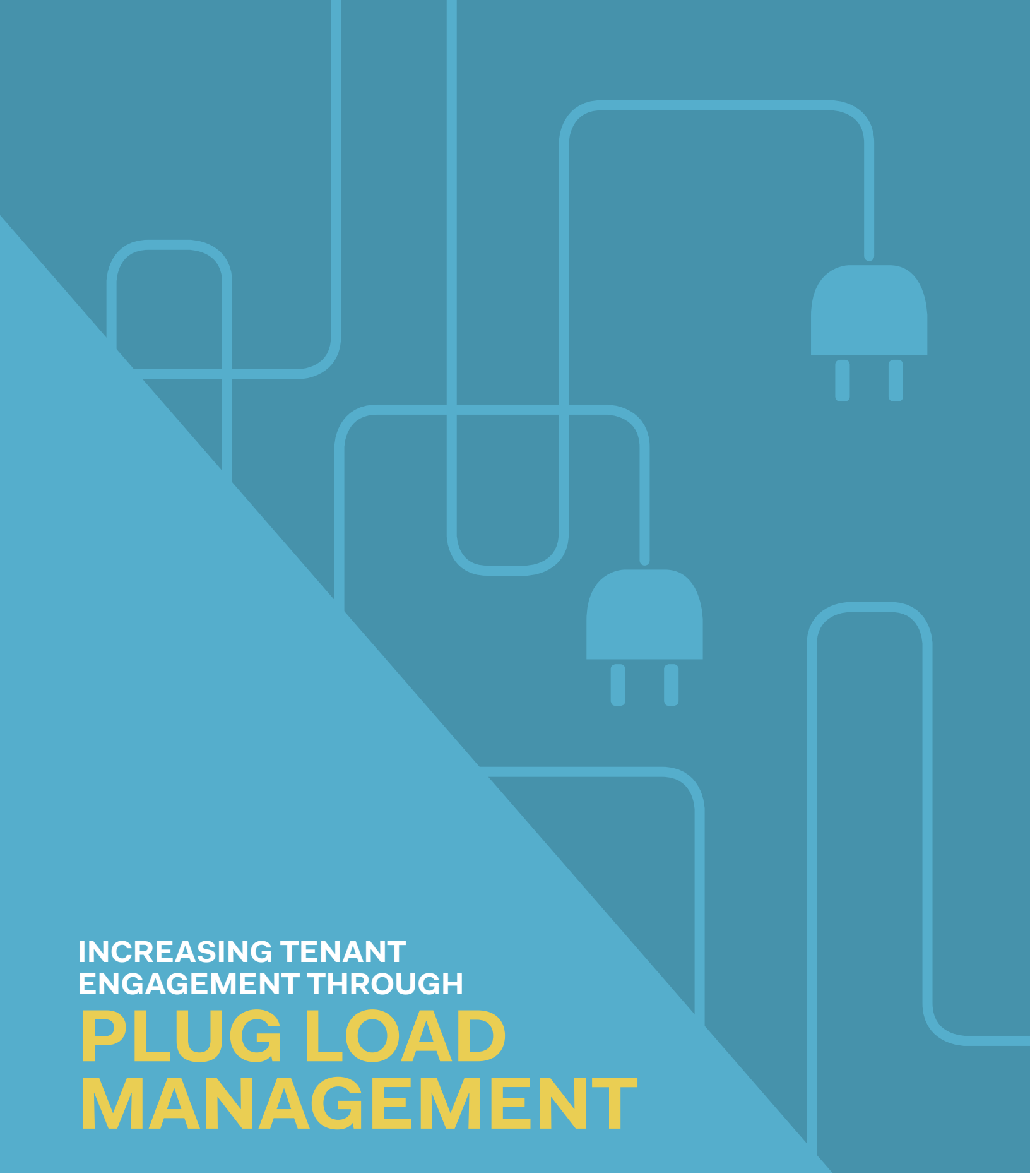
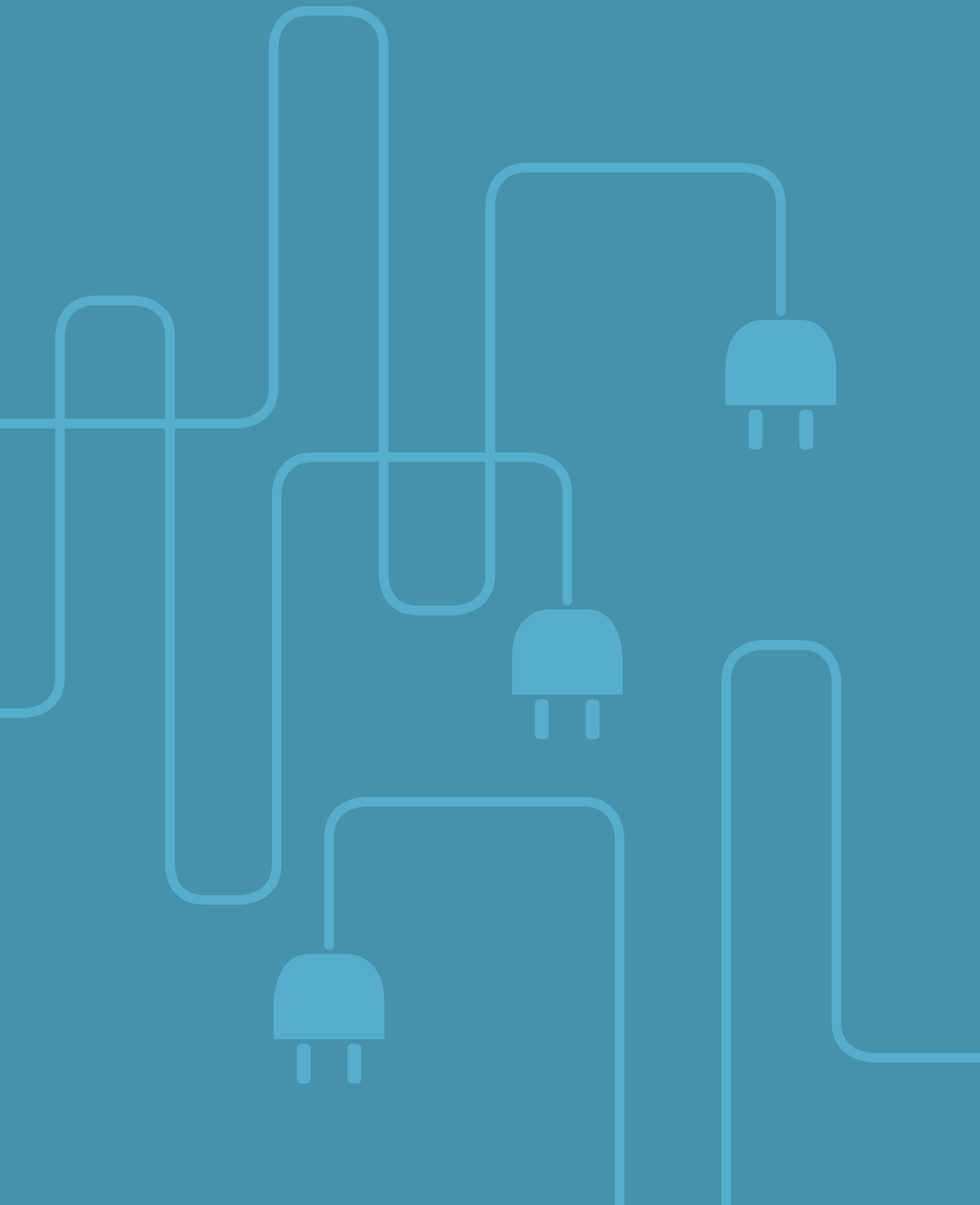


INCREASING TENANT ENGAGEMENT THROUGH PLUG LOAD MANAGEMENT

Alexandra Harry, LEED AP O+M
INSTITUTE FOR MARKET TRANSFORMATION



INCREASING TENANT ENGAGEMENT THROUGH PLUG LOAD MANAGEMENT

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Alexandra Harry, LEED AP O+M
INSTITUTE FOR MARKET TRANSFORMATION

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The District of Columbia Sustainable Energy Utility (DCSEU) funded this experiment, which focuses on lowering plug loads in commercial office spaces and understanding potential incentive structures for individual and business energy consumers. The Institute for Market Transformation (IMT), the DCSEU's teaming partner, managed the experiment with the following partners:

- The Tower Companies, agreed to hold the experiment at its property, the Millennium Building;
- Waypoint Building Group, provided plug load technical expertise;
- Aquicore, sub-metered and provided energy management software to monitor plug loads;
- TrickleStar, provided advanced power strips. The Millennium Building tenants, who agreed to be a part of the experiment; and
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Executive Summary

Introduction

Plug and process loads (PPLs) consume about one-third of energy in commercial buildings.[1] They can range from electronic devices and kitchen appliances to computers and other equipment that is commonly found in office buildings. These loads are often neglected by property owners seeking to lower utilities, while tenants have the most ability to control this particular energy end use. Because PPLs are such a large end use, good PPL management is a major key to reducing whole-building energy use.

As an environmentally conscious landlord, The Tower Companies (Tower), implemented a number of energy conservation measures (ECMs) at The Millennium Building, a multi-tenant office building in Washington, DC. To go beyond base building controls and reduce energy in tenant spaces, Tower sought out expertise from the Institute for Market Transformation (IMT), a DC-based nonprofit that promotes energy efficiency in buildings, and the Waypoint Building Group, a software and analytics provider for commercial real estate. IMT and Waypoint then conducted research at The Millennium Building to assess the cost and impact on energy usage from PPL management strategies over a 105-day period. For the commercial real estate market, this study presents PPL strategies and their associated energy savings, while also exploring the most cost-effective pathways to implementation. This study is meant to highlight the process and opportunities of PPL management rather than define a standard economic outcome, as several variables could affect the outcome on a case-by-case basis.

PPL Experiments

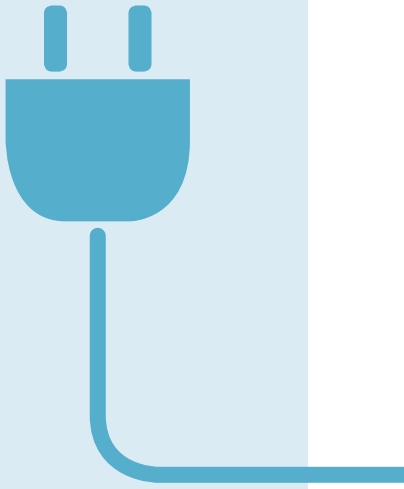
The plug load pilot team investigated measures to leverage the tenant-landlord relationship, while reducing whole-building energy usage. The study featured two different PPL experiments that leverage tenant-landlord relationships and appeal to other users seeking ECMs that are low- or no-cost and/or technologically advanced. The team focused on reducing typical plug loads from workstations, private offices, copy rooms, and break areas.

The experiment was conducted from August 2015 to November 2015, and consisted of three full- floor tenants that were individually metered for PPL electricity usage. One tenant participated in an experiment that incorporated education and messaging with behavioral change (Experiment 1), and another used Advanced Power Strips (APS) implementation (Experiment 2). The tenant in Experiment 1 was educated on best management practices to reduce PPLs. Experiment 2 included APSs, which operate in a similar manner to ordinary power strips, except these devices power down equipment that is not in use. The third tenant group was a control group. The team predicted that the APSs would produce greater PPL reductions than would messaging, as it is historically difficult to make durable changes to occupant behavior.

Results

The experiment's results showed that PPL management is best tackled using APS devices. The APS experiment had the biggest impact on PPL energy reduction at nine percent average reduction in PPL energy use per rentable full floor. These devices derived the majority of their savings during non-working hours such as late evenings, weekends, and holidays because they automatically power down connected computers and other equipment due to inactivity or schedule. Experiment 1 saved

The experiment found that PPL management was best tackled using APS devices, but would only yield an internal rate of return of one percent under "best-case" conditions in an occupied office space. However, in a tenant build-out scenario, labor costs and disruption for tenants could be lower and a return on investment could be higher.



[1] U.S Department of Energy: Better Buildings Alliance. "Plug and Process Loads". https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads

The experiment's initial uptake was dependent on the property's ability to get buy-in and interest from tenants and having an engaging and dedicated property management team.

no energy as compared to the control. In fact, Experiment 1's floor experienced a one percent increase in daily PPL usage over the 105 days. The absence of savings may have resulted from a disconnect between the audience profile, a law firm, and the messaging technique used. The small PPL usage increase may have been due to random variation.

Business Case

Most property owners will take initiatives to manage PPLs only if it will produce an attractive internal rate of return (IRR). A proper analysis should account for as many benefits and costs as practical, including labor costs, impact on tenant satisfaction, and other factors influencing tenant retention. This analysis includes all labor costs, but did not quantify key intangible factors, including impacts on brand, tenant satisfaction, and tenant retention. If a hypothetical property owner's PPL management initiative were to yield improvements in these areas, then the owner's IRR could be higher than the IRRs calculated below.

In this experiment, messaging was the least expensive (less than $2,000) option to implement for a full-floor tenant with 45 employees. But, it yielded no energy savings and cannot be recommended on the basis of this experiment. Including all labor costs and no incentives, the full APS experiment costs approximately $6,000 for a floor serving 46 employees. APS prices vary greatly based on volume and incentives. A best case scenario, which includes coupling utility incentives with tenant-landlord cost sharing could lower this experiment's cost to approximately $4,000, yielding an IRR of one percent.

This experiment involved tenants in an existing office space. The business case for a similar initiative at tenant build-out could be more attractive because the owner's labor costs and disruption for tenants would be lower. The reader should review this study's assumptions and calculations described in Appendix 4 and explore likely IRRs for their unique circumstances using **IMT's Excel spreadsheet**.

Conclusion

APSs were more effective at managing PPL end uses than messaging. To save energy, the experiment depended on an engaging and dedicated property management team to secure buy-in and interest from tenants. In all, this pilot achieved the landlord's main objectives of identifying a PPL control strategy that is both relatively easy to implement and impacts tenant energy use.

Introduction

According to the U.S. Department of Energy (DOE), plug and process loads (PPLs) consume about one-third of energy in commercial buildings. They can range from electronic devices and kitchen appliances to computers and other equipment that is commonly found in office buildings. PPLs are expected to increase by five percent in commercial office buildings between the years 2010 and 2025[2]. These loads are often neglected by property owners and tenants seeking to lower utilities, while tenants have the most ability to control this energy end use. This study is designed to bring awareness to PPLs and the strategies on how to reduce them.

The Tower Companies (Tower) involvement in the experiment and their long-lasting client relationships were instrumental. Tower sought out expertise from the Institute for Market Transformation (IMT), a DC-based nonprofit that promotes energy efficiency in buildings, and the Waypoint Building Group, a software and analytics provider for commercial real estate for solutions to reduce plug and process load energy in their multi-tenant office building, The Millennium Building. As a recognized leader in the industry and an environmentally conscious landlord, Tower has already implemented a number of energy conservation measures (ECMs) at The Millennium Building and they have committed their portfolio to the DOE's Better Buildings Challenge to reduce both energy and water use 20 percent by 2020. The ECMs implemented to date include, but are not limited to, LEED and ENERGY STAR Certifications, an engaging real-time energy management program, green lease requirements, common area lighting upgrades, base building equipment and controls upgrades, solar photovoltaic roof arrays, and a building green team. The building owner had already achieved significant energy savings through these energy efficiency programs, but had a desire to go beyond base building control and green lease construction requirements to reduce additional whole-building energy through tenant office operations and behavior change. To achieve this goal, Tower recognized opportunities to reduce whole-building energy by focusing on tenant plug load use. With IMT and Waypoint's input, Tower sought to investigate:

- Which PPL management strategies would have the greatest impact on whole-building energy usage?
- What PPL management strategies are the most cost effective?
- Is the PPL management strategy easily replicable with more tenants or other buildings in their portfolio and other landlord's portfolios?

To address Tower's questions, the plug load pilot team investigated measures to leverage and to strengthen the tenant-landlord relationship to reduce whole-building energy use through PPL management. Tenants had the opportunity to reduce PPLs in their spaces via targeted strategies, decrease heat generated by PPLs, and lower operational costs. Unlike previous studies that focus on owner-occupied PPL management, this study empowered tenants and owners to work together to control PPLs in a mixed-tenant office environment. More importantly, it analyzed whether owner-occupied PPL strategies yield similar results in a mixed-tenant environment. The study featured two different PPL experiments to appeal to Tower and other users seeking ECMs that are low- or no-cost and/or technologically advanced. The study represents one building and its landlord's real-life experience of creatively using PPL management to improve whole-building energy efficiency over a short time period. For the commercial real estate market, this study presents PPL strategies and their associated energy savings, while also exploring the most cost-effective pathways to implementation.

[2] U.S Department of Energy: Better Buildings Alliance. "Plug and Process Loads". https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads

Figure 1: The Millennium Building

THE MILLENNIUM BUILDING

The Millennium Building, 1909 K Street NW, is a multi-tenant commercial office building located in Washington, D.C.'s Golden Triangle Business District. The 240,000 square foot Class A office building was renovated in 1997 to be more energy efficient. The building has earned ENERGY STAR certification every year since 2010 and has a current score of 89 out of 100. The Millennium Building achieved LEED® certification in 2009 under the Existing Buildings v2.0 and received LEED Gold Re-certification in 2013 under EBOM v3. In 2015, the property received the Outstanding Building of the Year Ward in the Earth Building Category. The property is owned and managed by The Tower Companies.

Sub-metering Plug Loads
The owner had an existing sub-metering contract with Aquicore, an energy data analytics company, to meter several common area energy data and major HVAC end uses. For this experiment, Aquicore used its sub-metering technology to monitor energy consumption at the plug load level by isolating the low-voltage panels that are dedicated to the plug load on each floor. Aquicore's wireless, Internet of Things (IoT) sub-meters were deployed and gathering real-time data during the baseline and intervention periods of the experiment. Tenants were not disrupted as wireless meters do not require extensive hardwiring like traditional sub-meters.

APS TIMELINE

Experiment Feasibility Period (30 Days)	
8/18/2015	Building Surveyed for Likely PPL Management Candidates
9/1/2015	Tenant Floor Surveyed for Sub-Metering Capability
9/3/2015	Tenant Asked to Participate in PPL Experiment
9/17/2015	Experiment Participants Confirmed

Baseline Period (30 Days)	
9/18/2015	Start Baseline Period
9/18/2015	Sub-Meters Installed
9/18/2015	Team Tests APSs in Management Office
10/1/2015	Kick-off Meeting with Plug Load Champion
10/1/2015	Team Tests APSs in Management Office
10/14/2015	End Baseline Period

Intervention Period (45 Days)	
10/15/2015	Start Intervention Period
	Held Lunch & Learn
	Install APS Occupants Given Flyers
11/2/2015	Conduct Night Audit APS Troubleshooting
11/19/2015	Installed Additional APSs
11/25/2015	Experiment Ends

PPL Experiments

The experiment explored two PPL management approaches tested on full-floor tenants. Three full-floor tenants were individually metered for PPL data. The selected tenants at the test building, The Millennium Building, included two law firms and a financial institution. The tenants were selected in part because they represented typical Washington, DC office worker's attitudes toward energy efficiency and because it was easy to wire tenant electrical panels for plug load readings. One tenant participated in an experiment that incorporated education and messaging with behavioral change (Experiment 1), and another used Advanced Power Strips (APS) technology (Experiment 2). APSs operate in a similar manner to ordinary power strips, except these devices power down equipment that is not in use. For more information on these devices, refer to Appendix A. The third tenant group was a control group. The active intervention participants were asked and agreed to be part of the experiment, while the control group was not aware of the experiment. The team predicted the APSs would experience a larger impact on PPL reduction than messaging, as technological intervention tends to be greater than human intervention.

The experiment was conducted over a 105-day period from August 2015 to November 2015. Experiment feasibility and planning was tackled over 30 days and included confirming tenant participation and plug load sub-metering capabilities. A baseline period was conducted over 30 days to gather data points for average PPL use in the three tenant floors. Sub-metering was provided by Aquicore with kilowatt data provided on 15-minute intervals. The intervention period with messaging and APSs lasted 45 days. Three full-floor tenants with roughly 19,000 square feet of rentable area and approximately 45 employees each participated (Table 1).

TABLE 1: Square Footage, Employees and Operating Hours

Experiment	BOMA SF	Employees	Approx. Worker Operating Hours
Messaging	19,422	45	7/8am – 7pm
Control	19,420	42	7/8am – 7pm
Advanced Power Strip	18,780	46	9am – 7pm

APS Experiment

A financial institution participated in the APS experiment. Studies have shown that APSs have the ability to reduce plug load energy usage by 48 percent per month[3].

For this experiment, devices were chosen based on the DCSEU/ Vermont Energy Investment Corporation (VEIC) list of APS rebate-eligible products. Other device criteria included:

- Cost and Payback
- Safety
- Functionality
- User-Friendliness

[3] U.S. General Services Administration Public Building Service. "Plug Load Control: Findings 03, September 2012".

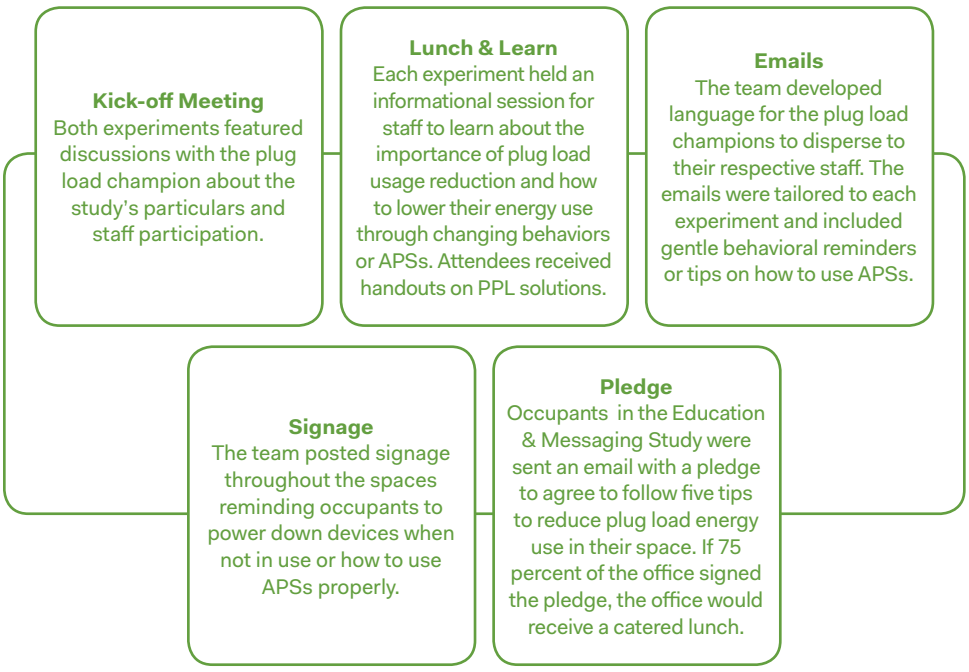
TrickleStar's TS1301 and TS1304 products were used for the experiment as they satisfied the criteria addressed above. Timer and occupancy sensors were used as both products were the most hands-off for tenants for Tower Companies' building-specific applications. For information about these products, refer to APPENDIX 1. Tower's property management, IMT, and Waypoint teams inventoried PPLs via tenant space walk-throughs and installed advanced power strips. Also key to the experiment was a tenant liaison, also known as the "plug load champion" who facilitated communication between property management and the staff.

Education & Messaging Experiment

The tenant, a law firm, selected to participate in the Education & Messaging study and was educated on best management practices to reduce PPLs. The team developed educational materials and an engagement plan on simple, no-cost solutions to reduce PPLs for all staff at the law office. Like the other tenants included in the study, this tenant also had its PPL usage metered. Property management, IMT, and Waypoint teams managed the messaging techniques while a plug load champion managed communications between tenant and landlord.

For more details about the engagement techniques used in both experiments, see Figure 2 below:

FIGURE 2: Methods of Engagement



Anomalies

During the experiment, certain data points were removed or re-calibrated during the data collection process. Other anomalies occurred due to office layout or installation. The issues are detailed in APPENDIX 3.

MESSAGING TIMELINE

Experiment Feasibility Period (30 Days)	
8/18/2015	Building Surveyed for Likely PPL Management Candidates
9/1/2015	Tenant Floor Surveyed for Sub-Metering Capability
9/3/2015	Tenant Asked to Participate in PPL Experiment
9/17/2015	Experiment Participants Confirmed

Baseline Period (30 Days)	
9/18/2015	Start Baseline Period
9/18/2015	Sub-Meters Installed
10/1/2015	Kick-off Meeting with Plug Load Champion
10/14/2015	End Baseline Period
10/1/2015	Team Tests APSs in Management Office
10/14/2015	End Baseline Period

Intervention Period (45 Days)	
	Held Lunch & Learn
10/15/2015	Installed Plug Load Signage
	Provided flyers
10/26/2015	Email Pledge to Staff
11/2/2015	Conduct Night Audit
11/17/2015	Email Pledge Reminder
11/25/2015	Experiment Ends

Results

The experiment's results showed that PPL management is best tackled using APS devices. The APS experiment had the biggest impact on PPL energy reduction. Through analysis of the data compared to the control, the team realized that messaging and incentives had virtually no impact on day-to-day PPL reduction, nor had an overall reduction impact.

TABLE 2: Plug Load Study Results

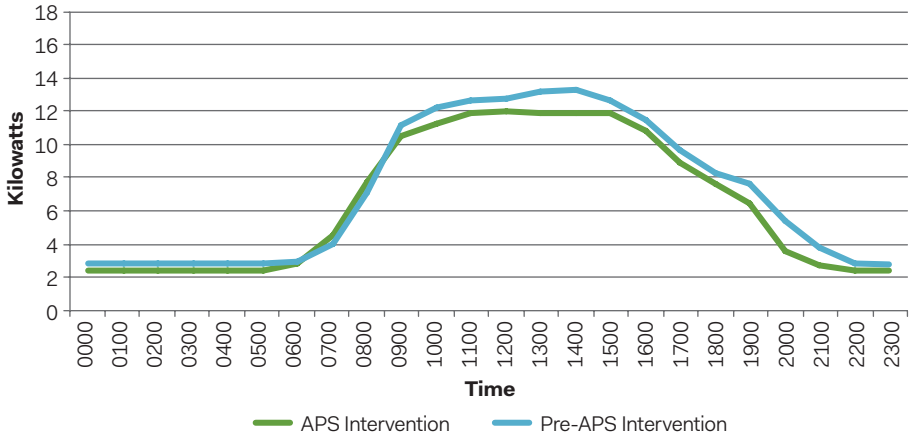
	Advanced Power Strips			Messaging			Control		
	Pre-Intervention	Intervention	Percent Change	Pre-Intervention	Intervention	Percent Change	Pre-Intervention	Intervention	Percent Change
Square Feet[4]		18,780			19,422			19,420	
Occupants		46			45			42	
Total PPL kWh	3,121	4,747		3,470	5,793		5,058	8,423	
Days	23	38		23	38		23	38	
Average PPL kWh use per day	136	125	-8.6%	151	152	1.0%	220	222	0.8%
PPL Watts per sq ft. per day	7.23	6.65	-8.6%	7.77	7.85	1.0%	11.3	11.4	0.8%
PPLKWH per occupant per day	2.95	2.72	-8.6%	3.35	3.39	1.0%	5.24	5.28	0.8%
Average Working Hours PPL KWH (M–F 700-1930)	135	127	-6.1%	116	118	1.4%	176	175	-1.0%
Average Non-Working Hours PPL KWH (M-F)	39	30	-28.7%	56	55	-1.9%	85	82	-4.5%
Average Working Day Usage PPL KWH (M–F)	173	157	-10.5%	172	173	0.3%	258	256	-0.7%
Average Non-Working Day PPL KWH (S–S)	65	55	-17.4%	111	108	-2.3%	149	147	-1.3%

Analysis

After reviewing the initial results, conclusions can be made about the effectiveness of each experiment's tactics. As mentioned earlier, the APS intervention proved to be the most effective in managing plug loads. These devices derive the majority of their savings during non-working hours such as late evenings, weekends, and holidays—29 percent for evening workdays and 17 percent for weekends—because they automatically power down connected devices due to inactivity (occupancy sensor power strips) or schedule (timer power strips). This trend becomes more evident when viewing average PPL use over the course of work day. The energy used during the APS experiment in Figure 3 shows the general decrease of energy use during the typical working day. Notice that the greatest reduction in kilowatts (1.9 kilowatts) occurred around 8:00 PM, an hour after the building's operating hours (7:00 AM–7:00 PM), which aligns with the early conclusion that APSs work most effectively during non-working hours.

[4] Square footage values are in Building Owners and Managers Association (BOMA) square feet.

FIGURE 3: APS- Average Rentable Floor Working Day Plug Load Usage



The APS experiment results show a decrease in energy use intensity on an hourly basis, yet the messaging experiment shows no decrease in energy intensity. In fact, the results of the messaging experiment mirror the control results, which again demonstrate that the messaging experiment's energy reduction was nominal.

APSs derive the majority of their savings during non-working hours such as late evenings, weekends, and holidays (29 percent for evening workdays and 17 percent for weekends).

FIGURE 4: Control- Average Rentable Floor Working Day Plug Load

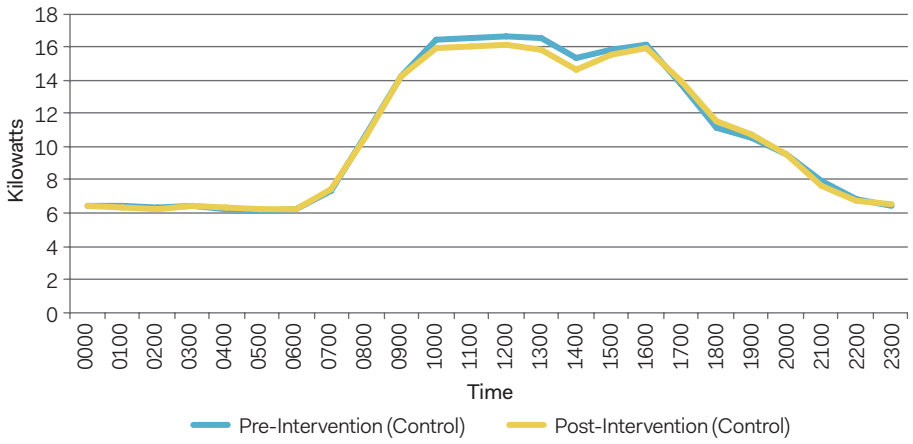
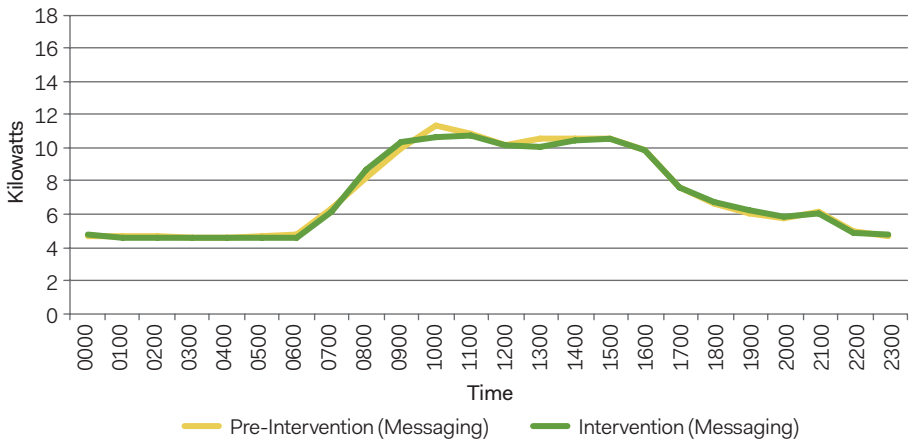


FIGURE 5: Messaging- Average Rentable Floor Working Day Plug Load Usage



When each round of messaging technique is analyzed independently, it also becomes clearer that the methods were not effective at influencing human behavior.

When each round of messaging technique is analyzed independently, it also becomes clearer that the methods were not effective at influencing human behavior. The only noticeable savings occurred during the first round of messaging. Most notably, during this period, weekend energy use decreased by eight percent when compared to the previous week's usage, representing that the occupants were mindful to turn-off devices before leaving for the weekend.

The subsequent messaging techniques (Pledge Incentives) saw slight increases in energy use. 22 percent of the occupants (10 occupants) had signed the plug load pledge, which was significantly short of the 75 percent response rate goal. The absence of savings may have resulted from a disconnect between the audience profile—a law firm, and the messaging technique used. The small PPL usage increase may have been due to random variation.

TABLE 3: Short-Term Impact of Messaging Techniques

	Trailing 7 Days	7 Days (KWH)	Percent Change
Lunch & Learn, Signage, Handouts (10/15/15)			
Total KWH	1,068	1,056	-1.1%
Average KWH	153	151	-1.1%
Working Day KWH	840	844	0.5%
Working Day off hours KWH	268	266	-0.8%
Weekends KWH	228	211	-8.3%
Email Pledge to Staff (10/26/15)			
Total KWH	1,045	1,081	3.3%
Average KWH	149	154	3.3%
Working Day KWH	834	860	3.0%
Working Day off hours KWH	269	264	-1.9%
Weekends KWH	211	221	4.5%
Email Pledge Reminder (11/17/15)			
Total KWH	1,045	1,084	3.6%
Average KWH	149	155	3.6%
Working Day KWH	824	870	5.3%
Working Day off hours KWH	224	277	19.2%
Weekends KWH	221	214	-3.4%

All told, plug load management with APSs yields an average savings of 11 kilowatt hours per day or a decrease of nine percent in plug load energy use per full floor rentable area. This result falls short of other publicized results such as the U.S. General Services Administration (GSA) study, which achieved 48 percent in plug load savings. One major difference between this study and the GSA study was this study measured all plug loads in the tenant space including computers, monitors, server rooms, refrigerators and commercial printers—while the GSA study only measured plug loads connected to APS devices such as laptops, monitors, and desk lamps. Other possible reasons that this pilot experiment less savings than GSA's study results include the experiment length, APS device choice, and experiment anomalies.

Recommendations

Based on the experiment team's experience, here are the recommendations and lessons learned that proved useful over the course of the experiment.

- *Start Planning Early*
  When conducting a plug load study, consider length of experiment and time of year. Avoid times of year when the building is the least occupied, such as summer and holidays, which may skew results.

- *Survey Building for Plug Load Sub-metering*
  Complete an inventory of electrical rooms to understand floor-by-floor wiring and electrical rooms as a first step to understanding the existing infrastructure in a building to prepare the building for plug load sub-metering.

- *Identify a Plug Load Champion*
  Select an occupant in the tenant space that will champion the cause. This plug load champion should be someone who has interest in saving energy and is well-connected to internal staff and can serve as the main contact point between tenants and property management.

- *Get Approval from Tenant Executive Staff*
  With the plug load champion, present the energy conservation opportunity to the tenant's leadership team. Offer to allow the tenant to keep signage or APSs.

- *Educate Tenant Staff*
  Demonstrate the value proposition of PPL management to tenant staff through a suite of educational techniques such as a lunch & learns, signage, reminder emails, and pledges.

- *Educate Property Management and Engineering Staff on PPL Management*
  Ensure that all property management and maintenance staff understand how to install and troubleshoot APSs and are familiar with the layout of the tenant's space. If pursuing messaging, educate property management on best management practices for PPLs. Identify a point person or a management plug load champion for the building so they can coordinate with the tenant directly.

- *Conduct Installation during Off-Hours*
  Cut down on lost occupant productivity time. If allowable, offer to complete the power strip or messaging installation during off-hours.

- *Select Appropriate APS devices for All Office Scenarios*
  During the experiment, the experiment team found the timer power strip device was programmable only for a standard 24-hour day and could not be scheduled to accommodate different days of the week such as weekends and holidays. As a result, the timer power strips in the common areas needed to be reprogrammed prior to the weekend. If replicating the project, select APS devices that allow for more programmability and hands-off feasibility.

- *Adjusting Messaging Techniques*
  The strategies used in the experiment focused on adjusting attitudes and increasing knowledge about PPL management and little on building relationships. According to *Fostering Sustainable Behavior*[5], relationship building is the biggest influencer

[5] McKenzie-Mohr, Doug. *Fostering Sustainable Behavior: An Introduction to Community-based Social Marketing*. New Society Publishers: Gabriola Island, BC, Canada, 2011.

when it comes to changing behavior. Interested owners should focus on developing messaging techniques that build relationships with multiple tenant stakeholders across varied levels in the tenant space.

- *Conduct Night Audits*
  Early on, conduct a night audit to verify that messaging or APSs are functioning according to plan. After the night audit, meet with the plug load champion to discuss findings and troubleshooting techniques.

Business Case

As established, PPL management with APSs is more effective than modifying behavior though messaging. To make this ECM scalable and practical for a wide range of property owners and tenants, it is important to understand the experiment team's return on investment and total cost of ownership for this pilot test.

Most property owners will take initiatives to manage PPLs only if it will produce an attractive internal rate of return (IRR). A proper analysis should account for as many benefits and costs as practical, including labor costs, impact on tenant satisfaction, and other factors influencing tenant retention. These analyses includes all labor costs, but did not quantify key intangible factors, including impacts on brand, tenant satisfaction and tenant retention.

Messaging Experiment Cost

While this experiment did not achieve any energy savings for this experiment, this PPL strategy is relatively easy to implement as equipment costs, management costs, and tenant productivity losses are much lower than the APS experiment. In this scenario, tenant time and productivity loss is estimated to be roughly $1,052 per full floor-suite. To see the full financial breakdown of the messaging and APS experiments, please view Appendix 4.

TABLE 4: Cost to Implement Messaging

Messaging	Cost per Tenant Floor
Printing Expenses	$34
Management Time	$1,190
Graphic Designer	$441
Catering for Lunch & Learn	$250
Total	**$1,912**

APS Experiment Cost

To generate an estimate for the total cost to implement the APS experiment, the experiment team discovered bottom line costs hinged on two key variables:

- APS Cost: the APS cost is the most expensive line item and the price of each device can vary greatly from the listed manufacturer's suggested retail price (MSRP) especially when several devices are purchased in bulk. On average, the devices cost $25-$50. In fact, the experiment team paid 30 percent of the MSRP cost. Utility incentives and a cost sharing techniques can also bring this cost down.
- Staff Hours: The team faced some obstacles during the installation process. When the recommendations above are taken into account, staff hours could be trimmed significantly.

Three scenarios, worst case, likely case, and best case, are modeled below based on varied APS cost scenarios. Tenant time and productivity loss is estimated to be roughly $2,250 per full floor-suite.

Worst Case Scenario: MSRP

This scenario models the APS implementation cost at full-price and is the worst case scenario. In this worst-case scenario, the rate of return (ROI) is -7 percent and the payback period is approximately 15 years which exceeds the 10-year lifespan of the device by 150 percent.

Likely Case Scenario: Utility Incentives

If building owners wish to replicate this study in the District of Columbia, the APSs may be eligible for a $20 rebate*. These rebates reduce the cost of APSs down to the cost of a standard (non-advanced) power strip. Several other utilities across the country offer similar programs. This likely case scenario can achieve a ROI of -3 percent and has a payback period of approximately 12 years.

Best Case Scenario: Utility Incentives + Expense Sharing

In this scheme, a landlord uses the utility incentives and tenant expense sharing to lower costs and improve the ROI and payback period. To overcome the split incentive between landlord and tenants, both parties could commit to an energy savings sharing arrangement, whereby, the cost of APS installation is shared between parties and/or savings are split between parties. This may depend on the agreed upon lease and operating costs structure.

In this example, the landlord agrees to cover the incremental cost of a tenant's APSs, while the tenant agrees to cover the remaining costs of the APSs. In this scenario, because typical power strips are approximately $20 each, incentives are $20 per strip, and APSs are $40 each, when factored all together, the total cost of the APS effectively becomes $0. This best case scenario yields a 1 percent return and a 10 year payback period.

The table below covers all three scenarios.

If building owners wish to replicate this study in the District of Columbia, the APSs may be eligible for a $20 rebate.*

TABLE 5: Cost to Implement APSs

	Worst Case	Likely Case	Best Case
APS Cost			
APS Cost (MSRP)	$2,119	$2,119	$2,119
Utility Incentives		-$1,240	-$1,240
Cost Sharing			-$1,240
APS Subtotal Total	**$2,119**	**$879**	**$0**
Management Costs	$3,145	$3,145	$3,145
Graphic Designer	$441	$441	$441
Miscellaneous	$284	$284	$284
Total Experiment Cost	**$5,990**	**$4,750**	**$3,871**
Average Annual Energy Savings	**$402**	**$402**	**$402**
ROI	**-7%**	**-3%**	**1%**
Payback	**14.92**	**11.83**	**9.64**

*APS incentives were available as of Fiscal Year 2016

Other Considerations

To earn a better return, lower overhead costs and shorten the payback period, tenant engagement and APS installation may be better implemented during tenant fit-out. Installation at tenant fit-out may be the ideal scenario for APSs from a financial and management productivity standpoint. In this scenario, this ECM would be added as a guideline in the lease agreement or included as part of tenant improvement allowance negotiations. For tenants considering this option, APS incentives and/or landlord cost-sharing can be less than or equal to the anticipated cost of new standard power strips.

The reader should review this study's assumptions and calculations described in Appendix 4 and explore likely IRRs for their unique circumstances using **IMT's Excel spreadsheet**.

Conclusion

APSs were more effective at managing PPL end uses than messaging. Based on this study, on average, APSs reduced PPL energy usage by nine percent in office spaces versus the unpredictable messaging route. More importantly, the results of the study confirm that owners in mixed-tenant situations can achieve energy savings as other landlords in owner-occupied buildings like the GSA study. For owners in mixed-tenant situations like The Tower Companies, the key to PPL management success is gaining buy-in and interest from tenants and having an engaging and dedicated property management team.

"The Tower Team learned a lot about implementing APSs in office spaces and how to be most effective when engaging with tenants to reduce energy."

—Eugenia Gregorio, Director of Corporate Responsibility, The Tower Companies

While this pilot experiment's business case seems less desirable, APS costs and staff hours are the biggest variables that affected this experiment's bottom line. Commercial owners inspired by this experiment should complete their own sensitivity analysis to determine their particular business cases. For higher returns and shorter paybacks, sharing installation costs or pass-through savings with tenants can tip the owner's scale to making a PPL project an easier adoptable solution. In addition, owners in mixed-tenant situation can use local incentives, while following this experiment's lessons learned to yield better returns. Lastly, tenants and landlords can develop a viable business case by considering this ECM as a tenant improvement allowance upon tenant build-out.

In a short time period, the experiment achieved the landlord's main objectives of identifying a PPL control strategy that is both relatively easy to implement and impacts tenant energy use. With an extended timeline, the results of the study could achieve deeper APS energy savings or even energy savings from the messaging experiment. Messaging techniques could be altered to achieve deeper results. In future experiments, a tenant could pilot a combined messaging and APS intervention in effort to achieve deeper energy savings. Building upon the lessons learned, if the experiment scales, the experiment team anticipates less productivity losses and better returns on investment. The Tower Companies had this to say about their involvement:

> *"The Tower Team learned a lot about implementing APSs in office spaces and how to be most effective when engaging with tenants to reduce energy. We were very happy to contribute to a project that will be a wonderful resource for our company moving forward and for the industry as a whole."*
>
> *—Eugenia Gregorio, Director of Corporate Responsibility, The Tower Companies*

In all, this study represents one landlord's experience leading the charge to test drive vetted solutions to PPL management.

Appendix

APPENDIX 1: APS Devices

APSs Basics

Unlike typical power strips, APSs have increased functionality to combat PPLs. All APSs have outlets that are designated as primary outlets, secondary outlets, and always-on outlets. Primary outlets act as the master outlet because it cuts off power to the secondary outlet when the primary outlet is turned off. In an office environment, computers and laptops are designated to primary outlets. Secondary outlets are the controlled outlet as these outlets are controlled by the primary outlet. When the primary outlet turns off, the secondary ones turn off automatically. Monitors, printers, and desk lamps are common secondary outlets found in an office situation. Lastly, always-on outlets are not controlled by the primary outlet and receive constant power. These outlets are reserved for critical devices such as landline phones, and miniature refrigerators.[6]

APSs USED IN EXPERIMENT

		
Type	Timer Power Strip TrickleStar TS1304	Motion Sensor Power Strip TrickleStar TS1301
Functionality	These power strips automatically turn off outlets based on a pre-set schedule on the dial, determined by the management team who installs the APSs.	These power strips are controlled by a motion sensor. After a pre-determined period of no activity in the room (e.g. 30 minutes), secondary outlets power down.
Location	Common areas	Workstations

[6] National Renewable Energy Laboratory. "Advanced Power Strips (APS): How to Use in an Office Setting". http://www.nrel.gov/docs/gen/fy15/63800.pdf

APPPENDIX 2: Tenant Education and Messaging

APS Informational Handout: Motion Sensor APS

HOW TO USE YOUR ADVANCED POWER STRIP (APS)

Motion

THE TOWER COMPANIES

Each Advanced Power Strip (APS) has three outlet types for equipment with various electricity needs:

1. Control Outlet: Computer/Laptop

- Acts as the "control," or "master," outlet.
- Turns off the power to secondary outlets when the device connected to it is turned off/put to sleep and/or no motion is detected for 30 minutes, but it will NOT shut down your computer.
- Typically powers your computer's central processing unit because most other devices connected to the power strip at an office desk depend on your computer for their functionality.

2. Switched Outlets: Monitor/Printer/Phone Charger/Lamp/Speakers

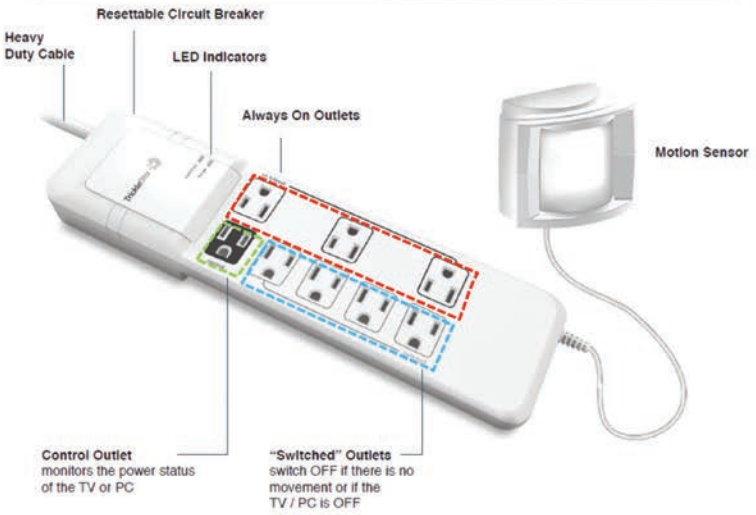
- Act as the outlets "controlled" by the device plugged in to the control outlet and/or the motion sensor.
- When the device connected to the primary outlet is turned off, goes to sleep, or no motion is detected for 30 minutes, the power will automatically be shut off to the devices connected to the secondary outlets.

3. Always-On Outlet: Landline Phone/Clock-Radio

- Remains on all the time
- Not affected by the control outlet or the motion sensor.

Do's and Don'ts for your motion sensor APS

Do	Don't
✔ Plug all your electrical devices into the APS!	✖ Unplug or disconnect your APS from the power outlet!
✔ Let your APS do the work for you! Simply walk away and the motion sensor will turn off your peripheral devices.	✖ Turn off your APS via the circuit breaker.
✔ Ensure that the motion sensor is placed so that it can detect your movement.	✖ "Daisy Chain" – i.e. don't plug one APS into another.



APS Informational Handout: Timer APS

HOW TO USE YOUR ADVANCED POWER STRIP (APS)

Timer

THE TOWER COMPANIES

Overview: Your 8-Outlet Timer Controlled Power Strip
This surge-protected power strip is perfect for the office – simply set the timer to turn off appliances and equipment that is not needed during working hours! Ideal items to plug into this power strip include, but are certainly not limited to: printers and copiers, automatic pencil sharpeners, coffee machines, microwaves, common-space lighting, and much more.

Time-Controlled Outlets – Printers/Copiers/Coffee Machines/Microwaves/Toasters

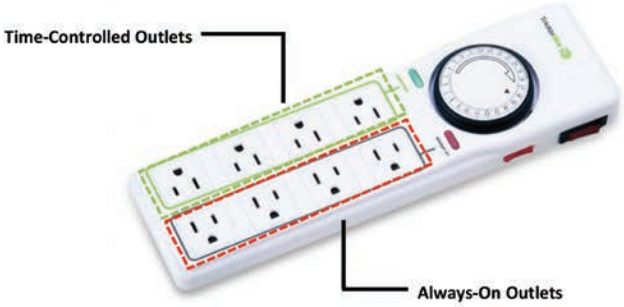
- Appliances plugged into the time-controlled outlets will turn off automatically within the set time period.
- There is no weekend setting for these outlets. Devices must therefore be turned off before leaving for the weekend!

Always-On Outlets – Landline Phones/Fax Machines/Refrigerator/Vending Machine

- Appliances plugged into the time-controlled outlets will turn off automatically within the set time period.

Do's and Don'ts for your timer APS

Do	Don't
✓ Plug common-use electrical appliances into the APS!	✗ Unplug or disconnect your APS from the power outlet!
✓ Before leaving for the weekend, turn off all devices plugged into the time-controlled outlets.	✗ Plug all devices into the always-on outlets.
✓ On Mondays, turn the devices back on and the power strip will take over again for the week!	✗ "Daisy Chain" – i.e. don't plug one APS into another.



Messaging Information Handout
Posted in Common Areas and inserted in Occupant Mailboxes

HELP SAVE ENERGY BY REDUCING YOUR OFFICE PLUG LOAD

What Are Plug Loads?

Any device that is plugged into the electrical system – that means **anything with a plug**, microwaves, computers, monitors, lamps, printers, and much more.

Why Care About Plug Loads?

According to the EPA and the US EIA, plug loads can **account for up to 30% of the average office building's electrical usage.**

- Each year, plug loads from office buildings equal the GHG emissions from 48.2 million cars!
- By 2035, plug loads will constitute the majority of U.S. electricity use.
- A 47% reduction in plug loads is equivalent to saving the power output of all U.S. nuclear power plants, or all Middle Eastern oil imports.

Top 5 Tips to Help You Reduce Your Plug Load

Before leaving the office…

1. Unplug your phone charger!
2. Turn off your monitor and computer!
3. Unplug all small electronics (e.g. radios, pencil sharpeners, calculators, etc.)
4. Turn off task lighting (e.g. small desk lamps)
5. Turn off common area electronics (e.g. printers, coffee machines, toasters, etc.)

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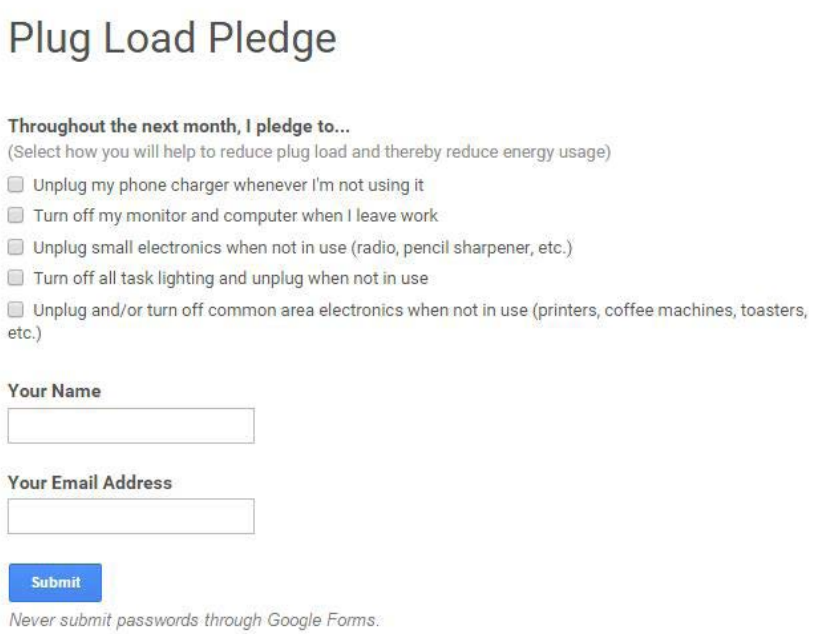
Messaging Signage
Posted in Common Areas

Internet Pledge for Messaging Experiment
Emailed to Occupants



Plug Load Pledge

Throughout the next month, I pledge to...
(Select how you will help to reduce plug load and thereby reduce energy usage)

- ☐ Unplug my phone charger whenever I'm not using it
- ☐ Turn off my monitor and computer when I leave work
- ☐ Unplug small electronics when not in use (radio, pencil sharpener, etc.)
- ☐ Turn off all task lighting and unplug when not in use
- ☐ Unplug and/or turn off common area electronics when not in use (printers, coffee machines, toasters, etc.)

Your Name

Your Email Address

Submit

Never submit passwords through Google Forms.

APPENDIX 3: Anomalies

Holidays & Low Occupancy Days

The following holidays and low-occupancy days were noted and removed from the data collection process.

Baseline Period	
9/23/2015	Pope Francis's Visit to D.C.
9/24/2015	Pope Francis's Visit to D.C.
10/12/2015	Columbus Day
Intervention	
10/15/2015	APS and messaging administered mid-day
11/2/2015	Teacher work day
11/11/2015	Veteran's Day
11/16/2015	Road closure

Daylight Savings Time

Daylight Savings Time was November 1, 2015. October 31, 2015 had 25 hours. To account for the anomaly, that day's kilowatt hours were averaged over a 24-hour period.

The timer APSs, manually set to specific office work schedules, also needed to be adjusted manually after daylight savings time to account for the 1-hour change. This motivated certain occupants to override the APSs and plug the devices into the "always on" outlet instead of the "secondary" outlets. The management team identified and corrected this during the mid-experiment Night Audit.

Devices Not in Study

During the APS installation process, some workstations, printers and appliances were not connected to APSs. These reasons included:

- High-voltage, high-volume printers, where the power draw was too high for APSs (two count)
- Refrigerators, where the power draw was too high for APSs (one count)
- Vending machines, where the power draw was too high for APSs (one count)
- Workstations where the occupant opted out of the experiment (one count)
- Workstations where furniture configuration created disruption (three count)

APS Device Malfunctions

Over the course of the experiment, two APSs malfunctioned. The secondary outlets failed to operate properly due to malfunctioning motion sensors. At two workstations, computers were plugged into the control outlet and desk lamps and monitors were placed into the secondary outlets. The desk lamps and monitors failed to power on when the computer was turned on. When notice of these malfunctions occurred, the power strips were first troubleshooted by re-setting the APSs, and if that did not solve the problem, they were replaced with new APSs.

APPENDIX 4: Business Case
Messaging Experiment

Tenant Floor			
Messaging			
	No./ Hours	**Rate**	**Total**
Management Time[7]			
Property Manager (2)	10	$29.92	$299
Day Porter (1)	0.5	$16.45	$8
Sustainability Director (1)	15	$55.11	$827
Engineer (4)	2	$27.92	$56
Subtotal	27.5		$1,190
Miscellaneous			
Catering	1	$250.00	$250
Printing Expenses	150	$0.01	$1
Lamination	11	$3.00	$33
Subtotal	162		$284
Consultant			
Graphic Designer/ Intern (1)	20	$22.07	$441
Subtotal	20		$441
Total			**$1,916**
Tenant Productivity Loss[8]			
Tenant Down Time	44	$40.82	$1,796
Executive Secretary	5	$26.69	$133
Subtotal	49		$1,930

Savings Per Day KWH	-1.58
Savings Per Day $	$ (0.17)
Savings Per Year	$ (63.44)

Messaging Experiment	
IRR	-
Payback Period (Years)	-30.20

[7] For the messaging experiment, management time was used to print and distribute educational materials, and educate tenants on PPL best management. *U.S. Bureau of Labor Statistics*.

[8] The team estimated that one-half hour per occupant (45 occupants $40.82/hr.) was used to attend the Lunch and Learn, while the Plug Load Champion (Executive Secretary) used 5 hours toward the project ($26.69/hr.). *U.S. Bureau of Labor Statistics.*

APS Experiment

	Tenant Floor		
	APS Experiment		
	No./ Hours	**Rate**	**Total**
Least Economical Case			
APS Experiment[9]			
Timer Power Strips (MSRP)	12	$29.99	$360
Occupancy Power Strips (MSRP)	44	$39.99	$1,760
Subtotal	56		$2,119
Management Time[10]			
Property Manager (2)	25	$29.92	$748
Sustainability Director (1)	35	$55.11	$1,929
Day Porter (1)	3	$16.45	$49
Engineer (4)	15	$27.92	$419
Subtotal	78		$3,145
Miscellaneous			
Catering	1	$250.00	$250
Printing Expenses	150	$0.01	$1
Lamination	11	$3.00	$33
Subtotal	162		$284
Consultant			
Graphic Designer/ Intern (1)	20	$22.07	$441
Subtotal	20		$441
Total			**$5,990**

[9] Each occupant was given one occupancy sensor power strip and the common area devices were covered by 12 timer power strips.

[10] The property management staff helped install troubleshoot and coordinate the APS experiment with its tenant. *U.S. Bureau of Labor Statistics.*

	No./ Hours	Rate	Total
Likely Economical Case			
Tenant Incremental Payment			
Power Strips[11]	62	$(20.00)	$(1,240)
Subtotal	62		$(1,240)
Total Incremental Cost			**$4,750**
Best Economical Case			
APS Incentives[12]			
Timer Power Strips	12	$(20.00)	$(240)
Occupancy Power Strips	50	$(20.00)	$(1,000)
Subtotal	62		$(1,240)
Total Increment Cost + Incentives			**$3,871**
Tenant Productivity Loss[13]			
Tenant Down Time	46	$40.82	$1,878
Executive Secretary	15	$26.69	$400
Subtotal	61		$2,278

Savings Per Day KWH	11
Savings Per Day $	$1.10
Savings Per Year	$402

APS Experiment			
	APS	APS Incremental Cost	APS Incremental Cost + Incentives
IRR	-7%	-3%	1%
Payback Period (Years)	14.9	11.8	9.6

[11] The average cost of a power strip was estimated to be $20 per device.

[12] Utilities such as the DCSEU offer rebates for APSs of approximately $20 per device.

[13] For this experiment, the tenant plug load champion or the executive secretary was very hands-on during the installation of the APSs. For all staff, downtime was estimated to be 1 hour per occupant for IT downtime and the Lunch & Learn. *U.S. Bureau of Labor Statistics.*

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