RESOURCE INNOVATION INSTITUTE

# HVAC Key Terms

for Cannabis Cultivation and Controlled Environment Agriculture.

| TERM | DEFINITION | COMMON UNITS OF MEASUREMENT | YOU MAY ALSO SEE IT EXPRESSED AS | WHY IT'S IMPORTANT FOR YOU TO UNDERSTAND | HOW IT'S OFTEN MISUNDERSTOOD OR MISAPPLIED |
|---|---|---|---|---|---|
| **CULTIVATION** | | | | | |
| **Evapotranspiration** | Evapotranspiration (ET) is the sum of evaporation (from sources such as grow media and irrigation tables) and plant transpiration to the cultivation space atmosphere. | | | Can drive the HVAC loads of the space; as plants transpire and bulk water from cultivation media or open water storage evaporates, there is an evaporative cooling effect, and a portion of the sensible loads of the space are converted to latent loads. Consider ET when providing evaporative cooling for a facillity while releasing water vapor (moisture). | When impact of ET is neglected when considering the HVAC loads generated by the faciility can yield inaccurate load calculations, which can result in wrong-sizing or mis-application of HVAC and dehumidification equipment. |
| **Powdery mildew** | One of the more common mold/fungus issues encountered by growers; affects a variety of plant species in addition to cannabis. | | | Indicator of environmental control issues in an existing cultivation space; may illustrate issues with air circulation and humidity control in a facility. Can lead to crop loss. | Powdery mildew is a form of biological contamination; other forms of biological contamination, or even enviornmental stress issues, can be confused with powdery mildew. |
| **ENERGY & POWER** | | | | | |
| **Power** | Measures the rate of energy transfer, or power. | W | Btu/hr | "Grams per watt" is often used as a measure of production efficiency but "grams per kWh" is a more accurate reflection of efficient use of electricity to produce one unit of product. With the increased use of LED lights using approximately 2/3 the amount of watts, the ratio of latent to sensible cooling changes. This is a result of reduced sensible load with the same latent load in a given space, thus changing load calulation and equipment specification. | Watts and watt-hour (or kWh) are often confused. Watt is a measure power, watt-hour (or kWh) is a measure of energy.<br><br>A light fixture drawing 1000 Watts for 1 hour consumes 1000 watt-hour (or 1 kWh). |
| **Kilowatt** | 1000 Watts | kW | | It is the basic unit associated with electrical energy demand, that is easier to express/digest with common sized loads (100 kW instead of 100,000 watts). Peak facility electrical demand is expressed in kW, and is used by most electric utilities to set the kW demand cost for the facilty.<br><br>Electrical demand charges on electrical bills may be misunderstood or misconstrued by growers and facility managers. | Kilowatts (kW) and kilowatt-hours (or kWh) are often confused. kW is a measure power, kWh is a measure of energy. |
| **Kilowatt Hour** | The amount of electrical energy required to operate a device for one hour. | kWh | | It is the basic unit associated with electrical energy consumption. kWh is generally only used to describe the electric energy consumption of a facility, but is sometimes used to describe total energy usage in a facility. kWh should be used to describe electric energy; Btu is a better unit for describing total energy usage. | Kilowatt-hours (or kWh) and kilowatts (kW) are often confused. kW is a measure power, kWh is a measure of energy. |

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| CULTIVATION KEY PERFORMANCE INDICATORS (KPIs) | | | | | |
| **Facility Space Efficiency** | Measures how much dried product is produced per square foot of canopy under cultivation. | g/sq ft | g/m2 | Since cultivators are limited by space by licensing, this metric determines the total output possible in a given square footage. | This metric makes no attempt to quanitify the amount of energy used. See ' Facility Electrical Efficiency' and 'Facility Energy Efficiency'. |
| **Facility Electrical Efficiency** | Measures how much dried product is produced per electrical energy input. | g/kWh | | Represents the total electricity required to produce a gram, including all electrical equipment including lights, HVAC, pumps, fans etc. | Sometimes used to describe the total energy efficiency of a facility, which neglects to address fossil fuel energy usage. |
| **Facility Energy Efficiency** | Measures how much dried product is produced per total energy input. | g/kBtu | | This is the most holistic key peformance metric of energy efficiency for a cultivation facility. This represents the total energy (from all fuel sources) required to produce a gram. | Grams per kWh and grams per kBtu are sometimes confused. |
| ENVIRONMENTAL CONDITIONS | | | | | |
| **Dry Bulb Temperature** | Temperature read by a standard dry thermometer. "It's 80 degrees outside today" refers to the dry bulb temperature. | F | C | Fundamental variable used to describe air. Most air cooled equipment is rated based on dry bulb. | Dry bulb is not the same as wet bulb temperature, and does not describe the humidity of the air. |
| **Wet Bulb Temperature** | The wet-bulb temperature is the temperature when air is at 100% relative humidity. | F | C | Wet bulb temperature is of little importance to the practical operation of a cannabis facility, though it may be used by engineers and designers calculalting HVAC loads and selecting equipment.<br><br>If a facility operates evaporative cooling towers, then wet bulb is relevent as it is the key parameter for designing and operating evaporative cooling equipment. | Wetbulb and dew point temperature are often confused. |
| **Dew Point Temperature** | Temperature at which air becomes saturated with water vapor. | F | C | Associated with the formation of condensation within the cultivation room or on the plant itself. | Dew point temperature and relative humidity (RH) are often confused. Dew point is used to calculate vapor pressure deficit.<br><br>Dew point is the temperature at which the air can no longer hold all it's mositure and condensation occurs, whereas RH represents the amount of moisture in the air relative to the amount of moisture the air could hold if it were saturated, which is very much dependent on dry air temperature. |
| **Relative Humidity** | The amount of water vapor in the air, expressed as a percentage of the maximum amount that the air could hold at the given temperature. | % | none | RH is relative because hot air can hold more water vapor than cold air; 60 degree air at 100% RH has much less water vapor in it than air at 100 degree air at 100% RH. | RH is sometimes misapplied to describe the actual amount of water vapor in the air. RH values without wet or dry bulb temperatures do not provide enough information to understand total moisture in the air. |

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| GENERAL HVAC | | | | | |
| **Sensible Load** | Sensible heat load is the heat you can feel. Sensible heat changes the temperature of a system without changing variables such as volume or pressure with no change in phase. | btuh | tons | The heating load associated with equipment like lights, and envelope loads from warm weather. It is important to consider for the correct sizing of systems, but is not the only factor to consider. | Systems sized with only the sensible loads considered can result in wrong-sizing or mis-application of hVAC and dehumidification equipment.<br><br>Sensible loads that are relatively easy to quantify are substantially offset through evapotranspiration (ET). This interactivity between sensible and latent loads drives low SHRs of cultivation spaces. |
| **Latent Load** | Latent heat load is the energy absorbed by or released from a substance during a phase change during a constant temperature process. | btuh | tons,lb/hr, pints/hr, pints/day or liters/hour | Dehumidification load; important in cultivation facilities as the latent loads very unique and play a critical role in properly selecting and sizing HVAC systems. | Typical commercial HVAC systems have limited latent capacity, meaning they are not designed for large dehumidification loads, and are not a good fit for indoor cultivation environments. |
| **Sensible Heat Ratio** | The ratio of sensible heat to the total heat. SHR = Sensible Heat/(Sensible heat + Latent heat) | expressed as an integer | | SHR is important to consider for the correct application of HVAC systems.<br><br>Cultivation spaces (flowering rooms in particular) generate SHRs as low as 0.5-0.6 while typical commercial HVAC systems have SHR between 0.7-0.9. This means that 40%-50% of the total load of cultivation spaces is associated with moisture in the air, or the latent load. | When 'typical' SHRs are applied to cultivation spaces, there is a mismatch between the loads of the space and equipment's ability to process those loads. |
| **Capacity** | A system's ability to provide a specified amount of heating, cooling, or moisture removal; typically based on performance at AHRI rated conditions. | Tons, pints/hr | btuh, Btu/hr | Consider capacity of HVAC and dehumidification equipment at typical and peak loads for the actual outdoor and grow environment conditions as AHRI rating conditions do not represent typical cultivation environment requirements. For right-sized equipment, load and capacity should match as closely as possible. | Rated capacity is often used in sizing equipment, which is unlikely to represent actual capacity/performance in cultivation spaces due to the unusual loads of these spaces. |

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| CONSTRUCTION | | | | | |
| **Permitting** | A building permit is an official approval issued by the local government agency that allows you or your contractor to proceed with a construction or renovation project. | | | Building permits are intended to ensure that the project complies with local codes and standards for land use, zoning, and construction.<br><br>Some states and municipalities may have energy codes that require facilities to satisfy certain performance requirements before permitting activities can proceed. | Prerequisites for building permits may be misunderstood by the project team and impact construction or renovation schedules. |
| **Start-up** | After installation and electrical wiring, an HVAC unit or system is powered on for the first time, or "started-up". | | | Almost every piece of HVAC equipment has a start-up checklist that must be followed to ensure the unit is installed and operating correctly. Start-up checklists are crucial for receiving warranty from equipment manufacturer. | Start-up performed by a manufacturer or mechanical contractor with the facility owner may be confused with commissioning, which is generally performed by third party consultants. |
| **Balancing** | The process of adjusting the flow rates of air and water within the HVAC system to verify the rates are as per the design. | | | A critical and often overlooked step to be performed after start-up and before or during commissioning.<br><br>Balancing air and water flows between spaces and equipment in a facility is crucial to ensure the design's sequence of operations is able to be met by the facility as constructed. Balancing reports are very helpful to inform commissioning agents activities during functional performance testing. | System balancing may be ignored as unnecessary during initial facility construction. Once a facility is operational, a lack of or improper system balancing can result in decreased thermal comfort and degraded energy performance. |
| **Commissioning** | Third party review of an installed HVAC system in a new building before occupancy to ensure that all systems are installed and operating as intended per the design. May include pre-functional, functional, and training and documentation tasks.<br><br>Commissioning of exisiting systems is refered to a retrocommisioning, or RCx.<br><br>Continous commisiong makes use of monitoring based controls to ensure systems continously operate as intended and to inform building operators of errors or systems that are out of parameter. | | | Facilities that are commissioned are better able to achieve energy performance as intended by design. New facilities are able to address construction issues earlier when commissioned, and existing buildings are capable of addressing controls sequences modifications that improve system energy performance, thermal comfort, and indoor air quality.<br><br>Start-up checklists can aid commissioning activites and make them more effective. | Commissioning and configuration are often confused. Manufacturers reps may indicate that they provide commissioning, but that scope of work is often limited to a few hours on site to start up equipment. Commissioning activities performed by owners or members of the design team are less likely to result in increased energy performance than commissioning performed by third parties, especially when Cx activities are performed by certified commissioning professionals. |