

Optimal Power Flow Calculations — Practical Requirements

Brian Stott, 2012

As a sub-technology of electric power systems analysis, optimal power flow (OPF) was introduced half a century ago. In its long journey of development, the OPF calculation is perhaps in mid-life. It has become a standard topic in power systems analysis text books and courses. It has long been a favorite area of small-scale research, typically on mathematical optimization techniques for very simplified OPF problem formulations.

Various industrial-quality OPF programs are now in large-scale use for power system operations/control, markets and planning. In fact, many power systems are already heavily dependent on OPF for their economy-security and market operations. And OPF calculations are increasingly being embedded in bigger power system optimizations, such as security constrained unit commitment and planning tools.

The above suggests that today's principal OPF software products are mature—providing reliable, accurate, versatile mathematical solutions for power systems modeled at any level of detail. But this is simply not the case. The unpleasant truth is that practical OPF problems are still very difficult to solve, and this difficulty increases as power system modeling, constraints and objective functions become more and more realistic.

With few exceptions, OPF technology is still in need of further work, to ensure completely trustworthy power system economy-security solutions. Partly in recognition of this, a number of attempts at developing new commercial-grade OPF methods and software are in progress round the world.

This lecture discusses some key basic requirements for solving practical OPF problems. Such requirements should be of interest to actual or potential OPF engineering users, developers, researchers, teachers, market designers, and regulatory bodies. The talk is based on decades of experience in developing industrial OPF methods and software that have been implemented throughout the world in major utility companies and regional transmission organizations.