The unrecognized contribution of renewable energy to Europe's energy savings target

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ABSTRACT
We show that renewable energy contributes to Europe's 2020 primary energy savings target. This contribution, which is to a large extent still unknown and not recognized by policy makers, results from the way renewable energy is dealt with in Europe's energy statistics. We discuss the policy consequences and argue that the 'energy savings' occurring from the accounting of renewable energy should not distract attention from demand-side energy savings in sectors such as transport, industry and the built environment. The consequence of such a distraction could be that many of the benefits from demand-side energy savings, for example lower energy bills, increase of the renewable energy share in energy consumption without investing in new renewable capacity, and long-term climate targets to reduce greenhouse gas emissions by more than 80%, will be missed. Such distraction is not hypothetical since Europe's 2020 renewable energy target is binding whereas the 2020 primary energy savings target is only indicative.

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1. Introduction

It is commonly recognized that with increased energy savings it is easier to increase the share of renewable energy in energy supply. In Europe's Renewable Energy Directive 2009/28/EC the European Commission states e.g. that 'energy efficiency and energy saving policies are some of the most effective methods by which Member States can increase the percentage share of energy from renewable sources, and Member States will thus more easily achieve the overall national and transport targets for energy from renewable sources laid down by this Directive' (European Commission, 2009, recital 17)

Less known is the fact that renewable energy contributes to Europe's target to save 20% primary energy by 2020. The aim of this article is to unravel and clarify this interaction of renewable energy with primary energy savings and to discuss its relevance for Europe's energy savings policy. In doing so, we first provide some background on Europe's energy savings target. Then, we show how increasing the share of renewable energy sources leads to primary energy savings. Subsequently, we analyze the interaction of Europe's energy savings target with the binding renewable energy target and quantify the primary energy savings impact of renewable energy in a scenario approach. Finally, we discuss the results of our analysis and their relevance for Europe's energy savings policy.

2. Europe's energy savings target: 20% energy savings in 2020

Europe aims to achieve 20% primary energy savings in the period 2005–2020. This target is non-binding (indicative) and originates from the 2005 Green Paper on Energy Efficiency (European Commission, 2005). It was restated in the Action Plan for Energy Efficiency in 2006 (European Commission, 2006), politically endorsed at the Spring Council of 2007 (European Commission, 2007), reconfirmed as part of the EU's Climate and Energy package in 2008 (European Commission, 2008a) and finally adopted 17 June 2010 by the European Heads of State of government (the European Council) as part of the 'Europe 2020' strategy (European Commission, 2010a, 2010b). Also in the Energy Efficiency Plan 2011 (European Commission, 2011a) and Europe's 2050 roadmap (European Commission, 2011b), the 20% target has been restated.

In none of the above mentioned documents from the European Commission it is documented how the 20% target should be interpreted, i.e. whether it is defined as a fixed energy savings volume or whether it is a target relative to a moving baseline scenario or a fixed baseline scenario. In case the target should be interpreted as a fixed volume of energy savings, the amount of savings to be achieved is fully
transparent (i.e. a fixed number). However, the level of primary energy use in the target year is uncertain as it depends on economic growth rates.

The second option is to interpret the target as being relative to a moving baseline scenario. This would mean that the baseline projection is corrected for new insights in economic growth, energy price development, etc. In this case, both the level of primary energy use in the target year and the amount of savings to be achieved is uncertain.

In case the target is relative to a fixed baseline scenario, this would mean full transparency regarding the level of primary energy use to be achieved in the target year. Such target would however also mean that the amount (volume) of energy savings to be achieved is uncertain as the actual growth of activity in the economy might differ (lower or higher growth) from what is projected in the fixed baseline.

Although the European Commission has not been explicit in the interpretation of its target definition, it can be derived from the 2008 communication from the European Commission ‘Energy efficiency: delivering the 20% target’ (European Commission, 2008b) that the 20% target should be interpreted as being relative to a fixed baseline projection, more specifically, the PRIMES-2007 baseline scenario ‘European Energy and Transport, Trends to 2030—Update 2007’ (Capros et al., 2008). In the communication, the European Commission indicates that the 20% target should lead to a total primary energy use in the European Union (EU) of 66 EJ (1574 Mtoe) in 2020 (European Commission, 2008b, Annex 1).

From Fig. 1 it can be derived that compared to the PRIMES-2007 2020 projection a volume of 16 EJ (394 Mtoe) energy savings needs to be achieved to realize the 20% target. According to the 2006 Energy Efficiency Action Plan (European Commission, 2006) these savings should be achieved by end-use energy efficiency improvements and more efficient energy conversion in the supply sector. The following priority actions have been listed in the Action Plan (European Commission, 2006):

- Appliance and equipment labeling and minimum energy performance standards.
- Building performance requirements and very low energy buildings (‘passive houses’).
- Making power generation and distribution more efficient.
- Achieving fuel efficiency of cars.
- Facilitating appropriate financing of energy efficiency investments for small and medium enterprises and Energy Service Companies.
- Spurring energy efficiency in the new Member States.
- A coherent use of taxation.
- Raising energy efficiency awareness.
- Energy efficiency in built-up areas.
- Foster energy efficiency worldwide.

In the 2011 Energy Efficiency Plan (European Commission, 2011a), the emphasis is put on (1) the exemplary and leading role of the public sector, (2) paving the way towards low energy consuming buildings, (3) the competitiveness of the European industry, (4) appropriate national and European financial support, (5) energy savings by consumers and (6) improving the efficiency of the transport sector.

In the 2006 Action Plan (European Commission, 2006) the word ‘renewable’ or ‘renewable energy’ does not appear at all. In the 2008 Commission communication ‘Energy efficiency: delivering the 20% target’ (European Commission, 2008b) renewable energy is mentioned but in the ‘classic’ way: with energy efficiency improvement it becomes easier to increase the share of renewable energy in total energy use. The contribution of renewable energy to the energy savings target is not recognized

(footnote continued)

1 The European Commission uses Mtoe (mega ton oil equivalent) as its default unit of energy (following Eurostat statistics). In this article, Mtoe has been converted into EJ (Exa Joule). Where deemed useful, the original Mtoe value is given between brackets.

2 This figure can be found in Annex 1 of the communication ‘Energy efficiency: delivering the 20% target’ (European Commission, 2008b). In the Energy Efficiency Action Plan 2011 (European Commission, 2011a), this figure is scaled down from 394 to 368 Mtoe. From the Impact Assessment accompanying the Energy Efficiency Plan 2011 (European Commission, 2011c), it becomes clear that the updated figure excludes the non-energy use projected for 2020 (126 Mtoe). The 368 Mtoe is calculated as follows: (1968 Mtoe (2020 projection total primary energy use) / 126 Mtoe × 20%).
in either of the two documents (neither the 2011 Energy Efficiency Action Plan does). Below we will argue that renewable energy indeed contributes to achieving Europe’s primary energy savings target. However, before we make this argument, we first need to discuss how renewable energy is dealt with in Eurostat energy statistics, which provide inputs for the PRIMES baseline scenarios.

3. Primary Energy Method

Eurostat and IEA use the ‘Physical Energy Content Method’ for reporting renewable energy statistics (IEA and Eurostat, 2005). This method is also referred to as ‘Primary Energy Method’ (Segers, 2008) or ‘Input Method’ (Buck et al., 2010). In this article we will further refer to the method as ‘Primary Energy Method’.

In the Primary Energy Method, primary energy is defined as the first commodity or raw material which can be converted to secondary energy (heat, electricity, etc.). For hydro power, wind energy and solar power the first usable commodity is the electricity produced. For electricity from a fossil fuel the first usable commodity is coal or natural gas. When electricity is produced from fossil fuels, typically 2.5 units of primary energy are needed to produce one unit of electricity (based on an average conversion efficiency of 40%). For hydro, wind and solar power, according to the Primary Energy Method, one unit of primary energy converts to one unit of electricity, that is, a conversion efficiency of 100% is assumed. This means that the growth of wind, hydro or solar power leads to ‘energy savings’ compared to the average conversion efficiency, for example: replacing 1 unit of fossil electricity (=2.5 units of primary energy) by 1 unit of wind, hydro and solar electricity (=1 unit primary energy) leads to 1.5 units of primary energy savings, see also Fig. 2.

Obviously, the use of a conversion efficiency of 100% for wind, hydro and solar electricity should be considered in the context of a (practical) convention applied in Eurostat and IEA statistics. It does not reflect (physical) reality. For wind energy for example, 50% is taken as the practical maximum rotor efficiency for converting the kinetic energy content of moving air (wind) into electricity, while slow-speed turbines may have efficiencies close to 20% (Patel, 2006). Hydro power efficiencies for converting the potential energy of falling water into electricity range between 50% and 90%, mainly depending on age and size of the turbines. Typical solar systems (based on polycrystalline silicon cells) have efficiencies ranging between 7% and 13% for converting sunlight into electricity (Andrews and Jelley, 2007), while the most advanced multi-layer solar cells reach cell efficiency in excess of 40%.

Conversion of Primary Energy to Electricity

It should be noted that not in all statistics electricity from wind, hydro and solar results in ‘energy savings’. The Dutch renewable energy statistics are for example based on the so-called ‘Substitution Method’ (CBS, 2009). In the Substitution Method renewable energy sources are compared with typical fossil energy sources and statistically expressed in terms of the fossil fuel input avoided. In doing so, no savings effect is attributed to renewable electricity from wind, hydro and solar. In terms of Fig. 2, the renewable primary energy bar (bottom) would have the same length as the fossil primary energy bar (top). Eurostat and the IEA do not use the Substitution Method anymore as it has the disadvantage of requiring the use of a hypothetical reference case, for example, a hypothetical conventional thermal power station. Either the conversion efficiency of the reference case must be kept the same over time which would introduce an increasing deviation from reality, or it must be made adjustable, which would introduce uncertainty as the contribution of the same quantity of renewable energy would fluctuate (European Commission, 2008c). In addition, with increasing shares of renewable energy in the power mix, the method would lose its foundations as renewable energy would increasingly be substituted by other renewable energy.

However, as Eurostat statistics provide inputs for the PRIMES baseline scenarios and the European Commission uses the PRIMES-2007 projection as the fixed baseline scenario for its 20% energy savings target, we need to deal with the Primary Energy Method, which means that we need to take into account the ‘energy savings’ from wind, hydro and solar electricity in the analysis of Europe’s primary energy savings target.

As opposed to wind, hydro and solar electricity, the conversion of biomass (and waste) to electricity does not lead to primary energy savings using the Primary Energy Method. For biomass the Primary Energy method does not use a conversion efficiency of 100% but efficiencies that reflect actual efficiencies. As biomass-to-electricity conversion has on average lower efficiencies than conversion of fossil fuels – at least natural gas – to electricity (Yoshida et al., 2003), an increase of biomass use for power production, displacing fossil fuels, will lead to (some) additional energy use when the Primary Energy Method is applied.

Knowing that electricity from wind, hydro and solar leads to accounting ‘energy savings’ and bio-electricity does not, the question comes up to what extent use of renewable heat and cooling (solar thermal, biomass, heat pumps, geothermal energy) and bio-fuels for transport leads to energy (un)savings.

For heat from biomass, there is no unambiguous answer. The conversion efficiency of biogas and bio-oil to heat is similar to the efficiency of heat production from conventional energy sources (Yoshida et al., 2003). Biomass sources with high moisture content, however, lead to increased primary energy use as conversion efficiencies for heat production are reduced (Lundgren et al., 2004). In Eurostat statistics this increase in primary energy use as a result of lower conversion efficiencies is not directly visible as only the fuel supply to end-users is reported and not the heat produced (Buck et al., 2010). In this case, an increase of the supply of biomass to end-users could either be explained by a growth of the heat demand or a decrease of conversion efficiency.

For geothermal energy a default thermal efficiency of 10% (reflecting the generally lower-quality steam available from geothermal sources) is applied in the Eurostat and IEA energy statistics (IEA and Eurostat, 2005), which means that an increase of geothermal energy will result in increased primary energy use according to the Primary Energy Method (see also Segers, 2008, Table 2).

The monitoring of bio-fuels for transport is linked to the sales of bio-fuels to end-users (European Commission, 2003, 2009).
The fossil energy needed for the production of bio-fuels cannot be derived directly from statistics as it is ‘hidden’ under the energy statistics of the industry or other sectors (if at all produced in Europe). Still, fossil energy is needed for the production of bio-fuels. For today’s (first generation) bio-fuels it is estimated that for the full life cycle 70–80% fossil primary energy is avoided for each unit of bio-fuel produced (Edwards et al., 2007; Patel, 2008; Buck et al., 2010).³

Next to fossil fuels, also renewable energy is needed for the production of bio-fuels (for example sugar crops for producing bio-ethanol). Patel et al. (2006) and Edwards et al. (2007) show that the amount of renewable energy in the production process is substantial both for bio-ethanol and bio-diesel production. This renewable energy is not considered as ‘energy’ in Eurostat statistics but as ‘raw material for the production of bio-diesel or bio-ethanol’.⁴ This means that an increase of bio-fuels also contributes to energy savings.


Fig. 3 provides an overview of the projected development of renewable energy in PRIMES-2007, the fixed baseline scenario used by the European Commission for its primary energy savings target. The additional wind, hydro and solar electricity (0.9 EJ final electricity) leads, according to the Primary Energy Method, to 1.4 EJ primary ‘energy savings’;⁵ whereas the 0.3 EJ bio-electricity leads to 0.2 EJ primary ‘unsavings’.⁶ The 1.2 EJ additional bio-fuels lead to 0.4 PJ primary ‘energy savings’,⁷ whereas the energy (un)savings of the additional renewable heat and cooling are assumed to be close to zero. On a net base, renewable energy leads therefore to an additional 1.6 EJ of ‘energy savings’ between 2005 and 2020 (1.4 EJ − 0.2 EJ = 0.4 EJ). As these additional savings are already included in the PRIMES-2007 baseline projection for 2020 (Fig. 1), they do not contribute to the 20% primary energy savings target. For assessing the potential contribution of renewable energy to Europe’s savings target we have to look at the additional renewable energy to be implemented on top of the baseline projection. Before doing that, we first need to introduce the Renewable Energy Directive.

5. Europe’s renewable energy target: 20% renewable energy in 2020

The Renewable Energy Directive (European Commission, 2009) sets binding national targets for the overall share of energy from renewable sources in final energy consumption and for the share of energy from renewable sources in transport. At the EU level, a 20% renewable energy share in gross final energy consumption⁸ needs to be achieved in 2020. The targets for individual Member States differ based on a country’s share of renewable energy in final energy consumption in 2005 and a GDP/capita index, but add up to 20% at the overall EU level. For transport a sub-target of 10% renewable energy has been set.

In PRIMES-2007 the share of renewable energy in final energy consumption increases between 2005 and 2020 by 4% points from 8.7% to 12.7% (Capros et al., 2008) (for comparison: Eurostat & European Commission (2011) reports a 10.3% share of renewable energy in the EU in 2008). This increase is modeled in response to energy policies and measures implemented up to 2006. Achieving 20% renewable energy in final energy consumption, the target that was set in 2008/2009 as part of Europe’s Climate & Energy Package, therefore requires substantial effort additional to the growth projected in the PRIMES-2007 baseline scenario.

The projected 12.7% share of renewable energy in final energy consumption in 2020 is composed as follows: 45% renewable electricity, 16% bio-fuels for transport and 39% renewable heat and cooling (largely dominated by biomass) in the domestic, tertiary and industry sector.

6. Interaction of Europe’s renewable energy target with its primary energy savings target

The PRIMES-2007 baseline scenario is the (fixed) reference projection for Europe’s energy savings target. According to this scenario, the 20% renewable energy target is not met in 2020. This means that achievement of the renewable final energy target will interact with the primary energy savings target. This interaction works as follows: to meet the renewable energy target a new wind turbine is built producing 100 units of electricity (final energy). As this turbine replaces 100 units of electricity production of a conventional power plant (40% efficiency), 250 units of fossil primary energy is replaced by 100 unit of primary wind energy. Primary energy savings therefore amount to 150 (250 minus 100 units), see also Fig. 2.

In order to quantify the ‘primary energy savings’ impact from renewable energy for the EU, we distinguish two scenarios:

- Scenario 1: Meeting the renewable energy target without additional end-use savings compared to the PRIMES-2007 baseline.

   (footnote continued)

 footnotes references
Scenario 2: Meeting the renewable energy target and realising maximum cost-effective end-use savings compared to the PRIMES-2007 baseline.

6.1. Scenario 1: meeting the renewable energy target without additional end-use savings

To achieve the 2020 renewable energy target without additional energy savings compared to the PRIMES-2007 baseline scenario, we first need to know how much additional final renewable energy needs to be realized between 2005 and 2020 in order to increase the share of renewable energy by 7.3% points from 12.7% (the PRIMES-2007 projection for 2020) to 20% (Europe’s 2020 renewable energy target). According to PRIMES-2007, the EU’s final energy demand in 2020 will be 56 EJ (Capros et al., 2008). Without additional energy savings, the amount of final renewable energy should increase by 7.3% × 56 EJ = 4.1 EJ.

The question is how to allocate this 4.1 EJ to the three renewable energy categories (RES-electricity, RES-heat and cooling and bio-fuels). We distinguish three variants:

- Scenario 1A: Achieving 4.1 EJ additional RES with a mix of renewable electricity, heat and cooling and bio-fuels for transport; similar shares for these three categories as projected for 2020 in the baseline scenario, i.e. 45% renewable electricity, 16% bio-fuels for transport and 39% renewable heat and cooling.
- Scenario 1B: Achieving 4.1 EJ additional RES with only RES-electricity (with 2/3 share wind, hydro and solar electricity and 1/3 biomass electricity, as in Fig. 3) and no additional renewable heat and cooling and bio-fuels for transport.
- Scenario 1C: Achieving 4.1 EJ additional RES with only wind, hydro and solar electricity.

Fig. 4 shows the net ‘energy savings’ from renewable energy for each of the three scenario variants as a result of the growth of wind, hydro and solar power (‘savings’) and biomass power (‘unsavings’). In scenario 1A the ‘unsavings’ effect of renewable heat and cooling (e.g. geothermal) and the ‘savings’ effect of bio-fuels for transport are neglected as they are relatively small. The figure shows that meeting the renewable energy target will lead to 1.8 EJ (scenario 1A) to 6.3 EJ (scenario 1C) additional primary energy savings (see Fig. 3) and no additional renewable heat and cooling and bio-fuels for transport.

One could consider scenario 1 as extreme as it is unlikely that no additional energy savings compared to the PRIMES-2007 baseline projection will be realized (in fact, additional energy savings have already been realized in the meantime). However, the scenario 1 variants provide valuable insight in the possible contribution of renewable energy to the primary energy savings target, which is relevant, as policy incentives for meeting the binding renewable energy target are stronger than those for meeting the indicative primary energy savings target.

Fig. 4 shows that without additional energy savings compared to the PRIMES-2007 baseline projection, 10–40% of the 16 EJ (394 Mtoe, see footnote 2) energy savings volume needed to achieve the 20% primary energy savings target is already provided by ‘energy savings’ from additional renewable energy, in case the renewable energy target will be met. Renewable energy can, therefore, substantially reduce the effort needed for meeting the primary energy savings target.

6.2. Scenario 2: meeting the renewable energy target and realizing maximum cost-effective end-use energy savings

For scenario 2 we assume implementation of cost-effective end-use savings. In a study for the European Commission (Fraunhofer, 2009) the cost-effective end-use energy savings potential for the EU (and individual Member States) has been identified. This study took a detailed bottom-up approach to assess energy savings potentials for end-use sectors (residential sector, services sector, transport and industry), differentiated across EU Member States. In order to ensure compatibility with projections from the European Commission, the Fraunhofer study uses the economic drivers as defined by the study ‘European Energy and Transport Trends to 2030: Update 2007’ based on PRIMES model runs (Capros et al., 2008). This is the PRIMES-2007 baseline scenario. Drivers refer to for example the growth of the buildings stock, transport volumes, energy prices and the development of industry’s value-added production. The PRIMES-2007 baseline scenario assumes an average economic growth of 2.2% per year until 2020 and includes policies and measures implemented in the Member States up to the end of 2006.

The left-hand side of Fig. 5 shows energy saving options which have negative marginal costs. Negative marginal costs occur when over the lifetime of energy efficient technologies revenues from energy savings (lower energy bill) more than compensate...
for the additional investment and operation and maintenance costs of energy savings options. Total cost-effective savings which can be realized between 2005 and 2020 according to the Fraunhofer study amount to 10 EJ final energy (which is similar to the 250 Mtoe final energy in Fig. 5, being the cut off value between total cost-effective savings – total area under the curve below the x-axis – and the savings that are not cost-effective—total area under the curve above the x-axis). Note, that we show the final energy savings cost-curve and not the primary energy savings cost-curve. The reason for this is that the final energy cost-curve provides insight in the potential reduction of final energy demand, which is relevant to assess the renewable energy target (which is expressed in final energy).

If the 10 EJ cost-effective final energy savings potential is fully realized, the 2020 share of renewable energy in final energy consumption increases from 12.7% (PRIMES-2007, projection 2020) to 15.6% without changing the absolute amount of renewable energy. To meet the 20% renewable energy target, another 4.4% points renewable energy (20%–15.6%) needs to be realized, which equals 2 EJ (final) renewable energy. As for scenario 1, also here the question is how to allocate the 2 EJ to the three renewable energy categories (RES-electricity, RES-heat and cooling and bio-fuels for transport). Again, we distinguish three variants:

- **Scenario 2A:** Achieving 2 EJ additional RES with a mix of renewable electricity, heat and cooling and bio-fuels for transport. Similar shares for these three categories as projected for 2020 in the baseline scenario, i.e. 45% renewable electricity, 16% bio-fuels for transport and 39% renewable heat and cooling.

- **Scenario 2B:** Achieving 2 EJ additional RES with only RES-electricity (with 2/3 share wind, hydro and solar electricity and 1/3 biomass electricity, as in Fig. 3) and no additional renewable heat and cooling and bio-fuels for transport.

- **Scenario 2C:** Achieving 2 EJ additional RES with only wind, hydro and solar electricity.

Fig. 6 shows the net primary energy savings from renewable energy for each of the three scenario variants as a result of the growth of electricity from wind, hydro and solar (‘savings’) and biomass power (‘unsavings’). In scenario 2A the ‘unsavings’ effect of renewable heat and cooling (e.g. geothermal) and ‘energy savings’ from bio-fuels for transport is neglected (as in scenario 1A). Fig. 6 shows that meeting the renewable (final) energy target will lead to 0.8 to 3.1 EJ additional primary energy savings in case the maximum implementation of cost-effective end-use savings is assumed.

From Fig. 6 we observe that even with maximum cost-effective end-use energy savings between 2005 and 2020 and realization of the 20% renewable energy target, the 20% primary energy savings target will not be met, although scenario 2C comes close to it. To meet the primary energy savings target, additional savings in the supply sector (fossil power plants, transport and distribution,
refineries, etc.), not covered by the Fraunhofer study, or nearly cost-effective savings end-use savings are needed.\textsuperscript{17}

We also observe from Fig. 6 that, although smaller than in scenario 1, also in scenario 2 the contribution of renewable energy to the primary energy savings target is significant.

6.3. Outlook 2020: heading towards a scenario 1 or scenario 2 future?

Scenarios 1 and 2 provide insight in the contribution of renewable energy to the energy savings target for two opposing situations: scenario 1 for the situation that the renewable energy target is met \textit{without} additional end-use energy savings compared to the PRIMES-2007 baseline and scenario 2 for the situation that the renewable energy target is met \textit{and} maximum cost-effective end-use savings are applied. The question is how the future will unfold: scenario 1-like or scenario 2-like?

In a recent study for the European Climate Foundation (ECF) (Ecofys and Fraunhofer Institute, 2010a), the updated energy outlook for Europe for 2020 (Capros et al., 2010) has been used to analyze the latest progress towards the 20% primary energy savings target. Starting point for this study was the PRIMES-2007 baseline scenario from which the 16 EJ (394 Mtoe, see footnote 2) primary energy savings volume can be derived which is needed to achieve the 2020 savings target. The updated PRIMES baseline scenario for the EU (referred to as ‘PRIMES-2009’\textsuperscript{17}) has been used to include the most recent insights regarding the 2020 energy outlook. This updated baseline scenario includes the impact of the recent economic recession, new insights on the development of important drivers such as mobility for the transport sector, and the impact of the latest climate and energy policies (implemented after 2006), both not included in the PRIMES-2007 baseline scenario.

Roughly half of the decreased energy use between PRIMES-2007 and PRIMES-2009 (3 EJ) can be attributed to the economic recession and adjusted growth figures (Ecofys and Fraunhofer Institute, 2010a). The 3 EJ has been calculated by adjusting the PRIMES-2007 2020 energy use to the reduced activity data (either value added or passenger- and ton-kilometers) in industry, tertiary sector and transport in PRIMES-2009.

The remaining difference in primary energy use between PRIMES-2007 and PRIMES-2009 has been attributed to recent energy savings policies and the additional renewable energy projected in PRIMES-2009 compared to PRIMES-2007. The additional renewable energy leads to almost 1 EJ ‘primary energy savings’ whereas the identified energy savings from recent energy savings policies are built up as follows (Ecofys and Fraunhofer Institute, 2010a):

- More efficient passenger cars (the \(\text{CO}_2\) regulation), realizing around 0.8–1.0 EJ of primary energy savings. This compares to a 9% overall energy savings in the EU passenger car fleet in 2020.
- Implementation of other energy savings policies such as the Eco-design Directive (5 implementation measures that are included in the PRIMES-2009 baseline scenario), the recast Energy Performance of Buildings Directive (EPBD), the recast Labeling Directives and the Combined Heat & Power (CHP) Directive (1.0–1.3 EJ).
- Implementation of four new implementation measures that were recently decided under the Eco-design Directive and \textit{not} included in the PRIMES-2009 baseline scenario (1.9 EJ).\textsuperscript{18}

In summary, the recession effect (3 EJ), additional renewable energy in PRIMES-2009 compared to PRIMES-2007 (1 EJ) and recent energy efficiency policies (4 EJ) sum to 8 EJ and are insufficient to meet the 16 EJ primary energy savings volume aimed for in 2020. The Ecofys/Fraunhofer study therefore identifies a policy gap of 8 EJ for 2020 (see Fig. 7) and stresses the need for further strengthening the energy policies in place and for additional policies to close the gap.

In the PRIMES-2009 baseline scenario the share of renewable energy in final energy consumption is 15% in 2020 (Capros et al., 2010). This is quite a bit higher than the 12.7% in PRIMES-2007, but still means that another 5% points renewable energy needs to be added to achieve the 20% renewable energy target. This can be realized (1) either via additional renewable energy or (2) via end-use energy savings (lowering final energy demand increases the share of a fixed amount of renewable energy in total final energy).

\begin{itemize}
  \item \textbf{Variant 1: Meeting the renewable energy target primarily with additional renewable energy.}
  \item Meeting the 5% additional share of renewable energy via additional renewable energy (left-hand bar in Fig. 8) on the other hand is a more expensive way of meeting both the renewable energy and energy savings target:
    \begin{itemize}
      \item To meet the renewable energy target, significant investments in new capacity are needed (in addition to the capacity already projected for 2020).
      \item A substantial share of the energy savings target is filled with more expensive renewable energy instead of cost-effective end-use savings. Fig. 5 already showed that the majority of the end-use energy savings potential is cost-effective. This insight is also confirmed in the IEA (2008) report ‘Energy Technology Perspectives’. In addition, several studies (e.g. McKinsey and Company, 2010; Ecofys et al., 2009) show that at the time horizon 2020–2030 most renewable energy potential is on the one hand not yet cost-effective and on the other, more expensive than most of the end-use energy savings potential.
    \end{itemize}
  \item This variant is scenario 1-like.
\end{itemize}

\begin{itemize}
  \item \textbf{Variant 2: Meeting the renewable energy target primarily with end-use savings.}
  \item Meeting the 5% additional share of renewable energy (largely) via end-use savings (right-hand bar in Fig. 8) can be considered the most cost-efficient way of meeting both the renewable energy and energy savings target:
    \begin{itemize}
      \item The renewable energy target is primarily met by reducing final energy demand which means an increase of the share of renewable energy without investing in new capacity (in addition to the new capacity already projected for 2020).
      \item The primary energy savings target is largely met with cost-effective end-use energy savings.\textsuperscript{19}
    \end{itemize}
  \item This variant is scenario 2-like.
\end{itemize}

\textsuperscript{17} It should be noted that in the Fraunhofer study relative low energy prices have been used compared to present (2010/11) price levels. Taking present levels would increase the cost-effective savings potential.

\textsuperscript{18} These additional Eco-design savings are included in the PRIMES-2009 Reference Scenario which has been published in the same report as the PRIMES-2009 Baseline Scenario (Capros et al., 2010). This Reference Scenario data was not yet available at the time of the Ecofys/Fraunhofer study for the European Climate Foundation (January–May 2010), whereas the Baseline Scenario data was.

\textsuperscript{19} Note however, that sufficient energy savings policies are not yet in place to meet the energy savings target (Ecofys and Fraunhofer Institute, 2010a).
In the title of this section we raised the question whether Europe is heading for a scenario 1-like future (focus on additional renewable energy) or a scenario-2-like future (focus on end-use savings). Most likely, the answer lies somewhere in between. On the one hand, the European Commission is well aware that Europe is not on track in meeting its energy savings target, being one of the main reasons for coming up with strengthened and new policy actions to close the gap (European Commission, 2011a). This would indicate a future which is more scenario 2-like. On the other hand, the Ecofys/Fraunhofer study for the European Climate Foundation shows that a tripling of today’s policy impact is needed to achieve the 20% primary energy savings target (Ecofys and Fraunhofer Institute, 2010a). It is doubtful whether such tripling of the policy impact can be achieved with the proposed policy package. This, in combination with the binding character of the renewable energy target, would indicate a future which will look more like scenario 1.

7. Consequences for policy

In this article we have shown that, on a net base, renewable energy provides ‘primary energy savings’. These energy savings are the result of the 100% conversion efficiency for wind, solar and hydro electricity used in Eurostat energy statistics and the rather strong penetration of these renewable energy sources, especially of wind energy. As a consequence, renewable energy contributes to Europe’s 20% primary energy savings target. This contribution is not yet recognized by policy makers. Neither the Green Paper on Energy Efficiency (European Commission, 2005), the Action Plan for Energy Efficiency (European Commission 2006), the Presidency Conclusions of the Brussels European Council of 25 and 26 March 2010 (European Commission, 2010a), nor the 2011 Energy Efficiency Plan (European Commission, 2011a) mention this interaction between renewable energy and energy savings. We feel, however, that insight in this interaction is crucial for policy makers to understand the impact of their policies.

Such insight, however, could result in wrong policy incentives. In one of its communications the European Commission shows that Europe is not on track meeting its 20% energy savings target: a maximum of 13% savings may be achieved in 2020 if policy measures are properly implemented at Member State level (European Commission, 2008b). In the 2011 Energy Efficiency Action Plan, it is even stated that only half of the 20% objective
will be achieved (European Commission, 2011a). This is confirmed by a recent study of Ecofys and Fraunhofer Institute (2010a), which also shows that only half of the energy savings target will be achieved without strengthening the energy policies in place or implementing additional policies.

Realizing energy savings and implementing effective energy savings policies turns out to be an extremely difficult policy effort. This, in combination with the indicative character of the energy savings target versus the binding character of the renewable energy targets, holds the risk that a policy focus on meeting the renewable energy target and looking in the primary energy savings (left-hand bar in Fig. 8) decreases the need and incentives for demand-side energy savings.

In our view, however, the fact that renewable energy leads to primary energy savings due to the use of the Primary Energy Method may not be an argument to give the renewable energy target a more pronounced place in the policy hierarchy than the energy savings target. This would also be undesirable as (part of) the benefits of realizing demand-side energy savings potential out there will be missed, whereas substantial additional investments in renewable energy are needed. Among the missed benefits are (Ecofys and Fraunhofer Institute, 2010a):

- €78 billion savings on Europe’s annual energy bill.
- Creation of 1 million new jobs by 2020.
- Reducing Europe’s import dependency.
- Increase the share of renewable energy without investing in additional renewable energy capacity.
- Get back on track for realizing deep GHG emission reduction objectives on the long term (2050).

Could the described interaction between renewable energy and energy savings be avoided? The answer is ‘yes’. An energy savings target focusing on end-use sectors (instead of the whole economy) and expressed in final energy (instead of primary energy) would avoid the interaction between the savings target and the renewable energy target. Moreover, the Ecofys and Fraunhofer Institute (2010a) shows that 85% of the total cost-effective energy savings potential up to 2020 can be found in end-use sectors. A final energy savings target would therefore still cover the majority of the energy savings potential available.20

If the European policy makers insist on an energy savings target covering all primary energy use, the role of renewable energy should be explicitly taken into account when setting the target.

References


20 Whereas efficiency improvement in the energy supply sector should be driven by the EU Emission Trading Scheme.