

GreenPulse on Geo-aware HVAC Setback Advisor powered by *COMSOL*



Meltem Sahin Ozkoc

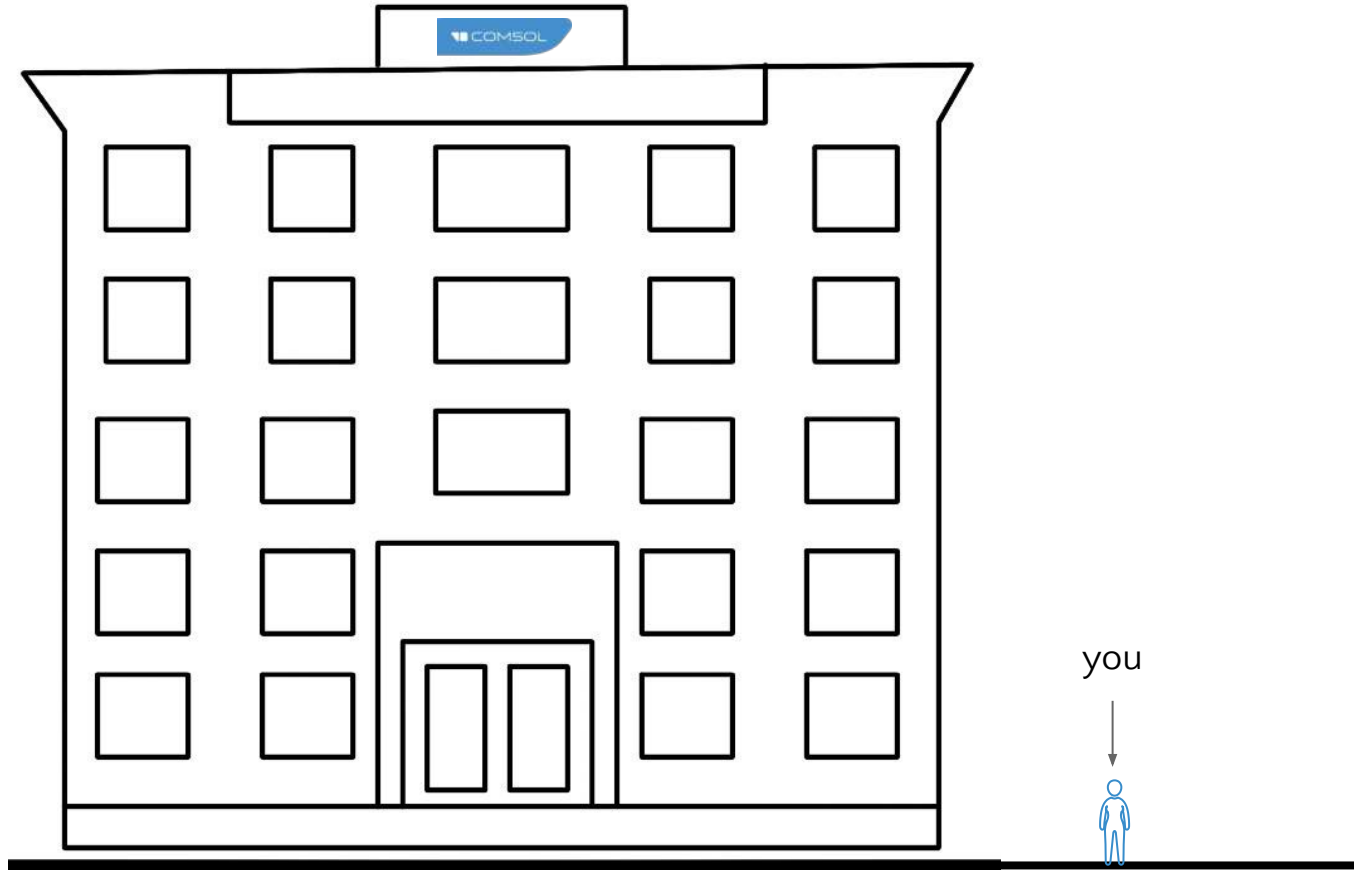
Building Performance & Diagnostics,
Carnegie Mellon University



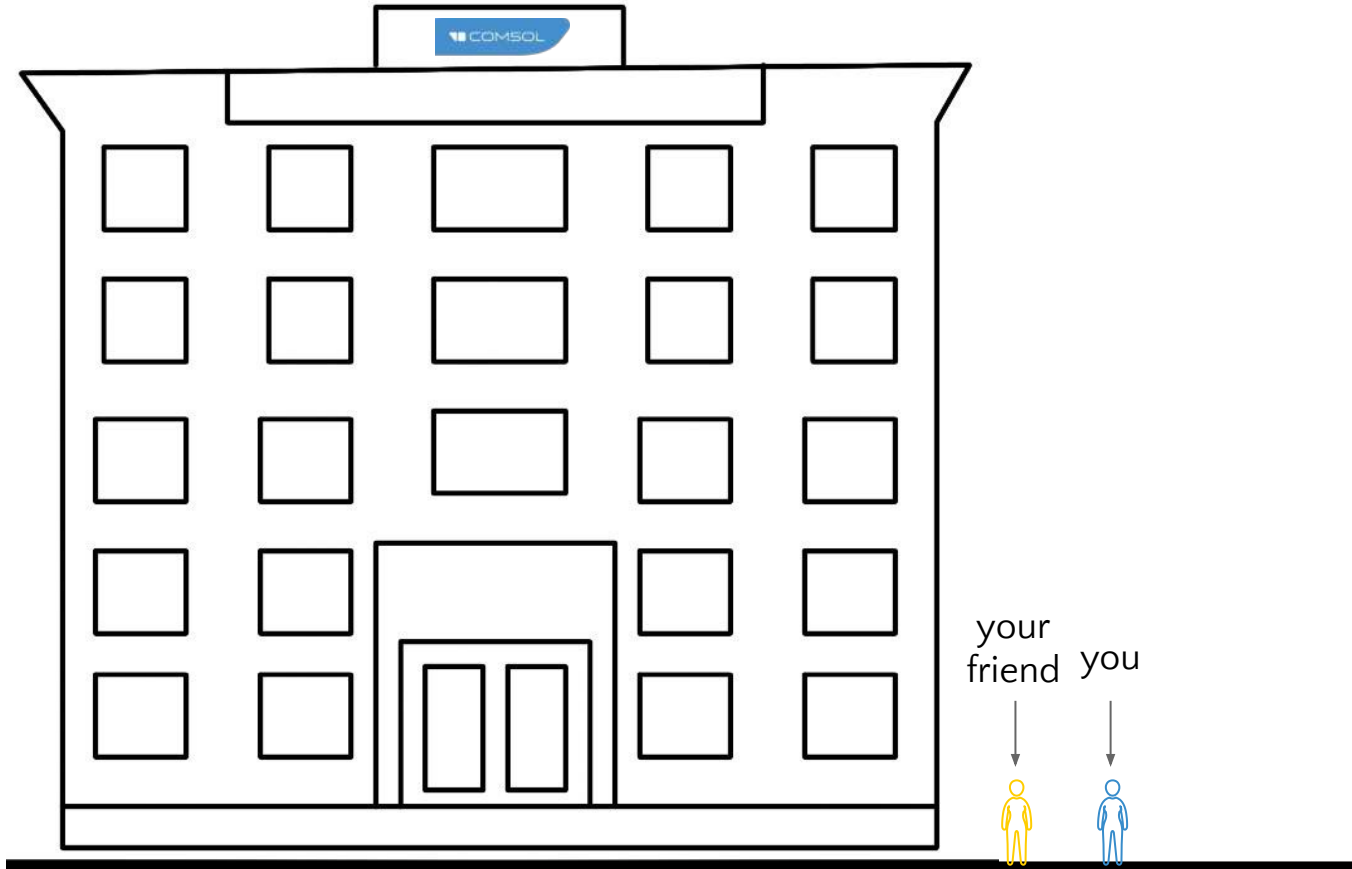
Yuki Huang

Sustainable Design,
Carnegie Mellon University

Imagine this is you after a busy office day...

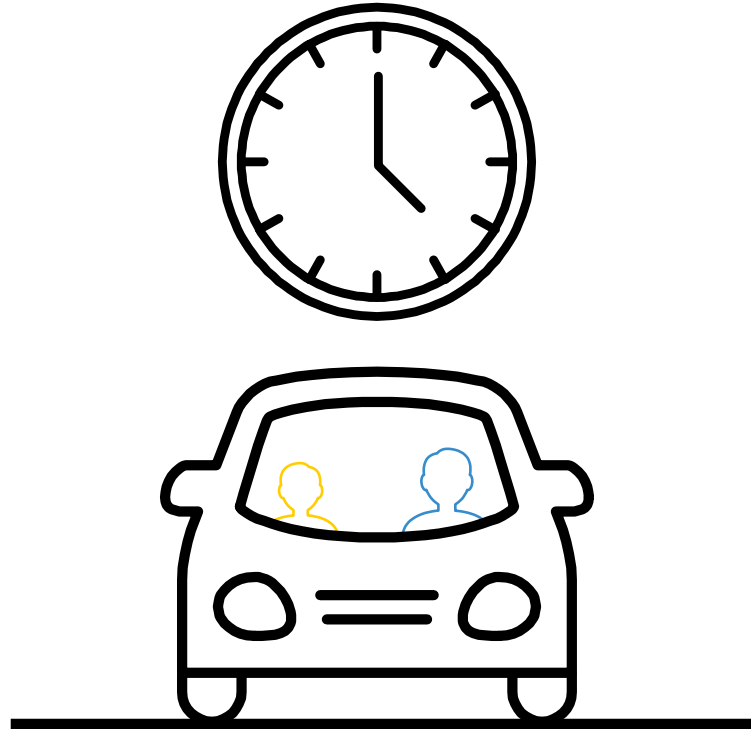


Suddenly your friend invites you for a drink

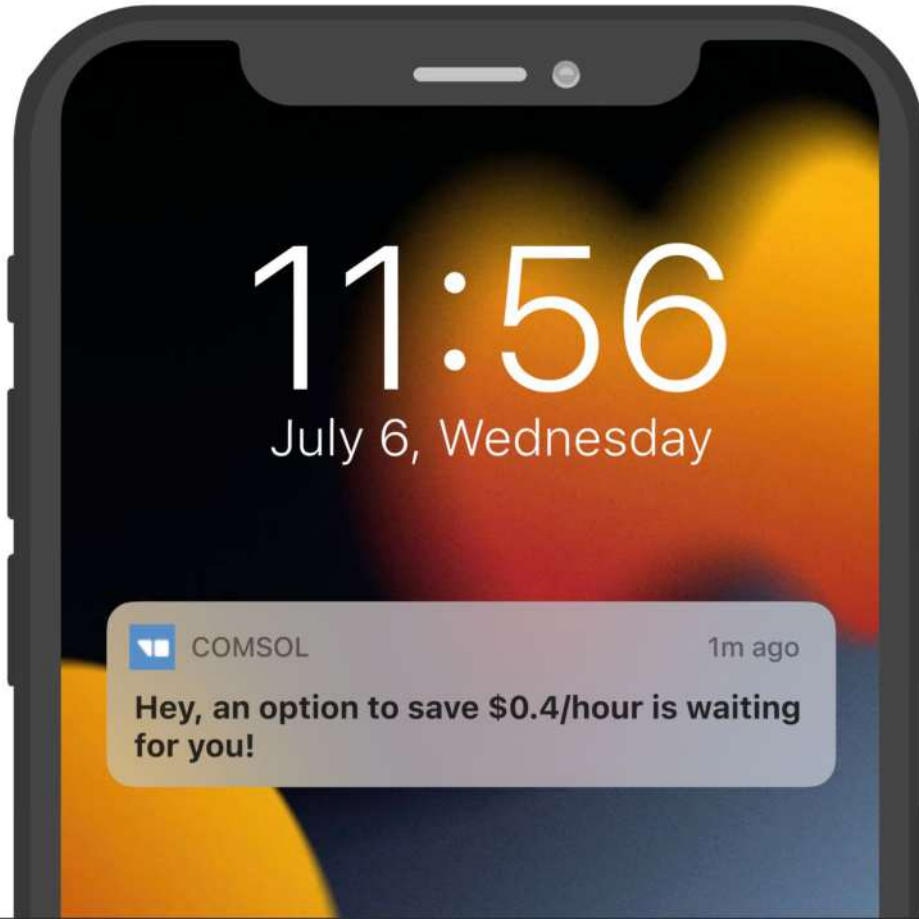


..which means you'll be arriving home late today

i.e. there is no need for your thermostat to be on your typical 5pm schedule!



you're on way out... and suddenly...



Hello!

We are;



Meltem Sahin Ozkoc

M.Sc. Building Performance & Diagnostics
M.Sc. Information Technologies for the Built Environment
B.Arch. Architecture

Carnegie
Mellon
University



Yuki Huang

M.Sc. Sustainable Design
M.Arch Architecture
B.Arch. Architecture

Carnegie
Mellon
University

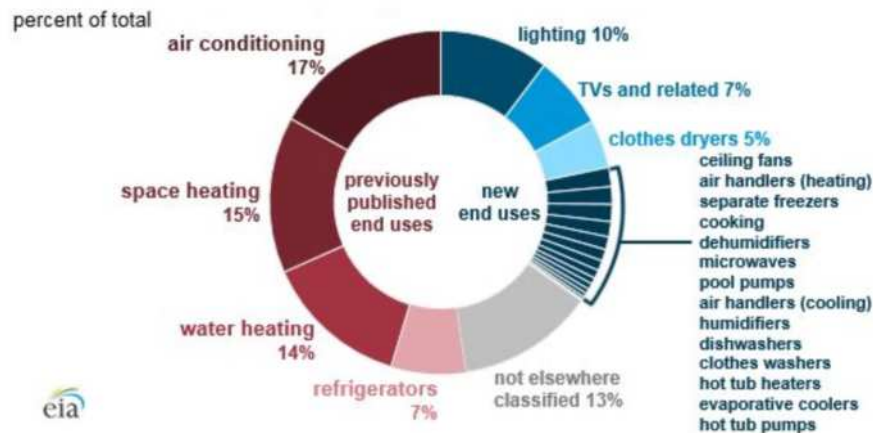


With focus on:

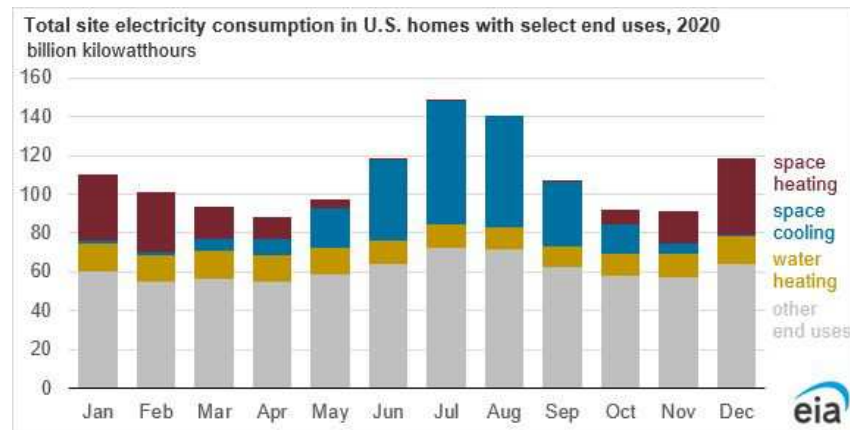
Built world analytics

Life cycle analysis

HVAC is almost **50%** of building's end use and space conditioning is the biggest portion of it.



Source: U.S. Energy Information Administration, 2015 Residential Energy Consumption Survey



Source: <https://www.eia.gov/consumption/residential/>

Challenge statement we were given

Create a physics-based application that models building performance and identifies actionable HVAC efficiency improvements.



“

How we interpreted it

Make building physics **simple**
enough to run anywhere, but
smart enough to change HVAC
behavior.



“

How we interpreted it

Cloud-connected
HVAC assistant
powered by **COMSOL**
physics models



“

Google Nest has “Home/Away Assist” logic but lacks physics-based actionable insights!

*Claimed** to have:

- 12% heating savings
- 15% cooling savings

*based on aggregated user data

Source: [Google Nest Thermostat: Popular Settings & Features - ARS/Rescue Rooter](#), [Saving energy starts with your thermostat](#).



NREL's research shows combining occupancy prediction + weather-forecast-based HVAC control saves

- **22-41%** HVAC energy in simulation studies

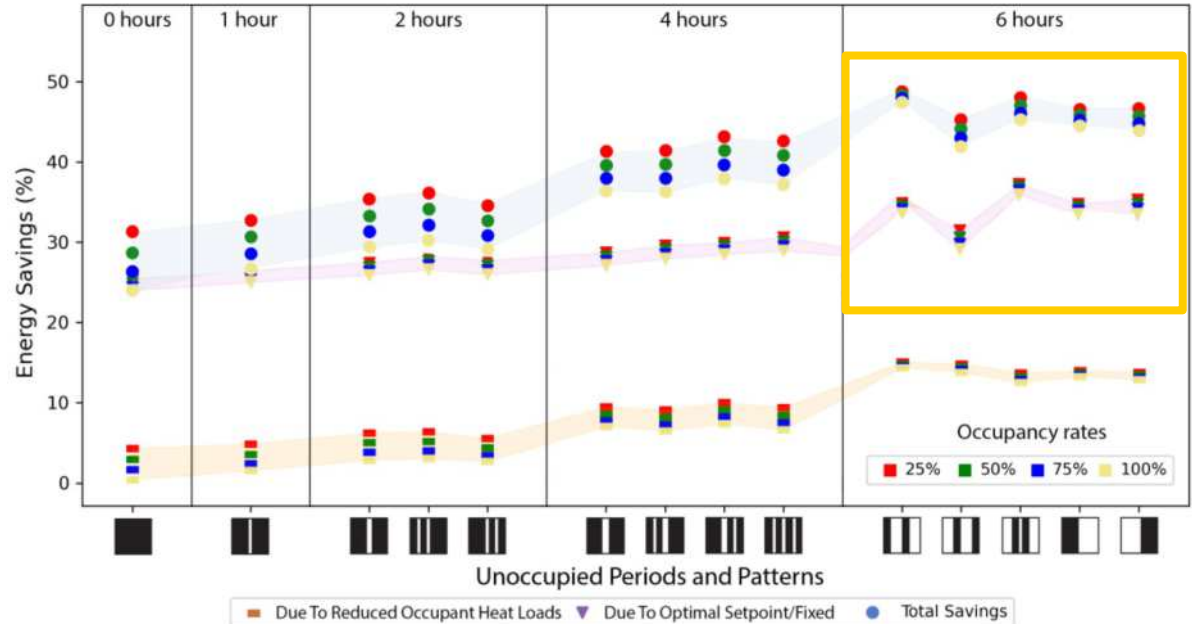


Source: Development and evaluation of occupancy-aware model predictive control for residential building energy efficiency and occupant comfort

Recent NUS research shows, combined occupancy + MPC reduces:

- Cost up to 34-38%
- Energy use by 50% in some cases*

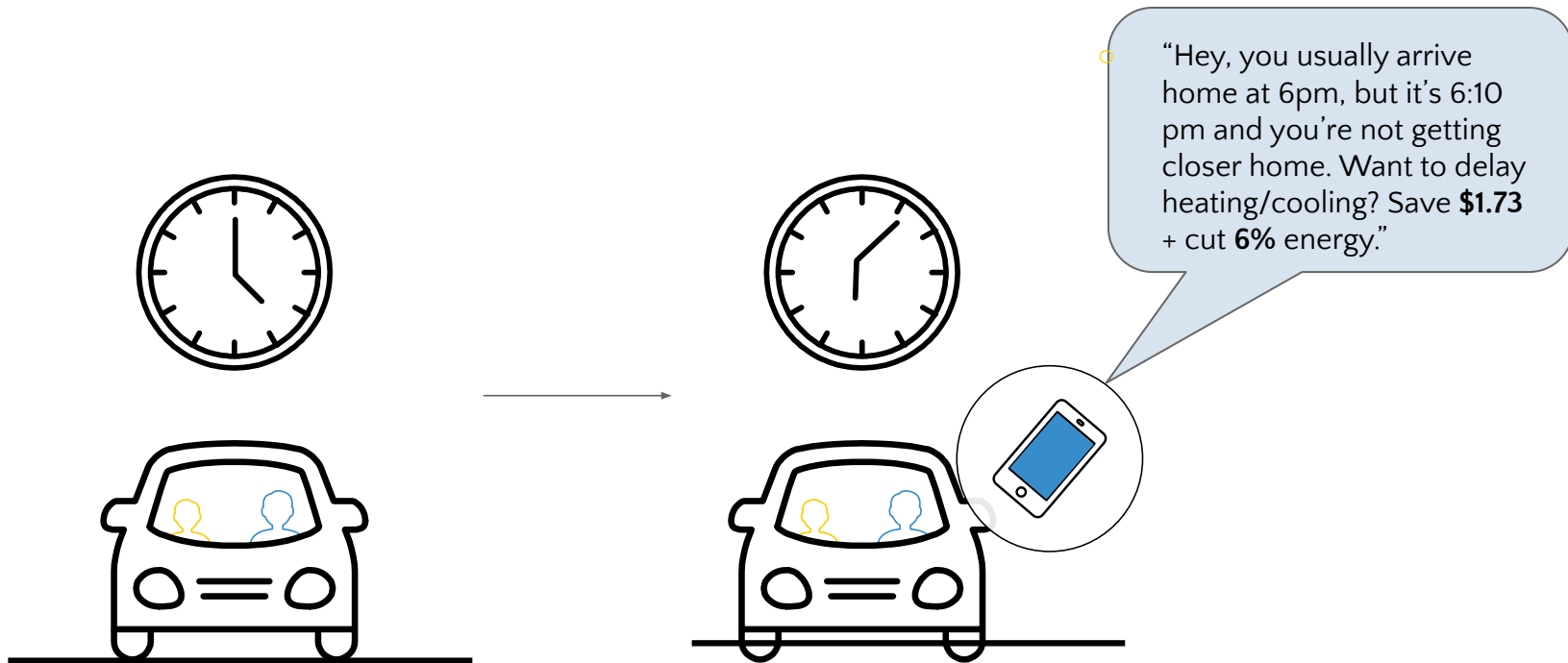
*combined with reduced internal gain



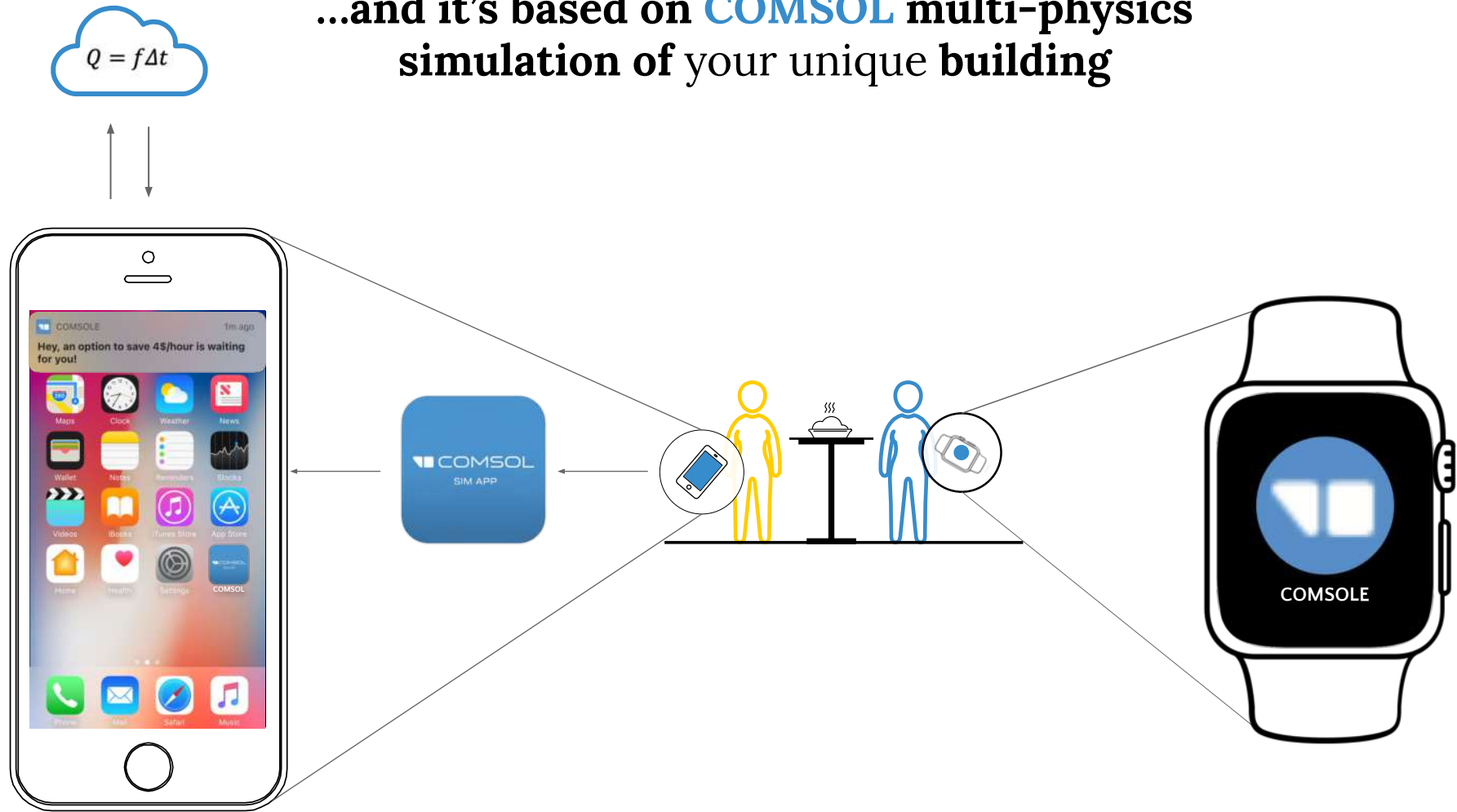
Source: [Quantifying Energy Savings from Optimal Selection of HVAC Temperature Setpoints and Setbacks across Diverse Occupancy Rates and Patterns](#) (2023)

COMSOL-Client tracks your location, notices you'll be late home

You just need to **tap** to adjust HVAC schedule!



...and it's based on **COMSOL** multi-physics simulation of your unique **building**



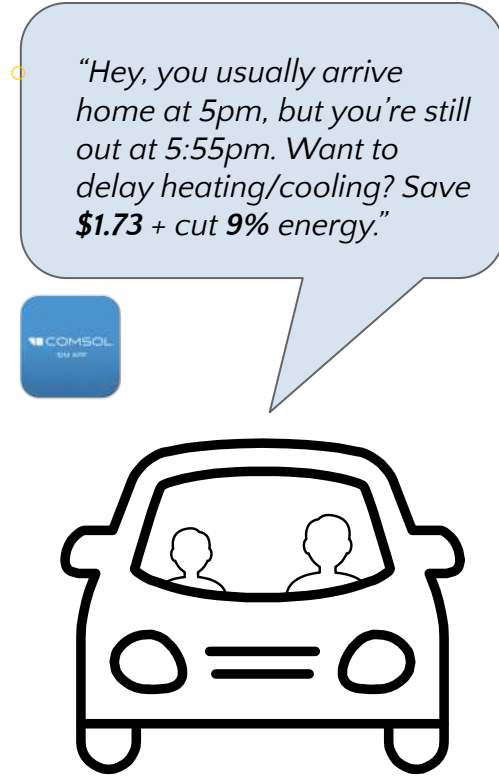


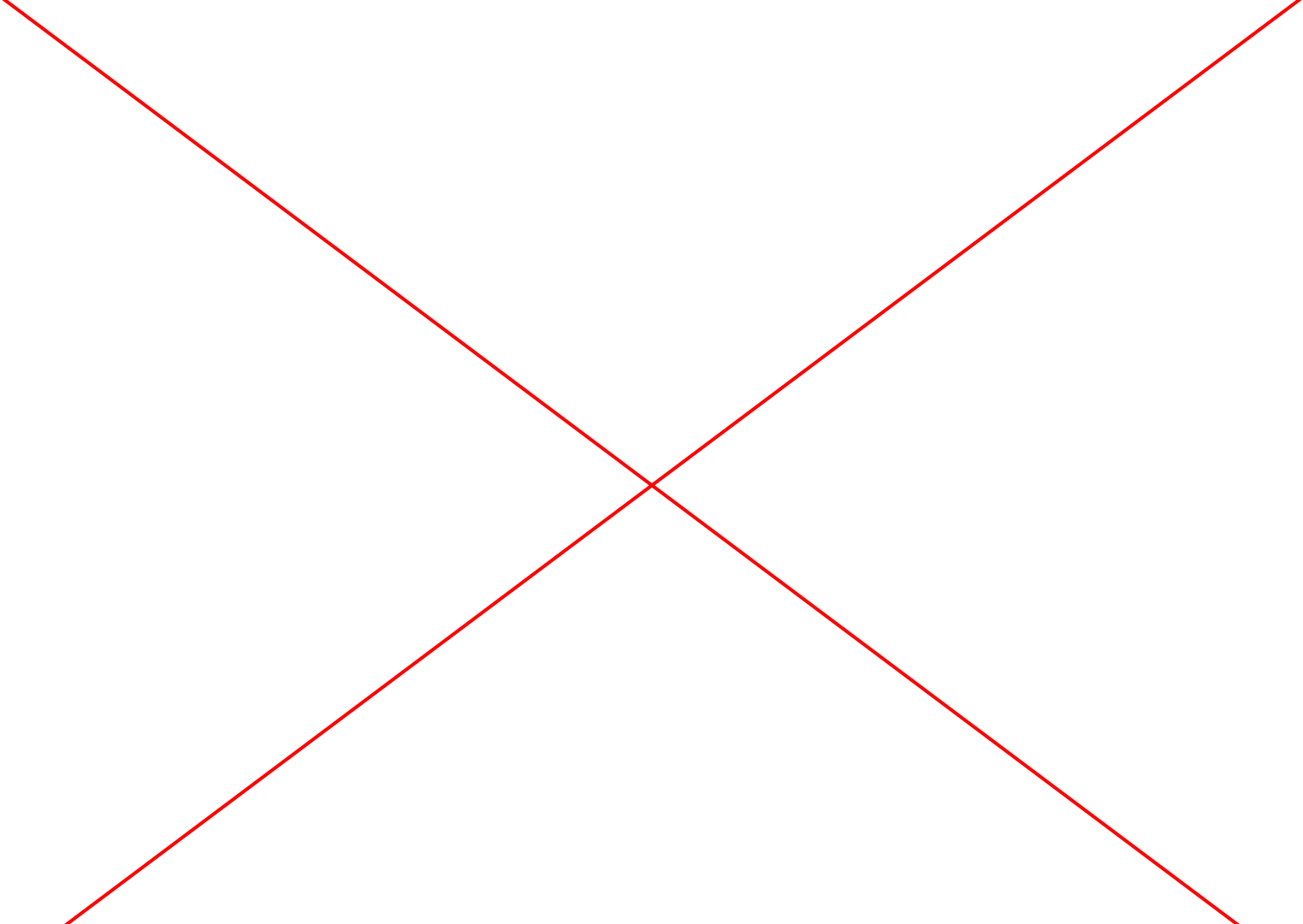
We imagine a **COMSOL**-centric world...

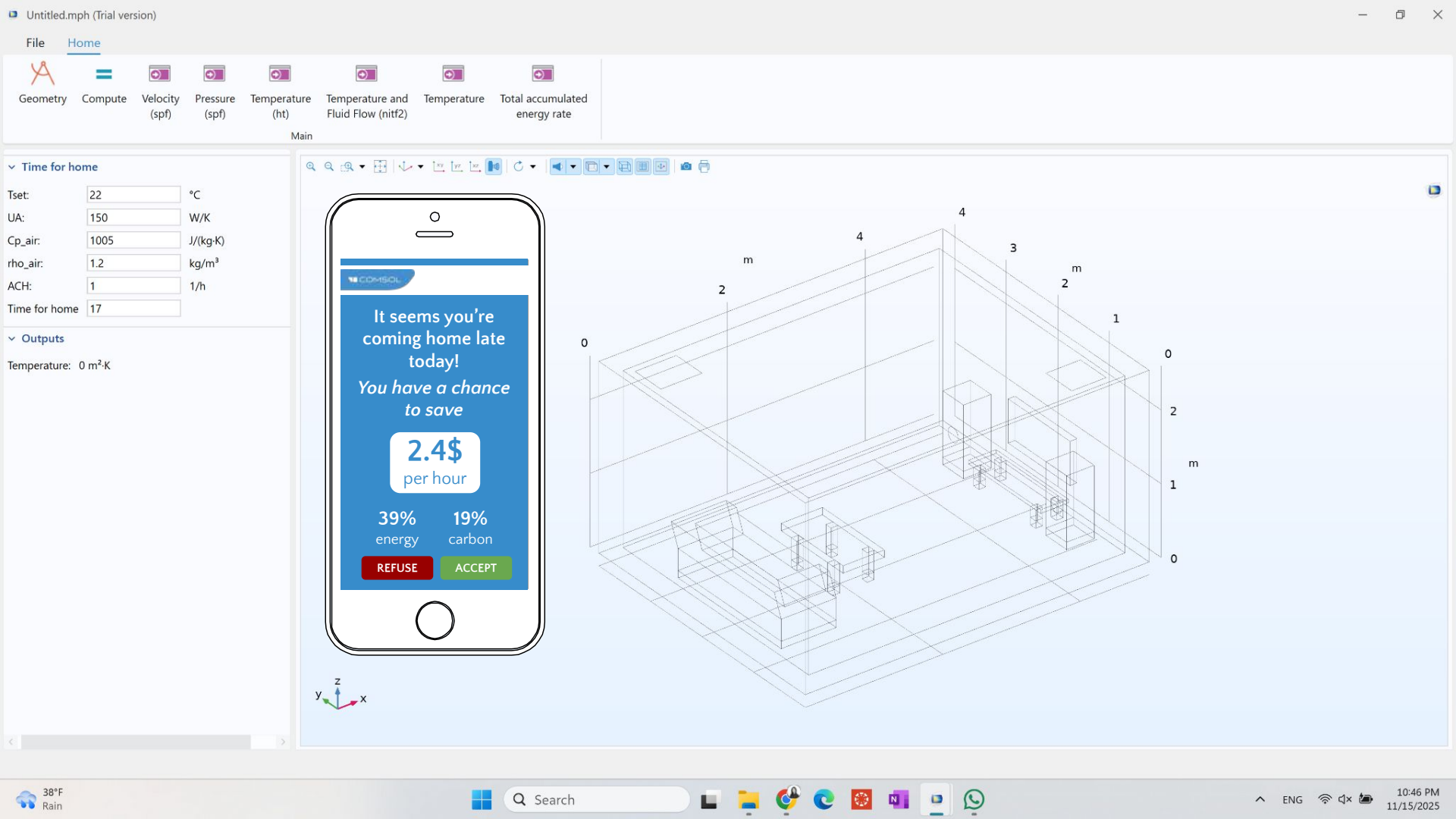
...where users get:

- A **mobile & web app** that tracks their thermostat routine using **geolocation + schedule prediction**
- A **cloud-hosted** COMSOL simulation engine (*COMSOL Server/Compiler*) that runs a fast physics-based surrogate model
- **Real-time notifications + savings insights** (\$, kWh, CO2)
- A **simplified shoebox building model** generated from **user inputs** (sqft, walls, insulation, window area, HVAC type, climate).
- **Actionable HVAC efficiency suggestions** like optimal setback schedule, insulation ROI, thermostat setpoint curves.,

powered by real **physics**, not data-driven **black-box** models.







44.36\$

Saved this year. That's a good amount of money...

1.4 kg CO₂

Carbon emission saved

+24%

More efficiency/hour

- Consider upgrading your HVAC system
(ROI: \$\$\$, 10 months)
- Consider buying a heat pump
(ROI: \$\$\$, 1 year)
- Consider upgrading your windows
(ROI: \$\$, 3.5 years)
- Consider upgrading your insulation to R13
(ROI: \$, 2 years)
- ...



44.36\$

Saved this year. That's a good amount of money...

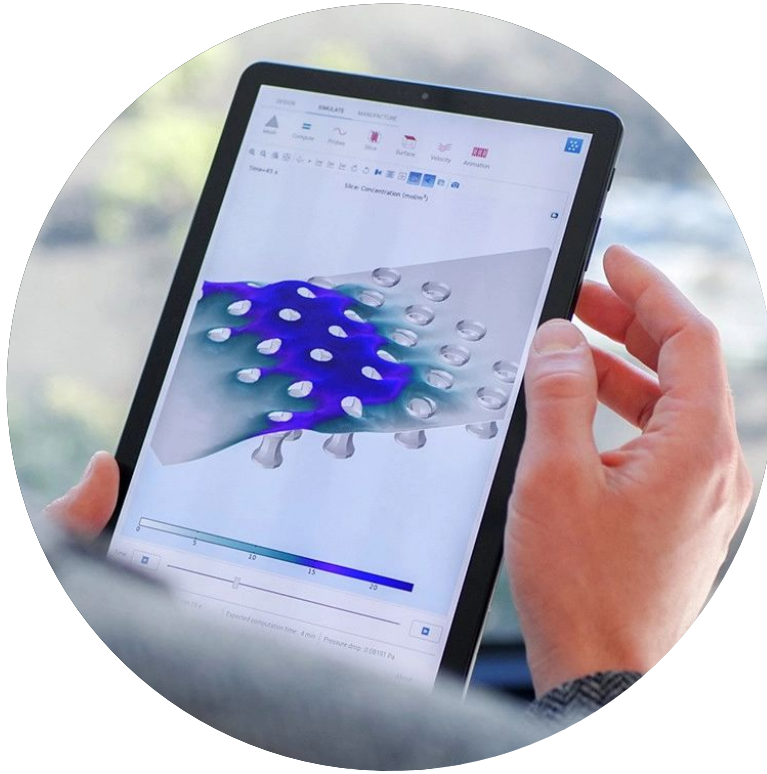
1.4 kg CO₂

Carbon emission saved

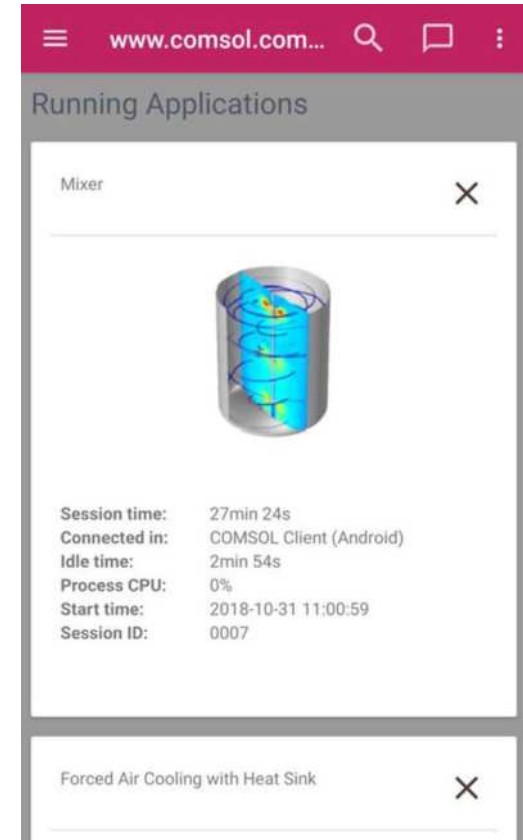
+24%

More efficiency/hour





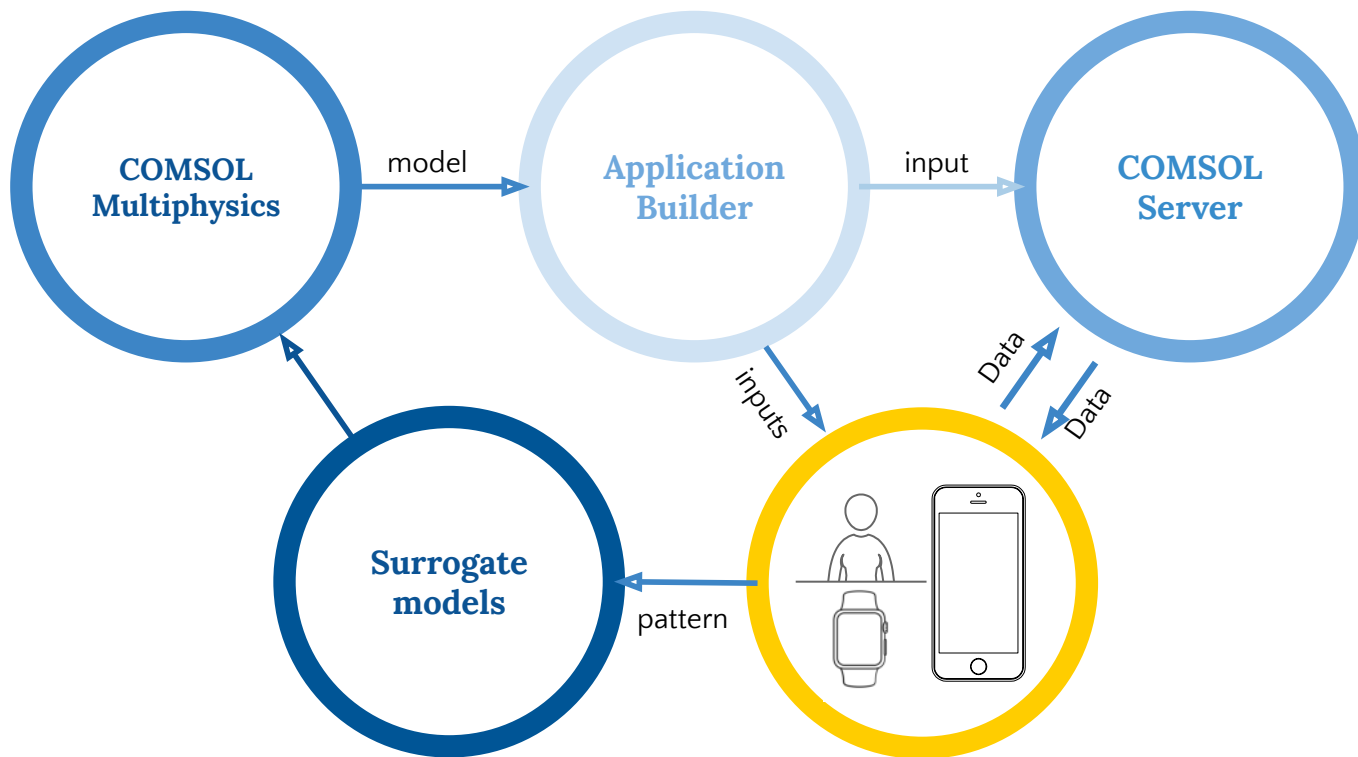
We propose a
valid case study
extension for
the existing
COMSOL-Client



Source: <https://audioxpress.com/news/simulation-on-the-go-with-comsol-client-for-android>



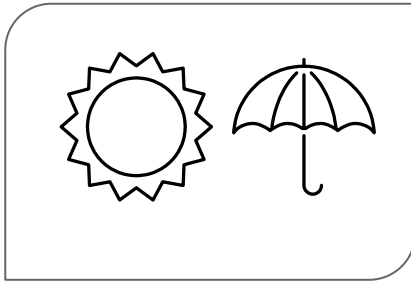
COMSOL+



INPUTS



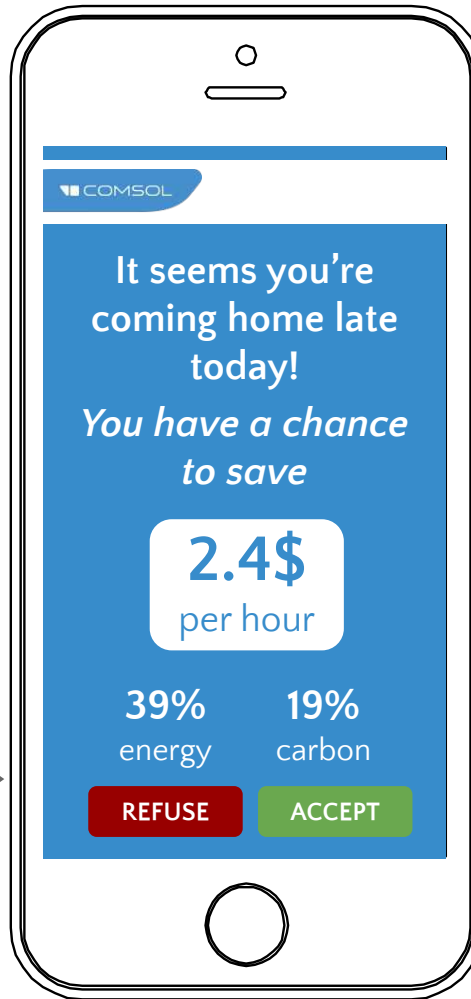
Smart thermostat API



Weather API



Geolocation (GIS)



OUTPUTS

\$ **cost** saving

kWh **energy** saving

CO2 **carbon** saving



Thanks!

Any **questions** ?



Meltem Sahin Ozkoc

Building Performance & Diagnostics,
Carnegie Mellon University

msahinoz@andrew.cmu.edu

(Linkedin: @meltemzahinozkoc)



Yuki Huang

Sustainable Design,
Carnegie Mellon University

yukih@andrew.cmu.edu

