



Universiteit
Leiden
The Netherlands

Untangling the web : integrating energy and environmental policy instruments by assessing their interactions along power systems

Simões, S.

Citation

Simões, S. (2013, September 4). *Untangling the web : integrating energy and environmental policy instruments by assessing their interactions along power systems*. Retrieved from <https://hdl.handle.net/1887/21628>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/21628>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/21628> holds various files of this Leiden University dissertation.

Author: Simões, Sofia

Title: Untangling the web : integrating energy and environmental policy instruments by assessing their interactions along power systems

Issue Date: 2013-09-04

**Untangling the web: Integrating energy and
environmental policy instruments by assessing
their interactions along power systems**

© 2013 by Sofia Simões, except for the Chapters 2 to 6. Copyright of these chapters belong to the publishers as noted at the beginning of each chapter.

Untangling the web: Integrating energy and environmental policy instruments by assessing their interactions along power systems

PhD Thesis University of Leiden, The Netherlands
Printed by Wöhrmann Print Service

ISBN 978-90-902-770-4

Untangling the web: Integrating energy and
environmental policy instruments by assessing their
interactions along power systems

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van de Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op woensdag 4 september 2013
klokke 10.00 uur

door

Sofia Simões

geboren op 17 september 1974
te Coimbra, Portugal

Promotiecommissie:

Promotor:

Dr. G. J. Kramer, Universiteit Leiden

Co-promotor:

Dr. G. Huppes, Universiteit Leiden

Second promotor:

Prof. Dr. J. Seixas, New University of Lisbon

Overige leden:

Dr. E. Worrell, Universiteit Utrecht

Dr. B. van der Zwaan, Energy research Centre of the Netherlands (ECN)

Prof. Dr. R. Friedrich, Stuttgart University

This work has been made possible by the financial support in the form of a scholarship grant reference SFRH/BD/14060/2003 from the Portuguese Foundation for Science and Technology of the Ministry of Science.

Contents

1	General Introduction	13
1.1	The need for environment and energy policy integration.....	15
1.2	Striving for energy and environment policy integration.....	21
1.3	Methods for policy evaluation and assessment of interactions between instruments	24
1.4	The Portuguese case-study.....	26
1.5	Research questions and Thesis Outline	28
1.6	References.....	30
2	A tangled web: assessing overlaps between energy and environmental policy instruments along the electricity supply chain*	39
2.1	Introduction.....	41
2.2	Background for non-coordination of energy and environmental policies and related studies	44
2.2.1	Why energy and environment policy instruments are not integrated	44
2.2.2	State of the art.....	47
2.3	Tangled web – energy and environment policy instruments in place in electricity systems.....	49
2.4	Assessing overlaps and co-effects between policy instruments	53
2.4.1	Concept of overlaps and of co-effects of policy instruments.....	53
2.4.2	Framework to assess overlaps and co-effects	54
2.5	Towards integration of energy and environment policy instruments	64
2.5.1	Structuring trade-offs	65

2.5.2	Improving the current policy making	67
2.6	Conclusions	68
2.7	Appendix A.....	71
2.8	References	77
3	Cost of energy and environmental policy in Portuguese CO ₂ abatement – scenario analysis to 2020*	83
3.1	Introduction	85
3.2	TIMES_PT model	87
3.2.1	TIMES_PT Model structure	88
3.2.2	Energy and materials demand projection.....	90
3.2.3	Other exogenous information inputs	93
3.2.4	Calibration and validation	94
3.3	Energy and environment policy scenarios.....	96
3.4	Results and discussion	99
3.4.1	Marginal abatement cost curve	99
3.4.2	Primary and final energy demand for the +10%, 0% and -30% CO ₂ emission caps.....	109
3.4.3	Sector abatement for the +10%, 0% and -30% CO ₂ emission caps 110	
3.4.4	Sensitivity analysis.....	113
3.5	Conclusions	115
3.6	Appendix – Other Exogenous information inputs included in TIMES_PT	118
3.7	References	121

4	The Savings of Energy Saving: Interactions between energy supply and demand side options - quantification for Portugal*	127
4.1	Introduction	129
4.2	Methods and model	133
4.2.1	Overview of the TIMES_PT model	134
4.2.2	Socio-economic scenarios and energy and materials demand projections for 2020	136
4.2.3	Present and future sources of primary energy supply	139
4.2.4	Scenarios for quantifying interactions between specific energy supply and demand-side options	140
4.3	Results and discussion	147
4.3.1	Avoided electricity generation installed capacity and costs in 2020	147
4.3.2	Impact of end-use energy efficiency on final energy consumption and share of renewables	153
4.3.3	Impact on greenhouse gases emissions	158
4.3.4	Sensitivity analysis	160
4.4	Discussion and Limitations	161
4.5	Conclusions	164
4.6	Appendix – National Primary Energy Potentials	167
4.7	References	168
5	Effects of exogenous assumptions in GHG emissions models - A 2020 scenario study for Portugal using the Times model*	175
5.1	Introduction	177

5.2	Overview of exogenous assumptions in GHG emission scenarios across Europe.....	178
5.3	Methods and model	183
5.3.1	Penetration of end-use efficient equipment in the demand sectors - EFF scenario.....	184
5.3.2	Socio-economic scenarios and energy and materials demand projections for 2020 – DEM scenario.....	186
5.3.3	Implementation of infrastructures and incentives for production of renewable electricity – low RES-e scenario	188
5.3.4	Availability of hydro resources – LowH and HighH scenarios	190
5.3.5	Primary energy import prices – 100\$/bbl scenario	190
5.3.6	Summary of the studied scenarios	192
5.4	Results and discussion	193
5.5	Discussion	198
5.6	Conclusions.....	199
5.7	Appendix – Energy services and materials demand assumptions in TIMES_PT	201
5.8	References.....	204
6	Top-down and bottom-up modelling to support low carbon scenarios: climate policy implications*	211
6.1	Introduction.....	213
6.2	Modelling Framework	215
6.2.1	GEM-E3_PT Model	215
6.2.2	Calibration methodology for a common baseline scenario	218
6.2.3	Low Carbon Scenarios	220

6.3	Results.....	220
6.3.1	Baseline scenario	221
6.3.2	Low Carbon Scenarios	222
6.4	Discussion on policy considerations	231
6.5	Conclusions.....	233
6.6	Appendix A.....	236
6.7	References.....	237
7	Overarching Conclusions.....	243
7.1	Answers to the four main research questions.....	245
7.1.1	What divergences exist between the objectives of energy and environment policies and how relevant are these?.....	245
7.1.2	How well can we assess the interactions between energy and environment policies and instruments? In particular, how can they be quantified?	246
7.1.3	How do the different energy and environment policies instruments & measures along the power energy system interact with each other and how does that interaction affect their effectiveness and cost-effectiveness?	248
7.1.4	How can energy and environment policy instruments be better integrated in order to improve their overall effectiveness and cost-effectiveness?	250
7.2	Insights gained.....	251
7.3	References.....	253
8	Summary	255
9	Samenvatting	265
10	List of Publications	275

11 Curriculum Vitae..... 277