

Generation Expansion Planning

Generation expansion planning consists of finding the optimal long-term plan for the construction of new generation capacity subject to various economic and technical constraints. It usually involves solving a large-scale, non-linear discrete and dynamic optimization problem in a highly constrained and uncertain environment. Traditional approaches to capacity planning have focused on achieving a least-cost plan. Initially, the aim of GEP was to search for the most economical scheme that could provide an adequate supply of electricity to meet the projected demand growth subject to a set of constraints over a planned period of time. The cost function typically included investment, fuel, and generation costs over the entire planning period. New challenges have steadily arisen, which have been gradually incorporated into the GEP problem. Those are:

1. Integration of generation and transmission power system, placing special emphasis on the role of electricity trade
2. Consideration of risk assessment in generation expansion planning
3. Integration of electric vehicles in power systems
4. Integration of long-term GEP with short-term power systems operation
5. Power and natural gas systems interdependence
6. Energy storage and demand-side impacts on GEP and
7. Policy implications on power investments, highlighting the role of supply of security.

Electric vehicles are considered as a separate category for energy storage, due to the fact that electric vehicles stand as a fast-growing, new load that has to be met, while energy storage is organized with demand-side, as they are both options for shifting existing load. There exist several GEP methodologies that tackle more than one of the above categories, however this classification enables organizing GEP methodologies based on their focus, rather than on the methodological framework they adopt.

The renewable energy resources have created new challenges for the GEP problem, due to their stochastic nature. The variability of power generation from renewable energy resources and the uncertainty it creates for the power systems' operation, is expected to be tackled with the integration of electric vehicles and electric storage, which stands as another important challenge of the GEP problem. The evolution of a centralized power system to a smart one with distributed generation and flexible demand is an important challenge of the GEP, thus several methodologies target to integrate the long-term energy planning with both demand-side management and short-term operation of power systems. This integration is usually implemented by incorporating the unit commitment problem into the GEP.