Economy

Johannes Herold

Microeconomic analysis of investment incentives under emission control

The case of carbon capture and storage

Diploma Thesis

Bibliographic information published by the German National Library:

The German National Library lists this publication in the National Bibliography; detailed bibliographic data are available on the Internet at http://dnb.dnb.de .

Imprint:

ISBN: 9783640347278

This book at GRIN:

https://www.grin.com/document/129016

Johannes Herold

Microeconomic analysis of investment incentives under emission control

The case of carbon capture and storage

GRIN Verlag

TECHNICAL UNIVERSITY of DRESDEN
FACULTY of BUSINESS and ECONOMICS

CHAIR of ENERGY ECONOMICS and
PUBLIC SECTOR MANAGEMENT

Diploma Thesis

Microeconomic Analysis of Investment Incentives under Emission Control
The Case of Carbon Capture and Storage

Submitted by: Johannes Herold

Dresden, August 2008

Abstract

The Kyoto Protocol has first set a price on carbon dioxide emission (CO_2). Participating economies are obliged to limit those emissions, with CO_2 emitting firms now facing an additional constraint in their profit maximization. The energy sector is, due to its nature, particularly afflicted. The combustion of fossil fuels emits massive amounts of CO_2 which need to be covered by means of limited emission permits. So in addition to the scarcity of fuel comes the scarcity of those allowances. Both increases pressure on electricity suppliers to switch to renewable or low carbon electricity production.

Coal is the fossil fuel which on the one hand is provided with the largest reserves (thus assuring future fuel availability at comparably low costs) but is on the other hand emitting the largest amount of CO_2 per MWhel. Therefore, technologies to capture and store that CO_2 are under development. Those technologies come with significantly higher capital cost for the plants and high energy losses in generation. Consequently, high carbon prices are required to incentivize investment into that innovative technology.

But the adoption and diffusion of innovations is not only a question of financial incentives. As on other markets, the market for innovation is characterized by potential failures which may impede or prevent the successful diffusion of advanced technologies.

The following thesis first provides an overview about the innovative technologies to capture CO_2 from large scale sources just reaching demonstration phase. Second, innovation from an industrial organizational point of view is analyzed. The focus here is set on market failures for innovation, in particular with respect to market failures which interact with failures on the market for pollution control.

Third, a model is introduced which simulates the adoption and diffusion of Carbon Capture and Storage (CCS) in a two player Cournot game. The producers are subject to emission control and can choose among several technologies to comply with that constraint.

The analysis shows that producers prefer a significant reduction in output and profit instead of investing into the expensive technology. The situation changes as nuclear energy production is phased out and learning effects are introduced. This indicates that a switch to environmentally friendly technologies needs strong policy support by stringent emission limits as well as by R&D support and public financed demonstration projects. Those can help to overcome early technical difficulties and assure that all marketers have access to that knowledge.

In extreme cases in which one player is initially equipped with a high share of coal while the other is nuclear based, no symmetric market shares develop. Then, despite being subject to a higher level of emission control, the fossil fuel based player dominates the market over a long time.

Table of Contents

List of Figures

List of Tables

Abbreviations

°C	Degrees Celsius
C	Carbon
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
d	Day
ECBR	Enhanced Gas Recovery
EGR	Enhanced Coal-Bed Methane Recovery
EOR	Enhanced Oil Recovery
et al.	And Others
ETS	European Emission Trading Scheme
EU	European Union
F.e.	For Example
G	Giga
GAMS	General Algebraic Modeling System
GHGs	Greenhouse Gases
GWh	Gigawatt Hours
h	Hour
H_2O	Water
HTFC	High temperature Fuel Cell
IEA	International Energy Agency

IGCC	Integrated Gasification Combined Cycle
IPCC	International Panel on Climate Change
K	Kilo
Kg	Kilogram
Kt	Kilo Tons
LNG	Liquified Natural Gas
M	Mega
MEA	Monoethanolamine
MPa	Mega Pascal
M€	Million Euro
Mt	Mega Tons
MW	Mega Watt
MWh	Mega Watt Hours
MWh_{el}	Mega Watt Hours electric
MWh_{th}	Mega Watt Hours thermic
NO_x	Nitrogen oxides
O_2	Oxygen
OECD	Organization for Economic Co-operation and Development
PC	Pulverized Coal
ppm	Parts per Million
R&D	Research & Development
R&D3	Research, Development, Demonstration and Deployment
RJV	Research Joint Venture
SOFC	Solid Oxide Fuel Cell
SO_x	Sulphur Oxides
T	Terra
Toe	Tons of Oil Equivalent
US	United States
W	Watt
yr	Year