International Journal of Greenhouse Gas Control 10 (2012) 181–190

Contents lists available at SciVerse ScienceDirect

International Journal of Greenhouse Gas Control

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

Understanding the pitfalls of CCS cost estimates

Edward S. Rubin*

Carnegie Mellon University, Pittsburgh, PA 15213, USA

ARTICLE INFO

Article history:
Received 16 March 2012
Received in revised form 30 May 2012
Accepted 4 June 2012
Available online 10 July 2012

Keywords:
Carbon sequestration
Cost methods
Avoidance cost
CO_2 capture and storage

ABSTRACT

This paper reviews and compares the prevailing methods, metrics and assumptions underlying cost estimates for CO_2 capture and storage (CCS) technologies applied to fossil fuel power plants. This assessment reveals a number of significant differences and inconsistencies across different studies, not only in key technical, economic and financial assumptions related to the cost of a CCS project (such as differences in plant size, fuel type, capacity factor, and cost of capital) but also in the underlying methods and cost elements that are included (or excluded) in a particular study (such as the omission of certain "owner's" costs or the cost of transport and storage). Such differences often are not apparent in the cost results that are reported publicly or in the technical literature. In other cases, measures that have very different meanings (such as the costs of CO_2 avoided, CO_2 captured and CO_2 abated) are all reported in similar units of "dollars per ton CO_2". As a consequence, there is likely to be some degree confusion, misunderstanding and possible mis-representation of CCS costs. Given the widespread interest in the cost of CCS and the potential for lower-cost CO_2 capture technology, methods to improve the consistency and transparency of CCS cost estimates are needed.

1. Introduction and objectives

Carbon dioxide capture and storage (CCS) is a potentially critical technology for mitigating global climate change, but its current cost is a major barrier to applications at power plants and other large industrial sources of CO_2 (NRC, 2010; IEA, 2011; GCCSI, 2011). Efforts are thus underway worldwide to develop new lower-cost technologies, especially for CO_2 capture—the costliest component of a CCS system (IPCC, 2005; Figueroa et al., 2008; Rubin et al., 2012). Given its potential importance in reducing greenhouse gas emissions, information on CCS costs is sought by a broad range of actors in government, industry and other organizations for purposes of policy analysis, investment decisions, technology assessments, R&D activities, and energy-environmental policy-making, including development of legislation and regulations involving CCS.

Yet, as this paper will show, there are significant differences and inconsistencies in the way CCS costs are currently calculated and reported by various authors and organizations. The major objective of this paper, therefore, is to highlight key methodological issues related to CCS cost estimates, including the specification of project scope, terminology, calculation procedures, and the items included (or excluded) in reported CCS costs. The paper also discusses the various measures of CCS cost that are commonly sought and reported, and identifies some of the critical (and sometimes controversial) assumptions underlying such estimates. Also discussed are how or whether CCS costing methods treat such issues as the level of technological maturity, technological change over time, and the vintage of facility analyzed (e.g., new vs. retrofitted plants). Issues related to uncertainty, variability and bias in assumptions and data also are discussed.

2. Cost measures and metrics

A variety of measures are used in the literature to report the cost of CO_2 capture and storage systems, as well as other CO_2 reduction measures. The most common metrics include the cost of CO_2 avoided; cost of CO_2 captured; cost of CO_2 abated (or reduced); and the increased cost of electricity (for studies related to power plants) (IPCC, 2005). As discussed below, the first three of these measures have very different meanings, but because all three are reported in similar units of "dollars (or other currency) per ton CO_2" there is significant potential for misunderstanding. Similarly, the metric of increased cost of electricity also is used in different contexts. Users of these CCS cost measures must therefore be careful to clearly understanding their meaning.

2.1. Cost of CO_2 avoided

The cost of CO_2 avoided is one of the most commonly reported measures of CCS cost (e.g., IPCC, 2005; EPRI, 2009; NETL, 2010; Finkenrath, 2011; GCCSI, 2011). It compares a plant with CCS to a "reference plant" without CCS, and quantifies the average cost of

* Tel.: +1 412 268 5897.
E-mail address: rubin@cmu.edu

1750-5836/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ijggc.2012.06.004