Journal of Cleaner Production xxx (2016) 1–12

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Considering risks in early stage investment planning for emission abatement technologies in large combustion plants

Carmen Mayer [a, *], Patrick Breun [a], Frank Schultmann [a, b]

[a] Karlsruhe Institute of Technology (KIT), Institute for Industrial Production (IIP), Chair of Business Administration, Production and Operations Management, Hertzstrasse 16, 76187 Karlsruhe, Germany
[b] University of Adelaide Entrepreneurship, Commercialisation and Innovation Centre (ECIC), Adelaide, SA 5005, Australia

ARTICLE INFO

Article history:
Received 22 October 2015
Received in revised form
1 February 2016
Accepted 15 May 2016
Available online xxx

Keywords:
Emission abatement
Risk portfolio
Real option analysis
Large combustion plant
Nitrogen oxide emission
Investment decision

ABSTRACT

Fossil fuels will continue to be the most important energy source for electricity generation in most parts of the world for the next decades. Therefore emission abatement technologies in large combustion plants are an important measure to reduce the emission of pollutants and to lower the negative effects thereof for humans, animals and the environment. Investment decisions for emission reduction measures are, however, facing various kinds of risks and uncertainties, caused by political, technological, economic and legal influences. The consideration of these risks in early stage investment planning is often complex yet important for investors. This paper investigates the possibilities to consider risks and uncertainties in early stage investment and cost calculation methodologies of different complexity. The real options analysis is presented as well as less complex methods, such as Monte-Carlo or sensitivity analyses that lower the calculation effort. The application of a specifically developed risk portfolio is recommended before quantitatively investigating risks. This portfolio helps to identify the most critical risks and to focus on them, reducing again the calculation effort. The presented approach is not only of interest for investors, but also for policies, especially if data is scarce or uncertainties exist regarding specific plant parameters or cost and price components. The content of this paper is presented using the example of nitrogen oxide emission reduction measures. It is, however, possible, to transfer the results to other pollutants or technologies in a related context.

1. Introduction

The public image of fossil energy generation suffered a lot over the last decades, due to the discussions on limited resources, pollutant emission and climate change. Nevertheless, in most regions of the world, combustion of fossil fuels is and will stay an economic way to meet the energy demand for the next decades (US EIA, 2015a). The statistics of the US Energy Information Administration (US EIA, 2015b) show that while the worldwide electricity consumption has been rising by 40% during the last ten years, the amount of electricity generated from fossil fuels has not only grown in an absolute manner but also in its relative share. In 2002 the worldwide share of fossil electric energy added up to 65%; in 2012 it reached a level of 67%. Yet local discrepancies are huge, for example between OECD and Non-OECD countries. In the OECD region the growth rate of fossil fuelled electricity generation between 2002 and 2012 amounted to 8%, while renewable energy increased by 40% and nuclear power generation declined by 15%. In the rest of the world, fossil generation grew by more than 96%, showing the highest growth rate compared to renewable and nuclear generation (US EIA, 2015b).

To lower the environmental damage of the rising energy demand, air emissions of environmentally critical pollutants need to be reduced. A large amount of fossil fuels is transformed into electricity and heat in Large Combustion Plants (LCP).[1] Therefore, emission reduction measures for these plants are an important instrument for global environmental protection programmes. On the other hand, energy is a very important cost driver for many industries. Emission reduction measures in fossil fuelled LCP are often end-of-pipe-technologies, or so called secondary measures.

* Corresponding author.
E-mail address: carmen.mayer@kit.edu (C. Mayer).

[1] LCP are defined as combustion installations with a rated thermal input exceeding 50 MW (European Commission, 2006).

http://dx.doi.org/10.1016/j.jclepro.2016.05.089
0959-6526/