Radon Mitigation through Optimized HVAC Scheduling

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Problem

Radon is a naturally occurring radioactive gas that is the second leading cause of lung cancer after smoking tobacco.

Its invisible and odorless nature often leads to it going undetected which poses a significant health threat in susceptible areas, especially schools.

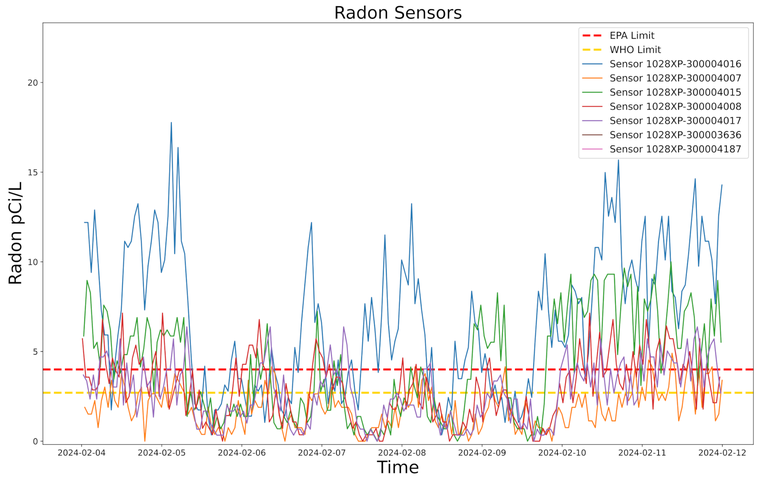
With sporadic fluctuations in radon levels and a lack of stringent testing regulations in educational institutions, **countless students and staff unknowingly face heightened health risks**.

One common mitigation strategy includes sub-slab depressurization (SSD). This method drills holes into the floor slab of a building and create negative pressure to draw out the noxious gas through an exhaust pipe.

While SSD proves to be a reasonable measure for private properties, the **cost of these strategies can become prohibitively expensive** and difficult for older and larger structures.

A possible, cost-effective alternative is to **harness the existing HVAC infrastructure to circulate the radon contaminated** air with fresh air outside the building.

We propose a framework that analyzes radon rates of susceptible buildings and **creates an cost-effective, optimized HVAC schedule for mitigation**.



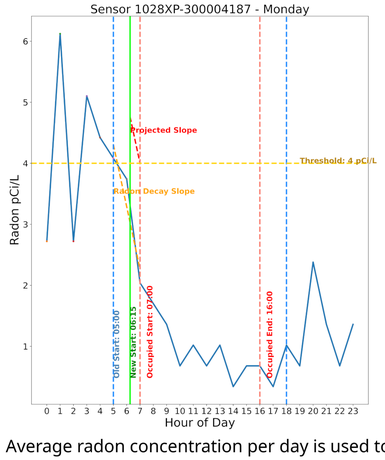
Radon levels at Naples Elementary School. Note the weekends tend to have higher levels of radon accumulation due to the lack of HVAC system use.

Floormap of Naples Elementary School in Naples, Utah. SunRADON 1028XP CRMs are indicated by the maroon points. Each block of classrooms in a different color represents different HVAC zones.

Methodology

To characterize the radon accumulation patterns inside the target building, we deploy a fleet of **SunRADON 1028XP CRMs in both high and low radon-concentrated zones**.

We monitor radon across two different periods HVAC schedule types: **control and extended**. We analyze the radon trends on a day-by-day basis and **create a third optimized schedule** which finds the **balance between health impact and power consumption**.



Average radon concentration per day is used to characterize the radon decay and predict the latest the HVAC system can be turned on in order to bring it to a suitable threshold

Creating Optimized Schedule

Our framework does the following during the analysis process:

(1) Average all radon values for a specific day of the week for specific testing period.

(2) Plot and **determine the slope of radon decay** between HVAC on time and building occupancy.

(3) Solve for starting point to ensure radon crosses acceptable threshold in time for beginning of school day.

Results

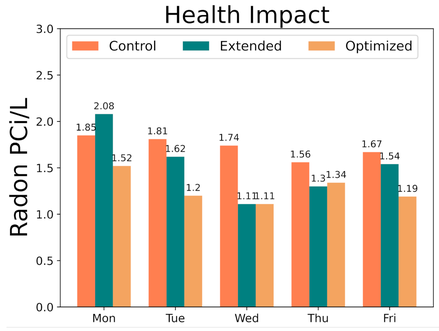
To develop our framework for HVAC radon mitigation, we deployed six SunRADON 1028XP CRMs at Naples Elementary School to monitor radon levels during the occupied hours of the building.

Across all HVAC zones in the building, **we use our optimization schedule creation algorithm to determine new "HVAC on" times** for each HVAC zone. We take the earliest start time and use that for the schedule.

We note that the optimized times are later than the extended time and occasionally the control time. This indicates that the **optimized schedule use less energy than the extended schedule**.

	M	T	W	Th	F
Control	6:00am	6:00am	6:00am	6:00am	6:00am
Extended	5:00am	5:00am	5:00am	5:00am	5:00am
Optimized	**5:33am**	**6:23am**	**5:48am**	**5:38am**	**6:12am**

Comparison between HVAC schedule. The optimized schedule saves more energy by starting later than the extended and at times the control schedule.



Average health impact of HVAC schedules on radon accumulation inside Naples Elementary School.

Health Impact

We analyze the health impact of the optimized schedule by measuring the average radon level by the day of the week **during occupied times**.

We note that the averages for all the days are below the established EPA threshold. However, we notice that the optimized schedule **significantly improves radon levels from the control.**

Future improvements on the work will entail characterizing radon accumulation across seasons and creating various schedules or one master.

Acknowledgements

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