Distributed Resources and Village Power a Challenge to Utilities

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We are coming to the end of a remarkable 100 years. A time span which saw major changes in the philosophy of people, their relationship to each other and their relationship with nature. Major changes in concepts of governance and major changes in technology that continues to push, pull and shape our lives.

These changes are occurring with different speeds in different parts of the world. The Utility Industry is also changing for it is not isolated, and the changes are embedded in the major global changes taking place already this century and the major global changes that will continue to take place in the next century. A recent insert in a Fortune cookie expressed this most succinctly " The philosophy of one century is the common sense of the next".

This century was also a time span where we began to doubt that our job on this planet was to conquer nature and began to evaluate our need to live in a symbiotic relationship with nature. There were limitations on what we could do to this earth. The environment will become evermore important as we move into this next century. Hopefully, we will slowly begin to move from conquering nature to living in harmony with nature. We act when the problems are local, but dealing with when they are global is more difficult. Rapid and coordinated action between governments on Global Climate Change will be difficult

The Electrical Utility Industry will increasingly come under environmental scrutiny, as it is a major contributor to atmospheric pollution and that concern will not go away. Nature has provided us with a Faustian bargain; **providing relatively cheap fossil fuels available in some form or other for at least the next hundred years but asking us not use them since the atmosphere cannot absorb the effluents.**

The provision of electrical energy and energy services is also undergoing technological change. These technology changes are calling into question the structure and with it the delivery systems of the traditional utility. The technology is changing from the dominance of large central station constructed energy to the more modular, flexible, manufactured energy. These new technologies provides a means for electrical service to move toward the customer, in many cases to the customer's premise, and be tailored to the customer's needs and ability to pay. The conceptual model of a utility as large central station power plants connected to their customers by wires may well not be the model for the future. This is particularly true for rural populations in developing countries.

These then are the major forces;

Governance - Competition and the increased use of market based approaches.

Environment - Sustainability and increasing emphasis on environmental impacts both local and global.

Technology - shifting from large central station constructed energy to smaller more modular, flexible, manufactured energy.

The development of modular flexible manufactured energy, distributed resources, introduces new factors into the traditional analyses of costs and technology choices. Traditional cost of service is a function of large central generation (+G), transmission (T), distribution (D), and, for some utilities, large central storage (S), like pumped hydro. T and D are costs for getting the product to market. The most variable factor is the cost of central generation. Utilities therefore focused on minimizing busbar energy costs.

This cost of service equation looks like:

Cost ($) = f (+G, S, T, D)

Service can now be provided by minimizing the total cost of service, not just the busbar energy costs. Many options are available to serve a customer. Providing either supply or efficiency close to the customer is, in many cases, the least cost of service solution. These are new factors in the cost of service equation, the distributed systems.

Cost ($) = f (±G, S, T, D, ±g, s)

+G	-	Central station power generation
-G	-	General decrease in energy intensity
S	-	Central station storage
T	-	Transmission
D	-	Distribution
+g	-	Small dispersed or distributed generation (often renewables)
-g	-	Targeted energy efficiency
s	-	Small-scale storage

The least cost of service for each customer provides a means for a broader evaluation of options including those technologies the customer chooses to include in the equation. Cost or price will not be the only values that a customer may consider.

There are three generalized situations for consideration of distributed systems, DR(±gs);

1. $G+$T+$D <<< $DR(±gs) Centralized operation based on central generation (large load centers). Cost of central generation plus the cost of T&D is much less than the cost of distributed resources (including renewables).

2. $G+$T+$D >>> $DR(±gs) Distributed operation (islands/villages) based on distributed resources . Cost of distributed resources is less than the cost of generation, transmission, and distribution.

3. $G+$T+$D ~~~ $DR(±gs) A mix of resources depending on localized costs, conditions and choices (market niches).Cost of distributed resources is approximately equal to the cost of generation, transmission, and distribution.

The wholesale or commodity market is characterized by situation 1.

$G+$T+$D <<< $DR (±gs)

This market is the traditional utility market. It revolves around the development of central station generation and its associated grid. Emerging for this market is a regulated or nationally operated powerpool and open access transmission grid with private companies building the generation systems.

Situation 2 where,

$G+$T+$D >>> $DR (±gs)

Describes the situation where there usually is no utility structure and the central station concept does not fit. It represents 2 billion people without electricity, the off-grid market, limited grid market, or the Village Power market. In this case there is a relatively unknown demand and an indeterminate ability to pay. Attempt to fit this situation into the classical utility model have not been successful, and the standard project financing models are not appropriate. Attempts to “parachute” in technologies using a standard utility approach have also not been successful.

There is also a subtle difference in approach between these two situations. In Situation 1, the centralized approach, the question is “at a given level of service what is the least cost at which services can be provided using traditional technologies”. In Situation 2, the decentralized approach, the design question is “given a cost (or ability to pay) what are the levels of service that can be provided and then expanded. The starting point of the analysis is quite different. This subtle shift in analysis starting point is difficult for traditional utilities to accept. It appears to be a radical notion. Utilities have no special expertise in this situation.

The most successful development of this market has been by Non-Governmental Organizations (NGO’s), religious and philanthropic organizations. One of the interesting developments is the private sector companies who are beginning to successfully provide energy services in this market. Private companies are beginning to provide energy services, that the rural population can afford to buy, using renewables at the point of use or at the village level.

The development of this market, as an example Village Power, is closer to business development than power project development. There is a need, therefore, that government policies to foster rural electric services deal with business development not project development.

The central focus should be to provide electrical services commensurate with the ability to pay and the capability of being expanded as need and ability to pay increase. This also suggests that the appropriate business model may be a "for profit" Franchise business model. This allows for centralized training, financing and technical backup, but localized ownership and focused products. It is a model that has more in common with McDonalds, Burger King and Kentucky Fried Chicken than large utilities, and requires different financing mechanisms than power project financing. In each of the successes it is private industry tailoring its product to the situation (market) with a profit in mind, and providing a degree of flexibility that national, regulated, or traditional utilities seldom exhibit.

Situation 3,

($G+$T+$D ~~~ $DR (±gs)

May best describe the evolving company of the future. It combines central station generation with a mixture of small storage and generation and energy efficiency programs located at specific distribution or dispersed sites. All of these situations imply a dynamic process that will be in a continual change.

Technology choices therefore feed into distinct markets. The grid connected wholesale market, where slight changes in the present utility model and project financing will continue to exist. The grid and non-grid connected markets where the present utility model and project financing are not appropriate and where the business model and associated financial instruments need to be brought into sharper focus and do not follow the traditional utility operational or decision models.

As distributed resources are challenging the traditional utility model so will the environment. Energy is a major aspect of the quality of life and has a major impact on the environment. It is becoming increasingly evident that renewables coupled with energy efficiency are important components of a sustainable energy future**.**

For a sustainable energy future there are really only three approaches;
1. High efficiency conversion of clean (low carbon) fuels,
2. Renewables and
3. Efficient use.

There are varying opinions on the ratios of the three and the emphasis. But that is all there is.

There is no silver bullet only silver buckshot.

Sustainable energy requires the increased use of the short-term flux of the sun or the heat of the earth, rather than the stored flux of eons represented by fossil fuel. The shorter the flux of the sun the more the electricity generation is dispatched by nature and not by man. The more dispatched by nature the more *radical,or disruptive,* from a central station electrical utility viewpoint, is the technology. The central station system with its associated grid requires an exquisite degree of control. Even the thought of relinquishing that control is radical to utilities

Distributed Technologies, in general, require cleaner fuel or utilize the short-term flux of the sun. Energy efficiency technologies are all self dispatched. Distributed resources are best self-dispatched or under some local control. The more dispatched by nature, self or locally dispatched, the more the technology is *radical or disruptive.*

Distributed technologies in general, are smaller and more modular. They work as well or better distributed rather then centralized. The more modular and the more distributed, the more *radical* is the technology. The more a grid is not required the more *radical or disruptive* the technology becomes. Photovoltaics, as an example, is immediately dispatched by nature, does not require a grid, and is the most modular of the renewable technologies and therefore easily qualifies as a radical innovation.

Numerous studies of technical innovation have shown that *radical or disruptive innovation has never been introduced by market leaders. (Users of traditional technologies)***.**[1] *Radical or disruptive* technologies are those that result in worse performance in the short term, but offer other features which a few fringe (and generally new) customers value. *Radical or disruptive* technologies don't seem to make sense because they are usually cheaper, promise lower profits, and they target insignificant markets, and large existing customers don't want them. Sustaining or evolutionary technologies improve product performance along the dimensions of performance that mainstream customers in major markets have historically valued. (Example; Combined cycle gas turbines)

One way to characterize these differences is that sustaining or evolutionary technologies are "better, cheaper, faster" and *radical or disruptive* technologies are " a brave new world" with different characteristics and values. The real question is why did companies fail to move to " a brave new world ". In study after study, good management was the most powerful reason they failed to change. Precisely because these firms listened to their customers, invested aggressively in new technologies that would provide their customers more and better products of the sort they thought they wanted, and because they carefully studies market trends and systematically allocated investment capital to innovations that promised the best returns, they lost their positions of leadership. It was impossible for these well managed firms to allocate resources for technologies that their traditional customers did not want and using technologies that did not provide as good a profit stream, had characteristics that they where not familiar with, and they could not centrally control. [2]

What did the companies have in common? One, the decisions that led to failure were made when the leaders in question were widely regarded as among the best companies in the world. Two, they were good, well-managed firms that " ignored the significance of a new technology. The *radical or disruptive* technologies began as apparently inferior products and then grew to overtake the traditional technologies and brought with them a new set of customers and values. Large traditional companies don't like *radical or disruptive* technologies as they typically supply small markets, which are not enough to satisfy the revenue needs of a large firm. In addition these markets are hard to estimate, so companies who require firm quantitative data, the hallmark of utilities, before making a decision will miss out. It just does not make sense for them to invest. The have developed a "value system" that progresses from the bottom to the top of the organization. This system is geared to the technologies that have made the company a leader. A *disruptive or radical technology* can never make it through such a system. Utilities represent such traditional companies. Distributed, renewable, and energy efficiency technologies represent radical and disruptive technologies. Utilities will not be able to make the transition to the kind of business structure and value system required to make these radical technologies a success.

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[1] Mastering the Dynamics of Innovation, James M. Utterback, HBS Press 1994

[2] Liberally adapted from " The Innovators Dilemma, When New technologies Cause Great Firms to Fail" Clayton M. Christensen, HBS Press 1997

The provision of energy services to the rural populations of the world, in a sustainable manner, will depend as much on innovation in organizational structures as it does on the innovation in technologies. So the challenge to utilities is that the delivery mechanism for energy services using renewables and distributed, new, radical technologies requires them to abandon the culture and the structure of control that made them a success. A metamorphosis that history tells us few, if any, companies have accomplished. And if there are any companies that seem incapable of doing so, it is utilities. ⊗

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