



WHITE PAPER SUMMARY

Rush Hour Rewards

Nest Labs, Inc.
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1. Introduction

In order to keep the lights on, electric grids are sized to accommodate peaks when everyone turns on the air conditioning at once - even though those peaks occur for less than 100 hours per year, or about 1 percent of the time. As demand increases, energy companies can build more power plants and distribution infrastructure, or they can take steps to encourage customers to use less during the peak periods. This second option, called Demand Response, has been used by energy providers for decades as a cost-effective (and environmentally friendly) alternative to building more infrastructure.

To date, Demand Response has yet to reach the mass market adoption. The reasons are simple: previous strategies to control air conditioning use during peak times were one-size-fits-all and prioritized load reduction over user comfort. We believe that in order for Demand Response to be successful, the shift has to be personalized for each home and the customer has to be a willing participant - they need to feel comfortable, in control of the temperature at all times, and should receive high enough rewards to balance any discomfort during the event.

So Nest has created a unique, personalized solution to this problem. **Rush Hour Rewards™** is a proprietary Nest service we believe will help make Demand Response more welcoming and less disruptive to customers while still meeting energy providers' needs. This paper describes our field trials of previously available load shift strategies, how the design of Rush Hour Rewards captures the benefits of those strategies without the drawbacks, and our simulations and field trials of this novel approach that can enable significant load shift while maintaining customer comfort and control.

It is worth noting that the rewards aspect of the experience is not discussed in this paper. All participants in our field trials are voluntary members and were not paid when testing Rush Hour Rewards. In summer 2013, customers with Rush Hours Rewards will receive substantial payments from their energy companies for their participation.

2. The use of the rush hour analogy

The success of Demand Response programs are contingent upon widespread customer adoption, which starts with their enrollment. Given that Demand Response is usually a new concept to the average customer, we believe it is important to educate them about the experience they're signing up for. To do this, we help customers understand what peak energy time is and why shifting energy loads is important by comparing peak energy events to traffic rush hours on the freeways. Everyone crowding onto the road at once is similar to everyone turning on their air conditioning at once - there are negative consequences of a large number of people trying to use a limited resource at the same time.

So we call periods of peak energy load "energy rush hours". Customers of Nest's energy partners can sign up for Rush Hour Rewards, which will act like a smart GPS during a traffic rush hour: it will guide them to avoid traffic jams and get them to their destination as efficiently as possible. This means that Rush Hours Rewards will dynamically tweak temperatures around each energy rush hour in order to reduce load and maximize

payments or credits to the customer, all while keeping the user comfortable and in control throughout.

This analogy will be used in all communications from Nest and our energy partners, on the web as well as in the Nest apps, to ensure a consistent user experience.

3. Highlights

- a. Rush Hour Rewards uses an algorithm that takes into account each home and HVAC system, the preferences of the occupants, whether they're home or not, and the weather. Then it dynamically adjusts the target temperature throughout the event. It achieves significant load reduction without impacting user comfort.
- b. The effectiveness of Rush Hour Rewards was estimated by using over 2,000 devices in Houston, TX from August 2012 to simulate how different comfort levels translate into different levels of load reduction.
- c. Preliminary Rush Hour Rewards trials were conducted and validated that a spectrum of comfort level versus load reduction capability of Rush Hour Rewards can be created. One of these trials, in which customer comfort was maintained and the average outside temperature was 80.2°F, yielded a point along that spectrum with a load reduction of 61%.
- d. Customers are allowed to change the temperature at any time while still achieving comparable load reductions. Field trial results shows that 87% of people felt they remained in control and only 10% felt their comfort wasn't preserved during the rush hour.

Rush Hour Rewards is marketed towards end customers from a trusted consumer brand that advocates for the best user experience. By being transparent with customers before, during, and after rush hours via notifications on their phone, tablet, and Nest Learning Thermostat, customers are more willing and able to participate. Then Rush Hour Rewards personalizes the experience for each customer. Through establishing and maintaining a great Rush Hour Rewards experience for the customer, we expect a virtuous cycle over the next few years to build upon, in which customers keep participating season after season and encourage others to join. This expansion of the installed base, in turn, will help shift more and more energy during critical rush hours. Keeping customers comfortable keeps them participating; then Nest will take care of the rest.

4. Full report

The full report is available to existing and future Nest partners by contacting Nest at nest.com/contact