THE END OF CENTRAL POWER?

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'The old shall become new and the new shall become old.' This phrase captures very neatly some of the changes taking place in the electricity sector today. We can say with some certainty that central power has probably already peaked in terms of its share of the global electricity market. The decline has already slowly started and will accelerate as DE and on-site power generation become increasingly competitive. At present, central power dominates world electricity markets. WADE has estimated, in its 2002 '*World Survey of Decentralized Energy – 2002/03*' (see *COSPP* November-December 2002), that electricity from DE systems accounts for only 7% of all generation – central power accounts for 93%.

Many parts of the world suffer from an excess capacity in power generation. The development of new plants has almost completely dried up in many parts of Europe and North America, although markets for new capacity in developing countries are more buoyant. This follows a period of rapid capacity expansion in the 1990s, which showed many of the hallmarks of a cyclical boom leading, sure enough, to a bust from 2001. This market pause may last five years or more, with electricity price signals for new capacity development not showing green until 2005 or later. When they do, what are the relative prospects for central and decentralized energy generation?

ALL-IMPORTANT COST

The all-important issue is one of cost. For DE advocates, including the World Alliance for Decentralized Energy (WADE), the economic benefits are the ultimate justification. Demonstrating the cost advantage is challenging because it is hard to get a clear financial view of the real costs of all aspects of central power generation, in particular the costs associated with transmission and distribution.

WADE Chairman Tom Casten, and his colleague Marty Collins from Private Power, have developed a robust economic model which seeks to identify the optimal means of meeting new electrical capacity requirements in the future. In essence, it compares the costs of future capacity development based on DE with that based on central power[2]. The model has been developed and refined following an extensive process of review and critique. For the moment, it has been applied to the US only, and WADE will run the model for other countries and regions in coming months.

The results are, please excuse the pun, electrifying. The model finds that full reliance on DE, in particular CHP, would supply power for 5.8 USc/kWh versus 8.9c/kWh from new central generation (see Figure 1). DE reliance would avoid $290 billion of capital expenditure by 2020 (Figure 2) and reduce carbon dioxide emissions by 46% (Figure 3) compared to total reliance on new central generation.

The horizontal axis in the three figures range from a distributed generation share of 6.11% of the total generation market in 2020 (this would be the share if nothing but central power was developed between now and 2020) and 39.38% (this would be the share if nothing but DE was developed between now and 2020).

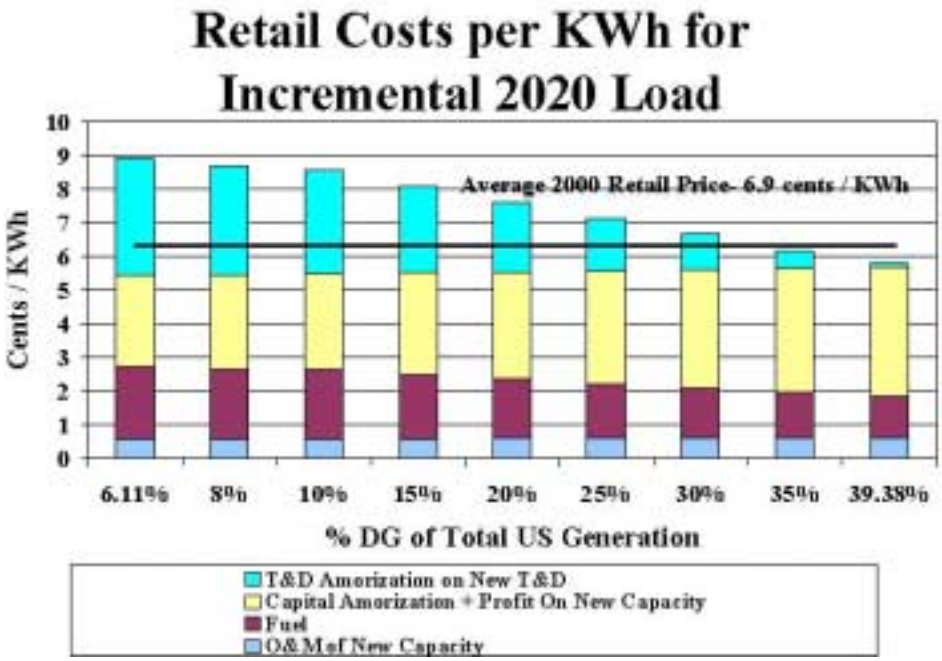

Figure 1. Retail costs per kWh for incremental 2020 load

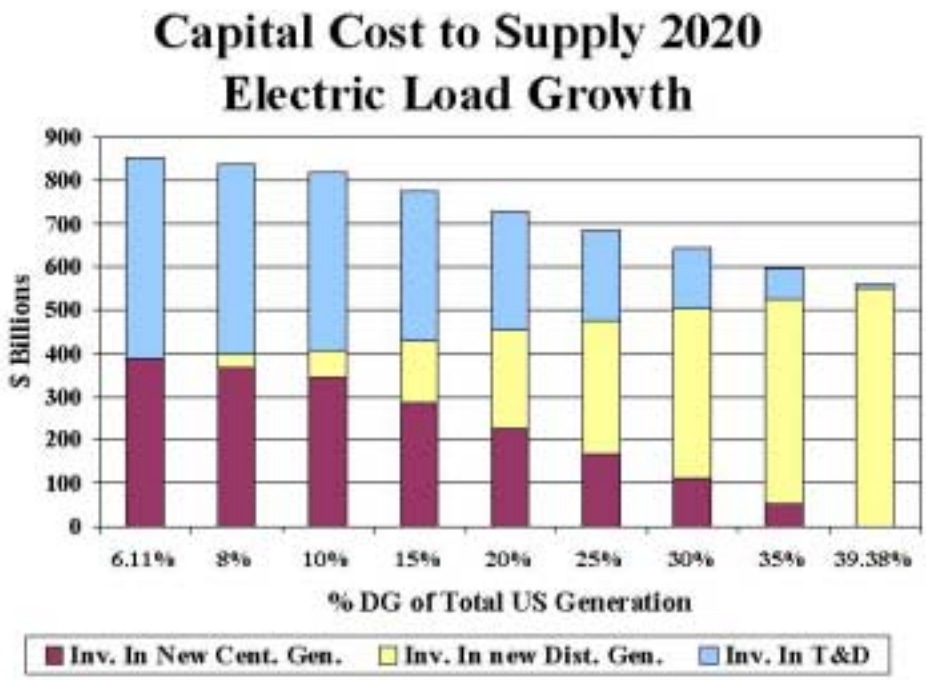

Figure 2. Capital cost to supply 2020 electricity load growth

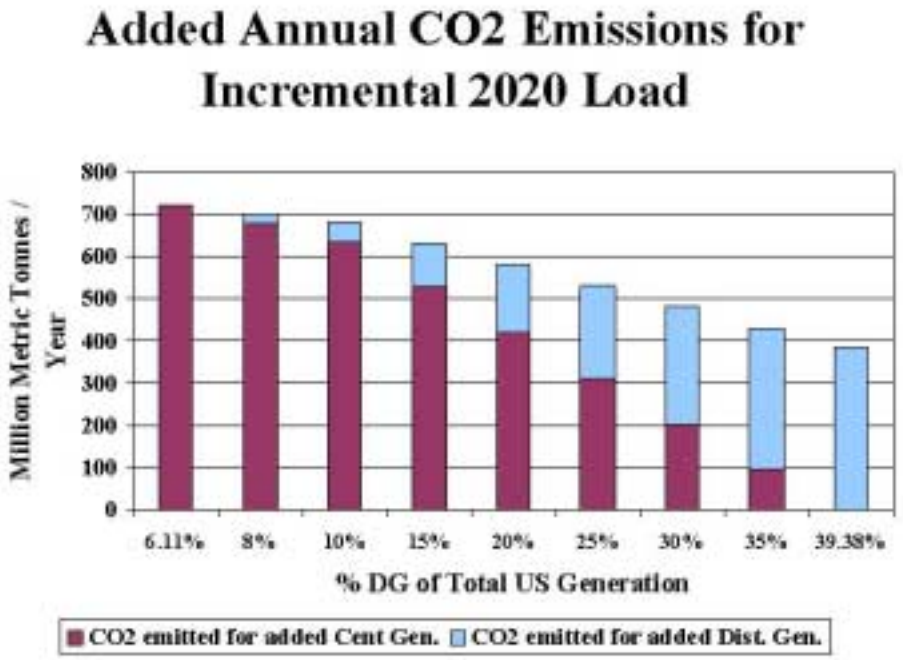

Figure 3. Added annual carbon dioxide emissions for incremental 2020 load

In short, the economic case for DE is conclusively made by this model. We expect similar results to arise when the model is run for any country or region in the world.

As the figures make clear, the key reason for the cost superiority of DE is through the savings made by avoiding most of the costs associated with the construction and operation of transmission and distribution (T&D) systems. In the US, these have been costed at around $1250/kWe.

This clear financial benefit of DE begs a question: if DE is so much more cost effective than central power, why is it not already the system of choice for new development? The reason, alas, is that in almost every country in the world there exist regulatory rules, institutional arrangements and market structures which were designed to accommodate central power and which, today, act as significant barriers to DE. Competition at the wholesale level ignores costs of T&D and T&D losses, treating these costs as an inescapable given. Until all suppliers compete at the retail level, without barriers, money will be wasted through the widespread and suboptimal implementation of central power.

Fortunately, the world's governments are beginning to recognize the need to reform power markets in ways which can deliver genuine least cost power supply through DE. In the US, many European countries and some key

developing countries, including China, India and Brazil, a few small steps have been taken to identify and remove barriers. A tremendous amount remains to be done, but the pause in development of new capacity around the world is creating a window of opportunity for the global DE community to make its case. If this is done effectively, more obstacles will have been eliminated by the time new capacity development starts again.

CARBON EMISSION BENEFITS

If cost benefits represent the main weapon in the competitive armoury of DE, then the carbon emission benefits run it a close second. Electricity and heat generation are responsible for around two-thirds of global greenhouse gas emissions. DE cuts these emissions dramatically. The fact is that even this clear environmental advantage increasingly presents associated financial benefits, and will reinforce the economic merits of DE described above.

World governments, with only few exceptions, are taking steps to ratify and implement their obligations under the 1997 Kyoto Protocol. The European Union takes the lead on this and will almost certainly aim to meet its emission reduction targets by 2012. Japan will also do so, as may Canada. The US and Australia look less likely to respond to Kyoto in the short-term.

One of the main tools which governments are likely to use to achieve their targets is emissions trading. Unfortunately, in its present design, the most important system under development worldwide, the EU scheme, is not likely to provide much help for cogeneration systems in Europe. Other mechanisms will include carbon taxes and incentives for low emission technologies and energy efficiency. In theory, emissions trading gives emitters an incentive to identify the costs of various abatement solutions and to shift investment, not only away from higher cost emission abatement options, but also away from high emission technologies and applications.

Such a market environment is likely to emerge rapidly over the next five to ten years. Investors, energy generators and project developers know this. While there may not be any significant environmental liability *today* in developing a power station based on fossil fuels and without heat recovery, the chances are increasing almost by the month that such a plant could face some form of carbon-related environmental liability in the future – and certainly during the life-time of operation of the plant. Emitters today can legitimately claim that they should not be penalized for plants built ten years ago, before the emergence of any realistic prospect of carbon emission constraints. Those claims will not have legitimacy in five or ten years' time.

One possible consequence of this is that any generator or developer which in future constructs a central fossil-fired station, including a CCGT gas-fired plant without heat recovery, runs a significant risk of incurring greater carbon emission costs than are necessary. In contrast, high efficiency cogeneration plants and some renewable technologies can now be built and deliver electricity to users at costs below conventional central fossil-fired plants. Yet their carbon advantage is substantial.

This may have profound consequences on the pattern of capacity development over the next 20 years, during which many countries aim to substantially reduce their emissions. Governments which wish to achieve compliance with these targets are increasingly likely to impose energy market frameworks which incentivize low emission DE systems and discourage relatively inefficient central plant. The carbon risk associated with the development of central power plants is creeping ever higher.

SECURITY ISSUES

A third factor which is making central power a less attractive option for governments and investors is the security of electricity supply. When an electricity supply system is composed of a small number of large plants, with its associated high voltage (and high visual impact) transmission system, it is more vulnerable to disruption than a system based on a large number of small DE plants. This is increasingly well understood. Two main causes of disruption are a growing threat – adverse weather caused by climate change, and the possibility of terrorist attack.

The climate may already be changing. Certainly, it seems that weather is becoming more extreme. What one cannot argue with is that insurance companies are having to respond to much higher weather-related claims almost on a year-by-year basis. Extreme weather can have very destructive impacts on transmission systems. The Canadian ice storms and French ‘hurricane’ are two examples from recent years where electricity supply was disrupted for weeks. We do not know whether the frequency of such events will increase, since there is so much uncertainty about climate change. But it would be unwise for plant developers to bank on the fact that they will not increase.

In short, electricity systems need to be structured in ways which provide greater protection against extreme weather – and this means that there should be a greater share of DE in world electricity markets.

The threat of terrorist destruction in some key industrialized countries is all too real. Central power stations, in particular nuclear plants, are under round-the-clock protection. Yet these plants, together with transmission lines and transformer stations, are an obvious and vulnerable target for terrorists which wish to disrupt economic activity. Again, a system with a greater share of DE generation would be less vulnerable to attack and it makes sense for governments to plan accordingly.

Gas-fired DE systems are themselves vulnerable from attacks on gas transmission infrastructure, but the diversity of a more balanced mix of central power and DE using all fuels and renewable energy will mitigate the overall risk.

WADE does not necessarily advocate 100% generation from DE, although our economic modelling suggests that as much new capacity as possible should be based on such local systems. Instead, a more equal hybrid market, based both on central power and DE, will provide a superior solution, in economic, environmental and security terms, than the present system where central power predominates.

The economic case for DE is becoming ever clearer. The environmental advantages are well known and new policies are being introduced to reflect this. The security benefits are less well understood but are emerging rapidly as the dangers and threats to power systems become plain. Putting all this together, the case for DE becomes powerful and the dominance of central power appears highly vulnerable.

WADE believes that it is becoming increasingly hard to make a fair case for the development of new central power stations as a preferred option The role of central power generation will evolve in the same way as has the mainframe computer – and move from a position of almost complete dominance to a more subsidiary and specialized position.

REFERENCES

1. WADE defines decentralized energy as including two main categories: high efficiency cogeneration systems, regardless of fuel, plant size of technology; and decentralized renewable energy systems, including PV, mini/micro hydro and on-site biomass, geothermal and wind systems.
2. More information can be found at www.localpower.org, including links to papers which describe the assumptions underlying the model.