Renewable-Energy Datacenters in the Real World

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This summer I learned about datacenters, a bunch of servers plugged together to run networked services, and how they can be designed to use renewable energy. A datacenter hosts computer systems and maintain these systems on a network in a secure location. These datacenters provide types of services like dedicated server hosting and co-location hosting. This project involves the application of technologies that use renewable energy sources such as wind turbines or solar panels, in order to reduce the dependency on electrical grid and promote the use of cleaner energy sources and the application of more efficient technologies.

With the increase of network dependent services such as e-commerce, the uninterrupted availability of datacenters is important. Organizations and companies rely on these datacenters to run their networked services. If a system becomes unavailable, this can affect how the company runs their services or even stop the services from working. Modern datacenters are built to minimize any chance of disruption. Information security is also a concern, and for this reason a data center has to offer a secure environment which minimizes the chances of a security breach. A datacenter must therefore keep high standards for assuring the functionality of its hosted computer environment. This can be accomplished by increasing reliability of the system, which includes using emergency backup power generation. Today, datacenters systems are built with good fault tolerance abilities. Besides hosting systems, datacenters also ensure the security of the information stored in these systems.

The main concern when applying renewable energy to datacenters is that this kind of energy is not available 24/7, it only there when the winds blows or when the sun shines. The main challenge by using renewable energy sources is the availability of these sources. Extra measures must be taken to ensure that we don't lose reliability in such datacenters. Because these energy sources are periodic, some measures have to be taken to ensure that the functioning of datacenters is continuous and effective. They need to have some type of monitoring systems to be aware of the state of a system and ensure that they're getting the energy need to operated there equipment. A monitoring systems, for instance can be useful in evaluating the energy needs of the systems and act accordingly when these needs are not met.

Many environmentally friendly green datacenters are all trying to lower their electrical bills or have no electrical bill at all by integrating renewable energy such as wind and solar power as a source of energy and also using energy efficient technologies to make these electrical set up possible. These datacenters are concerned with cutting down electric energy consumption in order to reduce their production cost. They considered the use of renewable energy sources as a solution. Datacenters use several megawatts on a daily base. By applying renewable energy technologies they can produce the energy they need on site from solar panels or wind turbines. This energy produced can be use or stored for later.

An important aspect of Professor Stewart's research is to find more effective ways to apply renewable energy to data centers and understand how these work. In other words, our goal is to make the datacenter "go green". This means that the energy used by the datacenter should be cleaner and better for the environment. In order to reach our goals, in this project, we studied the grid tie. This device called gird tie is used to integrate renewable energy into grid-powered facilities in most cases. One important thing that we found that grid-tie placement matters, good placements can use 30% less grid energy and produce 10 times more hours of 100% renewable-powered devices than typical placements. A genetic algorithm was used. This algorithm uses 90% fewer simulations than random search to find equivalent delivery subsystems.

My contribution to the research project was to study the design of real datacenters that use renewable energy in practice. This information is important because we can see what is actually used and why. It is also important in order to understand how renewable energy is being used and the results of its use. This will help in finding better ways of better of exploiting these resources.

1.AISO.NET:

First, I made contact with Phil Nail, Chief Technology Officer (CTO) of AISO.net, a green web-hosting company. AISO.net runs a solar powered network. They have work with solar power for 14 years by being 100% off grid. They have about 120 solar panels and a large shed of about 50 batteries. AISO.net main goal is to use as less energy as possible. In order to achieve this they had a very efficient technology. They use AMD opeteron power by IBM bladecenter severs that use 60% less energy and produce 50% less heat. Here an example of the difference of using more efficient technology: Fourteen of the regular 625 watt servers consume 8,750 watts; as fourteen comparable blade servers only consume 3,990 watts, which is 285 watts per server.

They also work on Virtualization. Virtualization is a dedicated server with advancements in data backup, redundancy, uptime and upgradeability. Energy consumption is a critical issue for IT today, virtualization allows AISO to save the environment and also a higher uptime than they would have with regular physical servers. Using VMware allows reducing energy consumption by 80% through virtualization with an average 60 to 1 ratio of virtual servers to physical servers. The sun is used in 2 ways in this datacenter one is first as energy. And also as lighting use the light outside and get it inside using lenses so that there no need for lighting at day.

They cooled the datacenter using Coolerado air conditioning systems, water is evaporated into air in one chamber and this cools the air flowing in an adjacent chamber. The cold air is used for cooling while the water vapor holding the heat is exhausted outside to be renewed by the atmosphere. This type of cooling uses 90% less electricity (600 watts max). The water used for the air conditioning system is collected by rain water. They also Planted a green roof so that the office and datacenter rooms get temperature reduce by 20 degrees or more.

2. Emerson:

Emerson is another company which offers wide range of products and services in the areas of process management, climate technologies, network power, storage solutions, professional tools, appliance solutions, motor technologies, and industrial automation. They build this datacenter so they to consolidate 130 datacenters this datacenter is the heart of all of these. They call it Emerson's Global Data Center at St. Louis. What is interesting of this of this data center they are is that this datacenter was building with the idea of being most efficient and effective IT operating environment with the idea also of being very energy efficient.

This data center has is has capacity for 5,000 servers and runs them with 31 percent more energy efficient than traditional data centers, due to latest energy-efficiency technologies, precision cooling products, and recommended efficiency strategies from the company’s Emerson Network Power business. Emerson Network Power expects to reduce the power bill for its new data center in St. Louis by 1 percent by using slightly higher voltage for the facility’s power distribution. Emerson is using 240 volt AC power instead of the traditional 208 volt.

3. Other World Computing:

The Other World Computing (OWC) datacenter is a 100% on-site wind powered by switching its daily operations energy needs over to a Vestas V39-500 kW wind turbine. This datacenter is 100% on this renewable, non-polluting power source. As a 100% self-funded project, this data center was built on October 19, 2009, so it’s a pretty recent project. The OWC wind turbine is expected to generate an estimated 1,250,000 kilowatt hours (kWh) per year. This is more than double the current energy requirements of for all OWC operations. With peak wind conditions, the OWC wind turbine can generate more energy in a single week than what OWC's operations require for an entire month. The excess unused energy produced is sold back to the local power provider, thus making OWC a net supplier of sustainable energy to the McHenry County, IL.

During extreme winds, the blades automatically go "flat" with the narrowest point into the wind, in essence, shutting the turbine down until it senses safe operational wind speeds. In OWC has implemented geo-thermal cooling system for an emission-free and also for reduce energy use. They use fiber optics on the rooftop for light-harvesting this technology brings in natural light to the building. Smart sensors are used to detect and adjust energy in unused rooms. Its wind turbine is expected to generate an estimated 1,250,000 kilowatt hours (kWh) per year. This is more than double the current energy requirements of all OWC operations. When the wind power generation is not enough they rely on the local utility company as the backup power source for OWC. In the event of a combined wind and utility company power blackout, OWC has two additional on-site OWC backup power systems so it can continue serving its customers without interruption.

REFERENCES:

W. Bower, C. Whitaker, W. Erdman, M. Behnke, and M. Fitzgerald. Performance test protocol for evaluating inverters used in grid-connected photovoltaic systems, 2004.

T. G. Grid. Quantitative efficiency analysis of power distribution configurations for data centers. Dec. 2008.
Us photovoltaic market growth through 2010. Renewable Energy World.Com, 2010

Christopher Stewart and Kai Shen
Some Joules Are More Precious Than Others: Managing Renewable Energy in the Datacenter

Workshop on Power Aware Computing and Systems (HotPower)
Big Sky, MT, October 2009

Understanding and Improving Power Delivery for Renewable-Energy Datacenters (in preparation)

Colocation usa—datacenter map.
http://www.datacentermap.com/usa/.