Construction Cost Overruns and Electricity Infrastructure: An Unavoidable Risk?

An analysis of 401 power plant and transmission projects in 57 countries suggests that costs are underestimated in three out of every four projects, with only 39 projects across the entire sample experiencing no cost overrun or underrun. Hydroelectric dams, nuclear power plants, wind farms and solar facilities each have their own unique set of construction risks.

Benjamin K. Sovacool, Daniel Nugent and Alex Gilbert

Dr. Benjamin K. Sovacool *is Director of the Danish Center for Energy Technologies at AU-Herning and a Professor of Business and Social Sciences at Aarhus University in Denmark. He is also Associate Professor of Law at Vermont Law School (VLS), where he manages the Energy Security and Justice Program at its Institute for Energy and the Environment.*

Daniel Nugent *is a Research Associate at VLS' Institute for Energy and the Environment, primarily providing legal support to the U.S. Department of Energy's SunShot Plug-&-Play Initiative. He is also nearing completion of his J.D./Energy Certificate and a Master's Degree in Environmental Law and Policy.*

Alex Gilbert *is an Energy Analyst at Haynes and Boone, LLP. He received his Master's Degree of Energy Regulation and Law from VLS, where he also served as a Research Associate at the Institute for Energy and Environment.*

I. Introduction

Those outside the construction industry may be surprised to learn that the cost of building power plants has escalated in recent years. The Power Capital Costs Index, which tracks the expense of power plant materials and components, showed an increase in North America by a factor of 2.26 between 2000 and 2013, and in Europe by a factor of 1.93 over the same period (IHS Costs and Strategic Sourcing, 2014). These expenses exclude other ''soft costs'' such as contingency fees, risk premiums, land, and permitting (Severance, 2009). The nuclear energy industry has been particularly hard hit, with material, labor, and engineering costs for nuclear power plants jumping more than the average over the same period, meaning a plant that cost $4 billion to build in 2000 would cost almost $12 billion today (Findlay, 2010).

 1040-6190/$–see front matter http://dx.doi.org/10.1016/j.tej.2014.03.015

But how do the risks of construction cost overruns compare across different forms of electricity infrastructure? How do utility-scale renewable sources of electricity such as wind farms and solar facilities perform compared to thermal plants, nuclear reactors, and hydroelectric dams? Where do high-voltage transmission networks fall on this continuum of overrun risk?

This article answers such questions by exploring initial construction budgets and final costs associated with 401 separate power plant and transmission projects, spread across 57 countries, representing nearly $820 billion worth of investment and 325,515 MW of installed capacity. We find that although costs are underestimated in three out of every four projects, the frequency and magnitude of those overruns differ substantially by size, location, and fuel source, as **Figure 1** summarizes.

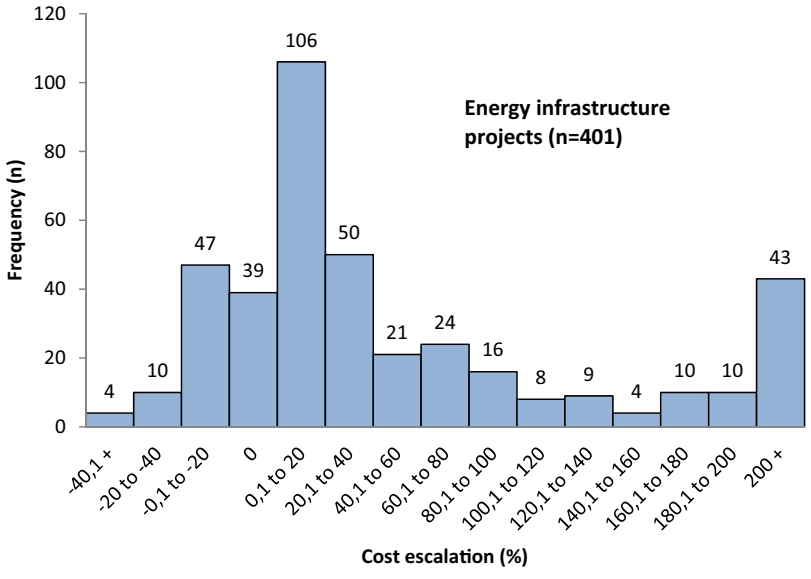

Figure 1: Frequency and Cost Escalation of Electricity Infrastructure Projects

Independent of their type, we conclude that construction costs for electricity projects are difficult to predict, as only 39 projects across the entire sample were completed at or under budget. We also find that hydroelectric dams, nuclear power plants, wind farms, and solar facilities each have their own unique set of construction risks, which we elaborate on below.

II. Research Methods

In defining the scope of this study, we first decided to limit our assessment to electricity infrastructure, given that transportation projects have already been assessed extensively by Flyvbjerg and his colleagues, who compiled a database of 258 transportation infrastructure projects worth $90 billion (Flyvbjerg et al., 2002, 2004). Secondly, we decided to investigate only actually completed utility-scale projects greater than 1 MW in size. This excluded forms of distributed generation such as fuel cells and Stirling engines, smaller-scale generation sources such as diesel generator sets and microhydro dams, and projects canceled or still under construction in late 2013 and early 2014. As locating reliable data for both the original cost estimate *and* the actual cost of a project was surprisingly difficult, we choose not to confine our data collection to any geographical area or period of time in order to make our database as large, and robust, as possible.

To begin collecting data, we first searched the energy, electricity, transport, and infrastructure literature for reliable peer-reviewed data, which we did find in a few instances (Flyvbjerg et al., 2002, 2004; De Bondt and Makhija, 1988; Marshall and Navarro, 1991; Grubler, 2010; Ansar et al., 2014; Bacon and Besant-Jones, 1998). However the rest we compiled ourselves by searching hundreds of project documents, press releases, and reports (Appendix I). We only included a project in our database when we could find complete information regarding:

- The year the project entered service;
- Its geographic location;
- Its name;
- Its size in installed capacity (in MW or kV);
- Its estimated or quoted construction cost;