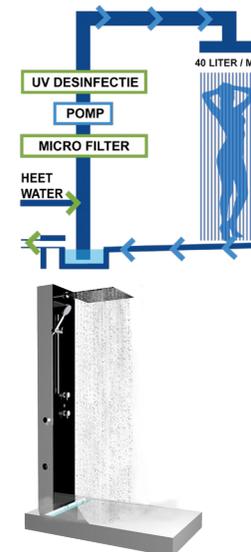
3.1.1 UPFALL SHOWER

Water use in American showers is given in numbers for 'old' and 'new' showers (USGS, N.D.). It is shown in the table underneath. The average for 'new' showers is used to show the big difference with our chosen products. We use the average Dutch shower time of 48,5L / 7,8L per minute is 6,2 minutes

Table 2 shower usage

| Liters per shower (NL average) | Liters per minute | Liters per shower (USA average) | Liters per minute (USA average) | Upfall average per shower (NL) | Upfall Average per minute (NL) |
|--------------------------------|-------------------|---------------------------------|---------------------------------|--------------------------------|--------------------------------|
| 48,5 L | 7,8 L | 47,12 L | 7,6 L (2Gallons) | 7,4 L | 1,2 L |

To reduce water usage Selficient uses the Upfall Shower. The Upfall shower filters and disinfects water that goes down the drain and circulates it back to reuse the water and heat. It adds 1,2 liters of fresh water per minute. With a reservoir of 2,5 liters automatically filling up, there is an astonishing flow of 40 Liter per minute.



The amount of water saved:

$$7,8 - 1,2 = 6,6 \text{ L}$$

$$6,6 / 7,8 \times 100\% = 85\%$$

The difference compared to the total water budget?

$$48,5 - 7,4 = 41,1 \text{ liters}$$

of water saved per person per day

$$41,1\text{L} / 120\text{L} = 34 \%$$

of total water saved per day

Because of the water circulation, we need less heat. Depending on your boiler system, savings can also rise to 90%.



3.1.2 TOILET

A current modern toilet has two flushing function: a 3 liter and 6 liter flushing mechanism. Selficient uses the Geberit Mera comfort toilet. It uses just as much water for flushing, and a little bit more because of the build in bidet function (WhirlSpray Technology). Our total is coming on 6,9 liters of waters per toilet use. In exchange, it eliminates paper usage.

Worldwide, we flush 27.000 trees through the toilet. Every day. This means, 548 tons of paper are flushed each day in The Netherlands. To degrade this takes 548.000 kWh of energy (Van Wechem, 2012). 1 kg of paper takes 20 kg (two liters) of water to be produced and cleaned. While manufacturing paper a lot of chemicals are added to the paper (and water) such as bleach. Same goes for recycled paper.

Numbers of energy usage for purifying water cannot be found. But by changing from cleaning with paper to cleaning with water:

- 548.000 kWh per day in the Netherlands will be saved (because we do not have to degrade the paper)
- All the chemicals like bleach will not end up in the sewer
- After pressing the paper it has to be dried by heating, which costs a lot of energy

We do not have hard numbers, but we think, in overall, cleaning with water is more energy-efficient, more environmental friendly and more efficient in water usage.

3.1.3 WATER SAVERS

To reduce water usage in the sinks we use water savers (VoltaSolar, N.D.). Water savers are a Dutch invention. It is a membrane that can be placed right before the filter of tap. The membrane adds extra air in the water. With it, it reduces the flow of 15 liters per minute to 7 liters per minute. Comparing these numbers with the numbers given in table 1, it shows the affects in the segments 'Washing hands', 'Dishes' and 'Rest'.

This is a total of: $6,1 + 5 + 5,3 = 16,4$ Liters

To ensure reduction, a 50% reduction is calculated for the water saver.

$16,4 \times 50\% = 8,2$ Liters saving of water per day

$8,2 / 120 = 6,8\%$ of the total water savings per day

3.1.4 WASHING MACHINE

To reduce water and energy Selficient uses a Samsung WD80J6400AW was/dry combination. The average washing machine uses 52,9 Liters of water per cycle. This one uses 48 Liters (BCC, N.D.).

Which means it saves: $4,9L / 52,9L = 9,3\%$

Per person per day: $15,2 \times 9,3\% = 1,4L$ per day

3.2 TOTAL WATER SAVINGS

4. SPRINKLER

The sprinkler system is a fire suppression system. This means it will not extinguish the fire but it will suppress the fire for 10 minutes before the water tank is empty if all sprinklers work. This will be enough time for the residents to leave the house. The system releases 1500 liters of water.

The system is equipped with a glass bulb sprinkler head. The sprinkler heads are filled with different types of fluid. In case of fire, the temperature rises, the fluid will expand and the bulb will explode. This triggers the sprinkler to release water.

Because each sprinkler has its own bulb, fire can be fought in specific spots in the house. This minimalizes the damage done by the water of the sprinklers. It is also possible to install sprinklers with different bulbs in various places. This gives the option to change the set points of activation. In example, the sprinklers in the living room activates at 63 degrees Celsius and the sprinkler above the stove activates at 79 degrees Celsius.

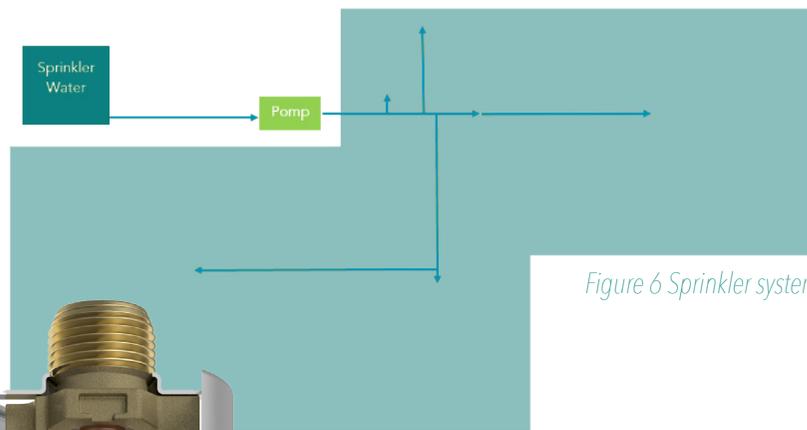


Figure 6 Sprinkler system

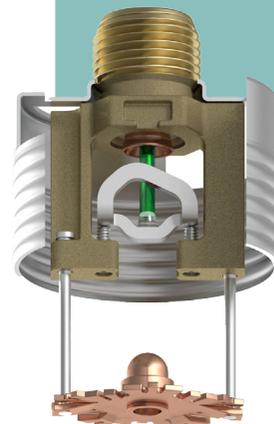


Figure 7 Bulb of a sprinkler



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