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Long-term climate policy implications of phasing out fossil fuel subsidies

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HIGHLIGHTS

- We assess implications of phasing out fossil fuel subsidies on the mitigation of climate change.
- The removal of subsidies leads to a net-reduction in the use of energy.
- Emission reductions contribute little to stabilize greenhouse gases at 450 ppm if not combined with climate policies.
- Low carbon alternatives may encounter comparative disadvantages due to relative price changes at world markets.

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ABSTRACT

It is often argued that fossil fuel subsidies hamper the transition towards a sustainable energy supply as they incentivize wasteful consumption. We assess implications of a subsidy phase-out for the mitigation of climate change and the low-carbon transformation of the energy system, using the global energy–economy model REMIND. We compare our results with those obtained by the International Energy Agency (based on the World Energy Model) and by the Organization for Economic Co-Operation and Development (OECD-Model ENV-Linkages), providing the long-term perspective of an intertemporal optimization model. The results are analyzed in the two dimensions of subsidy phase-out and climate policy scenarios. We confirm short-term benefits of phasing-out fossil fuel subsidies as found in prior studies. However, these benefits are only sustained to a small extent in the long term, if dedicated climate policies are weak or nonexistent. Most remarkably we find that a removal of fossil fuel subsidies, if not complemented by other policies, can slow down a global transition towards a renewable based energy system. The reason is that world market prices for fossil fuels may drop due to a removal of subsidies. Thus, low carbon alternatives would encounter comparative disadvantages.

1. Introduction

In 2009, G20 leaders committed to “rationalize and phase-out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption” (G20, 2011). Despite this commitment, subsidies to fossil fuels continue to grow reaching about 523 billion USD in 2011 (WEO, 2012). Motivations for these governmental expenditures range from energy security concerns to supporting domestic production and job markets, alleviating energy poverty, and redistributing wealth (Porter, 2020; Koplow et al., 2010; WEO, 2010; del Granado et al., 2012; OECD, 2012). However, by distorting markets and discouraging the production and use of clean energies, fossil fuel subsidies do not only cause economic inefficiencies but they may also hamper a transition towards a sustainable provision of energy.

In this paper, we aim to answer two questions: (1) To what extent can a phase-out of fossil fuel subsidies pave the road towards the stabilization of greenhouse gas emissions? (2) To what extent can a phase-out of fossil fuel subsidies trigger a transition of the energy system towards a clean and sustainable provision of energy? We answer these questions by analyzing scenarios that span two policy dimensions – a varying degree of phasing out fossil fuel subsidies in combination with varying degrees of climate stabilization policies.

Due to the difficulty in identifying, collecting, and measuring fossil fuel subsidy data, attempts to quantify global benefits from phasing out fossil fuel subsidies were made only recently. A milestone is the database published by the International Energy Agency (2013), which includes data for consumer subsidies in 37 countries for coal, natural gas, oil, and electricity. This large data set can be used to study scenarios for the phase-out of fossil fuel subsidies with the help of integrated assessment models. Currently, two models have provided an analysis of such scenarios. The first model is the OECD's world general equilibrium model ENV-Linkages that has provided the background analysis for the

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Table 1
Comparison of ENV-Linkages, the World Energy Model, and REMIND. See also Appendix A.1 for further details.

Feature	ENV-linkages	World Energy Model	REMIND
Time horizon	2001–2050	2010–2035	2005–2100
Regional coverage	12 regions	25 regions	11 regions
Sectoral coverage	25 economic sectors	15 economic sectors	10 final energy types
Type of model	Recursive-dynamic computable general equilibrium, myopic agents, some trend projections	Simulation of energy markets, no foresight apart from trend projections	Inter-temporal optimization, perfect foresight
Model objective	Static maximization of producer profit and consumer welfare	Least-cost approach to meet energy service demand	Dynamic max. of global welfare, Pareto-optimum among regions
Population	UN 2006/2008, medium project	UN 2010, medium projections	UN 2010, medium projections
Global GDP growth	3.5% (2005–2050)	3.5% (2010–2035)	3.9% (2010–2035), 3.5% (2005–2050)
Final energy demand	Based on existing energy infrastructure, demand met by the least cost approach, AEE tuned to meet WEO	Based on existing energy infrastructure, demand met by the least-cost approach	Short-/mid-term: tuned to meet Current Policies Scenario of WEO 2010, long-term: regional trend proj. for end-use sectors
GHG emissions	Full basket of Kyoto gases	CO_2 only, can be linked to ENV-linkages for non-CO_2	Full basket of Kyoto gases
Production	Perfect markets with CRS-technology (nested CES)	Energy market equilibrium	Perfect markets with CRS-technology (nested CES)
Capital accumulation	Solow–Swan neoclassical growth model	–	Solow–Swan neoclassical growth model
Investment dynam.	Old (lower substitution between factors) and new capital vintages, implies longer adjustment of quantities to price changes, increasing weight to services	Capacity additions based on changes in peak demand to previous year, retirement, and governmental policies; increasing weight to services	Vintages for energy supply technologies, adjustment costs for acceleration of capacity expansion
Share of technologies	Determined by relative prices, depending on substitution elasticities	Determined by regional long-run marginal costs (Logit and Weibull functions)	Determined by relative prices, depending on substitution elasticities
Price development	Exogenous trends	Exogenous trends	Endogenous
International trade	Bilateral, Armington-trade	No information	To and from a global pool

G20 initiative on removing fossil fuel subsidies (Burniaux and Chateau, 2011). Related to that, Burniaux et al. (2011) take a closer look into terms-of-trade implications. The second model is the World Energy Model (International Energy Agency, 2012) on which the analysis in the World Energy Outlook 2010 and 2011 is based (WEO, 2010, 2011).

There are large and partly intrinsic uncertainties inherent in modelling the global energy–economy system and its interlinkages with the climate system. These circumstances strongly suggest to compare results across a variety of models instead of looking at single model results, only. Thereby, the confidence into the robustness of result can be strengthened. This is even more important as this class of models cannot be validated (Oreskes et al., 1994). Using the integrated assessment model REMIND, we study the impacts of phasing out fossil fuel subsidies in light of an intertemporal energy–economy model with perfect foresight (Leimbach et al., 2010; Luderer et al., 2012a,b; Bauer et al., 2012).

The structure of this paper is as follows. In Section 2 we compare the model frameworks of REMIND, ENV-Linkages, and the World Energy Model and we describe our scenario set-up for studying the impact of phasing out fossil fuel subsidies. Section 3 discusses and compares results with those obtained by the two other models. The focus is on short- and long-term implications for the mitigation of climate change and a low-carbon transition of the energy system. Finally, we conclude, linking the results of our study to current policy initiatives.

2. Comparison of modelling frameworks and scenario set-up

2.1. REMIND compared to ENV-linkages and the World Energy Model

The global energy–economy system with linkages to the climate system is a complex system involving large uncertainties. These uncertainties do not only lie in historical data, interpretations of past and present developments, or limited knowledge of the best level of spatial and sectoral coverage. But uncertainties also concern fundamental laws governing the development of the socio-economic system. Therefore, and due to computational limitations, modelling teams have to make a multitude of choices and assumptions when modelling the global energy–economy system, refer e.g. to van Vuuren (2009) for a concise overview about challenges and different modelling approaches.

Here we provide an analysis of the effects of phasing out fossil fuel subsidies based on the REMIND model.[1] This model uses a different modelling approach than ENV-Linkages and the World Energy Model, refer to Table 1 as a basis for the comparison. A key difference is the assumption of myopic behaviour in the World Energy Model and in ENV-Linkages, whereas REMIND features perfect foresight. Furthermore, model objectives are distinguished in the following: ENV-Linkages is set-up to maximize producer profits and consumer welfare in a recursive-dynamic mode. The World Energy Model follows a least-cost approach to satisfy energy service demand. REMIND's objective is to maximize intertemporal welfare at the global level. It should also be pointed out that only in REMIND prices develop endogenously, determined by short- and long-term scarcities.

2.2. Data basis for fossil fuel subsidies

Fossil fuel subsidies come in different types targeting consumers and/or producers. They occur, e.g. as direct financial transfers, tax credits or tax exemptions, trade restrictions, reduced prices for energy-related services, or as governmental interventions in the energy market. The consequence of fossil fuel

[1] For the documentation of REMIND refer to Luderer et al. (2013).