

Timely and cost-effective decarbonisation – A case study from Cyprus

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Overview

Limiting global warming to no more than 2°C above pre-industrial levels requires strong commitment of governments to greenhouse gas (GHG) emission abatement measures. Apart from technical and economic barriers to decarbonisation, the attainment of long-term targets is further complicated by the fact that national emission reduction pledges are usually made for the medium term, e.g. for 2030; achieving medium-term targets without taking into account the long term perspective can lead to a lock-in effect, such that policies to reduce emissions in the medium term may bind countries in pathways that cannot lead to strong decarbonisation. These analysis is performed for the Republic of Cyprus, an island state in Southeast Mediterranean. As a member state of the European Union (EU), Cyprus has committed to GHG emission reductions in line with EU decarbonisation objectives for year 2030 for those sectors which are subject to the EU Emissions Trading system (ETS), and for all other economic activities, i.e. those of non-ETS sectors. Because deep decarbonization in the country's non-ETS sectors is very demanding, we consider the adoption of cost-effective mitigation measures coupled with the implementation of a carbon tax in these sectors. Our simulations offer evidence that if the medium-term strategy is not ambitious, deep decarbonisation by 2050 will be highly unlikely to achieve. 'Weak' scenarios result in under-investment in ambitious options in the medium term, which are however absolutely necessary to create a zero-emissions trajectory for the long term. More ambitious policy mixes result in the highest investment needs but seem to be the socially optimal approach, taking into account climate stabilisation as well as side-benefits such as air pollution improvement.

Methods

To analyse abatement policy options, we combine a long-term energy forecast model that is used for national energy planning with a dynamic optimisation model that examines optimal mitigation pathways under a specific set of constraints. The latter takes into account emission reduction objectives for two future years (2030 and 2050) and incorporates assumptions on the speed of implementation of each measure, which expresses technical and behavioural inertia in the deployment of a measure. The objective is to comply with the abatement targets, minimising total discounted present cost of abatement. The model runs for the period 2020-2050 with a time step of five years and identifies the cost-optimal policy mix by selecting the specific amount of abatement to be implemented by each measure expressed in avoided annual emissions in tonnes of CO₂-equivalent (CO_{2e}) per year. The optimisation model also considers non-climate external costs associated with the implementation of mitigation measures, thereby allowing to account for additional benefits of decarbonisation related to the reduction in local air pollution. For this purpose, the damage costs of emissions of major air pollutants nitrogen oxides, particulate matter and sulphur dioxide are considered. To assess the effect from the implementation of a carbon tax on aggregate energy use, we employ a long-term energy forecast model that is used by energy authorities of Cyprus for national planning. For different carbon tax scenarios, the energy forecast model assesses the changes in fuel consumption and carbon emissions. The carbon emissions reductions then used as an exogenous input to the optimisation model. We develop a number of alternative scenarios and compare their potential to turn Cyprus into a low-carbon economy, as well as the corresponding costs and investment needs in each case. The analysis is carried out from the perspective of a social planner; from the point of view of government of Cyprus.

Results

After experimenting with various simulations of emission pathways up to 2050, we present the results of three specific simulations and compare them with the evolution of non-ETS GHG emissions according to the scenario "With Existing Measures" (WEM) that was prepared by the government of Cyprus in its National Energy and Climate Plan. Main aspects of each one of the four scenarios are presented; costs and emission abatement up to 2030, including the potential cost for purchasing allowances in line with the possibility to use 'flexibility mechanisms' foreseen in EU Regulation 2018/1999 on the Governance of the Energy Union and Climate Action. Note that since the 2050 objective is still indicative and not mandatory, there are no market mechanisms (e.g. trade of allowances) to ensure compliance.

The first scenario, WEM, is used as a reference for our simulations. In this case, Cyprus falls short of its non-ETS emission reduction commitment of year 2030, and is nowhere near the 2050 decarbonisation target. We consider a ‘weak’ abatement scenario in which we assume that policymakers adopt measures with an abatement cost up to 30 Euros per tonne of CO_{2e} in addition to the WEM scenario— the cheapest measures that are approximately as costly as the emissions allowance price prevailing in EU ETS sectors by the end of 2019. Road transport measures are excluded from the policy mix up to 2030 based on this cost criterion, and they are only available from 2031 onwards. Such an approach not only affects the 2030 target, which appears to be unreachable, but also the long-term objective. This is due to the fact that these measures with large abatement potential, take time to be implemented; neglecting these measures during the period 2020-2030 leads to underachievement of the 2050 target.

In the third scenario, which we call ‘ambitious’ scenario, the optimisation model is forced to exploit for the period 2020-2030 only measures with costs up to 120 Euros per tonne of CO_{2e}. This cost threshold has been chosen because it is in line with carbon tax levels applied in some EU countries (e.g. Sweden) and proposed for others (e.g. Germany and Cyprus). This scenario includes also the implementation of a carbon tax of 120 Euros’2015 per tonne of CO_{2e} in non-ETS sectors, to be introduced gradually over the six-year period 2020-2025. After 2025, the carbon tax remains constant at this level up to 2050. The two scenarios, ‘weak’ and ‘ambitious’, obviously lead to different aggregate costs up to 2030. The first case yields lower total abatement and hence shows lower investment needs. Although the ‘weak’ scenario results in greater net benefits up to 2030 than the ‘ambitious’ scenario (because it does not deploy expensive abatement measures), if one takes into account external costs of GHG emissions and air pollutants the ‘ambitious’ scenario turns out to be more beneficial for society. From the viewpoint of long-term decarbonisation, the ‘ambitious’ scenario closes considerably the 2030 and 2050 emissions gap compared to the ‘weak’ scenario. This is not only due to the emissions reduction caused by the carbon tax, but also to the number of mitigation measures that enter in the ‘ambitious’ scenario.

In the last scenario, the so-called ‘full compliance’ scenario, all measures are available to implement regardless of their abatement cost. To meet the decarbonisation target of 2030, a higher carbon tax is necessary compared to the ‘ambitious’ scenario. This tax, which was determined iteratively in our long term energy forecast model, is introduced gradually over the eleven-year period 2020-2030, reaching 298 Euros’2015 per tonne of CO_{2e} by 2030. The optimisation model fully exploits the measures up to 2030, which leads to larger investment needs than the ‘ambitious’ scenario. Considering the 2050 objective, due to the large emissions reductions induced by the very high carbon tax, fewer investments up to 2050 are needed in comparison to the ‘ambitious’ scenario. It has to be noted, however, that such a tax is highly unlikely to be adopted because, at almost 300 Euros per tonne of CO₂ it would raise retail fuel prices by 50% or more. Moreover, even at gradual implementation, such tax levels can greatly affect the relative prices of goods and services in the economy, may lead to very high costs for parts of society and to a fast replacement of capital in some economic sectors, leading to stranded assets. Therefore, the ‘full compliance’ scenario is almost certain to lead to social costs and can be regarded as a theoretical one. It is presented here in order to exhibit how great the decarbonisation challenge is for an industrialised country with growing income levels.

Conclusions

In this paper we explore emission abatement options for Cyprus, where the already adopted policies and measures are insufficient for meeting mandatory emission reduction commitments for the sectors that are not subject to the EU ETS. In view of these challenges, we consider the adoption of additional measures coupled with the implementation of a gradually increasing carbon tax in non-ETS sectors. Our simulations provide evidence that if the medium-term climate strategy is not ambitious, deep decarbonisation required for 2050 will probably be impossible to achieve unless strong technological breakthroughs occur. Weak policies, involving the adoption of abatement options with a cost of up to 30 Euros per tonne of CO_{2e}, which is currently the business-as-usual norm in most EU countries, result in low investment in ambitious measures, such as those affecting road transport emissions. The resulting emission gap for 2050 suggests that lack of ambition in the medium term will lock the economy to a carbon-intensive trajectory. It is therefore important to be more ambitious in the medium-term and deploy also more costly measures with higher long-term abatement potential. For this purpose, we find that a carbon tax in the order of 120 Euros per tonne of CO₂ which is adjusted for changes in cost of living and whose revenues are recycled in the economy can reduce energy demand to a sufficient extent so as to induce green investments that can lead a country to deep decarbonisation in the mid-21st century. Although ambitious policies result in highest investment needs, they turn out to be the socially optimal approach not only because they can help achieve long-term decarbonisation targets, but also because they can improve air quality and human health to a considerable extent.