“District Cooling System”, as HVAC system of Sustainable India

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Abstract- District cooling is a local, sustainable solution to global cooling needs. In Europe, roughly 40% of all commercial and institutional buildings are equipped with some kind of climate control for comfort cooling. In the US and Japan, this figure is about 80%, and the demand for cooling systems in nations like China and India is increasing rapidly. District cooling makes possible the large-scale leveraging of natural cooling and the delivery of this cooling in an energy efficient manner. This entails major climate benefits.

Keywords – District Cooling, HVAC-Heat Ventilation & Cooling.

I. WHAT IS DISTRICT COOLING?

Defination - Basically, a district cooling system (DCS) distributes thermal energy in the form of chilled water or other media from a central source to multiple buildings through a network of underground pipes for use in space and process cooling. The cooling or heat rejection is usually provided from a central cooling plant, thus eliminating the need for separate systems in individual buildings.

1.1 DCS consists of three primary components:

1.The central plant,
The central plant may include the cooling equipment, power generation and thermal storage.
2.The distribution network
The distribution or piping network is often the most expensive portion of the DCS and warrants careful design to optimize its use.
3.The consumer system.

A District Cooling System (DCS) is essentially a centralised energy plant generating thermal media (chilled water) for air-conditioning requirements of several buildings within a district. Cogeneration is a process that converts a fuel into both thermal and electrical energy. The thermal energy may be in the form of steam, hot water, or hot air, or any combination of the three. The consumer system would usually comprise of air handling units and chilled water piping in the building. DCS applies in most areas with appreciable concentration of cooling loads, such as industrial complexes, densely populated urban areas and high density building clusters, and can offer economic and environmental benefits.
Different types of cycles an conventional HVAC building consists of & what if a building is converted into DCS or How a new building can be connected to DCS is well learnt from the schematic Figures 1, 2 & 3.

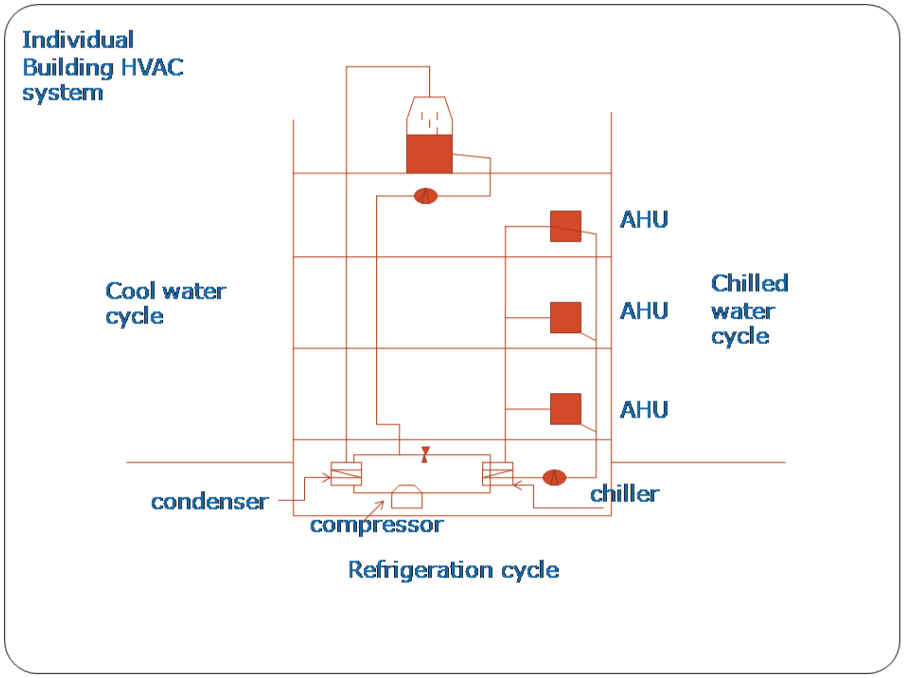

Figure 1. Schematic Sketch explaining individual building HVAC system.

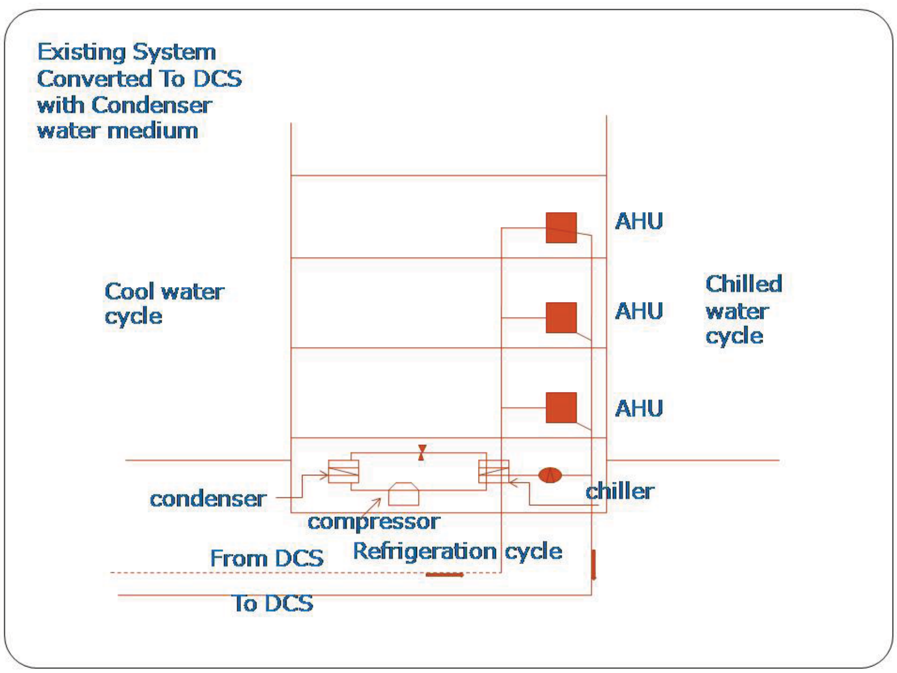

Figure 2. Schematic Sketch explaining existing system converted to DCS with condenser water medium.

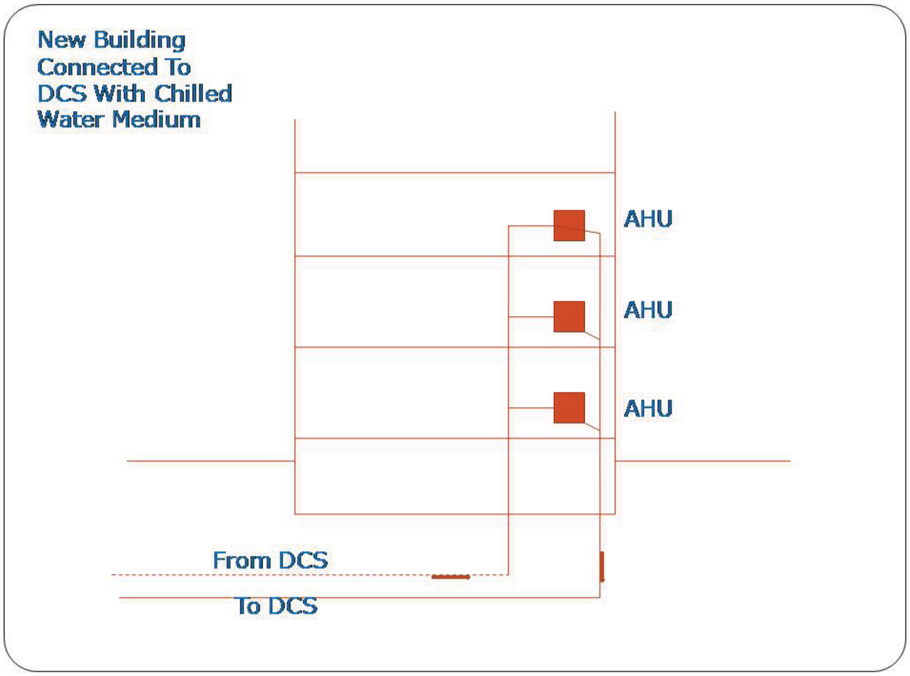

Figure 3. Schematic Sketch explaining new building connected to DCS with chilled water medium.

The deregulation of the power industry, in performance with the trends towards outsourcing and environmental concerns are fuelling interest in DCS, thermal storage and co-generation. DCS applies in most areas with appreciable concentration of cooling loads, such as industrial complexes, densely populated urban areas and high density building clusters, and can offer economic and environmental benefits. As the central plant of a DCS is large, there will be economies of scale and higher thermal efficiency as compared to that of many isolated small systems. A larger plant usually comprises of a number of capacity modules, which can be operated to match the combined cooling load. In addition, a centralized plant would be more optimal in terms of operation and maintenance. There is no need for individual building owners to employ operations and maintenance personnel for chiller plants. Usable space in the building would increase as large rooms for housing the cooling systems are no longer required.

II. LCA - LIFE CYCLE ASSESSMENT CONSIDERATIONS

If a base case & design case be assumed for the conventional HVAC system & DCS system for the said LCA criteria, the general global warming potential would be brought down during its life cycle period considerably by DCS. LCA would comprise of following heads in the table for said period of time.

Preliminary/Initial stage (4 years)	**Life during buildings operational stage (50 years)**	**Disposal/Discarding stage (1 year)**
1.Extraction of Raw material,	**5.Buiding operation phase**	**7. Discarding stage**
2.Manufacturing Building material in factory	**6.Repair & maintenance stage**	
3.Transportaion from factory gate to construction site		
4.Construction		

“Life Cycle Assessment (LCA) is an objective method to evaluate the environmental burdens associated with a product, process or activity by identifying and quantifying energy and material uses and releases to the environment, and to evaluate and implement opportunities to influence environmental improvements. The method assesses the entire life cycle of the product, process or activities, encompassing extracting and processing material;

manufacturing, transporting and distribution; use, reuse and maintenance; recycling and final disposal." (Ref: The Society of Environmental Toxicology and Chemistry 1993).

District Cooling System reduces life-cycle carbon footprint, particularly the carbon footprint from the repair and operational carbon footprints (50 years). However, District Cooling System has the higher carbon footprint from initial (4 Years) and disposal stage (1year) that required more carbon mitigation measures that reduces the footprint. Therefore, from the whole life-cycle perspective, we can draw the conclusion that the District Cooling System can reduce the Global Warming Potential (GWP) in comparison to conventional HVAC.

III. INNOVATIONS FOR TO USE NONRENEWABLE ENERGY SOURCES IN DCS

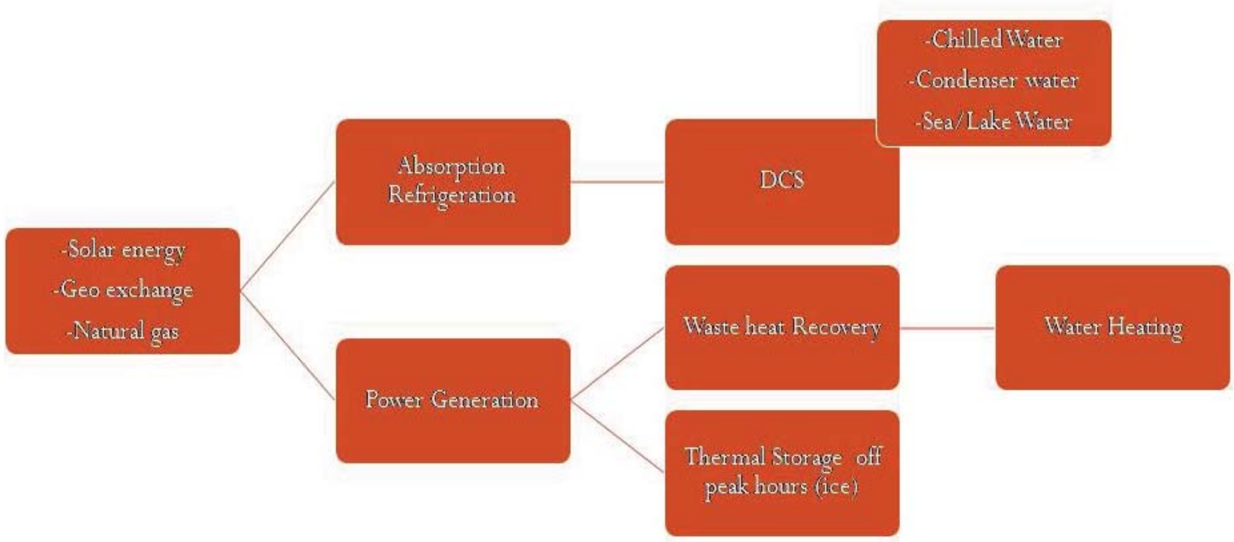

Figure 4. Flow Chart Explaining DCS Its sources & its opportunities.

District cooling is up to 10 times more efficient than conventional cooling technology. Also different 'Greener' energy sources like solar, natural gas geoexchange & it's different loop systems may enhance the energy efficiency. Centrally produced, and often based on natural cooling from the cold bottom water of lakes, ground water, rivers, the ocean, or from conversion of waste heat or bioenergy through absorption technology, district cooling is delivered to buildings via water at 6°C in a closed, in-ground pipe system. After performing the cooling service, the energy content of the now 16°C water can be recycled for use in a district heating system to provide heat and domestic hot water. The main idea behind district cooling is to use local sources for cooling that would otherwise be wasted or not used, in order to offer the local market a competitive and efficient alternative to conventional products. Whereas the cogeneration through waste heat recovery, power generation & water heating are the experimental physible areas adding another feather in the cap of DCS. District cooling projects of any size, from housing projects to hospitals, airports to shopping malls, and university and industrial campuses can be worthwhile in reducing global warming.

IV. RECOMMENDATIONS

A district cooling system can offer significant benefits to a community. The three groups most likely to benefit from district energy in a community are property/building owners, the municipality, and society at large.

4.1. Builders/ Building Owners

A district cooling system allows the building owner to eliminate their on-site chiller operation and maintenance. By doing this, the building owner no longer needs to purchase utilities, operate and maintain chillers, and replace chillers at the end of their life cycles. Because of the high efficiencies that district cooling systems operate at, and their ability to utilize inexpensive or waste energy sources, the building owners can expect more stability in their energy costs into the future. For future buildings that are constructed, the overall capital costs are reduced, when the cost of the chiller room is eliminated; or the space allocated to the building chiller may be converted to revenue generating space. The cost of insurance should also be reduced to reflect the lower risk. District cooling systems are built with standby cooling capacity to ensure that cooling is always available at the central plant. Distribution systems are generally designed with multiple loops or other back-up to provide additional reliability in distribution. Overall, the reliability provided by a properly designed and constructed district cooling system is greater than most buildings can achieve individually.

4.2. Municipalities

A district cooling system also provides significant benefits to the municipalities where they are built. The most obvious benefit to the municipality is the significant amount of infrastructure that will be added to the community.

This infrastructure will give the community a competitive edge in attracting new development over other communities who do not have district energy systems. A benefit that is often overlooked is the ability of a district cooling system to capture cash flows that were previously leaving the community. Typically, energy expenditures leave the community to pay for the natural gas and electricity that is imported. A district cooling system service expands the opportunities of using local energy sources like combined heat and power to keep more of the money, currently being spent on energy, circulating within the community.

4.3. Society

The development of a district cooling system is a response to the need to provide energy for the future in a manner that is consistent with the need to protect our environment. The production of cooling from a centralized facility allows for improvements in energy conservation. Energy conservation and the wise use of fuel sources are the most cost-effective ways available to us to reduce atmospheric emissions, global warming, and the release of ozone depleting gases. Not only can the quality of life be maintained without a significant increase in the cost of energy, but also the initiative is in line with meeting the international protocols for a positive reduction of nitrogen oxides (NOx) and carbon dioxide (CO2).The underlying principles adopted for district energy are to provide a cost-effective, reliable, efficient and environmentally friendly service which not only benefits the customer, but also the public at large through lower emissions of NOx and CO2 in the production of cooling.

V. CONCLUSIONS

Savings in Capital Investment to Muncipalties/Builders/Multinational companies/End Users/Building Owners;

Save on cost for chillers and cooling towers.

Minimise number of spare equipment.

Savings in operating cost to Building Owners.

Save on operating and maintenance cost, through reduced electricity and manpower costs.

Higher Energy Efficiency.

Cogeneration system efficiency of up to 80% against 35-40% for combine-cycle power plant.

Higher System Reliability.

Higher degree of reliable power and chilled water supply as two power supply sources are available; internal generation and back up from power grid Environment-friendly.

Clean natural gas as fuel, thereby minimising SOx and NOx emission.

Absorption chillers uses non-CFC based refrigerant Optimizations of building space by building owners

Alternative use for plant space to generate more revenue, either rent or sell.

Enhanced building aesthetics wider choice for building design, could enhance property value.

Also a LEAD criterion recognizes DCS for clean air criteria with energy efficiency.

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