Wind Integration Cost and Cost-Causation

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***Abstract*—The question of wind integration cost has received much attention in the past several years. The methodological challenges to calculating integration costs are discussed in this paper. There are other sources of integration cost unrelated to wind energy. A performance-based approach would be technology neutral, and would provide price signals for all technology types. However, it is difficult to correctly formulate such an approach. Determining what is and is not an integration cost is challenging. Another problem is the allocation of system costs to one source. Because of significant nonlinearities, this can prove to be impossible to determine in an accurate and objective way.**

Keywords-wind; integration cost

I. INTRODUCTION

Increasing deployment of wind energy in many parts of the world, coupled with a desire to accurately assess and assign costs to their source, has given much attention to the question of integration costs in the past several years. Although the basic idea appears to be quite simple, it turns out to be much more difficult in practice. The fundamental interest is to estimate the costs that are imposed on the power system for accommodating wind power, consisting primarily of the operational impact of wind power's variability and uncertainty and investments in grid infrastructure. This information is needed on the one hand for policy makers to ensure that the benefits of increasing wind energy will not be offset by negative impacts, and on the other hand for system operators and regulators to ensure fair treatment of all producers when designing market rules, tariffs, and allocation of costs. For policy makers, the integration costs could be compared with the benefits of wind power. For system operators and regulators, it is also important to see how current tariffs take into account these costs, such as network charges (to cover investments in network) and imbalance payments (to cover extra balancing costs). In many regions, wind power producers also pay for direct investment costs for grid connection. To treat wind power producers fairly, the same cost-calculation methodology should also be applied to other generation assets.

Any change in the resource mix, whether in shares of wind power or other forms of generation, will likely result in shifts in total system costs and changes in the costs incurred by other generators. Determining which of these costs are "integration costs" has proven to be surprisingly difficult. Integration costs are not directly observable, and this has resulted in numerous methods to calculate them. The use of different methods means that it is difficult, or impossible, to compare integration costs from different power systems or studies. Allocating integration cost to wind, or to any other technology, is really a policy question, and there may be multiple plausible (but not necessarily correct) ways to do so. Production cost modeling is now quite good at comparing costs between defined future scenarios. The problem is in specifying the scenarios to compare so that integration costs can be determined.

Allocating integration costs to a single resource type is challenging. The principles of cost-causation and methodological challenges to calculating integration costs have been discussed in [1]. Cost-causation-based tariffs provide transparent signals to markets and regulators that, if well defined, provide appropriate incentives for efficient investment and behavior [2]. Common errors and important assumptions in integration cost analyses are reported in [3].

Integration costs, once calculated, are not always applied in the same way. One application is to add the integration cost to the cost of energy from wind power to provide a comparison of wind energy to a more dispatchable technology, such as natural gas. Another application is to use increases in balancing costs or ancillary services in tariffs that aim to allocate the cost of the variability and uncertainty impacts of wind power. However, as wind turbine technology advances so that some ancillary services can be provided by wind power, estimating the need for more ancillary services as a result of wind power is no longer enough. This calls for a more rigorous assessment method that can capture both consumption and provision of ancillary services. Further, a performance-based approach would be technology neutral and provide price signals for all technology types.

In this paper, the focus is first on the issue of operational integration cost. We then discuss total system cost (fixed plus variable). The focus is on total portfolio cost, which can be compared for two or more portfolios. Methods for the estimation of integration costs and benefits are discussed.

II. WHAT ARE INTEGRATION COSTS AND WHY CALCULATE THEM?

The idea of integration costs at first seems quite simple. They are supposed to be the "extra" costs imposed on the power system as it accommodates an unusual resource. Integration costs, once calculated, are sometimes used to compare wind power with some form of conventional power, which presumably has no integration cost itself (we show that may not be true in a later section of this paper). Production cost modeling appears to provide an ideal tool