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# The Effect of Energy Efficiency Policies on the Medium-Term Energy Outlook of Cyprus

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**Theodoros Zachariadis**

## Abstract

This paper presents an energy outlook for Cyprus up to the year 2020, quantifying the energy savings that can be attained depending on the degree of implementation of energy efficiency policies and the use of natural gas in power generation. It turns out that the recent economic crisis does not seem to hinder progress towards a more energy efficient economy, thanks to the increasingly stringent energy efficiency regulations for buildings foreseen in EU legislation. Proactive implementation of all energy efficiency measures promoted by EU policies, and a stronger commitment towards improving the energy performance of the transport sector, can lead to a substantial improvement in national energy productivity. In view of the future EU-wide commitments to reduce greenhouse gas emissions, a decisive adoption of energy efficiency policies will bring about a significant structural shift in the country's energy outlook, which will probably pass the cost-effectiveness test as well.

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**ΠΕΡΙΛΗΨΗ**

Το άρθρο μελετά τις ενεργειακές προοπτικές της Κύπρου μέχρι το έτος 2020, ποσοτικοποιώντας το δυναμικό εξοικονόμησης ενέργειας ανάλογα με το βαθμό υλοποίησης των ενεργειακών πολιτικών καθώς και τη χρήση φυσικού αερίου στην παραγωγή ενέργειας. Σύμφωνα με τις υπάρχουσες ενδείξεις, η σημερινή οικονομική κρίση δεν φαίνεται να εμποδίζει την πρόοδο της χώρας προς μια ενεργειακά αποδοτικότερη οικονομία, χάρη στους αυστηρούς ενεργειακούς κανονισμούς για τα κτίρια που προβλέπονται στην Ευρωπαϊκή νομοθεσία. Η προληπτική υλοποίηση όλων των ενεργειακών μέτρων που προωθούνται από την ΕΕ καθώς και ισχυρότερες δεσμεύσεις προς την κατεύθυνση της βελτίωσης της ενεργειακής απόδοσης του τομέα των οδικών μεταφορών μπορεί να οδηγήσει σε ουσιαστικές βελτιώσεις στην ενεργειακή παραγωγικότητα. Εν όψει των μελλοντικών Ευρωπαϊκών δεσμεύσεων για τη μείωση των εκπομπών των αερίων του θερμοκηπίου, η αποφασιστική υιοθέτηση τέτοιων μέτρων θα μπορούσε να επιφέρει μια αποφασιστική στροφή στις ενεργειακές προοπτικές της χώρας, χωρίς υπέρμετρο κόστος.

## 1. INTRODUCTION

In 2009 the European Union (EU) adopted a legislative package on energy and climate change, which involves several legally binding measures that aim at reducing greenhouse gas emissions in the EU by the year 2020. Apart from mandatory targets on emission reductions and penetration of renewable energy sources, an indicative non-binding target for an EU-wide 20% improvement in energy efficiency by the year 2020 was agreed. Although the intention was to make this target also mandatory, this was not achieved due to reactions from several EU Member States and other stakeholders. However, according to EU legislation, each Member State has to prepare a National Energy Efficiency Action Plan, which shall be submitted to the European Commission (the EU's executive body) and periodically updated. In line with this obligation, the 2nd National Action Plan was submitted by the Republic of Cyprus in summer 2011 (MCIT 2011) and was based on energy forecasts conducted by the author (Zachariadis 2011) in combination with information and bottom-up energy efficiency studies carried out by authorities.

This paper presents an update of the national energy forecasts for the Republic of Cyprus that were carried out with the latest version of our 3EP/CUT energy forecast model. These forecasts were used by national authorities in the submission of the updated 3rd National Energy Efficiency Action Plan to the European Commission (due in May 2014). In addition to the scenarios used by national authorities, the author has developed an additional scenario of more aggressive energy saving measures, which intends to demonstrate the realistic potential for energy savings in Cyprus based on today's possibilities and regulatory commitments for the near future.

Since the last submission of these Action Plans in year 2011, both the macroeconomic environment of Cyprus and the EU-wide regulatory environment in energy issues have changed considerably. In the macroeconomic front, after the dramatic events of March 2013 and the requirements for fiscal adjustment as well as downsizing and restructuring of the domestic banking sector in order to attain sustainable levels of public debt in the medium term, an economic and

financial adjustment programme for Cyprus was agreed between the national authorities and the Troika (European Commission, European Central Bank and International Monetary Fund); this led to the signature of a Memorandum of Understanding on 2 April 2013. This adjustment programme assumed a strong contraction of the national economy in years 2013-2014 – mainly due to significant decreases in private and public consumption as well as fixed investment – and a slow rebound of economic growth from 2015 onwards. After a re-examination of this programme in November 2013 and February 2014, some further revisions of the troika's macroeconomic projections have been made.

As far as the regulatory environment is concerned, an important change has been brought about by the EU's "Energy Efficiency Directive" (2012/27/EU). This Directive, pursuing the overall objective of saving 20% of the EU's primary energy consumption by 2020, calls (among other measures) for energy-efficiency-oriented renovations in the existing building stock – with specific obligations for governmental buildings in all EU Member States – and for specific energy savings to be attained by energy distributors or retail energy sales companies or by taking other policy measures to achieve energy savings to final energy users.

The national energy forecast model calculates future annual energy consumption in each major economic sector of Cyprus (agriculture, cement industry, other industry, households, services, road passenger transport, road freight transport and air transport) as a function of future macroeconomic variables and future energy prices. Simultaneously it calculates fuel shares in each sector, depending on technology costs (investment, operation, maintenance and fuel costs), the penetration potential of various technologies and technical constraints for the uptake of new technologies, and allows computing future final energy consumption by sector and fuel.

## 2. MACROECONOMIC AND OIL PRICE ASSUMPTIONS

Table 1 presents the basic macroeconomic assumptions up to the year 2020 that have been used in this study. Aggregate indicators, i.e. GDP and private consumption, are in line with the winter macroeconomic forecast of the European Commission (2014) that was published in February 2014. Economic output has declined substantially in 2013 and is projected to fall considerably in 2014 as well. According to this outlook, after some rebound in subsequent years, real GDP may only reach in 2020 the level that was recorded in year 2007. Although the adjustment programme is generally expected to affect services more strongly than other sectors of the economy, there are still vague indications about a potential change in the structure of GDP; in fact, some subsectors of the tertiary sector have turned out to be less vulnerable to the adjustment than initially expected. As the published macroeconomic forecasts do not include projections for the evolution of sectoral GDP shares, we assumed modest changes in sectoral contributions to GDP until 2020.

As regards the evolution of crude oil prices, which also affect the energy outlook of Cyprus, this study has adopted the latest oil price forecasts published by the International Energy Agency (2013). According to the IEA's medium forecast ('New Policies Scenario'), crude oil price is expected to increase slightly and reach $113 per barrel in 2020 (at constant prices of year 2012) with a further increasing trend in later years.

TABLE 1: Macroeconomic assumptions for Cyprus as of March 2014.

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Real GDP (mio Euros at 2005 prices) | 15106 | 15172 | 14806 | 13932 | 13264 | 13383 | 13633 | 13953 | 14259 | 14527 | 14790 |
| *Annual growth rate of GDP:* | *1.3%* | *0.4%* | *-2.4%* | *-6.0%* | *-4.8%* | *0.9%* | *1.9%* | *2.3%* | *2.2%* | *1.9%* | *1.8%* |
| Real private consumption (mio Euros at 2005 prices) | 10135 | 10271 | 10012 | 9108 | 8534 | 8594 | 8850 | 9151 | 9453 | 9699 | 9928 |
| *Annual growth rate of private consumption:* | *1.5%* | *1.3%* | *-2.5%* | *-7.5%* | *-6.3%* | *0.7%* | *3.0%* | *3.4%* | *3.3%* | *2.6%* | *2.4%* |
| *Sectoral shares of GDP:* | | | | | | | | | | | |
| Agriculture | 2.1% | 2.1% | 2.1% | 2.1% | 2.1% | 2.0% | 2.0% | 2.0% | 1.9% | 1.9% | 1.9% |
| Industry | 9.9% | 9.5% | 9.4% | 9.4% | 9.4% | 9.3% | 9.3% | 9.3% | 9.2% | 9.2% | 9.2% |
| Construction | 8.8% | 7.8% | 7.9% | 7.9% | 7.9% | 8.0% | 8.0% | 8.0% | 8.1% | 8.1% | 8.1% |
| Services | 79.3% | 80.5% | 80.6% | 80.6% | 80.6% | 80.7% | 80.7% | 80.7% | 80.8% | 80.8% | 80.8% |

Source: For years 2010-2012, official national accounts, Statistical Service of the Republic of Cyprus. For years 2013-2020, assumptions regarding GDP and private consumption from winter macroeconomic forecast of the European Commission (2014); sectoral GDP shares are author's own estimates.

## 3. ENERGY EFFICIENCY CONSIDERATIONS

To simulate the effect of energy efficiency measures on national energy consumption, the two available scenarios from earlier national Action Plans ('reference' and 'additional energy efficiency' scenario respectively) have been updated. Moreover, an additional scenario has been included in this study, assuming full implementation of all provisions of recently adopted EC Directives.

The three scenarios contain different assumptions with regard to the implementation of energy efficiency measures in the various sectors of the Cypriot economy. Such measures include:

– Actions taken as a result of mandatory compliance with EU legislation, such as the 'Energy Services Directive' (2006/32/EC), the Directive on labelling and standard product information of the energy consumption by energy-related products (2010/30/EC), the Directive on energy performance of buildings (2010/31/EC), and the recent Energy Efficiency Directive (2012/27/EU); and

– Additional national measures such as subsidies for energy efficiency and renewable energy investments by households and firms.

More specifically:

- The 'reference' scenario assumes that no additional measures – at EU and national level – are implemented after 2010. In other words, Directives adopted in year 2010 and national subsidies up to the year 2010 are assumed to take effect, but no post-2010 actions are included. It has to be noted that this scenario is not identical with the corresponding 'reference scenario' that was used in the NEEAP of Cyprus of 2011 because this scenario incorporates the latest macroeconomic and energy price developments as described in Section 2 of this paper.

- The 'additional energy efficiency' scenario assumes that further energy efficiency measures are adopted in the post-2010 period, such as a continuation of national subsidies for investments in energy saving technologies, the implementation of the 'recast Buildings Directive' at EU level, and some modest adoption of further legislation on near-zero energy buildings later in this decade.

- The ‘over-compliance’ scenario (which is new in this study) assumes a more aggressive adoption of near-zero energy building regulations, the implementation of strong regional and local energy saving initiatives from municipalities and the implementation of measures to achieve (or even exceed) full compliance with the recent Energy Efficiency Directive (2012/27/EU). It therefore leads to higher energy savings in building sectors, i.e. households and services, than the ‘additional energy efficiency’ scenario. It has to be emphasised that this scenario is based on assumptions and calculations of the author and has not been agreed with (or endorsed by) the Ministry of Energy, Commerce, Industry and Tourism of the Republic of Cyprus.

As regards the fuel shares in each end-use sector, for all three scenarios described above, the energy model calculates with dynamic recursive equations – for each future year – the allocation of final energy demand among different fuels. For this purpose, the uptake of different technologies/fuels by sector is simulated, based on each technology’s costs as well as on the technically exploitable potential of each technological option. For this purpose, detailed technical information was obtained from the Cyprus Energy Service and the Cyprus Institute of Energy on the basis of earlier specialised sectoral studies and data collected in the frame of national grant schemes for investments in energy efficient and renewable energy technologies. In principle it was assumed that no drastic changes in the fuel mix of final energy consumption will take place until 2020, apart from some shifts towards renewable energy forms (including biomass and biofuels) to ensure compliance with related EU legislation.

## 4. POWER GENERATION

The electricity sector is not modelled explicitly by our energy model in its current form; however, the model’s projections for final electricity demand by sector and scenario are combined with official forecasts of the power generation sector, and fuel inputs for power generation are then calculated on the basis of appropriate assumptions.

For the purpose of this update of energy forecasts, the governmental power generation forecast (developed by the Transmission System Operator in April 2013 and adopted by the Energy Regulatory Authority in June 2013) was not

used as such. The governmental forecast has taken into account, apart from recent macroeconomic developments, some energy saving measures that are more advanced than what is included in the definition of the 'reference scenario' (see Section 3) and partly more advanced than in the 'energy efficiency scenario', but does not include other measures that have not started being implemented yet and are included in the definition of the 'over-compliance scenario'. As a result, the power generation forecasts of year 2020 shown for the three scenarios of this report are:

- substantially higher than the official forecast in the 'reference scenario';
- somewhat higher than the official forecast in the 'additional energy efficiency scenario';
- considerably lower than the official forecast in the 'over-compliance scenario'.

As regards fuel inputs in power generation, in line with the definition of the two scenarios that was used in the NEEAP of Cyprus of 2011, the 'reference scenario' assumes that natural gas will not penetrate in power generation of the country until 2020, whereas the other two scenarios were calculated by assuming that natural gas will enter the market in 2016, as foreseen by national authorities in November 2013.

In all three scenarios it was assumed that renewable electricity generation will reach the levels foreseen by the official Renewable Energy Action Plan of 2010, i.e. 101 ktoe[1] in the year 2020.

Thermal efficiency of power generation in the case with natural gas was calculated on the basis of earlier official forecasts of the Cyprus Energy Regulatory Authority. Overall thermal efficiency of non-renewable power plants is forecast to increase considerably thanks to the introduction of natural gas form 2016 onwards, up to 49.2% in 2020. Most of the power generation in year 2020 will take place in natural gas fired combined cycle gas turbine (CCGT) power plants. A considerable fraction of electricity will be produced by renewable energy sources, and only a tiny fraction of fuel oil and diesel oil will be used.

[1] ktoe (thousand tonnes of oil equivalent) is a unit of energy consumption that is commonly used in energy statistics and forecasts.

For the case of no natural gas penetration (i.e. in the 'reference scenario'), it was assumed that the thermal efficiency of non-renewable power plants will improve slightly over the years. This may happen because all newly built power plants in Cyprus use the CCGT technology. Even though their utilisation will not be as high as in the case of natural gas (because in the absence of natural gas they have to operate with more expensive diesel oil and plant operators will prefer to use cheaper fuel oil burning power plants more intensively than CCGT plants), and despite a somewhat lower thermal efficiency of these plants when they operate on diesel oil instead of natural gas, still they will improve the average thermal efficiency to some extent, so that a gradual increase of average efficiency up to 40% in 2020 seems to be justified.

## 5. RESULTS

Tables 2-4 present the energy demand forecasts by fuel up to the year 2020, for the economic sectors falling under the 'heating and cooling' category (households, cement industry, rest of industry, services and agriculture) for the 'reference scenario', the 'additional energy efficiency scenario' and the 'over-compliance scenario' respectively. Tables 5-6 display the corresponding results for the transport sectors (road passenger, road freight and air transport); it has to be noted that the 'additional energy efficiency' and 'over-compliance' scenarios are identical for all transport sectors. Table 7 presents the total national energy consumption forecasts for the three scenarios, while Table 8 shows the resulting energy savings that can be used in the updated National Energy Efficiency Action Plan of Cyprus.[2]

[2] More detailed results by economic sector can be found in MECIT (2014, pp. 247-267) for the two official scenarios; results of the 'over-compliance scenario' are available from the author upon request.

TABLE 2: Forecast of final energy demand for heating and cooling in Cyprus in the Reference Scenario (ktoe).

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diesel | 10 | 9 | 8 | 6 | 5 | 4 | 4 | 4 | 4 | 4 | 4 |
| Aviation fuel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Heating fuel | 135 | 153 | 154 | 142 | 133 | 130 | 129 | 132 | 135 | 139 | 143 |
| Light Fuel Oil | 31 | 28 | 32 | 27 | 25 | 27 | 28 | 30 | 32 | 33 | 35 |
| Heavy Fuel Oil | 16 | 12 | 10 | 9 | 8 | 7 | 7 | 7 | 8 | 9 | 9 |
| LPG | 58 | 64 | 64 | 60 | 56 | 56 | 56 | 59 | 62 | 65 | 68 |
| Electricity | 207 | 198 | 203 | 187 | 178 | 176 | 178 | 187 | 199 | 212 | 224 |
| Other solid fuels | 102 | 77 | 60 | 55 | 52 | 50 | 51 | 53 | 55 | 58 | 60 |
| Biofuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biomass | 10 | 13 | 15 | 15 | 15 | 16 | 18 | 20 | 24 | 27 | 30 |
| Geothermal | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Solar Thermal | 61 | 63 | 61 | 57 | 54 | 54 | 56 | 61 | 67 | 74 | 81 |
| **Total** | **632** | **619** | **608** | **559** | **527** | **522** | **528** | **553** | **587** | **622** | **656** |
| **Total non-electricity** | **424** | **421** | **405** | **371** | **349** | **345** | **350** | **366** | **387** | **410** | **432** |
| **Total renewables** | **72** | **77** | **77** | **72** | **70** | **71** | **74** | **82** | **92** | **102** | **112** |

TABLE 3: Forecast of final energy demand for heating and cooling in Cyprus in the Additional Energy Efficiency Scenario (ktoe).

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diesel | 10 | 9 | 8 | 6 | 5 | 4 | 4 | 4 | 4 | 4 | 4 |
| Aviation fuel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Heating fuel | 135 | 153 | 154 | 142 | 131 | 128 | 128 | 129 | 130 | 131 | 132 |
| Light Fuel Oil | 31 | 28 | 32 | 27 | 25 | 27 | 28 | 29 | 31 | 32 | 33 |
| Heavy Fuel Oil | 16 | 12 | 10 | 9 | 8 | 7 | 7 | 7 | 8 | 8 | 9 |
| LPG | 58 | 64 | 64 | 60 | 55 | 55 | 55 | 57 | 58 | 59 | 60 |
| Electricity | 415 | 397 | 392 | 362 | 337 | 336 | 345 | 364 | 387 | 406 | 427 |
| Other solid fuels | 102 | 77 | 60 | 55 | 52 | 51 | 51 | 54 | 56 | 59 | 61 |
| Biofuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biomass | 10 | 13 | 15 | 15 | 14 | 15 | 16 | 19 | 21 | 24 | 26 |
| Geothermal | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Solar Thermal | 61 | 63 | 61 | 57 | 53 | 52 | 53 | 56 | 60 | 63 | 66 |
| **Total** | **839** | **818** | **798** | **734** | **682** | **676** | **688** | **719** | **755** | **787** | **818** |
| **Total non-electricity** | **424** | **421** | **405** | **371** | **345** | **340** | **343** | **355** | **368** | **381** | **391** |
| **Total renewables** | **72** | **77** | **77** | **72** | **68** | **68** | **70** | **75** | **82** | **88** | **93** |

TABLE 4: Forecast of final energy demand for heating and cooling in Cyprus in the Over-Compliance Scenario (ktoe).

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diesel | 10 | 9 | 8 | 6 | 5 | 4 | 4 | 3 | 3 | 3 | 3 |
| Aviation fuel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Heating fuel | 135 | 153 | 154 | 142 | 131 | 124 | 120 | 118 | 117 | 117 | 116 |
| Light Fuel Oil | 31 | 28 | 32 | 27 | 25 | 26 | 26 | 27 | 27 | 28 | 29 |
| Heavy Fuel Oil | 16 | 12 | 10 | 9 | 8 | 7 | 6 | 7 | 7 | 8 | 8 |
| LPG | 58 | 64 | 64 | 60 | 55 | 53 | 51 | 51 | 52 | 52 | 52 |
| Electricity | 207 | 198 | 203 | 187 | 173 | 164 | 160 | 160 | 162 | 165 | 167 |
| Other solid fuels | 102 | 77 | 60 | 55 | 51 | 49 | 48 | 49 | 51 | 52 | 54 |
| Biofuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biomass | 10 | 13 | 15 | 15 | 14 | 15 | 15 | 17 | 19 | 21 | 22 |
| Geothermal | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Solar Thermal | 61 | 63 | 61 | 57 | 53 | 50 | 49 | 51 | 53 | 55 | 57 |
| **Total** | **632** | **619** | **608** | **559** | **515** | **492** | **481** | **484** | **492** | **501** | **509** |
| **Total non-electricity** | **424** | **421** | **405** | **371** | **342** | **328** | **321** | **324** | **330** | **336** | **342** |
| **Total renewables** | **72** | **77** | **77** | **72** | **68** | **66** | **65** | **68** | **73** | **76** | **80** |

TABLE 5: *Forecast of final energy demand for transport in Cyprus in the Reference Scenario (ktoe).*

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 410 | 404 | 384 | 348 | 318 | 310 | 312 | 319 | 329 | 339 | 345 |
| Diesel | 359 | 345 | 314 | 290 | 267 | 267 | 273 | 286 | 304 | 321 | 335 |
| Aviation fuel | 285 | 311 | 278 | 250 | 230 | 225 | 227 | 237 | 255 | 268 | 277 |
| LPG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 3 |
| Other solid fuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biofuels | 16 | 17 | 16 | 15 | 13 | 16 | 19 | 25 | 34 | 44 | 55 |
| Biomass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **1070** | **1077** | **992** | **902** | **828** | **819** | **832** | **869** | **924** | **975** | **1015** |
| **Total renewables (excl. electricity)** | **16** | **17** | **16** | **15** | **13** | **16** | **19** | **25** | **34** | **44** | **55** |

TABLE 6: Forecast of final energy demand for transport in Cyprus in the Additional Energy Efficiency & Over-Compliance Scenarios (ktoe).

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline | 410 | 404 | 384 | 348 | 316 | 306 | 306 | 310 | 317 | 320 | 322 |
| Diesel | 359 | 345 | 314 | 290 | 266 | 264 | 268 | 280 | 295 | 309 | 320 |
| Aviation fuel | 285 | 311 | 278 | 250 | 228 | 223 | 224 | 233 | 248 | 260 | 268 |
| LPG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 3 |
| Other solid fuels | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Biofuels | 16 | 17 | 16 | 15 | 13 | 16 | 18 | 24 | 33 | 42 | 51 |
| Biomass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **1070** | **1077** | **992** | **902** | **824** | **809** | **817** | **847** | **894** | **933** | **964** |
| **Total renewables (excl. electricity)** | **16** | **17** | **16** | **15** | **13** | **16** | **18** | **24** | **33** | **42** | **51** |

When comparing these projections with the forecast of NEEAP 2011, five points stand out. First, it is evident from Table 7 that Cyprus can attain in relative terms essentially the same energy savings (14.5%) as those foreseen in the NEEAP 2011. This is possible thanks to the current implementation level of EU regulatory initiatives, and despite strongly declining energy consumption up to 2015 as a result of the serious economic recession of years 2012-2015, which brings the reference energy consumption in 2020 to 2575 ktoe – 20% down from 3219 ktoe of the reference scenario of NEEAP 2011.

Second, according to Table 7 when compared with the corresponding results of NEEAP 2011, the buildings sector contributes more to energy savings in the current Action Plan, while the potential energy savings in transport have been revised downwards, in line with information provided by national transport authorities. This means that if more stringent or aggressive measures were taken in the transport sector (mainly as regards promotion of public transport and early adoption of more fuel-efficient and low-CO2 cars and trucks), the relative energy savings could be clearly higher than in NEEAP 2011. In the absence of such measures, however, and assuming that transport-related measures will only involve the adoption of EU Directives and Regulations, the result of Table 7 seems to be a plausible evolution until 2020.

Third, the absolute figure of energy savings to be attained in the 'energy efficiency scenario' is markedly lower than in the earlier NEEAP – 375 ktoe as opposed to 463 ktoe in the 2011 Action Plan. This should not be surprising since the projected national energy consumption, as illustrated in Figure 1, is considerably lower. When total demand for energy declines, as a result of lower incomes and reduced economic activity, the savings that can be obtained with the aid of energy efficiency measures will inevitably be lower as well. Energy intensity drops considerably in the current 'energy efficiency scenario', albeit less fast than foreseen in the corresponding scenario of NEEAP 2011: the economic recession, reinforced by limited capital investment expenditure and lack of adequate public funds, leads to delays in the expansion of new activities utilizing modern energy technologies and slower adoption of energy efficient technologies in both the existing and new stock of buildings and equipment. Thanks to the increasingly stringent energy efficiency regulations as foreseen in EU legislation, particularly in the buildings sector, the economic crisis is not expected to cause a serious setback in the progress towards a more energy efficient economy.

Fourth, in contrast to the 'energy efficiency scenario' of the NEEAP of 2011, where most of the savings came from the introduction of natural gas in the energy system, in the current scenario almost half of the total savings (182 ktoe) can come from energy saving measures in end-use sectors and the other half (192 ktoe) from additional savings in primary energy consumption due to the use of natural gas in power generation. Again, this has to be attributed to the stronger efficiency improvements in the buildings sector, while the reduced needs for electricity in the current scenarios constitute the improvements thanks to natural gas somewhat less important than in NEEAP 2011.

Finally, the full and stringent implementation of all additional energy efficiency measures foreseen in the 'over- compliance scenario' might lead Cyprus to achieve a reduction of 621 ktoe, or more than 24%, in national energy consumption compared to the reference scenario. In such a case, and in contrast to the 'energy efficiency scenario' and the NEEAP of 2011, the major portion of these savings can come from energy saving measures in end-use sectors and less than one third (192 ktoe) from additional savings in primary energy use due to the introduction of natural gas in power generation. It has to be underlined, however, that this scenario has to be considered as a high-end estimate of potential energy savings in Cyprus up to 2020; in view of the practical and

administrative barriers (as well as the substantial costs) from the eventual implementation of all measures foreseen in the 'over-compliance scenario', this option has to be treated with caution and should not be regarded as a realistic path – at least at the time of this writing (March 2014).

FIGURE 1: Comparison of the projected evolution of national energy consumption in Cyprus according to the NEEAP of 2011 and the current update of NEEAP

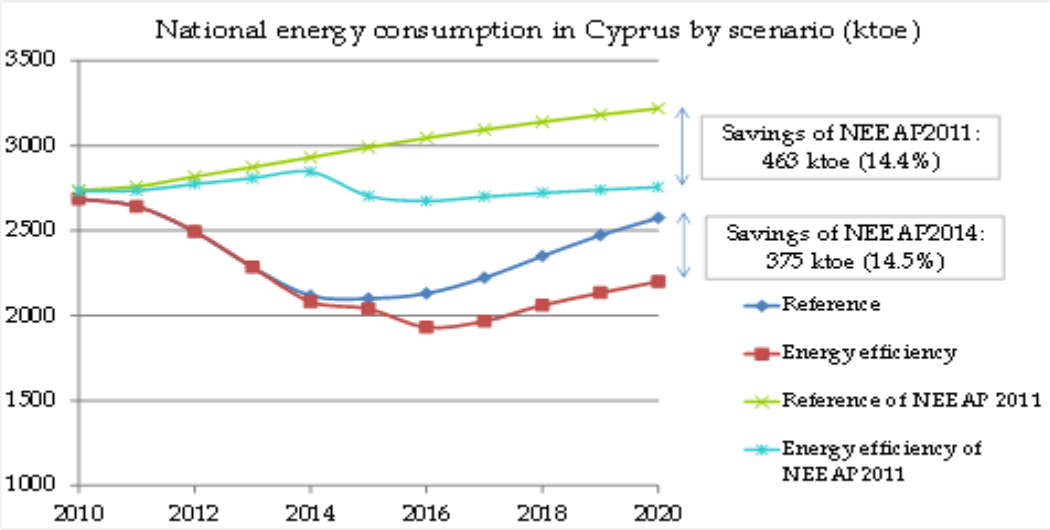

TABLE 7: Forecast of national energy consumption in Cyprus according to the scenarios considered (ktoe).

| **Reference scenario** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary energy input for power generation | 1194 | 1146 | 1097 | 1011 | 940 | 936 | 950 | 989 | 1041 | 1091 | 1132 |
| Fuel inputs for power generation | 1174 | 1125 | 1075 | 980 | 901 | 890 | 897 | 926 | 967 | 1004 | 1030 |
| Renewables input for power generation | 20 | 21 | 22 | 31 | 39 | 46 | 53 | 63 | 74 | 87 | 101 |
| Final non-electricity consumption | 1494 | 1498 | 1397 | 1274 | 1177 | 1164 | 1181 | 1234 | 1310 | 1382 | 1444 |
| Industry | 176 | 140 | 124 | 108 | 99 | 98 | 100 | 105 | 112 | 119 | 125 |
| Services | 50 | 74 | 77 | 72 | 69 | 71 | 72 | 76 | 82 | 89 | 95 |
| Households | 172 | 183 | 176 | 164 | 156 | 152 | 154 | 162 | 170 | 179 | 188 |
| Road Transport | 785 | 766 | 714 | 653 | 598 | 592 | 601 | 625 | 659 | 692 | 721 |
| Air Transport | 285 | 311 | 278 | 250 | 230 | 226 | 230 | 243 | 264 | 280 | 291 |
| Agriculture | 26 | 25 | 29 | 27 | 25 | 24 | 23 | 23 | 23 | 24 | 24 |
| Final electricity consumption | 415 | 397 | 392 | 362 | 346 | 352 | 364 | 387 | 416 | 444 | 471 |
| **National energy consumption** | **2688** | **2643** | **2494** | **2284** | **2118** | **2100** | **2131** | **2223** | **2351** | **2473** | **2575** |

TABLE 7 (continued)

| **Energy efficiency scenario with NG in 2016** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary energy input for power generation | 1194 | 1146 | 1097 | 1011 | 913 | 891 | 772 | 766 | 800 | 823 | 848 |
| Fuel inputs for power generation | 1174 | 1125 | 1075 | 980 | 874 | 845 | 719 | 703 | 726 | 736 | 747 |
| Renewables input for power generation | 20 | 21 | 22 | 31 | 39 | 46 | 53 | 63 | 74 | 87 | 101 |
| Final non-electricity consumption | 1494 | 1498 | 1397 | 1274 | 1169 | 1149 | 1159 | 1202 | 1261 | 1311 | 1352 |
| Industry | 176 | 140 | 124 | 108 | 99 | 98 | 100 | 105 | 112 | 118 | 123 |
| Services | 50 | 74 | 77 | 72 | 68 | 68 | 69 | 72 | 75 | 78 | 80 |
| Households | 172 | 183 | 176 | 164 | 153 | 149 | 151 | 155 | 158 | 161 | 164 |
| Road Transport | 785 | 766 | 714 | 653 | 595 | 585 | 589 | 608 | 636 | 660 | 680 |
| Air Transport | 285 | 311 | 278 | 250 | 228 | 224 | 227 | 239 | 257 | 271 | 281 |
| Agriculture | 26 | 25 | 29 | 27 | 25 | 24 | 23 | 23 | 23 | 24 | 24 |
| Final electricity consumption | 415 | 397 | 392 | 362 | 337 | 336 | 345 | 364 | 388 | 408 | 430 |
| **National energy consumption** | **2688** | **2643** | **2494** | **2284** | **2082** | **2040** | **1931** | **1968** | **2061** | **2134** | **2201** |
| | | | | | | | | | | | |
| **Over-compliance scenario with NG in 2016** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Primary energy input for power generation | 1194 | 1146 | 1097 | 1011 | 911 | 874 | 727 | 684 | 676 | 664 | 651 |
| Fuel inputs for power generation | 1174 | 1125 | 1075 | 980 | 872 | 828 | 674 | 621 | 602 | 577 | 549 |
| Renewables input for power generation | 20 | 21 | 22 | 31 | 39 | 46 | 53 | 63 | 74 | 87 | 101 |
| Final non-electricity consumption | 1494 | 1498 | 1397 | 1274 | 1166 | 1137 | 1138 | 1170 | 1222 | 1267 | 1304 |
| Industry | 176 | 140 | 124 | 108 | 97 | 95 | 94 | 97 | 101 | 105 | 109 |
| Services | 50 | 74 | 77 | 72 | 67 | 65 | 65 | 65 | 66 | 68 | 70 |
| Households | 172 | 183 | 176 | 164 | 153 | 144 | 140 | 140 | 140 | 140 | 140 |
| Road Transport | 785 | 766 | 714 | 653 | 595 | 585 | 589 | 608 | 636 | 660 | 680 |
| Air Transport | 285 | 311 | 278 | 250 | 228 | 224 | 227 | 239 | 257 | 271 | 281 |
| Agriculture | 26 | 25 | 29 | 27 | 25 | 24 | 23 | 22 | 23 | 23 | 23 |
| Final electricity consumption | 415 | 397 | 392 | 362 | 336 | 331 | 327 | 329 | 333 | 337 | 341 |
| **National energy consumption** | **2688** | **2643** | **2494** | **2284** | **2077** | **2011** | **1865** | **1854** | **1898** | **1931** | **1954** |

TABLE 8: Assessment of energy savings in Cyprus up to the year 2020.

| **Savings, 'Additional Energy Efficiency Scenario' compared to Reference Scenario** | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***(ktoe)*** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Savings in final non-electricity consumption | | | | | | | |
| *Industry* | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| *Services* | 2 | 2 | 3 | 4 | 7 | 11 | 15 |
| *Households* | 3 | 3 | 4 | 7 | 12 | 18 | 24 |
| *Road Transport* | 3 | 7 | 12 | 17 | 23 | 33 | 41 |
| *Air Transport* | 1 | 2 | 3 | 4 | 7 | 9 | 9 |
| *Total Transport* | 4 | 10 | 15 | 22 | 30 | 42 | 50 |
| *Agriculture* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Savings in final electricity consumption | 9 | 16 | 19 | 23 | 27 | 36 | 41 |
| Savings in primary electricity production because of savings in final electricity | 27 | 45 | 46 | 53 | 61 | 81 | 91 |
| Savings in primary electricity due to introduction of natural gas | 0 | 0 | 132 | 171 | 179 | 187 | 192 |
| Total savings in primary electricity | 27 | 45 | 178 | 223 | 240 | 268 | 283 |
| **Savings in national energy consumption** | **36** | **61** | **200** | **255** | **290** | **339** | **375** |
| ***(% of reference scenario)*** | ***1.7%*** | ***2.9%*** | ***9.4%*** | ***11.5%*** | ***12.3%*** | ***13.7%*** | ***14.5%*** |

| **Savings, 'Over-Compliance Scenario' compared to Reference Scenario** | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***(ktoe)*** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
| Savings in final non-electricity consumption | | | | | | | |
| *Industry* | 1 | 4 | 6 | 8 | 11 | 14 | 16 |
| *Services* | 3 | 5 | 8 | 11 | 16 | 21 | 25 |
| *Households* | 3 | 8 | 14 | 22 | 30 | 39 | 48 |
| *Road Transport* | 3 | 7 | 12 | 17 | 23 | 33 | 41 |
| *Air Transport* | 1 | 2 | 3 | 4 | 7 | 9 | 9 |
| *Total Transport* | 4 | 10 | 15 | 22 | 30 | 42 | 50 |
| *Agriculture* | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Savings in final electricity consumption | 10 | 22 | 37 | 59 | 82 | 107 | 130 |
| Savings in primary electricity production because of savings in final electricity | 29 | 62 | 90 | 135 | 186 | 240 | 289 |
| Savings in primary electricity due to introduction of natural gas | 0 | 0 | 132 | 171 | 179 | 187 | 192 |
| Total savings in primary electricity | 29 | 62 | 223 | 305 | 365 | 426 | 481 |
| **Savings in national energy consumption** | **40** | **89** | **266** | **369** | **452** | **542** | **621** |
| ***(% of reference scenario)*** | ***1.9%*** | ***4.3%*** | ***12.5%*** | ***16.6%*** | ***19.2%*** | ***21.9%*** | ***24.1%*** |

## 6. CONCLUSIONS

With the aid of a long-term energy forecast model, we have quantified the energy savings that can be attained in Cyprus up to 2020 for three different scenarios, depending on assumptions as regards the degree of implementation of energy efficiency policies and the use of natural gas in power generation. Our calculations show that Cyprus can attain in relative terms essentially the same energy savings that were foreseen in 2011, before the economic and financial crisis of recent years. Out of these savings, almost half may come from energy saving measures in end-use sectors and the other half may be due to the use of natural gas in power generation. Compared to the earlier National Energy Efficiency Acton Plan of the Republic of Cyprus, the buildings sector is now projected to contribute more to energy savings, while the potential improvements in energy productivity of transport have been revised downwards; this means that if more stringent measures are taken in the transport sector (mainly as regards promotion of public transport and early adoption of more fuel-efficient and low-$CO_2$ cars and trucks), total energy savings can be clearly higher. The recent economic crisis in Cyprus does not seem to hinder progress towards a more energy efficient economy, thanks to the increasingly stringent energy efficiency regulations as foreseen in EU legislation.

In addition to two scenarios that are used by national authorities, this paper has provided an alternative forecast with a third scenario that assumes stringent implementation of all additional energy efficiency measures foreseen in EU legislation and policy initiatives. It turns out that such a strategy can lead to a substantial improvement of energy productivity. Detailed analyses of such policies in other European countries have shown many of these measures to be cost-effective. In view of the future EU-wide greenhouse gas emission reduction commitments, which Cyprus will have to implement, a proactive adoption of strong energy efficiency policies will bring about a significant structural shift in the country's energy outlook, which will probably pass the cost-effectiveness test as well.

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