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

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7 Overarching Conclusions

In this dissertation the necessity and benefits of developing integrated policy approaches to the energy systems in general, and power systems in particular were assessed. The research work covers not only the integration of energy and environment policy objectives, but also the integration of different policy instruments along the power system. In order to do so, the dissertation focussed on developing an applied policy evaluation methodology to assess the relevance of divergences between the objectives of current energy and environment policies and its instruments.

In order to further assess the interactions between energy and environment policies and instruments a two part methodology was developed:

- a simple framework to map and qualitatively assess the most relevant interactions between the energy and environment policy instruments currently in place along European power systems, not considering the other components of the policy process (e.g. structures and procedures), and
- a complementary methodology to quantify the effects of the most relevant interactions (as identified in i) using an optimisation bottom-up energy system model (TIMES model, implemented for Portugal as a case-study).

Naturally, the methodology has limitations since the framework has to be simplified in order to be able to implement it to the whole power system and thus obtaining a full view of the tangled web of policy instruments. Also, bottom-up optimisation energy system models depict a simplified reality without fully including aspects as stakeholder behaviour, among many other. Nonetheless, the dissertation defends that this is still an acceptable trade-off in order to achieve quantified insights that can easily be communicated to policy-makers.

It is concluded that there are relevant interactions between current energy and environment policies instruments & measures along the power system.

These are named co-effects and can be either synergetic or antagonistic. In this dissertation emphasis was placed in assessing the latter. It was found that antagonistic co-effects affect effectiveness and cost-effectiveness of the policy instruments and measures and can represent a significant cost for the overall energy system. For the case-study of Portugal used in this dissertation, antagonistic interactions between policies were estimated to representing roughly up to 2% of the 2010 Portuguese GDP.

7.1 Answers to the four main research questions

This section presents more detailed conclusions for each of the research questions addressed in this dissertation.

7.1.1 What divergences exist between the objectives of energy and environment policies and how relevant are these?

We conclude in Chapter 2 that there are significant divergences between the objectives of environment and policy instruments, although at EU level the "(...) central goals for energy policy [are] (security of supply, competitiveness, and sustainability)". However in practical terms the minimisation or mitigation of caused environmental impacts is a secondary goal of energy policy, but of course a main goal of environment policy. Because the ultimate goal of environmental policies is to protect natural resources, the difference in policy goals (implemented by different agencies and organizations) is an important cause for non-coordination between energy and environment policy instruments.

Moreover, because both concern natural resources, environment and energy policy instruments are partly overlapping in terms of targeted stakeholders. Consequently, a large number of overlapping energy and environment policy instruments is targeting the various stakeholders in the power system. Although there are synergies between different policy instruments exist, there are also some whose effects counter each other, not only within different environment policy instruments but also with energy policy instruments.

The seemingly most relevant conflicts found are between hidden subsidies provided to energy supply infrastructures and environment command-and-control regulation. Although there are policy instruments acting both on the supply and the demand side, these do not necessarily lead to integration of supply and demand-side policy instruments.

7.1.2 How well can we assess the interactions between energy and environment policies and instruments? In particular, how can they be quantified?

Although several applied policy evaluation studies have looked into interactions of policy instruments they are mostly limited to specific pairs or limited groups of instruments from the field of energy policy and/or climate policy. This dissertation proposes both a qualitative framework and a qualitative methodology to assess these interactions.

1. Qualitative framework to assess interactions

The qualitative framework in Chapter 2 considers both the energy policy instruments and those from the broad field of environment policy. The concept of overlaps of policy instruments is used to measure the extent to which: 1) target stakeholders are shared, and 2) their steering effects occur within the empirical domains related to the different policy goals. If there are relevant overlaps in policy instruments co-effects between them will occur, i.e. effects on each other are felt at the level of their intended steering effects. These can be complementary, synergetic or counteracting.

The framework systematically assesses overlaps and co-effects of policy instruments looking into their objectives, mechanisms and targeted stakeholders. The first step of the framework is the screening of the objectives of the different policy instruments to assess to what extent they steer related behavior of the same stakeholders, followed by the identification of the type of overlap (complementary, synergetic or counteracting). The coordination of the policy instruments' mechanisms is then analyzed and classified in two straightforward levels: a) no-coordination - the instruments do not touch and are complementary or b) some overlap exists, synergetic or counteracting. Finally, divergences in the target stakeholder's steering effect are assessed. Then coordination between the instruments is due, like derogations or alterations in scope.

2. Quantitative methodology to assess interactions

Besides the qualitative approach this dissertation develops a quantitative bottom-up approach that estimates the losses or gains on effectiveness and cost-effectiveness of interacting policy instruments. This quantitative approach (presented in Chapter 3) is essential to support successful policy assessment and integration. Such a methodology is most useful to assess the relevance of counteracting effects between policy instruments, to set priorities for their integration, and to test more integrated policy designs. For this purpose TIMES_PT is used, a bottom-up technology optimization model, here exemplary implemented for Portugal.

Economy-Energy-Environment models, such as MARKAL, PRIMES, TIMES, RAINS or GEM-E3 have been widely used for the analysis of policy effects and to support decision-making. However, these models have not yet been used to assess how different policy instruments interact with each other. This dissertation brings such a modeled approach use one step further by illustrating how they can be used in energy and environment policy integration. The effects of the implementation of the policy instruments are transformed into technology changes (e.g. alterations in stock, costs, emission factors) into TIMES_PT, reflecting the impact of the policy instruments to be analyzed. This is followed by simulations of the implementation of different combinations of policy instruments. The analysis of the different optimum solutions achieved by the model in the different situations, e.g. the different CO_2 emissions and total costs allow a quantification of the counteracting (and possibly also synergetic) effects between instruments (Chapters 3 and 4).

3. Limitations of the quantitative methodology to assess interactions

The outcomes of Economy-Energy-Environment models (and thus the proposed quantitative methodology) depend on the assumptions implemented in the model as exogenous parameters. The main causes for uncertainty in such models are the different assumptions on exogenous parameters such as demographic and economic evolution, technology deployment, energy resources availability and the implementation and effectiveness of policy instruments. The contribution of different exogenous parameters for the case study was assessed in Chapter 5.

The greenhouse gas (GHG) emission estimates of the studied scenarios related to costs and availability of primary energy lead to variations in 2020 total national GHG emissions that are less than 2% different from baseline. The high promotion of end-use efficient equipment results in a higher difference in 2020 emissions from baseline (less 9%), followed by assumptions of macro-economic growth (roughly 7% higher). The delayed or slower implementation of policy incentives & investments to renewable electricity leads to an increase in emissions of only 2.5%. Thus, in overall terms it seems that the emission changes are not significant. Nonetheless, these relatively small differences in GHG emission scenarios have an impact in compliance with the energy-climate policy package, especially regarding the RES target of 31% for 2020.

The scenarios' comparison concluded that the most relevant assumptions for overall uncertainty are the ones related to the socio-economic assumptions, followed by the assumptions on technology deployment. Contrary to what is commonly assumed by policy makers, the availability of energy resources presents minor variations on GHG emission (less than 2%).

When further comparing the results of the bottom-up technology TIMES_PT model with the alternative economic GEM-E3_PT top-down model (Chapter 6) we found that although there are differences in model outcomes with relevance for climate policy making these differences are not substantial which confirms the robustness of the quantitative methodology using TIMES_PT.

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?

1. Quantitatively assessing interactions for the whole of the energy system

The quantitative methodology using the TIMES_PT model was implemented in Chapter 3 to estimate CO2 Marginal Abatement Costs (MAC) for Portugal for 2020 for a set of policy scenarios including one or more of the following policies: ban on nuclear power; ban on new coal power plants without carbon sequestration and storage; incentives to natural gas power plants, and a cap on biomass use. The different MAC were used to show the policies' effects in the potential for CO_2 abatement and thus as a measure of interaction between the policy options. From a CO_2 emission mitigation perspective it was found that the existing policies introduce significant inefficiencies, possibly related to other policy goals. The total energy system costs are 10-13% higher if all policies are implemented – 76 to 101 B€ - roughly the equivalent to 2.0-2.6% of the 2005 GDP.

2. Quantitatively assessing interactions between policies targeting the supply side and the demand side of the power system

From the qualitative framework depicting the tangled web of policy instruments in place it was found that policies seem to be developed either focussing on the supply side or on the demand side of the power systems, not always in a coordinated way (Chapter 2).

The impact of interacting end-use energy-efficiency & renewables applications policies for Portugal in 2020 was estimated in Chapter 4 in terms of (i) reduced electricity generation capacity, (ii) final energy consumption, (iii) share of renewables in final energy and, (iv) reduction of GHG emissions.

Results showed that aggressive industry and buildings demand-side measures can make the increase in renewable electricity capacity with approximately 4.7 GW, as discussed by policy-makers, superfluous. These measures represent savings in total energy system costs of approximately 3000 M€2000 - roughly the equivalent to 2% of the 2010 GDP.

Specifically for electricity generation, it appears that energy efficiency demand-side measures make the new combined cycle gas turbines (CCGT) plants non-competitive in the Portuguese energy system. By removing antagonistic policy support on the supply side of the energy system it is possible to avoid costs of 454 to 2129 Meuros$_{2000}$, corresponding approximately to 0.34% and 1.57% of the 2010 Portuguese GDP.

These results show that there is substantial room for improvement in coordination of supply-side and demand-side policies for the example of Portugal. It seems to be the lack of coordination in policy objectives (namely end-use energy efficiency targets, RES targets and energy security targets via liberalisation of electricity markets) that leads to issuing of permits for new power plants by authorities. Even considering that the roughly 10% of the centralised electricity installed capacity in 2005 will achieve its end of life by 2020 it is not clear why it would be necessary to increase the total electricity 2005 capacity by 42-64% by 2020. Thus it seems that the neither the current moderate energy efficiency targets of the NEEAP nor the potential role of more demanding ones are fully considered for achieving the 31% RES targets and for ensuring security of supply.

7.1.4 How can energy and environment policy instruments be better integrated in order to improve their overall effectiveness and cost-effectiveness?

It might be unrealistic to aim for fully coordinated policy instrumentation. Given the severe limitations on policy development and implementation sparse instruments are difficult to develop. Therefore, coherent policy packages can be more effective, as long as co-effects are assessed and dealt with. When governments develop and implement such packages it is fundamental to make sure that clear signals are sent out to stakeholders. While doing so governments should pay attention to minimise distortion of policy goals due to lobbying in developing on specific policies, easily disregarding their interrelations, development level and ensuring stability at policy implementation level (Chapter 2).

The integration of policy instruments inevitably brings out the issue of trade-offs. Not only is it necessary to assess the trade-offs between two different policy instruments, but also between having them separate versus their integration. For simplification it is necessary to reduce the analysis to two things to be traded at one time. But even if it is possible to isolate just two policy goals and two costs of these policies involved, with two simple policy instruments; there is not one *numeraire* available to express different non-market effects, as in trading security of supply against CO2 reduction. Reflecting this, the approaches to structure trade-offs in policy integration are mostly quite vague and generic. For further structuring of trade-offs it is necessary to increase the objectivity of the criteria to use, which can only be done if there is more information on the functioning of co-effects of policy instruments and on their quantitative impacts on overall effectiveness and efficiency (Chapter 2).

7.2 Insights gained

This dissertation has used the Portuguese energy system as an example for developing and applying the methodology. However, not only the methodology for assessing interactions can be easily implemented for other countries, but also most of the findings (naturally, not the specific quantification of interactions) can constitute learned lessons for other countries. This is the case of the identified antagonisms between supply-side and demand-side policies or between policies aiming to promote renewable energy and cheap fossil fuels. Although there are obviously differences in configuration of each energy and power system across countries, in particular for the European Union (EU), member states use broadly the same energy and environmental policies, stemming from EU wide common policies and targets as specified in EU Directives.

As in any research work focusing on policy aspects, a most critical question is: what is the actual policy appropriateness of the methodology for assessing interactions here presented? To what extent will it ever be implemented by policy makers affecting “real life” policy making? These questions cannot be replied easily or perhaps cannot even be replied at all. As discussed throughout the dissertation, the policy making process includes many non-rational and unclear elements that cannot be fully captured and modeled. This brings to other underlying questions throughout the dissertation: Is integrated policy evaluation really feasible? Or even further, to what extent is policy integration feasible?

The approach to assess interactions between policies presented in this dissertation concerns the interactions between policy instruments and therefore is limited to only two of the components of the policy process (the policy instruments and actors or stakeholders). The other components - objects, goals and structures and procedures – are not approached. To achieve policy integration it is not enough to simply secure the integration of its instruments, as the effects of the policy instruments are dependent of the context and thus of all the other components of the policy process.

Nonetheless, integration at the level of the policy instruments is a good starting point towards the next challenge, the integration of the policy processes in all its components. This dissertation argues that although it is desirable to have full policy integration in all policy components, in practical terms this is unfeasible, due to its high complexity. Despite well-intentioned claims to achieve policy integration, practice shows that there is still a long way to go. Energy and environment policy integration so far seems to have been done mostly at the broadest level by including vague mentions to sustainability in overarching energy policy goals. These intentions and claims have not yet trickled down to the level of the policy makers and their policy instruments. This dissertation has suggested that the approach to policy evaluation and integration should be supported in more practical terms with a bottom-up evaluation of concrete policy instruments in place. Despite the limitations of the suggested methodology and modeling tools, a simple quantified measure of antagonisms and synergies between policy instruments is tangible result that can more easily be grasped by our limited human minds.

In order to do so more work is needed on methodologies for the assessment of interactions of policy instruments and case application. Due to the systematic lack of analysis of existing policy instruments it is not possible at this stage to assess the relevance of interactions and co-effects between them regarding overall cost-effectiveness, effectiveness and equity. This entails significant effort and costs. In complement, a possible more simplistic way forward to untangle the web of policy instruments is reducing complexity as defended by Tinbergen (1956) by having one instrument per goal. However, political and administrative impediments make this approach not feasible in many domains; It then is perhaps a more realistic strategy to reduce the stakeholder-technology-behavior specificity of policy instruments as much as possible, as defended by several authors (Huppes, 2011). Examples are carbon taxes applying to all stakeholders leaving technology choices open instead of technology specific subsidies. Policy instruments should focus on supporting the removal or mending of market imperfections such as lack of investment funds, access to information, reducing inertia and resistance to change, among other.

The work involved in better policy development and alignment is worthwhile as we have made highly probable that currently substantial losses are made in the tangled web of fuzzy policy mixes.

7.3 References

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