

Centralized and Distributed Generated Power Systems-A Comparison Approach

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A **centralized generated system** has a central location of power being generated before the generated power is transmitted, distributed and therefore made available to consumers. Clearly, power generated at the central station cannot be same as the total sum of power supplied to consumers.

A **distributed generated system** on the other hand has its location closer to power users. This architecture there needs not a transmission network. Hence, losses inherent in DG architecture are far less than CG system.

The objective of this presentation is to evaluate the relative benefits and weaknesses of centralized generation (CG) and distributed generation (DG) in the future electric grid interface.

To embark on development of grid flexibility for the future, research effort is needed to evaluate the potentials of available options amidst the increasing power demand.

To offer criteria for analysis of DG and CG, taking into consideration the reliability, sustainability and resiliency of either grid architecture as well as the possibility to combine the systems for optimal performance.

Enhancing the Reliability of Power Grid through DG:

In consideration of the economies of scale involved for the CG and DG system, combination of both CG and DG would better prove to attain a better scale. In regards to this, consideration should be given to densely populated regions. Either the CG system is installed closer to such densely populated region to minimize losses or a DG is installed at such location to minimize same effect.

With the widespread of increasing power demand, an increasing need for better economies of scale becomes apparent. Most power plants are built due to a number of economic, health & safety, logistic, environmental, geographical and geological factors.

DG and CG Technologies

Reliance on CG will affect the travel and mobility and information transfer during emergency. The supporting infrastructure can be made useless if there is no power supply. The role of DG at this time cannot be underestimated.

The use of DG will minimize the disruption to essential services and hence mitigate disaster and down time of essential services.

Impediments that may affect DG installation include: interconnection charges, application and study fees, insurance, reliability requirements and other charges for application processes which could be time consuming.

Some distributed generation systems are geographically distributed and can be located near to the region of power consumers thus reducing transmission and distribution losses, robust term because of the very large numbers of individual generators and statistical robustness of such a collection compared to centralized generation.

The resilience prevalent in either a CG or DG system is the property associated with the system such that increased or decreased load demand is appropriately compensated with increased or decreased supplied power. The Resilience metric defined as: $R(x, u) = \int_t^n [\sum_{i=1}^n cifi(x, u)]dt$

Sustainability in a CG/DG system would aim at addressing the following: Energy consumption reduction, Reduction of sources of energy waste, Minimization of energy production pollution, and Minimization of life-cycle costs of renewable energy resources. The measure of sustainability is:

$$T(S_r) = P(S_r)(f(S_r))^{-1} = [\sum_{j \in S_r}^n P_j] [\sum_{j \in S_r}^n P_j \sum_{j \notin S_r}^n \lambda_{jr}]^{-1}$$

Economies of Scale in Power Demands

As power demands increase, the ability of the power grid to enhance power reliability becomes indispensable. To ensure power system resiliency, sustainability and reliability, the present grid has diversified the technologies of power production

Marginal Pricing Scale for CG and DG Systems

Hence, a DG system supplying power in same region as a CG has lower congestion charge implying that the DG network is prone to power system stability as against the CG system.

Component Cost	Centralized Generation (CG)	Distributed Generation (DG)
Cost of Capital	Lower Cost per unit	Higher cost per unit Saved cost of system design due to reduced capacity Saved cost of system design due to use of waste heat in cogeneration
Fixed Operation and Maintenance Cost	Higher	Lower
Variable Operation and Maintenance Cost	Lower	Higher
Fuel	Same as DG	Same as CG
Transmission	High voltage transmission is mandatory Far higher unit cost compared to DG	Only distribution required Unit Cost is far lower than CG
Expense for unserved energy	High	Low

Roadmap: A National Research Agenda for Development of the Infrastructure for the Future Electric Grid

Distributed generations can be depicted as attractive energy resource solutions whether in the near future or long-term when the energy supply and capacity challenges becomes critical. There are numerous benefits in the distributed generations. Some of such benefits reiterated include: increased power supply efficiency, reduced line losses, greenhouse gas emissions reduction, decreased distribution and transmission infrastructural spending. With all these benefits coupled with enhanced security, stability and flexibility of the distributed generation, it thus becomes vital to evaluate the roadmap for distributed generations.

A National Research Agenda for Development of the Infrastructure for the Future Electric Grid will include:

- Determination of costs and trades off between CG and DG with respect to control costs, life cycle analysis, and protection and maintenance.
- Introduction of resilience sustainability metric into power systems planning and operation which will help to evaluate stability margin, demand response, reliability issues of the system under resilience.
- Determination of value added CG and DG incentives for renewable energy storage, plug-in cars, ramping, and price response, and demand management in the grid.
- Better use of new tools like phasor measurements, time of day pricing, and other intelligent infrastructure for system support
- Develop better and faster algorithms which include adaptive predictive model and state estimation for better management and planning.
- Development of new curriculum and education to provide human capacity training.