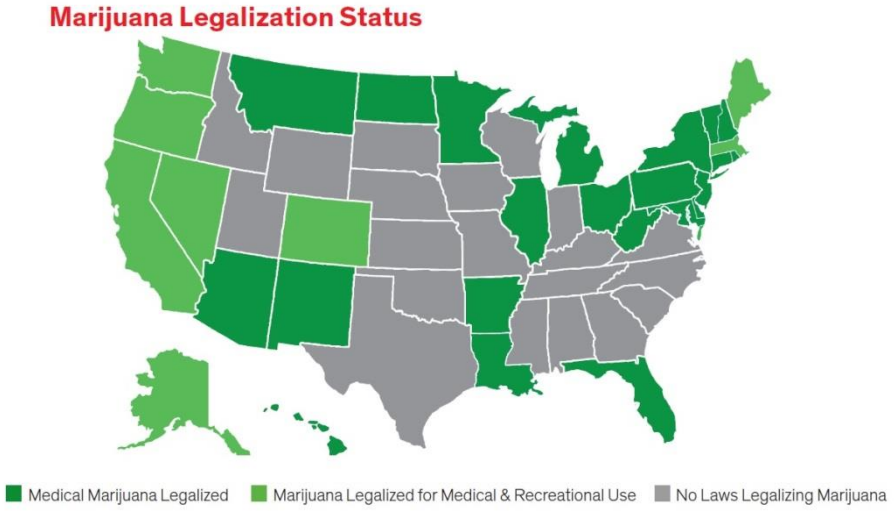
ASHRAE Meeting London, Ontario

Enviormental Controls for Indoor Cannabis Cultivation

2017

What Has Been Happening to the South

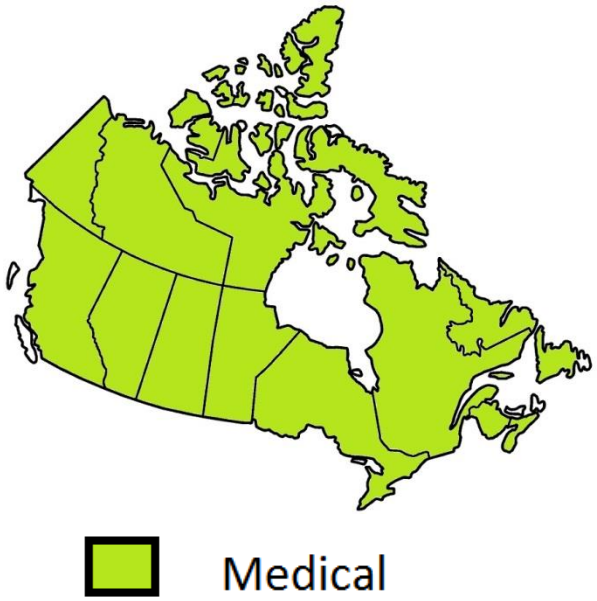
- Currently 29 states, 3 indigenous nations, and the District of Columbia have legalized medical cannabis
- Currently 8 states have legalized recreational cannabis
- Federally all is still illegal



Current Legal Status in Canada

- Cannabis (marijuana) remains a Schedule II drug under the Controlled Drug and Substances Act, and, unless otherwise regulated for production and distribution for medical purposes, is subject to offences under that Act.

- Possessing and selling cannabis for non-medical purposes is still illegal everywhere in Canada.

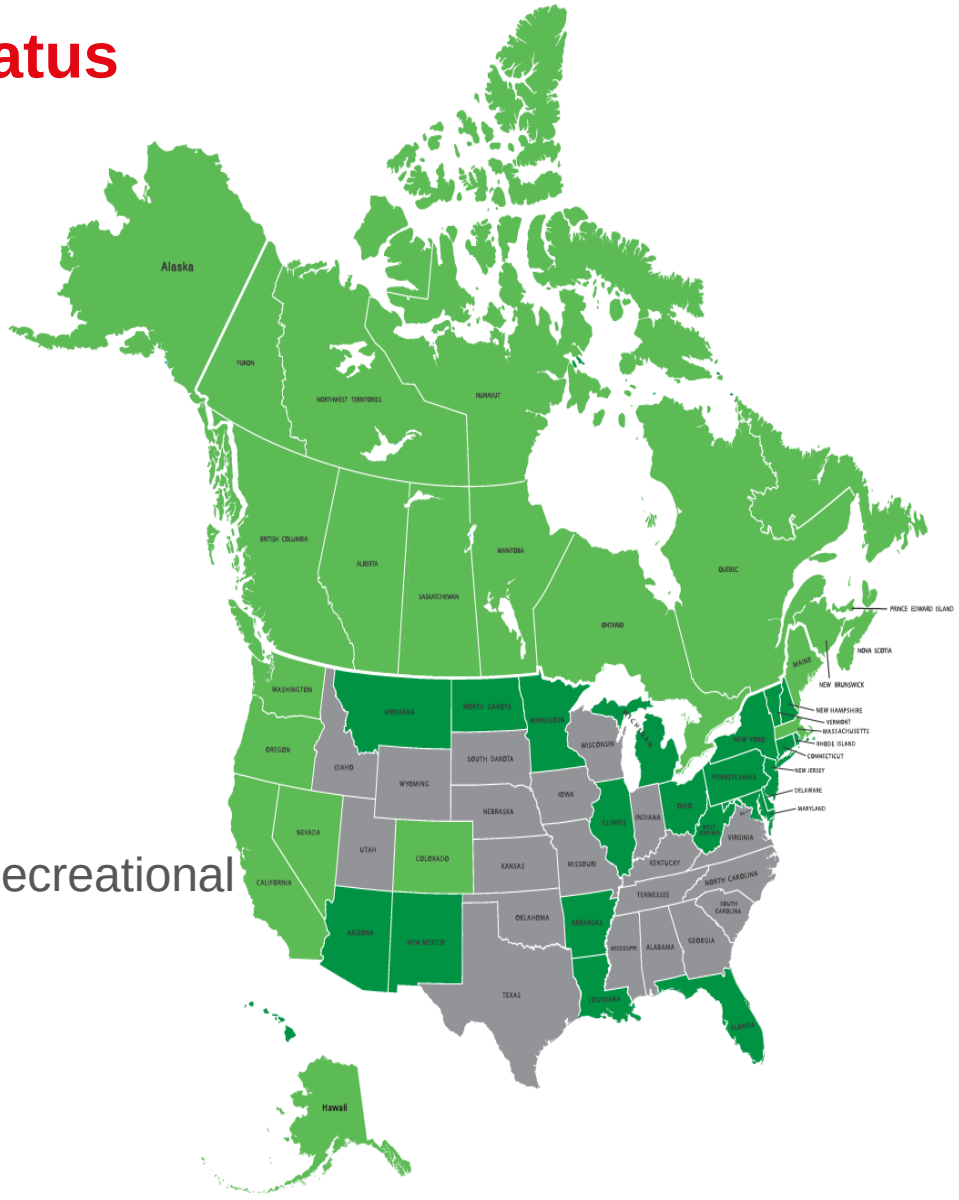


Pending Legal Status in Canada (Recreational)

- The final wording was still under discussion but a “likely” date for the official effect of the legislation has been widely publicized as 1 July 2018. The provinces will have the power to determine the method of distribution and sale.

Marijuana Legalization Status

- Medical Marijuana Legalized
- Marijuana Legalized for Medical & Recreational
- No Laws Legalizing Marijuana



A Very Different Industry With Unique Challenges

- Lack of experience within the engineering community
- Lack of HVAC experience in the operator community
- Lack of consensus within the grower community
- Latent cooling , latent cooling, and latent cooling

My Personal Experience So Far, a Very Steep and Confusing Learning Curve

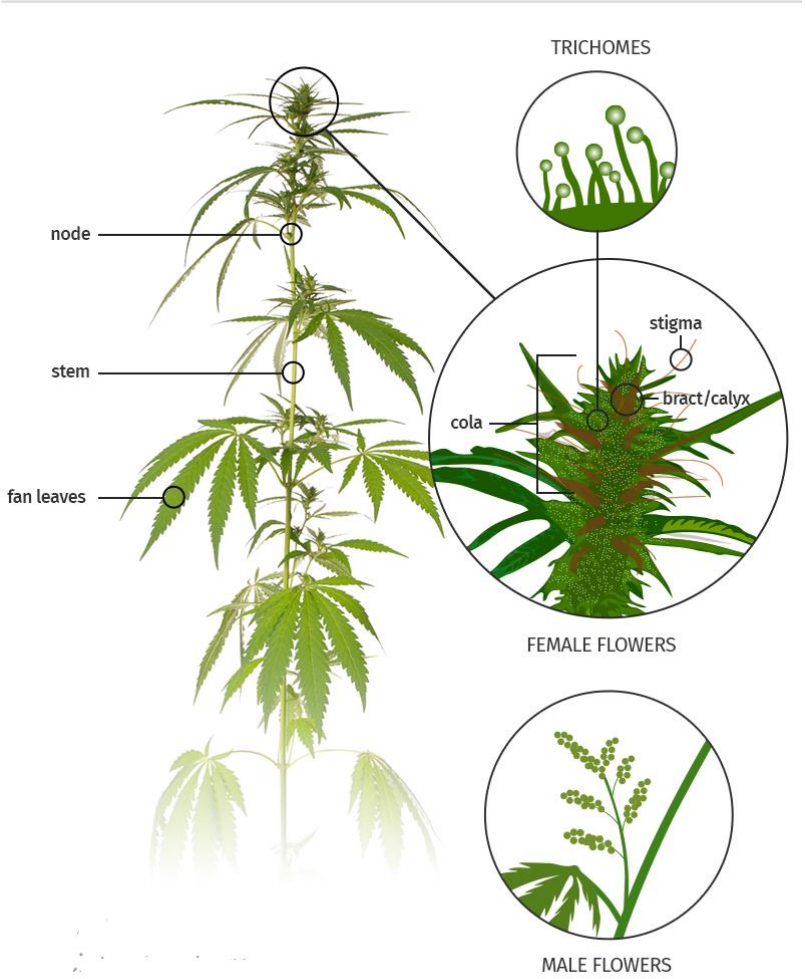
- We have supplied equipment to multiple grow facilities over the last 4 years
- Sought out experts to educated myself so I can assist engineers
- Initially modified 5 ton data center CRAC units to better suit the grow space
- Partnered with an industry leader (MMT)
- We are now modifying larger units to meet the needs of a changing industry (Dual circuit, up to 30 tons) , the rooms are getting larger
- Mostly dirt farming, areoponics and hydroponics are out there as well
- Greenhouses seem to add additional challenges

A Growers Biggest concerns

- Thermally stressed plants
- White mold or Mildew
- Pests
- Cross contamination between strains or rooms
- Economic impact of the loss of a room
- Continuation of a strain

To Understand the Environmental Requirements You Must Understand the Plant

- Life cycle
- Transpiration rates
- Impact of elevated levels of CO^2
- Lighting needs



Cannabis Cycle with Room Typical Requirements

- Mother room 23.9°C (75°F) 40%RH
- Clone room 26.7°C (80°F) 75%RH
- Veg room 23.9°C (75°F) 50%RH
- Flower room 22.2°C (72°F) 55%RH
- Curing room 23.9°C (75°F) 35%RH
- 63 days clone to harvest

Mother Room

- Mother room 23.9°C (75°F) 40%RH

Clone Room, The Nursery

- Clone room 26.7°C (80°F) 75%RH

Vegetative Room, Veg Room

- Vegetative room 23.9°C (75°F) 50%RH

Flowering Room, Bloom Room

- Flowering room 22.2°C (72°F) 55%RH

Drying Room, Curing Room

- Curing room 23.9°C (75°F) 35%RH Dew Point 7.5°C (45.5°F)

Types of Systems

- Direct Expansion
- Chilled Water
- Desiccant dehumidification
- Ultrasonic or steam canister humidification
- Requires tight control of conditions
- Co^2 control system
- Air scrubbers
- Combinations of multiple types of units

Custom Medical Cannabis Features

- Enhanced dehumidification

Custom Medical Cannabis Features

- Ultraviolet lighting

Custom Medical Cannabis Features

- CO^2 monitoring, Control, and alarms

What Information Does a Engineer Need?

Project name	Green Leaf Inc.
Project location	Denver, CO.
Date	October 10 2016

Type of room	Mother	Clone	Vegitative	Flowering
Lights on duration (hours)	12	18	18	12
Number of plants per room	25	200	200	200
Room design conditions				
Room design dry bulb temp (°F)	70	75	74	74
Room design RH (%)	45	45	45	45
Room dimensions				
Room width (ft)	20	20	20	20
Room legnth (ft)	15	40	40	40
Room height (ft)	12	12	12	12
Calculated floor area (Ft^2)	300	800	800	800
Calculated room value (FT^3)	3600	9600	9600	9600

Water and lighting				
Net water use	12.5	100	100	100
Watering technique	Batch	Batch	Batch	Batch
(Batch, Drip, Areoponics, Hydroponics)				
Lighting output per room	13.2	35.2	35.2	35.2
Type of lighting	HPS	HPS	HPS	HPS
Design requiremnts				
Room tightness	Medium	Medium	Medium	Medium
(Tight, Medium, loose)				
Type of heat rejection	Air	Air	Air	Air
Design summer ambient (°F)	95	95	95	95
Design winter ambient (°F)	0	0	0	0

Vapor Pressure Deficit

°C	°F	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%
15	59	0.0	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5	9.4	10.2	11.1
16	60.8	0.0	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.2	9.1	10.0	10.9	11.8
17	62.6	0.0	1.0	2.0	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7	10.6	11.6	12.6
18	64.4	0.0	1.0	2.0	3.1	4.1	5.1	6.2	7.2	8.2	9.3	10.3	11.3	12.4	13.4
19	66.2	0.0	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2	14.3
20	68	0.0	1.2	2.4	3.5	4.7	5.9	7.0	8.2	9.4	10.6	11.7	12.8	14.0	15.2
21	69.8	0.0	1.2	2.4	3.7	4.9	6.2	7.4	8.6	9.9	11.1	12.4	13.7	14.9	16.1
22	71.6	0.0	1.3	2.6	3.9	5.3	6.6	7.9	9.2	10.5	11.9	13.2	14.5	15.8	17.2
23	73.4	0.0	1.4	2.8	4.2	5.6	7.0	8.5	9.9	11.3	12.7	14.1	15.4	16.8	18.2
24	75.2	0.0	1.5	3.0	4.5	5.9	7.4	8.9	10.4	11.9	13.4	14.9	16.4	17.9	19.4
25	77	0.0	1.6	3.2	4.8	6.4	8.0	9.5	11.1	12.7	14.3	15.9	17.4	19.0	20.5
26	78.8	0.0	1.7	3.4	5.1	6.7	8.4	10.1	11.8	13.4	15.1	16.8	18.4	20.1	21.8
27	80.6	0.0	1.8	3.5	5.3	7.1	8.9	10.7	12.4	14.2	16.0	17.8	19.6	21.3	23.1
28	82.4	0.0	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.1	17.0	18.9	20.7	22.6	24.5
29	84.2	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.1	24.1	26.1
30	86	0.0	2.1	4.2	6.4	8.5	10.6	12.7	14.8	17.0	19.1	21.2	23.3	25.4	27.5
31	87.8	0.0	2.2	4.5	6.7	9.0	11.2	13.4	15.7	17.9	20.2	22.4	24.6	26.9	29.1
32	89.6	0.0	2.4	4.7	7.1	9.5	11.9	14.2	16.6	19.0	21.3	23.7	26.1	28.4	30.8
33	91.4	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.6	20.1	22.6	25.1	27.6	30.1	32.6
34	93.2	0.0	2.7	5.3	8.0	10.6	13.3	15.9	18.6	21.2	23.9	26.5	29.2	31.8	34.5
35	95	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0	30.8	33.61	36.4

- Stay in the green zone for healthy plants

*Chart courtesy of Big Buds Newsletter

What Does a Typical Grow Site Look Like?