Residential Energy Savings from Air-tightness and Ventilation Excellence

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Presented to

California Energy & Air Quality Virtual Conference

(Hosted at LBNL, Berkeley, CA)

October 26, 2010

Background

- Title 24 building code leads U.S. for energy efficiency
- Quality homes are built tight to minimize air leakage
  - In tight home, infiltration does not provide adequate ventilation
  - California survey found that many people don't open windows
- California has adopted ASHRAE ventilation standard
  - Minimum mechanical ventilation for outdoor air exchange
  - Specific requirements for kitchen and bath exhaust
  - Energy efficiency of ventilation systems <u>not</u> addressed

Concept of RESAVE

- Possible to provide ventilation for indoor air quality and health with energy efficient strategies
- Integrated program including research and application
- Air sealing and indoor air quality
  - Air tightness; Pollutant source reduction; Efficient kitchen exhaust
- Efficient ventilation technologies
  - Intermittent mechanical; Sustainable ventilation; Commissioning
- Implementation
  - Retrofit guidelines; Title 24 support; Integration

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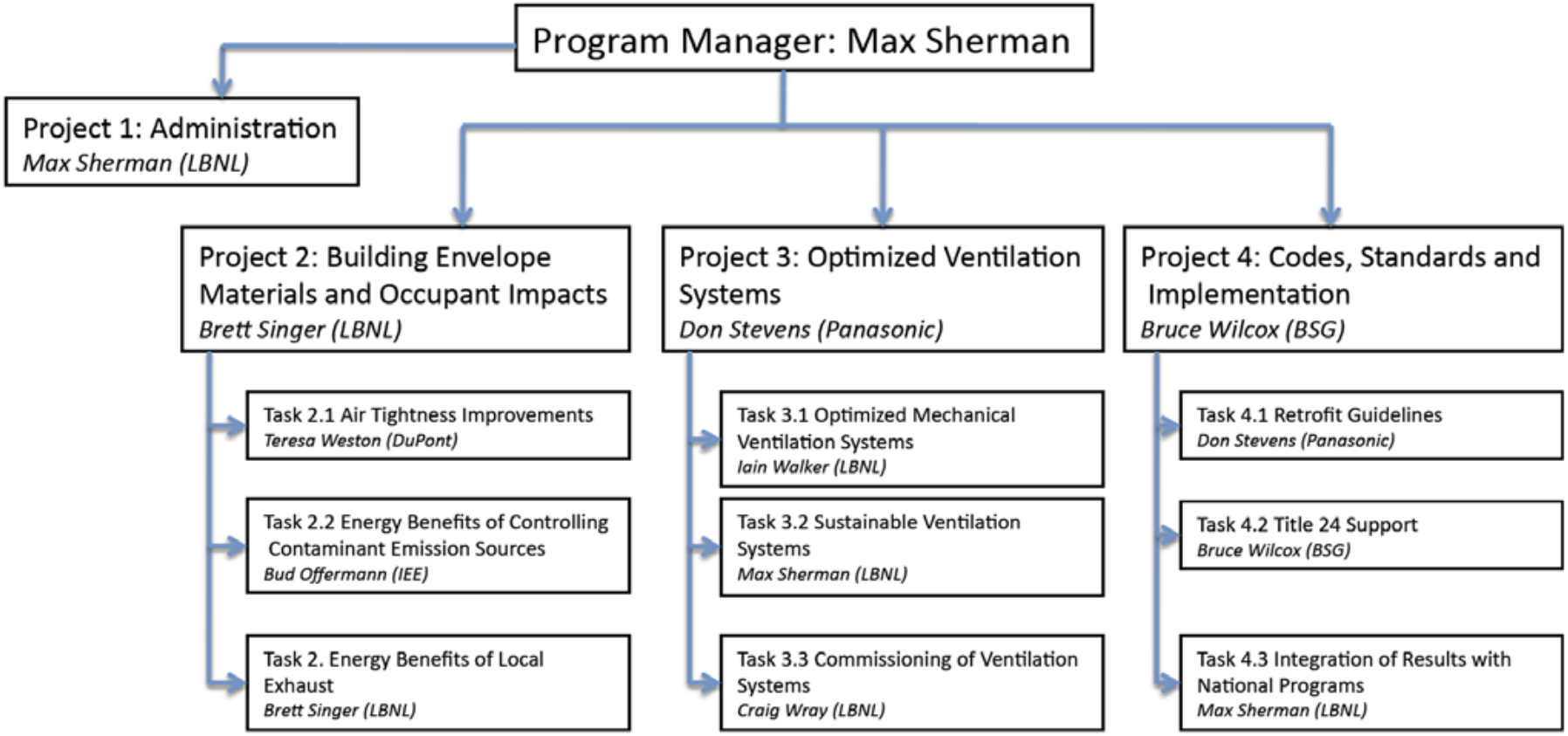
Program Aims to Provide Guidance to…

- Reduce ventilation-related energy demand during peak four hours of each day
- Reduce energy attributable to infiltration by 25% in existing homes and 50% in new homes
- Reduce the need for whole house ventilation using contaminant control measures
- Improve ventilation control technologies
- Improve performance of existing ventilation strategies by through commissioning

Program Structure & Key Staff



PROJECT 3: Overview

PROJECT MANAGER: Don Stevens (Panasonic)

3.1 Optimized Mechanical Ventilation Systems

- Smart ventilation systems (Iain Walker)

3.2 Sustainable Ventilation Systems (Sherman)

- Do we really have to always have fans?

3.3 Commissioning Ventilation Systems

- Make them work as intended (Craig Wray)

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Sustainable Ventilation

- Passive and hybrid systems
- Retrofit applications
  - Passive stacks easier to retrofit: do not require fans or new wiring – less embodied energy, materials and labor
- Reliability and functionality tradeoffs of passive systems
  - No fan to replace; function w/o electricity
  - Weather dependant
- Analyzing benefits and costs by simulating airflow, energy and indoor air quality by simulation in CA climate zones

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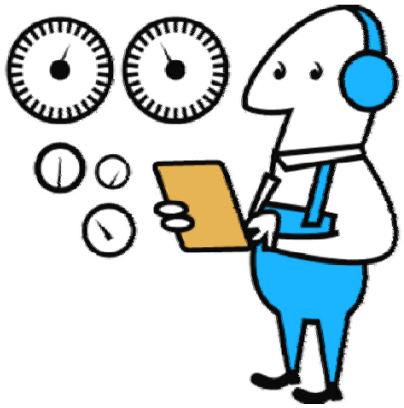
Commissioning Process

1. Audit and Diagnostic
   - Using appropriate metrics, measure, & compare with norms
2. Tuning and Tweaking
   - Minor adjustments on the spot without repair or retrofit
   - Meet intended or best possible performance
3. Opportunity Identification
   - Provide information on repair & retrofit
   - Optimize beyond norms with new technology



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Elements Needing Commissioning

- Envelope air tightness
- Air distribution systems
- Venting and combustion appliances

PROJECT 4: Overview

PROJECT MANAGER: Bruce Wilcox (BSG)

4.1 Retrofit Guidelines (Don Stevens)

4.2 Title 24 support (Wilcox)

4.3 Integration of National Programs (Sherman/Singer)

- DOE (Building America)
- ASHRAE (62.2)
- EPA/HUD (Healthy Homes, Energy Star)

PROJECT 2: Overview

PROJECT MANAGER: Brett Singer (LBL)

2.1Air Tightness Improvement (Theresa Weston)

- Stock characterization; contaminant mitigation

2.2 Energy Benefits of Controlling Contaminant Source (Bud Offermann)

- What do ventilate for? Can we be smarter?

2.3 Energy Benefits of Local Exhaust (Singer)

- Cooking contaminants really matter; vent it!

Air Tightness Database

- Objectives:
  - Current stock characterization; data for modeling and simulation
  - Assess needs, potential benefits; targeted retrofit efforts
- LBNL compiled database of air leakage measurements
  - Most data from just a few states; very limited for California
  - Most data for new homes; few data from existing, retrofits
  - Data and analysis used extensively
- Dept of Energy funding next generation national database
  - RESAVE focused effort on California data

Ventilation and Indoor Air Quality

- Can we improve energy efficiency while maintaining IAQ of current ventilation standards?
  - IAQ and energy impacts of variations in context of current and projected Title 24
  - Credits for low-emitting materials & finishes in context of California Dept. of Public Health standards (Section 01350)
  - Performance requirements for kitchen exhaust
- Approach
  - Physics-based simulation model of IAQ applied to California population using data on emissions, activity, etc.
  - Physics-based airflow and energy simulation model applied to representative homes based on IAQ model outputs, climate zones

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Kitchen Exhaust Efficiency

Design variations, costs, rated airflow of existing and available devices?

Compiled database from web-based search

Capture efficiency by design and installation?

Conducted extensive lab experiments on 3 archetypal designs

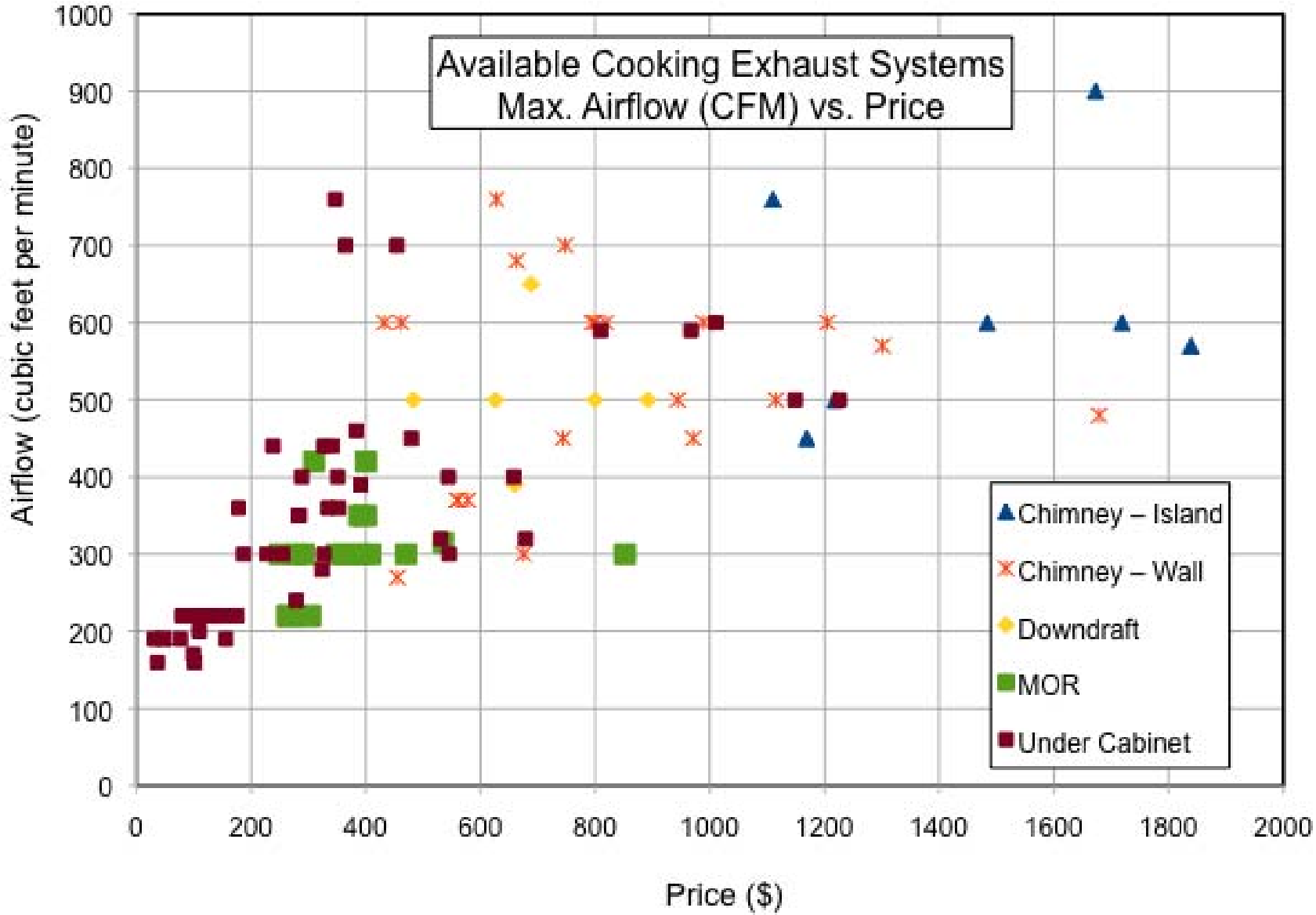
Distribution of devices, installations in new, existing homes?

Observations from online real estate listings (starting today!)

Current and theoretical usage patterns?

Limited data available on usage patterns; may augment with online survey

Survey of Cooking Exhaust Systems



Range Hood Performance: Lab

Microwave over range (MOR)

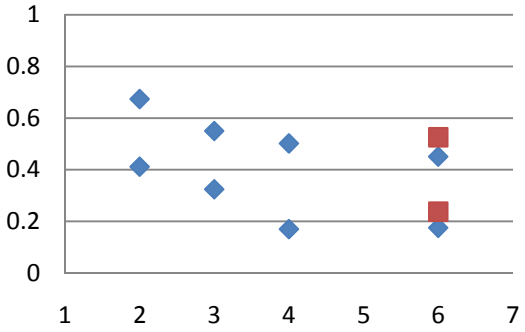
Shallow capture hood

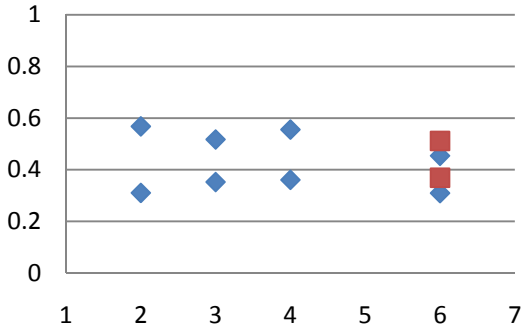
- Experiments to measure capture efficiency
- Duct static pressure = 0.1 in. H_2O (HVI).
- Vary height and extension from wall.
- Various burner combinations; cooktop with pots.
- Simulated counter and cabinets.

Hood flush with back wall

Extended to cover front burners

24”





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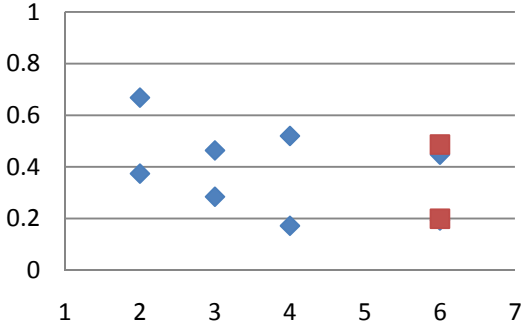

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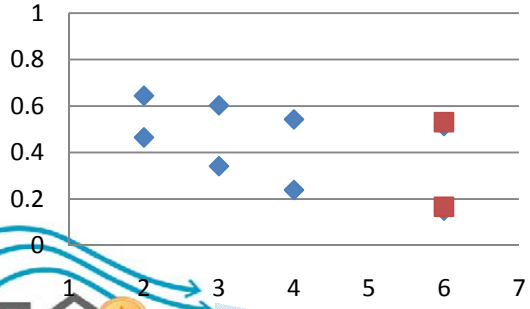


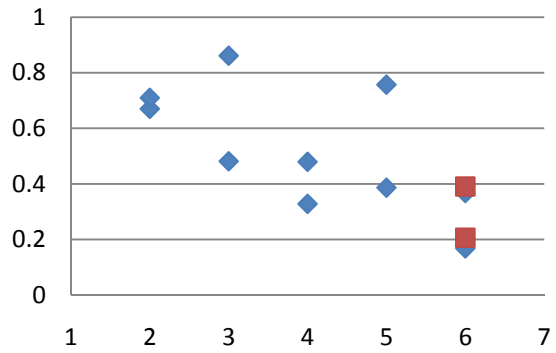
Measured Pollutant Capture Efficiency

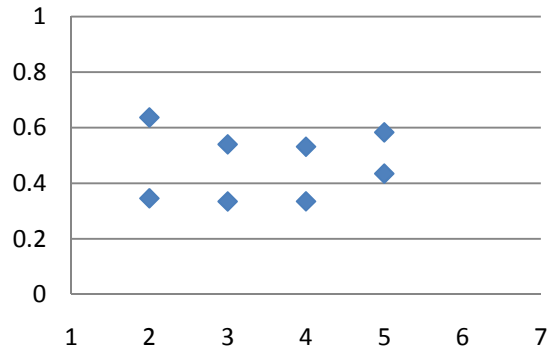
2: Two back burners
3: One back, one front
4: Two front
6: Oven (Red = no open)

Hood flush with back wall

Extended to cover front burners

30”





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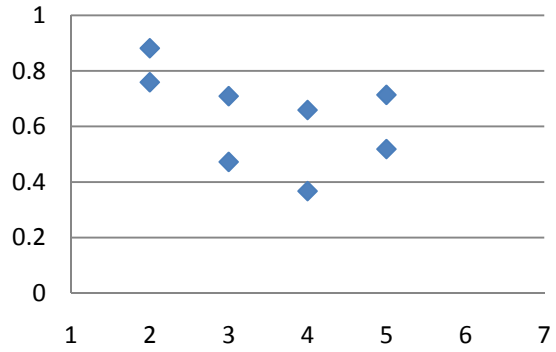

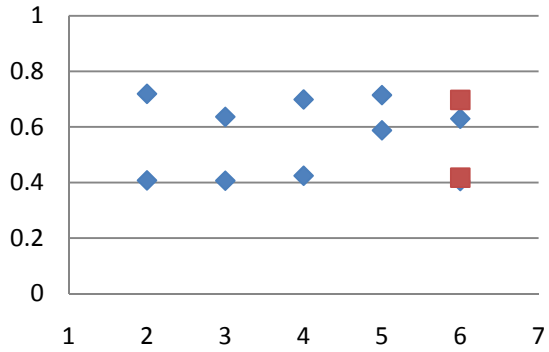

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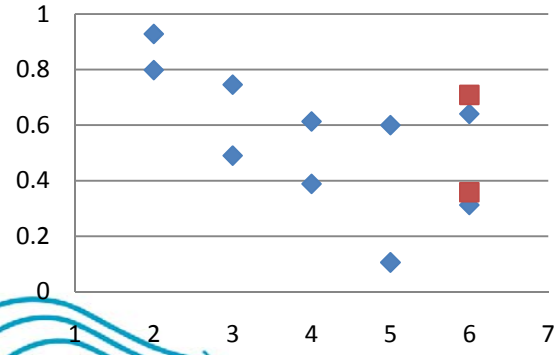

Measured Pollutant Capture Efficiency

2: Two back burners
3: Four burners
4: One back, one front
5: Two front
6: Oven (Red = no open)

Airflow:
~100, 200 cfm

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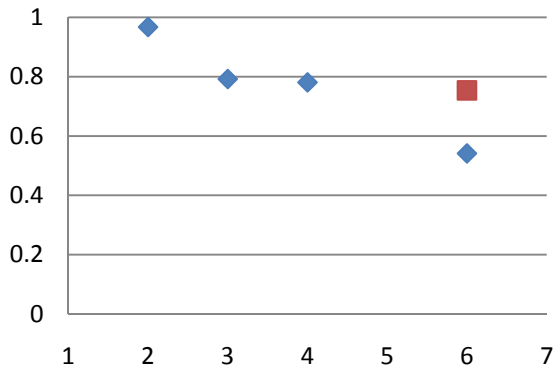
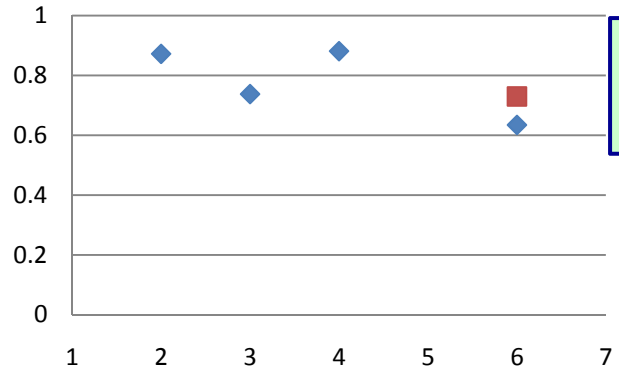
Hood flush with back wall

Extended to cover front burners

30”





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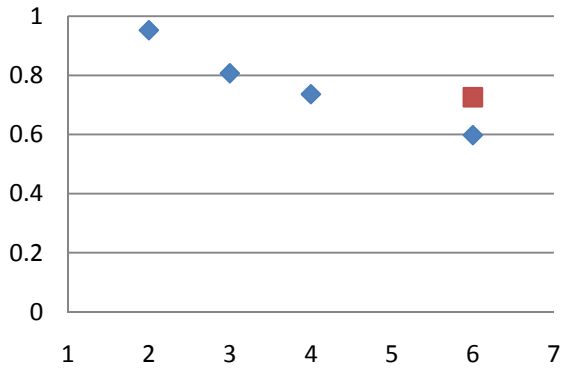

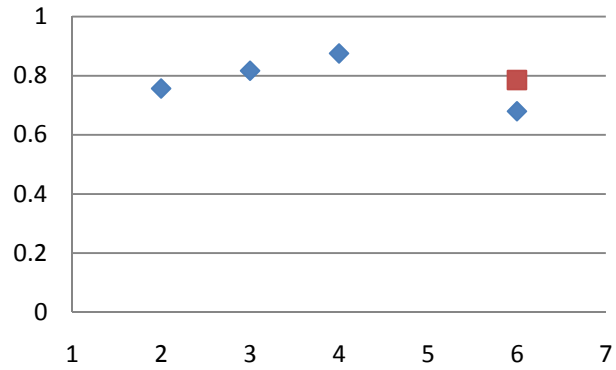

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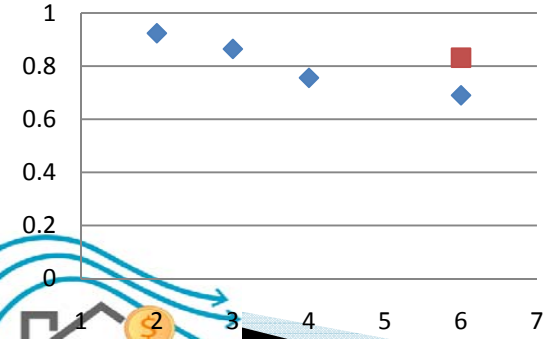

Measured Pollutant Capture Efficiency

2: Two back burners
3: : One back, one front
5: Two front
6: Oven (Red = no open)

Airflow:
~250 cfm

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