WHY NEW DISTRIBUTED GENERATION UNITS
MIGHT TRANSFORM POWER INDUSTRY’S ORGANIZATION?

THE CASE OF GAS MICROTURBINES.

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ABSTRACT (about 1450 words)

Worldwide, for the last two decades, energy network industries have undergone major changes in terms of industrial organization and competitiveness. Led by a combination of economic, technological, political and ideological forces, these industries are now less and less protected and controlled by governments. After restructuring reforms in the transportation, telecom and natural gas sectors, deregulatory initiatives have been taken in the electric power industry to eliminate traditional constraints and protectionism. A new era has emerged: in some segment of the value chain, electric monopoly activities are now open to competition. There is lively debate about whether these experiments will succeed and how they should be conducted.

In several industrial sectors, especially in networks industries, monopolies are regarded as either directing or delaying innovations. There is an obvious link between the form of industrial organization and the dynamic of technological progress. Thus, one concern is raised: the role of technology in the new emerging structure of electric industries and more precisely, its contribution to change monopolistic situations in various activities. With the deregulatory reforms, the influence of new technologies on the current evolution of the power sector seems to be highly relevant.
In this paper, we will focus on the relationship between innovation and industrial organization in electric power industry.

- In the first part, we will discuss the theoretical impact of new technologies on industrial organization and vice-versa, keeping in mind that technological progress’ dynamic is different in a regulated market than in a competitive one.
- Then, in the second part, we will study the evolution of power generating system towards new highly efficient distributed generation units. These technological improvements might revolutionize not only generation activity but the whole power industry.
- Finally, we will present the case of gas microturbines to underline the drawing forces and obstacles of the development of some small generators on site.

I/ THEORETICAL INFLUENCE.

For the most part, the academic literature points out that technology, which once set the basis for regulated monopoly, is now perceived as eroding it in network industries. The outcome of monopolization in parallel sectors was a tendency toward suppressing competition and retarding innovation (J. SCHUMPETER 1942, H. AVERCH & L. JONHSON 1962, A. KAHN 1970 et 1988). "In many circumstances a regulated monopolist can maximize the present value of profits only by delaying adoption of an innovation" (G. SWENNEY 1981 p. 437).

In a deregulation process, innovation can be the key to erode or eliminate monopolies by giving new comers special advantages. The dynamic of technological progress depends on the degree of competitive pressures (N. ROSE & P. JOSKOW 1990, R. VIETOR 1994 et W. SHEPHERD 1997). For two decades, the electric power industry is undergoing a major transformation from a regulated market place to one exposed to the influence of market forces. Potentially competitive segments are being separated from the natural monopoly segment. The changes are designed to foster competition in the power generating activity and to reform regulation of the transmission and distribution functions, which continue to be viewed in some extent as natural monopolies.

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3 See a summary discussion in P. JOSKOW (1997).
In the United States, the electric power industry's organization has evolved through **new technologies** and **progressive deregulatory laws**. For instance, in 1978, the Public Utility Regulatory Policies Act (PURPA) helped to stimulate innovations in combined cycle generating technologies using natural gas as fuel. Ever since, independent producers, appeared with PURPA, have built most of the new generating capacities⁴. The lack of competition caused by the regulatory regime left utilities frozen over the decades unable to invest (R. HIRSH 1989). During the eighties, power plants relatively smaller scale and with shorter construction cycle than traditional plants have been built by an increasing number of independent producers. The 1992 Energy Policy Act (EPAct) has promoted competition in the wholesale market by expanding opportunities for independent producers to sell electricity to utilities for resale. Competition and innovation have been gradually increasing. Since last year, some states (California, Illinois, Maine, Massachusetts, Pennsylvania, Virginia…) have programs that separate transmission activity and that allow retail consumers to choose among several generation service suppliers. In the electric industry, these experiences are new steps towards competitive power generation and retail sectors.

### 2/ Distributed Generation.

In power generation activity, current deregulation entails a fundamental shift from guaranteed cost recovery to open market competition. The need to reduce costs has been the key driver of the present transition which has been furthered by a technology push. Result of the last years of generation research has been the evolution of thermally efficient technology for the production of electricity at much smaller unit sizes than those which dominated the industry. Recent technological progresses have resulted in the emergence of so-called **distributed power generation system**: low cost, clean, easy to site, modular, short lead time electrical generators and in sizes from 1 MW (even less) to 50 MW to serve one large customer or several customers close to each other.

With these advances in microgenerators' technology and the loss of significant economies of scale in production, a new generation market is emerging and is about to revolutionize the electric power industry's organization. Distributed generation units have changed the fundamental premise that shaped electricity systems for more than a century. The long trend of

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⁴ In the last few years, independent producers have accounted more than 50% of annual generating capacity addition.
large expensive central power plants which take years to build, require miles of distribution wires and take decades to pay off (see the discussions on stranded costs) is replaced by smaller units closer to end-user. History just might repeat itself: distributed generation units have the same relationship to large power plant that the PC had to the mainframe; it puts the source of power at the user site. These new generating units can do more than reduce the costs of electricity. Without or with less wires, the maintenance costs and of the grid diminish. And what is the interest of a grid with units generating on site? The functions of power transmission and distribution should be transformed (or might disappear) as the whole network's structure.

3/ Gas microturbines.

Many analysts say future demand will be met by smaller generators which are closer to where the electricity will be used. Gas microturbines are the latest distributed generation option.

<table>
<thead>
<tr>
<th></th>
<th>Microturbine</th>
<th>Gas turbine</th>
<th>Fuel cells</th>
<th>Gas turbine combined cycle power plant</th>
<th>Existing coal power plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (kW)</td>
<td>30-200</td>
<td>1.5-50</td>
<td>3 kW - 2 MW</td>
<td>400 MW</td>
<td>30 MW - 40 MW</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>22% - 30%</td>
<td>21% - 42%</td>
<td>40% - 65%</td>
<td>60%</td>
<td>32% - 35%</td>
</tr>
<tr>
<td>Cost ($/kW)</td>
<td>$450-$700</td>
<td>$650-$900</td>
<td>$900-$3000</td>
<td>$350-$400</td>
<td>$900-$1300</td>
</tr>
<tr>
<td>Maintenance ($/kWh)</td>
<td>0.3¢-1.0¢</td>
<td>0.3¢-0.8¢</td>
<td>0.5¢-1.0¢</td>
<td>0.2¢-0.4¢</td>
<td>0.5¢-1.0¢</td>
</tr>
<tr>
<td>Emissions (CO₂, kg/kWh)</td>
<td>0.1-0.5</td>
<td>0.1-2.0</td>
<td>0.1-0.2</td>
<td>0.2</td>
<td>4.0-10.0</td>
</tr>
</tbody>
</table>

* Costs do not include price of fuel, which varies depending on source. ¢ = US$ cents


There have been six main basis factors leading to the growth in the use of these new small microturbines generators:

- Low capital costs
- Relatively maintenance free (which reduces capacity requirements for utilities)
- Very high efficiencies achieved

5 An other option of distributed generation units is the fuel cell system which use electrochemistry, not combustion, to convert hydrogen to electric power and useful heat.
• Abundance of cheap gas
• High levels of availability and reliability
• Low impact on the environment

The optimism regarding microturbines may be premature because they have yet to be commercially proven. Over 10,000 MW of small generating units less than 2 MW in size are already being purchased and installed each year for use as a primary power supply (not just as a standby jet). However, costs of microturbines, the first generation of which were scheduled for commercialization in 1997, were almost four times what manufacturers expected. If there is not a large demand for the units, manufacturers are not going to get their costs down. Markets for microturbines vary with geography, be reliant on favorable net metering policies and require extensive environmental and regulatory licensing and permitting.

These new highly efficient small generators are eroding economic advantage of traditional plants generating electricity at lower costs. Many challenges faced by gas microturbines could nullify these technology’s benefits. Nevertheless, new technologies are one of the most potent drivers of industry change today. These innovations will be indeed capable of reducing much of the monopoly in the power sector: they will speed up the move. The explosion of interests in gas microturbines over the last years has resulted in intense competition with new rent-seeking players. Electric utility companies have to show agility and strength in controlling the new technology rather than letting their positions erode. Future technological development can provide the strategic advantage needed by utilities to thrive in the newly competitive market place. Distributed generation is an illustration of number of technologies about to transform the electric power industry’s organization and competitive profile of the players. Technology is only begun to make a difference.
References:


POURQUOI LES NOUVELLES UNITES DE PRODUCTION DISTRIBUTEE POURRAIENT TRANSFORMER L'ORGANISATION DE L'INDUSTRIE ELECTRIQUE ?

LE CAS DES MICROTURBINES A GAZ.

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RESUME

Dans cet article, nous nous sommes centrés sur la relation entre les innovations technologiques et l'organisation de l'industrie électrique. Avec les mesures de déréglementation, l'influence des nouvelles technologies de production d'électricité sur l'évolution actuelle du secteur électrique apparaît pertinent à étudier. Les récentes avancées technologiques ont favorisé l'émergence de nouvelles unités plus petites qualifiées de production distribuée. Ce terme s'applique à différentes technologies de production d'électricité près des lieux de consommation (à la place des grandes centrales transmettant l'énergie aux consommateurs par des kilomètres de câbles). Une des derniers options est la microturbine à gaz qui pourrait transformer l'ensemble de l'organisation de l'industrie électrique aux Etats-Unis.
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ABSTRACT

In this paper, we will focus on the relationship between innovation and industrial organization in electric power industry. With the deregulatory reforms, the influence of new generating technologies on the current evolution of the power sector seems to be relevant to study. Recent technological advances have resulted in the emergence of so-called distributed power generation system. One of the latest option of decentralised generation units is the gas microturbine which might transform the whole American electric power industry.
¿POR QUÉ LAS NUEVAS UNIDADES DE PRODUCCIÓN
PODRÍAN TRANSFORMAR LA ORGANIZACIÓN
DE LA INDUSTRIA ELÉCTRICA?

EL CASO DE LAS MICROTURBINAS CON GAS

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RESUMEN

En este artículo, nuestra atención estará centrada en la relación que une las innovaciones tecnológicas con la organización de la industria eléctrica. Dado las reformas legislativas, parece pertinente estudiar la influencia de las nuevas tecnologías de producción de electricidad sobre el sector eléctrico actual. Los recientes avances tecnológicos han favorecido la emergencia de nuevas unidades de producción, más pequeñas, denominadas producción distribuida. Se puede emplear este término para las diferentes tecnologías de producción eléctrica cerca de los lugares de consumo (en vez de las grandes centrales que transmiten energía al consumidor por metros y metros de cables). Una de las últimas opciones es la microturbina con gas que podría transformar toda la organización de la industria eléctrica en Estados Unidos.