The Energy Contest Cover Page
Rutgers New Brunswick Undergraduate Students
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200 word (maximum) summary of the proposal or video:

We plan to address an energy consumption issue through minimizing water usage in residence halls at Rutgers University — New Brunswick. The program, called Bathing in Savings, will utilize a three-pronged approach. First, we will install a more energy-efficient showerhead in order to reduce water usage, and thus, energy consumption. In addition, we will utilize a no-cost, educational approach to mitigate energy usage through posters. Finally, the contest will encourage students to be more energy-efficient, with a pizza party as an incentive to shorten shower times.

Introduction

According to the U.S. Energy Information Administration 2018 findings, about 4,178 kilowatt hours of electricity were generated by utility scale electricity generation facilities in the United States; of which, 63% of the electricity was generated from fossil fuels.[1] This high usage of fossil fuels contributes to climate change and resource depletion, in addition to a myriad of other negative environmental impacts. Energy consumption is a wide-ranging issue, particularly at large institutions like Rutgers — New Brunswick. Bathing in Savings is a plan devised to mitigate energy usage through showers. Although cost may be a prohibitive factor for Rutgers to make environmentally driven changes, our plan is efficient and cost-effective, with a large return on investment.

"Showering is one of the leading water uses in the home, accounting for nearly 17% of residential indoor water consumption or about 12 gpd [gallons per day] per person. That's more than 1.2 trillion gallons of water used for showering in the United States annually, which is approximately the amount of water delivered by the public supply system for the states of New York and New Jersey for a year," according to the EPA.[2]

By reducing water flow and water usage, energy consumption can be drastically reduced, particularly in regard to showers, as the majority of water consumption in residence halls comes from showers. Additionally, water consumption is not regularly considered in the framework of energy consumption, so this solution will stand as a pioneered solution to energy consumption issues.

Model of Behavior

We are piloting the program in a Cook/Douglass residence hall, Lippincott Residence Hall, as many environmental science majors are housed on Cook/Douglass campus, thus making

them more apt to participate in the program. The first aspect of the proposal is the installation of the the Niagara Conservation 2.0 Gpm Niagara Chrome Handheld Massage Showerhead, hereafter referred to as Niagara 2.0. Cost will be a determining factor for Rutgers, but because the cost of the selected showerhead is $12.49, the pilot program will be inexpensive to implement.[3,4] Furthermore, if expanded across campuses, the cost will be outweighed by the energy and water consumption reduction and consequent cost reduction.

The decision to participate in behaviors that lessen energy-consumption in the shower relies on the residents. While shortening shower times may seem mildly inconvenient at first to the average resident, we can influence them through food incentives and education. Through posters and outreach events, we will educate the residents on water consumption and how it relates to energy usage and the consequent negative environmental impacts. The residents will be encouraged to participate through the Drip Drop Contest, which will reward the floor with the lowest energy consumption for the semester with a pizza party. This data will be obtained from Rutgers Maintenance.

Our Solution: ***Bathing in Savings***

In order to reduce energy consumption by showers, we have created a program called Bathing in Savings. We critically analyzed multiple energy-efficient showerheads in order to select the most cost-effective, efficient and beneficial showerhead.

Table 1

Name	**Price***	**Review (5 stars)***	**Number of Reviews***	**Features**
Niagara 1.25 GPM Earth Showerhead[5]	$9.99	62%	860	Watersense Labeled Ensures 75% lower water usage than traditional "low-flow" showerheads currently on the market Reduced cost for usage and heating of water Patented pressure-compensating technology, no batteries required

				Three spray settings: 9-jet spray, shower and combo Corrosion-resistant high-impact ABS thermoplastic body, maintenance-free Large spray diameter with even, vacillating motion Limited lifetime warranty
Niagara Conservation 2.0 Gpm Handheld Showerhead[3,6]	$12.49	71%	1,734	Watersense Labeled Patented internal pressure compensator (consistent water output despite available water pressure) Corrosion-resistant high-impact ABS thermoplastic body, maintenance-free 9-Jet adjustable turbo massage No batteries required 10 year warranty
Peakman Hotel Anystream 2.0 GPM[7]	$33.99	80%	2,086	WaterSense Labeled Patented Anystream 360° technology (diverse spray settings) Patented plungers (controls pressure despite low water pressure) Self-cleaning plungers reduce hard-water buildup and sediment Corrosion-resistant polished chrome finish, durable plastic
HYDRAO Aloe[8]	€69.90 ($78.99)	N/A	N/A	Watersense, ACS, FCC and CE certified Category A water consumption index (Watersense index) Measures and informs water consumption in real time using integrated multicolor LED system Customizable consumption thresholds; no battery necessary Maximum flow rate: 6.6L/min; triple jet (rain, massage, mixed) 56% water/ energy savings versus standard showerheads (12 L/min) 41% water/energy savings versus water-saving showerheads (9L/min) Clean 2-4 times/year depending on local water hardness Spray diffuser in silicon (protects against lime-scale) IP Rating: IP65 (protection against moisture) 2 year warranty
HYDRAO Cereus[8]	€79.90 ($90.29)	N/A	N/A	Same as HYDRAO Cereus Wall shower
HYDRAO Yucca[8]	€99.00 ($111.87)	N/A	N/A	Same as HYDRAO Cereus, with the addition of a mono jet Rain shower
Fyeer 3-Way Thermostatic Mixing Valve[9]	$32.99	65%	26	Temperature control: thermostatic mixing valve (non-return inlets) Cold water supply temperature:4-29°C (39-84°F) Hot water supply temperature:55-85°C (131-185°F) If cold water supply fails, flow rate will shut off to avoid scalding Temperature accuracy: Constant ±2°C for the setting
Hiendure Thermostatic Mixing Valve[10]	$29.00	81%	16	Same as Fyeer 3-Way Thermostatic Mixing Valve

*Source: Amazon Prime

After careful consideration of price, customer reviews and unique product features of various energy-efficient showerheads, LED powered smart showerheads and thermostatic shut-off valves, we selected the Niagara 2.0 showerhead.

For energy-efficient showerheads, we exclusively examined products with a WaterSense label. WaterSense, a program run by the US Environmental Protection Agency, created a collaboration with plumbing industry leaders who worked in the American Society of Mechanical Engineers and the Canadian Standards Association to develop standards for water-efficient showerheads based on studies in consumer preferences, public feedback and environmental concerns.[2] From a monetary perspective, each home using a WaterSense-labeled showerhead can save up to $50 in utility bills, and greater than 2,300 gallons of water per year.[2]

Next, we examined pricing and customer reviews of energy-efficient showerheads through a high traffic ecommerce site, Amazon.com. The Niagara N2912 1.25 GPM Earth Showerhead Massage, hereafter referred to as Niagara 1.25, had 62% of 860 customers rate it as 5 stars, the Niagara 2.0 had 71% of 1,734 customers rate it as 5 stars and the Peakman Hotel Anystream 2.0 GPM Showerhead had a 80% of 2,086 customers rate it as 5 stars.[3,5,7] Despite its high rating, the Peakman Hotel Anystream 2.0 GPM Showerhead was much more expensive than the Niagara products, at $33.99.[7] The Niagara 1.25 and the Niagara 2.0 had similar features with a maintenance free, corrosion-resistant, high impact ABS thermoplastic body and patented pressure-compensating technology[3,5,6]. The Niagara 2.0 has a slightly higher price ($12.49) compared to the Niagara 1.25 ($9.99).[3,5] However, the Niagara 2.0 has a higher gallon per minute (GPM) and longer warranty compared to the Niagara 1.25.[3,5,6] Customer reviews revealed that the higher flow rate might be necessary for thicker, curly hair. Considering Rutgers' diverse population, we chose to go with the higher GPM to accommodate the wide range of hair types.[3]

We considered using a showerhead designed to measure and inform water consumption in real time using lights. The HYDRAO showerheads change color depending on a customizable water consumption threshold, which alerts the shower user to end their shower.[8] The price was

much higher than the energy-efficient showerheads mentioned previously, ranging from $78.99 to $111.87.[8] We also examined potentially utilizing a thermostatic shut-off valve. According to a study conducted by Lawrence Berkeley Laboratories, "behavioral waste events" occur when users turn on the shower and let the hot water run unused.[11] Behavioral waste tends to last between 38 and 56 seconds and can lead to 1.7 to 4.9 gallons per event.[11] A thermostatic shut-off valve would limit this waste by controlling the hot water released from the showerhead, cutting down on time users wait for the shower to warm up.[11] However, the prices of these thermostatic shut-off valves far exceed the energy-efficient showerheads, as seen in Table 1. Unlike the thermostatic shut-off valves or the HYDRAO products, the Niagara 1.5 and Niagara 2.0 showerheads minimize dependence on human involvement. The shut off valves would require additional education on how students can use them, and usage of the HYDRAO showerheads assumes that the students would pay attention to the change in light at a predetermined threshold, and actively reduce their shower times. For the energy-efficient showerheads, human involvement only further increases benefit, rather than relying on it. Through education on environmental impacts and incentivized contests, students will begin to reduce water usage.

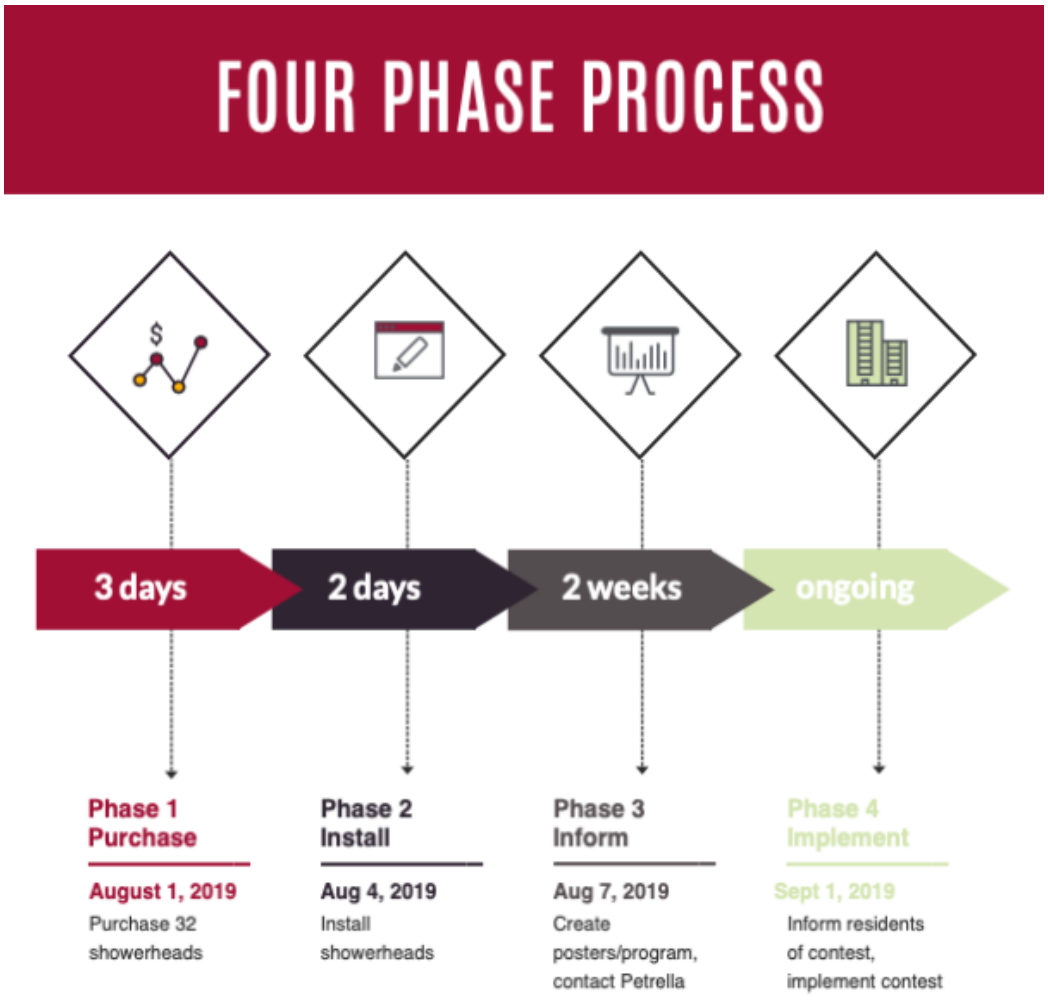
Implementation

The installation of the Niagara 2.0 will maintain the majority of the energy usage reductions. Bathing in Savings implementation is determined by administration at Rutgers, and further developed through Rutgers maintenance, as they will install the new showerheads. Additionally, it is imperative to have support from the residents in order to make a larger impact. To do so, we will utilize an educational angle to inform the residents through posters. These posters will consist of facts and tips about energy consumption as a result of showers. Some of the facts included are as follows:

- The average American shower uses 17.2 gallons per shower[12]
- The average American shower lasts for 8.2 minutes at average flow rate of 2.1 gallons per minute.[12]
- Turn off the water while shampooing and lathering or shaving to save water.

We will contact Martin Petrella, the Rutgers University Coordinator for Training & Staff Development in Residence Life in regards to working with the Resident Assistants (RAs). Mr. Petrella can distribute the posters to the RAs, who will then hang the posters on each of the bathroom shower stalls. We will also provide a program that correlates to the "Responsibility" aspect of the CARES model for programming. It will explain how each individual resident's water usage leads to overall energy consumption and the negative impact of this consumption. The program will also encourage residents to take responsibility for the environment by simply reducing shower times. This program will introduce the Drip Drop Contest. Data comparing water consumption between floors will be obtained through Rutgers maintenance at the end of each month and will be documented on a bulletin board in the main lobby to keep residents invested in the competition. The semesterly winning floor with the least consumption will be rewarded with a pizza party. The programs and competition will have an added benefit of tying the community of students together in achieving the goal of reducing water usage.

Timeline



Cost-Benefit Analysis

	Monthly Water/Sewer Cost ($)	CURRENT SHOWER: CCF with 2.2 GPM	CCF with Niagara 2.0GPM	CCF Savings	Cost Savings ($)
June	4592.83	945.026749	859.1152263	85.91152263	417.53
July	5191.03	1068.113169	971.0119716	97.10119716	471.91
August	4334.61	891.8950617	810.8136925	81.08136925	394.05
Sept	5230.05	1076.141975	978.3108866	97.83108866	475.46

October	5333.24	1097.374486	997.6131687	99.76131687	484.84
November	3933.84	809.4320988	735.8473625	73.58473625	357.62
December	3579.62	736.5473251	669.5884774	66.95884774	325.42
Jan	3977.26	818.3662551	743.9693229	74.39693229	361.57
Feb	3735.94	768.7119342	698.8290311	69.88290311	339.63
March	3698.25	760.9567901	691.7789001	69.17789001	336.20
April	6968.67	1433.882716	1303.529742	130.3529742	633.52
May	1969.31	405.2078189	368.3707445	36.83707445	179.03
Total	52544.65				**4,776.79**

	Monthly Natural gas cost	CCF with 2.2 GPM	Cost of Natural gas/CCF	CCF with Niagara 2.0GPM	Monthly Cost of Natural gas with 2.0 ($)	Savings ($)
June	280.71	945.026749	0.297039211	859.1152263	255.19	25.52
July	239.04	1068.113169	0.22379651	971.0119716	217.31	21.73
August	293.15	891.8950617	0.328682165	810.8136925	266.50	26.65
Sept	412.44	1076.141975	0.38325798	978.3108866	374.95	37.49
October	2941.02	1097.374486	2.680051375	997.6131687	2673.65	267.37
November	5614.45	809.4320988	6.936282868	735.8473625	5104.05	510.40
December	6132.92	736.5473251	8.326579693	669.5884774	5575.38	557.54
Jan	5725.62	818.3662551	6.996402851	743.9693229	5205.11	520.51
Feb	5626.32	768.7119342	7.319152663	698.8290311	5114.84	511.48
March	3752.31	760.9567901	4.931042142	691.7789001	3411.19	341.12
April	2283.68	1433.882716	1.592654667	1303.529742	2076.07	207.61
May	262.72	405.2078189	0.648358664	368.3707445	238.84	23.88
Total	33564.38	10811.65638	40.66330079	9828.778526	30513.07	**3,051.31**

According to maintenance records from the 2018 fiscal year at Lippincott Residence Hall, one CCF (hundred cubic feet) of water costs $4.86. Using this conversion, the monthly water/sewage costs acquired from the maintenance records can be converted to CCF. Next, the

monthly CCF of water used by the current 2.2 shower heads may be converted to gallons to ultimately find the expected gallons of water used with the Niagara 2.0GPM showerheads. The number of gallons used with the Niagara 2.0GPM may then be converted back into CCF, so that the CCF savings per month can be calculated using the cost per CCF ($4.86/CCF). Rutgers would save $4,776.78 in one year as a result of utilizing the Niagara 2.0GPM. After 10 years, Rutgers would save $47,767.86, which is calculated due to the 10 year warranty.[3,6]

The monthly cost of natural gas can be divided by the CCF of water used with the current 2.2 GPM showerhead to find the cost of natural gas per CCF of water. This ratio can then be used to find the expected monthly cost of natural gas with the Niagara 2.0 showerhead, and subsequently to find the savings per month on natural gas. After one year, Rutgers can expect to save approximately $3,051.30, and after 10 years (due to the 10 year warranty) Rutgers can save approximately $30,513.07. Considering the Niagara 2.0 showerhead's corrosion-resistant, high-impact ABS thermoplastic body and description as maintenance-free, the cost of maintenance would be minimal or nonexistent.[3,6] The total savings on natural gas and water bills far surpasses the purchase of showerheads, saving Rutgers a total of approximately $77,881.25 after 10 years, after subtracting out the price of the showerheads ($399.68). These savings are only for one residence hall; with expansion, the monetary and energy savings can be astronomical across the five New Brunswick campuses. The savings in water are beneficial for the monetary savings, while the savings in natural gas are both beneficial monetarily as well as for energy consumption reduction. The monetary savings demonstrate the reduction in costs for heating the water, which directly proves the reduction in energy usage, as a reduction in cost means less energy is being used.

Topic	Cost	Benefit	Non-Monetary Benefit
Purchase of showerheads	$399.68		- Reduced energy consumption - Reduced water usage
Posters/Program	$0	- Could contribute to reduced energy consumption and water usage	- Increased resident awareness - Increased participation in competition
Monthly Water/Sewage Cost	$52,544.65	$4,776.79 per year	-Reduction of water consumption
Heating	$33,564.38	$30,513.07	-Reduction of energy consumption

Conclusion

Our solution provides a multifaceted approach to the issue of energy usage in showers. By involving maintenance, RAs and residents, the program is bound to succeed. Educating and encouraging residents to participate, along with the installation of the Niagara 2.0 will lead to a decrease in energy usage by showers, as well as monetary savings for Rutgers University. This symbiotic relationship between Rutgers and the environment is cost-effective, environmentally beneficial and educationally driven. With a profit of $77,881.25 after 10 years in just one residence hall, Rutgers must utilize Bathing in Savings to mitigate energy usage through reduction of waterflow in showers using the Niagara 2.0.

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