

# The House as a System

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



- **What makes up “The House as a System”**
- **What can happen to the House as a System when we make changes**
- **Health and Safety: what to do, what to avoid. Especially with combustion gases, mold and moisture**
- **In very efficient homes, how does the House as a System work?**



## Interdependent Parts

- The operation of one part affects many others.
- When they all work together, the house is: Comfortable, Safe, Efficient, and Durable.

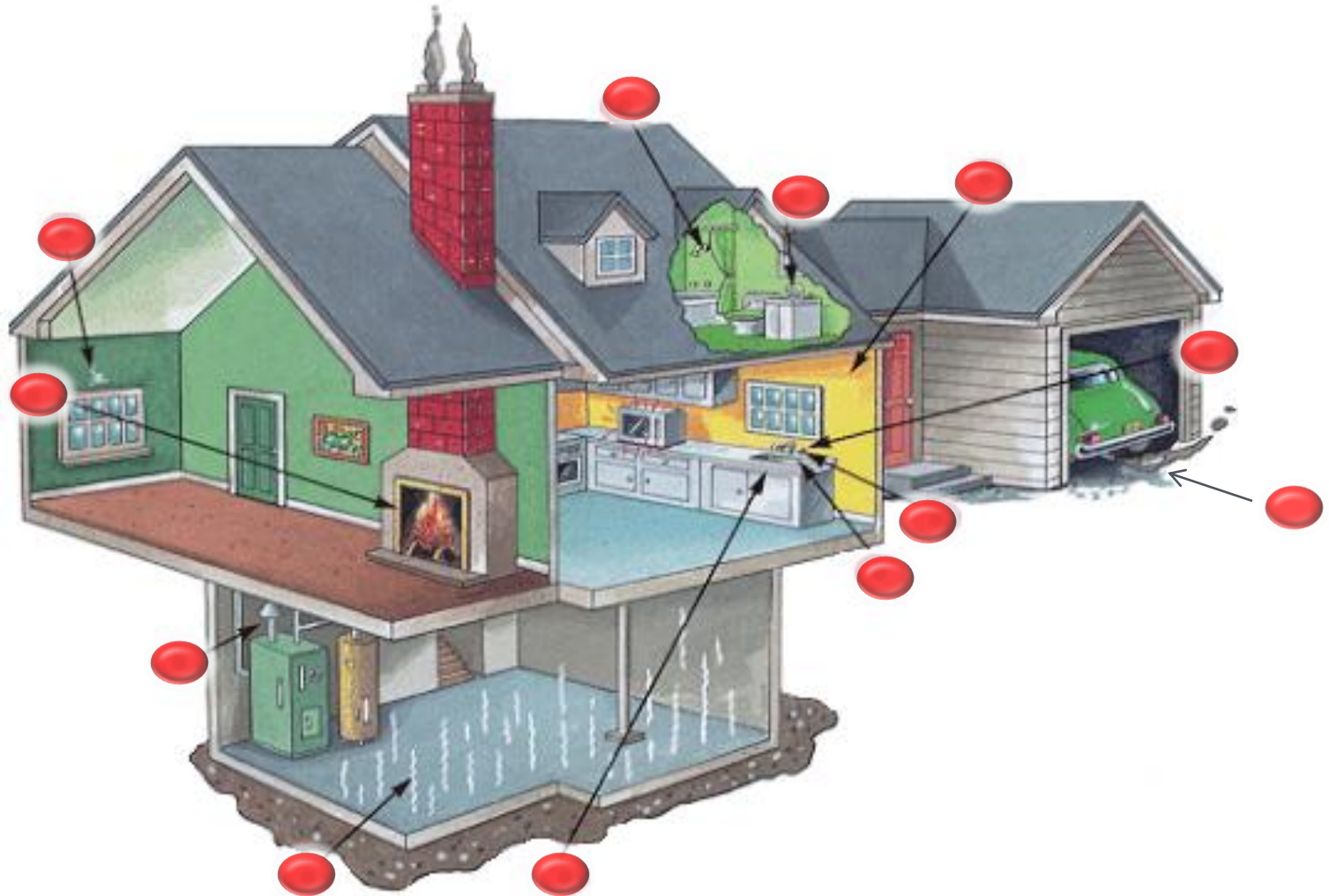
## **A house will experience problems when its house parts don't work together properly.**

- Some obvious, some invisible.
- Some now, some years down the road.



# House as a System

## HOUSE AS A SYSTEM



## HOUSE AS A SYSTEM



An un-insulated attic ...



*Photos courtesy of The US Department of Energy*

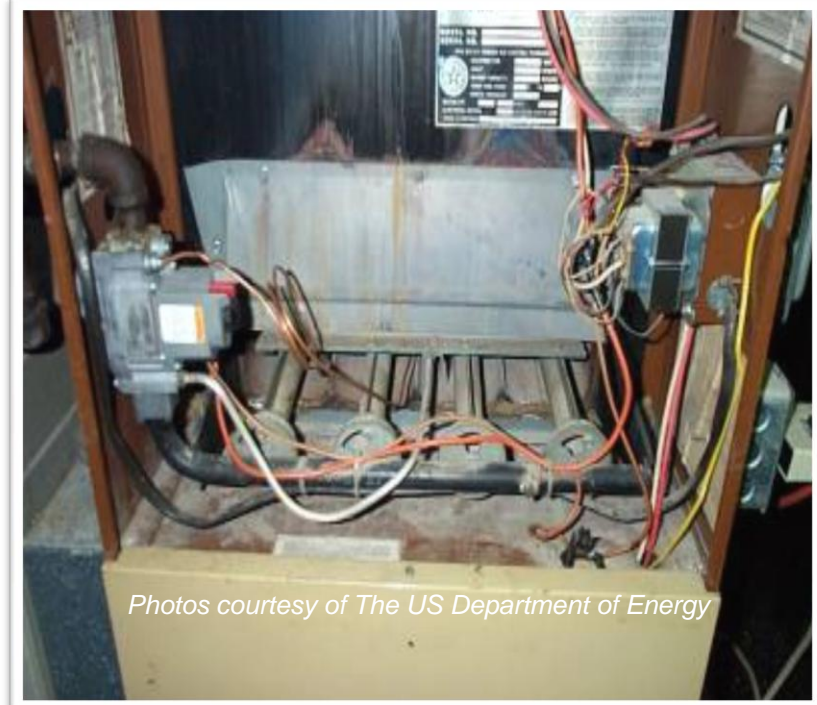
Makes the heating  
and cooling system ?????.

# Examples - House as a System

## HOUSE AS A SYSTEM



A Well Insulated attic ...

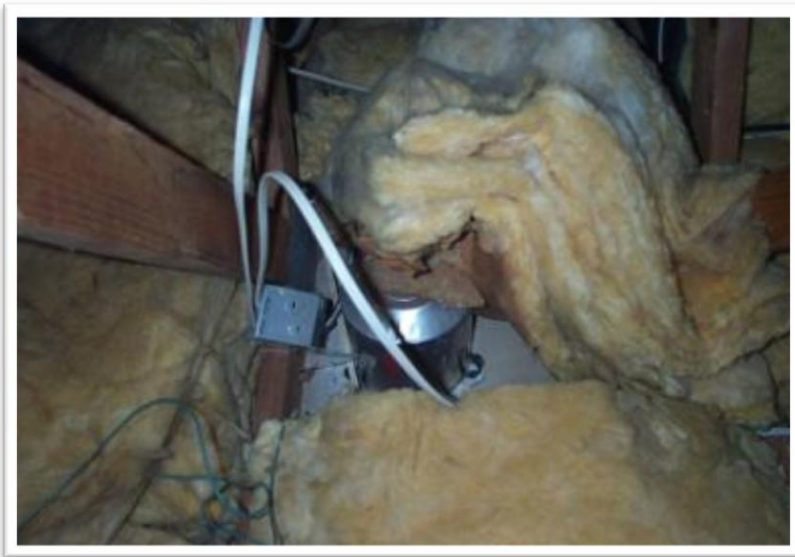


*Photos courtesy of The US Department of Energy*

Makes the heating  
and cooling system ??.



## HOUSE AS A SYSTEM



Leaky recessed lighting fixtures...



Increases heat loss/gain, and can cause ice dams.



## HOUSE AS A SYSTEM



This bathroom exhaust fan does not exhaust to outdoors – just to the soffit.

The moisture condenses on the roof deck and trusses causing damage.


# Sealed Chimney Bypass

## HOUSE AS A SYSTEM

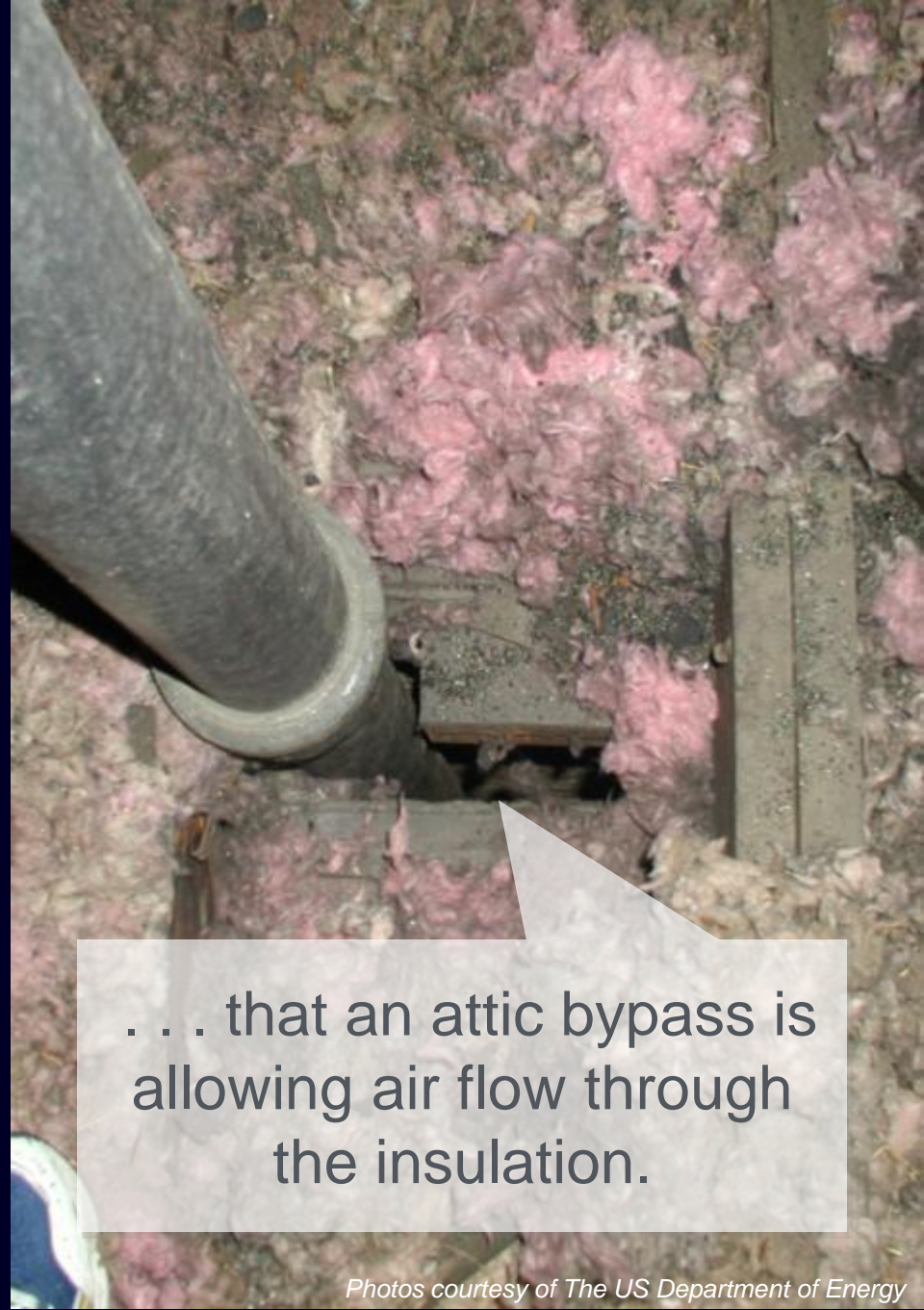


*Photos courtesy of The US Department of Energy*





Plumbing pipe and dirty insulation are clues . . .



. . . that an attic bypass is allowing air flow through the insulation.

*Photos courtesy of The US Department of Energy*



# Another Tub

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*Photos courtesy of The US Department of Energy*



# Under the Tub

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*Photos courtesy of The US Department of Energy*

# Plumbing and Wire Opening

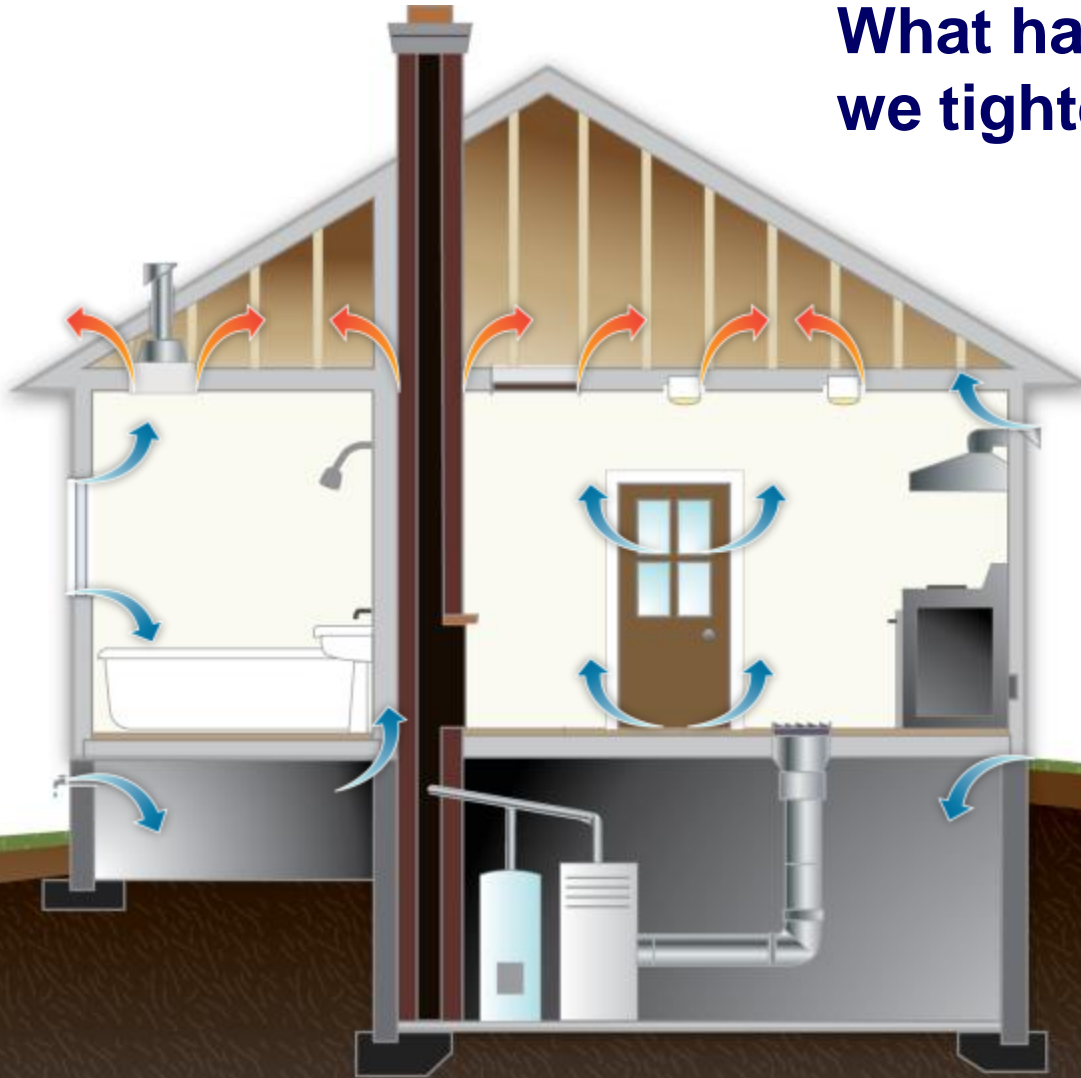
## HOUSE AS A SYSTEM



*Photos courtesy of The US Department of Energy*

## HOUSE AS A SYSTEM

**What happens when we tighten a home?**





# Today's Houses Have More and Bigger Fans

## HOUSE AS A SYSTEM



*Photos courtesy of The US Department of Energy*



**All exhaust appliances “suck” on the house.**



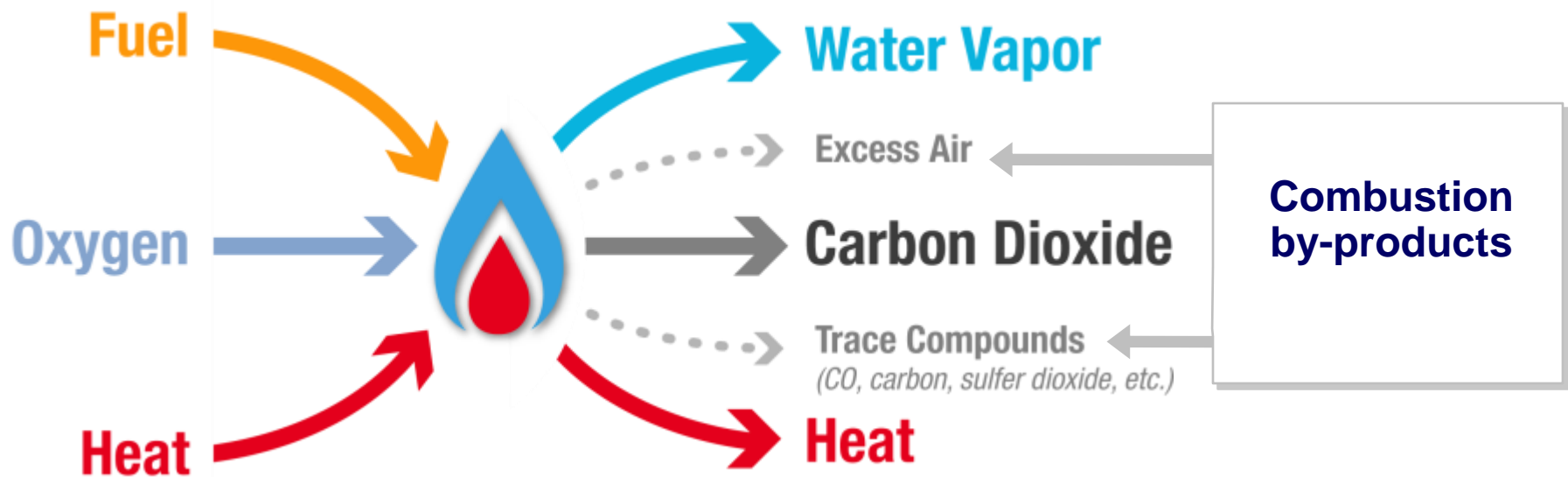
*Photos courtesy of The US Department of Energy*

# Atmospheric Draft Appliance



## Complete Combustion Occurs....

- When all the fuel is burned with sufficient oxygen to produce carbon dioxide and water vapor.





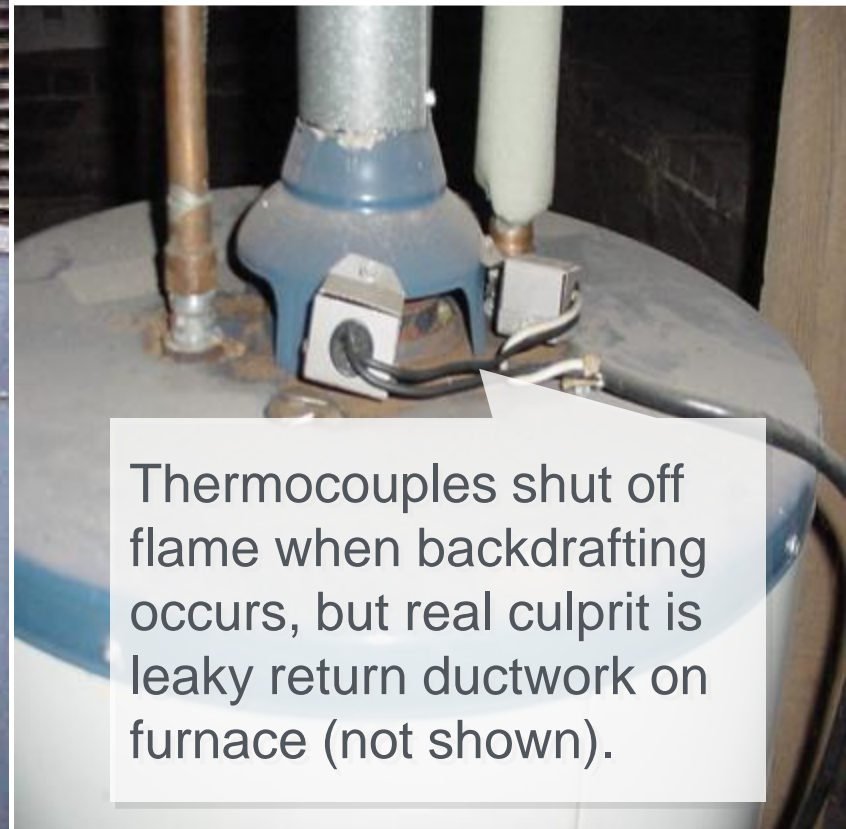
## HOUSE AS A SYSTEM



Grille cut into return plenum sucks on barometric damper.

*Photos courtesy of The US Department of Energy*

# Danger!



Thermocouples shut off flame when backdrafting occurs, but real culprit is leaky return ductwork on furnace (not shown).



# In the Garage

## HOUSE AS A SYSTEM



*Photo courtesy of The US Department of Energy*

# Occupant Behavior

## HOUSE AS A SYSTEM

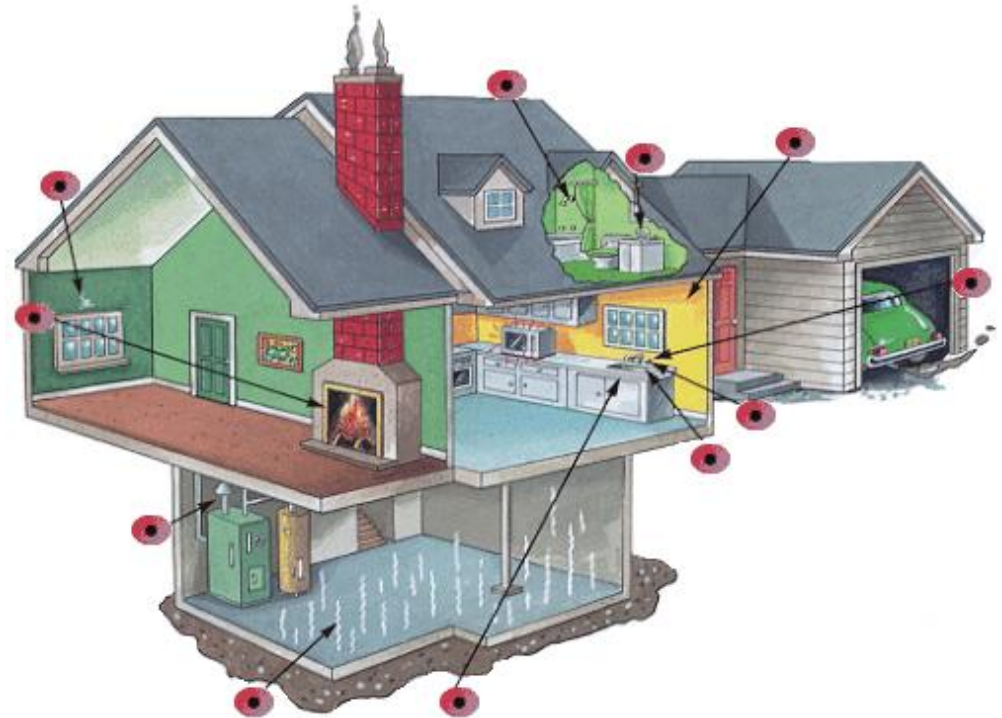


*Photos courtesy of The US Department of Energy*

## HOUSE AS A SYSTEM

### Houses:

- Are tighter.
- Have more exhaust appliances.
- Have “weaker” natural draft combustion appliances.
- Have less drying potential.



*Diagram courtesy of John Tooley*



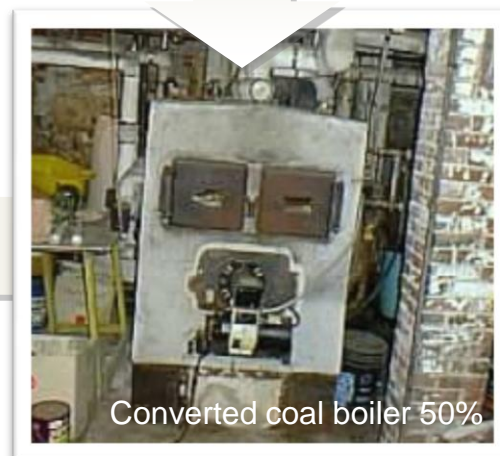


Photo courtesy of Rainbow International Restoration and Cleaning.



# Today's Houses Have Weaker Draft Appliances

## HOUSE AS A SYSTEM



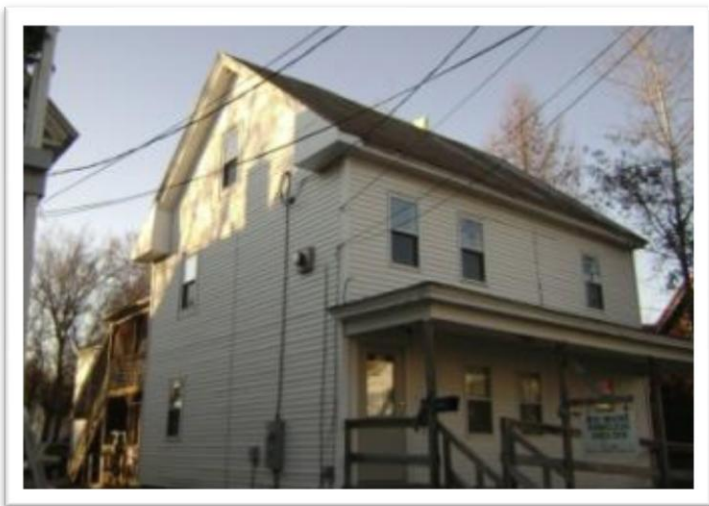
Photos courtesy of The US Department of Energy

# Today's Houses Have Less Drying Potential

## HOUSE AS A SYSTEM

The **old house** got wet in the summer (humid) & dried in the winter (low humidity).

The **new house** gets just as wet but can't dry; therefore poor IAQ and mold/mildew.



*Photos courtesy of The US Department of Energy*

### Older Home:

- Balloon-framed two-story home (lots of stack effect).
- Boards, plaster & lathe.
- No insulation.
- Construction style and materials inherently leaky.

### Newer Home:

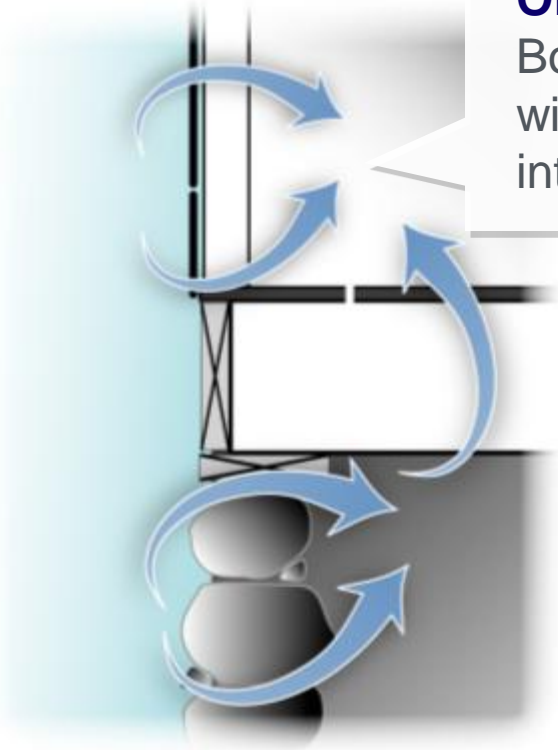
- Low (little stack effect).
- Plywood & drywall.
- Construction style and materials inherently tighter than older home.

# Today's Houses Are Tighter

## HOUSE AS A SYSTEM

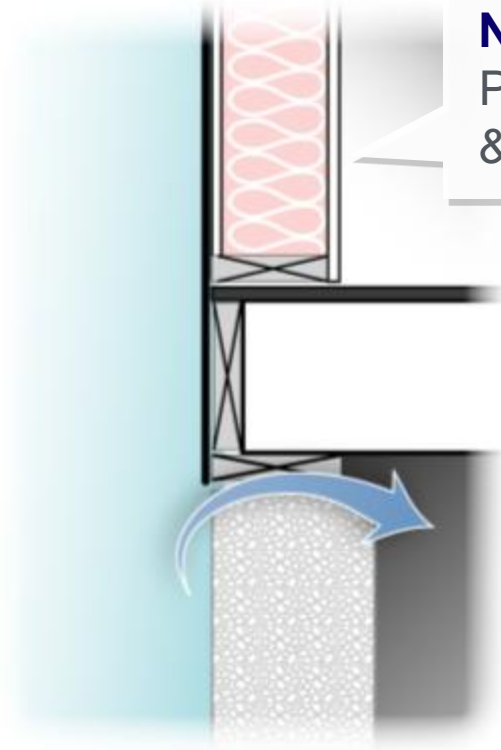
### OLD

Boarded exterior  
with lath & plaster  
interior walls.



### NEW

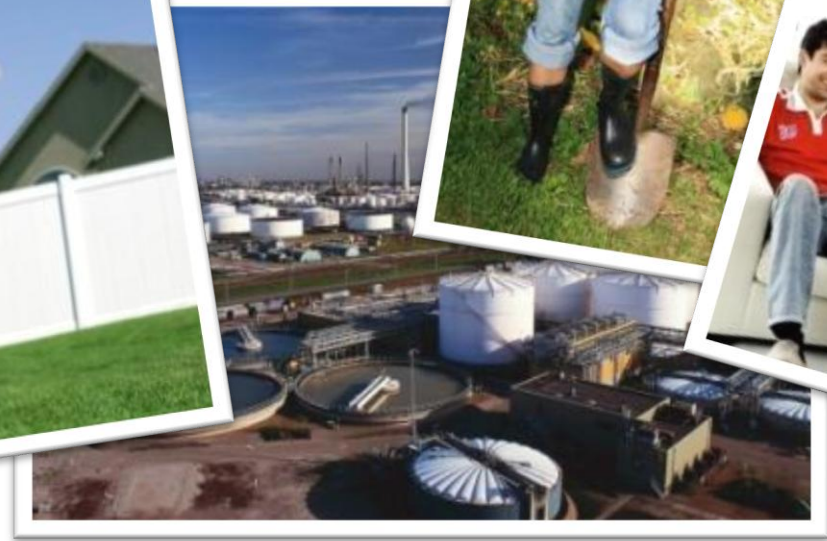
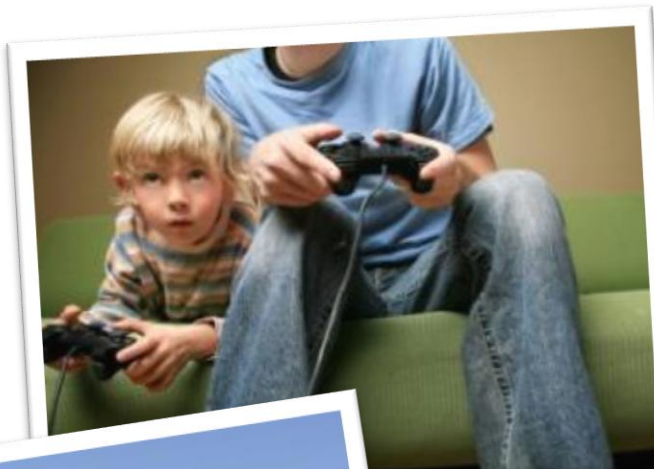
Plywood  
& drywall.



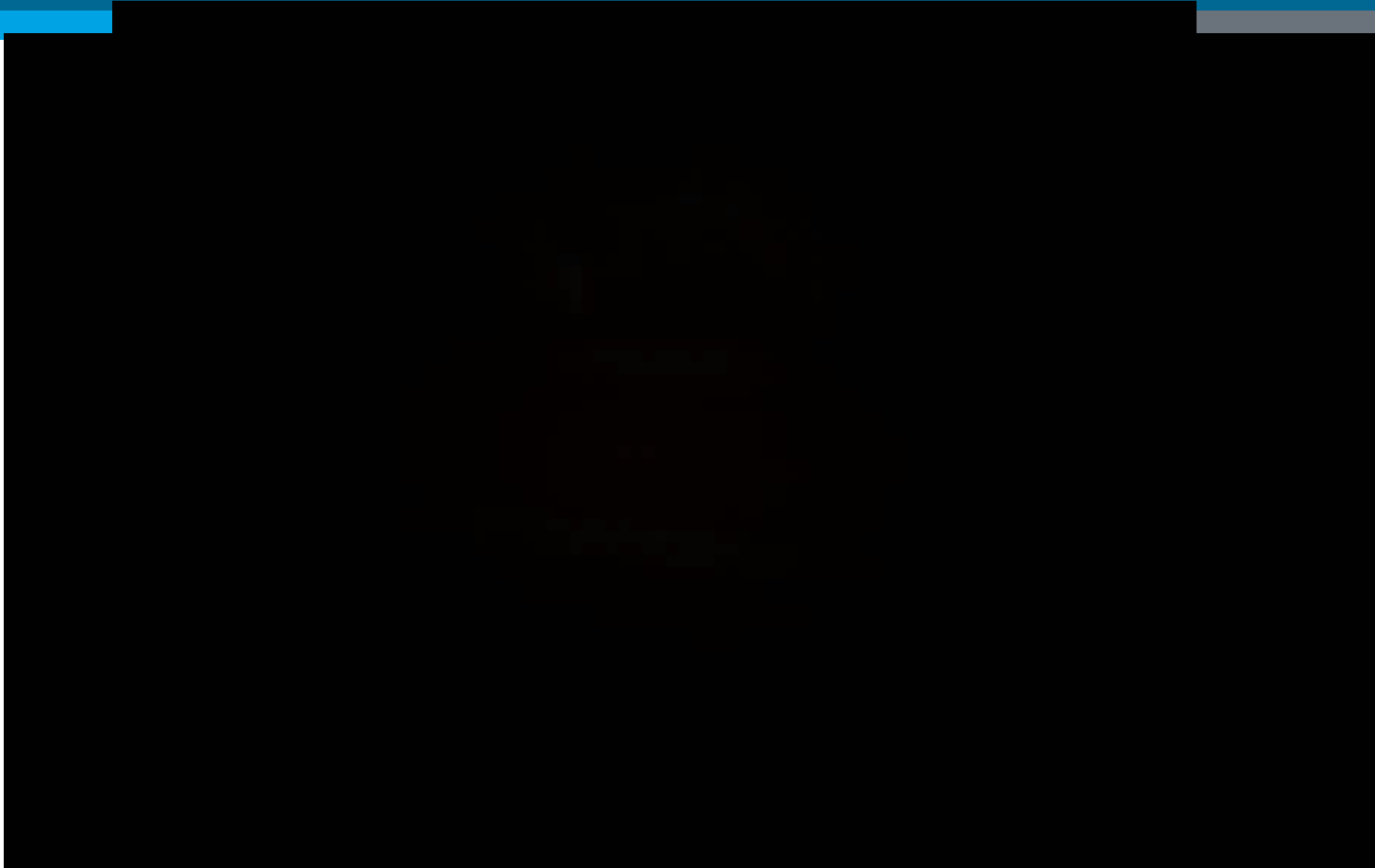


# Lifestyle Changes

## HOUSE AS A SYSTEM



- GRANDMA'S HOUSE





## HOUSE AS A SYSTEM

- We build very differently than we did as little as 40 years ago.
- Economic pressure is driving the move to tighter houses with smaller margins of safety.
- The tighter a house is, the more influence individual components have on the others.
- All pollutants inside the pressure boundary will eventually be dispersed over the entire area.
- Altering a building or its mechanicals can have unexpected consequences.

# HOW MUCH: Energy/Comfort Savings VS Cost VS Safety VS ??

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