1 INTRODUCTION

1.1 Starting point and problem definition

Almost 40 years after the recognition of the negative impact of human behavior on climate,[1] the Major Economies Forum on Energy and Climate (MEF) has declared climate change one of the greatest challenges at the present time.[2] Based on the scientific view that, at very high confidence, the global average net effect of human activities since 1750 has led to climate warming,[3] low carbon development is seen as indispensable for future sustainable development. Nationally appropriate GHG mitigation actions and the implementation of low carbon growth plans are seen as measures to prevent an increase in global average temperature above pre-industrial levels by more than two degrees Celsius (°C).[4]

A prior milestone towards this goal was already set in 2005, when the Kyoto protocol came into force.[5] The participating developed countries committed to a GHG emission reduction of 5.2 % on average until 2012 based on 1990 levels. The CDM, one of the protocol's flexible mechanisms, was initiated as a market mechanism to generate cost effective emission reductions while contributing to local sustainable development in the host country.[6] It enables EU-ETS compliance companies to fulfill part of their GHG emission reduction obligation in developing countries at potentially lower cost compared to measures within the home country.

Based on the number of initiated projects and generated CERs, the CDM has experienced significant growth over the last five years. As of October 2010, more than 5,000 CDM projects were at the validation stage or already registered with the UN. Emission reductions of about 440 Mt carbon dioxide equivalents (CO_2e) were achieved and CERs issued to CDM project participants.[7] However, the inconclusive outcome of Copenhagen's climate conference at the end of 2009 has led to uncertainty about the future CER application in a post-Kyoto scenario and has blurred recent CDM growth.[8]

[1] The UN conference on Human Environment in Stockholm in 1972 dealt with human-made GHG effects for the first time. (Bräuer, Kopp, & Rösch, 1999, p. 31)

[2] (MEF, 2009, p. 1)

[3] (IPCC, 2007a, p. 3)

[4] (MEF, 2009, p. 2)

[5] (UNFCCC, 1998)

[6] (UNFCCC, 1998, Article 12, Paragraph 2), (UNFCCC, 1992, Article 3)

[7] (UNEP Risoe, 2010a)

[8] (UNFCCC, 2009a, pp. 2-4)

This was reinforced through the negative impact of the financial crisis resulting in investors moving their capital away from CDM investments towards safer assets and markets.[9]

While there are some studies on the CDM target to achieve sustainable development in host countries,[10] a comprehensive analysis of CDM cost effectiveness is not yet available.[11] Publicly accessible information on negotiated CER prices between investors and project hosts do not serve as an indication of CDM cost effectiveness. CER prices are typically negotiated on the basis of current or future market price settings while the CDM origination cost and the project host’s financial gains are not disclosed.[12]

The minimum CER price required for financial viability of the project idea can serve as a measure for CDM cost effectiveness. Available data from ex ante CDM project documentation can be applied for calculation of the CER price floor in a deterministic, risk-free scenario. As CDM projects are located in developing countries, they are exposed to a variety of CDM process and financial risks.[13] On the one hand, considering all registered CDM projects, current actual CER output is at about 75 % of planned number of CERs.[14] On the other hand, financial parameters like invested capital and operating & maintenance (O&M) costs might deviate from planned figures. To provide an expectation for CER prices for CDM cost effectiveness, the deterministic CER price floor would need to be adjusted to financial impact from associated project risks. This leads to the scientific question of the monetary assessment of risk influence on CDM cost effectiveness which is addressed in this study.

Transparency of CER floor prices and associated risk premiums for different combinations of project types and host countries is highly valuable for EU-ETS compliance investors. It not only contributes to an improved negotiation position to project hosts, but also enables a ranking of CDM project types and host countries according to their financial attractiveness. Measures can be defined to address identified risks. Therefore transparency from analysis results also contributes to the inherent target of the CDM to steer investment into most cost effective GHG emission reduction projects.

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[9] (Kossoy & Ambrosi, 2010, pp. 1-2)

[10] A good overview is provided by Olsen (2007). Seres (2008) focuses on the technology transfer through CDM. (Olsen, 2007, p. 67), (Seres, 2008)

[11] For an overview of available research about CDM cost effectiveness see Chapter 3.2.

[12] (IETA, 2010)

[13] To provide an example of risk impact, in 2009, Austrian Kommunalkredit had to take four CDM projects out of its 44 project portfolio due to unexpected project terminations. In October 2010, UK listed fund Trading Emissions had to cut its CDM portfolio by 25% of CERs until the end of 2012 mainly due to slower than expected UN registration. (Kommunalkredit, 2010, p. 26), (Allan, 2010, pp. 1-3)

[14] (UNEP Risoe, 2010b)

1.2 Target and approach

The target of this study is to fill the scientific gap introduced in Chapter 1.1 and to develop a model for CDM cost effectiveness analysis taking account of risk from the EU-ETS compliance investor's perspective. The model is designed to integrate the financial impact of project risks and to provide a CER price expectation for CDM cost effectiveness on a project cluster specific level.[15] Model results should culminate in a statistical analysis of CDM cost effectiveness taking risks into account for every project cluster to provide reliable decision support for the comparison of project clusters' CER price floors. The study follows the structure shown in Figure 1. Indicated numbers represent Chapter numbers.

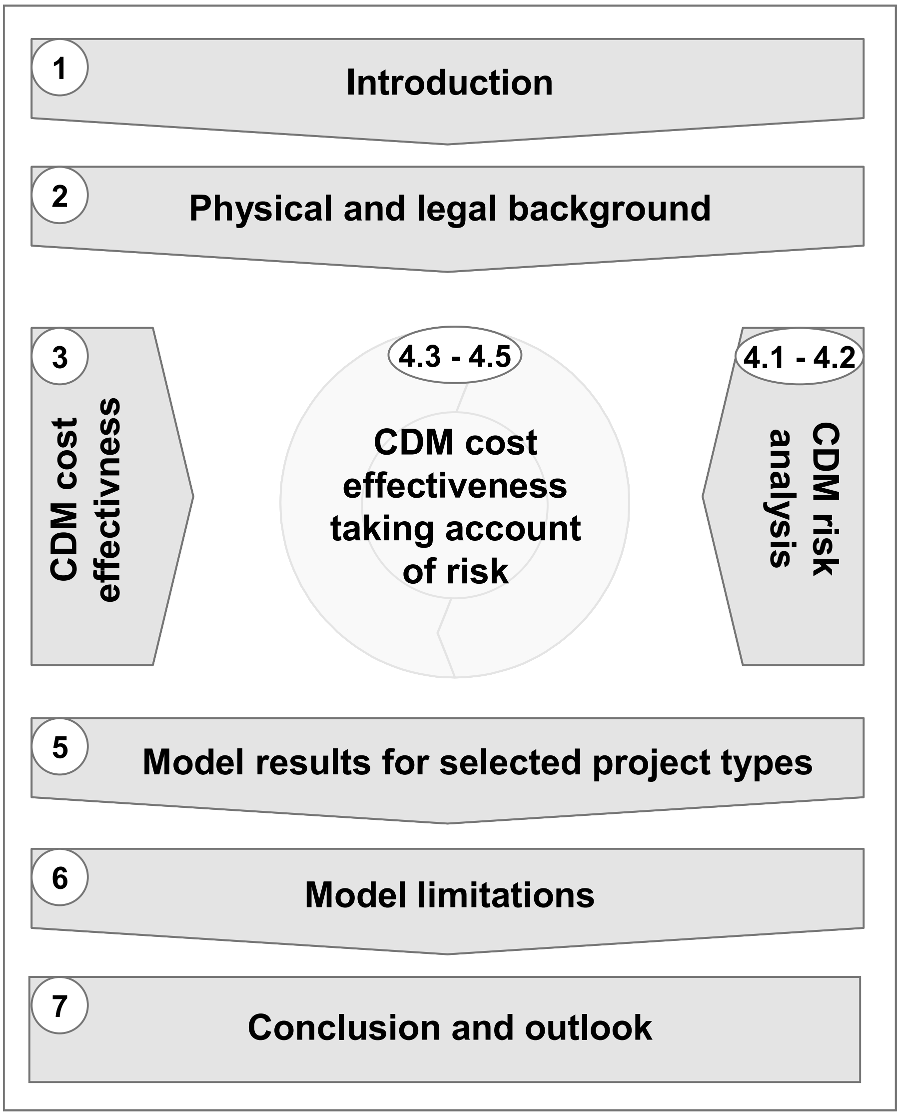

Figure 1: Structure of the present study

[15] A CDM project cluster comprises of a CDM project type and host country.

Following the introduction, the physical background of GHG emissions is provided together with the relevant legal frameworks regarding the EU-ETS and CDM. This includes the presentation of the CDM project cycle. CDM cost effectiveness is defined in the third Chapter. Available studies on CDM cost analyses are introduced and relevant parts applied for definition of a model for a deterministic calculation of CER prices for CDM cost effectiveness.[16] Chapters 4.1 and 4.2 deal with a definition of risk and a literature research on recent studies regarding CDM risk analysis. CDM risk factors are the basis for a simulation based risk evaluation model in Chapters 4.3 and 4.4. Probability distribution functions are modeled for all risky input factors. Chapter 4.5 combines both the CDM cost effectiveness and the risk evaluation model in one framework for an assessment of CDM cost effectiveness taking account of risk. The simulation approach is fully integrated so that model iterations result in a distribution function for CER floor prices for every project cluster. The monetary impact from risk on CDM cost effectiveness is derived from the comparison of the deterministic and the expected CER floor price.

In Chapter 5, deterministic CDM cost effectiveness and CDM cost effectiveness taking account of risk are exemplarily analyzed for the application of the project types wind power, LFG power generation, and WHR from cement kiln in selected countries. Differences between expected CER floor prices taking risks into account and deterministic CER floor prices indicate the risk premium per project cluster.

Chapter 6 deals with the limitations of the developed model and critically considers its results. The final Chapter concludes and provides indications for promising future research.

[16] In the deterministic model, each variable and parameter is assigned a fixed number for any given set of conditions. If a variable is related to a data series, the average of values is applied. The reverse of the deterministic model is the probabilistic model developed in Chapter 4. (Haimes, 2009, p. 59)