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INTEGRAL GROUP

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Your Partner in Energy Solutions

AEE Monthly Meeting
November 1, 2017
Presented by: Fran Boucher | National Grid
Fred Green | Horticulture Consultant

Presenters

- **Fran Boucher** — **National Grid**
- **Fred Green** — **Horticulture Consultant**

Don’t say “NEVER”!

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The *buzz* about cannabis is not all about getting a *buzz*!

Sample uses:

- **Neuropathy**
- **Migraine headaches**
- **Pain relief**

Psychoactive Effects?

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- Cannabidiol (CBD) oil
- No Psychoactive high

The “common” understanding:

“no known adverse CBD oil side effects and it’s shown to be well tolerated even at higher doses”

General Cannabis Info

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Demand for Marijuana Infused Products (MIPs) Increasing Rapidly

- Market is 50% MIPs and growing
- Edibles: gum, cookies, candies, and lozenges.
- Concentrated oils for vaping or cooking.

Activity Varies by State

- **Recreational: Maine and MA in 2018**
- **Medical : RI , VT, MA, NY**
- **Projections for MA 2018 alone :**
  - **$450 Million in sales**
  - **$ 90 Million in tax revenue**

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Facilities Description

What is a grow facility?

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Space types:

Warehouse Design

What does a facility look like
Greenhouse design

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What does a facility look like

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What does a facility look like

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What does a facility look like

What does a facility look like

Project S I Z E

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Size varies by State

- **States regulate the size (licenses)**
- **2,000 sf to 1.0 Million Sq. Ft. locally**
  - **Annual lighting 1.0 MM SF could be $30 million!**
  - **Maybe $60 million in product**

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The Energy Picture

Money Slide

- **Energy is the largest cost component of bringing product to market**

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Plant Science

Grow Cycle

Seedlings

- Lights on 18 to 24 hrs./day
- 2 weeks or less

Vegetative

- Transitioned to full size pots and grow rooms
- Lights 18 hrs./ day
- 2 Weeks or less

Flowering

- Growing the buds
- Lighting 12 hrs./day
- 8 to 10 weeks

Plant Requirements

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Requires TIGHT construction

Supplementary CO_2

- Increasing levels to +/-1300 ppm will speed growth and increase yields.
- Sources of supplemental CO_2 are:
  - High pressure bottled gas –
  - Open flame gas burners – .
  - Purified machine exhaust –

Environmental Parameters

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VARIES ALL OVER!!!

Lights On: 78*F +/-2*, RH 50-55% +/- 3% Higher

Lights Off: 68*F +/- 2*, RH <50% +/- 3% Lower

Other Design Factors

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Moisture Removal Effectiveness

- The **KEY** component in the design of cultivation facilities.
- Mold and Mildew are the greatest threats to the crop.
- Disease prevalent when RH is high and air movement is poor: corners of rooms and around the base of mature plants.
- Prevention is best; applications of Hydrogen Peroxide can be helpful.

Moisture Removal Design

- Only use equipment PROVEN to work effectively at desired set points. Ask for documentation!
- Must install dedicated dehumidification system, not based on A/C operation.
- Incorporate a design buffer: performance at 65*F.
- Capacity to remove one day's irrigation volume within 24 hours.
- Traditional DX or refrigerant based dehumidifiers do not perform well at temperatures below 70*F and at RH below 60%.
- Outside air can be used for dehumidification during cold periods, but dilution of supplemental CO_2 will result.

Economics of Cannabis Production

Typical Production Costs

- Traditional Indoor Facility: $1000/lb.
- High Efficiency Indoor Facility: $500/lb.
- Greenhouse Facility: $250/lb.

Current Retail Price in MA per pound = $4,000 to $5,000.

Looking Forward

- Increased energy efficiency and labor efficiency to reduce COGS.
- Improved space utilization to maximize production.

Other Design Factors

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Don't forget *cooling* from plants!

- **The process of transpiration cools the air due to change in state of water from a liquid to a gas. (heat needed to evaporate liquid / water)**
- **8,000 Btu's per gallon.**

Odor Control

- **Is that a skunk?**
- **Reek HVOC on neighborhood relations**

Economics of Cannabis Production

Cost of Production per Pound

- **COGS will be the prime focus as prices drop and margins shrink.**
- **COGS range from 10% to 25% of Revenues depending on efficiency of operation.**

COGS Breakdown

- **Labor** **35%**
- **Energy** **50%**
- **Growing Supplies** **15%**
- **CO_2** **> 0.15%**

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Energy Efficient Design

Energy Profile

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Energy use drivers

1. Lighting #1
2. Dehumidification
3. Cooling (heat from lights and dehumidifiers)
4. Reheat

Lighting Power

Office:	00.8 w/ sf
Flower room:	60.0 w/ sf

Energy Profile

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Potentially $30 to $50/ Sq. Ft. annually



Energy Profile –

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Energy Intensity

1. Office – 21 MJ/m^2/year
2. Inpatient healthcare – 39 MJ/m^2/year
3. Cannabis cultivation – 139 MJ/m^2/year
    1. Source: Evan Mills, Lawrence Berkley National Lab

3 x Hospital

Energy Profile

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Greenhouses

1. Save up to 75% on energy use
2. Less control of product
3. Estimated 10% of New England market

State of Industry Standards

- Standards are still evolving
- Nothing specific in ASHRAE / IECC
- Lighting needs, irrigation, Temperature and Humidity, CO2
- No strong industry reference resources
  - High Times Magazine
  - Grower Blogs
  - Finding an “expert”

Horticulture Lighting
Metrics, Standards & Opportunities

Lighting Energy Use Baseline Standard

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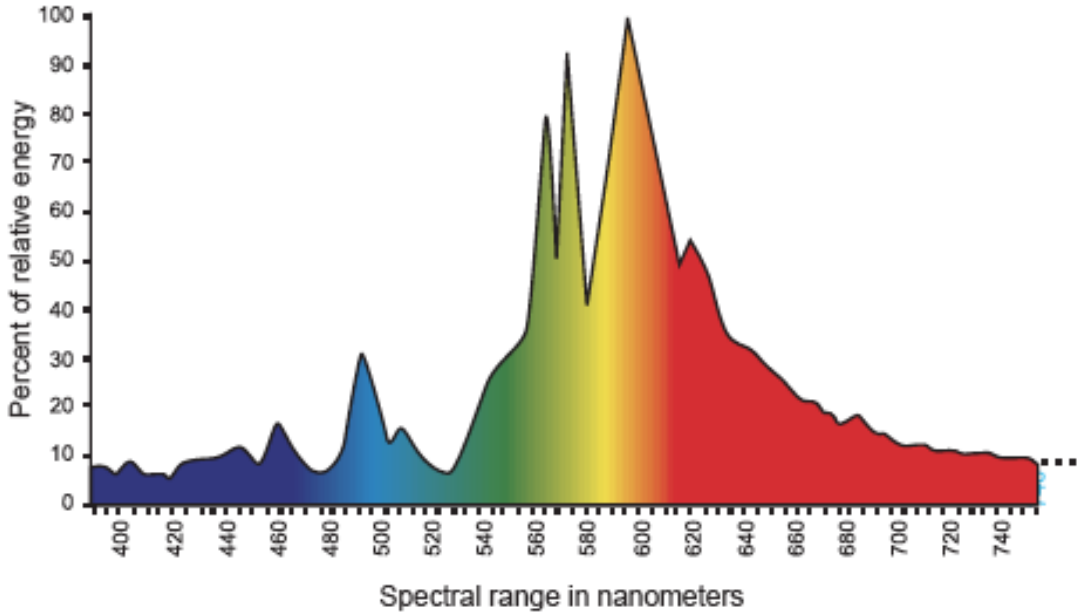
- **High-Pressure Sodium (HPS) lights standard practice**
- **Typically 16 S.F. per 1000 Watt HPS (Flowering Stage)**



“Lumens are for Humans”

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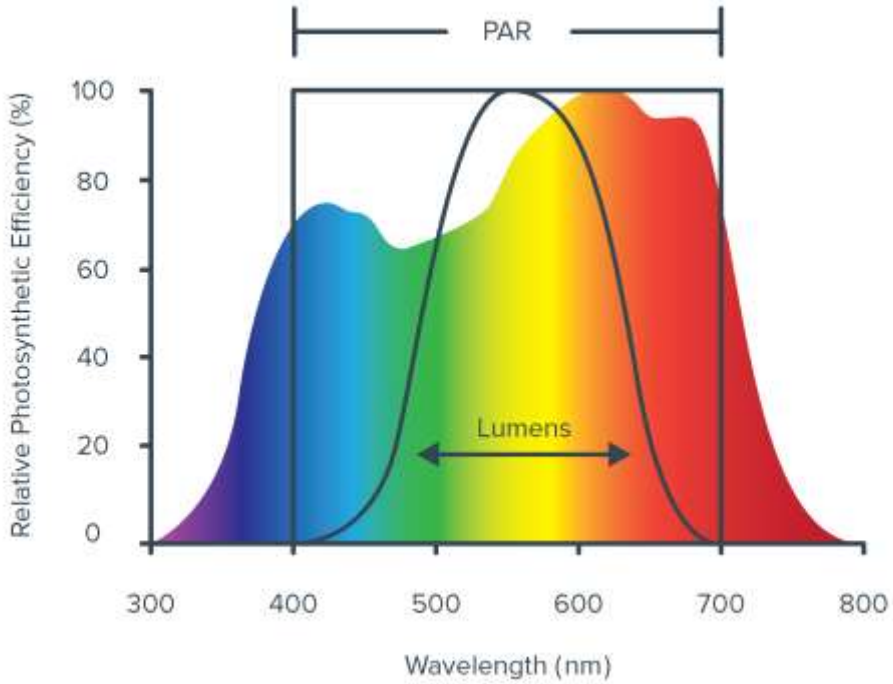
PAR:

Wavelength plants love

Micromoles:

Measures intensity



Description	Input Watts	PPFD per µmol/m²	Lamp Image
High Pressure Sodium -HPS	1080 W	700 to 800	
Double-Ended HPS	1080 W	800 to 1,000	
Ceramic Metal Halide - CMH	(2) 315 W 630 W	700 to 800	
Plasma	(2) 270 W 540 W	400 to 600	
Light Emitting Diode - LED	600 W	700 to 900	

Simple LED Case Study

5,000 Sq. Ft. flowering room:

Base:

(312) 1,000 watt HPS **(1055 watts)**

Proposed:

(312) 600 watt **LED (630 watts)**

Saved:

$75,000 / year excluding HVAC savings

$234,000 cost,

3 year payback (before utility incentive)

HVAC

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1. Primary HVAC drivers (7 x 24, 365)

- Remove heat of lights
- Dehumidification load
- Reheat

MOLD DESTROYS CROPS!

95% plus of irrigation water requires dehumidification

HVAC a Mixed Bag

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1. **Common cooling systems**
   - **Chillers**
   - **Spit system**
   - **VRF (variable refrigerant flow heat pumps)**

2. **Common dehumidification**
   - **Desert Air (take off on Pool Pak units)**
   - **Chilled water coils**
   - **Heat recovery units (MSP)**

The VRF Option

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1. MA CEC grants ***(up to $180,000!)***
2. Favorable redundancy
3. A favorite on West Coast

Still need supplementary dehumidification

Cannabis specific equpment

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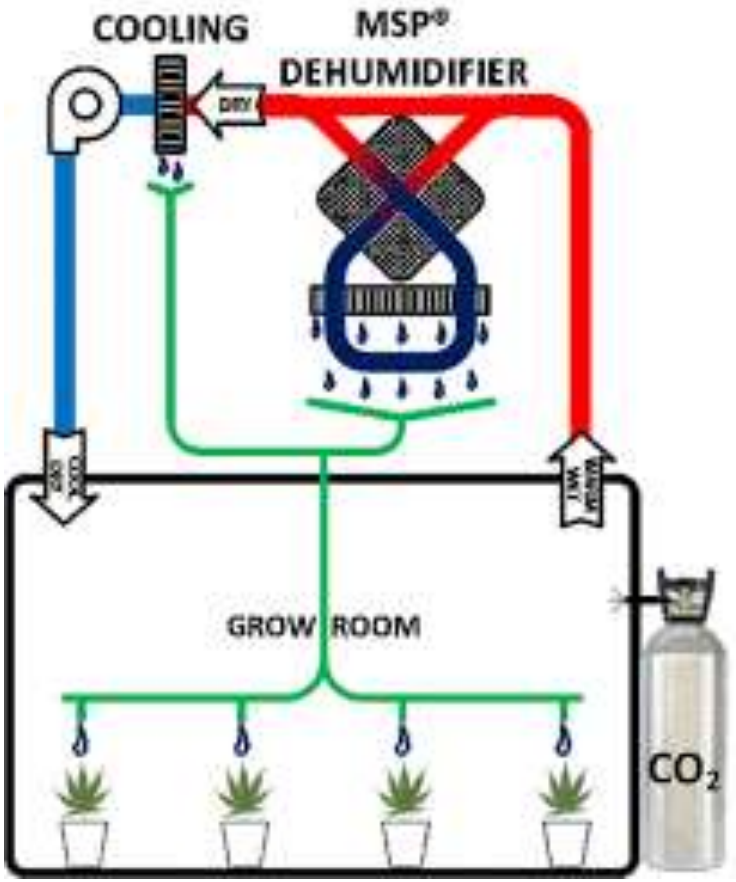
Specialized EE solutions

1. MSP: heat exchanger



33 degree chilled water needs reheat

High End HVAC Systems $$$

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- Gas engine driven chillers
- GSHPs (deep well)
- Combined Heat and Power (absorption chillers)

HVAC Energy Efficiency

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Potential HVAC measures

1. Desert air dehumidifiers (*may be base case!)*
2. Gas engine chillers (a best practice)
3. MSP HVAC units (unique for cannabis)
4. Economizers (rarely seen)
5. Beyond code chillers
6. Condensing boilers

The ultimate package????…….

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Utility Incentives

MA and RI and UNY Utility Incentives

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All custom (MA, UNY and RI)

- Yes lighting too!

MA and RI and UNY Utility Incentives

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How much are the incentives?

- **$50k to over $1.0 million**
- **Often short paybacks (under 2 yrs.)**
- **Combining LED and HVAC helps maximize incentives**
- **Top end incentives**
  - **LED lights**
  - **High end HVAC (CHP, Gas chiller)**

Incentives

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Measure list from an actual 45,000 sq ft facility

Table 0-1: Summary of ECMs

Description	Measure Analysis Method	Annual Savings			On Peak	Demand Reduction		Increm. Cost	Payback Period
		Electric kWh	Gas therms	Cost $	%	Summer kW	Winter kW	$	Years
LED Grow-Lights	Custom	382,642	7,358	$57,028	-	82.55	82.55	$206,375	3.6
Exhaust Fans with EC Motors	Custom	1,251	0	$163	100%	0.49	0.25	$1,350	8.3
Gas-Driven Chiller with Heat Recovery	Custom	286,674	-18,199	$19,251	50%	49.26	32.02	$97,240	5.1
Condensing Boilers	Custom	0	1,565	$1,549	-	-	-	$20,018	12.9
VFDs on HWS Pumps and CW Pumps	Custom	16,114	0	$2,095	57%	2.68	1.95	$7,093	3.4
High Performance Lighting	Prescriptive	24,794	0	$3,223	-	2.83	2.83	-	-
High Performance Site Lighting	Prescriptive	5,366	0	$698	-	0.00	1.23	-	-

ual cost savings assume default utility rates of $0.13/kWh and $0.99/therm.

Approximately $330,000 of incremental cost

Incentives could be upwards of $200,000 for this from a MA utility

Incentives

Gas engine chillers project

Local Example

- 200 Ton gas engine driven chiller
- 33 degree chilled water
- Compared to electric chiller
- Incremental cost $98,000
  - **Electric savings 290,000 kWh** **$39,150)**
  - **Gas use 19,000 Therms** **($20,900)**
  - **Net** **$18,250**

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Thank you for participating today

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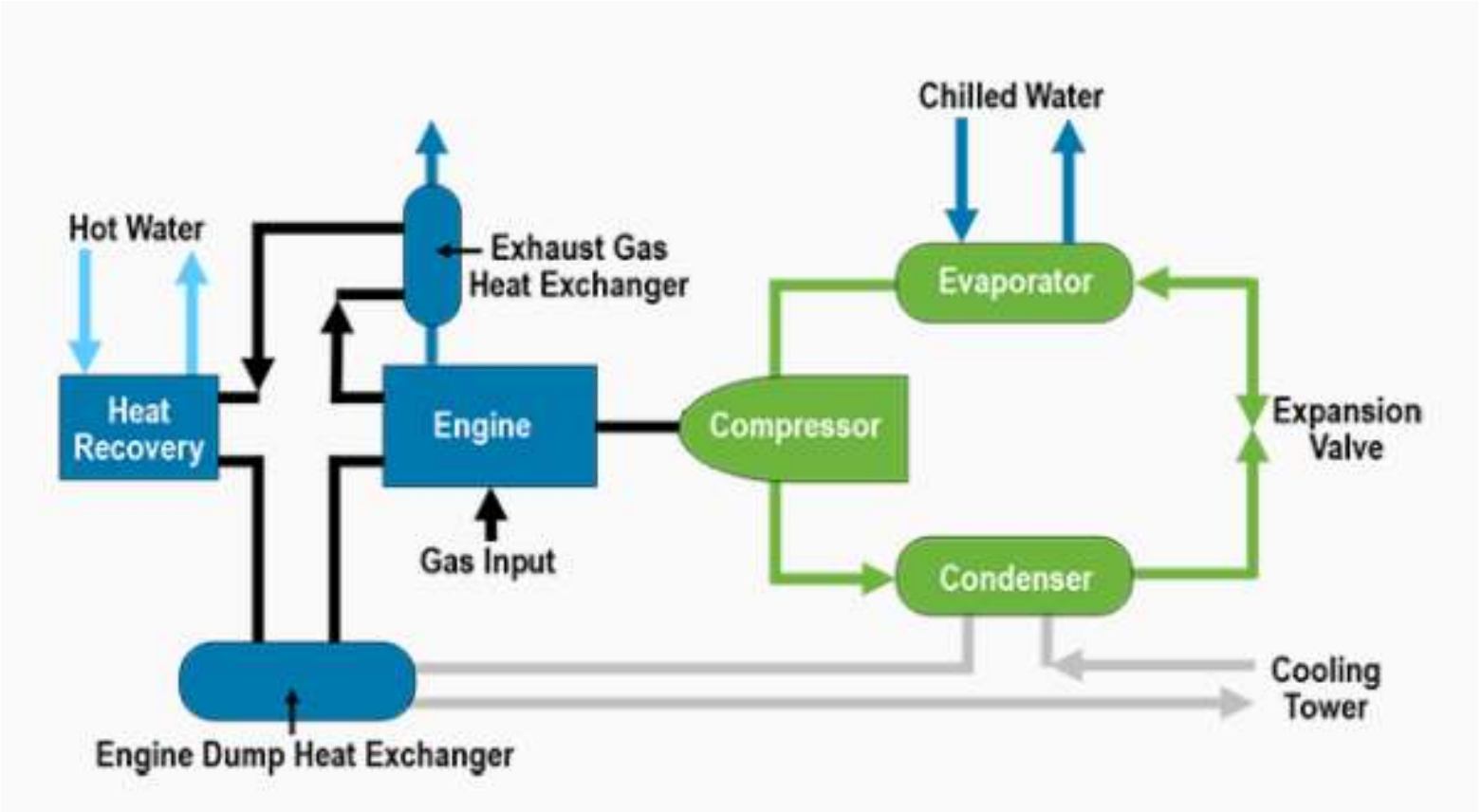
Incentives

Gas engine chillers (Starting at 50 Tons air cooled)



Incentives

Desert air dehumidifiers

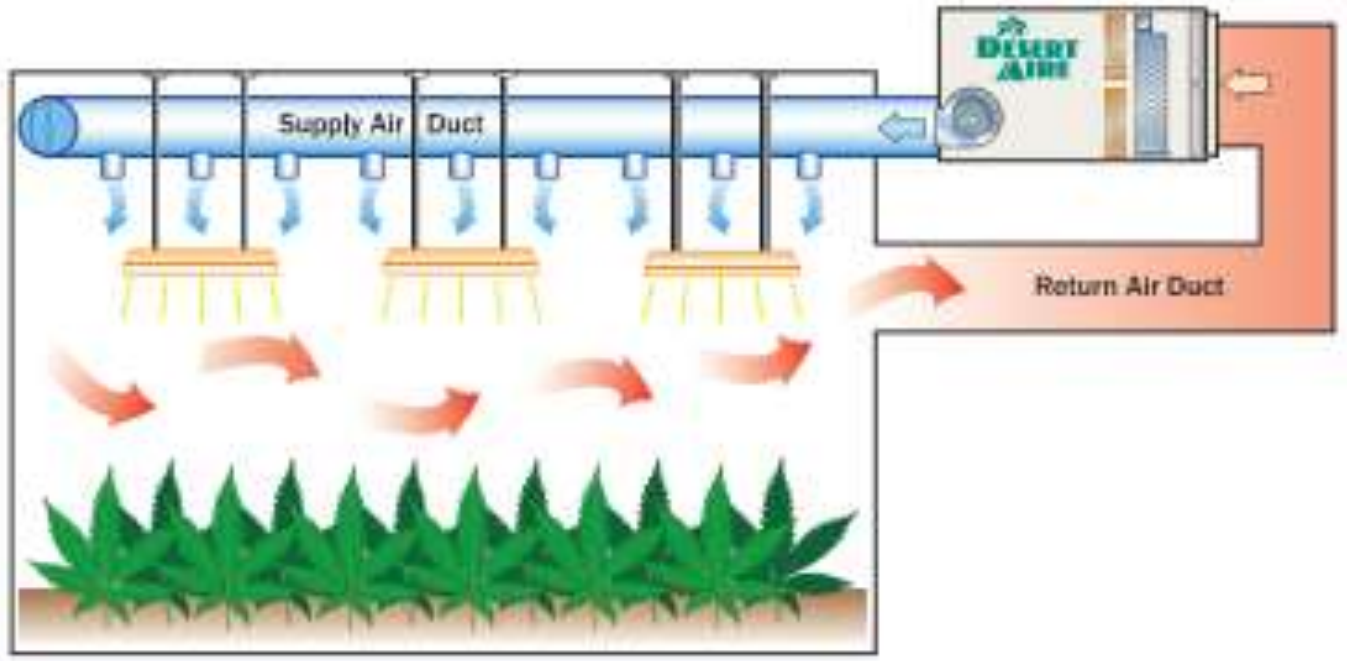


Figure 1 - Lights ON Mode Dehumidification • Cooling and Air Movement

Lights on: Compressor heat can be discharged outdoors. (option)

Incentives

Standard low cost dehumidifiers