

Ice Bear Technology

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Abstract: Ice bear is a device that saves the energy required to drive the air conditioning unit. The ice bear consist of elements such as an insulated cabin in which copper coils are present which includes refrigerant surrounded by the water, compressor, condenser, a small pump, a control panel that controls the sensors to tell us the temp. Updates and a special evaporator unit that fits in air conditioning unit. Now a day, the air conditioning is the subject in which there is great scope of research. There are many applications of this technology such as in malls, theatres, offices in tool room, etc. where air conditioning is essential but a solution on this problem. This technology uses the cold atmospheric air of surrounding at night, to prepare an ice in the insulated cabin. So that this ice stored in insulated space can be used for air conditioning purpose instead of electrical energy during the peak time of day. This device saves very much energy, as the energy required during the peak time of the day is high because the temp. During peak time is very high. So, the compressor has to do very much work so the electricity required is also more. There are mainly two types in ice bear that are Ice Bear 20 and Ice Bear 30. The 20 and 30 indicates the versions. The Ice Bear 20 serves for total 4 hours, while the Ice Bear 30 serves for total 6 hours. The further research is going on for the version Ice bear 40. More research is going in this field to increase the working time of the system. New innovations in this field will definitely beneficial.

Keywords: Ice bear, insulated cabin, special evaporator unit, energy saved during peak time of day.

1. Introduction

Ice bear system is the technology developed by the company name as Ice Energy. Ice bear technology enables a powerful change in how and more importantly when energy is consumed for air conditioning.

The ice bear system is an intelligent distributed energy storage solution that works in conjunction with commercial direct expansion air conditioning system, specially the refrigerant based, 4-20 tons packaged rooftop system common to most small to mid-sized commercial buildings.

The system stores energy at night, when electricity generation is cleaner, more efficient and less expensive, and delivers that energy during the peak of the day to provide cooling to the building.

Day time energy demand from air conditioning – typically 40-50% of a building's electricity use during peak day time hours can be reduced significantly. In kilowatts, each ice bear delivers an average reduction of 12 KW of source equivalent peak demand for a minimum of 6 hours daily, shifting 72 KW hours of on peak energy to off pick hours.

Ice bear units are typically owned by utilities and installed at distributed locations behind the customer meter on commercial and industrial sites.

When aggregated and deployed at scale, a typical utility deployment will shift operation of thousands of commercial AC condensing units from on peak periods to off pick periods, reducing electric system demand, improving electric system

load factor, reducing electric system costs, and improving overall electric system efficiency and power quality.

2. History

Ice Bear Technology was first invented in New York City in United States of America. The main reason to find out the ice bear technology was that the consumption of the electricity required during pick period in the day is very high. So there was a great issue of electricity usage and the issue of release of CO₂ as well as chlorofluro carbon. The main product of the ice energy company that developed the ice bear technology was ice batteries. Then the ice energy thought about how we can save the electric energy that is used during pick period in day time for air conditioning purpose and also how can we reduce the harmful gases that releases due to air conditioning. Mike Hopkins the CEO of the ice bear technology then found that we can save the energy by forming the ice during night time and use that ice temperature during the pick period of the day.

The first challenge in front of the team of the ice energy was how we can store the energy at the night. The solution was to invent the cabin that has insulation so that there is no heat transfer and so ice can be stored till pick period of the day. Another issue was the component that will act as evaporator as well as condenser as per need. Hence the copper coils were invented that is good conductor of electricity so it can take coolness of refrigerant to form ice and act as evaporator, during pick period of day it acts as condenser and transfer the heat of refrigerant to the ice to make the refrigerant cool.

Then the new type of evaporator is installed in the normal air conditioning unit that acts as evaporator coil for normal air conditioning system as well as for ice bear technology.

First the ice bear 20 was invented to give air conditioning for 4 hours and then ice bear 30 was invented that serves for 6 hours.

Parts of Ice Bear

1) Insulated Cabin

It is also called as insulated tank. It is made of polyurethane foam. This material does not allow the heat

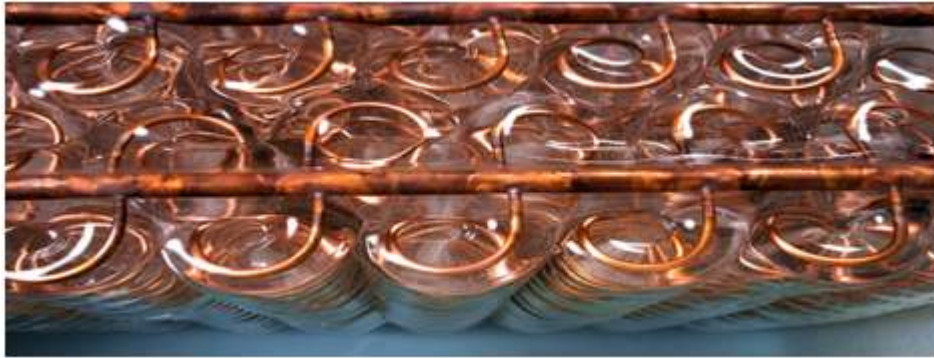


Figure 2.1: Heat exchanger coils (Copper coils)

3) Compressor

Hermetically sealed compressor is used in the ice bear unit. This compressor compresses the vapour refrigerant and then sends it to main condenser at night time so that ice can be formed and send to the copper coils so that it can act as condenser and ice energy can be used for air conditioning.

4) **Refrigerant Pump:** - Pump is situated near the compressor in system. When the ice is used during pick period of the day then the pump is used to circulate the refrigerant instead of compressor in the system. As the pump can pressurize the refrigerant as well as circulate the refrigerant properly in the system.

5) **Water pump:** - This pump used to fill up the water inside the insulated tank. As the water level due to exchange of heat cannot be always same. There is need of water to be again filled inside the insulated tank. With the help of this pump we can always automatically maintain the level of water no need to look after i.

6) **Refrigerant management system:-** This system helps to regulate and manage the direction of flow of the refrigerant through the system. Refrigerant management system can be said as the brain of the system as it thinks in what way the refrigerant should be flow according to the requirement in the system. During night time the refrigerant flows to compressor and then to condenser and then to copper coil. During day time the refrigerant flows from insulated tank to pump to evaporator coil and then again back to insulated tank.

7) **Cool Data controller:-** As the name given to this unit is cool data controller it consists of no. of sensors that helps

transfer from surrounding air directly to the ice inside the tank. This is the main component in the system.

2) Heat exchanger

The heat exchanger is the copper coils that are located inside the insulated tank. This element is very important. The refrigerant flows inside the copper coils. During the night time as the ice charging mode turns on the coils act as evaporator and helps to form ice. While at pick period of the day the coil acts as condenser that rejects the heat to the ice and by absorbing the coolness of ice and cools the refrigerant.

to control the temp. required to be maintained for air conditioning. It also tells the detail for how many hours does the ice bear works to provide conditioned air. The sensors also detect the level of water in the tank and if it is decreased then the sensor starts the water pump automatically. It also detect the time at which the ice bear is to be start and time at which the ice bear stops. It also does the work of switching on the ice charging mode.



Figure 2.2: The arrangement of pumps, compressor, data cool controller

8) Condensing coil

As the condensing coil is used during normal air conditioning and also when ice charging mode is on. The condenser is the element that helps to transfer the heat of refrigerant to the atmosphere so that the vapour refrigerant can change its phase from vapour to liquid.

9) Evaporator coil

This is special type of evaporator coil that does the operation during regular refrigeration as well as when the ice bear is on. This evaporator is situated inside the air conditioning unit. This evaporator coil plays important roll to cool the air to required temp. and provide the heat of air to refrigerant. To covert liquid refrigerant into the vapour refrigerant.

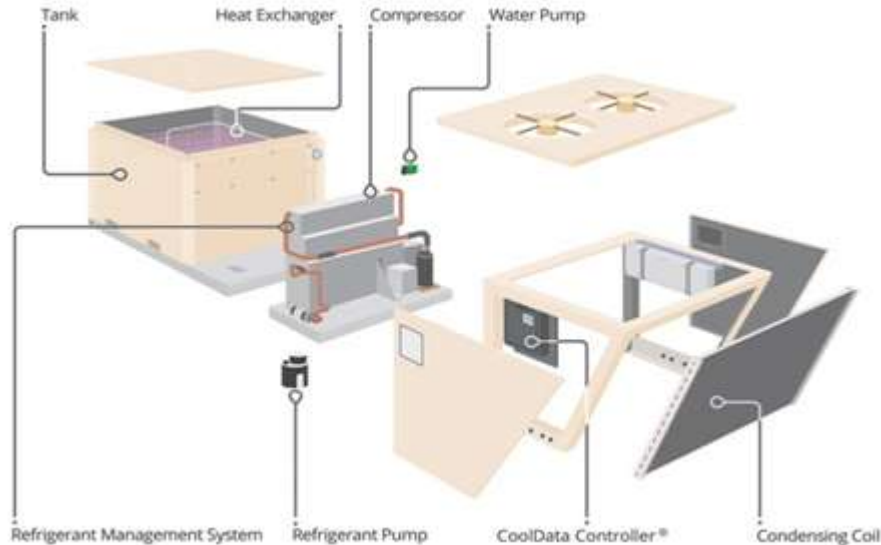


Figure 2.3: Inside Ice Bear



Figure 2.4: Control Dashboard

3. Introductory information and Setup of unit

3.1 Introduction

Ice storage is a clean reliable and least-cost distributed energy storage solution for the grid. Since 2005, ice bears have been installed in more than 40 utility services, transforming inefficient and polluting air conditioning into efficient and clean cooling systems. With a reliability record in excess of 98%, they benefit both utilities and their costumers Ice batteries improved the efficiency and resiliency of the grid, lower cooling bills and reduce carbon emissions.

3.2 Working Principle

The ice bear is the system that is works to conserves the energy required for the air conditioning in the malls, offices, houses, etc. So it works on the principle of preparing the ice at night by using the cold atmosphere at night then using this ice for the air conditioning at the pick period of the day.

3.3 Ice bear unit Setup

As this unit can be installed at the top of the building. This unit is connected to the main air conditioning unit at the top of the building. For the commercial use only one ice bear unit can be used, while for industrial or mall or any other large

building air conditioning many ice bear units are connected to each other. This all units can provide the required air conditioning effect.

The evaporator is the only component that is installed inside the main air conditioning unit. The other components such as compressor, condenser, water pump, refrigerant pump, insulated cabin, heat exchanger, cool data controller, refrigerant management system are all installed inside the ice bear unit.

3.4. Different types of ice bear:-

1) Ice Bear 20

Santa Barbara, Calif. – February 2, 2016 – Ice Energy, the leading provider of distributed thermal energy storage solutions, has introduced the Ice Bear 20 – a smaller-capacity version of its flagship Ice Bear system. The new system combines Ice Energy’s patented thermal storage and smart-grid technology with integrated cooling; enabling utilities to control residential cooling load and reduce peak demand by up to 95% for up to four hours. It also allows increased load during periods of solar over-generation, while providing homeowners the cooling they desire.

The Ice Bear 20 is ideally suited for residential and small commercial applications. In residential applications, it seamlessly integrates with the HVAC systems of new or existing homes.

“The Ice Bear 20 is a uniquely cost-effective, reliable and green energy storage system that transforms residential AC load into a clean, flexible and responsive grid resource for utilities while providing cooling comfort for homeowners,” said Mike Hopkins, CEO of Ice Energy. “It incorporates the same technology as our proven Ice Bear 30, with the added benefit of an integrated cooling and storage system. With Ice Bear 20s and Ice Bear 30s in place, almost any part of the grid with peak demand or solar over-generation issues can be reliably and cost-effectively addressed by utilities, all while reducing CO2 emissions.”

Ice Energy’s flagship product, called the Ice Bear 30, is a thermal battery that attaches to one or more standard 5 to 20-ton commercial AC units. During off-peak hours, both the Ice Bear 30 and the Ice Bear 20 freeze water to store cooling energy; as it makes ice, the Ice Bear 20 can also deliver cooling to the home, resulting in 24/7 comfort to residents. During peak hours, stored ice provides up to four hours of cooling using only 5% of the power that otherwise would have been required. Both Ice Bear systems can be deployed in smart grid-enabled, megawatt-scale fleets, with installation as easy as a standard AC system.

Ice Energy also offers a unique solar-plus-ice storage solution that integrates distributed solar resources into the grid and maximizes on-site solar energy. More than 1,000 Ice Bear 30 systems have been installed in more than 40 utility service

territories nationwide, surpassing 32 million hours of reliable, energy-saving operation.

Ice Energy at DistribuTECH 2016 Ice Energy will display its Ice Bear technology in Booth #355 at DistribuTECH 2016 in Orlando, Florida, from February 9-11, 2016

About Ice Energy

Ice Energy is a leading energy storage provider for the grid. Its Ice Bear units deliver behind-the-meter thermal storage for HVAC systems, providing peak capacity to over 40 utility service territories nationwide. With contracts to deliver 25.6 MW of storage to Southern California Edison in partnership with NRG Energy, 5 MW in Riverside, CA, 6 MW in Redding, CA, and an additional 100+ MW in the sales pipeline, the company is expanding quickly in the U.S. and internationally.

2) Ice Bear 30

The main difference between these two units is that it is of the different capacities. One can give us air conditioning for the 4 hours and other gives the air conditioning for 6 hours.

SANTA BARBARA, CA--(Market wired - Apr 12, 2017) - Ice Energy, the leading provider of distributed ice battery storage solutions, in partnership with NRG Energy, Inc., announced that it will start installing its award-winning Ice Bear 30 systems on qualifying commercial and industrial buildings in Orange County, as part of an historic procurement by Southern California Edison (SCE). The companies will deliver up to 1,800 Ice Energy behind-the-meter ice batteries - the world's largest such deployment -- on a first-come, first-served basis.

"Our distributed ice batteries will solve local grid issues in Orange County while reducing CO2 emissions by up to 200,000 tons over the life of the project," said Mike Hopkins, CEO of Ice Energy. "Orange County commercial and industrial customers that qualify for the program will get free use of Ice Bears, lowering electric bills and further extending the life of their HVAC systems."

The Ice Bears will provide a total of up to 25.6 MW of peak storage capacity to SCE under 20-year Power Purchase Agreements (PPA). The installations are part of SCE's 250 MW energy storage procurement -- one of the largest ever undertaken by a U.S. utility.

Ice Bears are field-proven and reliable, cost-effective and clean, delivering peak capacity to the grid while reducing cooling costs for businesses. Freezing water when demand for power is low, Ice Bears use the energy stored in ice to cool buildings during peak hours without using power-intensive conventional AC compressors. Air conditioning units that are equipped with Ice Bears consume up to 95 percent less electricity during peak hours, reducing air conditioning bills by up to 40 percent.

SCE customers not participating in this procurement program can take advantage of rebate programs, such as the Self-Generation Incentive Program (SGIP), to upgrade their air conditioning units and install Ice Bears with little or no upfront investment. SGIP provides rebates up to the total eligible project cost, providing an attractive payback.

HVAC systems in commercial, industrial and residential applications, and now commercial refrigeration, providing peak capacity to over 40 utility service territories nationwide. With contracts to deliver 25.6 MW of storage to SCE in partnership with NRG Energy; 5 MW in Riverside, CA; 6 MW in Redding, CA; and an additional 450+ MW in the sales pipeline, the company is expanding quickly in the U.S. and internationally.

About Ice Energy

Ice Energy is a leading energy storage provider for the grid. Its Ice Bear units deliver behind-the-meter ice battery storage for



Figure 3.1: Ice bear 20 used in house

IceBear30

Technical Specifications

<p>Cooling Capability</p> <ul style="list-style-type: none"> • Maximum Cooling Load 10 Tons • Total Storage Module Capacity 30 Ton-hours <p>Peak Power Reduction</p> <ul style="list-style-type: none"> • On-Peak Demand Reduction Up to 14kW • On-Peak Electric Demand 300 watts • Round Trip Efficiency w/ 12 SEER HVAC : 95% • Energy Shifted to Off-Peak 42 kWh <p>Off-peak Ice Make</p> <ul style="list-style-type: none"> • Copeland Scroll Compressor 4.3 Ton • Ice Make Time (full make) @ 55° F 10 hours • Ice Make Time (full make) @ 75° F 11.5 hours 	
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Line Set Restrictions

- Length (Ice Bear to airside coil) 150 feet
- Height (Ice Bear to coil above/max) 35 feet
- Height (Ice Bear to coil below/max) 20 feet

Ice Storage

- Tank Capacity (tap water) 480 gallons
- Thermal Storage Capacity (latent) 360,000 BTU

Refrigerant Management System (RMS) & Compressor

- Refrigerant R-410A

CoolData® SmartGrid Controller

- Built-In Web Server & Data Logging
- NI LabVIEW On-Board Application Lay...
- Historian
- 1-Wire Dallas Sensor Network



Electrical Requirements (by model #)

- #IB30A-521: 208/230 VAC, 1 phase 50A min. service
- #IB30A-523: 208/230 VAC, 3 phase 30A min. service
- #IB30A-543: 460 VAC, 3 phase 20A min. service

Physical Properties

- Size 100 7/16" W x 60 3/8"D x 48 1/8" H
- Weight (dry) 1,400 lb. (approx.)
- Weight (filled) 5,400 lb. (approx.)
- Load Distribution (filled) 152 lbs. per sq.ft

WARRANTY

Ice Energy products are warranted to be free from defects in workmanship and materials under normal use and service per the terms below. See full warranty for details.

- Tank & Ice Heat Exchanger 5 years
- Compressor 5 years
- Condensing Unit Heat Exchanger 5 years
- Other Components 1 year

Manufactured under the following U.S. Patents: 5,647,225 - 7,124,594 - 7,162,878 - 5,255,526 - D501,490 - 7,363,772 - D540,452 - D538,412. Additional patents pending. All trademarks, logos and copyrights are the sole property of their respective owners. ETL Authorized.

Figure 3.2: Ice Bear 30 technical specification

IceBear20

Technical Specifications

Cooling Capability

- Maximum Cooling Load 10 Tons
- Total Storage Module Capacity 20 Ton-hours

Daytime Peak Power Reduction

- On-Peak Power Reduction up to 14 kW
- On-Peak Electric Demand up to 300 Watts
- Round Trip Efficiency: >95% using Ice Cooling, 100% DX
- Energy Shifted Off-peak 28 kWh

Nighttime Ice Make

- Copeland Scroll Compressor 4.3 T
- Ice Make Time (full make) @ 55F 6 hours
- Ice Make Time (full make) @ 75F 7.5 hours

Line Set Restrictions

- Length (Ice Bear to airside coil) 150 feet
- Height (Ice Bear to coil above/max) 35 feet
- Height (Ice Bear to coil below/max) 20 feet

The diagram shows two cross-sections of a house. The top section shows the Ice Bear 20 unit installed in a room, with arrows indicating air being circulated from the unit into the room. The bottom section shows the unit with arrows indicating air being drawn into the unit, representing the ice-making process.

Physical Properties

- Size 44" W x 75"D x 40 H
- Weight (dry) 1,200 lb. (approx.)
- Weight (filled) 3,900 lb. (approx.)



Figure 3.3: Ice Bear 20 technical specification

4. Ice Bear Technology

4.1 Working

Think of the Ice Bear as a battery for the air conditioning system. Only this one is cooler, because it's made out of Ice. At its most basic, the Ice Bear consists of a large thermal storage tank that attaches directly to a building's existing roof top air-conditioning system. The unit makes ice at night, and uses that ice during the day to efficiently deliver cooling directly to the building's existing air conditioning system. The Ice Bear energy storage unit operates in two basic modes, Ice Cooling and Ice Charging, to store cooling energy at night, and to deliver that energy the following day. During Ice Charge mode, a self-contained charging system freezes 450 gallons of water in the Ice Bear's insulated tank by pumping refrigerant through a configuration of copper coils within it. The water that surrounds these coils freezes and turns to ice. The condensing unit then turns off, and the ice is stored until its cooling energy is needed.

As daytime temperatures rise, the power consumption of air conditioning rises along with it, pushing the grid to peak demand levels. During this peak window, typically from noon to 6 pm, the Ice Bear unit replaces the energy intensive compressor of the building's air conditioning unit. The Ice Bear fully charged from the night before, switches to Ice Cooling mode. The Ice Bear uses the ice, rather than the AC unit's compressor, to cool the hot refrigerant, slowing melting the ice as it travels through a series of copper coils. A small, highly efficient pump pushes ice-cold refrigerant through a modified Ice Energy LiquidDX® evaporator coil installed in the conventional air conditioning unit. The Ice Cooling cycle lasts for at least 6 hours. Once the ice has fully melted, the Ice Bear transfers the job of cooling back to the building's AC unit, to provide cooling, as needed, until the next day. During the cool of the night, the Ice Charge mode is activated and the entire cycle begins again. The Ice Bear technology is targeted

for installation on low-rise (under three stories) buildings which represents over 95% of the buildings in the U.S. The system consists of four primary parts, an insulated ice storage tank with main heat exchanger, an ice make compressor, a refrigeration management system, and a sophisticated controller. The system is installed with the existing (typically) rooftop air conditioning system and leverages the existing blower subsystem.

The condenser subsystem is used to create the night time ice stored in the unit as well as for cooling during daytime operation. Four possible operating configurations have been identified:

- Adding an additional evaporator coil inside a packaged unit
- Adding an additional evaporator coil in the ductwork
- Adding a ductless evaporator
- Re-purposing an existing coil, and removing its associated compressor

For all four configurations, the Ice Bear system is installed using conventional techniques (no special training required) and existing equipment (tools, gauges and test equipment). The condenser subsystem is charged with R410-A refrigerant, the mandatory re-placement for all direct expansion units manufactured after December 31, 2009. One characteristic of this refrigerant that is exploited by the Ice Bear system is that it is more energy efficient operating in an ambient environment of 95°F or less than the more commonly used R-22 refrigerant.

In addition to the refrigerant choice, the key technology elements of the Ice Bear system are the ice coil design, controller, and control interface. The ice coil and refrigerant loop subsystem are designed for maximum energy exchange at all temperatures, using an oil-less liquid overfeed system. As this subsystem is physically isolated from the compressor, the proper oil ratio needed

to maintain compressor operation can be independently controlled. The refrigerant loop uses an adjustable pump to regulate ice consumption during operation, and the power draw is limited to less than 300 watts for the pump. The controller is capable of operating in intercept mode, whereby it receives the signals from the existing thermostat or building control interface. In this configuration, the end user simply sets the temperature and the Ice Bear controller optimizes the use of the stored ice in conjunction with the existing air conditioning unit. The controller is also capable of more exotic schemes, including one known in the control industry as "PID" (proportional-integral-derivative) control. The controller interface has been designed to work with a well-known time series data application, but also is designed to deliver information using typical internet technology and the browser interface. The Ice Bear system is designed to store energy off-peak and deliver cooling on peak, while consuming less overall energy on the building. Because it naturally compensates for inefficiencies in the storage/discharge cycle, thermal storage for air conditioning is unique among storage technologies. In fact, it is the industry's first effectively "loss-

less" energy storage solution. Here's how: When an Ice Bear unit is storing energy, it is operating an integrated high-efficiency AC condensing unit at night, when temperatures are low and thermal efficiency is high. During the day, the opposite happens.

When the Ice Bear unit is discharging its stored energy, it offsets the operation of the energy-intensive commercial AC condensing unit at times when temperatures are high and efficiency of the AC unit is at its worst. This means the difference in operating efficiencies between the Ice Bear condensing unit and the commercial unit more than compensates for any inherent inefficiencies in the storage/discharge cycle common to other types of energy storage. In fact, when you factor in age, size, and high operating duty cycles, the Ice Bear condensing unit is clearly more efficient than the commercial condensing unit it is displacing. The Ice Bear system reduces total net energy consumption for most buildings under virtually all operating conditions and installations.

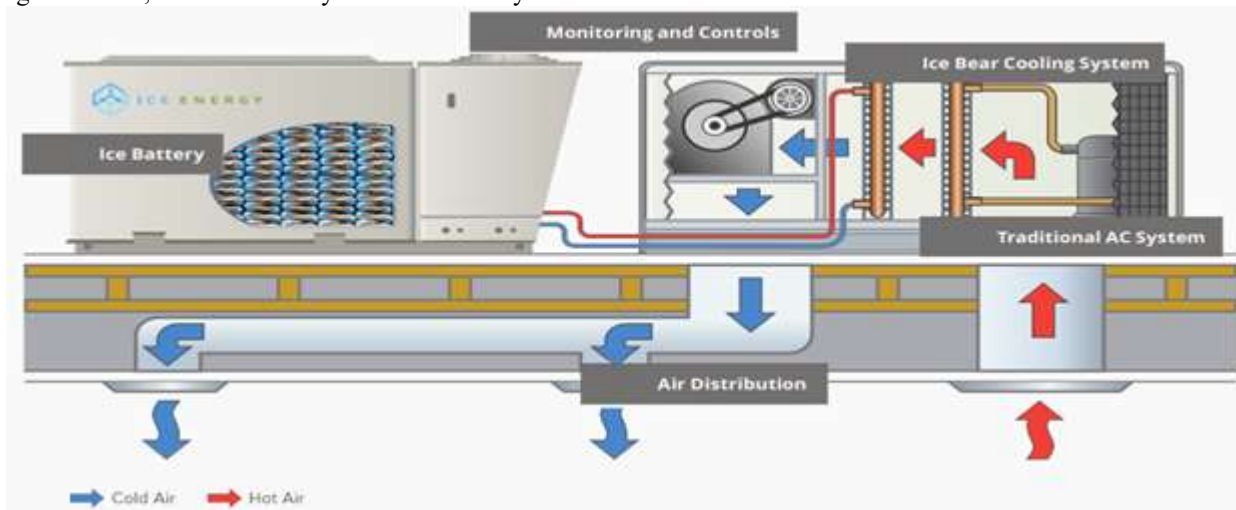


Figure 4.1: Ice bear 30 for industrial application unit setup with main AC unit

4.2 Ice Bear Eco system

Ice Energy is building the Ice Bear ecosystem through active engagement with a broad range of companies and stakeholders, including utilities, regulators, policy makers, partners and industry organizations.


These companies include:


- **Carrier:** Carrier Corp. is the world's leader in high technology heating, air-conditioning and refrigeration solutions.
- **Data Aire:** An innovator in total environmental control for critical applications, Data Aire designs and manufactures high-capacity, precision cooling equipment for telecommunications facilities and computer datacenters.
- **LogiFusion:** LogiFusion is a leader in information technology (IT) and business process services, with the expertise and capabilities to serve the needs of businesses of all sizes.
- **Mercury Corporation:** Mercury Corp. has grown to become a leader in the Contract Manufacturing world and a global supplier of metal fabricated and assembled solutions.
- **OSIsoft:** OSIsoft® delivers the PI System®, a real-time enterprise infrastructure for secure smart grid operations and beyond, including generation, transmission & distribution, substation automation, AMI and trading.
- **Verde Energy USA:** Verde Energy USA, is a rapidly growing Retail Energy Supplier focused on the residential and small to mid-size commercial power markets. Through Verde Energy Solutions, its wholly-owned subsidiary, Verde broadens and accelerates the adoption of state-of-the-art clean energy technologies in order to promote energy efficiency and savings for its customers.


4.3 Recognition


Ice Energy was recently named as one of the top ten company in Lux Research's Top Innovators from Q3 2013. The recognition from Lux Research comes on the heels of Ice Energy recently winning the Innovation Award from Energy Storage North America (ESNA) for a Thermal Energy Storage program with the Southern California Public Power Authority (SCPPA), which involves Ice Bear installations at 200 customer facilities, totaling 2.5 MW, or 15 MWh of rated capacity to the grid. The Technology scored 90 out of 100 in SGN Smart Grid Scorecard.


5. Why Ice Bear?


 **Smart**
Two way communications allow real-time control and monitoring of each individual unit or groupings of units. Most fixes, software upgrades and firmware updates can be performed remotely. End-to-end data and network security provide additional peace of mind.

 **Reliable**
Ice Bear storage is commercially-proven. Since 2005, our smart ice batteries have logged over 34 million operating hours with a reliability record in excess of 98%. Our ice batteries were built to last and require minimal maintenance.

 **Cost-effective**
Ice batteries cost less than half of lithium ion batteries of the same capacity on a life-cycle basis. They can eliminate the need for expensive peaker plants, and new transmission and distribution upgrades. Customers save up to 40% on their cooling bills too.

 **Durable**
While chemical batteries degrade over their relatively short life, our ice batteries last at least 20 years and suffer no degradation, regardless of use. They can be fully charged and discharged every day for up to 20 years without any capacity loss.

 **Flexible**
Ice Bear storage is available for both commercial and residential applications. Utilities can dispatch individual units, custom groupings or fleets, and schedule them for permanent load shifting or for real-time dynamic load optimization.

 **Solar-friendly**
Ice storage firms solar capacity and makes productive use of solar over-generation. Unlike chemical batteries, ice batteries can work with solar for the entire life of the solar assets, and do so every day, at the full rated capacity of the ice batteries.



Sustainable

By eliminating the need for fossil-fuel "peaker" plants and supporting renewable energy, Ice storage reduces CO2 emissions by up to 40% and NOx emissions by up to 56%. Unlike chemical batteries, it does not use any hazardous or toxic material, and does not create any end-of-life disposal issues.



Community-focused

Ice Bear storage provides air conditioning savings to businesses and homeowners, and generates long-term business opportunities for local HVAC contractors. It integrates seamlessly into the existing infrastructure and enables a cleaner, more efficient power grid for the community.

5.1 Installation

Ice Bear is easy to install and seamlessly integrates into a building cooling system

- Ice Energy works with select certified HVAC contractors in your area. We supervise and coordinate the installation to give you peace of mind.
- In residential applications, Ice Bear simply replaces the compressor unit that sits outside the home.
- For commercial and industrial buildings, Ice Bear attaches to one or more 4-20 ton commercial AC units and can be installed on rooftops or on the ground.

5.2 Operation and maintenance

Ice Bear storage is a commercially-proven and reliable technology that has been deployed in more than 40 utility territories with a reliability record in excess of 98%. Each ice battery is designed to last 20 years and requires minimum maintenance. A smart-grid controller monitors the system's performance, controls its operation and allows for most repairs and fixes to be performed remotely. Our ice batteries are backed by Ice Energy's comprehensive warranty.



Figure 5.1: Installation and maintenance of ice bear unit

5.3 Smart grid enabled

5.3.1 Remote Monitoring

Ice Bear is fitted with sensors that remotely monitor the performance of each unit.

- Coolant systems pressure
- Ice Temperature
- Control housing temperature
- Outside ambient temperature
- Ice Bear components
- Supply and return air temperature, on either side of the air handler
- Indoor thermostat
- AC compressor on/off status

5.3.2 Remote Controls

Operating instructions and needed adjustments can be sent remotely

- Dispatch Ice Bear to make or melt the ice
- Set or modify charge/discharge schedule
- Control how much cooling is provided and for how long
- Update software and upgrade firmware to roll out new product features and fixes
- Control and dispatch additional demand-response assets

5.3.3 Security

Ice Bear network is a secure, private wireless network with end-to-end encryption. Servers and databases are located behind firewalls that use security best practices.



Figure 5.2: Security control access

6. Applications, Advantages and Limitations

6.1 Applications

- 1) Commercial application: - It is used at houses for air conditioning by providing controlled condition that provides human comfort.
- 2) Industrial applications: - It is used in industries to provide the controlled conditions in the tool room for maintaining the precision and accuracy of the measurement instruments in the tool room. As well as for some applications such as

ice cream industries, cold drinks industries, Food stuff industries, etc.

6.2 Advantages and Limitations

6.2.1 Advantages

6.2.1.1) Advantages for utilities

- 1) Eliminates the need for carbon-intensive peaking generation.
- 2) Defers or eliminates expensive transmission upgrades.
- 3) Flattens traditional mid-day peak by eliminating the peak AC load
- 4) Flattens traditional mid-day peak by eliminating the peak AC load.
- 5) Flattens the duck curve by using solar over-generation to charge ice bear batteries and using the stored cooling to eliminate the peak AC load.
- 6) Reduces greenhouse gas emission.
- 7) Quickly deployed at megawatt scale.
- 8) Maintenance cost is less.
- 9) Installation cost is also less as the whole unit is already prepared.

6.2.1.2) Advantages for homeowners

- Reduces cooling bills by up to 30%
- No or low cost system with rebates and utility incentives
- Reduces home carbon footprint by 10% or more
- Delivers superior cooling comfort even when outside temperatures are extremely high
- Stores excess solar generation for later use
- Generates business opportunities for local contractors
- Helps prevent blackouts by reducing stress on the grid
- Ice Bear technology works for 24 hours for use in house

6.2.2 Limitations

- 1) As the size is a bit large it cannot be used in automobiles air conditioning.
- 2) It also cannot be used in aircraft air conditioning as it has high weight.
- 3) The particular type of evaporator is required to do the work.
- 4) The charging can be done only during night.
- 5) The Refrigerant management system is required to maintain the flow and direction of the refrigerant through the whole system according to whether the ice charging mode is on or off.

7. Conclusions and Future Scope

7.1 Conclusions

Thus, from this report following conclusions are made:

- 1) The Ice Bear technology is the modern technology helps in reducing power consumption of the air conditioning.
- 2) That's why it also reduces our electricity bill.

- 3) In the history of refrigeration and air conditioning the ice was used for cooling purpose but it wasn't help us to maintain the lowered temperature, but now with the help of Ice Bear technology it is become reality.
- 4) New type of evaporator has been established that can help us to use two air conditioning technologies just in one unit.
- 5) As it helps to reduce the greenhouse gases that are polluting our environment, it has blessed us and indirectly saved our life.

7.2 Future Scope

The Ice Bear technology has a large scope in innovation as well as in demand. As to reduce the bill of electricity while having air conditioned environment has become a need of the human. This technology will help all those persons who wants to buy air conditioning unit but due to the electricity expenses the refuse to buy. Some years ago human was getting fresh air as well as good conditioned air due to the large forest, trees, etc. but now a days the air conditioning has become a need due to air pollution. But the normal air conditioning also emits some greenhouse gases that are reducing the layer of ozone. But Ice Bear technology reduces the emission of such a harmful gases and protects the ozone layer.

The new innovation in this field is going on. They are trying to develop a Ice Bear Unit that can withstand throught the day can helps us reduce the power consumption throughout the day. They are also trying to make such a model in compact way so that it can be used in the automobiles, locomotive. They are also trying to make it light in weight so that it can be used for the aircraft as any other system till now is unable to be used in aircraft excluding air refrigeration system.

Difference between Simple air conditioning system and Ice Bear Technology

Sr. No.	Simple air conditioning system (central A/C)	Ice Bear Technology
1	Running cost of the simple AC is about 1,50,000 Rs. Per month considering 700 unit per day, because of compressor has to do lot of work during pick period.	Running cost of AC is reduced to 1,05,000 Rs. Per month approx. It is reduced because the compressor is not used during pick period of day and the pump requires only 24 unit for 6 hours to run.
2	Installation cost of normal air conditioning system is 2,50,000 Rs.	Installation cost of Ice bear unit is 1,00,000 Rs for Ice bear 20 & 1,50,000 Rs for Ice bear 30. As it uses previously set ducts and AC unit no other cost is added.
3	As 20 TOR capacity AC is used 60 pounds means 27 Kg of refrigerant is to be used which costs about 10,800 Rs	The refrigerant cost for the Ice bear Technology is increased to 50 Kg approx. and hence costs is 20,000 Rs
4	Time required to give cooling effect as per requirement is 10 minutes.	Time required to provide required cooling effect is reduced to 5-6 minutes.

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