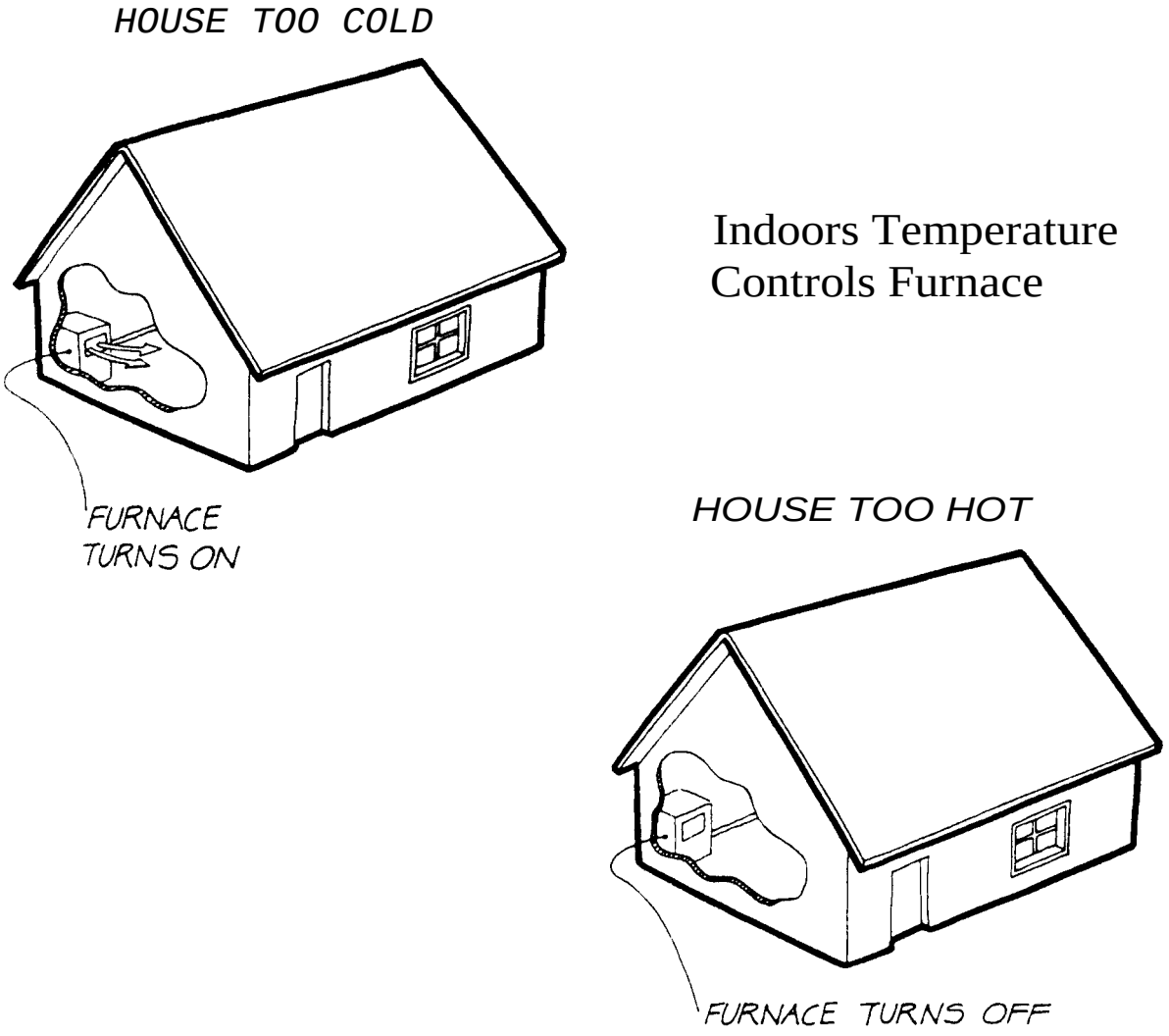
HOUSE HEATING

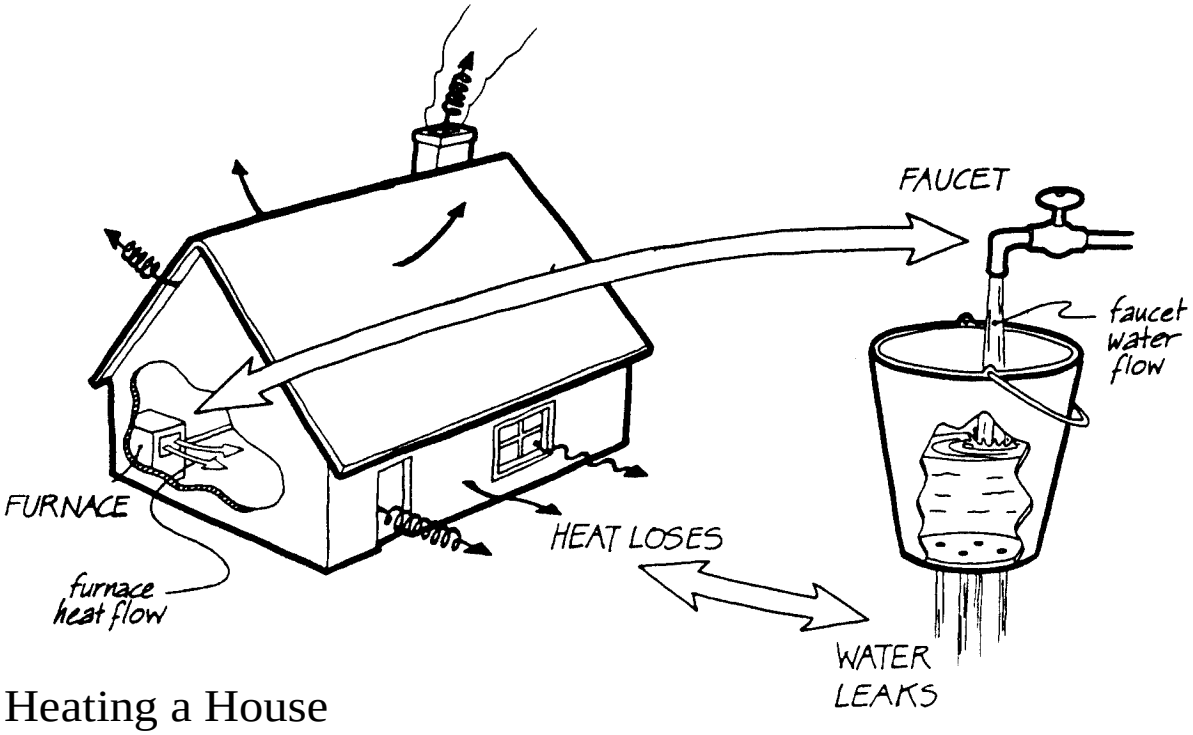
We know that heat can be transferred by several different methods and that heat can also be stored. Let's see how *all* the different types of heat flow and storage combine together in a familiar application. Later, when we talk about solar heating systems, one important use will be in heating a house: the solar heating system will add heat and the house will lose heat. The heating losses of a house provide a good example of the way heat can flow by several methods at the same time.

Before we can talk about *house heat losses,* we have to understand *house heating. A* house's heating system-whether it is gas, oil, electric, or even solar-tries to keep the house at a more or less fixed temperature. When the house gets too cold the furnace comes on and adds heat to the inside of the house. The heat might be added by means of baseboard electric heaters, a gas-burning hot-air system, an oil-fired water furnace delivering heat through baseboard radiators, or any number of other heating systems. The added heat, by whatever system, tends to heat the rooms-to increase their temperature. Once the indoors temperature gets a little hotter, the thermostat sends a signal to the furnace and it turns off.

Once the furnace turns off, the house slowly loses heat to the outdoors. It doesn't lose heat right away, because heat is stored for a time in the walls and floors. When the thermostat senses that the house has become too cold, it turns the furnace on again and the cycle repeats. You usually don't notice these changes in temperature in the house because they are so small. For example, if you set your thermostat at 70° F, the furnace might turn on when it cooled to 68° F and turn off again when it reached 72° F. Room temperature is always moving slightly up and down-getting hotter and colder-but it always remains very close to the set temperature.



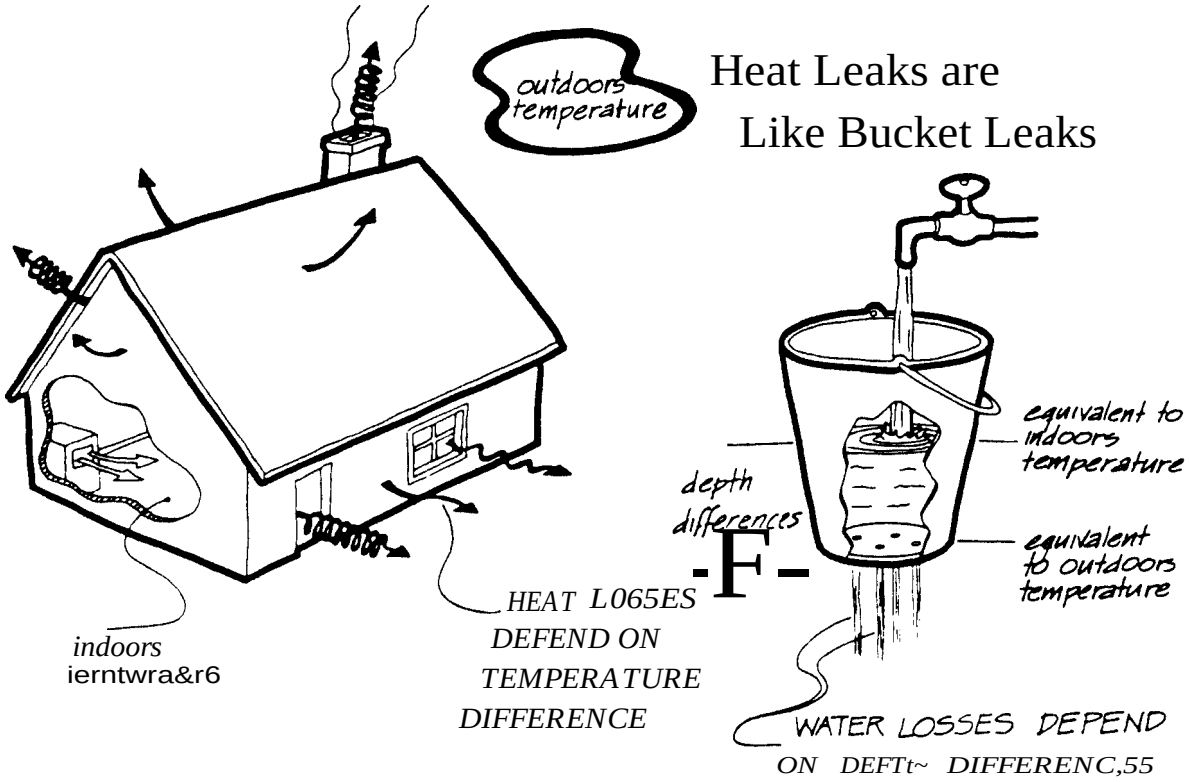
Now, remember the water analogy to heat and temperature. The temperature of an object is equivalent to the water depth of a tank; the heat is equivalent to the volume of water; and the heat flow is equivalent to the water flow. How could we make the *water equivalent* of a house-heating system? Suppose we let water pour from a faucet into a bucket that has small holes in its bottom. The faucet is equivalent to a house's furnace because the faucet adds water to the bucket just as a furnace adds heat to a house. The holes in the bucket represent the way the heat leaks from the house. When the faucet adds water to the bucket, it leaks out through the holes; when the furnace adds heat to the house, it leaks out through the walls, doors, windows, roof, and cellar.



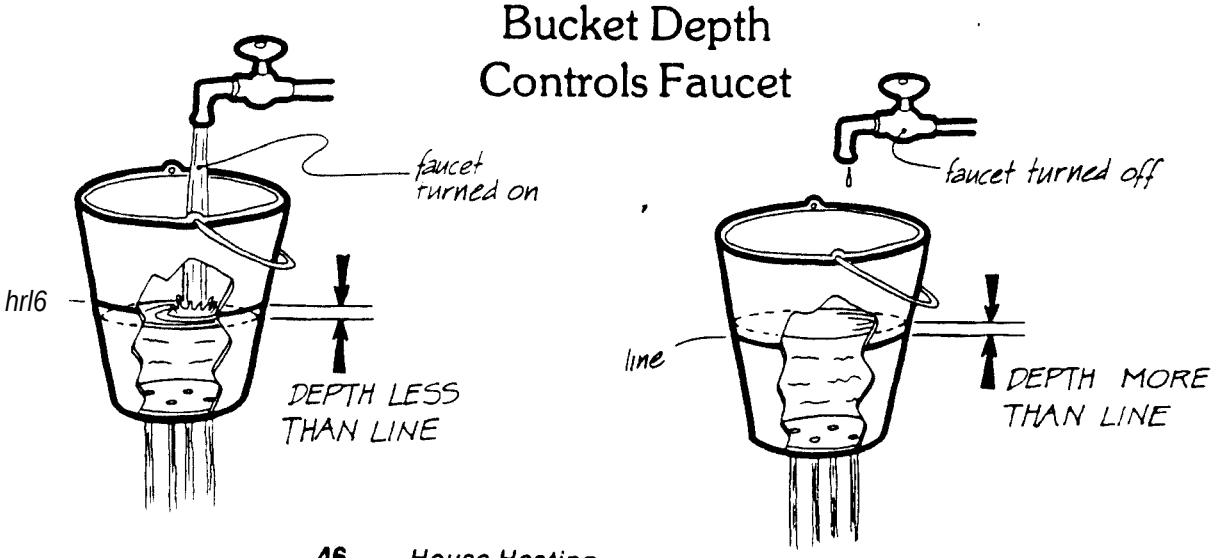
Heating a House is Like Filling a Leaky Bucket

The depth of water in the bucket is equivalent to the room temperature in the house. While the temperature difference is what drives the heat from the house, the *depth difference is* what drives the water from the bucket. The depth difference is simply the depth of water In the bucket, since the holes are at the bucket's bottom. The bottom of the bucket is equivalent to the outdoors temperature.

Just as the thermostat keeps the house's temperature relatively stable, you could keep the depth of the water in the bucket relatively constant. Suppose you were to draw a line on the bucket indicating the depth you wanted to hold. If the depth dropped *below* the line, you'd turn on the faucet. Similarly, when a thermostat senses that the house is getting a little too cold, it turns on the furnace. The faucet adds water to the bucket just as the furnace adds heat to the house. When the depth went *higher* than the line on the bucket, you'd turn off the faucet. Likewise, when the thermostat senses that the house's temperature is getting a little too hot, it turns off the furnace. After a while, the water would leak out of the holes in the bucket and the depth would drop below the line. It wouldn't happen very

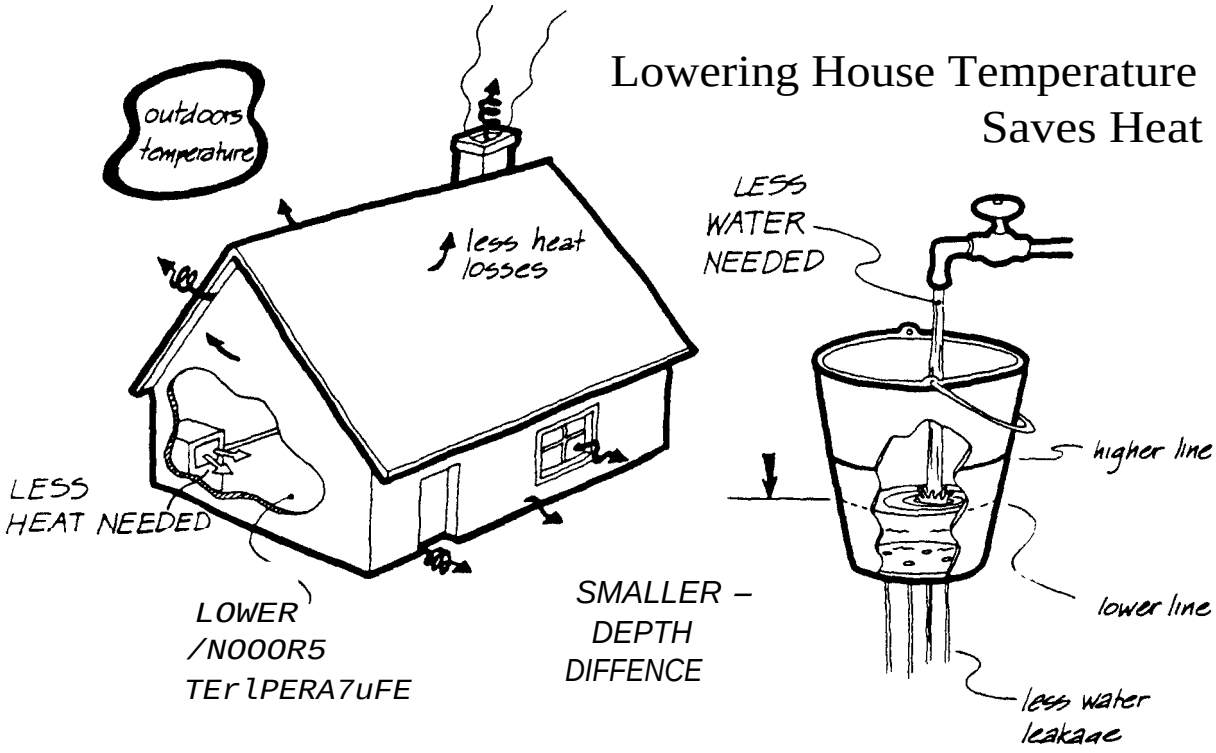


fast, because the bucket stores volume and it would take a while for the volume to leak away. Similarly, the heat flows from a house through all of its heat leaks, and the house slowly drops in temperature as it loses heat. When the water goes below the marked line, you'd again turn on the faucet and begin the cycle again.



If you **were very** diligent, you'd be able to keep the depth pretty close to the line on the bucket by turning the faucet on and off properly. Since you were holding the depth more or less constant, the water lost through the holes would be more or less constant. If you held the depth constant for a long time, say an hour, the total volume that poured into the bucket would equal the volume that leaked out during the same hour. Just as the faucet adds as much volume each hour as is necessary to balance the water leakage during that hour, so a furnace adds the same amount of heat that leaks out of the house each hour.

Suppose we set the house's thermostat at 65° F instead of 70° F. What would happen? Heat losses would be less because the temperature difference would also be less. Your heating bill would be less too, because the furnace adds just what the house loses. Similarly, if you marked another line on the bucket at a lower level and kept the depth at this lower line, the water leakage would be less. Since depth differences drive out the water through the holes, less water leaks out. On the average, the faucet adds just as much water as leaks out, so you would use less water at the lower line that at the higher line.



Our country's leaders have urged us to turn down our thermostats to save scarce energy resources-now you have an understanding of why it helps.