### Abstract
Airtight construction of energy efficient homes increasingly limits the indoor and outdoor air exchange. Consequently, Volatile Organic Compounds (VOC) and Formaldehyde can accumulate to toxic levels. Formaldehyde is an eye and respiratory irritant suspected as one of the inducing agents of asthma [1]. Exposure to Formaldehyde has been linked to nasopharyngeal cancer and leukemia [2]. This study evaluated the effects of increasing ventilation rates through Energy Recovery Ventilator (ERV) in a new home. The study objective is to determine the effects of increasing ventilation rates on the concentrations of Formaldehyde and the associated emission rates. The results indicate that increasing ventilation rates effectively reduced Formaldehyde concentrations. However, increasing ventilation rates elevated the whole-house emission rates, which suggests more Formaldehyde was brought out from materials. This effect is expected to decline in the long term.

### Introduction
- Societies spend an average of 15-16 hrs/day indoors [3].
- Airtight home construction began in the 1990s to reduce heating and cooling leakage.
- Formaldehyde is emitted mainly from pressed wood products, but also in vinyl flooring, subfloor, carpets, and disinfectants [4].
- There is a need to evaluate the impact of increasing ventilation on materials emission and indoor concentration.

### Methods
- **Air sampling and analysis protocol**
  - Introduction Tracers
  - PMCH Tracer
  - PDCB Tracer
  - Collect Air Data
  - Calculate VOC & Formaldehyde Concentrations (GOMS & HPLC)
  - Calculate Whole-House Emission Rate (Mass Balance Equation)
  - Increase Ventilation Rate
  - Analyze Results
- **Active Sampling**
  - Sample collected with syringe and PFT air bags
  - Placement of PDCB (only first floor) tracer
  - Placement of PMCH (only second floor) tracer
  - Aldehyde and VOC sampling sites
- **Home Characteristics**
  - 1 year old, reconstructed
  - Air tightness of 1.0 NL at ACH50 (NL=Normalized Leakage, ACH=Air Changes per Hour)
  - Fully furnished and occupied home
  - Temperature controlled at 75°F
  - ERV was used to control ventilation in home

### Results
The following figures show the impact of ventilation rates on chemical concentrations and calculated emission rates:

![Image of Formaldehyde Concentration graph](image1)

**Figure 2.** 1st floor (left) and 2nd floor (right) with locations of PFT (perfluorocarbon tracer) emitter and sampling locations

### Discussion
- **Introduction**
  - ERV and subsequently increasing ventilation rates helps reduce Formaldehyde exposures.
  - Similar trend has been shown in previous homes (results not reported here) and other ongoing project by the NRCC (preliminary results reported in Aubin et al, 2010 [6]).
  - Results also indicate higher emission rates with ventilation.
  - It is envisaged that emission would decrease with time and eventually reach a lower steady-state proportional to lower loading in materials.
  - Increasing ventilation rates is expected to reduce long-term Formaldehyde exposure.

### References

### Acknowledgements
Special thanks to Marion Russell, Tosh Hutschi, Mary Connolly, Dr. Susan Brady, Dr. Hui-Ju Huang, Dr. Bryan Rebar, Celeste Flood, Jaime Arzu, Dr. David Andrews, and the Department of Energy Workforce Development of Teachers and Scientists, Lawrence Berkeley National Laboratory, Center for Science & Engineering Education.

This material is based upon work supported by the S.D. Bechtel Jr. Foundation and by the National Science Foundation under Grant No. 0955853 and 0954687. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the S.D. Bechtel Jr. Foundation or the National Science Foundation.