The authors really welcome the valuable comments and suggestions of the referees. In this rebuttal letter we give detailed replies to the comments and suggestions of the referees. We will revise the manuscript based on the comments and suggestions of the referees.

Referee 1

1. Related publications/comparable studies

Indeed, we could not find a lot of studies regarding this topic. Only two studies were found. One was "Application of an exhaust heat recovery system for domestic hot water" (Liu et al., 2010). This study proposes a system for recovering energy from large-scale public shower facilities. The other one "Shower heat recovery in high-rise residential buildings of Hong Kong" (Wong et al., 2010) was about using a shower heat exchanger to recover shower heat in each household. We incorporated these references in the introduction of the document.

Our study was quite close to the second study which was done in Hong Kong. We proved the potential of the shower heat exchanger in our own situation (individual dwellings), and made an estimation for annual energy savings. However, the type of heat exchanger used, the situation where the exchanger was installed, and the way how we calculated the energy savings were different. For example, in Hong Kong, they calculated the energy savings for a 40 floors building, which has 20 apartments per floor; they used electricity while in Amsterdam people use gas to heat water.

2. The added value of the paper

As already described under 1, our study was different from the two cited papers, and in that respect our paper has already added value.

The recovery efficiency of the exchanger claimed by DSS was tested under the standard method (NEN 7120+C2:2012). In this study, the practical conditions were applied to test the recovery efficiency (i.e. observed shower temperature instead of 40 ◦C). The performance of the heat exchange in a practical situation was shown (and compared with laboratory experiments) which is also an added value. We proved that this commercial type of shower heat exchanger was able to contribute to the sustainability aims of a city (i.e. Amsterdam).

3. Laboratory experiments

The repetitions were 3. Since the recovery efficiency was calculated for each shower, it was necessary to maintain the same condition for each shower, but not necessary to conduct one shower per day. The laboratory experiments were conducted since the parameters could be adjusted to examine the relevant impacts, while this was not possible in the Uilenstede study (field conditions).

The data from the other 9 rooms were not correct, as the sensors were installed in the wrong position (technical problem). Therefore, the calculation of efficiency could not be based on these data, and could not be shown.

Long term results were not the focus of this research (see also effect of fouling and corrosion). Main aim was to have a first good indication of the efficiency to calculate how shower heat exchangers can

contribute to the CO_2-target of Amsterdam. Of course we will follow the long term performance of the systems and will report on that in the future.

4. Comparison with peer reviewed publications

We addressed this issue under 1.

5. Figures, tables, sections

Figure1: The distance between the heater and the water tap is mentioned in the text. Table 1 and Table 2: Table 1 is showing the conditions, parameters for the experimental showers, while Table 2 shows the time schedule of shower in one test. We have the opinion that combining tables 1 and 2 will make reading more complicated. The test is a set of showers, for instance, in winter conditions, there were 6 showers in one test, three tests were conducted to make an average. The showers in one test are named as 1, 2, 3, 4, 5 and 6. The room temperature and humidity were not registrated, this is now mentioned in 2.2.

Section 2.2: the temperatures and flow rates were based on the values measured in Uilenstede, this will be explained in the text.

The shower water in this study means the water coming into the drain. Theoretically, it is used water. But in the laboratory, it was impossible to have someone really take a shower there. And the temperature of shower water we talked about was that coming into the shower heat exchanger, thus the conditions before the heat exchange started was not that important.

In the results and discussion section we will elaborate more on the results of the monitored sites. We will explain the calculation of the payback period.

Section 3.3: The referee is correct that on the long term the efficiency may decrease due to fouling and corrosion. We will mention this in the text (3.2 and 3.3). The present study was too short to see effects of fouling and corrosion, and as mentioned under 3, this was out of the scope of the present research.

Figures 2 and 4 will be improved.

The influence of the intervals between showers will be explained in more detail.

Referee 2

Reaction on general comments of referee 2

1. Authors connected to Waternet and focus on Waternet

Indeed authors are connected to Waternet. We do not support the opinion of referee 2 that this may weaken the research. At Waternet we are very critical in implementing only effective and efficient measures. So, it may also be considered as a strong point as the authors are very critical to identify the best measures.

The focus on Waternet offered the possibility to broaden the general results (what is the efficiency of a shower heat exchanger) to a specific application (knowing the efficiency of a shower heat exchanger, to what extend the implementation can contribute to the specific target of reducing the emission of greenhouse gas emissions in a city?).

2. Focus on one specific heat exchanger

Indeed this is a limitation of the study. Due to limited research resources we had to make this decision. In the text we will explain why we choose for the DSS shower heat exchanger.

3. CO_2 footprint and costs of installations

With respect to CO_2 emission studies (as well as with environmental impact studies) the choice of system boundaries is always important and arbitrary. We focused on the CO_2 emissions in Amsterdam (= boundary condition), and shower heat exchangers affect this through the recovery of energy: households avoid the use of fossil fuels to heat the water. The CO_2 footprint due to the manufacturing of the heat exchangers (probably outside the Amsterdam region) and the activities and used materials are outside the system boundary. We will mention the system boundary in the paper.

The costs of installation were obtained from quotations of plumbers/installers.

4. Shower heat exchangers in all households of Amsterdam

We assumed that all households will install a shower heat exchanger. This implies a maximum scenario. We will mention this in the text. It is difficult to forecast to what extend this maximum scenario will be realized, as it also depends on incentives and thus the policy of the city of Amsterdam.

Although in paragraph 3.2 we may assume a fictive city, we think it is more interesting to describe the effect for a real city (Amsteredam) and to see to what extent heat exchangers may contribute to the CO_2 target of a real city. In this way we avoid that it will only be an academic exercise.

Reactions on detailed comments of referee 2

Page	Line	comment of referee	Reaction of authors	Changes in manuscript
several		Use 'shower turn' instead of shower in relevant situations	We agree	modified
120	7	The objective not to compare lab and field conditions. The objective is to evaluate the supplier's claim of the	Yes, we agree on that	modified

		efficiency.		
	9	58-62 should be 57-62 (see page 127, line 3)	It is modified in the test	modified
	11	Why mention 4% of the total energy of all households in Amsterdam could be saved? The results are valid for a single household as well.	The 4% was calculated based on the total energy consumption in Amsterdam. The energy consumption in a single household may vary from other households (i.e. 2-4 persons), there is a bigger chance that this 4% is not accurate for individual household. Although it was not the case and not likely that all households would install this DSS shower heat exchanger, the estimation is a maximum scenario and could be a reason to apply this method (installing a shower heat exchanger) for increasing the sustainability of the city.	A discussion added in 3.2
	23	'Heated' should be 'heating'	We would keep it as 'heated', since it is an Adjective, while 'heating' is a Noun	
	23	Define 'heat loss'	The 'heat loss' can be defined as: the total thermal energy lost from a house: a.o. water (discharged wastewater), air (ventilation)	Definition added
121	3	'Reduction of greenhouse in 2040' compared to?	The reduction of greenhouse was always compared to 1990, which is according to report of IPCC. The sentence will be improved.	The sentence has been modified
	10-12	Relevant for the urban environment, the emission of greenhouse gasses will contribute to heat stress of cities.	The referee is correct, but heat stress of cities is out of the scope of this manuscript	-
	27-28	Description is only valid for horizontal exchangers	the description is valid for both types of exchangers. Because for the vertical exchangers, if the bathroom is on the second floor, they can be installed	-

			under the shower tray, on the first floor, as in the Uilenstede project.	
122	9-22	The majority of these lines should be moved to the method.	Yes, you are right. these line was considered to be an introduction of the pilot project. But it will be discussed and re-arranged	Modified in introduction and 2.1.1
	9-13	Why 2 horizontal and 6 vertical? 4 vs 4 would have been more logic.	According to the recovery efficiency claimed by DSS, the vertical version has a higher potential. However, they are not suitable to be installed on the first floor, so 2 horizontal exchangers were used. The vertical version was preferred and more focused.	To be explained in 2.1.1
	11	'for comparison'. It's not completely clear why the lab set up was needed? More accurate measurements, more measurements, more extreme conditions? Lab setup has just one extra T measurement compared to Uilenstede.	in the lab, parameters such as temperature, flowrate, shower intervals and shower durations can be adjusted, in order to examine the impacts on the recovery efficiency. While these adjustments were not possible in the Uilenstede project.	Explanation added in 2.1.2 and 2.2
123	3-4	Authors probably refer to the reason why the exchangers were installed in Uilenstede, not why they were used in this research.	Yes, that's true.	Sentence modified
	17	Starts should be start	Yes	Modified
	19	What measurement is meant here? Flow? Temperature? And what do you mean with manually? Please explain in more detail how the data was logged and transferred to the Waternet database. Real time? Dataloggers? Manually written?	the measurements include temperature and flowrate, as mentioned above. Due to the difficulty in installation and maintenance, there was no sensor for the shower water, thus the flowrate and temperature were measured by hand. Three types of temperature sensors and two type of flow meters were used to ensure the accuracy of these manual measurements.	Modified in 2.1.1

	20-21	This should be moved to results	Yes.	see 3.1.2
124	15	'30 min'. Why so (unrealistically) long? On page 126 line 8-11 you seem to prefer realism.	Because this 'unrealistically' long hot water consumption was observed in the student house.	Explanation given in 2.2
	13-14 & 21	Why different flow rates?	These two flow rates should be the same for summer and winter conditions, which are based on the observation in Uilenstede. However, due to the difficulties in controlling the flowrate with the available pump, they had some differences.	Explanation given in 2.2
	24-26	On page 123 line 20-21 you speak about a failing 'monitoring system', do you mean the system consists of uncontrolled students?	these are two different things. On page 123, the problem was caused by the technical work. Here it is not a problem, because in this way, we got the data of the 'real showers' taken by the students.	Improved in 2.1.1
125	2	The should be a	We agree	modified
126	6-11	Why introduce a standard if you decide not to follow the standard?	We applied the same equations used in the standard method, but under different conditions. Thus to emphasize that the efficiency we calculated is more realistic.	-
	10	Influence should be approach	Yes	Modified
	11	It might be more realistic, but by not using the standard, the results cannot be compared to other research? Most probably the results will be less accurate when including the water before stabilization.	It depends on how you define accuracy. We focus on the energy recovered by the exchanger, it's recovering energy before stabilization, why this should be excluded?	-
	15	Is supposed to be. You measured it, so why suppose?	Yes, the expression should be modified	See 2.2
	14-17	This is method, not result.	Yes	Deleted
	18	In the range of should be between		Modified
	25	Chosen? Couldn't you measure	Yes, the expression should	See 3.1.1

		or is a reference available. Page 127 line 18 mentions 34,5 degrees.	be modified	paragraph 2
127	4	Remove 'rises to'		Modified
	5	Only should be limited to		Modified
	10	Slightly, please give the percentage rather than a subjective measure	Yes	Modified in 3.1.1
	10	Recognizable should be significant	Yes	Modified
	21	Lower: how much?	The value is added	See 3.1.2
	24	First comfort class, what is that?	This is the definition of 5.8 l/min as a shower flow rate. To reduce the confusion, only the value will be kept	See 3.1.2 las paragraph
128	14	Mostly should be mainly		Modified
	16	Nm3/year		Modified
	17-18	Remove	We would like to keep it as a reference	
	19-24	Explain, or discuss	We re-considered the content, and think this paragraph is less relevant and can be removed	
129	11	Regarding should be for		Modified
	Fig. 2	Light blue and dark blue difficult to discriminate	We changed the colour to purple	See text and Figure 2
	Fig. 2	Add a line from the shower (the discharge) to the heat exchanger.	We think that adding a connection between the discharge and shower heat exchanger will make the figure too complicated. And this connection can be seen in Figure 3.	