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Case in Point : Oregon's Recent Efforts to Reduce Plug Load Energy Consumption

July 22, 2020

1:00 – 2:00 pm EDT

Plug and Process Loads Technology Research Team

Technical Team Lead:
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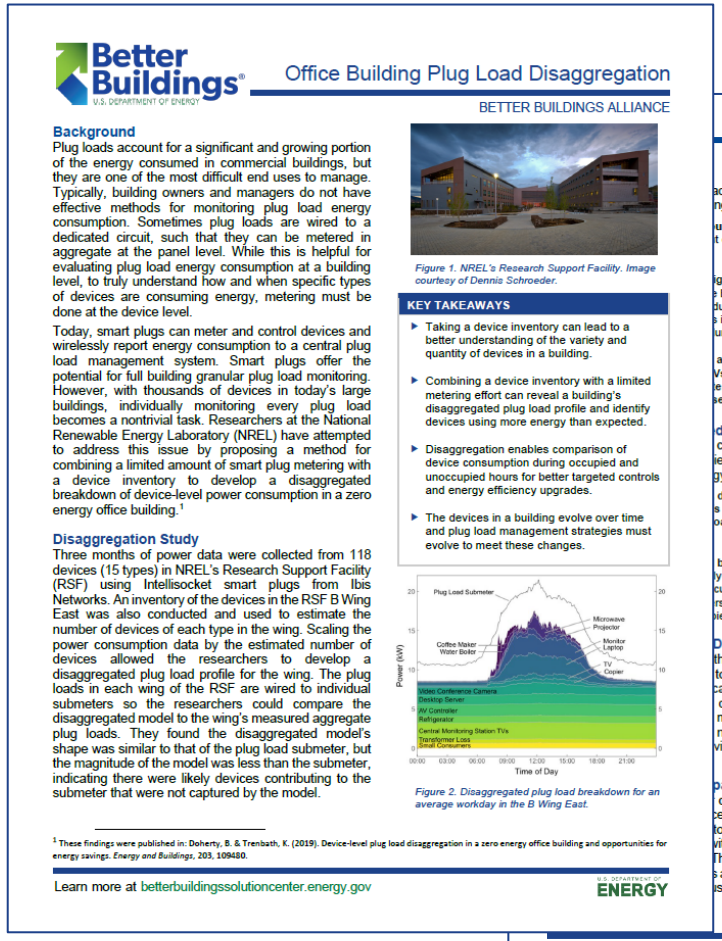
Plug and Process Loads Technology Research Team

Making U.S. commercial buildings more efficient through plug and process loads.

Check out our website and explore our resources!

https://betterbuildingssolutioncenter.energy.gov/alliance/technology-solution/plug-process-loads

- Plug load disaggregation fact sheet
- Paper on Emerging Technologies for plug load management in 2020 ACEEE conference proceedings
- Guides for assessing and reducing plug loads
- Utility incentives
- Recorded webinars



Better Buildings® U.S. DEPARTMENT OF ENERGY

Office Building Plug Load Disaggregation

BETTER BUILDINGS ALLIANCE

Background

Plug loads account for a significant and growing portion of the energy consumed in commercial buildings, but they are one of the most difficult end uses to manage. Typically, building owners and managers do not have effective methods for monitoring plug load energy consumption. Sometimes plug loads are wired to a dedicated circuit, such that they can be metered in aggregate at the panel level. While this is helpful for evaluating plug load energy consumption at a building level, to truly understand how and when specific types of devices are consuming energy, metering must be done at the device level.

Today, smart plugs can meter and control devices and wirelessly report energy consumption to a central plug load management system. Smart plugs offer the potential for full building granular plug load monitoring. However, with thousands of devices in today's large buildings, individually monitoring every plug load becomes a nontrivial task. Researchers at the National Renewable Energy Laboratory (NREL) have attempted to address this issue by proposing a method for combining a limited amount of smart plug metering with a device inventory to develop a disaggregated breakdown of device-level power consumption in a zero energy office building.[1]

Disaggregation Study

Three months of power data were collected from 118 devices (15 types) in NREL's Research Support Facility (RSF) using Intellisocket smart plugs from Ibis Networks. An inventory of the devices in the RSF B Wing East was also conducted and used to estimate the number of devices of each type in the wing. Scaling the power consumption data by the estimated number of devices allowed the researchers to develop a disaggregated plug load profile for the wing. The plug loads in each wing of the RSF are wired to individual submeters so the researchers could compare the disaggregated model to the wing's measured aggregate plug loads. They found the disaggregated model's shape was similar to that of the plug load submeter, but the magnitude of the model was less than the submeter, indicating there were likely devices contributing to the submeter that were not captured by the model.

Figure 1. NREL's Research Support Facility. Image courtesy of Dennis Schroeder.

KEY TAKEAWAYS

- Taking a device inventory can lead to a better understanding of the variety and quantity of devices in a building.
- Combining a device inventory with a limited metering effort can reveal a building's disaggregated plug load profile and identify devices using more energy than expected.
- Disaggregation enables comparison of device consumption during occupied and unoccupied hours for better targeted controls and energy efficiency upgrades.
- The devices in a building evolve over time and plug load management strategies must evolve to meet these changes.

Figure 2. Disaggregated plug load breakdown for an average workday in the B Wing East.

[1] These findings were published in: Doherty, B. & Trenbath, K. (2019). Device-level plug load disaggregation in a zero energy office building and opportunities for energy savings. *Energy and Buildings*, 203, 109480.

Learn more at betterbuildingssolutioncenter.energy.gov

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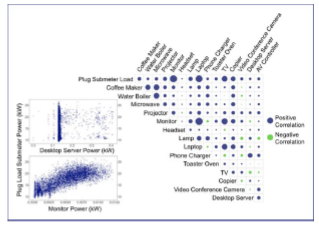

Figure 3. (Left) Scatterplots demonstrating the relationship between the plug load submeter, desktop server, and monitors. (Right) Graphic of Spearman rank correlation coefficients. Larger circles indicate stronger correlation.

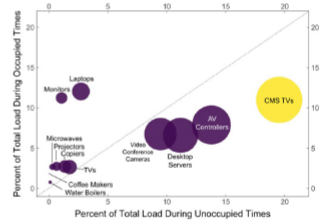

Figure 4. Mean power consumption as a percentage of the mean total plug load power in the B Wing East during occupied times (9 a.m. to 5 p.m.) and unoccupied times (9 p.m. to 5 a.m.). Purple indicates metered data and yellow indicates estimated data.

Conclusion

This study demonstrated that a device inventory and a limited device-level metering effort can produce a disaggregated plug load breakdown, uncovering energy savings opportunities. This study is limited to the RSF, however, and should be validated in other buildings to see if the method is generally effective.

Learn more at betterbuildingssolutioncenter.energy.gov

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Agenda

1. Dave Wortman - Oregon's Statewide Plug Load Strategy
2. Stephanie Kruse - Oregon's Efforts to Reduce Plug Load Consumption: Implementing Plug Load Practices
3. Questions

Today's Presenters

Dave Wortman
Oregon Department of Administrative Services

Stephanie Kruse
Oregon Department of Energy

Dave Wortman

Statewide Sustainability Office

Oregon Department of Administrative Services

Submit Questions

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Oregon Department of **Administrative Services**

Oregon's Statewide Plug Load Strategy

Dave Wortman
Statewide Sustainability Officer
July 22, 2020

DAS DEPARTMENT OF ADMINISTRATIVE SERVICES
SUSTAINABILITY PROGRAM

Presentation Overview

- Oregon's commitment to energy efficiency and climate change
- Why develop a statewide plug load strategy?
- How it was developed?
- Major elements of the strategy
- Implementation through statewide policy

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SUSTAINABILITY PROGRAM

State of Oregon Government

- About 40,000 employees
- Over 80 state agencies
- Over 1,500 agency-owned facilities
- Over 700 leases – including privately leased space
- Long history of energy efficiency/sustainability efforts (2001 Oregon Sustainability Act)
  - Executive Orders 17-20, 17-21 on building energy, climate change and electric vehicles
  - Recent Executive Order 20-04 on climate change

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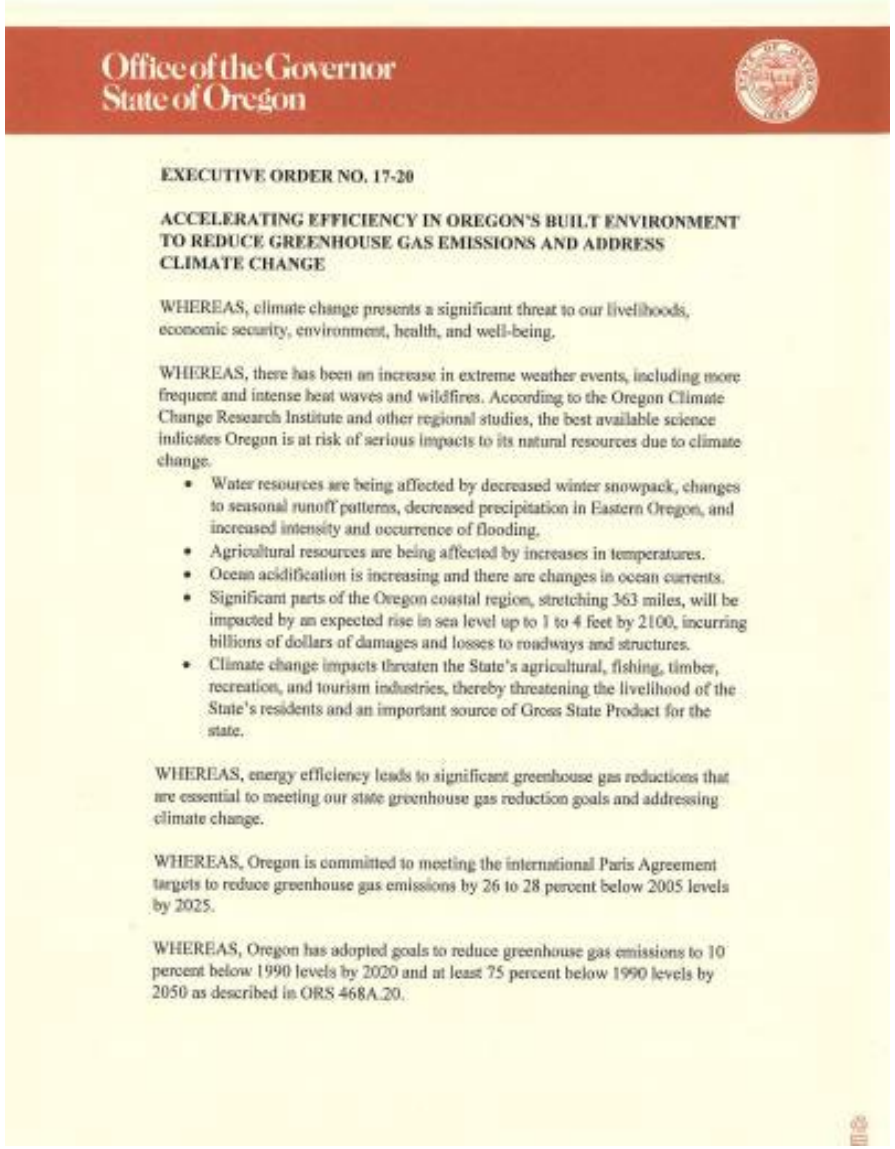
EXECUTIVE ORDER 17-20

- Signed by Governor Kate Brown in November 2017
- Lays out several energy efficiency and climate change-related directives
  - Energy efficiency in state buildings
  - Commercial and residential energy codes
- Leadership in state government
  - High performance building energy targets
  - Carbon neutral-ready new construction
  - **Statewide plug-load strategy**
  - Energy and water efficiency standards for equipment



Office of the Governor
State of Oregon

EXECUTIVE ORDER NO. 17-20

ACCELERATING EFFICIENCY IN OREGON'S BUILT ENVIRONMENT TO REDUCE GREENHOUSE GAS EMISSIONS AND ADDRESS CLIMATE CHANGE

WHEREAS, climate change presents a significant threat to our livelihoods, economic security, environment, health, and well-being.

WHEREAS, there has been an increase in extreme weather events, including more frequent and intense heat waves and wildfires. According to the Oregon Climate Change Research Institute and other regional studies, the best available science indicates Oregon is at risk of serious impacts to its natural resources due to climate change.

- Water resources are being affected by decreased winter snowpack, changes to seasonal runoff patterns, decreased precipitation in Eastern Oregon, and increased intensity and occurrence of flooding.
- Agricultural resources are being affected by increases in temperatures.
- Ocean acidification is increasing and there are changes in ocean currents.
- Significant parts of the Oregon coastal region, stretching 363 miles, will be impacted by an expected rise in sea level up to 1 to 4 feet by 2100, incurring billions of dollars of damages and losses to roadways and structures.
- Climate change impacts threaten the State's agricultural, fishing, timber, recreation, and tourism industries, thereby threatening the livelihood of the State's residents and an important source of Gross State Product for the state.

WHEREAS, energy efficiency leads to significant greenhouse gas reductions that are essential to meeting our state greenhouse gas reduction goals and addressing climate change.

WHEREAS, Oregon is committed to meeting the international Paris Agreement targets to reduce greenhouse gas emissions by 26 to 28 percent below 2005 levels by 2025.

WHEREAS, Oregon has adopted goals to reduce greenhouse gas emissions to 10 percent below 1990 levels by 2020 and at least 75 percent below 1990 levels by 2050 as described in ORS 468A.20.

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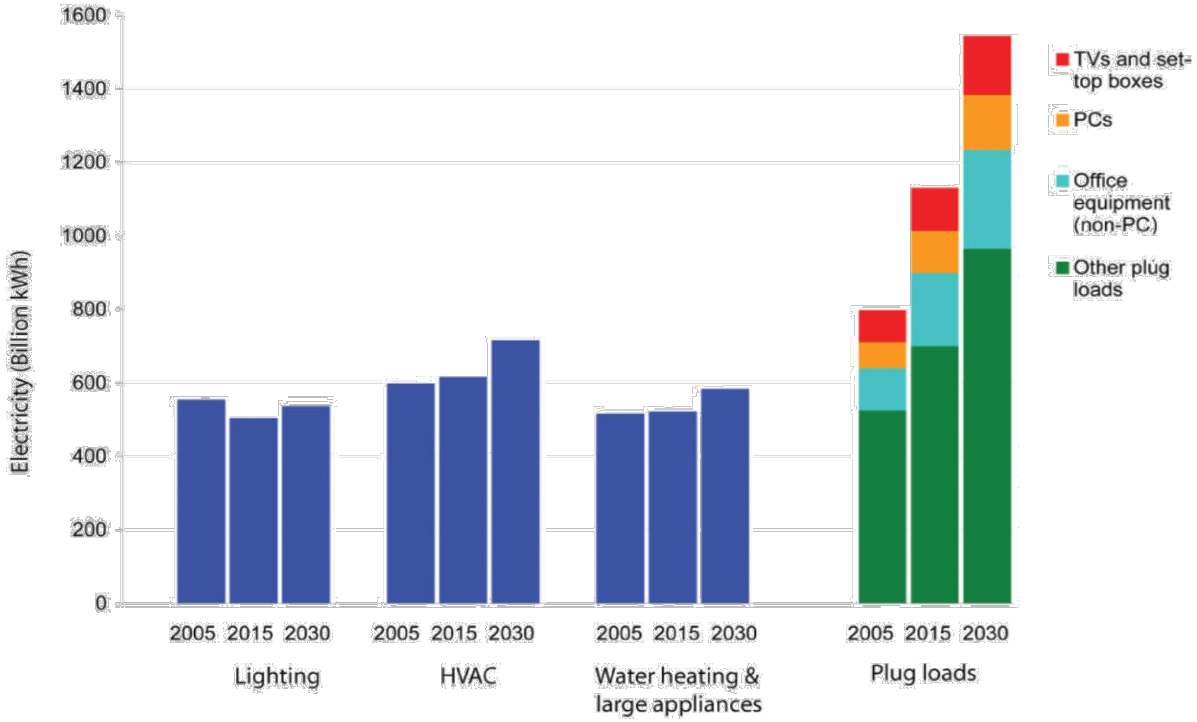
WHY FOCUS ON PLUG LOADS?

- Plug loads can be two to three times larger than lighting loads in offices
- Plug loads comprised 25-30% of electricity use in standard office building in 2012
- Can be as much as 50% of electricity use in high efficiency office buildings



Source: Graph created by ecova with data from EIA 2008 Annual Energy Outlook

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Poll #2

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Types of Plug Loads

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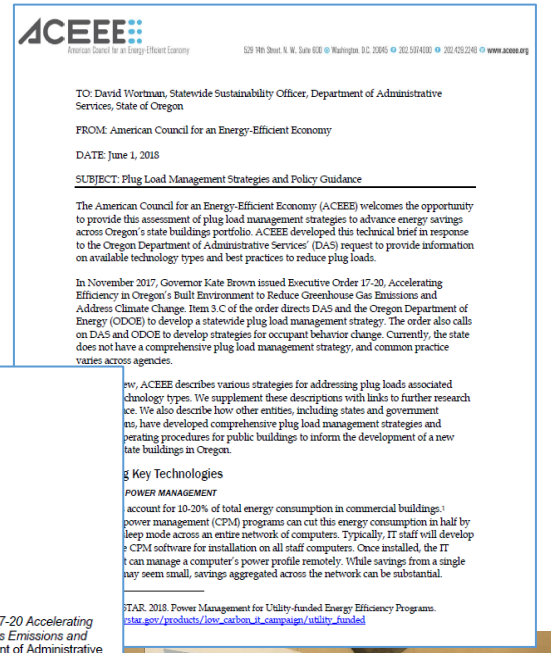
Plug Loads Addressed by the Strategy

- Computers, laptops, and monitors
- Copiers, printers, scanners, faxes, and multi-function devices
- Televisions, DVD players
- Smart boards and projectors
- Computer speakers and other peripheral devices like personal space heaters and fans, phone chargers
- Work area task lighting
- Refrigerators, microwaves, water coolers/dispensers, and coffee machines
- Cold beverage and vending machines
- Clothes washers/laundry facilities

STRATEGY DEVELOPMENT PROCESS

- Defined scope of strategy with Governor's office (stationary equipment inside buildings)
- Obtained grant-funded research support from ACEEE, New Buildings Institute
- Engaged stakeholders
  - Agency IT managers, facility managers, energy analysts, sustainability coordinators
  - Multi-agency working group
  - Energy Trust of Oregon
- Overall one-year development process



ACEEE
American Council for an Energy-Efficient Economy

TO: David Wortman, Statewide Sustainability Officer, Department of Administrative Services, State of Oregon

FROM: American Council for an Energy-Efficient Economy

DATE: June 1, 2018

SUBJECT: Plug Load Management Strategies and Policy Guidance

The American Council for an Energy-Efficient Economy (ACEEE) welcomes the opportunity to provide this assessment of plug load management strategies to advance energy savings across Oregon's state buildings portfolio. ACEEE developed this technical brief in response to the Oregon Department of Administrative Services' (DAS) request to provide information on available technology types and best practices to reduce plug loads.

In November 2017, Governor Kate Brown issued Executive Order 17-20, Accelerating Efficiency in Oregon's Built Environment to Reduce Greenhouse Gas Emissions and Address Climate Change. Item 3.C of the order directs DAS and the Oregon Department of Energy (ODOE) to develop a statewide plug load management strategy. The order also calls on DAS and ODOE to develop strategies for occupant behavior change. Currently, the state does not have a comprehensive plug load management strategy, and common practice varies across agencies.

ew, ACEEE describes various strategies for addressing plug loads associated chnology types. We supplement these descriptions with links to further research ce. We also describe how other entities, including states and government ns, have developed comprehensive plug load management strategies and perating procedures for public buildings to inform the development of a new tate buildings in Oregon.

g Key Technologies

POWER MANAGEMENT

account for 10-20% of total energy consumption in commercial buildings.[1] power management (CPM) programs can cut this energy consumption in half by leep mode across an entire network of computers. Typically, IT staff will develop e CPM software for installation on all staff computers. Once installed, the IT t can manage a computer's power profile remotely. While savings from a single nay seem small, savings aggregated across the network can be substantial.

TAR. 2018. Power Management for Utility-funded Energy Efficiency Programs. rstar.gov/products/low_carbon_it_campaign/utility_funded

nbi new buildings institute
celebrating 20 YEARS

Memo

To: Dave Wortman, Statewide Sustainability Officer
From: New Buildings Institute
Date: February 28, 2018
Subject: Oregon Executive Order 17-20 Implementation Opportunities

Introduction

In November 2017, Governor Brown signed *Executive Order (EO) 17-20 Accelerating Efficiency in Oregon's Built Environment to Reduce Greenhouse Gas Emissions and Address Climate Change*. The EO specifically directs the Department of Administrative Services (DAS) and Oregon Department of Energy (ODOE) to take five actions to make state buildings more efficient and to reduce greenhouse gas emissions paraphrased as follows:

A. Energy Targets for Existing State Buildings
B. Carbon-Neutral Operations for New State Buildings
C. Statewide Plug Load Strategy
D. Energy Efficient Equipment
E. Lifecycle Cost Analysis
F. Efficiency Across the State

NBI recommends that DAS and ODOE partner with Oregon energy efficiency organizations to develop strategies to meet the EO energy efficiency and carbon reduction goals. Organizations may include New Buildings Institute (NBI), NW Energy Coalition, Northwest Energy Efficiency Agency (NEEA), Energy Trust of Oregon (ET), Bonneville Power Administration (BPA), and others. This memo includes recommendations for implementing the directives within Executive Order 17-20. The end of this document includes a summary of the directives and primary responsible agency/party, as NBI understands the EO. If implemented, these efforts should be implemented in collaboration with and in support of ODOE and other associated state agencies.

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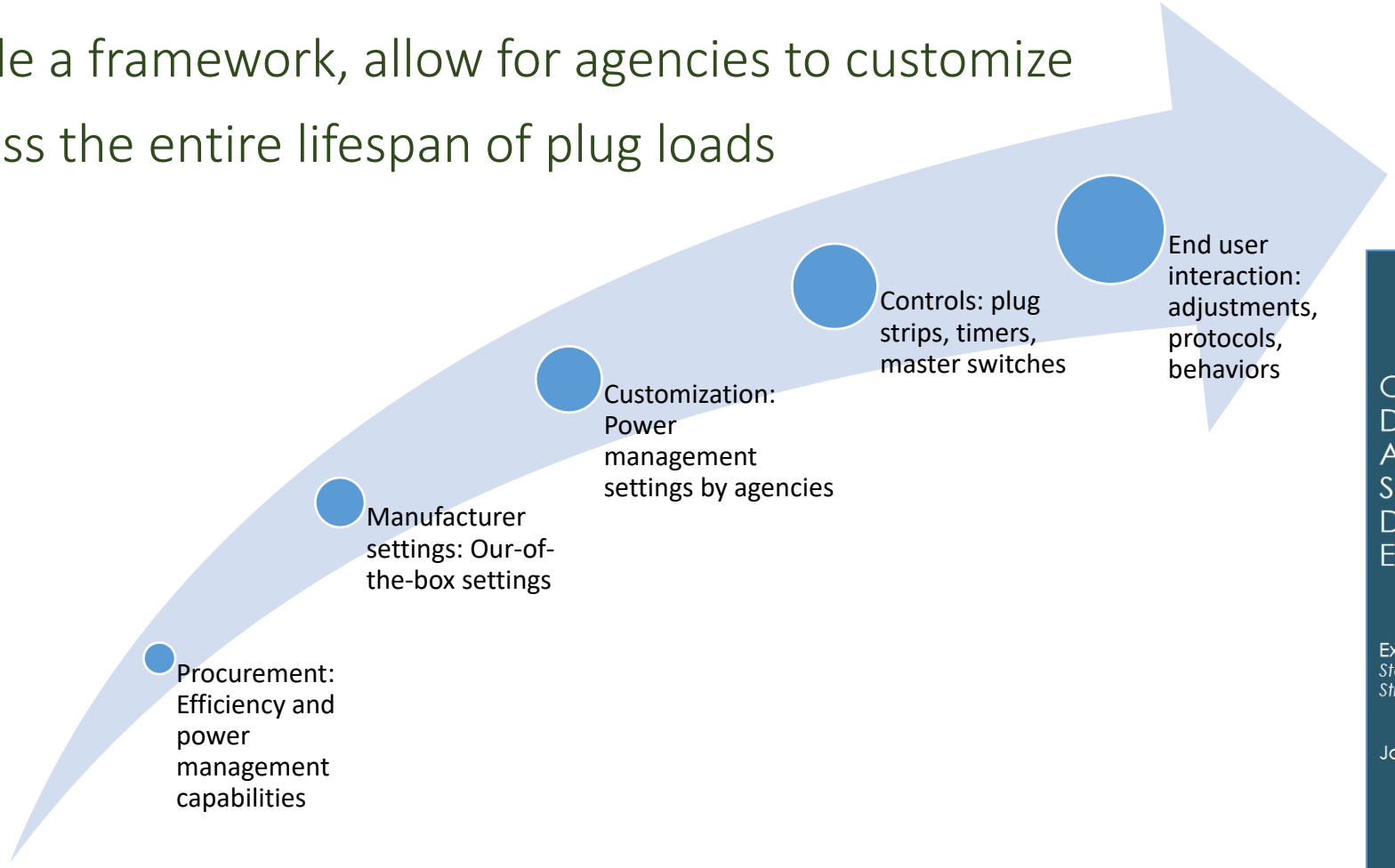
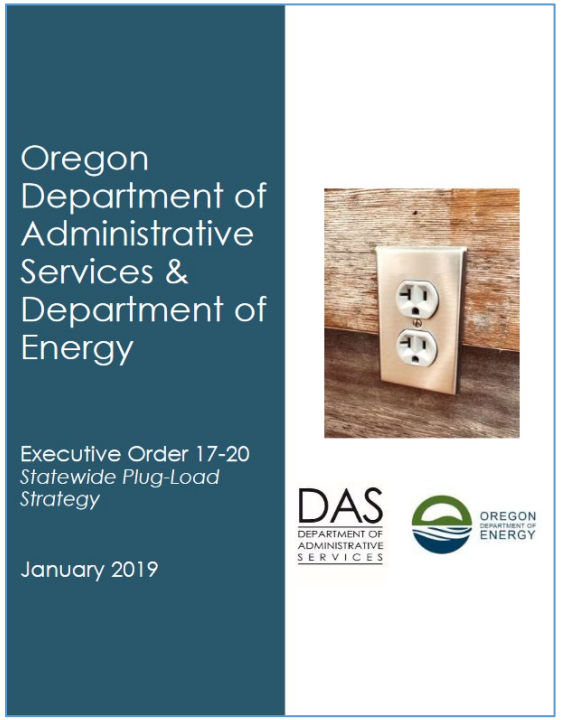
THE FINAL STRATEGY

Guiding Principles

- Provide a framework, allow for agencies to customize
- Address the entire lifespan of plug loads





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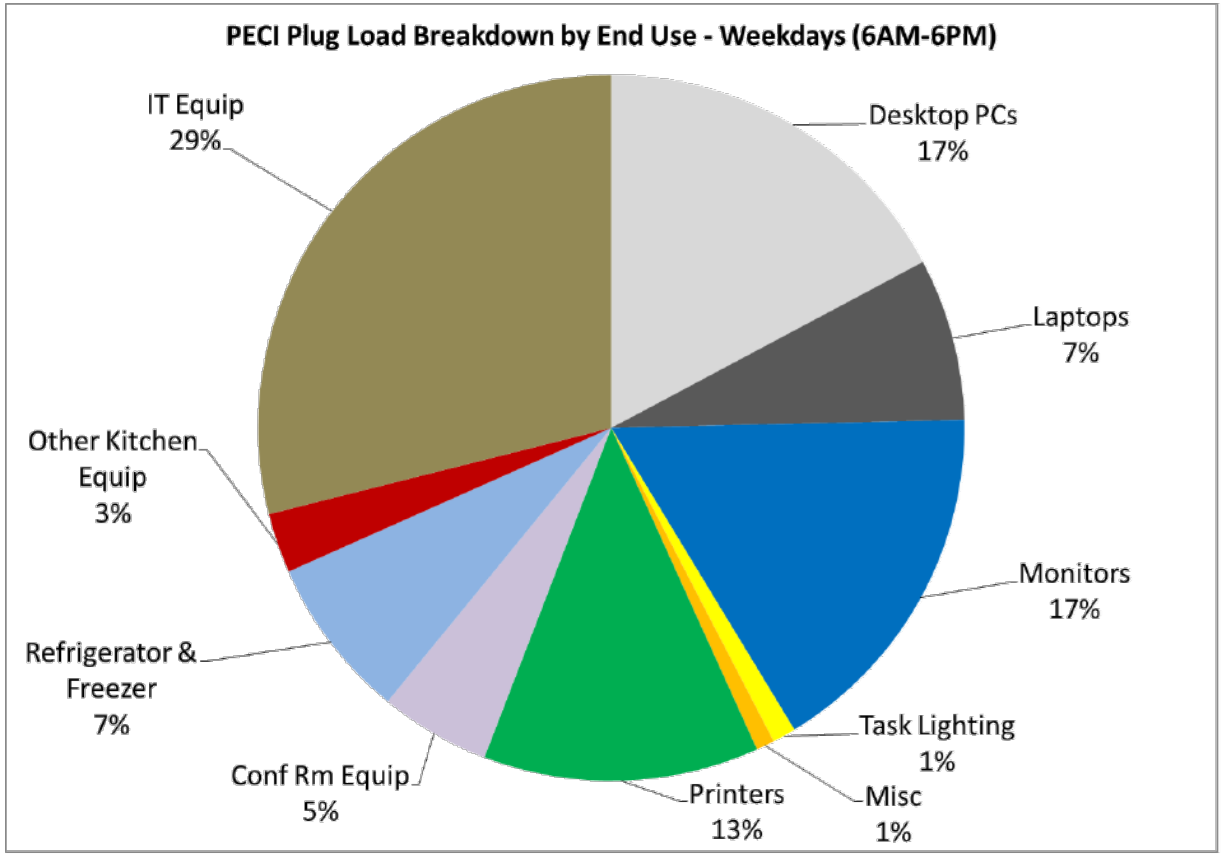
THE FINAL STRATEGY

Portfolio Management

- Create inventory
- Conduct user assessments
- Review and adjust internal settings or add controls
- Replace equipment
- Remove equipment not being optimally used



Plug load breakdown in small office in Portland, Oregon.

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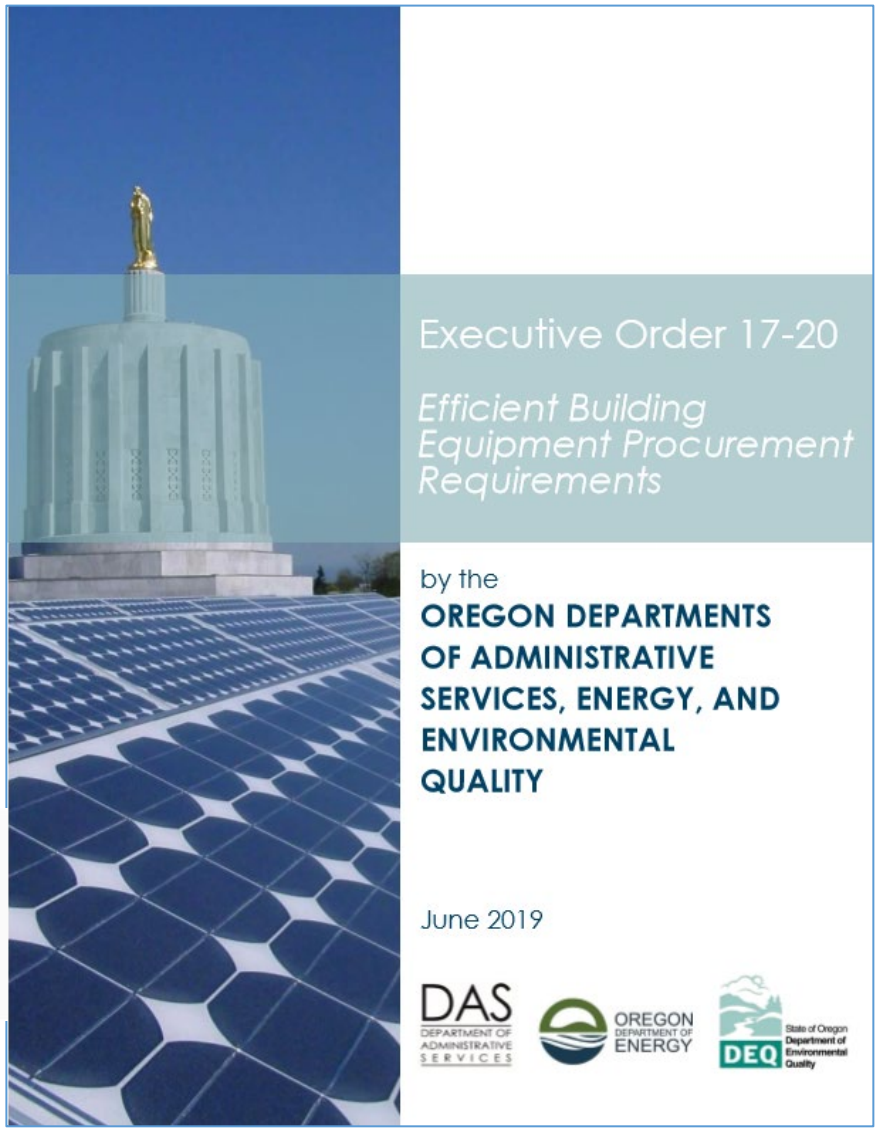
THE FINAL STRATEGY

Develop Procurement Specifications

- Consolidate and centralize first
- Choose the right size and quantity
- Identify standards and specifications for procurements
- Pick the right time to upgrade



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THE FINAL STRATEGY

Optimize Use

- Complete periodic assessments – surveys, equipment logs, night walks
- Continually engage users
- Adjust configurations over time
- Look to external controllers

DAS SUSTAINABILITY PROGRAM

DAS audit

Agriculture Building

February 5, 2015

ANNUAL WASTE DUE TO OVERNIGHT PLUG LOAD ELECTRICITY

	kWh	COST	PERCENTAGE OF TOTAL
Computers	28,787	$2,159.01	93.42%
Task Lights	154	$11.56	0.50%
Appliances	326	$140.43	6.08%
TOTAL WASTE	29,267	$2,311	100%

SUSTAINABILITY IMPACTS OF FOUND ENERGY WASTE

ACTUAL POUNDS OF COAL USED	1,941
TOTAL POUNDS OF COAL	4,853
GALLONS OF GASOLINE	868
POUNDS OF CO2*	6,739
AUTO MILES DRIVEN	19,540
AUTO TRIPS AROUND THE EARTH	0.8

EQUIVALENCY

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AUDIT NOTES:

1. Consistant overhead lighting: 2x4 troffers, 2 lamps
2. North Tower - LC&D: 10,448 kWh, phone headsets common, did not go into lab, Rm. 323 needs new fridge
3. South Tower - NR: 18,819 kWh, 3rd floor needs new fridge, 3rd floor lights are on with no one present
4. Updated recycling signage needed in all breakrooms

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THE FINAL STRATEGY

Educate and Engage

- Explain benefits, business case, value of employee action
- Engage with employees and managers
- Identify a plug load champion and train the trainers
- Quickly address user needs and configurations
- Partner with IT and other departments on implementation
- Run a pilot program to address concerns

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MEASURING AND MONITORING

Assumed Savings

- Project savings from literature or other case studies
- No direct measurement

Spot Measure and Extrapolate

- Use data loggers on specific pieces of equipment, over-the-outlet meters, circuit level meters
- Extrapolate results

Sub-meter

- Separately meter plug loads on floor, section, or building
- Can be temporary or more permanent

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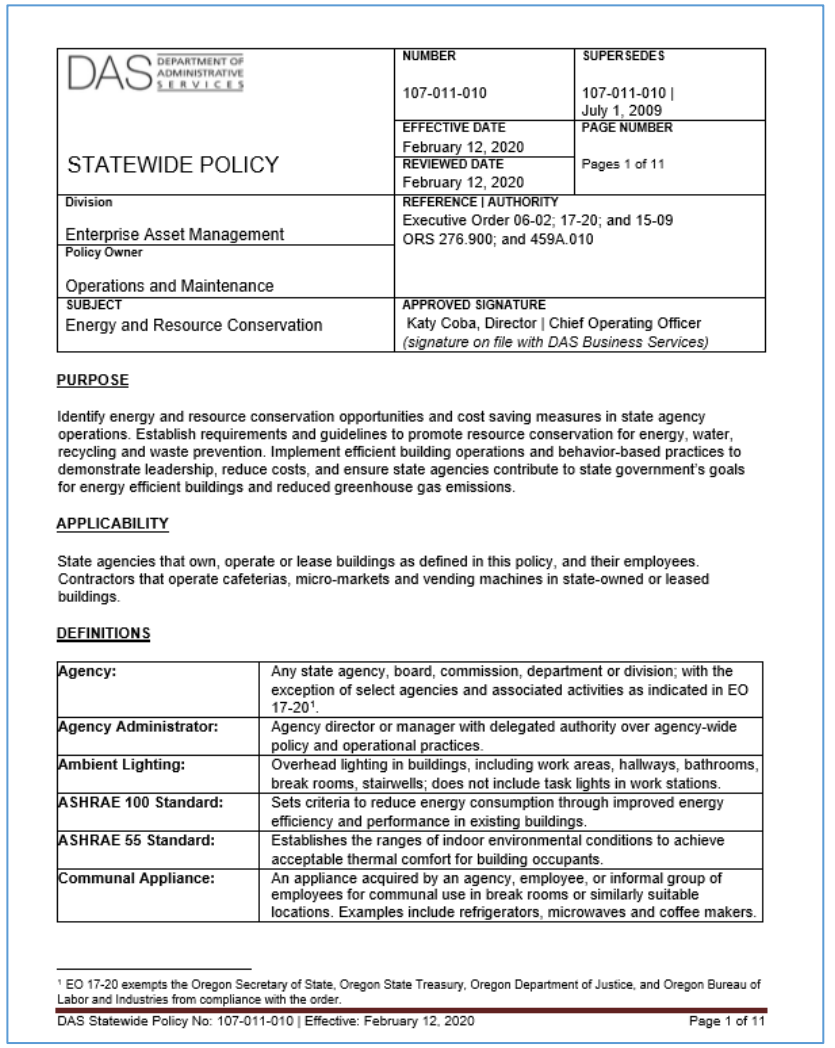
IMPLEMENTATION: STATEWIDE POLICY

- Executive Order 17-20 directed DAS to update statewide policy
- Department of Administrative Services Statewide Energy and Resource Conservation Policy
  - Vehicle for implementing plug load strategy
  - Every agency must comply with policy
  - Applied to state owned and leased facilities



DAS DEPARTMENT OF ADMINISTRATIVE SERVICES

STATEWIDE POLICY

NUMBER	SUPERSEDES
107-011-010	107-011-010 | July 1, 2009
EFFECTIVE DATE: February 12, 2020	PAGE NUMBER: Pages 1 of 11
REVIEWED DATE: February 12, 2020	

Division / Policy Owner	REFERENCE | AUTHORITY
Division: Enterprise Asset Management Policy Owner: Operations and Maintenance	Executive Order 06-02; 17-20; and 15-09 ORS 276.900; and 459A.010
SUBJECT: Energy and Resource Conservation	APPROVED SIGNATURE: Katy Coba, Director | Chief Operating Officer *(signature on file with DAS Business Services)*

PURPOSE

Identify energy and resource conservation opportunities and cost saving measures in state agency operations. Establish requirements and guidelines to promote resource conservation for energy, water, recycling and waste prevention. Implement efficient building operations and behavior-based practices to demonstrate leadership, reduce costs, and ensure state agencies contribute to state government's goals for energy efficient buildings and reduced greenhouse gas emissions.

APPLICABILITY

State agencies that own, operate or lease buildings as defined in this policy, and their employees. Contractors that operate cafeterias, micro-markets and vending machines in state-owned or leased buildings.

DEFINITIONS

Agency:	Any state agency, board, commission, department or division; with the exception of select agencies and associated activities as indicated in EO 17-20[1].
Agency Administrator:	Agency director or manager with delegated authority over agency-wide policy and operational practices.
Ambient Lighting:	Overhead lighting in buildings, including work areas, hallways, bathrooms, break rooms, stairwells; does not include task lights in work stations.
ASHRAE 100 Standard:	Sets criteria to reduce energy consumption through improved energy efficiency and performance in existing buildings.
ASHRAE 55 Standard:	Establishes the ranges of indoor environmental conditions to achieve acceptable thermal comfort for building occupants.
Communal Appliance:	An appliance acquired by an agency, employee, or informal group of employees for communal use in break rooms or similarly suitable locations. Examples include refrigerators, microwaves and coffee makers.

[1] EO 17-20 exempts the Oregon Secretary of State, Oregon State Treasury, Oregon Department of Justice, and Oregon Bureau of Labor and Industries from compliance with the order.

DAS Statewide Policy No: 107-011-010 | Effective: February 12, 2020 Page 1 of 11

DAS DEPARTMENT OF ADMINISTRATIVE SERVICES
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IMPLEMENTATION: STATEWIDE POLICY

- Directs agency IT departments to deploy computer power management
- Directs use of shared printers and central printing services
- Provides guidelines on personal appliance use in work spaces
- Provides guidelines for communal appliances
- Agencies must monitor, measure and periodically report on progress
- DAS, ODOE provide support

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HELPFUL LINKS

- List of Oregon executive orders: https://www.oregon.gov/gov/admin/Pages/executive-orders.aspx
- Statewide Plug Load Strategy: https://www.oregon.gov/energy/Get-Involved/Documents/2018-BEEWG-Plug-Load-Strategy.pdf
- Efficient Equipment Procurement Standards: https://www.oregon.gov/energy/Get-Involved/Documents/2019-Efficient-Equipment-Standards.pdf
- Energy and Resource Conservation Policy: https://www.oregon.gov/das/Policies/107-011-010.pdf
- DAS Sustainability Program: https://www.oregon.gov/das/Facilities/Pages/Sustainability.aspx

THANK YOU!

Dave Wortman, Statewide Sustainability Officer: david.wortman@Oregon.gov

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Stephanie Kruse

Facilities Engineer

Oregon Department of Energy

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Oregon Department of **ENERGY**

Oregon's Efforts to Reduce Plug Load Consumption: Implementing Plug Load Practices

Stephanie Kruse

July 22, 2020

OREGON DEPARTMENT OF ENERGY

Implementing Plug Load Practices

Outline

- Implementation
- Measurement and Verification
- Policy actions to reduce plug loads
- Impact of COVID-19 on Oregon State's plug loads

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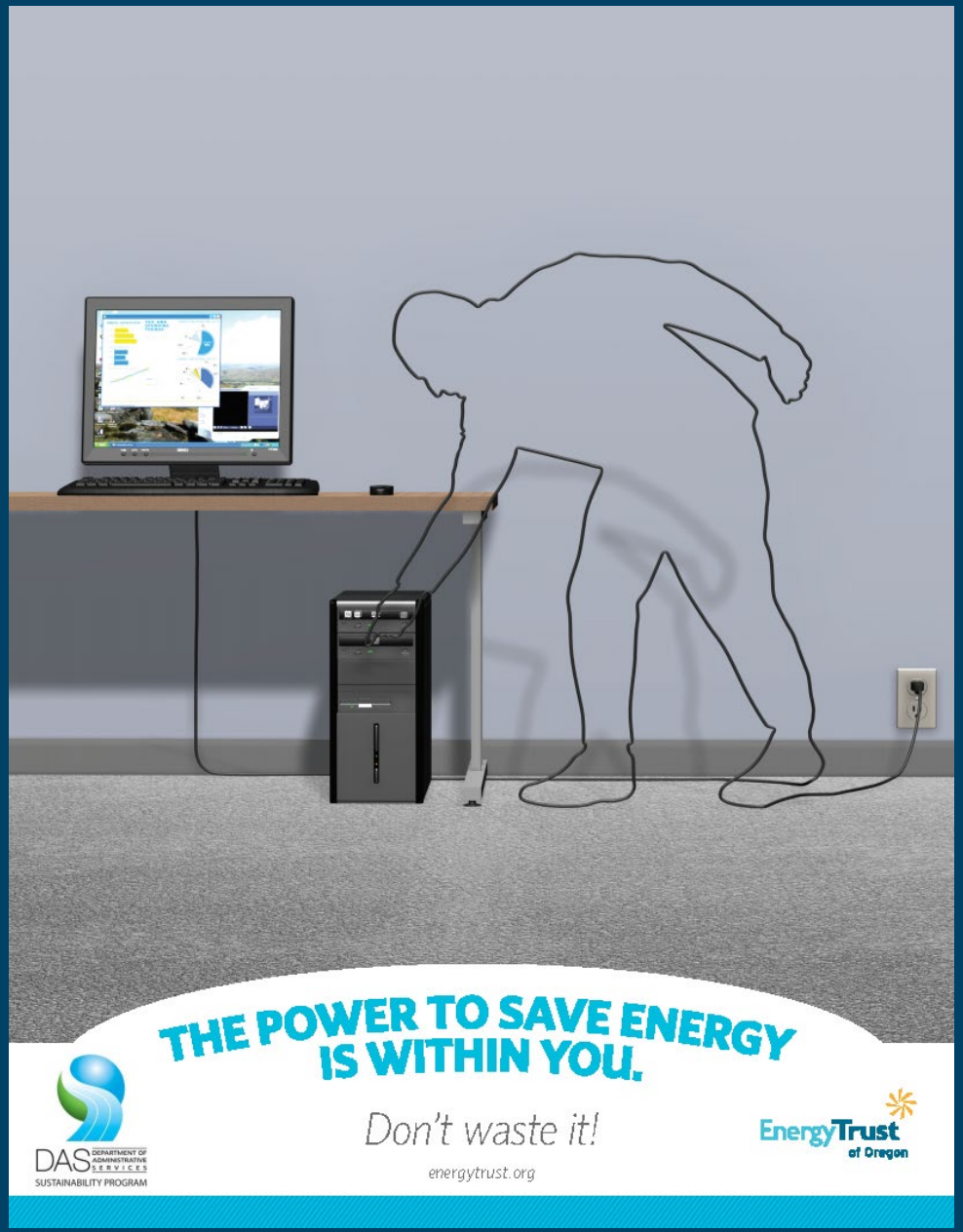
Plug Load Workshop

ODOE and DAS

partnered to present the

Plug Load Workshop

for state agencies to learn about the new policy and how to start implementation.



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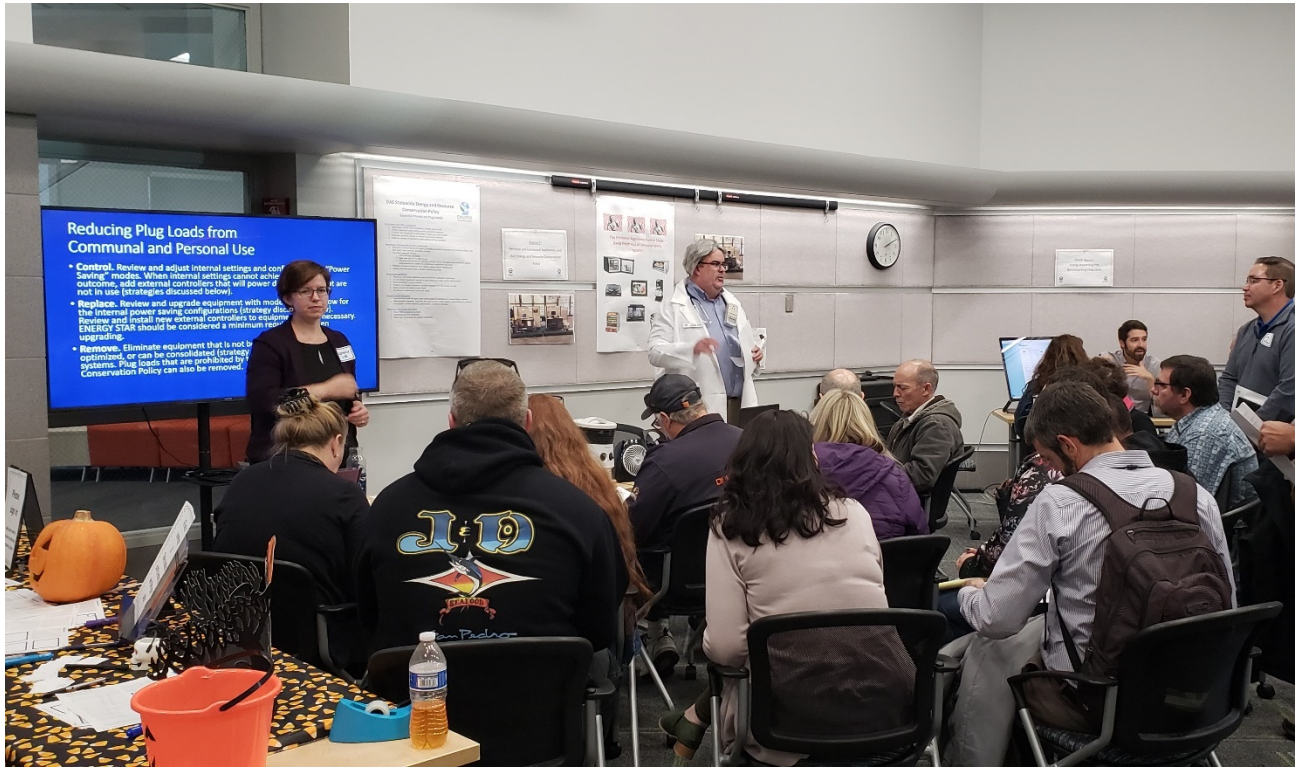
Plug Load Workshop included:



- Measurement methods with tool examples and demonstrations
- Energy Trust of Oregon utility incentive information booth
- How to conduct a night audit
- Intro to the resource conservation policy
- Common plug load pitfalls and how to start addressing them.

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Personal Appliance Cubicle examples

Plug Load Workshop included:

- Resources available to agencies including:
  - educational posters
  - worksheets for measuring impact
  - utility incentive information
- M&V through ODOE's SEED program
- Networking with other agencies' sustainability and facility teams

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DAS Information Services rolled out network conservation strategies in DAS managed facilities across the state in 2019

Network Managed Energy Conservation Strategies

Average electricity use per computer was reduced approximately 25 kWh per day!

- Address variance in existing power management settings (many disabled)
- Enabling wake on LAN to enable maintenance and other work during off hours
- Implementing automated shut downs
- Enable ‘hibernate’ instead of ‘sleep’ due to security risks

- Energy efficient procurement

- Virtualization of servers
- Decommissioning unused servers
- Consolidating servers

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Network Managed Energy Conservation Strategies

In 2016 ODOE committed to modernize and increase efficiency in information technologies.

- Replaced servers with hyperconverged server cluster
  - 3 servers each run 6 virtual servers.
  - Reduced load on building cooling system
- Re-imagined printing
  - There used to be 8 division printers, 3 multi function machines, and Many desktop printers
  - Implemented a secure print network, requires a badge scan to print at device where you want to print
  - Now less than 10 printers for whole department

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Network Managed Energy Conservation Strategies

- For ODOE modernization means:
  - conversion to secure cloud based systems where possible.
  - moving document storage to the cloud
  - Addressing and replacing old energy inefficient equipment on an aggressive cycle.

These existing practices set ODOE up to smoothly transition to remote work in the recent response to COVID-19

OREGON DEPARTMENT OF ENERGY

Custom Plug Load Project

5 DAS Building + Capitol Building work with ETO

- Energy Trust of Oregon worked with DAS to develop a custom incentive package for plug load control in state buildings
- Program includes:
  - Free onsite assessment of plug loads
  - Free report with recommended strategies, costs and simple payback
  - Eligibility for advanced plug strip incentive

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Poll #4

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Measurement and Verification

- ODOE's SEED program tracks facility energy data for 312 existing state buildings for 21 state agencies
  - Buildings greater than 10K square feet
- In 2018, 43% of tracked buildings met their performance targets (ASHRAE 100 or custom target for unique building types per EO 17-20)
  - Significant opportunity to capture energy efficiency savings
- This developed baseline can be used for comparison to measure the impact of the Resource Conservation Policy.

OREGON DEPARTMENT OF ENERGY

Oregon's Policy Action on Plug Loads

Building Energy Codes

- Developed Zero Energy Ready Home baseline for residential
- Commercial code updated to ASHRAE 90.1-2016
  - This code includes provisions for including automatic receptacle control in some spaces
- Executive Order 20-04 sets ambitious 60% reduction target in building energy use

OREGON DEPARTMENT OF ENERGY

Oregon's Policy Action on Plug Loads

Appliance Standards

- Oregon is in the process of updating appliance standards
  - Remove standards that have been pre-empted by federal regulation
  - Add standards for appliances not covered under federal regulation

1) High CRI fluorescent lamps
2) Computers and computer monitors
3) Faucets
4) Shower heads
5) Commercial fryers
6) Commercial dishwashers
7) Commercial steam cookers
8) Residential ventilating fans
9) Electric storage water heaters
10) Portable electric spas

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OR Building Energy Use and COVID-19

In spaces, where the majority of state workers are able to work from home

- Direct actions
  - Many agencies are physically unplugging and turning off devices in unused space
  - Plug load energy consumption has been reduced by as much as 60%
- Automated Building Control Adjustments
  - Facility managers are adjusting building automation systems to respond to COVID-19
  - Recommendations include increasing outside air, installing finer filters and disabling demand controlled ventilation to minimize the spread of disease.
  - This is currently generating cooling savings, and increasing load on fans, but could become an added cost once heating becomes primary in the fall.
- Existing Control Strategies
  - Existing energy savings practices, such as occupancy sensor controlled lighting is yielding energy savings in unoccupied spaces
  - Lighting energy consumption has dropped by as much as 35%

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Q & A

Submit Questions
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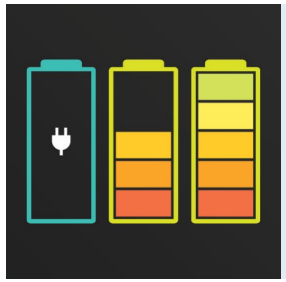

CASE IN POINT:
OREGON'S RECENT EFFORTS TO REDUCE PLUG LOAD ENERGY CONSUMPTION

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