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How Can Cyprus Meet Its Energy and Climate Policy Commitments? The Importance of a Carbon Tax

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Abstract

The paper presents a new set of energy demand forecasts for the Republic of Cyprus up to the year 2040, taking into account recent oil price developments and focusing on the ability of Cyprus to achieve the greenhouse gas emission reduction targets agreed by EU leaders in October 2014. The emphasis is on emission reductions in those sectors that are not subject to the EU Emissions Trading System, i.e. on final energy demand sectors excluding aviation and the cement industry. According to a 'baseline' scenario, energy demand will grow modestly over the coming decades, which is far from sufficient for Cyprus to achieve its 2030 emission targets. We therefore develop two additional scenarios that assume the implementation of an economy-wide carbon tax from 2016 onwards. It turns out that a strong tax increasing by around 15 Euros per tonne of CO_2 every year from 2016 onwards is necessary in order to induce a sufficient decline in carbon emissions, or alternatively a carbon tax that can start from very low levels and increase geometrically up to 2030. Such taxes, which are also recommended by international organisations, would lead to a more rigorous implementation of energy efficiency measures in buildings and transport than currently foreseen, and would allow Cyprus both to comply with the EU decarbonisation targets and to reduce its dependence on fossil fuels.

Keywords: Carbon tax, Climate change mitigation, EU policy, Energy demand, Forecast**.**

1. Introduction

It is well known that Cyprus remains highly dependent on imported petroleum products for covering its energy needs. Moreover, energy is not used productively: Energy intensity (i.e. energy consumption per unit of economic output) is among the highest in the EU, due to the lack of adequate public transport modes, the absence of energy performance requirements for buildings until recently, and the exclusive dependence on

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aviation for international travel. As an EU member, the country is implementing policies promoting renewable energy and energy efficiency measures in compliance with the relevant EU legislation. It is also noteworthy that the country is located in a hot spot in terms of climate change impacts: it already has a semi-arid climate and is located in a region that is expected to experience the most adverse climate change effects in Europe. As a result, energy supply and demand are expected to be considerably affected in the long term (Zachariadis and Hadjinicolaou, 2014); this reinforces the need for long-term energy planning as it constitutes an important part of a coherent climate change adaptation policy for the island.

The Republic of Cyprus is also committed to meet the EU objectives on reducing its emissions of greenhouse gases, among which CO_2 (carbon dioxide) emitted during fuel combustion is the most prominent. After the 'energy and climate policy package' agreed in 2009 with targets for year 2020, EU leaders agreed in October 2014 on a new package for 2030. According to this, emissions of sectors subject to the EU Emissions Trading System (ETS), i.e. power generation and heavy industry, will have to reduce their emissions by 43% in 2030 compared to levels of year 2005. In the rest of the economy – the so called non-ETS sectors – EU greenhouse gas emissions have to be reduced by 25% in 2030 compared to 2005. The latter target does not have to be met uniformly by all member states; a so called 'Effort Sharing Decision', providing individual emission reduction targets for each country, is scheduled to be adopted in the first half of 2016. However, according to Cypriot officials, the most likely target for Cyprus is for a 22% reduction.

The emissions target for year 2020 in non-ETS sectors is likely to be met for Cyprus. It did not seem likely some years ago but, due to the economic downturn since 2013, energy demand has dropped in recent years, so that carbon emissions have also declined. As a result, a 5% reduction in year 2020 is probable. The outlook is different, however, until 2030. If an economic rebound occurs in the next years, as expected by the national government and international organisations, energy use will most likely grow in line with economic activity, even despite EU-wide energy efficiency legislation. Therefore, the -22% emissions target is very difficult to achieve under a 'business as usual' evolution in the way that energy is used in Cyprus.

This paper delves further into this issue, with the aid of an energy demand forecast model that was developed in order to support national authorities in their energy and environmental action plans. We show that the current energy path is unsustainable and diverges substantially from EU policy objectives, and explore economic policy measures (exemplified by an economy-wide carbon tax) that can help Cyprus achieve its 2030 emission reduction commitment and stay on course for complying with the broader EU decarbonisation objective until the mid-21st century.

2. Methodology

2.1 General description of the energy model

Energy forecasts for national policy analyses are usually performed with the aid of end-use accounting models or econometric models (Bhattacharyya and Timilsina, 2009). The model used for energy demand forecasts for Cyprus uses a combination of these approaches and runs until the year 2040. Its specification is described in detail in IRENA (2015). On the econometric side, it employs recursive equations of final energy demand per year by sector and fuel, which describe the evolution of final energy consumption as a function of exogenous macroeconomic and price variables, using income and price elasticities (distinguishing between long-term and short-term effects) that have been largely derived from national econometric estimations and international literature.

As regards the sectoral breakdown, the model addresses the major energy-using sectors in the Cypriot economy. On the end-use accounting side, technology and fuel shares are determined in the model at the level of end-use energy technologies, as a function of their annualised costs and the maturity of each technology. Sectoral and technological breakdown are shown in Table 1.

TABLE 1

List of economic sectors and fuels covered in the energy demand model.

Sector	*Fuels / energy forms in each sector (where applicable)*
Agriculture	Gasoline
Cement industry	Automotive diesel
Other industry	LPG (liquefied petroleum gas)
Households	Gas oil
Services	Light fuel oil
Road passenger transport	Heavy fuel oil
Road freight transport	Aviation fuel
Aviation	Pet coke / coal
	Biomass
	Biofuels
	Renewables (solar thermal, geothermal, hydrogen)
	Electricity

As explained by Zachariadis and Taibi (2015), that study was the first one in Cyprus that exploited the availability of end-use data in households and the hotel sector. As far as the residential sector is concerned, the model employs data from a survey that was conducted by the Cyprus Statistical Service and was targeted on final energy consumption of households by end use (space heating, space cooling, water heating, cooking, lighting and appliances). These data were combined with information from the official national energy balance of year 2013 in order to disaggregate final residential energy consumption by end use and to enable a forecast of the future final energy needs of households. On the basis of this information, a forecast of residential demand for useful energy was performed. Each one of the five main end uses mentioned above was assumed to follow a different dynamic path in the future, with different sets of income and price elasticities and a different evolution of fuel shares until 2040 for each end use, depending also on the thermal efficiency of each fuel/technology and the turnover of old equipment and its replacement with new, more efficient equipment. The results of this forecast procedure were then used to calibrate parameters of the final energy demand model.

2.2 Assumptions on macroeconomic and oil price developments

As briefly explained in Section 2.1, the forecast model relies on the evolution of several exogenous variables, such as economic activity variables, international oil prices and variables expressing policy-induced energy efficiency improvements. As this paper's focus is on decarbonisation scenarios, the evolution of major macroeconomic and oil price variables is assumed to follow one specific path for all scenarios considered. The forecasts presented in this study adopt the official short-term forecasts of the Cypriot Ministry of Finance and international organisations as regards the evolution of macroeconomic variables such as GDP and private consumption, as of autumn 2014; according to these, GDP is expected to reach pre-crisis levels (i.e. those of the period 2008-11) by the year 2021. As for the evolution in the longer term, it was assumed that economic growth will continue albeit at gradually lower rates; this is in line with official demographic projections for Cyprus, which foresee that total population will start declining around 2030, so that moderate total GDP growth combined with a decreasing population will lead to a quite stable growth rate in per capita GDP of the order of 2.1% per year after 2030. As far as the sectoral contributions to GDP are concerned, it was assumed that the share of industry and agriculture will slightly fall in the future, the share of the construction sector will gradually rebound but not return to pre-crisis levels, and the share of the tertiary sector will increase further.

The evolution of crude oil prices adopted in this study follows the latest oil price forecasts available by the time of this writing by the International Energy Agency (IEA, 2014). According to the IEA's central forecast ('New Policies Scenario'), crude oil price was expected to increase slightly and reach $112 per barrel in 2020 (at constant prices of year 2013) with a further increasing trend in later years, up to $132 in 2040. To take into account the substantial decline in crude oil prices of years 2014 and 2015, which were only partly accounted for in the IEA projections, the latest data (as of April 2015) from the U.S. Department of Energy were used (EIA, 2015) and linked to the IEA forecast.

Zachariadis and Taibi (2015) have conducted a sensitivity analysis of the energy forecasts using alternative scenarios of economic growth and oil prices. As mentioned above, this paper does not follow the same approach because its emphasis is on carbon emission abatement scenarios; nevertheless a brief relevant discussion is made in Section 4.

2.3 Scenarios considered

Energy and carbon emission forecasts were carried out for three scenarios. The first one is used as a basis and is therefore described as the 'baseline scenario'. It reflects current energy policies of the government of Cyprus and their planned future modifications, as provided by national authorities by the end of 2014; the most recent data on energy demand and supply (energy balance of year 2014); and the effect of current and already planned EU policies as regards renewable energy and energy efficiency improvements. This is a slightly updated version of the 'efficiency scenario' of IRENA (2015) and Zachariadis and Taibi (2015), which – by the time of this writing, i.e. autumn 2015 – forms the basis for the action plans of the government of Cyprus.

The 'baseline scenario' assumes that national and EU-wide energy efficiency measures are adopted in the near future according to announced plans. Such measures comprise e.g. a continuation of national subsidies for investments in energy saving technologies by households and firms, the implementation of the 'recast Buildings Directive' (2010/31/EC) and the 'Energy Efficiency Directive' (2012/27/EU) at EU level, and some modest adoption of further legislation on near-zero energy buildings later in this decade.

It is evident from previous runs of similar scenarios (IRENA 2015) that they lead to growing energy use and carbon emissions after 2020. Therefore, since the targets of the EU's 2030 energy and climate package are binding for Cyprus, it is necessary to explore alternative scenarios that can lead to compliance with the non-ETS 22% emission reduction target mentioned in Section 1.

For this purpose, we developed two carbon tax scenarios:

- One assuming the implementation (from 2016 onwards and up to 2040) of a carbon tax that increases by constant increments (in real terms) throughout the forecast period. This will be called the 'linearly increasing carbon tax scenario'.

- One assuming the gradual implementation of a carbon tax, which would start at very low levels in 2016 and its rate of increase would grow linearly (in real terms) up to 2030. This will be called the 'geometrically increasing carbon tax scenario'.

The carbon tax rate is expressed in Euros (at 2005 prices) per tonne of CO_2. It is fully passed through to retail fuel prices by multiplying the tax rate with the carbon content of each fuel (expressed in tonnes of CO_2 per tonne of oil equivalent of each fuel). The fuels' carbon content is obtained from data of the UN Intergovernmental Panel on Climate Change (IPCC 2006). As a result of the increase in fuel prices because of this carbon tax, the model re-calculates aggregate energy demand by sector as well as the new fuel shares. The 'optimal' carbon tax in each one of the two scenarios is determined through iterations in order to attain the 22% CO_2 emission abatement target of all non-ETS in year 2030. Both carbon tax scenarios assume that the tax rate of year 2030 will continue unchanged through to 2040.

We did not examine the alternative of imposing a one-off carbon tax that would remain constant throughout the forecast period. The reasons is that, from preliminary calculations, it was evident that the such a tax would be too high – of the order of 135 Euros per tonne of CO_2 – and its immediate implementation from a given year onwards would cause a shock to consumers and firms.

It has to be reminded that the focus of this paper is on non-ETS sectors (i.e. essentially all final energy demand sectors except aviation and cement industry) because ETS sectors (in which power generation dominates) have their own emissions allocation plan, and their emissions reduction path is more or less pre-determined. Therefore, the main difficulty for the Republic of Cyprus in meeting its 2030 greenhouse gas emission commitments will be with the emissions of the non-ETS sectors.

3. Results

In the first carbon tax scenario, the model iterations lead to a carbon tax that increases by annual increments of 12.4 Euros per tonne of CO_2 at 2005 prices – which correspond to around 15 Euros per tonne at 2015 prices. Each year after 2016 the carbon tax increases by this amount. In the second variant, the carbon tax starts at 1.9 Euros/tonne in 2016, and each year a gradually increasing tax is added to fuel prices; this extra rate reaches 28.6 Euros/tonne at 2005 prices (or about 34 Euros per tonne of CO_2 at 2015 prices) in 2030.

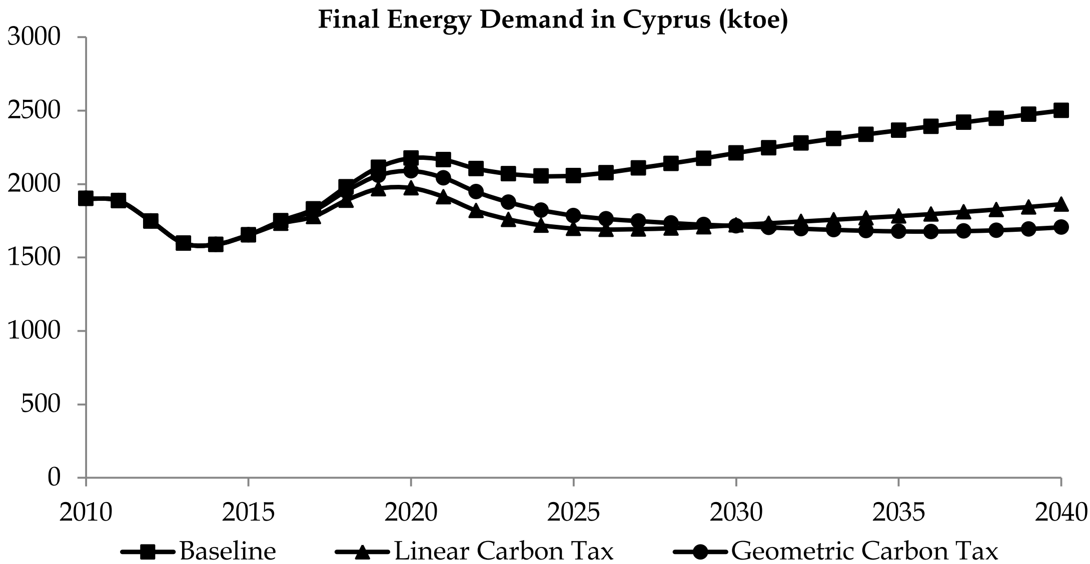
The tax rates mentioned above are quite high. Because the baseline evolution leads to increased energy use and higher carbon emissions in 2030, it will take a strong effort for Cyprus to reach the 22% emission reduction in its non-ETS sectors. The implementation of carbon taxes of the above mentioned levels, whether linearly or geometrically increasing, will induce serious structural changes on energy use in Cyprus. These will entail shifts both towards more energy efficient technologies and to fuels with a lower carbon content, i.e. biofuels and renewables. The first scenario causes a stronger decline in emissions in the first years of the forecast period but the second scenario leads to deeper emission cuts by the year 2040.

Figure 1 shows the model-based calculations of final energy demand up to 2040, in aggregate terms as well as per unit of GDP. Since both carbon tax variants involve a considerable increase in retail fuel prices, they are projected to lead to substantially lower energy consumption in the coming decades – by 25% in the linearly increasing carbon tax scenario and by 31% in the geometrically increasing tax case. This will bring about a significant improvement in energy productivity (the inverse of energy intensity which is shown in the lower part of Figure 1).

As a result of the drop in energy demand and the fuel shift (which results from the change in relative prices of fuels to the benefit of low-carbon fuels), CO_2 emissions are forecast to fall significantly. Figure 2 presents the evolution according to the three scenarios. The two carbon tax scenarios by design achieve the 2030 non-ETS emissions target, which – as already mentioned – is very far from the baseline evolution.

FIGURE 1

Evolution of aggregate energy demand and energy intensity in Cyprus up to 2040 for the three scenarios considered.



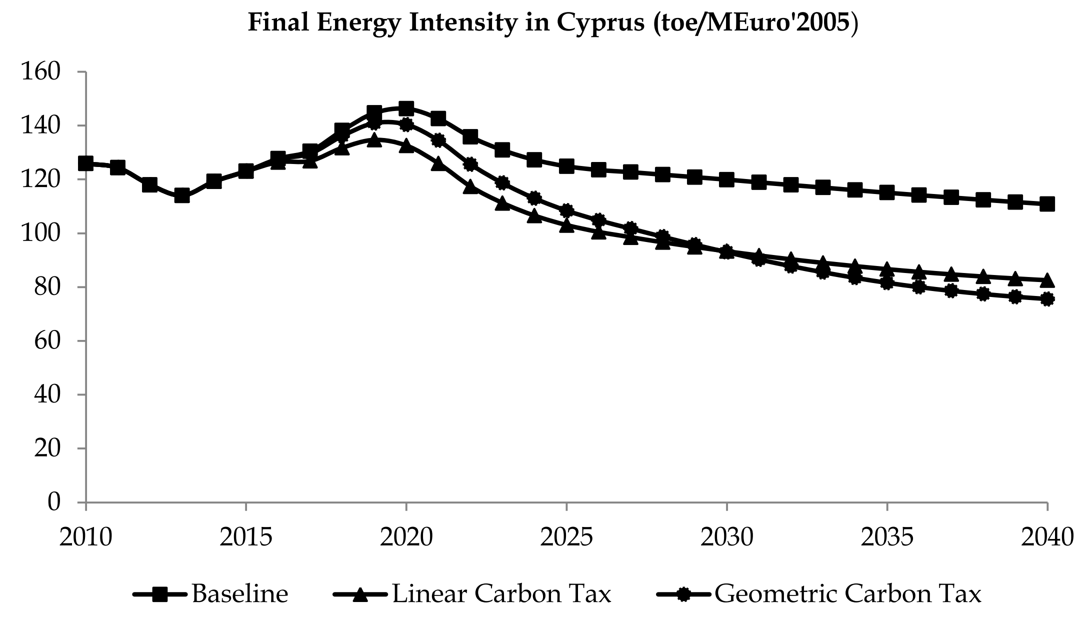
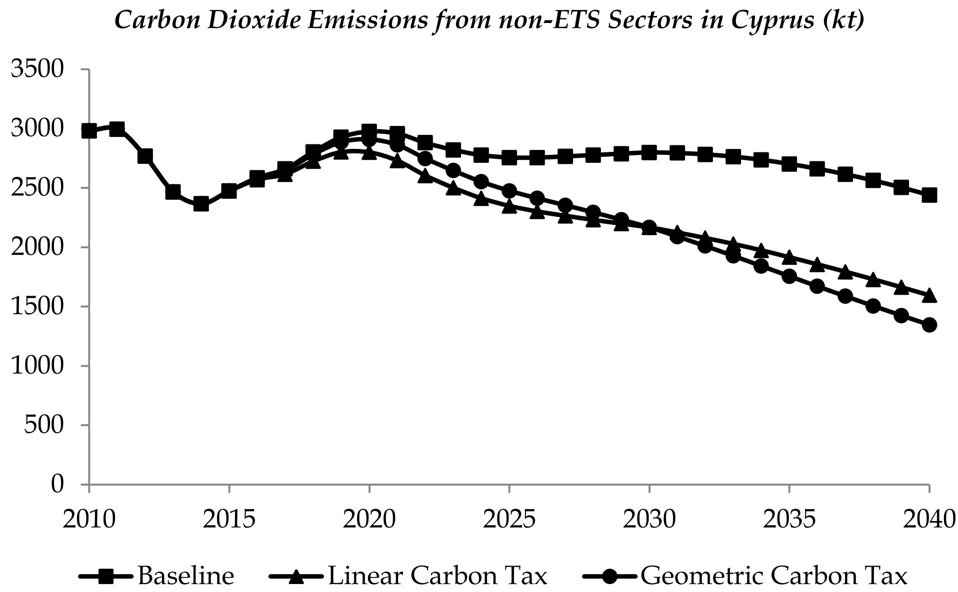


FIGURE 2

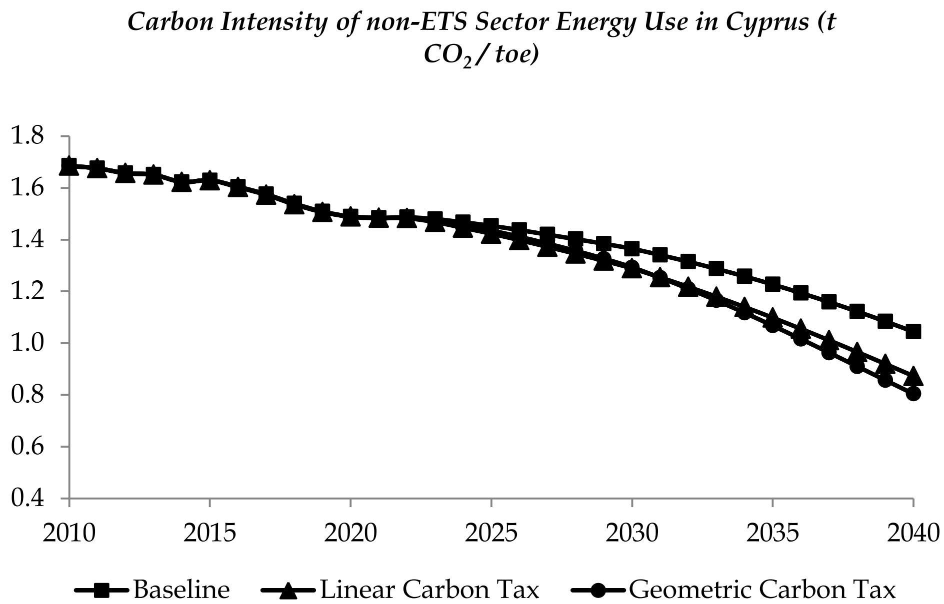
Evolution of non-ETS CO_2 emissions in Cyprus for the three scenarios considered.



Two important indicators of the country's progress towards decarbonisation are illustrated in Figure 3 – the carbon intensity of the economy and the carbon intensity of energy use. The former relates total emissions to total economic output (in this case, national GDP); the latter reflects the carbon content of the energy mix used in a country. Although decarbonisation has started and is expected to continue even under the baseline scenario, it is far from sufficient to help the country achieve its emission abatement targets. The two carbon tax scenarios accelerate this process, by shifting a larger part of energy use towards low-carbon fuels (such as biofuels), zero-carbon renewable energy options such as solar thermal and geothermal energy, and towards greater electrification; the latter does not necessarily reduce countrywide carbon emissions, but it certainly decreases direct CO_2 emissions of final energy users.

FIGURE 3

Evolution of two measures of carbon intensity of non-ETS sectors in Cyprus for the three scenarios considered.



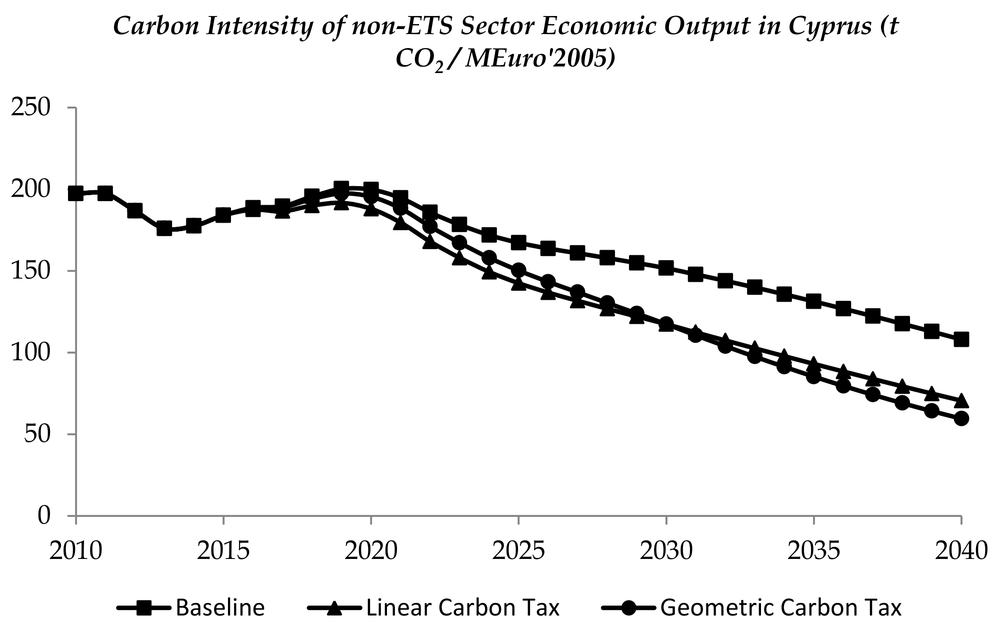


Figure 4 takes a closer look at the electrification process. According to the baseline scenario, the share of electricity in most end-use sectors is projected to drop slightly in the coming decades. This is expected to happen despite the continuing electrification of most end uses such as cooling and heating, because the energy efficiency of heat pumps, lighting systems and electric appliances is projected to progress faster than the efficiency of other technologies using conventional fuels. However, the carbon tax scenarios lead to an even stronger penetration of electricity use because the carbon tax will not apply to electricity as it is not a direct source of CO_2 emissions, and any change in the price of electricity will happen because of the participation of power generation in the ETS system irrespectively of the carbon taxes in non-ETS sectors simulated in this study. The higher share of electricity will be especially pronounced in the road transport sector (cars and trucks) and in households. Although Figure 4 shows even higher electricity share increases in industry and agriculture, the amount of electricity used in those sectors is much lower than in households and services.

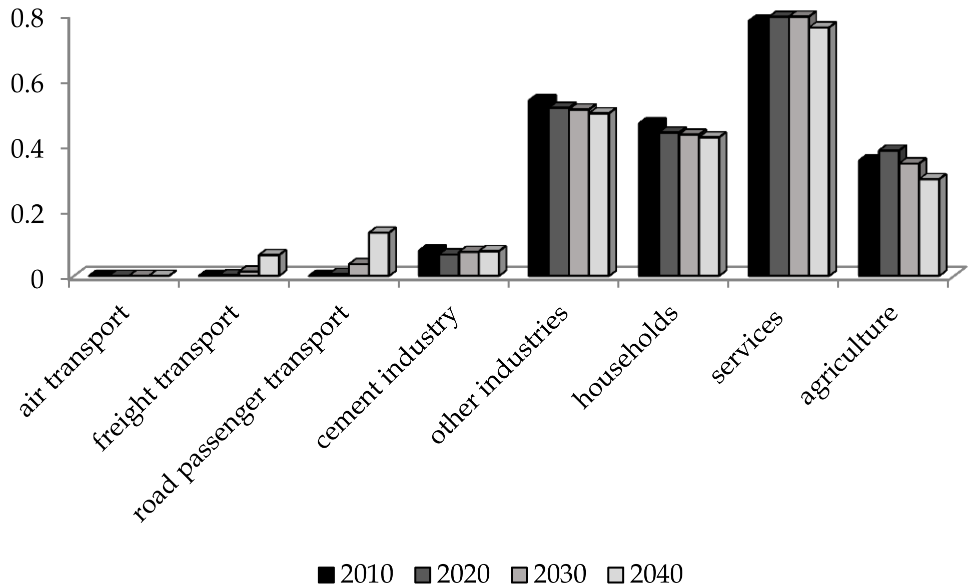
Figure 5 focuses on the two major final energy consuming sectors in Cyprus – transport (including road and air transport) and buildings (including residential and tertiary sectors). A carbon tax affects transport energy use substantially – depending on the scenario, it falls by 31-40% compared to the baseline evolution in year 2040. As this sector is still almost entirely dependent on petroleum products, a fuel shift towards low-carbon fuels (such as LPG or natural gas) and electricity is difficult to realise. Transport has a tremendous inertia because of the infrastructure required to make alternative fuels competitive to conventional petrol and diesel fuel. Therefore, the largest part of decarbonisation in this sector is projected to take place through the shift towards more fuel efficient vehicles. To some extent, as mentioned above, faster penetration of electric cars and trucks will also contribute to carbon emissions abatement in the sector.

Conversely, the buildings sector cannot contribute to a large extent to the decarbonisation effort since it largely depends on electricity. Therefore, carbon taxes applying to fuel use in non-ETS sectors have only a small effect on the average energy cost of residential and service sectors. As a result, a drop in final energy consumption of the order of only 10% is projected to occur in buildings until 2040. However, as shown in Figure 4, the shift towards more electricity use will be significant, especially in households.

FIGURE 4

Electrification in Cyprus by sector up to 2040 with and without a carbon tax

Baseline Scenario
Share of electricity in final energy demand by sector



Scenario with geometrically increasing carbon tax in non-ETS sectors - Share of electricity in final energy demand by sector

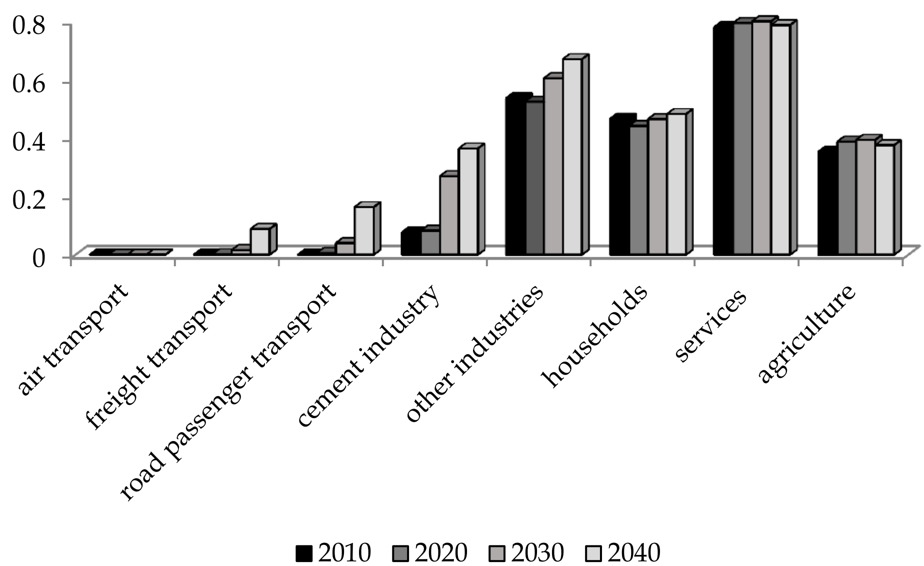
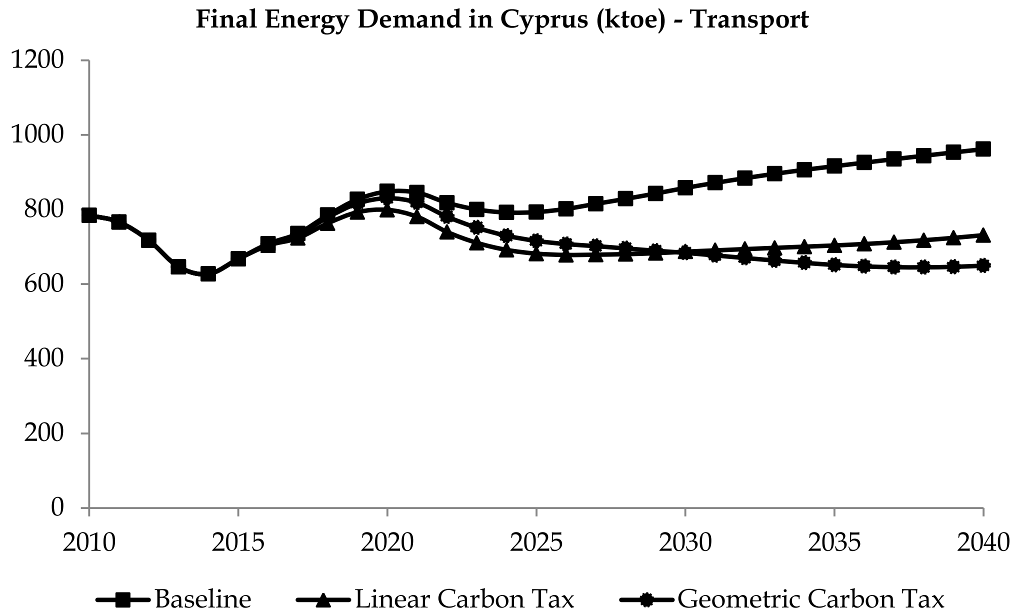
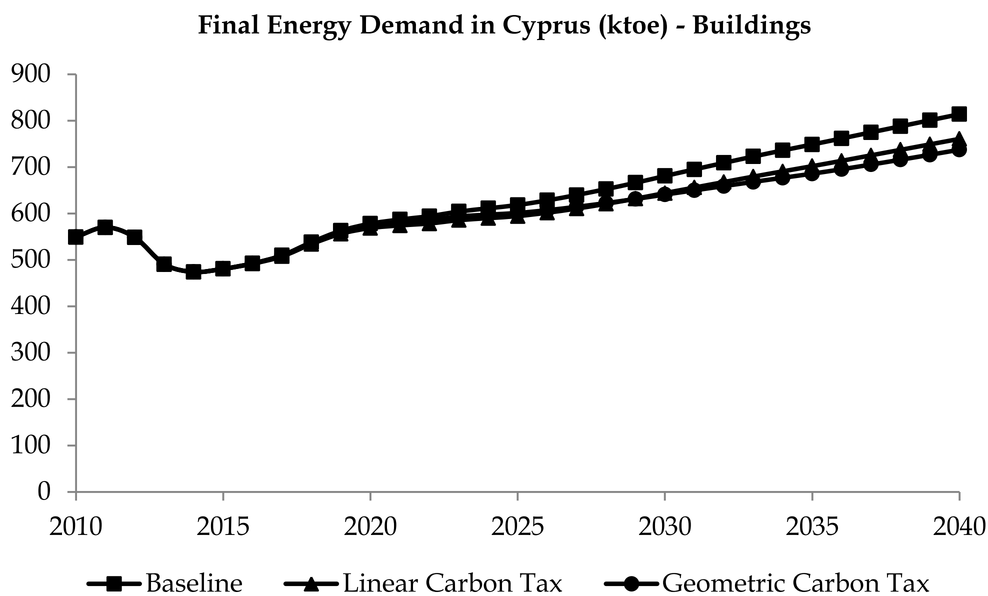


FIGURE 5

Evolution of energy use in transport and buildings for the three scenarios considered.





4. Discussion

As mentioned above, the carbon taxes required for compliance of Cyprus with its non-ETS commitment are rather high; they are expected to increase retail prices of petroleum fuels gradually but very substantially. Automotive petrol, for example, is projected to have a sales price in year 2030 that will be 37-46% higher in the carbon tax scenarios than in the baseline scenario. Heavy fuel oil, due to its higher carbon content, is forecast to be sold at more than double its baseline price. Is it realistic to expect a government to adopt such high carbon taxation? There are several observations that one can make to this point, which are mainly related to uncertainties in the future EU policy environment.

An important question is whether there are going to be further regulatory requirements at EU level that will mandate improved energy efficiency of buildings and vehicles. As shown earlier in this Section, the transport sector is particularly crucial for non-ETS emissions in Cyprus. In this regard, if stricter CO_2 emission standards are adopted by EU member states after 2020, this will make it easier for Cyprus to achieve its commitments for 2030 as fewer national policies (e.g. a lower carbon tax) will be required (T&E 2015). In its recent Energy Union initiative, the European Commission (2015) declares that special attention will be given to exploiting the large potential for energy efficiency improvements in the buildings and transport sectors.

Moreover, current decisions at EU level underline the need for flexibility in achieving the non-ETS emission reduction targets. Examples of such flexibility are the following:

- Some trading of emission allowances between ETS and non-ETS sectors may be allowed;
- Countries may have the option to 'carry over' excess allowances from the pre-2020 regulatory period to post-2020 years;
- International emission credits may be used in order to offset a part of national emissions;
- The effect on greenhouse gas emissions due to land use change may be taken into account when calculating a country's compliance with its non-ETS emission target.

With the exception of land use change, which may not be significant for Cyprus, all other flexibility provisions, to the extent that they may be used, may allow the country to comply with its non-ETS commitment even with lower abatement of direct greenhouse gas emissions. In this case a lower carbon tax would be needed.

A steep increase in fuel prices may have serious effects on competitiveness of enterprises and social equity. However, these can be adequately addressed if the implementation of a carbon tax is accompanied by a broader fiscal reform, involving a reduction in other taxes – e.g. social security contributions of both employers and employees. The carbon taxes will generate considerable additional public revenues, which will allow the government to reduce taxes that are more detrimental to economic activity. As we have noted in a recent policy brief (Zachariadis 2015), experience from many European countries has shown that such a fiscal reform can be deigned in a way to be beneficial both for the economy and the environment.

Finally, it should be noted that the non-ETS emission abatement commitment refers to greenhouse gases in general, and not only CO_2. Significant amounts of methane, another greenhouse gas, come from agriculture and waste management. It may be possible to reduce methane emissions more deeply than carbon emissions and at a lower cost. In such a case the carbon emission reduction requirements will be lower. This, however, is an uncertain development, which should not distract authorities from pursuing the goal of curbing CO_2 emissions from buildings and transport.

Notwithstanding the uncertainties mentioned above, Cypriot authorities should be prepared for taking action that will enable a substantial degree of decarbonisation of final energy use. For this purpose, it is highly advisable to start as soon as possible the gradual implementation of carbon taxation. Instead of other policies such as additional regulatory measures, voluntary agreements and awareness-raising campaigns, an economy-wide carbon tax is an appropriate measure that will complement EU regulations and should be the cornerstone of national energy and climate policy. Carbon taxation can gradually change the behaviour and investment decisions of energy consumers and can generate revenues that can be used to invest in low-carbon buildings and transport infrastructure, and also to compensate firms and citizens in a targeted manner – thereby addressing concerns about competitiveness and social equity. A carbon tax will also prove to be appropriate in preparation of the country's stronger decarbonisation efforts later in this century, in view of the deeper cuts in greenhouse gas emissions expected after 2030, as announced by the EU in its low-carbon energy roadmap (European Commission 2011, 2012). International organisations like the World Bank and the International Monetary Fund state clearly that carbon pricing, along with elimination of subsidies to the use of fossil fuels, are the most appropriate policy instruments for tackling climate change and improving economic performance of nations at the same time. At the IMF-World Bank annual

Meetings in October 2015 it was mentioned that, with oil prices being at low levels in 2015 (and most probably in 2016 as well), now is the right time for introducing carbon taxation.[1]

It is out of the scope of this paper to provide detailed estimates of the revenues to be generated through such a tax reform, the extent to which these revenues can be spent for different purposes, the competitiveness effects on Cypriot enterprises and the distributional impact across households. However, the analytical tools to estimate these effects are available and have already been used in the past to evaluate the corresponding impact of EU's earlier energy and climate policy package (Ketteni et al. 2013, Pashardes et al. 2014). With the support of national authorities, these tools can be employed for the detailed analysis of the carbon tax reform proposed in this paper.

5. Conclusions

This paper presented a new set of energy demand forecasts for the Republic of Cyprus up to the year 2040. They are based on a study prepared by the author for the International Renewable Energy Agency in 2014, but they are more up-to-date as regards recent developments in oil prices and focus on the ability of Cyprus to achieve the greenhouse gas emission reduction targets agreed by EU leaders in October 2014. The emphasis of the paper is on emission reductions in those sectors that are not subject to the EU Emissions Trading System, i.e. on final energy demand sectors excluding aviation and the cement industry.

According to a 'baseline' scenario, final energy demand will grow modestly over the coming decades, thus leading to some decoupling of energy use from economic growth. However, this development is by no means sufficient for Cyprus to achieve its 2030 emission targets. We therefore developed two additional scenarios that assume the implementation of an economy-wide carbon tax from 2016 onwards. It turns out that a strong tax which increases by around 15 Euros per tonne of CO_2 every year from 2016 onwards is necessary in order to induce a sufficient decline in carbon emissions, or alternatively a carbon tax that can start from very low levels and increase geometrically up to 2030.

Despite uncertainties in the details of the future EU policy regime on these emissions, Cypriot authorities should be prepared for taking action that

[1] See e.g. news item "Policymakers Face Historic Opportunity to Fight Climate Change", available at
http://www.imf.org/external/pubs/ft/survey/so/2015/NEW101015A.htm.

will enable a substantial degree of decarbonisation of final energy use. For this purpose, it is highly advisable to start as soon as possible the gradual implementation of carbon taxation in the frame of a broader environmental fiscal reform. A carbon tax would lead to a more rigorous implementation of energy efficiency measures in buildings and transport than currently foreseen, and would allow Cyprus both to decrease its carbon emissions in line with the long-term EU decarbonisation targets, and to reduce its dependence on fossil fuels.

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