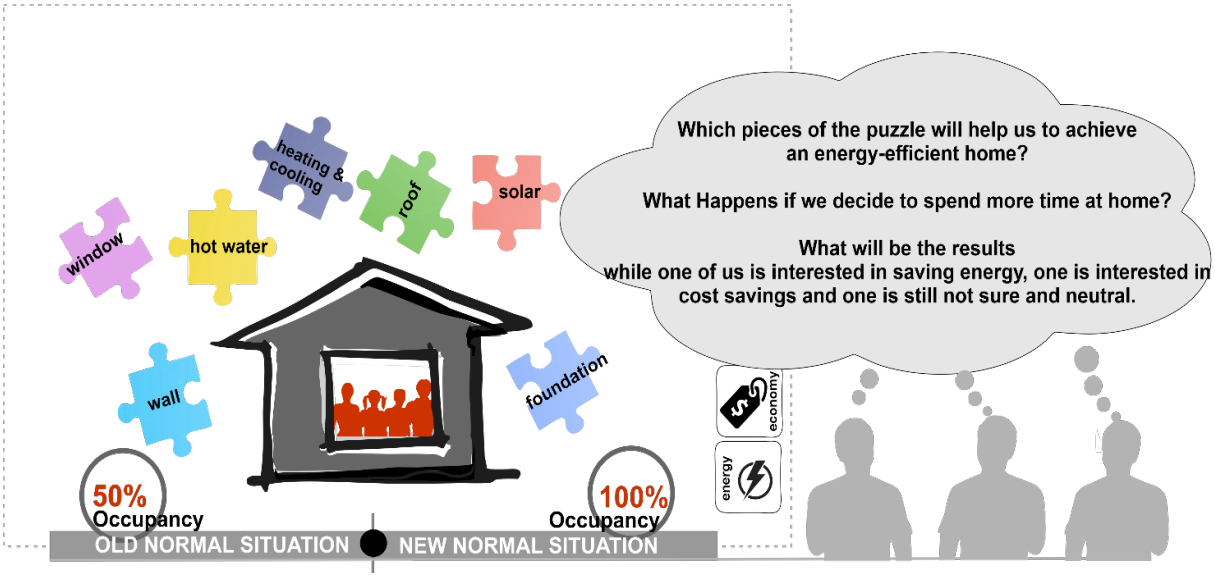
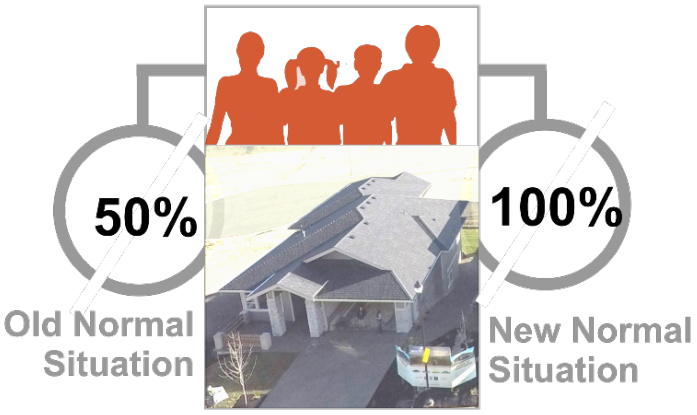
Impact of time spent at home on the selection of energy upgrades



The Wilden Living Lab (WLL) researched optimal energy upgrades under increased occupancy time under COVID-19 lockdowns.

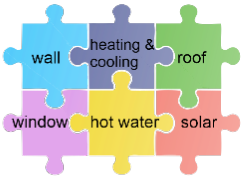
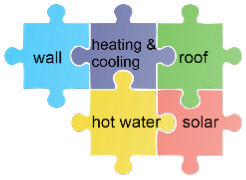
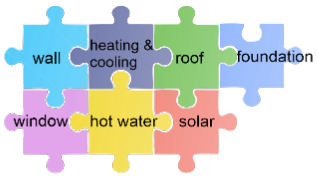
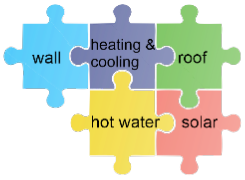
We all have observed how COVID 19 pandemic has impacted our lifestyle in the last couple of years. Staying for longer times at home and remote working (also called the “new normal situation”) are the two most outcomes of this pandemic. This new normal situation has significantly increased residential buildings' energy consumption mainly due to the increased use of air conditioning systems, appliances, and lighting. For example, researchers found a 30% increase in residential electricity consumption during the 2020 lockdown. In contrast, this change in occupancy also showed advantages, such as a better work-life balance, improved work efficiency, and enhanced focus at work. his lifestyle change opens a potential future design where "stay at home" can be a long-lasting strategy, especially when considering that staying home might be prolonged for reasons other than lockdowns such as age, health issues, and retirement.

Upgrading the heating and cooling system, window, roof, wall, solar, and other energy efficiency measures is a valuable technique for increasing energy efficiency and reducing energy bills. However, changing occupancy patterns could slow down the performance of these measures. Therefore, it is required to test the resiliency of upgrades under increased occupancy time. To this end, UBC Okanagan’s researchers investigated “Home of Today", a single-family detached home representing Canada's typical type of residential building, which was constructed in the first phase of the Wilden Living Lab project in 2016. This home has been occupied by four occupants (two working adults and two teenagers). Since the emergence of COVID-19, occupants have started spending more time at home. This research aims to see how homes can be made energy efficient when they stay at home 50% of time (old normal situation) or all 100% of the time (new normal situation). 100% is technically an extreme scenario which is not going to present but this analysis will give a good idea on what can happen if people stay at home for extensive time periods.



Seven energy upgrades, including wall, roof, heating and cooling system, windows, solar, hot water, and foundation were tested to find the best combinations (for old normal and new normal situations) that yield higher environmental and economic benefits. Details of these upgrades can be viewed in our previous blogs. The performance of each energy upgrade combination informed annual energy consumption (electricity and natural gas) and the associated payback period. Hence, each energy upgrade combination resulted in different energy use and payback period for the old and new normal situations. This means the puzzle pieces most suitable for the old normal situation may not fit the new normal situation.

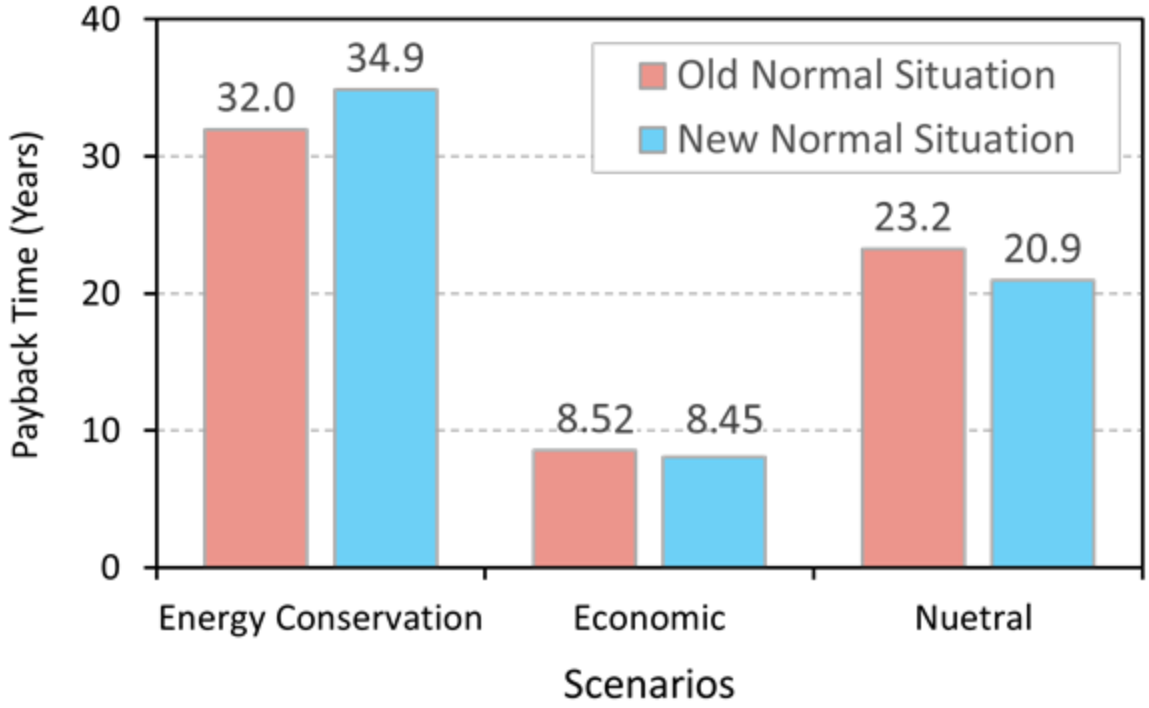
Stakeholders' priorities on energy upgrading including pro-energy (energy conservation is the priority), pro-economic (lowest payback period is the priority) and neutral (equally important) were also considered as three different scenarios to analyze performance of energy upgrades combinations. The results showed that the selection of optimal energy upgrade combination greatly depends on stakeholders' priorities in addition to the occupancy time. The optimal energy combinations for the three scenarios are shown in the table below.

	Scenarios		
	Energy Conservation	**Economic Impact**	**Neutral**
Old Normal Situation			
New Normal Situation			

For the pro-energy scenario, the optimal combination under the old normal situation is wall, heating and cooling, roof, window, hot water, and solar, while under new normal situation, implementing all seven

upgrades is recommended. Remarkably, the pro-economic scenario suggests the same result for the old normal and new normal situation where hot water is the optimal energy upgrade. This indicates when the main priority is low payback time upgrading the hot water system is the best option. When it comes to the neutral scenario which offers a balance between the energy conservation and payback time combination of wall, heating and cooling, roof, hot water, and solar upgrades performs the best. This indicates that the time spent at home doesn't have an impact on the optimal energy upgrade combination for pro-economic and neutral stakeholders. However, the detailed analysis also showed that there is a variation in ranking even for the top ten energy upgrade combinations as we move down. More details of these results are present in our upcoming research article.

The research also figured out the payback period of different scenarios for the old and new normal situations. The findings revealed that the payback period of energy upgrading is a bit longer under the latter situation. Under the old normal situation, the payback periods for pro-energy, pro-economic, and neutral scenarios are 32.0, 8.53, and 23.2 years, respectively, while the corresponding payback periods under the new normal situation are: 34.9, 8.46, and 20.9 years. Since the overall energy consumption is higher in the new normal situation, it was observed that energy savings potential increased; consequently, the related payback times decreased. Only exception was the pro-energy scenario case where for the new normal situation a higher number of energy upgrades were found more feasible compared to the old normal situation (see Table above) which requires more investment. Despite the increased potential for energy saving in the new normal situation, this corresponding cost saving cannot compete with this additional investment; therefore, the payback period is longer. This implies higher investments for enhancing the energy efficiency when designing homes for higher occupancy time if the main priority is preserving energy and the environment.



Usually, the primary concern of the occupants, developers, and contractors is "cost". The past studies also showed that investments in efficient technologies at the construction stage could result in life cycle cost reduction. However, if stakeholders' main concern is using less energy, the investments make sense even with more extended payback periods. Likewise, the non-energy benefits (better air quality, reduced noise, better health, and productivity, etc.) associated with a more energy-efficient and environmentally friendly building far exceed the monetary benefits.

Overall, this research found that stockholders' interests—whatever they want in terms of environment, economy, or neutral stance, will impact puzzle pieces that will fit the game.