USING DISTRIBUTED GREEN DATA CENTERS AS A DISPATCHABLE LOAD FOR CLOUD HOSTING & ENERGY SERVICES

A Unique Business Method Approach to Supporting the Implementation of Distributed Energy Resources

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Centralized vs. Distributed

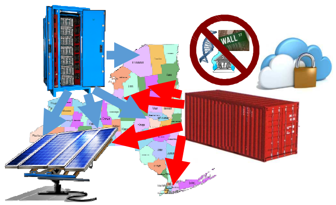
Traditional Data Centers

- **Large Multi-MW facilities.**
- **Largest single data center power consumer is 150MW in China.**
- **Largest operators (e.g. Amazon, Google Facebook) have 30 or less physical locations worldwide.**
- **Can strain electric grid in places where located and not likely to participate in Demand Response programs.**
- **Data centers consume more than 2% of all electricity in US.**
- **This compares to more than ½ of all electricity consumed in the entire state of New York.**
- **Servers are active less than 12% of the time, but consume approximately 40 to 80% of active power when in idle state.**
- **The majority of data centers are still housed inside standard office buildings conditioned for tenants, though actual hands on need is very infrequent.**

- **Power Usage Effectiveness (PUE) is used to measure data center computing efficiency.**
- **After the actual computer equipment, cooling is generally the greatest source of electricity consumption.**
- **2013 Survey shows average PUE of 2.9, *nearly 3x* the amount used for computing.**

Distributed Data Centers

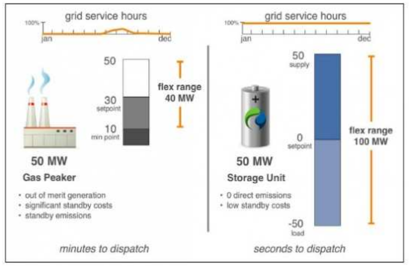
- **Distributed Green Data Center (DGDC) units can be Single Rack (10-30kW) to 20' or 40' Container (250kW to 500kW) and scalable to MW+ with multiple containers.**
- **Unmanned, highly efficient, and able to operate at higher temps; self-contained units operating as part of distributed network.**
- **At scale the concept envisions 100s of units in NY state alone, 1000s across US.**



- **Enables investments in renewable power and energy storage by consuming on-site generation, reducing transmission loss**
- **Provides justification for larger renewable installations, and providing solution for utility capacity issues.**
- **Data duplicated on several DGDC units providing superior level of redundancy and data backup security.**
- **Master Controllers route requests to combination of lowest latency, most efficient energy use, lowest GHG or other optimizations.**
- **Installed outdoors to maximize free-cooling potential providing estimated range of PUE between 1.02 and 1.2 depending on climate.**
- **Specific sites can selectively reduce power consumption or shutdown entirely to respond to higher value energy service needs (i.e. Peak Demand Shaving, Demand Response, Frequency Response, and other Ancillary Grid Services.)**

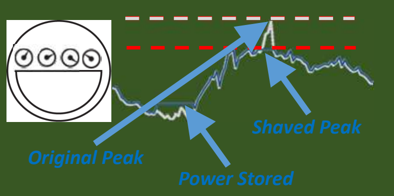
Leveraging Distributed Energy Resource Investments

- **Distributed Energy Resources (DER) include renewables (e.g. solar, wind, small hydro), energy storage, and other forms of non-centralized electricity generation.**
- **DER can often react to grid needs faster, cheaper and cleaner than peaking power plants.**
- **A DGDC unit can also provide the same service by reducing or entirely removing its load from the grid. Several units together can represent a significant and rapid response; and it can do so in a more targeted manner than is currently realized in current demand response programs.**
- **Energy storage is a small but growing market. Investments are often made to realize savings from behind the meter peak demand shaving.**



"...the energy storage business could grow from $200 million in 2012 to a $19 billion industry by 2017." - Information Handling Services, Cambridge Energy Research Associates

Peak Demand Shaving



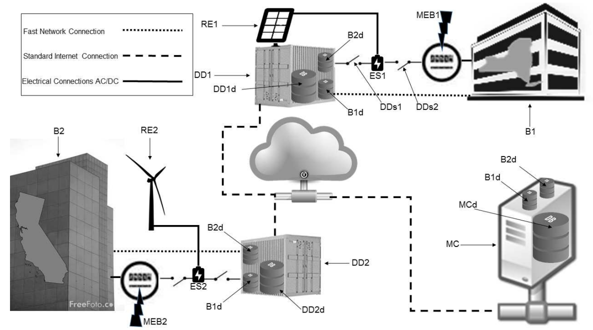
- **Commercial, Industrial and larger users of electricity often have both a kWh and a peak demand charge based on peak kW use usually calculated as the highest monthly peak during a 5 to 15 minute period during the month.**
- **Demand charges vary by location and in some cases the time of use; and can represent up to 50% of the total bill.**
- **Storing energy when the energy load is low and then using it to reduce the peak is called peak shaving and can result in significant savings especially in facilities that have very peaky energy profiles.**

- **Adding a DGDC unit to an energy storage investment extends the capacity to respond with a predictable dispatchable load that can also be used to off-set inefficient internal IT load for many small to mid-size data centers.**
- **Unlike energy storage which is used infrequently to provide peak demand shaving (5 to 15 mins/mo) and demand response services (<100 hrs/yr). A DGDC unit is operating as a data center the majority of the time producing revenue or services and when it is removed from the grid it can provide a similar service.**
- **Together a DGDC unit combined with energy storage and on-site renewable generation provides further efficiency, increased utilization of on-site generation, and a level of flexibility that is superior to a DGDC unit operating alone.**
- **The DGDC unit also enables the other DER investments by providing a platform for the hardware. software, and sensor control devices used for the DER smart-grid interaction and can host building efficiency hardware and software to further increase building performance. Working together the technologies support one another and leverage the overall investment.**

The DGDC units will support investments in micro-grids, solar, wind, energy storage, and therefore help New York State in realizing the Reforming the Energy Vision goals. Changing existing policy to recognize the full value of Distribute Energy Resources (DER) including dispatchable loads, like the DGDC units proposed here, will save money, the environment, create jobs and opportunities for new innovations of clean and smart energy. New York will be an inspiration nationally and internationally and help to create the electricity grid of the future.

NEW YORK STATE OF OPPORTUNITY. | Reforming the Energy Vision

How it Works



Referring to the figure above depicting two locations one in NY (B1) and one in CA (B2), consider a demand response need from the NYISO, wherein the 1MW DGDC unit DD1 is disconnected via switch DDs1 from the main electricity meter (MEB1). The electricity load from the data center is disconnected thus reducing the energy demand from B1 by 1MW. In addition, any stored energy in ES1 can also respond to reducing the demand of B1. Meanwhile data users in B1 that were accessing their data (B1d) via the fast network connection are now connecting via the standard internet connection to a copy at building B2 in California or from the Master Controller (MC) which is in yet another location. The data from B1 is constantly updated and mirrored to B2 and MC providing seamless data services during the electricity demand response period of time. Though the data is accessed via a remote location during electricity responses, this is no different than under current cloud outsourcing services and for the majority of the time the cloud data is accessible via the much faster network connection, which is better than current cloud outsourcing options.

The process described above can also be used to shave periodic peak demand in the buildings. Other scenarios exist wherein the data center may be primarily run on energy storage stored in ES1 and replenished by on-site renewable generation like solar (RE1) and wind (RE2); or where the greenhouse gas (GHG) potential or cost of electricity in NY is lower than CA and thus data requests are redirected to the optimal location based on algorithms that can be customized to achieve specific goals.

Next Steps

We are currently in the process of deploying a small scale demonstration project that will deploy pairs of servers at 3 different Clarkson University locations as well as 5 or more off-campus locations across New York State. The goal is to demonstrate the ability to respond in an automated manner to real and simulated energy scenarios that will remove the servers from the electric grid in effect acting as a dispatchable load. Though this demonstration will only dispatch the load of the small servers (each is approximately 400W), these numbers will be multiplied to a 100kW to MW scale to predict what the benefits of a larger scale energy response would provide.

Small Scale Scalable Simulation

An LLC named Youbicwitus™ has been formed and a provisional patent filed. We are looking for partners, investors, and applying to grants to move forward in commercializing the technology as we continue our research. By developing an expanding network of revenue generating distributed data center locations we look to use that network to also provide energy services to save host locations on peak demand charges and to support the electric grid.

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