Shower Feedback in Switzerland

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Webinar Transcript

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Landmark Designation

The program described in this case study was designated in 2016.

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The panel that designated this program consisted of:

- Doug McKenzie-Mohr, McKenzie-Mohr Associates
- Arien Korteland, BC Hydro
- Brian Smith, Pacific Gas and Electric Company
- Marsha Walton, New York Energy Research and Development Authority
- Dan York, ACEEE

This transcript covers a webinar held on Wednesday, March 6, 2017. Additional materials about this program can be found at: http://www.toolsofchange.com/en/case-studies/detail/697.

Verena Tiefenbeck: Thank you very much for the introduction, Jay, and thanks to all of you for joining today's webinar. Let me say one thing up front: Maybe the title (about shower feedback in Switzerland) sounds a bit strange to some of you, and maybe some of you are wondering why on earth we don't let people take their showers in peace in Switzerland. One of my goals for this webinar is to convince you that providing feedback on resource consumption is a very reasonable thing to do and that it generates much larger energy savings than typical smart metering programs do. I also think the insights that we generate in the study are relevant for other smart-metering projects.

[Slide] How much energy do you think is used in a typical shower? You all know that showering consumes water but we also need to heat the water up for our showers. How much energy goes into a typical shower – in one second of showering – how long could you power a typical laptop like a MacBook Air with that amount of energy? Is it A) Roughly four seconds or is it B) 42 seconds, or is it C) 12.6 minutes or D) one-and-a-half hours?

Most people chose either B or C but the correct answer is, in fact, D. The energy that you use in a single second of showering could power your laptop computer for an hour and a half; that's massive. A typical shower only lasts for a few minutes but it's one of the most energy intensive activities throughout your entire day. That's why, even in water-rich countries like Switzerland, it makes sense to pay attention to that activity from an energy-conservation point of view.

Study Overview

[Slide] Before I go into the details of the study, I thought I would first give you a very brief overview. There are millions of smart meters deployed all over the world - in North America, Europe and many other regions. There is more and more interest in feedback programs. This involves taking the information from electricity – smart meters, in particular – to inform people about how much energy or how much gas they're using at home on a daily basis.

What is different about our study is that we focus on a single behaviour, showering. The study shows that this narrow focus on a specific activity actually has a much larger impact than a typical smart-metering program. We provided feedback to people as they took their showers; they could see how much energy and how much water they were currently using in the shower.

We ran a study with roughly 700 households. In a nutshell, the average participant reduced her energy use by 22%. That is substantial. You could ask, "It's only 22% of shower energy. What does it mean?" For a typical home that translates into yearly savings of roughly 450 kilowatt hours a year, which is larger than what the average European home uses for all lighting. It is more than what two, large, modern refrigerators use in a year.

[Slide] I will now give you more details on the study. I'll cover how we ran it, who is

behind the study, what we found out, and what it means for the individual household, and also what it means from the perspective of a utility company or government.

Bits to Energy Lab, Partners and Funders

[Slide] I'll start with who is behind the study. I'm part of the Bits to Energy Lab, a joint research initiative of three universities. They are ETH Zurich, the University of St. Gallen in Switzerland, and the University of Bamberg in Germany. Our joint mission is to combine information technology and social science research in order to help households reduce their energy consumption.

The idea is to take advantage of new developments with smart meters and smartphones and so on, by combining it with behavioural insights from psychology, behavioural economics, and so on. The study that I'm presenting today on shower behaviour was a joint study with two other universities, the University of Bonn and the University of Lausanne, in addition to the Bits Energy Lab. The study was funded by EW Zurich, a local utility company in Zurich, and the Swiss Federal Office of Energy.

The Focus on Shower Behaviour

[Slide] Switzerland has abundant water resources. However, using less shower water is important from an energy conservation point of view. What you can see here is the typical energy use of a home in the U.S. It is the same situation in Europe. Water heating is the second-largest energy end use in the average home both in the U.S. and in Europe, accounting for 18% of our energy use. Showering actually accounts for the vast majority of it. In Europe, 80% of hot water is used in the shower. At that point it makes more sense to focus on shower behaviour than things like lighting, which most people actually focus on when they think of energy conservation.

A lot of governments and other organizations are trying to get people to install a low-flow showerhead. However, a lot of people refuse because it reduces comfort. Information campaigns – like providing energy conservation tips to people – are also not very effective. Usually, the people you reach are the people who already care, and a lot of people are just overwhelmed with these lists of tips. People then often try to pick one or two things that are quite easy to implement but that usually don't have a very large impact.

Economists say, "Well, you simply have to increase the price of electricity. Make it more expensive," but that is quite challenging to implement in most cases. Also, there's research that shows that most households are not very responsive to price increases for electricity because it's usually a small part of their budgets.

Finally, with all these electricity smart meters that we have in place these days, there has been interest in the past few years to actually provide feedback to households on in-home displays or web portals. These devices connect to the smart meter and they show people how much electricity the household has been using throughout the day. Recent studies

have shown typical reductions from this approach in the order of two or three percent. While that's something, the reductions are too small to make these programs scalable because the equipment costs are greater than the savings.

[Slide] What we do in our study is different. We also provide feedback to people on their energy use but we focus on a single behaviour - showering. We target showering as a single activity, which allows us to provide concrete and actionable information on that activity. Also, we provide the information in real time so people see that feedback as they take their showers. That means that they get the feedback while they can still do something about it. We investigated the impact of this kind of shower feedback.

The Meters

[Slide] We used these smart-shower meters that were manufactured by Amphiro, a spin-off company of ETH Zurich. We sent them to households and then the households themselves installed the devices. They are very simple to install in any shower that has a handheld showerhead (which most homes in Switzerland do). You can do it without any tools.

The information is then visible at eye level. The device is close to the showerhead and you can see how much energy and water you've used since you started your shower. The standard device displays the current water temperature, how much water you've used since you turned on the water, and how much energy you've used. You also get additional information such as your energy efficiency rating. Europeans are quite familiar with energy ratings. Every time you buy a refrigerator or other appliance, it comes with some efficiency rating from A to G. People know that A is very good and G is really bad. When they start their shower, they usually start out in energy efficiency class A+ and then, as the shower takes longer and longer, they move towards B, then C and so on. Finally, there's also a little polar bear animation; it might be more controversial in other countries but not in Europe. In fact, most people responded positively to it. If you take a long shower, the ice flow on which the polar bear stands shrinks.

One interesting thing from a research point of view is that the data are not only displayed to the individual who's taking her shower, it's also stored on the devices. We, as researchers, can access the granular data and see what's happening in the field over time.

Another interesting thing is that the device doesn't need a battery; from the water flow it harvests the energy needed to power the screen and on-board computer. You can use it for years without having to replace any batteries. It also means as soon as you turn on the water, the screen automatically activates; people don't need to press a button. It is there every time they take a shower.

The Study

[Slide] We recruited 697 households from the utility company EWZ. It was an opt-in study. All of them had already participated in other electricity smart-metering studies and

had received this smart-shower meter as a "thank you" gift. We limited our study to only 700 households; roughly 1,350 people had signed up to participate but we had to limit it to 700 for logistics reasons. We also had to limit it to one and two-person households because back then the devices had a smaller memory and we were afraid they might not be able to store all the shower data for the entire study.

Now, you could say, "Oh, that's kind of a selective sample - people who have already participated in another study. Aren't these people particularly green minded?" In fact, our participants were slightly less pro-environmentally minded than average. We ran a survey both before and after the study and we compared their environmental attitudes with a representative group from Switzerland. We saw that our participants were certainly not greener than the average citizen. That's important to keep in mind when we talk about generalizing the results. Given that our participants had already participated in an electricity smart-metering study, we can compare their behaviours and responses in our study with their behaviours in the electricity smart-metering study. I will do that later on.

[Slide] We recorded shower behaviour over two months in a randomized controlled field trial, which means we assigned households to different groups randomly and were comparing how the different groups were doing, over time. In the baseline phase at the beginning of our study, all participants only saw the water temperature displayed on the devices. They didn't get any feedback yet on energy or water consumption. For the first ten showers, everybody only saw water temperature. We could also have shown nothing at all but the reason we showed them water temperature was we wanted participants to be aware that the device was actively measuring something, that it was working, and that they had installed it properly.

After the tenth shower, we started the intervention phase. From that point on, two-thirds of the households could also see how much energy and water they were using in their current showers. That was our treatment group. The remaining one-third continued to see only water temperature. They were our reference (or control) group; they enabled us to tell how much change was driven by seasonal factors and how much was driven by the feedback itself.

We also administered a survey both before and after the study to know a bit more about our sample – their environmental attitudes, personalities and so on.

[Slide] The entire study lasted for two months, with a measurement phase in the field. Data collection was the most cumbersome part of the study because back then we had to ask participants to ship back the devices to us after the study so that we could read the data. We used software that we had written ourselves. The new generation of devices can now transfer the data to participants' smart phones via a Bluetooth connection. From there, it is easy to send to us. That makes the whole procedure much less painful.

Impacts

Per Home

[Slides] What did we find? On this chart you see the energy used per shower on the Y axis. The blue line shows the average consumption per shower by the control group. You see that in the first showers the control group roughly used 2.6 kilowatt hours per shower. The X axis is more or less a time axis, with the showers ordered in sequential order. You can see that the control group, the people who only saw water temperature throughout the entire study, slightly increased their consumption at first. We think that's because at the beginning of the study participants knew they were being observed and after a while they got used to that. After a while, their behaviour stabilized at what we think was their usual behaviour, whereas at the beginning they took shorter showers. This highlights that it's really important to have a control group.

What you see in orange is the treatment group during the baseline phase, when everybody only saw water temperature. You can clearly see that there's no difference between the two groups. The randomization had worked out well.

[Slide] Now, what happens when we activate the feedback in the 11th shower? Well, you see quite a massive impact. You see that the participants in the treatment group reduced their consumption massively from that shower on. The effect was immediate. When you look at the distance between those two curves, you notice that the effect doesn't get smaller over time. In addition to analyzing these patterns visually, we calculated the savings in detail and we found out that the average treatment effect is 22%, and that effect is stable over time.

[Slide] How did people reduce their energy use in the shower? Almost all participants took shorter showers. In theory, they also could have reduced the flow rate, taken colder showers, or stopped the water flow during the shower while they were putting on soap. But hardly anybody did those things. People were not willing to give up comfort during the shower. Instead, they took shorter showers.

Is this approach scalable and cost effective? As I said before, we can compare the behaviour of our participants in our study with their behaviour in the previous electricity smart-metering study.

[Slides] In the first electricity smart-metering study, they reduced their household electricity use by only 3.2%. In our study, they reduced their energy consumption in the shower by 22%. Now at first glance those two numbers seem hard to compare, but when we look at absolute energy savings we see the reduction in the electricity smart-metering study yielded only 86 kilowatt hours' savings a year, whereas in our shower study, the savings were 452 kilowatt hours of heat energy. That's five times as much! Our study had a narrow focus on a single behavior – showering – and it yielded much larger savings than the feedback intervention on electricity use that used in-home displays.

Now, engineers may still say, "Yes, but one is electric energy, the other is heat energy," but at least for households we heat our water with electricity, so we really can directly compare these savings.

In terms of CO_2 reduction, the difference is even larger. The savings from the shower study are 11 times as big as from the electricity study. To be fair, I should say that here electricity generation in Switzerland is very clean, which explains part of this factor of 11.

In addition to saving energy and reducing carbon emissions, we also have a reduction of water consumption. When we take into account the cost saving for each household, we end up with 17 Swiss Francs on average (roughly $17 US) for the electricity smart-metering study. In contrast, the feedback on shower behaviour generated savings of 110 Francs, again substantially larger.

In summary, we observed a large reduction of 22% for the target behaviour – showering - which translated into large, immediate, absolute savings that were stable over the two-month study. These savings exceed the average energy used for lighting in European homes. These savings are primarily driven by high-users - people who take very long showers at first.

[Slide] It's not the very environmentally friendly people who respond most to the treatment; it's in fact people who have a very large consumption up front. Our participants live in Zurich and the average household in Zurich uses 9,000 kilowatt hours of energy per year, which is really small. That is because most buildings are apartments. This 450-kilowatt reduction is from an average of five persons per household. If we were to run the study in other places like the U.S., a typical shower in the U.S. uses 65 litres of water, versus 44 litres in Switzerland.

[Slide] Given that our effects are mainly driven by baseline consumption, we think that in other countries that have a higher baseline use, we would see even larger savings. But we still have to run a study in North America to prove that. We have replicated the studies in The Netherlands, Germany, Switzerland, and Singapore. The effects are almost always as large as in the first study - across countries, across different cultural settings. They're always immediate and they're always stable. That gives us reassurance that this will work in very different settings.

Overall Impact

It's nice that the savings for one household are large, but to what extent is this scalable and how large an effect has the program had so far?

[Slide] We don't have data from all the devices that are out there. The startup that manufactures the devices has sold roughly 40,000 devices. If we apply the savings we observed in our study to all 40,000 households, the savings amount to 80 gigawatt hours per year, which is quite large. In addition, we have water savings of close to 300 million litres of water on a yearly basis.

Is it cost effective? When we ask ourselves that question, we have to distinguish between

who pays for the devices. Is it the individual household or is it a larger organization?

[Slide] If you take the perspective of an individual household, they reap both the water and energy savings from the device. With that, the device pays itself off within nine months. If you anticipate a three-year lifetime, then we end up with a net benefit of 190 francs.

If you take the perspective of a utility company or of a policymaker, you aren't saving on your electricity or water bill; you tend to be more concerned from a cost of carbon abatement perspective. Each kilowatt hour abated cost roughly three U.S. cents. If you follow the usual approach to calculating this, we end up with negative carbon abatement cost of $234 (US). They actually make money by deploying these devices. From a financial point of view or from a question of cost effectiveness, it clearly makes sense to deploy these devices on a large scale.

Further Reading and Conclusion

[Slide] If you want more details about this study, read the journal article that recently appeared in *Management Science*. It's available online for free. The article is called "Overcoming Salience Bias: How Real-Time Feedback Fosters Resource Conservation."

I'm happy now to answer questions. With that, I would like to thank you already for your attention.

Q&A

Jay Kassirer: Thank you, Verena. First off, how does the device attach to wall-mounted showerheads?

Verena Tiefenbeck: That is a problem and there is no solution, yet. In theory, you could attach it to a wall-mounted showerhead but the problem is you won't see the information at eye level. Shower fixtures are standard worldwide, so in theory you could attach that way. But it doesn't make much sense to have the information 'up on the ceiling', which is the reason why we haven't run a study yet in North America. In Europe 95-97% of the showers are handheld showerheads but in North America I know that the majority are wall-mounted. That is something that is currently a barrier for running these studies and deploying these devices in North America.

Previous versions of these devices had the display separate from the measurement unit so that you could actually have a little screen at eye level that would receive the data from the measurement unit. The problem is that then you need to power the screen with a battery. For the device to work without any battery, the screen has to be powered by the water flow, which makes it a challenge for wall-mounted showers.

Jay Kassirer: In this slide [2nd slide, p. 6, PDF], is that the portable part that's hanging down? It almost looks like it's on the wall, there.

Verena Tiefenbeck: It's not on the wall but a lot of people don't hold the showerhead in their hands all the time; they put it in a little fixture on the wall of the shower. Right above the picture, the showerhead would start. This is actually a device that was installed in a handheld showerhead but you just don't see the showerhead, here.

Q: Can alarms be set on the meter when thresholds are reached for time or water or energy consumption? Did you think about doing that? You have the graphic of the polar bear disappearing but did you think about pros and cons and was there a reason why you didn't set any alarms for those things?

Verena Tiefenbeck: That's a great question. In some of the follow-up studies that we ran, we provided a conservation goal of X litres of water or a certain amount of energy. We tried to figure out to what extent people would respond to that. A lot of people do respond quite well to these savings goals. At the same time, it can also create some negative reactions because you can imagine that a lot of people will say, "Hey, who are you to tell me who much energy or water I'm allowed to use? This is getting way too personal." What we found is that the standard display without any threshold or any particular limit is much more acceptable to the majority of people. You can decide on a daily basis what is right for you.

For instance, some women wash their hair one day and then the next day they don't. That clearly defines how much water and energy they want to use on different days. It's hard to come up with a particular number. Most people come up with a goal on their own. We asked people after this first study if they had set up and formulated a goal for themselves - a certain limit which they tried not to exceed. The vast majority of them did that automatically.

Jay Kassirer: The decision to go with the polar bear – can you say a little bit more about that? It provides some additional feedback in the graphic.

Verena Tiefenbeck: The polar bear doesn't contain much information. The idea was to provide a bit of a playful element, not just dry numbers. We are now running tests with and without the polar bear. The polar bear doesn't improve the effectiveness of the device, but from a marketing perspective the polar bear is what people talk about. While it's the numbers to which people apparently respond, it's the polar bear that people remember. I often get the reaction, "Oh, you're the folks with the polar bears," so it's something that really, apparently, sticks in people's heads but it's probably not the thing that really drives behaviour change.

Jay Kassirer: You don't get people trying to drown the polar bear?

Verena Tiefenbeck: I think that in households it doesn't really matter because the animation is very simple. It's just black lines and it's not very spectacular. A lot of people probably try to drown it. They try it once, and then they've seen it. They see that it's not very spectacular, especially in these times where we have 3D movies. It's nothing people

would try to do on a daily basis. However, in a hotel, you only take a couple of showers, usually, because you only stay for one, two, three days. We have some evidence now from hotels that people – out of curiosity –do try drowning the polar bear.

Jay Kassirer: How is the energy consumption calculated on the smart meter? And how do you figure out the efficiency of the heating system?

Verena Tiefenbeck: What the device measures and stores is both the water consumption and the temperature – the average temperature – of the shower. We calculate the minimum amount of energy that goes into the shower by simply multiplying the amount of water that is being used with the temperature gradient. The difference between the cold-water temperature and the average shower temperature is the minimum temperature. Essentially, that gives us the energy consumption if the heating system was 100% efficient. Then, to calculate realistic values we ask the participants what kind of heating system they have and we take average values on a country level. We know in Switzerland exactly what percent of households uses gas heating, electricity, or oil heating to heat their water. We also know the average efficiency for each of these fuel sources. We plug these numbers into the calculation of the actual, average energy being consumed per shower.

Jay Kassirer: You've observed significant savings over two months. Do you have evidence that the effect lasts longer?

Verena Tiefenbeck: The study that we ran in Singapore was about six months. In the six-month study, we do not find any evidence of decay. We also have another study that lasted 16 months, but it was only with 50 households. We found no evidence of decay for a behaviour that was carried out on a daily basis – and people in Singapore take two showers a day, on average. People have actually created new habits at that point.

Jay Kassirer: Are you saying that in all of the locations you get roughly the same amount of savings and the behavior change persists?

Verena Tiefenbeck: Yes. Exactly. The biggest difference between the different locations is the baseline use. People in Singapore take much shorter showers. The average shower in Singapore uses only 20 litres, which is less than half of what people use in Switzerland. In the U.S. it would be 65 litres. The savings in Singapore tend to be smaller simply because they start out from 20 litres; it's much harder for them to cut ten litres out of their shower than it is for a Swiss citizen who starts out with 40 or 50 litres. Once we control for baseline consumption, the affects really replicate to an extent that is actually kind of shocking. It seems to have reached across cultures and places.

Jay Kassirer: You've provided feedback and not provided a lot of judgments, other than the polar bear graphic. What has been people's experience in the end? They've used less energy, they've used less water. Did they feel like their lifestyles have been compromised as a result?

Verena Tiefenbeck: The responses that we have are quite positive. You can say that those who opt-in are particularly receptive. However, we have run the study now in nine hotels in Switzerland and in Germany. There, we did not have opt-in participants. In other words, people just came to the hotel room and the device was there as part of the hotel room infrastructure. Even in this situation the savings were almost as large as in households, and the vast majority of people really liked having the devices.

To be honest, there are certainly people who would oppose having something like this. The polar bear might cause more controversial reactions in some countries. However, in Europe the majority of people believe in climate change. It would be interesting to see what fraction of people in other countries would be willing to install this kind of device.

Jay Kassirer: What was the most surprising finding from this study?

Verena Tiefenbeck: Two things. First, there is the magnitude of the savings. We did not anticipate the effect to be that large. The second thing for me was the replicability. We were scratching our heads when we ran the second and the third study and found exactly the same patterns again and again and again. Even things like the control groups slightly increasing their consumption, over time – all of that really replicates and that was really striking.

Jay Kassirer: Do you have any idea about when a wall-mount version of the meter might come out?

Verena Tiefenbeck: There are a lot of people who have been trying to build something like that, but we haven't seen it materialize yet. At this point I'm not aware of anything in the near future that would do it.

Jay Kassirer: Thank you very much for a very informative webinar.