Applied Energy, vol.170, pp.1-21, May, 2016.

An optimization framework for the integrated planning of generation and transmission expansion in interconnected power systems

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Abstract-

Energy, and particularly electricity, has played and will continue to play a very important role in the development of human society. Electricity, which is the most flexible and manageable energy form, is currently used in a variety of activities and applications. For instance, electricity is used for heating, cooling, lighting, and for operating electronic appliances and electric vehicles. Nowadays, given the rapid development and commercialization of technologies and devices that rely on electricity, electricity demand is increasing faster than overall primary energy supply. Consequently, the design and planning of power systems is becoming a progressively more important issue in order to provide affordable, reliable and sustainable energy in timely fashion, not only in developed countries but particularly in developing economies where electricity demand is increasing even faster. Power systems are networks of electrical devices, such as power plants, transformers, and transmission lines, used to produce, transmit, and supply electricity. The design and planning of such systems require the selection of generation technologies, along with the capacity, location, and timing of generation and transmission capacity expansions to meet electricity demand over a long-term horizon. This manuscript presents a comprehensive optimization framework for the design and planning of interconnected power systems, including the integration of generation and transmission capacity expansion planning. The proposed framework also considers renewable energies, carbon capture and sequestration (CCS) technologies, demand-side management (DSM), as well as reserve and CO2 emission constraints. The novelty of this framework relies on an integrated assessment of the aforementioned features, which can reveal possible interactions and synergies within the power system. Moreover, the capabilities of the proposed framework are demonstrated using a suite of case studies inspired by a real-world power system, including “business as usual” and “CO2 mitigation policy” scenarios. These case studies illustrated the adaptability and effectiveness of the framework at dealing with typical situations that can arise in designing and planning power systems.

Index Terms- Optimization framework; Integrated design and planning; Generation and transmission expansion; Interconnected power systems; Reserve and emission constraints

Citation:
Guerra, O.J.; Reklaitis, G.V.; Tejada, D.A. "An optimization framework for the integrated planning of generation and transmission expansion in interconnected power systems", Applied Energy, vol.170, pp.1-21, May, 2016.