Rain, Ice & Snow (RIS) Harvesting System Decreases Water Bills in SmartH2OHome concept

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Introduction

Water is a constitutive element of all living beings. Out of 3.5% of freshwater supplies, 68% is “locked” in ice, 30% is located in the ground. The development of industry, farming and irresponsible human behavior towards nature, have led to water pollution. However, many efforts are taken to find alternative ways of providing people clean water for drinking, personal hygiene and decreasing water stress by using other source of water – rainwater.

Background and Problems

Malaysia has successfully implemented RWHS. RWHS can be applied in various occasions and surroundings. Implementation of these systems can cover urban and rural areas, domestic sector and agriculture. One of the problems with RWHS is their economic feasibility, e.g., implementation of RWHS in Brunei was not feasible. Another problem is the amount and frequency of rainfall in a region, although e.g. Australia has successfully implemented RWHS, despite minimal 45 mm average monthly rainfall. Rainfall is one of the factors for determining capacity of a rain tank (apart from a user’s needs).

Research Focus & Objectives

Focus of this research is to determine whether an individual can implement a RWHS with minimal costs and are there other sources of water that can be harvested and how.
The first objective is to consider other suitable sources of freshwater by adapting the primitive RWHS to current needs (correlated with the water source). The second is to design two harvesting systems (HS) for collecting rain, hail and snow (sophisticated and primitive) - SmartH2OHome; implement the primitive one in a home; determine its costs and compare those costs with monthly water bills.

Primitive RIS

Pipeline and wavy roof extension are used for harvesting rainwater. Containers with 30 liter capacity are placed below the wavy roof extension, while the ending of the pipeline is put into a container with 100 liter capacity of. Both, instead of generating a massive loss of rainwater, are now being used to direct rain to containers and preserve it for various needs. Containers and pipelines have to be cleaned and closed and stored inside when not in use. Collected rainwater has to be removed from the sunlight; otherwise the algae will form and limit the use of rainwater. PET bottles can be used for storing rainwater for two reasons. Firstly, the FDA has declared PET as safe for storing food and drink. Secondly, people already get PET bottles when they buy drinks, so instead of throwing them and polluting the environment, they can be put to a good use. If growing fruits and vegetables is the case, the rainwater does not have to be filtered. For toilets, rainwater has to be filtered to prevent e.g. leafs from clogging the sewage. For showering and dishwashing, rainwater does not have to be treated, unless the object is located near factories or other source of pollution. Then the water has to be boiled as well, to kill microorganisms and become safe. Heating system and washing machine were not using rainwater in the observed household.

Sophisticated RIS

Pipeline transfers the roof rainwater to the first tank with capacity of 5,000 liters. Before entering, water is being physically cleaned by a filter made of stainless surgical steal. This prevents leafs and other debris from the roof and the pipelines to contaminate the first tank. The first tank has three exit points. The first is faucet in the garden, which covers needs for watering plants, vegetables and fruit. The second is toilet. These two points eliminate the need to withdraw water from a town’s water supply system. The third exit point sends water to a water cleaner.

Cleaned water is sent to the second tank with capacity of 4,000 liters. It transfers clean water to two bathroom points: the boiler (for showering) and washing machine. It also supplies the kitchen: dish machine and boiler, thus eliminating water consumption for washing the dishes, hands, cleaning rooms etc. It also enables water refill for gas and/or solid fuel heating system.
The last pipe carries water to the third tank, with capacity of 2,000 liters, where the water is boiled and chlorinated to kill bacteria and microorganisms to ensures that the collected rainwater is safe to drink and it is connected to a glass container with capacity of 30 liters for drinking and cooking water.
Each tank’s inside is made of stainless steel, isolated with glass wool and covered with durable plastic and has to be cleaned occasionally.
Each tank and glass container have minimal water level supply. Tanks and the glass container have sensors for water levels. Every time water level in any of the tanks or glass container goes to minimum or below, sensors send a refill signal to the preceding tank. For example, if water level in glass container is equal to or lower than 10 liters, the sensor sends a signal to the preceding third tank, which then refills the glass container. If water level in third tank equals to or is less then minimum, the sensor sends request to the second tank. After receiving the refill, decontamination process is started in the third tank.

Collecting Ice(Hale) and Snow

Collecting hail is identical in both, primitive and sophisticated RIS-HS. The process of collecting hail includes spreading shallow containers in the yard and let the hail melt. Afterwards, the collected water is filtered and bottled in primitive RIS, while water is transferred to the first tank in sophisticated RIS.
Collecting snow in a primitive RIS system includes pipelines and wavy roof extension, which will transfer snow into the designated containers. The water will, afterwards, be filtered and bottled.
However, collecting snow with a sophisticated RIS is a bit different. Apart from pipeline snow transfer during melting, it includes one more tank with capacity of 5,000 liters for collecting snow during winter. Therefore, instead of just letting the snow melt, RIS-HS transforms it into a valuable water reserve. This “zero” tank, is connected to the first tank via pipeline, so that the remaining tanks could be refilled according to current needs.

Implementing Primitive SmartH2OHome

The first step in transforming the homestead in SmartH2OHome was to develop an energy management strategy and implement it in three stages.

First stage of implementation

Conditions for collecting atmospheric falls had to be created, which meant small construction changes on the roof and in the yard. Two important construction segments, pipelines and wavy roof extension, transfer atmospheric falls (rainwater, snow and hail) to containers. Additional shallow containers are used for collecting and melting hail. 30 to 20 liter containers are located below the wavy roof extension, while the pipeline ending is located above a 100 liter container. They preserve atmospheric falls and have to be cleaned regularly, to prevent soft water contamination. When not in use, containers should be closed and stored inside.

Second stage of implementation

Collected atmospheric falls are filtered when bottled in PET bottles and removed from the sunlight. PET bottles are already in the individual’s possession. Soft water is used both for indoor and outdoor purposes.
Indoor utilization includes toilet, shower, dishwashing and hand washing. Soft water is filtered from debris to eliminate contamination and sewage clogging. Toilets and showers are disconnected from the town’s water supply system. Dishwashing is done manually (dishwasher is not used in the observed home) with soft water and soft water is also used for hand washing. The town’s water supply system provides drinking and cooking water and heating system and washing machine are also connected to it. The home does not have air condition.
The individual is growing fruits, vegetables and plants and is completely independent of the town’s water supply system and soft water used for this purpose is not filtered (outdoor usage).

Third Stage of Implementation

Progress of the SmartH2OHome concept implemented since 2011 is presented There were no additional costs for changing construction, because it was already appropriate. PET bottles for storing soft water are used which eliminates package costs and they are even changed after several usages and sent to recycling. Containers for collecting soft water varied in capacity and their number has increased over the observed 8 years. Some were bought, but were affordable. Toilet is refilled with soft water, so every flush saves 20 liters from the town’s water supply system and decreases water bill significantly. E.g. if a person flushes 5 times a day, 30 days a month and with the current price of 123.2 dinars per cubic meter of water, cost savings will be 4,453,2 dinars per person per year. For 8 years, cost savings per one person is 35,481.6 dinars. For a family of four during 8 years, this cost savings will be 141,926.4 dinars.

Conclusion

Investing in a primitive RIS Smart H2OHome is feasible, because cost savings reflected through monthly water bills are higher than costs related to acquiring necessary equipment and changes in a home’s construction.
When water needs for showering, dishwashing, hand washing, gardening and growing fruit and vegetables are taken into consideration, cost savings generated by the primitive RIS in SmartH2OHome are measured in tens, even hundreds of thousands of dinars and will continue to rise in the future.
One of the key characteristics of this system is transformation of certain amount of soft water into supplies, which is important during years with low level of rainfall. Collecting rain and hail has contributed to the stability of soft water supplies.
This enables the homestead to be relatively independent from the town’s water supply system – water is only used for drinking, cooking, washing machine and heating system. Very often it is 1 cubic meter, or 2 (which is determined by the number of washing cycles and number of boiler refills). The monthly water bill is between 220 and 350 dinars. Huge benefit for the town’s water supply system is significantly lower water consumption from the observed homestead, which is of great importance during drought.