

# Emerging Low-Carbon **Cooling** & **Heating** Practices & Technologies

Friday, September 16, 2022. International Conference, ANGAN  
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## 2021 AT-A-GLANCE

FOUNDED  
**1890**

HEADQUARTERS IN  
**ST. LOUIS, MO USA**

WORLDWIDE



**86,700**  
EMPLOYEES



**170**  
MANUFACTURING  
LOCATIONS

TWO  
BUSINESS  
PLATFORMS

**\$11.6B**  
IN SALES

**AUTOMATION SOLUTIONS**

**\$6.7B**  
IN SALES

**COMMERCIAL & RESIDENTIAL SOLUTIONS**

**\$18.2**  
**BILLION**

IN GLOBAL SALES  
FISCAL YEAR 2021

**3 COVID-19**  
**VACCINES**

PRODUCED  
USING EMERSON'S  
SOFTWARE

**65**  
YEARS

CONSECUTIVE  
YEARS OF  
INCREASED  
DIVIDENDS

NYSE:  
**EMR**

INNOVATION  
**EMERSON**  
**EMPLOYEES HELD**

**20K**

ACTIVE PATENTS  
WORLDWIDE  
IN 2021

**#181 FORTUNE 500**  
AMERICA'S LARGEST CORPORATIONS BY REVENUE

### RECOGNITION - 2021

**TOP 50 EMPLOYERS**  
WOMEN ENGINEERS  
MAGAZINE

**BEST EMPLOYERS  
FOR DIVERSITY**  
FORBES MAGAZINE

**IoT ANALYTICS  
PLATFORM OF THE YEAR**  
IOT BREAKTHROUGH

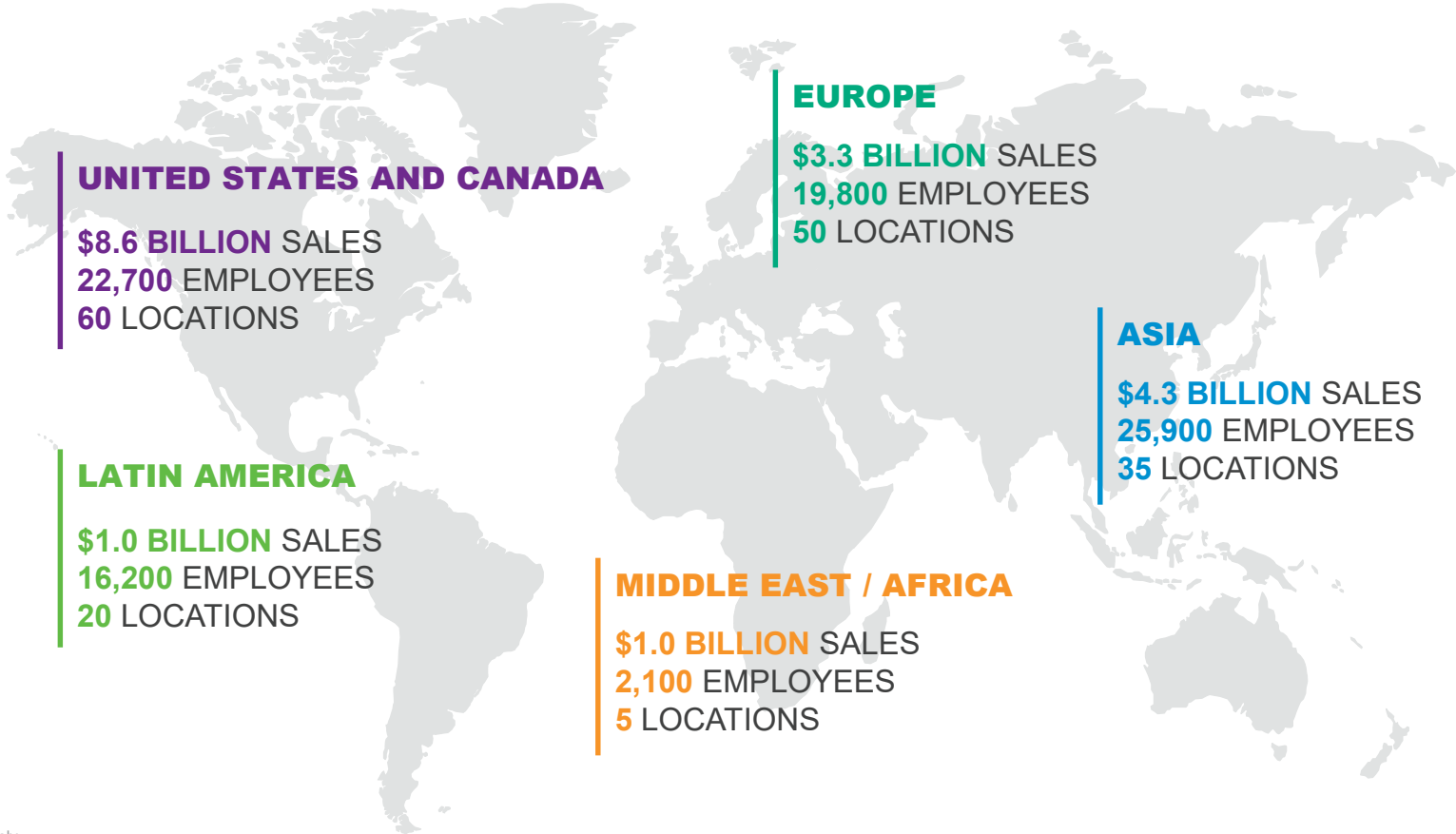
# Emerson Global Presence 2021

## GLOBAL

**\$18.2B**  
SALES

**86,700**  
EMPLOYEES

**170**  
LOCATIONS



Note: Locations include manufacturing locations only.

# Commercial & Residential Solutions

2021 At-A-Glance

**\$6.7B**  
SALES

**~28,100**  
EMPLOYEES

## CUSTOMERS INCLUDE

Amazon, Carrier Global Corporation, Daikin-Goodman, HD Supply, The Home Depot, Johnson Controls, Johnstone Supply, Lennox, Lowe's, Midea, Rheem, Trane Technologies, United Refrigeration, Wolseley, W.W. Grainger



CLIMATE  
TECHNOLOGIES  
**71%**

TOOLS & HOME  
PRODUCTS  
**29%**



AMERICAS  
**68%**  
  
EUROPE  
**13%**

ASIA, MIDDLE  
EAST & AFRICA  
**19%**

# Commercial & Residential Solutions

Transforming the Way People Live and Work Globally



## INDUSTRIES SERVED

Residential Construction & Home Improvement  
Commercial Buildings & Construction  
Energy & Utilities  
Facility Management & Maintenance  
Food Service & Hospitality  
Food Retail  
Healthcare & Life Sciences  
Transportation

## MARKETS SERVED

Heating & Air Conditioning Technology  
Cold Chain Software & Technology

- Real-time tracking and data services
- Refrigeration and cold storage
- Temperature and environmental monitoring

Energy & Facility Management Solutions  
Smart Thermostats  
Home Improvement, Repair & Maintenance  
Professional Tools  
Commercial Comfort & Cleaning  
Food Waste Management

## OUR PRODUCT BRANDS

**COPELAND™**

**LUMITY™**

sen|si

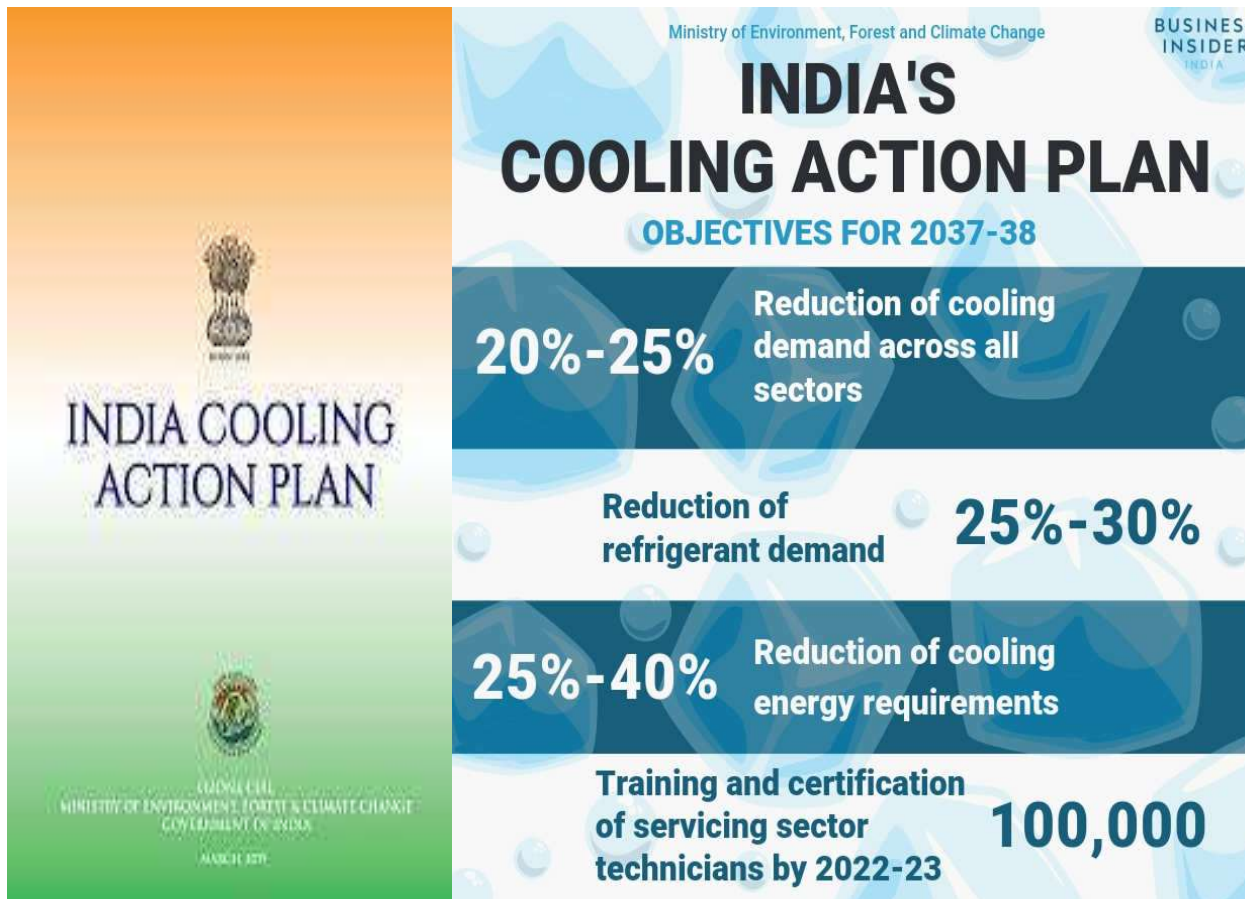
**GREENLEE.**

**RIDGID**

**Klauke™**



## Low Carbon Emission **Cooling** & **Heating** Practices/Technologies



### For Sustainability & Decarbonization

- 1 Seasonal Energy Efficiency
- 2 Green Refrigerants
- 3 Cleaner Heating

# Labeling Standards Focusing On Part Load Efficiency

## IS 16590- Chiller Test Standard

ISEER Rating Condition : Chillers			
Load Rate (%)	Weighting Coefficients	Condenser Entering Temp.	
		Liquid Cooled	Air Cooled
100	A=6	30°C (86.0 °F)	39°C (102.2 °F)
75	B=48	26°C (78.8 °F)	32°C (89.6 °F)
50	C=36	23°C (73.4 °F)	26°C (78.8 °F)
25	D=10	20°C (68.0 °F)	20°C (68.0 °F)
Leaving Temperature		Evaporator Liquid Temperature 7°C	
Flow Rate		5°C Delta Temperature	

$$\text{ISEER} = A \cdot \text{COP}_{100\%} + B \cdot \text{COP}_{75\%} + C \cdot \text{COP}_{50\%} + D \cdot \text{COP}_{25\%}$$

- Scope Includes All Types Of Chillers
- Mandatory Labelling Jan 2023
- Shall Comply Pre- Qualification Criteria Of Minimum COP @100% Load To Become Eligible For Star Rating Plan

Pre-Qualification  
@ 100% Load

84%:  
Part Load



kW Cooling	Minimum COP	ISEER Air Cooled Chiller				
		1 *	2 *	3 *	4 *	5 *
<260	2.40	3.00	3.30	3.60	4.00	4.40
>=260	2.60	3.10	3.50	3.90	4.30	4.70

kW Cooling	Minimum COP	ISEER Water Cooled Chiller				
		1 *	2 *	3 *	4 *	5 *
<260	4.20	4.80	5.20	5.60	6.10	6.60
>=260 & <530	4.70	5.00	5.60	6.20	6.80	7.40
>=530 & <1050	5.00	5.50	6.10	6.70	7.40	8.20
>=1050 & <1580	5.20	5.80	6.50	7.20	7.90	8.70
>=1580	5.60	6.00	6.70	7.40	8.20	9.00

ISEER Rating Condition: VRF

Load rate (%)	Weighting Coefficients	Testing Conditions	
		Temp of Air Entering Indoor side	Temp of Air Entering Outdoor side
100	A=6	Dry Bulb Temp - 39°C (102.2 °F)	39°C (102.2 °F)
75	B=48	27°C	32°C (89.6 °F)
50	C=36	Wet Bulb Temp - 19°C	26°C (78.8 °F)
25	D=10	19°C	20°C (68.0 °F)

\* Tests to be Done at Rated Frequency & Voltage

\* Compressor Speed – Speed set as per % load capacity condition (or) Controller Setting of full capacity

## Multiple Modulation Options To Deliver Part Load Efficiency

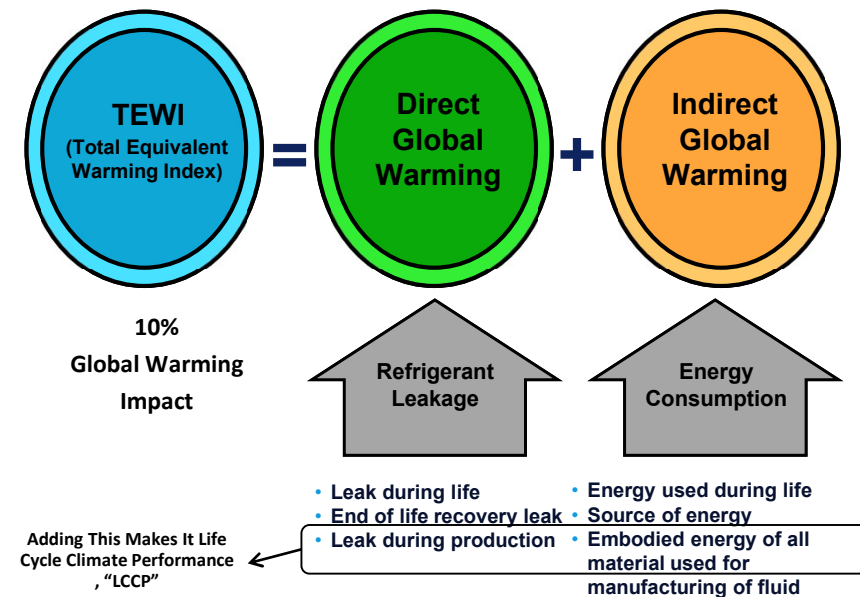
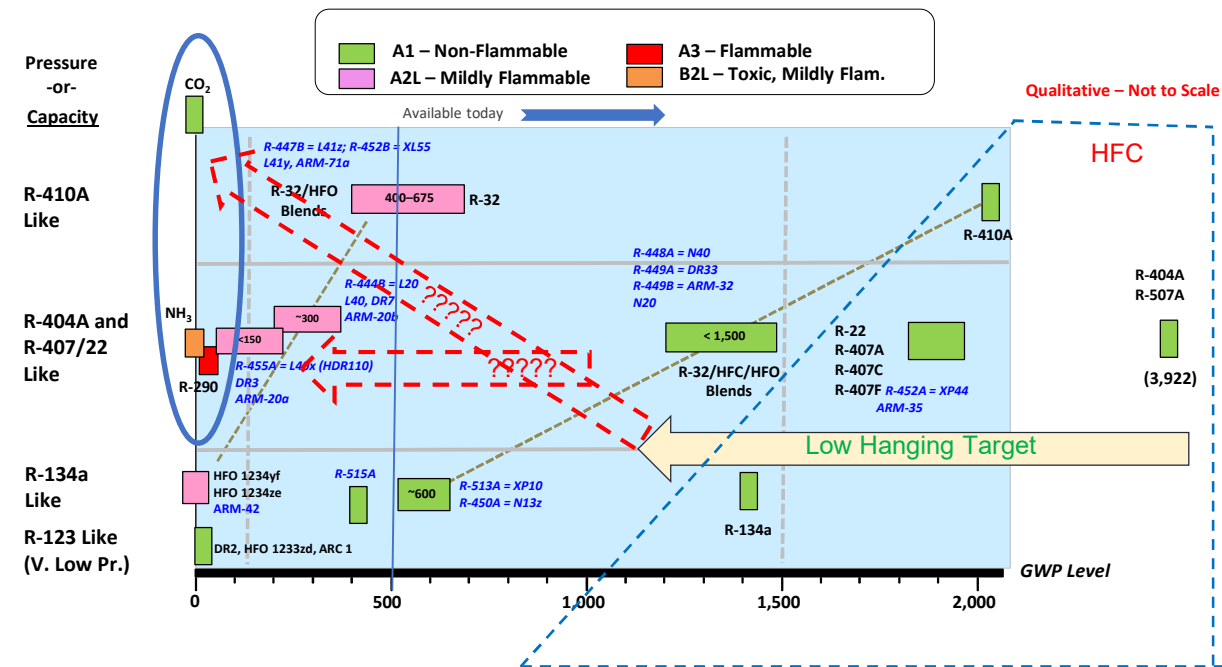


Modulation Technologies	Capacity Steps (Range)	Part Load Efficiency	Full Load Efficiency	Comfort/Precise T	Complexity
Variable Speed Scroll	Expansive Control 15-130Hz Variable Frequency	Best	Medium	++++	++++
Digital Scroll	10%-100% Mechanical Modulation	Best	Medium	++++	+
Two-Stage Scroll	2 Steps 65%, 100%	Better	High	++	+
Tandem/Trio Scroll	Up to 10 Steps	Better	High	++	++

Multiple Modulation Platforms Provide Opportunity To Achieve Part Load Efficiency Benefits



# Reduce Global Warming – Use Refrigerants Which Are Best in Life Cycle Performance



Ozone Depletion → Global Warming → Climate Change

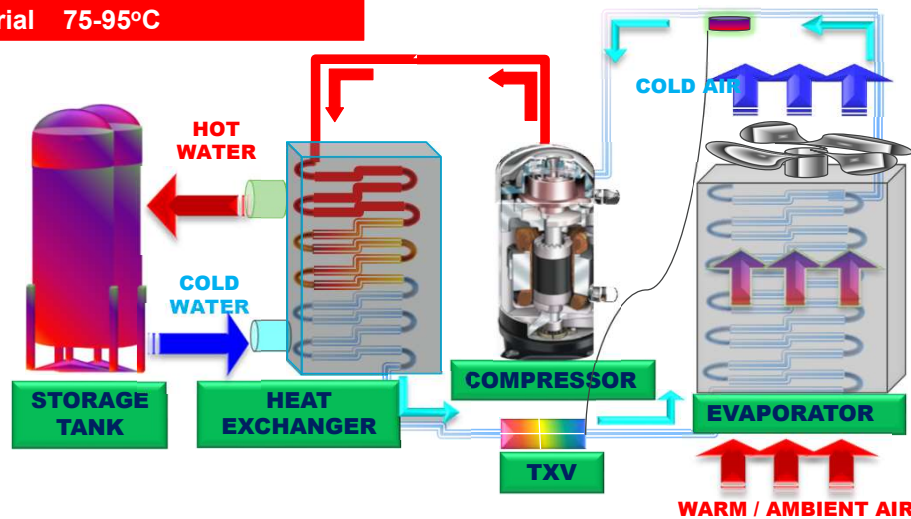
# Cleaner Heating Using Heat Pumps For Domestic & Commercial Sanitary Heating

## Hot Water Out

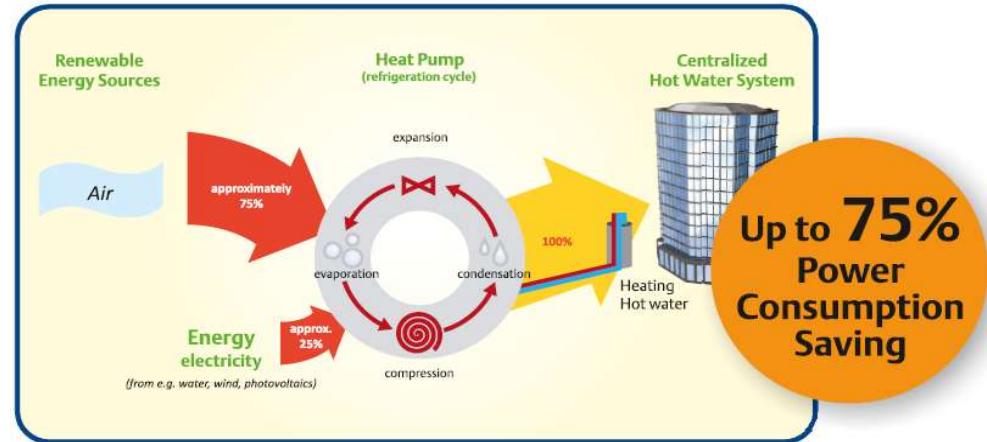
Pool	<35°C
Sanitary	55-60°C
Industrial	75-95°C

## Low GWP Refrigerant Options

R407C, R134a



	Electric Heating	Combustion Type	Heat Pump
COP	< 1.0	$\leq 0.8$	> 3.5 - 4
CO2 Emissions	100%	100%	<40%



## Electrical Infra

Huge Savings In Transformer For Multiple Flat Apartments



## Hot Water 24/7

Hot Water Available On Demand; No Waiting; Luxury



## Real Estate

Huge Savings In Space At Bathrooms/ Rooftop Solar



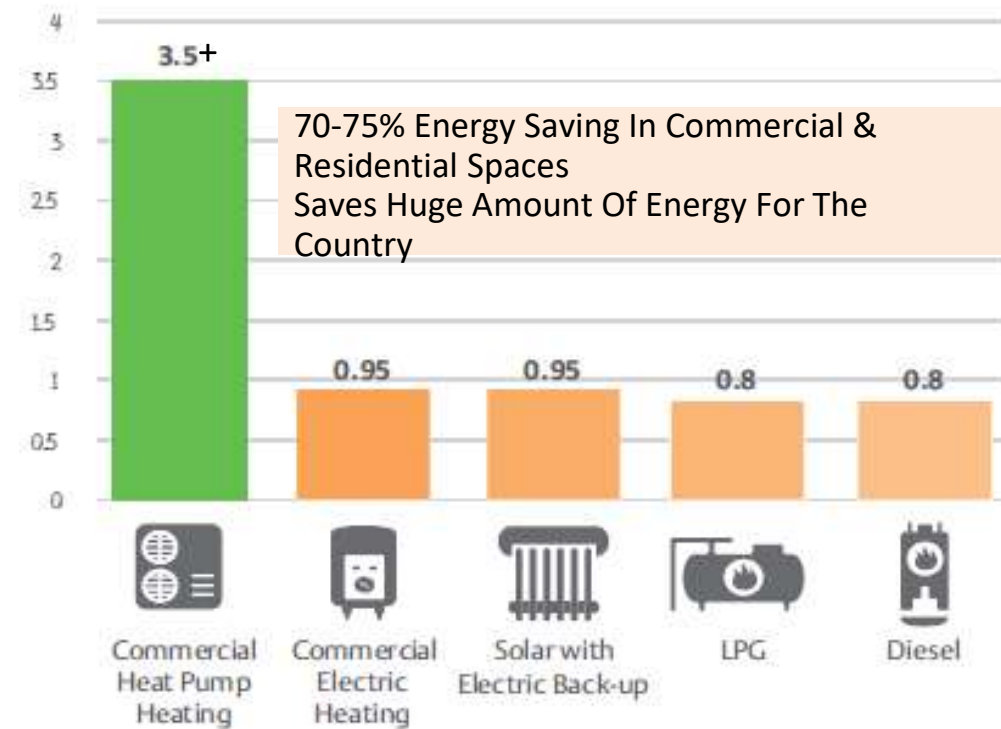
## CO2 Reduction

Reduction At Primary Energy Generation  
5kg CO2/Flat Saved

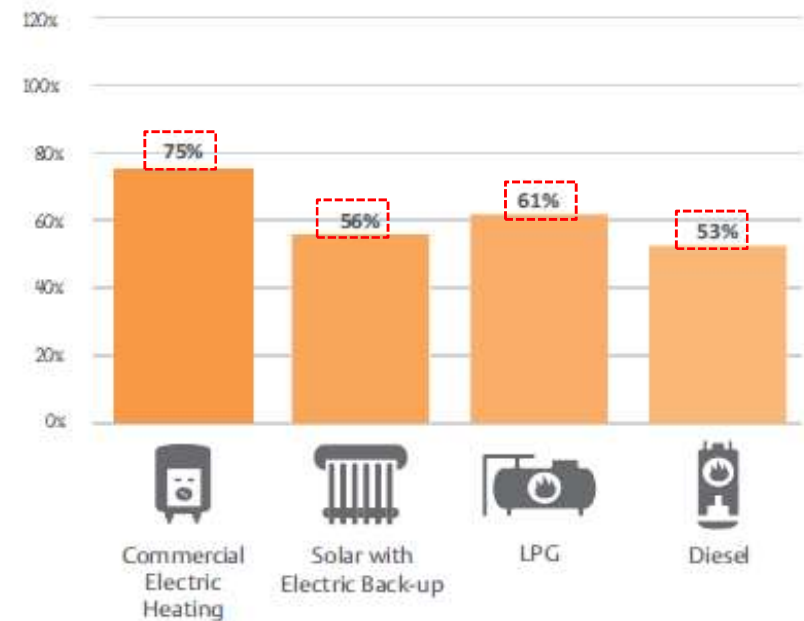


# Benefits Of Heat Pump Over Traditional Technology

## Heating efficiency

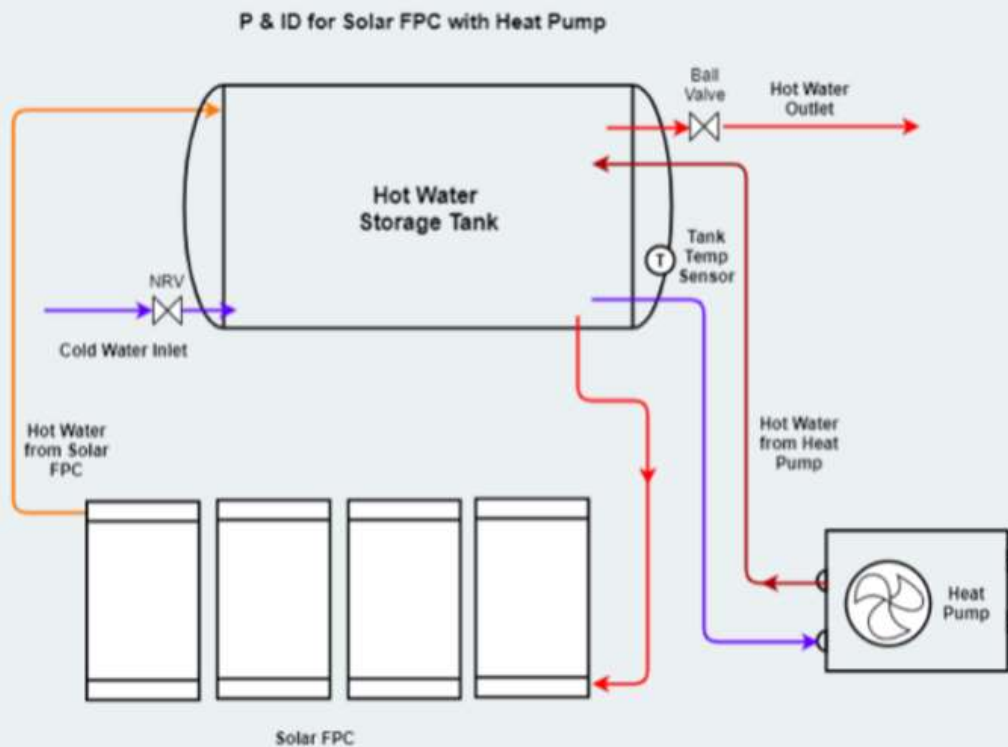


## Annual energy saving in % Heat pumps vs other heating systems





## Hybrid System: Heat Pump + Solar



- Use Daily Usage Programming Capability
- First Priority To Solar
- Second Priority To Heat Pump
- If Hot Water Gets Used During Day time
- Heat Pump Automatically Triggers On

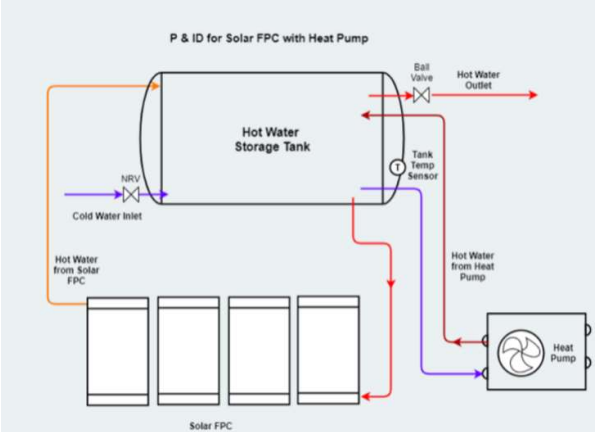
Schedular Facility Can Take Care Of Priority Of Solar & Heat Pump To Minimize Power Consumption



# Case Study Solar+ Electrical Backup v/s Solar+ Heat Pump Backup

Solar Thermal System With Heat Pump Hybrid			
	Hot water System	Solar Backed Up With Electrical Heater	Solar Backed Up With Heat Pump
Heat Pump/ Solar		500 LPD X 6	100 LPH X 3
Tank Size		500 X 6 + <b>100 X 3 (EB)</b>	1000 X 3
Total Hot water storage		3300	3000
Hot water requirement per Day		<b>6300 (3000 S+3300 Heater)</b>	<b>(3000S+3300HP)</b>
Daily Working Hours		12 Hrs	11 Hrs
Heating Capacity (KW)		(3* 6kW) 18 Kw	(3* 3.5kW) 10.5Kw
Input Power (Kw) for 3 Machines		<b>18 Kw</b>	<b>3 X 1.25 Kw</b>
Required Electrical units per day		<b>216 Kw</b>	<b>41Kw</b>
Electricity charge per Unit (INR)		12 Rs.	12 Rs.
Energy Cost/ Day (INR)		<b>Rs. 2592</b>	<b>Rs 492</b>

- Average Cost Saving Per Day = Rs. 2,100
- Annual Saving (With 10months Running) = Rs. 6,30,000
- Capital investment cost for Heat pump & Tanks =Rs. 6,00,000
- Return On Investment (ROI) = 10 Months



- Use Daily Usage Programming Capability
- First Priority To Solar
- Second Priority To Heat Pump
- If Hot Water Gets Used During Day time
- Heat Pump Automatically Triggers On





## Heat Pump Case Study Versus Boiler

HEAT PUMP VS DIESEL BOILER			
	DESCRIPTION	VALUE	UNIT
A	Daily hot water consumption in hotel	5000	LTRS/DAY
B	Divided into 2 tanks	2500 X 2	L/Day
C	Total Boilers	2	
D	Diesel Per Boiler	17 Lit/Boiler/Day	
E	Total Diesel Usage	34 Lit / Day	
F	Cost Of Diesel	90 Rs/Lit	
G	Total Cost to Heat Water With Boiler (90 X 34)	3,060	Rs./Day
H	When Used 2 Heat Pumps Of 36Kw For 2500 X 2 Tanks Input Power is 10 Kw/Hr		
I	For 5000 Lit Of Water Heating Total Input Power is 50Kw For Delta Of 40°C (North). Input Power Per Day Was 70Kw	70Kw/5000Lit @40°C Delta	
J	Cost of Elect 11 Rs/Unit	11 Rs/Unit	
K	Total Heating Cost With 2 Heat Pumps – 11 X 70	770 Rs/Day	
	Cost Saving Per Day (G-K) - (2312-770)	2290	Per Day
	Total Cost Saving Per Year	8,24,400	



- For 50 Rooms Hotel , Energy Saving of 8.3L Per Annum
- There are Thousands Of Hotel, If Shifts To Heat Pump, There Will Be Huge Saving

**ROI Is Achieved in 12 to 15 Months For this Hotel**

## Key Takeaways

- Seasonal Energy Efficiency Is An Important Parameter To Lower Down Carbon Emission
- Compressor Modulation Technology Helps Achieve Seasonal Energy Efficiency
- Industry Is Working Towards Exploring Low TEWI Refrigerant Option
- Sanitary Water Heat Pump Is A Strong Technology Candidate To Replace Conventional Heating For Cleaner Heating
- Sanitary Water Heat Pump Delivers Up to 75% Power Consumption Saving
- Heat Pump Augments Well With Renewable Energy Water Heaters Like Solar