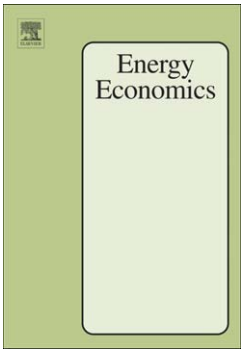

Deep Transformations of the Energy Sector: A Model of Technology Investment Choice

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PII: S0140-9883(18)30017-3
DOI: doi:10.1016/j.eneco.2018.01.009
Reference: ENEECO 3883

To appear in: *Energy Economics*

Please cite this article as: Landis, Florian, Rausch, Sebastian, Deep Transformations of the Energy Sector: A Model of Technology Investment Choice, *Energy Economics* (2018), doi:10.1016/j.eneco.2018.01.009

Deep Transformations of the Energy Sector: A Model of Technology Investment Choice

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January 11, 2018

Abstract

Economy-energy equilibrium models have emerged as a dominant tool to investigate future pathways taking into accout technological aspects, economic behavior, markets, and policy. A challenge for any model is to represent situations which involve large departures from a benchmark mix of energy technologies which would be associated with "deep" transformations of the energy sector (e.g., energy mix with a high penetration of renewables or near-complete decarbonization). This paper proposes a model which differentiates technologies at the level of investments and which is capable of representing large shifts in the market shares of competing technologies that produce a homogeneous energy good (e.g., electricity). We compare the partial equilibrium properties of the proposed technology investment choice model with the standard approach for modeling technology competition based on product differentiation. We also embed both approaches in a numerical general equilibrium multi-sector Ramsey growth framework. We find that the technology investment choice model overcomes some important limitations of the standard approach and is more suited to accommodate large changes in market shares of energy technologies in response to highly stringent energy and climate policy.

Keywords: Modeling Electricity Supply, Technology choice, Investment differentiation, Constant elasticity of transformation, Energy sector transformation
JEL: Q43, D92, C68

1. Introduction

Coping with the major challenges related to fossil fuels—limiting carbon dioxide (CO_2) emissions to mitigate global climate change, lowering local air pollution to yield health benefits, and enhancing the security of energy supply—will require drastic future changes in the mix of energy technologies to reduce the current reliance on fossil fuels and to deploy other, potentially renewable, forms of energy. To this end, it is crucial to enhance our understanding both of how the evolution of market shares of competing energy technologies is determined and how the future technology mix responds to incentives from energy and

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