7 Reasons Why Oversizing is a Bad Idea

As homes have become more efficient, oversized HVAC equipment has emerged as one of the more serious problems in building science. Although there's general awareness of this issue among industry practitioners, few understand the full extent of the problem and its consequences.

1. **Economics**

   Most people understand that oversized equipment has a higher first-cost. However, oversized equipment also costs more to operate due to increased cycling losses, depending on how badly the system is oversized. Short run-times are like stop-and-go driving: system efficiency drops off as cycles become shorter. Also like automobiles, excess cycling is hard on equipment, especially the compressor. On average, an oversized compressor will have a shorter life than an undersized or correctly sized compressor.

2. **The high efficiency trap**

   The highest efficiency ratings go to multi-stage equipment. If sized correctly, a multi-stage air conditioner or furnace will operate at reduced output (first stage) most of the time. Longer run times reduce cycle losses and thus improves efficiency. However, many HVAC contractors intentionally size multi-stage equipment based on the first stage capacity and consider the high stage as reserve capacity for extreme weather conditions or a big party. By taking this approach, contractors unknowingly cheat homeowners out of the efficiency they paid for. Even when sized properly, the payback for multi-stage may exceed the life of the equipment.

3. **Comfort**

   Oversized equipment causes wider temperature swings, especially in perimeter areas and remote zones. Consider what happens if on the coldest day, a furnace only operates 20 minutes an hour. As soon as the furnace cycles off, the house begins to cool from the outside in. The thermostat is purposely located away from exterior walls and windows, often in a hallway. While the furnace is off, air doesn't circulate. By the time the thermostat senses the lower temperature, perimeter areas may have dropped by several degrees. During mild weather when loads are tiny, minimum runtime logic enforced by the furnace controls assures significant overshoot. Either scenario can cause discomfort – the greater the oversize ratio, the larger the temperature swings. The same result occurs in cooling mode.

   Indoor relative humidity plays an important role in comfort. In cooling mode, increased moisture will heighten the body's sensation of heat, often leading occupants to compensate by lowering the thermostat setting. Moreover, oversizing compromises an air conditioner's ability to remove moisture (see Moisture Control, below), resulting in discomfort and increased energy consumption.

4. **Ergonomics**

   An oversized system produces more noise than one that is properly sized. Not only is the source equipment noisier but diffuser noise can be annoying if proper design procedures aren't followed. With proper design, a correctly sized system in a low load home can be virtually silent.

5. **Indoor Air Quality**

   Because an oversized system has shorter run-times, air filtration is reduced. During winter months, heat pumps provide the best filtration since they run nearly continuously during cold weather. Grossly oversized air conditioners can lead to dust mites, mildew, and even mold in extreme cases, the result of inadequate moisture removal (see Moisture Control, below).

6. **Moisture control**

   An air conditioner's ability to remove moisture (latent capacity) is a function of the indoor coil temperature. Each time the air conditioner starts up, it takes at up to 10 to 15 minutes for the coil to get cold enough to condense water vapor. Because an oversized system has shorter run-times, it spends a higher percentage of the time operating in this initial 'dry coil' phase, thus removing less moisture.

   Peak moisture loads tend to occur at part-load conditions, especially during Spring and Fall. In this situation, an oversized air conditioner may not run long enough to condense *any* moisture, thus permitting indoor relative humidity to rise to unacceptable levels. A major selling point of multi-stage air conditioners is improved moisture control during part-load conditions. At best, this is an expensive solution to the part-load problem. But when a multi-stage system is oversized, it's no solution at all. In most climates, properly sized single stage equipment can maintain acceptable humidity levels in high performance homes.

7. **Structural Durability**

   In many areas of the country, air conditioning is necessary to manage moisture loads. Perhaps the most insidious consequence of oversizing is its impact on moisture removal. An oversized air conditioner removes less moisture than an air conditioner that's properly sized. Depending on the climate and the degree of oversizing, the consequences of excess moisture range from discomfort to serious health issues, and from minor damage to structural failure.

   High relative humidity provides an ideal environment for destructive fungi to thrive. Aside from the obvious health concerns, mildew left unchecked will eventually damage the host material. Paint, drywall paper and wood products are all at risk. Atmospheric moisture also affects the dimensional integrity of wood. Solid wood products such flooring and wainscoting expand as their moisture content rises. This can lead to cupping or bowing if the relative humidity gets too high.

And now the bad news: Oversizing, endemic in code-built homes, is potentially an epidemic in high performance homes. Even though most HVAC contractors have been taught the virtues of right-sizing, they can't seem to break free of their 'bigger is better' bias. As a result, high performance homes often end up with egregiously oversized equipment. This not only undercuts potential energy savings, but makes these homes especially vulnerable to comfort and moisture problems.

Extracted from *The Elephant in the Room – HVAC for High Performance Homes* (http://bit.ly/jz0Xpn)

Also see *10 Reasons Why Oversizing Persists* (http://bit.ly/lGTCbU)

10 Reasons Why Oversizing Persists

In order to address the oversizing problem, it's important to understand why this practice continues to be the status-quo, despite the overwhelming rationale against doing so.

1. **Fear of undersizing**

   How many homeowners ever complain that their HVAC system is too large? On the other hand, they're quick to complain if they believe their system is too small.

2. **That's how I've always done it**

   Many HVAC contractors still size by 'rules of thumb' developed decades ago when homes were far less efficient (and forgiving). And many who use software-based load calculation tools don't completely trust the results, rounding up at every chance to protect against undersizing.

3. **Can't afford to do it right**

   Equipment is typically sized during the estimating process before the job is secured. At this point, it's hard to justify the time required to accurately model the home. Rather than tracking down detailed window, insulation, orientation and other construction details, most HVAC estimators use worst-case assumptions, resulting in larger equipment than necessary. Once a job is secured, it's the rare contractor that goes back to fine tune the load analysis.

4. **Substituting size for quality**

   Comfort and HVAC complaints in general account for more callbacks than any other issue in new construction. Contrary to popular belief, undersized equipment is rarely the problem. The culprit is usually poorly designed and constructed ducts, or envelope issues. Consciously or not, HVAC contractors tend to compensate for substandard workmanship by upsizing source equipment.

5. **The builder dilemma**

   Few builders understand the importance of proper sizing. And those who are, hesitate to push too hard. The last thing a builder wants is for his or her HVAC subcontractor to abdicate responsibility for customer satisfaction.

6. **Quality isn't free**

   Consider the HVAC contractor who hires top notch labor and follows best practices. In all likelihood, his bids will be higher and systems smaller than the competition. Despite all efforts to convey the value proposition, this contractor routinely loses jobs to those who do only what they can get away with to satisfy the building inspector, a low hurdle indeed.

   It's difficult for builders to accept paying more for less. In this scenario, the low bidder may be asked to downsize and re-bid. The standard response to that is to put doubts in the builder's mind whether a smaller system can handle the job. Or push oversized multi-stage equipment, falsely claiming higher efficiency when sized to operate on low stage. In the end, the builder usually opts for the low bidder with an oversized system 'just to be safe' (see Fear of undersizing, above).

7. **Managing expectations**

   Homeowners expect their air conditioners to keep their homes cool even under the most extreme conditions. And why shouldn't they? Most folks have no clue about the consequences and trade-offs associated with excess capacity. With a bit of education, most people can understand the right-sizing rationale and will adjust their expectations accordingly.

8. **No help from code officials**

   A growing number of state and municipal building codes now require load calculations. However, enforcement is almost non-existent in many areas. Even in jurisdictions that require load submittals during permitting, inspectors aren't in a position to question or verify their accuracy. This is also a problem for HERS raters who endeavor to follow Energy Star's requirement to verify proper sizing.

9. Financial disincentive

With no accountability, there's little incentive for an HVAC contractor to take the necessary time to perform accurate load calculations. If anything, he has the least incentive to sharpen his pencil and do it right, with plenty of forces pushing back. After all, larger systems mean bigger contracts and profits. On larger homes, the status quo often adds tens of thousands of dollars to the cost. No one seems to complain. Perhaps because they don't realize doing it right might actually cost less.

10. Outdated training

As with other building trades, the HVAC industry has been slow to embrace change. For the most part, training programs rely on curriculum materials developed decades ago. Trainers as well as those who train the trainers tend to be retired technicians who are largely unfamiliar with the unique challenges and nuances of high performance homes.

Nothing in a contractor's training or experience prepares him for homes sizing out to 1,000 square feet per cooling ton, sometimes much higher. A seasoned contractor was dumbfounded when confronted with my 3,000+ square foot home that had a nominal design cooling load of less than two tons. He retorted, "That'll never work… 800 CFM ain't enough air to blow out a candle!"[1]

[1] This home illustrates how Energy Star's 6% duct leakage limit is meaningless when applied to moderately high performance homes. A Duct Blaster® result of 180 CFM(25) would pass muster even though the nominal fan flow is only 800 CFM!