

# Crowdsourcing an Infrared Street View through Citizen Science



## The Team

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We appreciate your expertise and time on helping this project!

# **Research & Development**

# What problems are we trying to solve?

## Hypothesis

People are unaware of the energy waste in their homes or communities as heat transfer across the building envelope is often unnoticeable—until it is revealed by a thermal camera. An infrared street view, like Google's Street View, can become an Internet magnet that draws people's attention to energy efficiency – *the fifth fuel* —and hopefully ignites large-scale changes. For instance, people may improve the thermal efficiency of their residential or commercial buildings as infrared proofs of good conditions may add value and promote sale.

## Challenge

Unfortunately, previous IR scanning startups have all failed commercially (e.g., Essess and Sagewell). We need to develop a new technology and find a new business model that engages building owners, runs at a low cost, and is scalable worldwide.





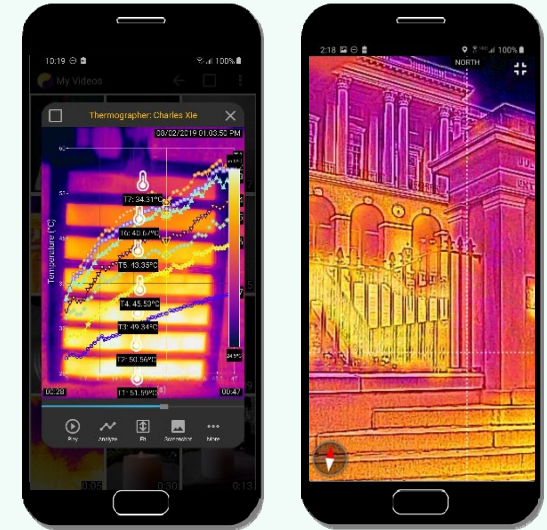
# If we create the technology, then who will use it?

## A new way

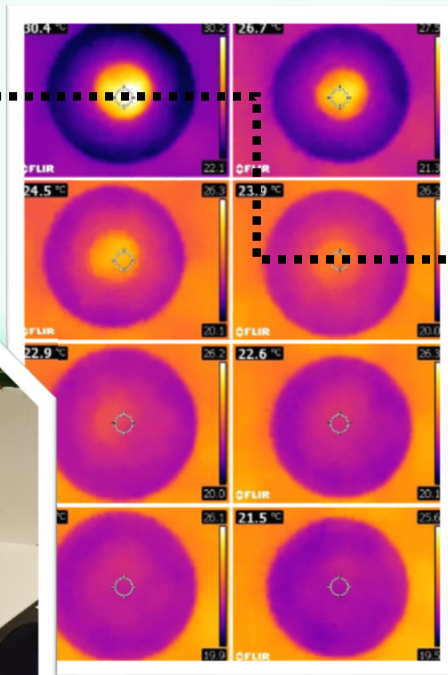
Based on innovative technology, our project aims to integrate energy efficiency, STEM education, and citizen science to make it possible to engage students to crowdsource the Infrared Street View, accomplishing something that would otherwise take a giant company like Google to do.

**IR cameras to physical science can be as instrumental as microscopes to biological science.**

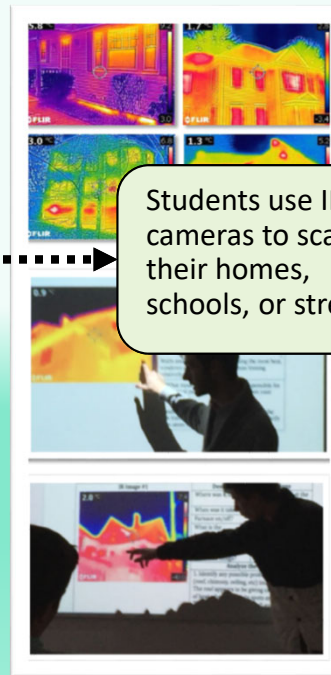
Everyone has to learn about heat and temperature in school. There is no better tool for teaching thermal energy and heat transfer than an IR camera.



Students learn science concepts in classrooms with IR cameras.



An IR experiment to observe thermal equilibrium

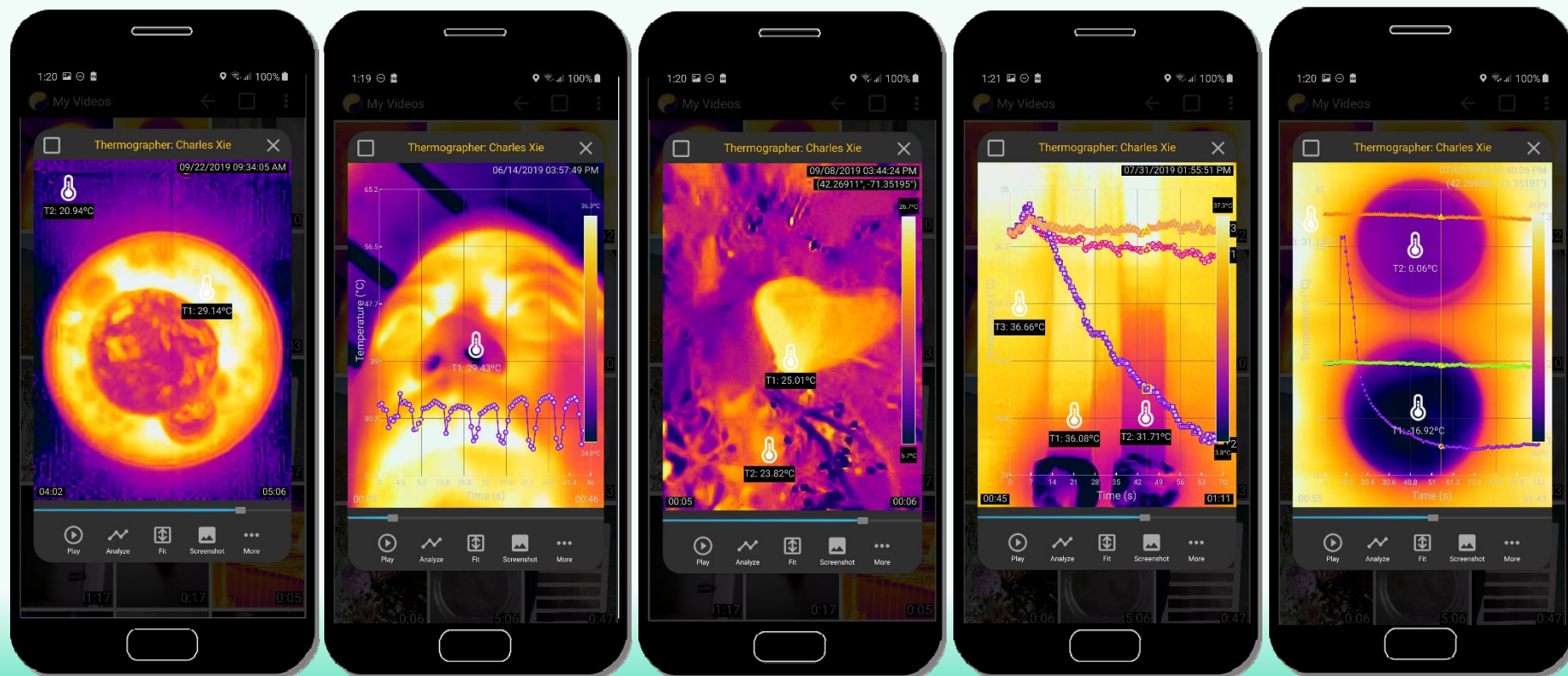


Students use IR cameras to scan their homes, schools, or streets.

**Formal-informal pathways from school science to citizen science**

Students contribute thermal images to the Infrared Street View (with parents' permission).

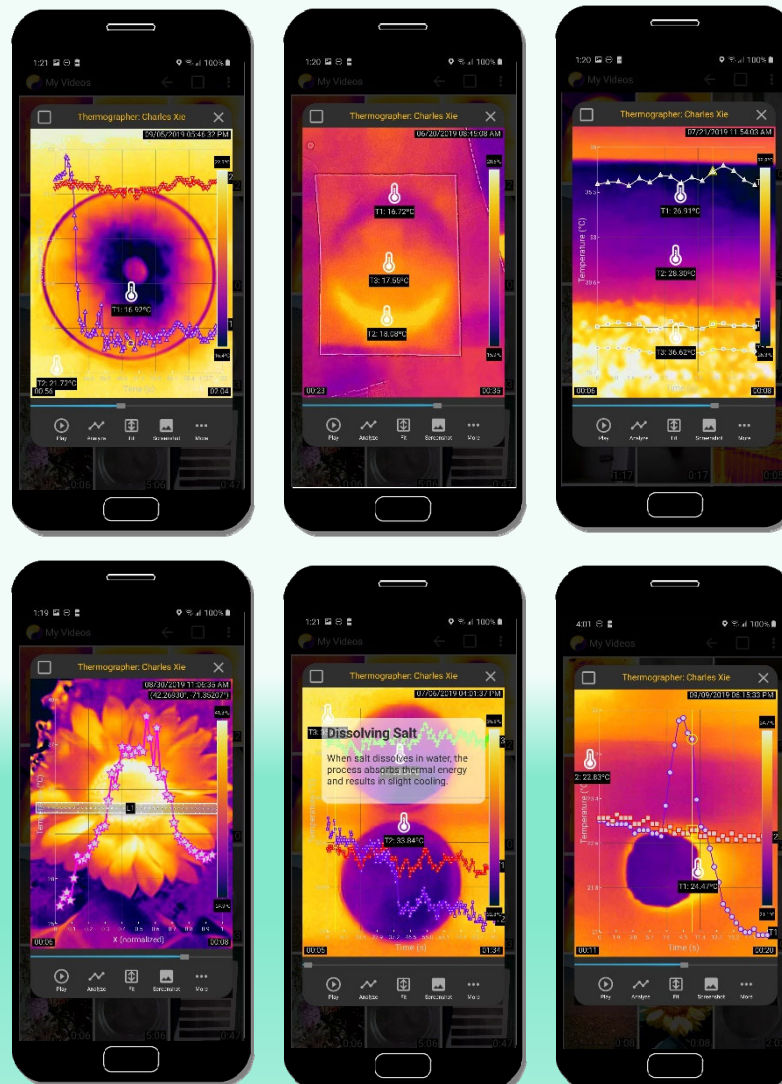
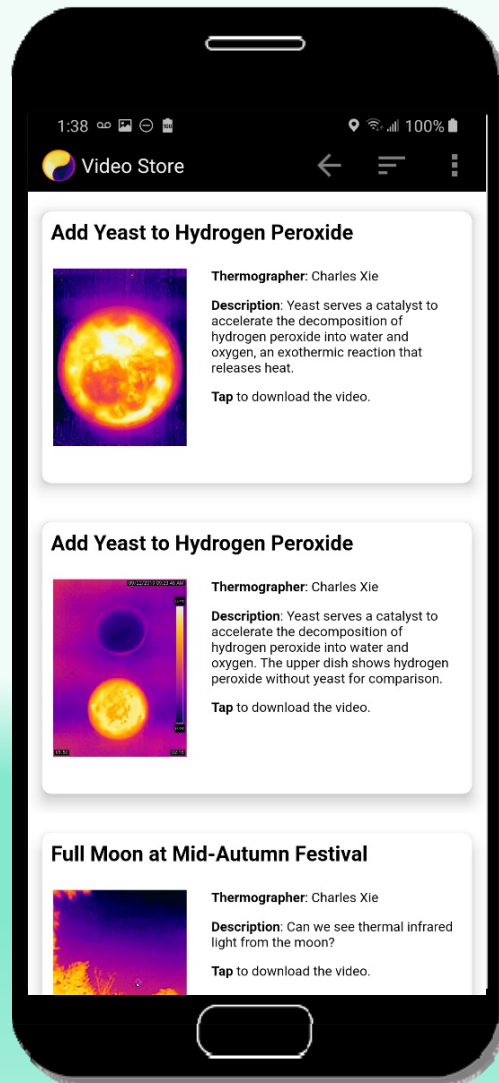
# Incredible science through an infrared camera



Anything that leaves a trace of heat leaves a trace of itself under a thermal camera.

"Captivating, intriguing, and thought-provoking" – *Journal of Chemical Education* editor's comments on our paper *Visualizing Chemistry with Infrared Imaging* (2011)

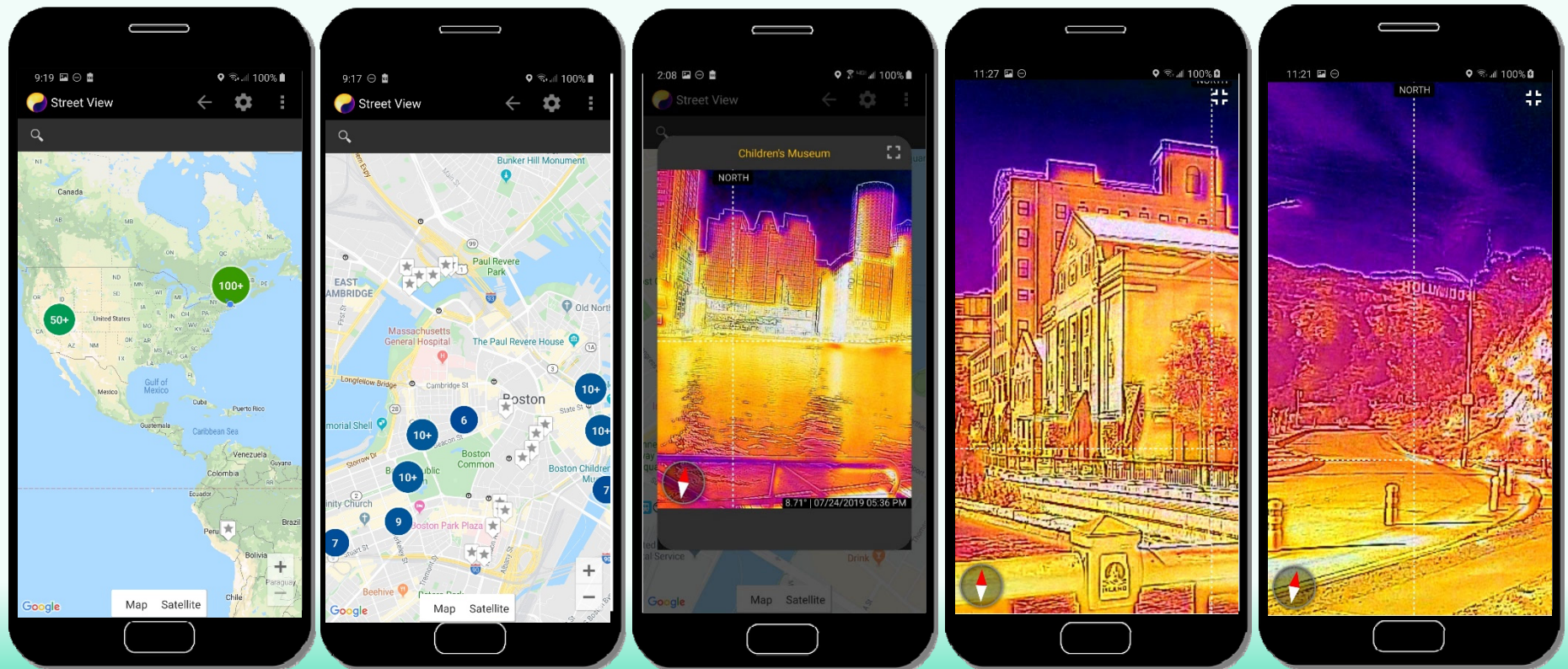
# In-app video store: Numerous recorded observations for download and analysis



Physics  
Chemistry  
Biology  
Geoscience  
Environmental Science  
Medicine  
Engineering  
...



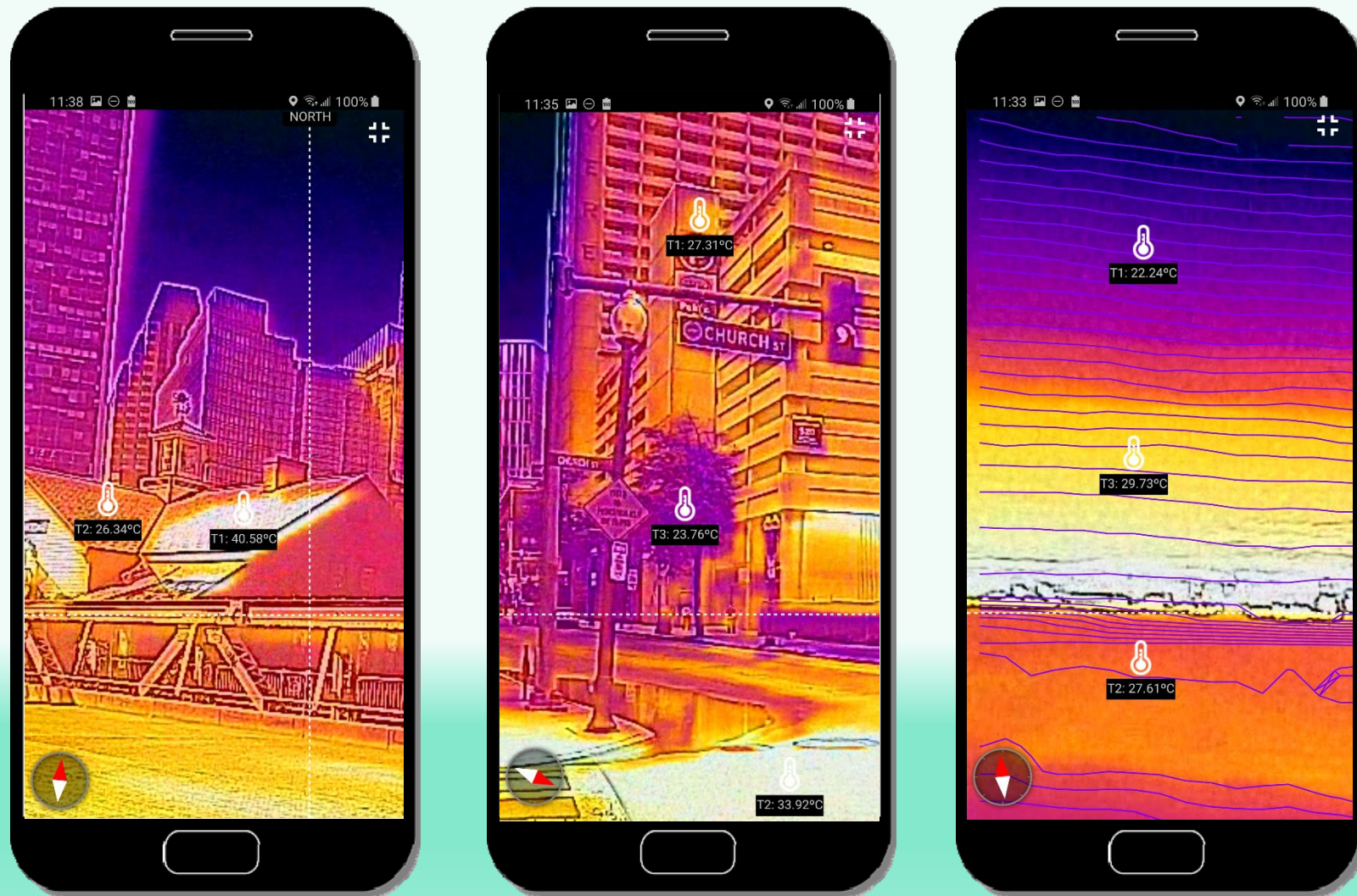
# Experimental infrared street scans in multiple locations



East Coast, West Coast, South America  
(Android version)



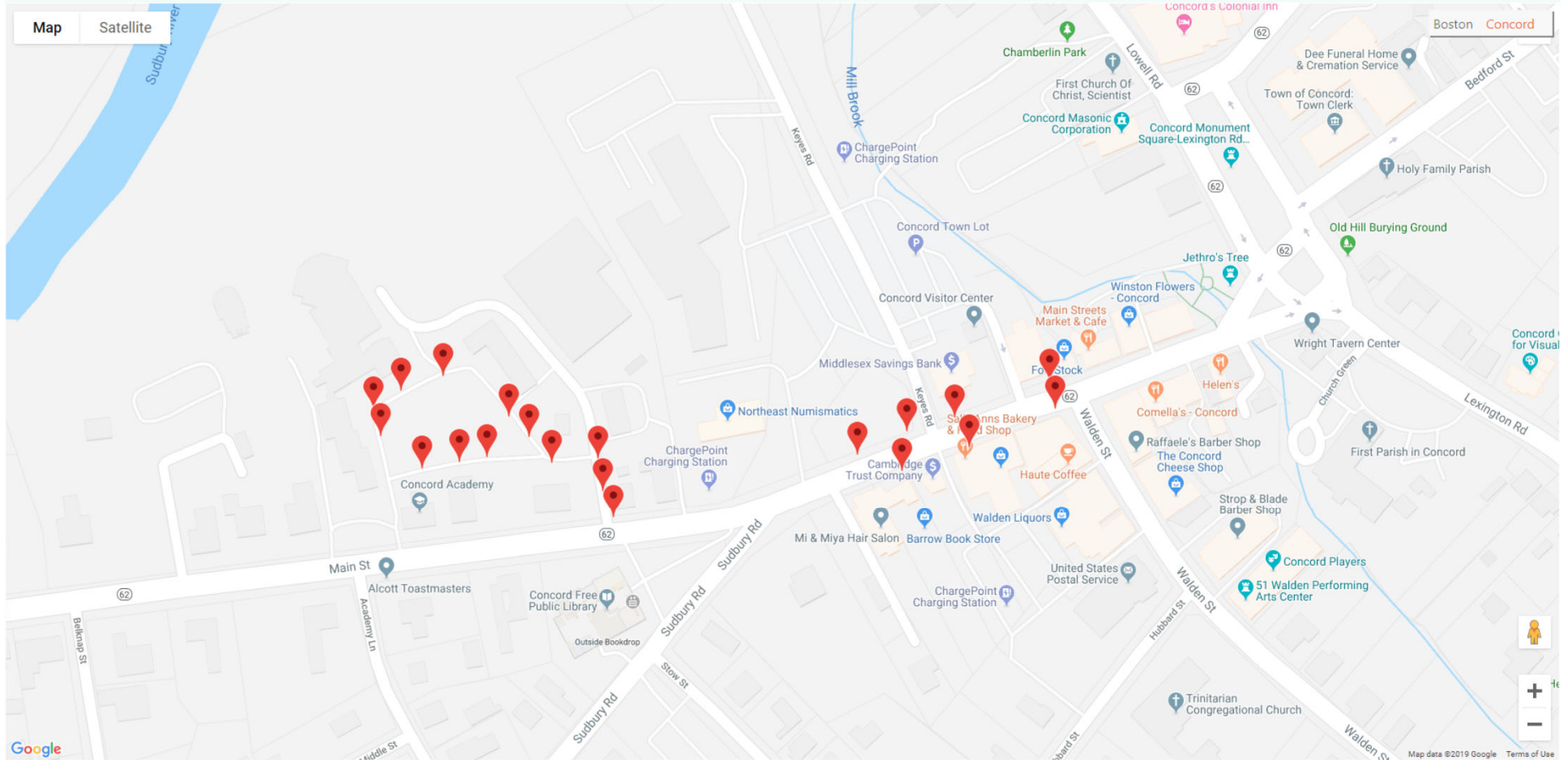
## What can we see from infrared street views?



Solar potential, thermal bridges, urban heat island, street science, wandering ghosts☺, ...

# An alpha version based on Google Maps and WebGL

<http://energy.concord.org/irstreetview/>



2D markers for infrared panoramas in Google Maps



# Switch between Google Street View and Infrared Street View

<http://energy.concord.org/irstreetview/>

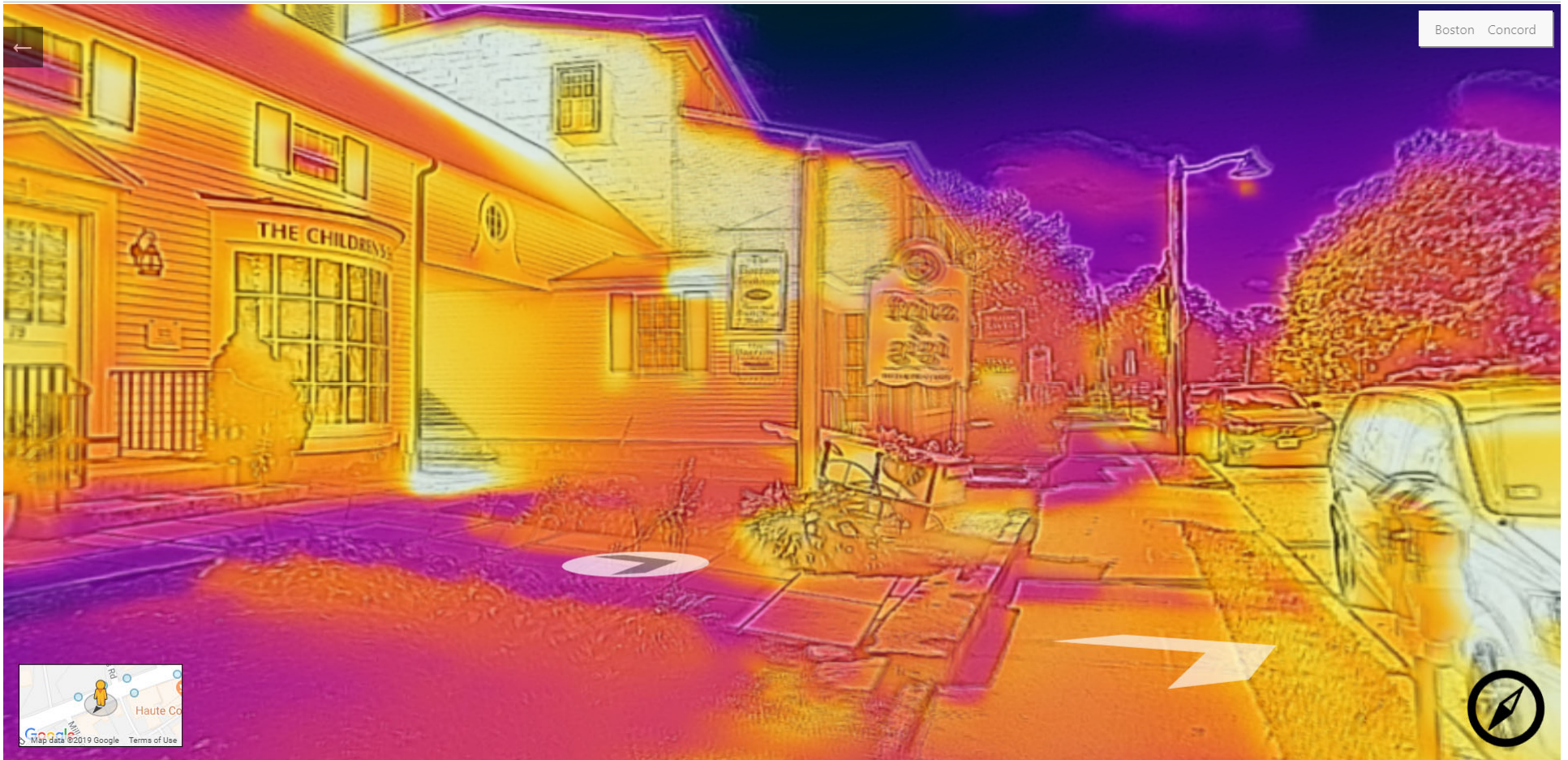


3D markers for infrared panoramas in Google Street View



# Immersive thermal vision in Infrared Street View

<http://energy.concord.org/irstreetview/>

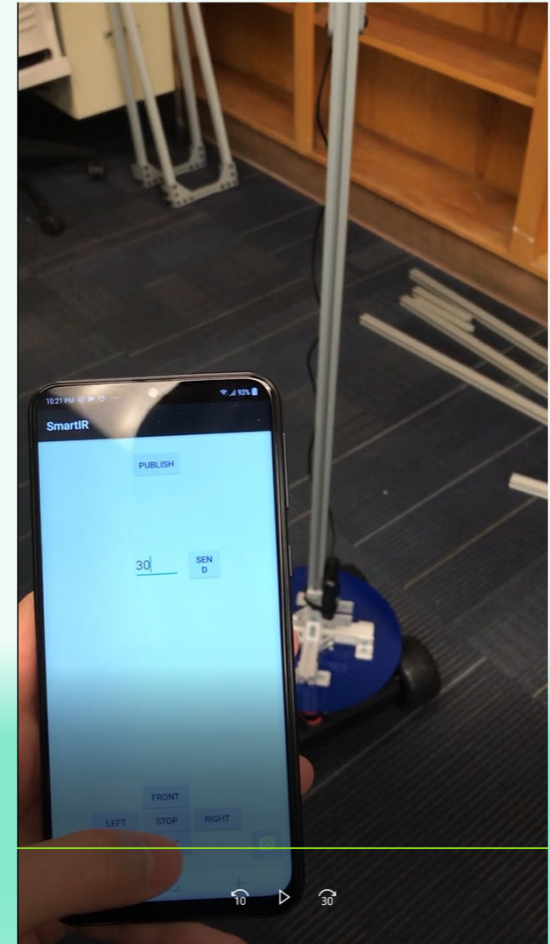
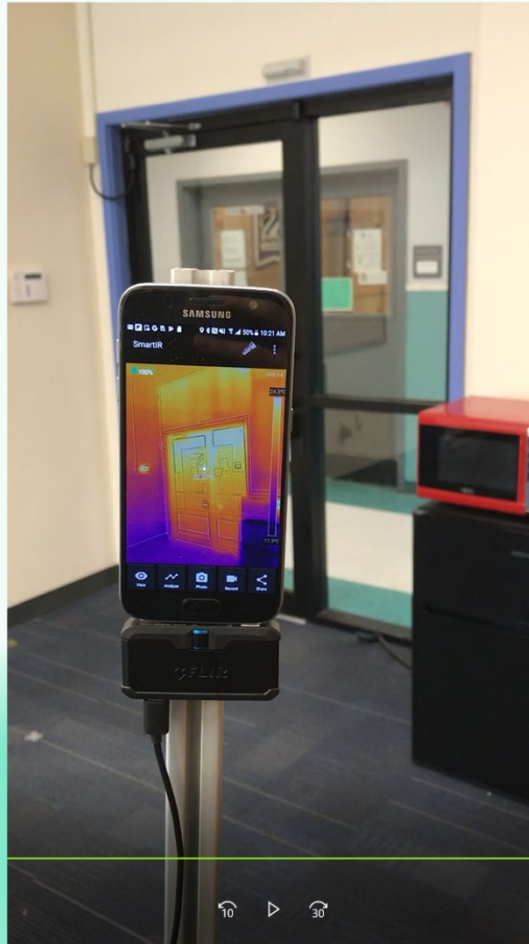


Infrared panoramas connected through embedded hotspots and navigation arrows create an immersive experience of walking on the street with 360° thermal vision.



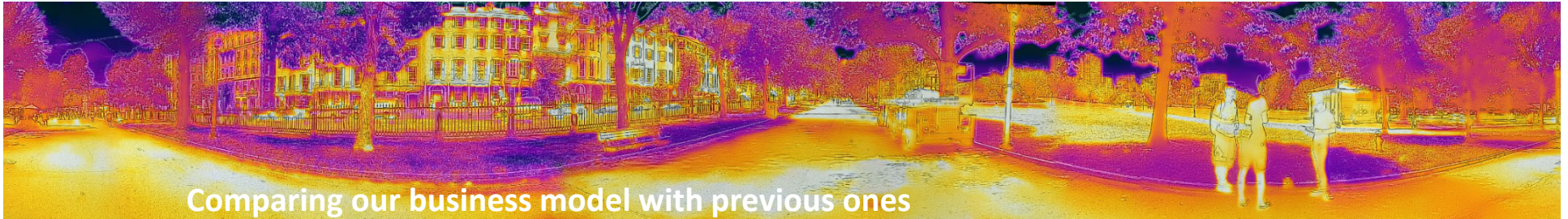
# Automating thermal scanning for large-scale applications

Manual scanning is tedious and error-prone. We need robots and cobots.



Contracted to the Robotics and Locomotion Lab at UMass Lowell

# What makes us think that we would have a better chance?



Comparing our business model with previous ones

	Our Model	Previous Models
<b>Strategy</b>	Start with the education of students who may be able to motivate homeowners (and who are future homeowners) and teach them how to interpret an IR image based on simpler school experiments about the science of conduction, convection, radiation, and so on, thus building customers' trust in and appreciation of IR thermography.	Start with IR images
<b>Scalability</b>	Engage a large number of students and volunteers (crowdsourcing through citizen science projects)	Drive-by trucks or fly-by drones
<b>Holism</b>	Take images of buildings from 360° angles	Front or aerial images
<b>Appeal</b>	Use 360° panoramic views and 3D virtual reality to enhance the visual effects	2D images
<b>Privacy</b>	Students scan their <i>own</i> houses, their neighbors' houses, or public buildings in their towns, and publish images only with permission by building owners and managers.	Unsolicited scans

## Who may want it?

- Real estate (infrared proofs of building conditions)
- Energy efficiency companies (customer acquisition)
- Governmental research (thermographic information system)
- Schools and colleges (inquiry-based, project-based learning for solving real-world problems)
- Amateur thermal lovers (believe it or not, they are out there in the winter)



# **Teacher Professional Development, School Implementations, & Educational Research**



## Teacher professional development workshop in York, ME, June 2019



### **NARST 2020 workshop proposal accepted**

*(Title: Next Generation Labs for Next Generation Science Standards: Mobile Sensing as an Example)*



**In the classroom**



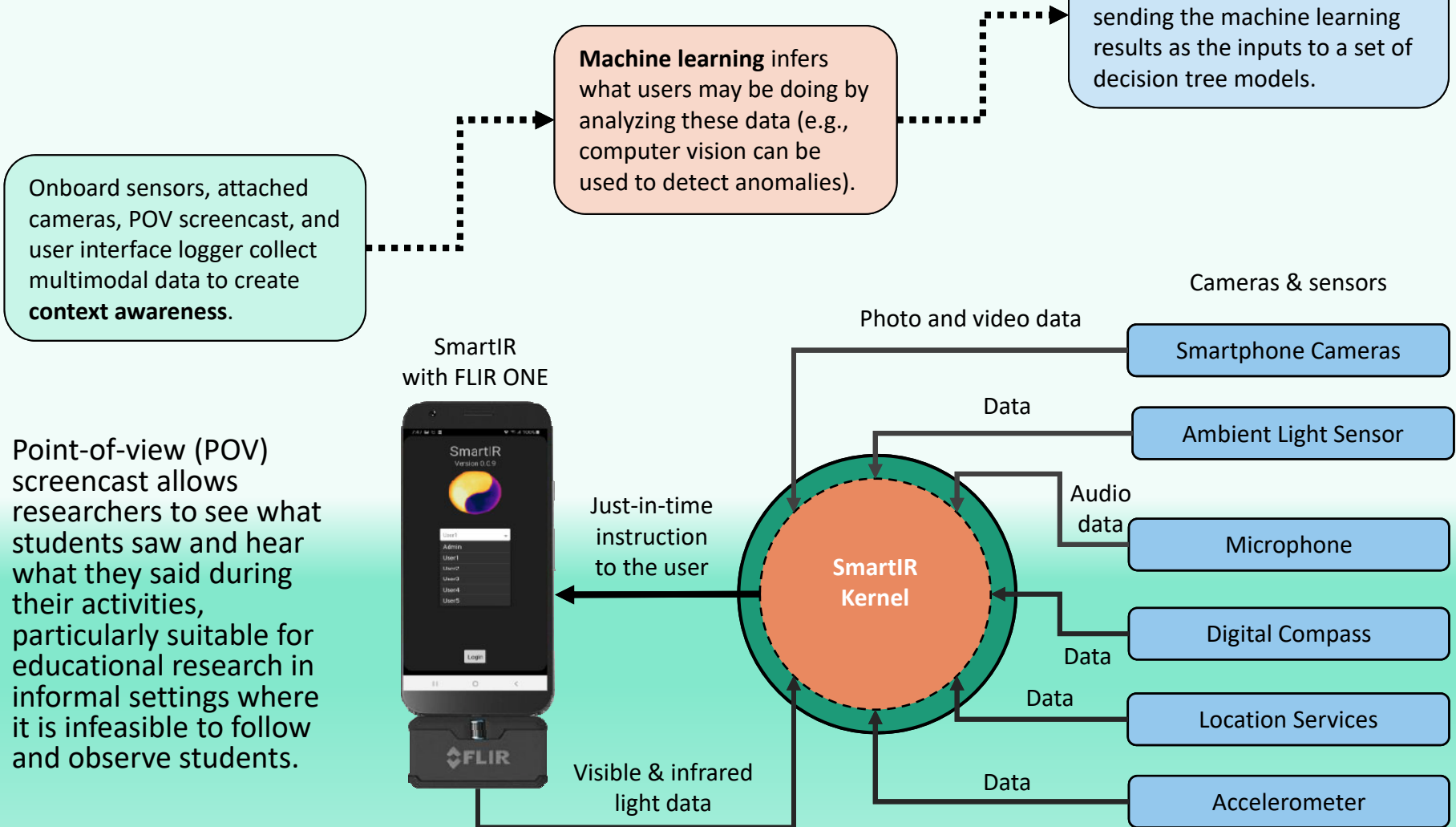
**143 students in a  
diverse local  
high school**

**October 2019**

# How can we collect data for educational research?

## Data mining to the rescue

SmartIR collects fine-grained sensor, image, video, and gesture data that are being mined to understand learning in the formal and informal contexts and across.



## Future plans in the no-cost extension year

Goal: Focus on citizen science

Strategy: Collaborate with informal science educators

Michelle Hall, Teen Science Café, Science Education Solutions  
David Sittenfeld, Vicked Hot Boston, Museum of Science  
Darlene Cavalier, SciStarter, Arizona State University  
Jeremy Hoffman, Science Museum of Virginia

Goal: Develop artificial intelligence for automatic thermal analysis

Strategy: 3D thermal mapping onto building envelopes

Construct 3D dynamic thermal models of buildings

Goal: Disseminate results to educator communities

Strategy: Publications and presentations

Submit papers to *Journal of Science Education and Technology*,  
*Computers & Education*, *Science Teacher*, ... Start a SciStarter project

# **Thank you very much for your time!**

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