

Overcooling of Offices Reveals Gender Inequality in Thermal Comfort

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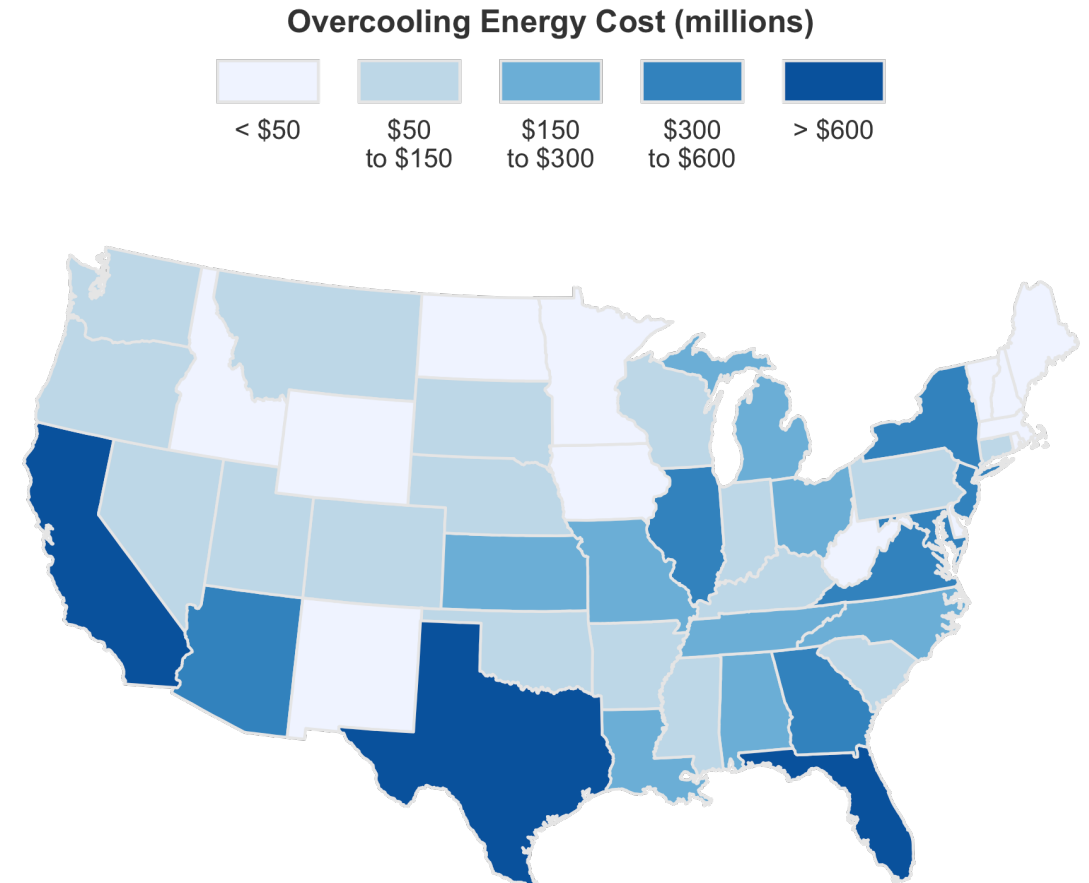
Cooling requirements in the U.S.

Cooling is increasing

- Accounted for 23% of increased electricity demand from 1990-2016
- 84% increase by 2050 due to climate change

Overcooling of offices

- Offices can be cooler in summer than winter
- Evidence that it is a global problem
- Annual costs:
 - USD 10 billion
 - 8% of total building electricity use
 - 57,000 kt of CO₂e
 - decreased occupant satisfaction



Source: Derrible and Reeder (2015)

ANNALS OF TECHNOLOGY

IS YOUR THERMOSTAT SEXIST?

Can an Office Temperature Be 'Sexist'? Women, and Science, Say So



YOUR HEALTH

Women, There's A Reason Why You're Shivering In The Office



LIVING

Cold office temperatures are hurting women's productivity, study says

Project overview

Objective

- Explore gender inequity in office overcooling

Approach

- Analyze CBE Occupant Survey responses about office temperatures
- Collect Tweets about cold offices

Funding

- SinBerBEST
- CBE



Source: Shutterstock

Thermal comfort questions in the CBE Occupant Survey

Thermal comfort is a common issue

- 38% of respondents are dissatisfied with the thermal environment
- Second most common issue behind acoustics

Branching questions on temperature

- Dissatisfied respondents evaluate the temperature in summer and winter
- Analyzed over 38,000 responses from 435 offices

CBE Occupant Survey Example Thermal Comfort Question

How satisfied are you with the temperature of your workspace?

Very dissatisfied	Dissatisfied	Somewhat dissatisfied	Neither	Somewhat satisfied	Satisfied	Very Satisfied
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



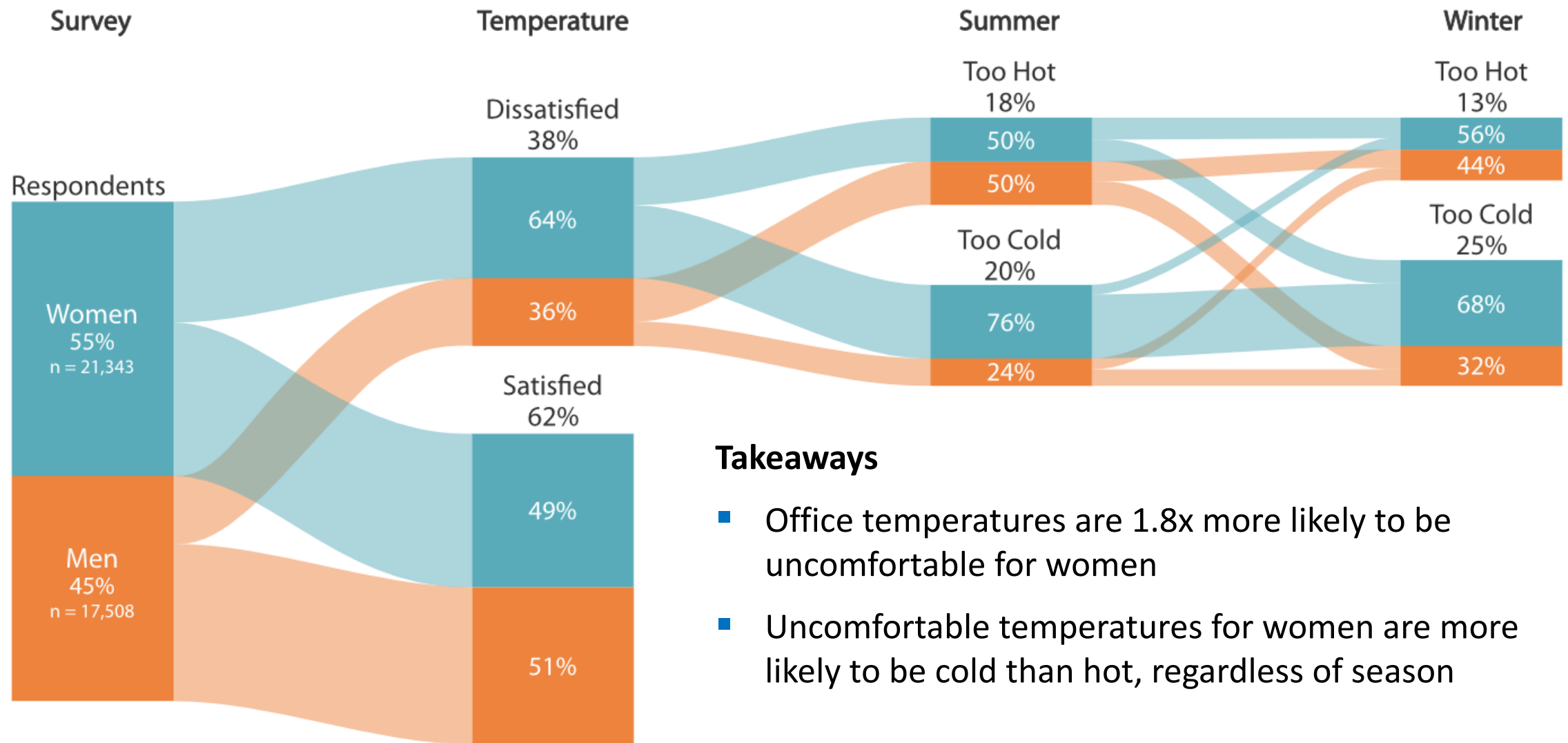
In warm/hot weather, the temperature in my workspace is:

<input type="radio"/> Often too hot	<input type="radio"/> Often too cold
-------------------------------------	--------------------------------------

In cool/cold weather, the temperature in my workspace is:

<input type="radio"/> Often too hot	<input type="radio"/> Often too cold
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Overcooling and gender in the CBE Occupant Survey



Mining Twitter for cold office complaints

Novel crowdsourcing method

- Tweets about cold offices
- Complements the CBE Occupant Survey

Tweets about cold offices

- Keyword search for "cold", "office", "freezing", "desk", "🥶" etc.
- Must include geotag and in the U.S.
- Found 16,791 tweets:
 - 14,771 users
 - 3,761 cities





Steph in a Million!
@steph_in_a_million



It doesn't need to be this cold in the office 😞

3:22 PM · Jul 30, 2019 from Lancaster, PA



Copy link to Tweet

[Tweet your reply](#)



Steph in a Million!
@steph_in_a_million



Apparently it was over 100 today but i had no idea because I was in my office, freezing and warming myself with my space heater because this building is forever cold.

12:20 AM · Sep 11, 2018 from Santa Rosa, CA



3



Copy link to Tweet

[Tweet your reply](#)



Steph in a Million!
@steph_in_a_million



My office is so cold that walking outside in 93 degree heat feels like heaven on my 15 minute break

8:37 PM · Aug 8, 2018 from Florida, USA

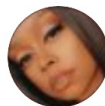


2



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[Tweet your reply](#)



Steph in a Million!
@steph_in_a_million



I hate being in a freezing cold building. Like why is that a norm?

9:47 PM · Sep 9, 2019 from Austin, TX



Copy link to Tweet

[Tweet your reply](#)

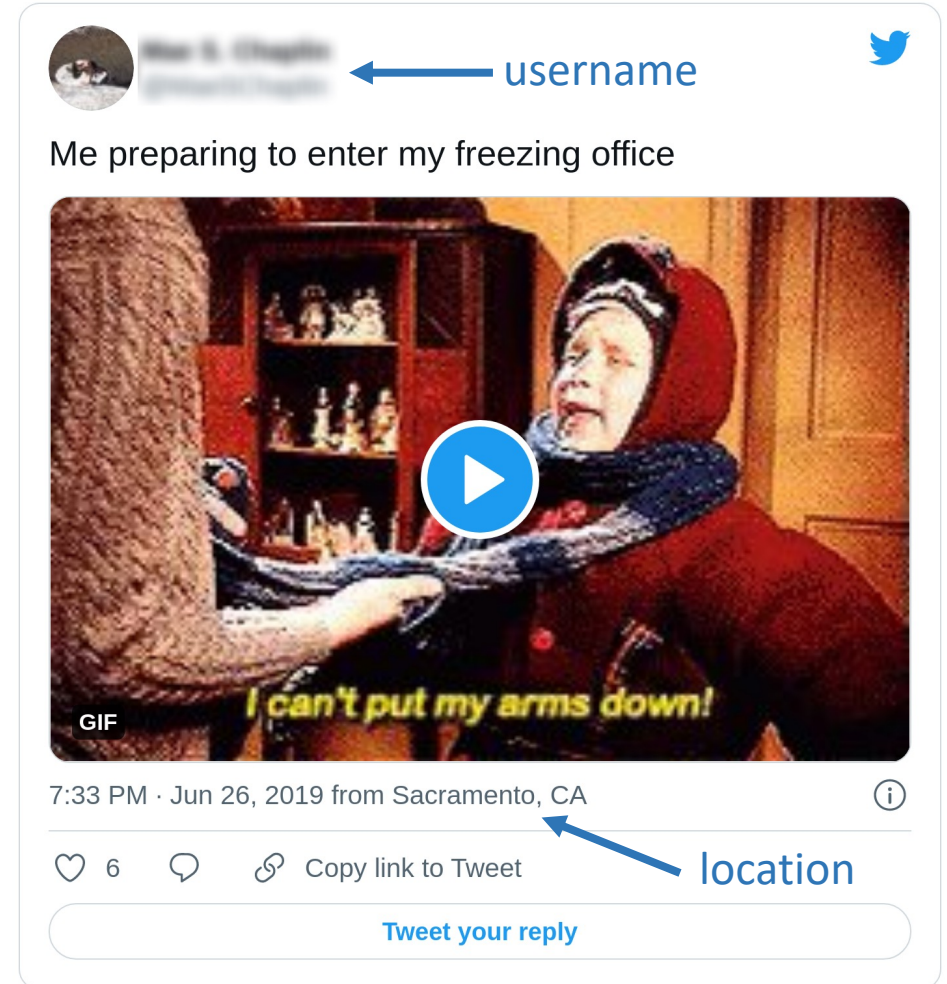
Adding context to cold office tweets

Gender

- Based on Twitter username
- Guess gender using algorithm on list of names from Social Security Administration
- Manual verification found 93% accuracy

Weather

- Based on tweet time and location
- Retrieve daily temperature from nearest weather station on the day of the tweet
- 75% of stations <10 km (6 mi) from user



Gender and cold office tweets

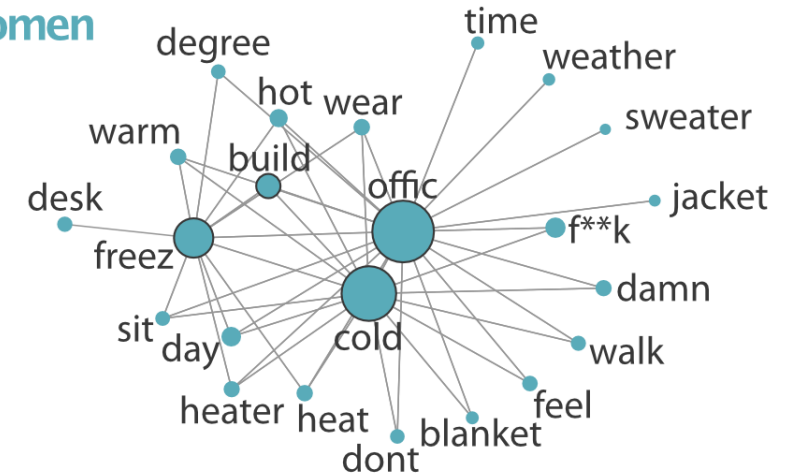
Guessing gender

- 66% of the matched usernames were women
- Higher than the estimated 55% of Twitter users who are woman

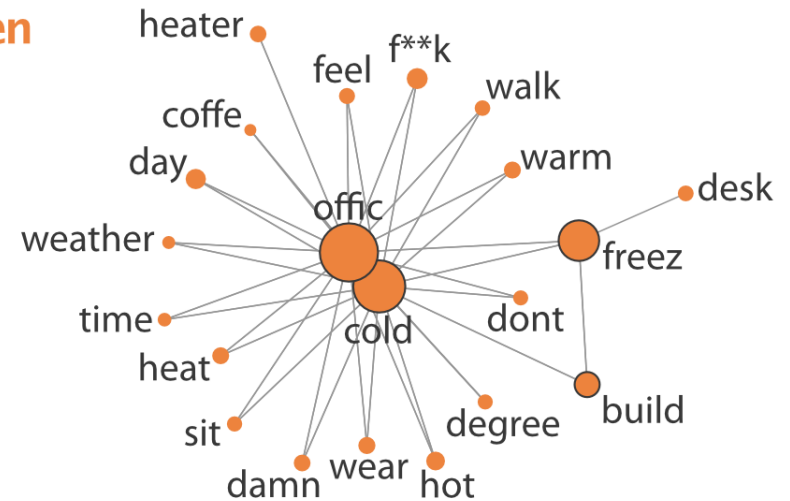
Text mining of tweets

- Cooccurrences of frequent words in tweets
- Search keywords (cold, office, building) shown in the center
- Women discussed responses to overcooling e.g., clothing, blanket, heater etc.

Women



Men



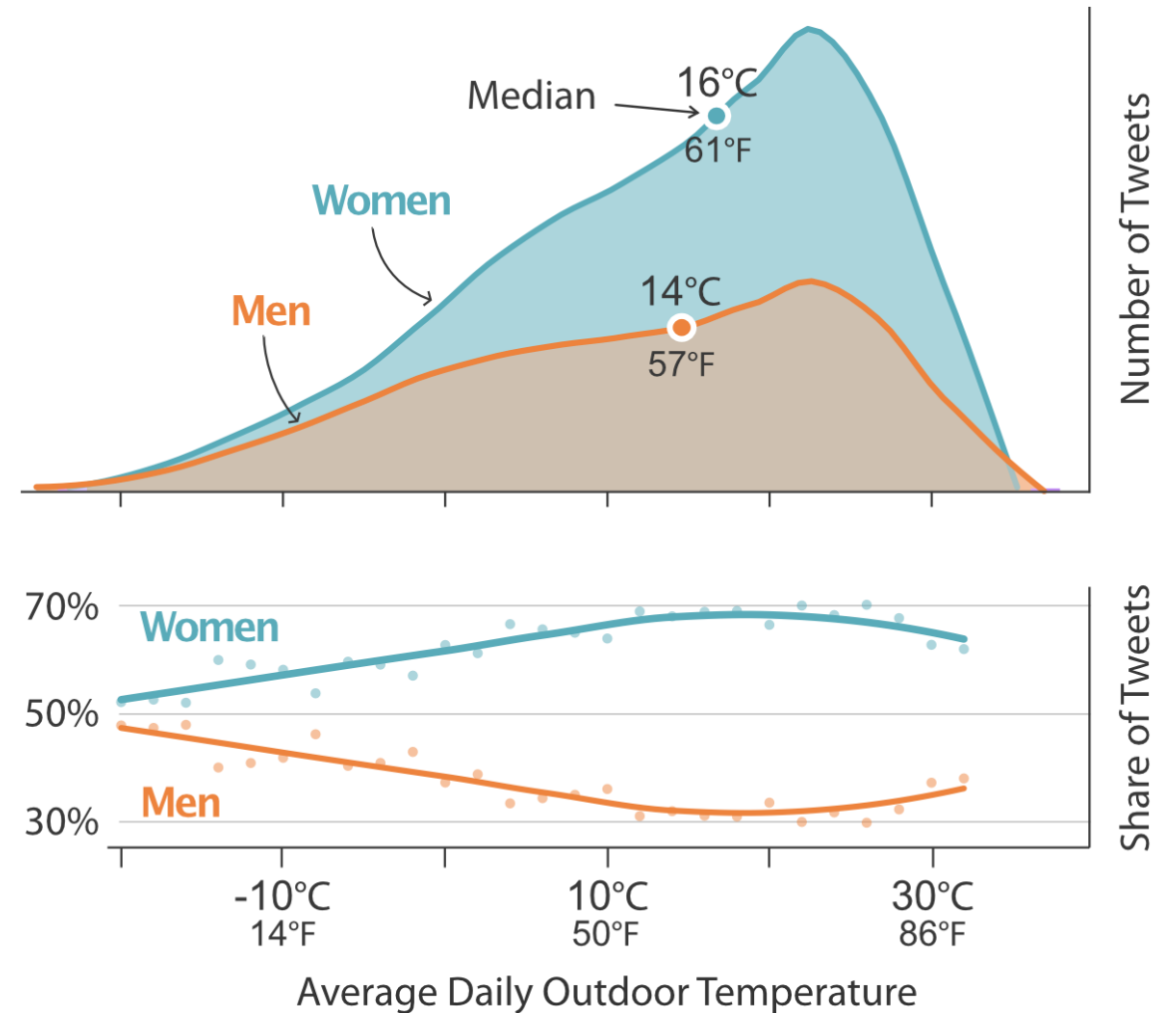
Weather and cold office tweets

Outdoor temperature

- Tweets were common when daily temperature was above 20°C (68°F)
- Share of tweets from women increased with outdoor temperature

Regional differences

- 40% of cold office tweets were from Southern states
- Median temperature was higher for women in all regions
- Similar share by gender in all regions



Solutions to overcooling

Adjust thermostats

- Seasonal changes to thermostats would reduce overcooling and save energy
- Likely to improve thermal comfort for women

Modify HVAC configuration

- VAV minimum air flow setpoints are too high
- Reduced flow improves comfort, perceived air quality, and lowers energy use

Use personal comfort systems

- Meet individual thermal preferences without making office uncomfortable for others



Summary

- Cool office temperatures in summer cause occupant dissatisfaction
- Overcooling disproportionately affects women
- Gender inequity confirmed by two independent datasets
- Existing solutions would improve thermal comfort for all occupants and save energy

