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Application of Geothermal Power for Data/Comm Centers

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ABSTRACT

Two industries, not historically connected, are likely to find common ground. To date, data centers and geothermal plants have never been co-located on the same site. Co-locating them together completely eliminates the need for a connection to the electric grid. Trends and requirements in each industry strongly suggest the time to co-site them together is now.

Data centers use much of the world's electricity (Figure 1). Their appetite for more power continues to grow. A major factor driving the siting of new centers is low-cost power.

One geothermal field can produce sufficient baseload power to drive a large data center. Ideal candidates for such an application would be the hundreds of "stranded" resources. These are untapped, geothermal fields far from available electric transmission. If that power is completely consumed locally, than there is no need to connect to the electric grid (Figure 2).

Data centers, however, need to connect to data networks such as the Internet. They do so through fiber-optic cable, satellite, microwave, and other communications technologies. Installing and operating data networks is far cheaper and easier than electric networks.

Siting the data center on the geothermal field opens new markets for the geothermal industry. It similarly changes the risk factors for geothermal developers. Most notably, this model moves bits, not megawatts.

1. PROXIMITY TO TRANSMISSION, A CONDITION

Applications of geothermal energy have typically been divided into two categories: for electrical generation and for "direct use." Overwhelmingly, geothermal for electrical generation has had a plant tie directly into an electric grid. Direct-applications, on the other hand, use that power locally, often for heating purposes. This can be district heating of homes and businesses, for instance (Dickson, 2003).

Some geothermal plants do provide electricity locally, such as in Papua New Guinea's Lihir, gold-mining operations. Relatively few such applications have been found that both consume vast amounts of power locally and are economic.

As a consequence, the location of a geothermal field historically has been a huge factor in determining if the field is economic. A critical requirement of any site for power generation is its proximity to transmission (BLM. 2009). Huge tracts of land as a result have been passed over as uneconomic because they are not near transmission.

For instance, the Western United States has thousands of megawatts of geothermal power available on federal lands. However, 100 million acres of that land is more than 17 kilometers from the nearest transmission (Piszczalski, 2009).

2. DATA CENTERS: HUGE POWER APPETITE AND GROWING ENERGY COSTS

Meanwhile another industry, data centers, is growing rapidly. Accompanying its growth is a huge increase in energy consumption and spending. Locating new centers, also known as "server farms," has become a major issue.

Data centers spent $4.4 billion on power in 2006 just in the United States. This electric bill will grow to $7.4 billion by 2011, estimates the USA's Environmental Protection Agency. Indeed, large-enterprise, data centers are forecasted to spend as much on electricity as on computer hardware over the next five years (Kumar, 2007).

Given this ferocious energy appetite, it is not surprising that the location of new data centers is a major issue. In the early days, data centers were sited in urban centers. However, the explosive growth in the industry has created huge server farms that are both very large and consume vast quantities of power.

Their power demands are so high that they outstrip the available power in some cities. Urban centers are also where energy costs are the highest. Data-center power consumption is so great, that some regional networks now have data centers voluntarily reduce energy consumption during periods of peak demand.

As the Internet doubles from its current 1 billion users, even more and bigger server farms are needed. For instance, just one Microsoft server farm in the Chicago, USA is provisioned for 180 MW of power.

3. ELECTRIC TRANSMISSION: PROBLEMS EVERYWHERE

Transmission difficulties proliferate everywhere. Most countries have a woefully inadequate transmission infrastructure. Adding new transmission capability is complex, lengthy, expensive and uncertain.. This is transmission both to deliver power from new power plants as well as to get electricity to new load centers - including computer facilities. Lack of transmission is so fundamental that it is often cited as the number one problem for not achieving government-mandated, renewable energy goals.

Today's overstrained, transmission networks have serious reliability problems as well. This manifests in brown outs and black outs. Because transmission build out is not keeping pace with demand growth, even current users may face escalating costs or outright service denial.

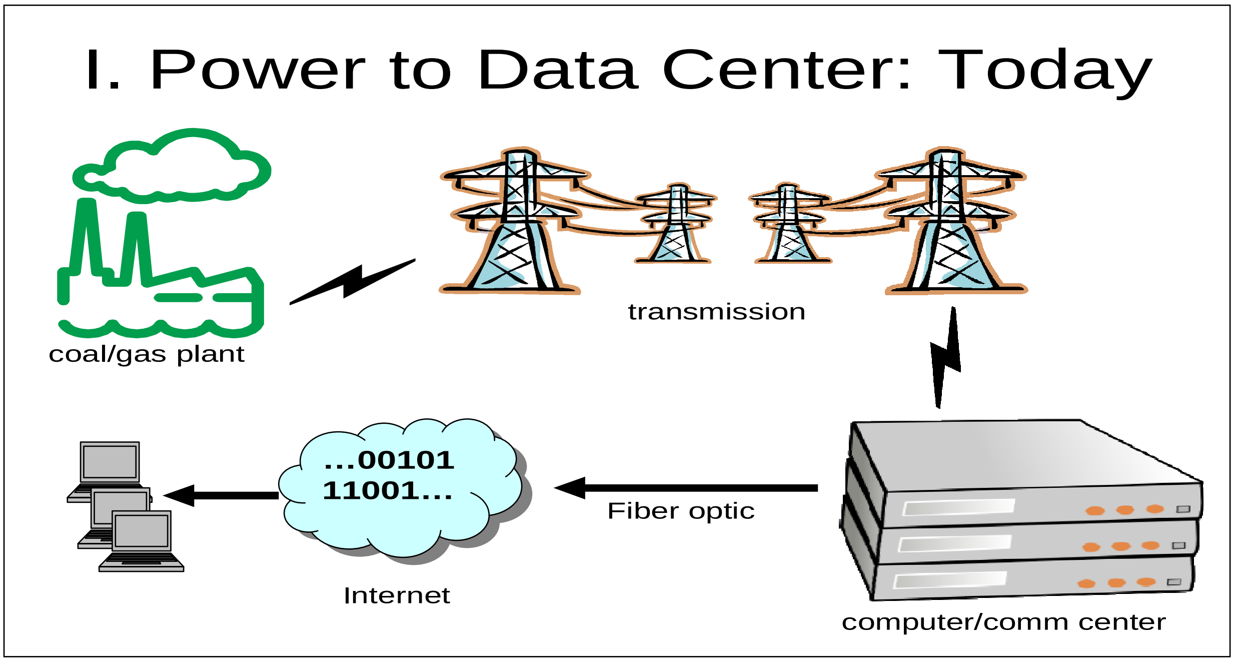

Figure 1: Existing data centers rely on the electric grid for their primary power. Mushrooming power and transmission costs make this model uneconomic in many circumstances.

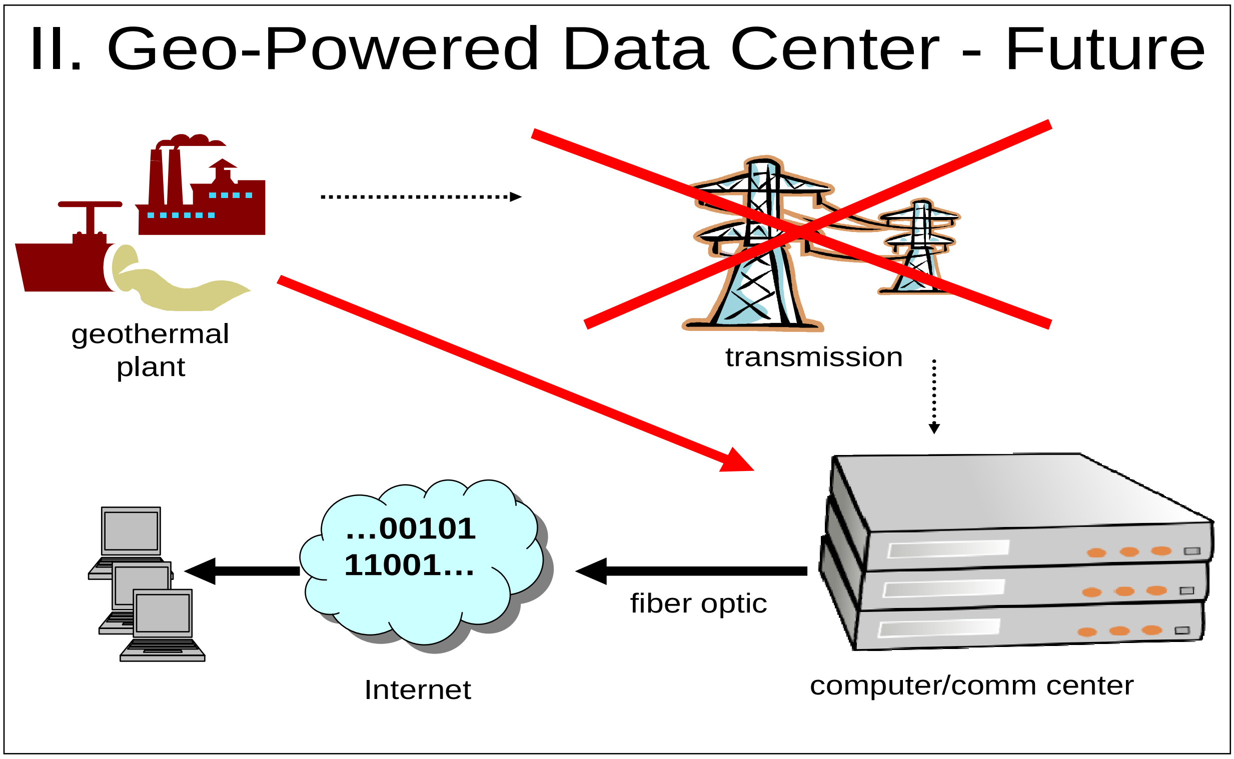

Figure 2: A data center can be sited adjacent to the geothermal plant. Doing so directly taps low-cost, baseload power. The configuration eliminates the electric grid and associated costs. Those drawbacks have made many geothermal sites uneconomic in the past.

Transmission woes also have a chilling effect on geothermal investment in particular. Lack of rock-solid, transmission commitment stops many worthy projects from even getting funded. Aside from high costs, adding new transmission lines and towers also typically require years of planning. Stiff environmental and regulatory push back routinely delay new projects for years.

4. DATA TRANSMISSION: PROLIFERATING, AFFORDABLE

Data transmission, on the other hand, sharply contrasts with many of the difficulties incumbent in electric network build out. Geothermal-powered, data centers effectively substitute data transmission for long-haul electric transmission to reach their markets (Figures 1 and 2).

The state of data transmission contrasts starkly with electric transmission. Long-haul, data networks in general have considerable untapped capacity. The datacomm industry overbuilt $70 billion in fiber-optic networks in the late 1990’s. Only 25 percent of the currently installed cable is now in use. There is so much “dark fiber” that users routinely expect price reductions in data-transmission charges.

When new data transmission must be added, the process is relatively simple, cheap and fast compared to adding electric transmission over the same path. A new fiber-optic line is so unobtrusive, for instance, that most residents do not even know when it is nearby. Also, adding redundancy is far cheaper with data networks than with electric networks.

5. CONVERGENCE OF GEOTHERMAL AND DATA CENTERS

Serving data centers with geothermal power offers several advantages. It mitigates risks that each would face when operating independently.

Data centers would vastly prefer long-term, fixed energy costs. The current practice exposes data centers to unpredictable energy prices. These could rise considerably due to a number of causes – fossil-fuel price increases, carbon taxes and the like.

To this end, some data center owners are already locating data centers near low-cost, stable power supplies. An example is Google’s planned data center in The Dalles, Oregon, USA (Strand, 2008). That center would tap 108 MWs of below-market-price, hydroelectric power.

Likewise there is a strong push to “green” data centers. This has led to planned and existing data centers running in part on solar, wind and biomass power. (Note, however, that the intermittency of solar and wind power preclude them from being the sole primary power source.)

On the geothermal side, the data-center application opens new markets for geothermal power (*Economist*, 2008). This could even impact a geothermal plant near transmission, but without a competitive market of power buyers. For instance, some sites today are “captive,” in that they can reach only a single buyer such as one electric utility. This eliminates any market power for the geothermal developer.

In contrast a geothermal-powered, data center could serve users anywhere. Indeed, one promising technology, “cloud computing,” de-couples applications and data from a specific data center. Processes may seamlessly jump from data center to data center anywhere in the world. Highly likely is that data and computer tasks will migrate around the world, residing on centers with low operating costs. This is leading to situations such as Microsoft considering Siberia, Russia for a data center. That center would serve Microsoft’s global business.

Constructing data centers in remote locations has become much more straightforward. For instance, a complete, pre-constructed, data center is now available in a shipping container. An example is Sun Microsystem’s BlackBox.

5. TECHNICAL CONSIDERDATIONS FOR OFF-GRID OPERATIONS

A geothermal power plant operating off-grid and expected to provide 24/7 availability does have additional engineering requirements beyond a conventional, grid-connected plant. In particular the plant is expected to operate in a fault-tolerant mode. This would require no single point of failure that could bring down the entire installation.

Needed is parallelism, both in the subsurface and surface equipment. For instance, independent production wells, re-injection wells, pumps and so forth would be necessary on the subsurface side. For the surface equipment, multiple, modular turbines such as from United Technologies Corporation would serve this end. The Raser geothermal plant in Utah, USA, for example, uses 50 UTC power-generation units (see *Renewable Energy World*, 2009). Similar modularity is available in “data center in a box” equipment.

Additional engineering is required for grid-independent operations. Conventional geothermal plants, for instance, rely on grid power to start up operations of the plant. The Chena Springs installation in Alaska USA installed its own 3 MW uninterruptible power supply (UPS) as a substitute. This provided the stable input voltage and frequency for starting up its stand-alone generator (Holdmann, 2007).

5. CONCLUSION

A new application for geothermal power could open up a potentially large, new market for developers. Geothermal-powered data centers could effectively “rescue” geothermal sites that historically have been uneconomic due to their geographical remoteness. Independent of the electric grid, this application of geothermal power serves one of the most rapidly growing segments of the power industry.

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