9. Internationale
Energiewirtschaftstagung
an der TU Wien

IEWT 2015

Kurzfassungsband

Energiesysteme im Wandel: Evolution oder Revolution?

11. – 13. Februar 2015
Wien, Österreich

Tagungsort:
Technische Universität Wien
Karlsplatz 13
1040 Wien

Veranstalter:

Institut für Energiesysteme und Elektrische Antriebe der TU Wien (ESEA)

Energy Economics Group (EEG)

Austrian Association for Energy Economics (AAEE)

TU WIEN ESEA Institut für Energiesysteme und Elektrische Antriebe

Energy Economics Group

RES-COOPERATION PERSPECTIVES BETWEEN THE EU AND TURKEY

Marijke WELISCH, André ORTNER, Gustav RESCH, [(1)] Cristina DE LA RUA, Natalia CALDES,[(2)] Andreas TUERK[(3)]

[(1)]TU Wien (Energy Economics Group), [(2)] CIEMAT, [(3)] Joanneum

Abstract:

The successful implementation of the fourth cooperation mechanism (EU Directive 2009/28/EG) enabled EU Member States to use cooperation with third countries in renewables to reach their goals for RES deployment – i.e. European countries could benefit from Turkish RES-imports by adding them to their share of renewables. At the same time, Turkey would benefit by increasing its own RES-deployment in an efficient way up to 2020 and beyond.

The main analysis of this paper assesses medium- and long term potentials for generation of electricity from renewable sources in Turkey. From these results, policy advice and political measures for future cooperation with the EU were derived. Moreover, results from a business case analysis, describing cooperation possibilities at the micro level, as well as environmental and socio-economic benefits from RES cooperation from an impact assessment are discussed.

The study’s results show substantial RES potentials in Turkey that are mainly untapped. Cooperation with the EU would aid Turkey through investments and technology transfer. As resource quality of RES in Turkey is high, import could be beneficial for countries currently experiencing problems with reaching their 2020 RES targets and at the same time lead to considerable savings.

Keywords: Cooperation Mechanisms, Renewable Energy, Turkey, Europe

1 Introduction

The following analysis provides estimations of the potential for renewable energy source (RES) deployment, and in particular for development of electricity from renewable energy sources (RES-E) in Turkey. From these results the potential for cooperation in renewables production with the European Union (EU) is assessed and evaluated, in a medium- (2030) and long-term (up to 2040) perspective.

Article 9 of EU Directive 2009/28/EC – the Directive on the promotion of the use of energy from renewable sources (RES Directive) – regulates the cooperation of EU Member States and third countries in the respect that the Member States can enter joint projects with third countries “regarding the production of electricity from renewable energy sources” (EU, 2009). Specifically this allows EU Member States to produce a certain share of the renewable energy to reach their national RE-target in another country. Especially for countries that are currently behind their targets, importing RES-(E) with a high resource quality could be beneficial. Cooperation on renewables in general can also contribute to the promotion and further development of low carbon technologies for the EU and its neighbouring countries – and thus be an important step towards a sustainable energy system in the long term.

The framework for this assessment is provided by the Intelligent Energy Europe project BETTER. This project intends to address RES cooperation between the EU and its neighbours in several dimensions. The starting point is given through the cooperation mechanisms provided by the RES Directive as discussed above. The assessments providing the results for this paper thus focus on the medium-term (2030) period for cooperation potentials as well as on long-term prospects (up to 2040). Short-term improvement nevertheless provides a valuable contribution to European energy and climate goals. Implementing successful cooperation mechanisms now and strengthening ties in an overall integrated EU and third countries energy network is crucial to achieve long-term environmental sustainability.

This paper presents results of quantitative assessments undertaken on the extent to which RES cooperation can create mutual benefits, identifying costs and benefits for both sides but in particular with respect to RES target achievement (2020 and 2030) at EU (macro-)level. The potentials for RES generation in Turkey are calculated under different policy pathways and taking into account different levels of economic and non-economic barriers that could occur. The overarching integrated assessment paints a big picture scenario and provides valuable policy implications for future cooperation between the EU and its neighbouring countries. Furthermore, results from a concrete business case are presented to discuss the role of the micro-level (stakeholder perspective) in RES cooperation. Socio-economic and environmental impacts of different levels of potential RES cooperation are also discussed, providing a holistic view of the cooperation possibilities and how they would affect Turkey as a host country for renewable energy production.

1.1 Background Information Turkey

Turkey occupies an important and special place in the world due to its geographic, dimensional, economic, cultural and historic characteristics. With its strategically positioned, large land mass and a population of approximately 75 million, producing around 820 billion USD gross domestic wealth (just over 10,000 USD per capita), the country is the 18th largest economy in the world (World Bank, 2015).

Recording fluctuating but high economic growth rates, Turkey has population and urbanisation growth rates more akin to the emerging economies rather than to Europe to which it sees itself associated historically. This has made the country record the second highest demand for energy inputs into the economy after China and its concurrent dependence on fossil resources for energy supply has also made it the country with the second highest rate of GHG emissions increases. The high economic growth through imported fossil energy supply is endangering both its balance of trade accounts as well as its claims to sustainable development. Turkey needs to power its development increasingly with local renewable energy resources and the country is in fact in an excellent position regarding resource endowments to do so (Ortner et al., 2013).

1.1.1 Economic Indicators and Geopolitical Situation

Turkey's significance as a regional energy transit hub is increasing, especially since the worsening of the situation in Ukraine. The complicated geopolitical situation (being surrounded by Syria, Iraq and Iran) together with its insufficient oil resources to face local consumption have aroused the interest in using local resources such as coal and nuclear power but also renewable energies through the implementation of RE supporting policies (Ortner et al., 2013).

The current framework for cooperation can be quantified by several indices of interest for potential investors or cooperation partners: the OECD considers Turkey to have a medium-high risk, comparable to other developing countries such as Tunisia or EU members like Latvia or Romania. Concerning the ease of doing business, Turkey ranks 69th - close to European countries like Luxembourg (60th) and Italy (65th) and higher than some EU countries like Greece (72nd) or Romania (73rd). In the Global Competitiveness Index, a rank of 149 countries, Turkey is in the 44th position (OECD, 2014).

Furthermore, Turkey's electricity sector has a global foreign equity ownership index of 78.6%. Power transmission as well as power distribution for new projects is closed to foreign ownership for new and existing companies, whereas foreign ownership is fully allowed for RE projects - both new and existing. This could favour the deployment of RES in the country.

Turkey's current account balance shows a deficit of 6.1% of GDP. Again this is due, among others, to the country's high foreign dependency on fossil fuel and natural gas. The rate of transmission and distribution losses amounts to 14.9%, similar to other countries in the region like Iran, Egypt or Russia but also to EU members such as Bulgaria or Romania (Ortner et al., 2013).

1.1.2 The overall energy system

The Turkish energy sector has been transformed in the last 20-25 years, in line with the waves of change overtaking the global economy towards deregulation, privatization of public assets and open competitive markets. It should be stated that the main motivation for the new legislation were the 'acquis communautaire', the agreement that initiated Turkish candidacy for the European Union, the European Economic Community (EEC) at that time. While all distribution companies have been privatized, 50% of the generation assets are still state owned.

The Turkish economy is dependent on supply of imported fossil resources for its growth. The foreign dependence of the energy sector is around 72% and growing. Due to the very high demand growth despite periodic downturns, the last 25 years have seen the quadrupling of Turkish installed capacity. Turkish energy consumption was around 110.000 Mtpe (Mega tons of petroleum equivalent) in 2011 and power demand amounted to approximately 230 billion KWh in 2011 with an 8% increase compared to 2010. Total installed capacity in power production is around 53.000 MW. Turkish per capita power consumption however, is low compared to other industrialized countries (Ortner et al., 2013).

High economic growth rates thus, are predicted to result in demand scenarios of 6.7% per annum for low and 7.5% for high scenario cases. The Energy Ministry predicts investment needs in the power sector for the next 15 years of 100 billion USD while the Electricity Market Regulation Authority (EMRA) forecasts investment needs until 2030 in the range of 225-280 billion USD.

Approximately 90% of consumed energy is from fossil fuel resources. The extraordinary place natural gas has taken in just a decade is not surprising. As the technology that demonstrated the best cost/benefit ratio in the years following the deregulation of the energy sector, natural gas conversion power plants dominated private investments in electricity generation. Besides wind energy, non-hydro renewables are presently close to absent in the mix.

According to data provided by the Ministry, Turkish energy demand has grown by 106% while national production has not been able to keep up, increasing foreign dependence on imports to 72% (MENR, 2009).

2 Methodology

Possible RES(-E) cooperation between the EU and Turkey can be assessed from different dimensions. This paper presents the techno-economical perspective, namely results a scenario analysis taking into account different policy pathways. A quantitative assessment of potentials for cooperation from the bottom-up as well as from the integrated (top-down) perspective was executed by application of the Green-X model. Green-X is an energy system model that offers a detailed representation of RES potentials and related technologies in Europe and in the analysed neighbouring countries. It aims at indicating consequences of RES policy choices in a real-world energy policy context. The model allows conducting in-depth analyses of future RES deployment and corresponding costs, expenditures and benefits arising from the preconditioned policy choices on country, sector and technology level on a yearly basis, in the time span up to 2040.

2.1 Bottom-Up Analysis of RES(-E) Potentials

The scenarios analysed in the *bottom-up assessment* for Turkey, combine two different characteristics: different ambition levels for RES deployment in 2030 in particular and different support policies for renewables from 2020 onwards. With respect to the underlying policy concepts the following assumptions are taken for the assessed alternative policy paths:

- The “Business as Usual (BAU)” scenario, as the name implies, represents unchanged national policies and efforts for implementation of RES: the current policy path will be followed. The scenario can be varied by whether or not different (non-economic) barriers remain in the countries or if they are mitigated over time.
- Alternative policy paths follow the concept of “Strengthened National Policies (SNP)” where a continuation of the current policy framework with national RES targets (for 2030 and beyond) is assumed. In general this implies for each country to use national support schemes to meet its own target, complemented by RES cooperation between Member States (and with the EU’s neighbours) in the case of insufficient or comparatively expensive domestic renewable sources. Within the bottom-up assessment conducted for Turkey it was assumed that either moderate or generous (i.e. high) support is offered to the applicable renewable energy technologies in the electricity sector and in heating and cooling. Thereby it is assumed that support levels differ by technology and change over time, reflecting expected technological progress.

Building on BAU and SNP eight possible future scenarios were obtained. The scenarios basically differ in their ambition level for financial support, the assumed demand development and the presence of non-cost-barriers that jeopardise the development of RES. Generally, the bottom-up assessment serves to open up a corridor of feasible future RES developments by targeted EU neighbouring regions, aiming to provide a first indication of feasible RES cooperation potentials from an export country perspective and focussing hereby on the short (2020) and mid-term (2030) perspective.

2.2 Integrated Assessment

The integrated assessment serves as an overarching top-down approach framework to identify opportunities for RES cooperation under varying policy pathways in a large scale cooperation scenario, including the 28 EU Member States as well as the Western Balkan region and North Africa as additional cooperation partners. The integrated assessment was also performed using the Green-X model.

For the ambition level related to the future RES expansion three distinct RES pathways were assumed for 2030 (and beyond), one following a strong RES target for 2030 (i.e. 32.5% as RES share in gross final energy demand at EU level), one aiming for a moderate 2030 RES target (i.e. 30.0%), and one reflecting the current policy thinking, aiming for a 2030 RES share of 27%. Then, different policy cases were assessed for achieving these targets, all assuming full RES cooperation within certain system boundaries. The following key scenarios were thus distinguishable:

- Reference cases: RES cooperation only within the EU, domestic RES target fulfilment within neighbouring countries.
- Default cases: these scenarios assume full RES cooperation across the EU as well as all three case regions (North Africa, Western Balkans and Turkey)

To fully understand the use of policy instruments and RES targets in this model, the following aspects have to be kept in mind: First, a (harmonised and uniform) RES trading regime is used in modelling to identify the opportunities and benefits related to RES cooperation. It has to be noted in this respect, that whereas future RES development was modelled for all energy sectors (i.e. electricity, heating & cooling and biofuels in transport), the detailed assessment of cross-border RES cooperation is limited to the electricity sector.

Then, the reference cases were created, in which RES trade is assumed to take place among Member States and within the EU boundaries only. For all further scenarios that included cooperation between the EU and third countries, similar RES targets to those at EU level (i.e. related to RES expansion, in particular new installations beyond 2020 that are allowed to participate in the RES-E trading regime) were assumed to be applied in the Energy Community Member Countries. For Turkey, a sensitivity variant assesses the impact of whether accession to the Energy Community or respectively the EU takes place or not. A different sensitivity variant was further followed for the North African countries which indirectly also affects cooperation with Turkey in an integrated assessment framework. In this case, DLR's (Deutsches Institut für Luft und Raumfahrt) preferred concept of transferring electricity from concentrated solar power (CSP) via High Voltage Direct Current (HVDC) lines to centres of Europe is followed (DLR, 2009). This consequently implies a less strong expansion of the "conventional" transmission and distribution grid in North Africa as well as to Southern Europe, and may lead to a delayed expansion of wind power and photovoltaics (PV), that appear less viable for HVDC transfer due to their variability. The Annex presents a more detailed overview of the specific sensitivity variants assessed throughout the integrated assessment.

3 Findings

3.1 Levels of RES(-E) deployment in Turkey under different scenarios

For Turkey, from the bottom-up perspective in 2030, a large bandwidth of merely 9.5% (in a business as usual scenario) and up to 26.4% (assuming strengthened national RES policies and mitigated non-cost barriers) was identified for the RES share in gross final energy demand. The integrated assessment provides results that lie in this range. Solely the strong target cooperation case exceeds the assessed values and exhibits an even higher share (concretely 27.7% in 2030).[1] Assuming a strong target in the reference case (without cooperation), leads to a consistently lower RES share in comparison to the cooperation case, that lies roughly two to three percentage points below the ones for the default scenario. A moderate target also leads to a higher share in the cooperation scenario whereas a weak target exhibits lower RES shares for Turkey in gross final energy demand in the cooperation case when compared to the reference scenario (cooperation only among EU28 Member States).

[1] Under these circumstances in the long-term Turkey massively imports biofuels for transport purposes as well as solid biomass feedstock for power generation and for heat supply from the EU and the Western Balkans, respectively.

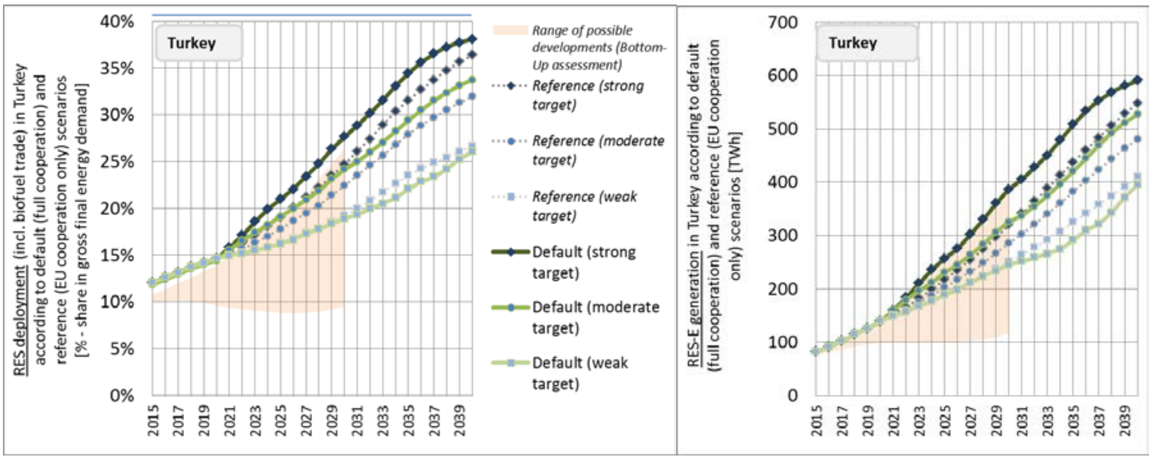


Figure 1: RES share in gross final energy demand and RES-E generation for Turkey according to default (full cooperation) and reference scenarios

Note: For RES in the electricity sector and in heating and cooling deployment is accounted where electricity and heat generation takes place while for biofuels in transport consumption is relevant.

Looking specifically into the electricity sector, shows absolute values of TWh generated from renewable energy sources for the same scenarios as depicted above.

Turkey exhibits a corridor between 118 and 389 TWh of potential RES-E generation from the bottom-up perspective for 2030. The integrated assessment estimates values for the period up to 2030 that all lie within this range, the maximum with underlying strong cooperation being 387 TWh in 2030 for the default case and a strong RES target – very similar to the bottom up perspective. The paths for the following decade up to 2040 follow the pattern that the default case for the strong target lies above the reference case, followed by the default case with an underlying moderate target which lies above the corresponding reference case. This is seen for the absolute as well as the relative values. Only for the weak target the case is reversed: RES deployment as well as RES-E generation are on a slightly higher absolute and relative path in the reference (only cooperation amongst EU28 Member States) scenario as compared to the default scenario.

Expressed in numerical values, this means that assuming a strong target for RES deployment leads to an average of a 50 TWh difference between the two paths over the decade between 2030 and 2040. In 2040 for instance, the value amounts to 548 TWh in the reference case in comparison to 591 TWh when full cooperation occurs. In the case of a weak target, more RES-E generation would take place for the reference scenario, where only EU28 Member States cooperate amongst themselves as compared to the full cooperation scenario. Expressed in numerical terms, e.g. in 2040 this means 411 TWh in the reference scenario in contrast to 395 TWh in the default case.

Figure 2 contrasts the scenarios under different target assumptions with the actual path that the RES-E share in gross final electricity demand has followed in Turkey between 1995 and 2012. Furthermore, the graph includes the official targets for RES deployment in 2023 by the Turkish government. It can be seen, that the share of RES-E decreased over time and that if official targets are followed, its level will basically stay unchanged up to 2023 – amounting to 27.7 up to maximally 29.5%. Looking at 2030, a slight increase in comparison to the official targets (to 33.2%) can be expected if Turkey does not become a member of the EU or the Energy Community and thus exhibits low RES policy ambition for domestic deployment. In consequence, development of RES-E would primarily take place for export, e.g. to EU28 Member States through the cooperation mechanism.

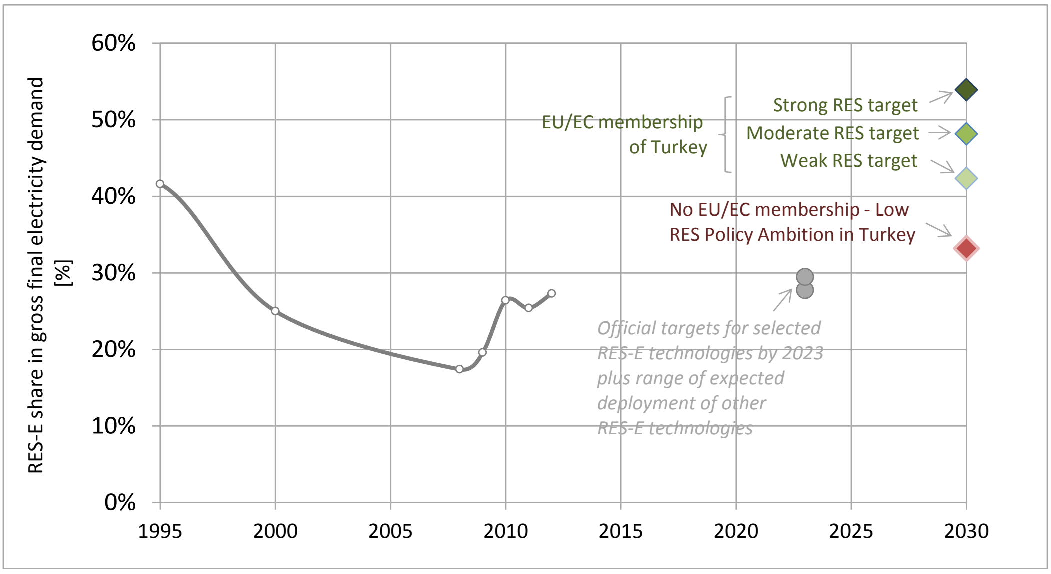


Figure 2: Development of the RES-E share in gross final electricity demand over time for different RES targets

For the case that Turkey becomes a member of the EU or the Energy Community and aligns its targets, the scenario shows more optimistic values. Depending on whether the EU or Energy Community decide on a weak, moderate or strong RES target, the potential RES-E shares in Turkey for 2030 would take on values of 42.3 up to 53.9%. These scenarios again underline the significance of the policy path Turkey will follow concerning RES deployment in the upcoming decades and how thereby the EU or Energy Community membership is of crucial importance.

3.2 Export Potential of RES from Turkey to the EU

In which way the levels of RES-E deployed under the different scenarios could be exported, is shown in Figure 3 below. The left-hand side of the graph shows absolute values in TWh for different scenarios under the three RES target assumptions for the medium (2030) and long-term (2040) perspective. On the right-hand side, the share of gross electricity demand of these different values is presented, again for 2030 and 2040 respectively. The different scenario variants shown are, concretely, the default case for the respective RES target (strong, weak or moderate) as well as the sensitivity variants described above: low ambitions for RES deployment in Turkey on the one hand and delayed wind and PV installations in North Africa, due to a focus on CSP and the corresponding HVDC grid expansion. In total, the different combinations of the scenario assumptions lead to nine separate cases that have been assessed in detail.

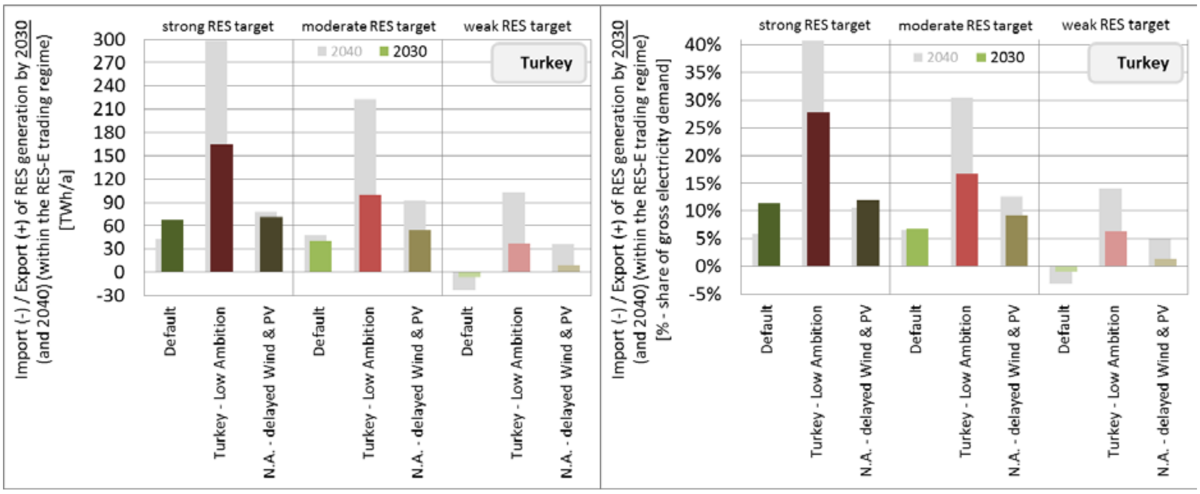


Figure 3: Exchange of RES volumes by 2030 and 2040 in absolute (TWh) and relative terms (% domestic demand share) according to default (full cooperation) scenarios following a strong, moderate or weak RES target (left) and according to sensitivity cases for a moderate RES target (right)

Turkey would export 67.85 TWh under a strong target in the default case in 2030 or 11.4% share of the gross electricity demand. A strong RES target and low ambitions for RES deployment in Turkey would lead to an even higher export potential, namely 164.8 TWh as no domestic targets would have to be fulfilled. As a share of gross electricity demand, this would amount to 27.8%. The third sensitivity specification, the varied case for North Africa, described in more detail in the methodology section, exhibits slightly higher export levels than the default case. This is due to the fact that in this special case, North Africa would export less RES-E due to delays, which could be partly compensated by Turkish RES-E exports. Concretely, the level rises to 71.2 TWh in 2030, a relative share of 12% of gross electricity demand or 0.6 percentage points more than in the default case with a strong target for RES.

In comparison to this, Turkey would be a net importer of 5.7 TWh (1% of gross electricity demand) in a weak target scenario for 2030 in the default case. Assuming low ambition for RES deployment, Turkey would export RES-E, but at a substantially lower level, namely 37 TWh or 6.2% of gross electricity demand. For the sensitivity case with delayed wind and PV in North Africa, Turkey would export a mere 8.7 TWh in 2030, which amounts to 1.5% of gross electricity demand.

Figure 3 furthermore presents values for 2040, depicted by the shaded bars behind the values for 2030. For the sensitivity case that implies low ambition for RES deployment in Turkey, the export potential increases substantially to more than double its 2030-level in all variants depicted, i.e. the strong, moderate and weak RES target case. This shows that even if domestic policies would not encourage RES deployment, RES deployment for reasons of export only would still be beneficial. In the default scenario, the development up to 2040 does not take on such a linear path. Depending on the target, the level and share of RES exports under the different scenarios either decreases (in the strong and weak target case) or increases by a small amount (namely by 6.8 TWh in the moderate target case), which is nevertheless a slight decrease in relative terms. For the North Africa sensitivity variant a very small increase in exports can be seen for the strong target case, a higher increase in the moderate target case and a very substantial increase in the weak target case. In relative terms, this is a slight decrease in the share of gross electricity demand for the strong target, a higher increase in the moderate target case and for the weak target the increase is substantial in relative as in absolute terms.

4 Discussion and Policy Implications

The results presented in the previous section show that there is considerable scope for cooperation in RES between the EU28 Member States and Turkey. The highest possible RES deployment in Turkey in the 2020 timeframe is expected to exceed the official technology-specific targets for 2023, in particular for hydro power and wind onshore. In principle, this creates opportunities for Turkey to export a certain share of the surplus generation to EU countries that could otherwise only comply with their RES target at a relatively higher cost.

At the same time, political willingness has to be strengthened as to make this cooperation feasible. A lot of effort is needed at the policy as well as at the regulatory and technical level: a clear legal framework for RES would give security to investors and ensure sustainable long-term joint projects. Disentangling the licensing process and creating more transparent structures would speed up said projects and encourage project developers to focus on Turkey as a promising location for RES deployment. Grid extension, especially increasing transfer capacities and strengthening the link to neighbouring countries will then physically enable RES cooperation.

Whether or not these different barriers will be mitigated and in which timeframe this will happen depends to a large extent on a possible membership of Turkey in the EU or the Energy Community. An accession would favour RES development because Turkey would align its domestic goals and also because cross-border exchange of electricity would be facilitated and encouraged among the Community. Summing up, whether or not the levels of RES deployment assessed by the full cooperation scenario under different target assumptions will be reached depends on Turkish policy as well as decisions at the European level and to that extent, if accession takes place, also on the overall target set for RES deployment in the European Union.

Currently, the future developments of these factors influencing the different cooperation scenarios are unclear. To make the case for cooperation, aside of tackling the macro (policy) level, the micro level – i.e. concrete business cases for joint projects – and the social acceptance perspective are further areas which need to be considered to make RES cooperation work and to create an integrally sustainable way of implementing the cooperation mechanism. Concretely, this means involving the private sector, i.e. stakeholders as well as the local community – by increasing awareness for socio-economic as well as environmental benefits that would result from increased RES cooperation.

4.1 Micro Perspective

Especially concerning wind onshore, Turkey exhibits low and decreasing costs of deployment. Using the cooperation mechanism that provides attractive conditions for EU countries when entering in joint projects, could generate additional income in Turkey and enable a cost-efficient contribution to Turkish national RES targets after the agreed export period.

Currently, wind onshore provides the most interesting perspectives for entering into joint projects. Electricity from wind that could be exported ranges between 10 and 28 TWh in 2023 (Ortner et al., 2015). Turkey could use RES cooperation to gain additional foreign RES support in order to leverage its own RES deployment, which would enable Turkey to cost-efficiently reach its 2023 target for wind onshore. The potential savings would result from lower necessary national support for target achievement in the range of approximately 10 to

60 million €. This could be achieved via co-funding of renewable capacity whereas a certain amount of generation remains within Turkey and also counts to the national RES targets.

If Turkey were willing to export the total RES surplus potential exceeding their 2023 targets to the EU it could generate an additional income in the range of approximately 300 million up to 130 billion € within a ten-year period (beginning 2023), depending on the parameters of the joint project and the overall RES ambition level of the EU. Additional benefits of cooperation are the development of the Turkish RES market and the corresponding transfer of technology and know-how with regard to the market and grid integration of RES. This would enable Turkey to build already at an early stage adequate framework conditions for enhanced national RES deployment later on.

Despite the fact that the neighbouring EU countries of Turkey, Greece and Bulgaria, do not need major amounts of RES imports in order to reach their targets for RES deployment, they could however act as “RES cooperation hubs” for other EU countries. This would mean that Turkey exports RES-E generation only to Greece and/or Bulgaria and those countries would make use of statistical transfers to other EU countries, which would then not include any obligatory requirement for physical transfers (Ortner et al., 2015).

As can be seen, the potential for RES cooperation at the micro level is given, i.e. a business case is clearly visible to potential investors. Nevertheless, the previously described non-economic barriers, especially the long-lasting administrative and licencing processes are likely to deter potential investors. Furthermore, as the National Energy Strategy of Turkey currently seems willing to focus on nuclear projects rather than RES expansion, project developers could be further discouraged.

4.2 Acceptance Perspective

To achieve social acceptance of RES deployment, it is important to engage the local population. If this is done in a transparent and participatory way, it cannot only facilitate the implementation of RES projects, but it could even achieve broad acceptance for renewable energies among the local population. Thus far, the overall Turkish population seems to be in favour of renewable energies and largely opposed to the planned nuclear plants by the Turkish government (Ortner et al., 2013). Reactions of locals to concrete projects can nevertheless not be easily foreseen (i.e. the NIMBY (not in my back yard) phenomenon could occur, when concrete construction plans are put into action). For this reason, benefits should be outlined and disseminated in advance.

The benefits for the local economy depend strongly on the share of local content in the manufacturing and construction phase. When comparing the 100% local content scenario results with the medium local content (70%) and low local content (50%) scenarios, the total increase in the demand of goods and services in the economy is reduced by approximately 66% and 47% respectively (Caldés et al., 2013). Thus, having in place a proper industrial policy and local industrial capabilities which allow to implement the maximum share of local content have very important implications for the Turkish economy.

The total number of jobs created through enhanced RES deployment ranges between 80,000 and 340,000 for the construction and 8,000 to 70,000 for operation and maintenance. Sectors relevant for all renewable technologies during the operation and maintenance phase profit the most from enhance RES deployment. Specifically to be named are electricity, gas and water supply and the machinery sector among others (Caldés et al., 2013).

CO2 Emissions are also assumed to fall substantially in the scenarios with higher RES deployment and negative effects from land use and ozone depletion could be mitigated. These are further benefits associated with an increase in the share of RES which could aid in creating public acceptance. Nevertheless, large amounts of investment will be needed to deploy renewables in 2020 and 2030 in Turkey according to the future scenarios considered. While in the less ambitious scenarios, the required investments imply 5 and 4% of the national GDP in 2020 and 2030 respectively, the more ambitious scenario will need investments which represent 10 and 21 % of Turkish GDP in 2020 and 2030 respectively. Aside of financing being a great challenge, public acceptance for this could be difficult to achieve as well. On the other hand, as cooperation could – as explained beforehand – lead to substantial additional income, implementing RES via the cooperation mechanism and joint projects seems more likely to be accepted as it can ease the financial burden.

5 Conclusions

In summary, RES cooperation potential between Turkey and the EU28 Member States is high and considerable exports could be realised in the medium- and long-term. While Turkey would benefit from investments and technology transfer as well as through adding RES deployment for compliance with its national RES targets, the EU could export RES(-E) with a good resource quality and achieve substantial savings. Notwithstanding, many barriers have to be mitigated to make this cooperation beneficial and feasible.

While at the Turkish policy level, RES deployment should be moved up higher in the list of priorities, RES cooperation can at the same time aid in pushing the agenda forward. Social acceptance and concrete, viable and profitable business cases can aid in further developing RES deployment and diffusion through different levels. Cooperation between Turkey and the EU28 Member States can thus help mitigating these barriers, but it requires concerted action from both sides to really make large scale cooperation in RES deployment work.

Literature

André Ortner, Gustav Resch, Marijke Welisch, Gerhard Totschnig, Natalia Caldes, Cristina De La Rua, Andreas Türk, 2015. D5.3: Case study report on prospects for RES cooperation with Turkey using the cooperation mechanisms.

André Ortner (TUWIEN), Gerhard Totschnig (TUWIEN), Karina Veum (ECN), 2013. D5.1: Report on power system inventory and status of RES(-E) deployment in Turkey.

André Ortner, Gustav Resch, Baha Cuban, Caner Demir, Esra Demir, 2013. D5.2.2: Existing and expected framework conditions for RES development in Turkey.

Natalia Caldés, Cristina de la Rúa, Inés López-Dóriga, Korhan Tunarli, 2014: Impact assessment in Turkey. Better Project. WP5 Deliverable.

DLR, 2009: Characterisation of Solar Electricity Import Corridors from MENA to Europe. Potential, Infrastructure and Cost.

EU, 2009. DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL.

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

IEA – International Energy Agency. “Energy Policies of IEA Countries – Turkey 2009 Review,” 2010.

OECD. “OECD Better Life Index – Turkey.,” 2014.
http://www.oecdbetterlifeindex.org/countries/turkey/.

MENR. “Turkey’s Electric Energy Market and Supply Security Strategy Paper,” 2009.
http://www.enerji.gov.tr/yayinlar_raporlar/Arz_Guvenligi_Strateji_Belgesi.pdf.
World Bank Country Data – Turkey, 2015.
http://data.worldbank.org/country/turkey#cp_gep

ANNEX

A1. Detailed description of the Integrated Assessment and Underlying Parameters

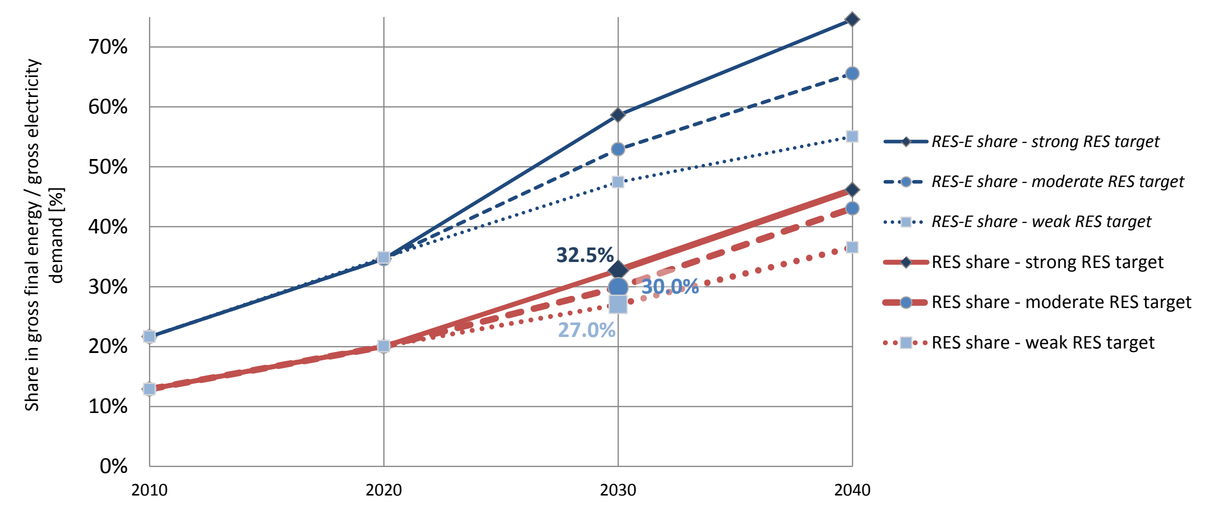
The ***integrated assessment*** serves as an overarching top-down approach framework to identify opportunities for RES cooperation considering supply and demand for doing so across the whole enlarged geographical region. Large-scale cooperation scenarios are assessed in the mid- (2030) and long-term (240) perspective, geographically including the 28 EU Member States as well as the Western Balkan region, Turkey and North Africa as additional cooperation partners.

An overview on assessed scenarios of the integrated assessment is given in As listed in and illustrated in Annex Figure , for the ambition level related to the future RES expansion three distinct RES pathways were assumed for 2030 (and beyond), one following a strong RES target for 2030 (i.e. 32.5% as RES share in gross final energy demand at EU level), one aiming for a moderate 2030 RES target (i.e. 30.0%), and one reflecting the current policy thinking, aiming for a 2030 RES share of 27%. Then, different policy cases were assessed for achieving these targets, all assuming full RES cooperation within certain system boundaries. The following key scenarios were thus distinguishable:

- Reference cases: RES cooperation only within the EU, domestic RES target fulfilment within neighbouring countries.
- Default cases: these scenarios assume full RES cooperation across the EU as well as all three case regions (North Africa, Western Balkans and Turkey)

	Reference case **of no RES cooperation** with EU neighbours*	Default case **of full RES cooperation** beyond 2020	Sensitivity analysis, incorporating regional specifics Turkey: Low domestic RES targets by 2030 and beyond	North Africa: Delayed development of Wind and PV
Strong RES target **by 2030** (i.e. 32.5% RES at EU level) **and beyond**	**Reference** (strong target)	**Default** (strong target)	*Sensitivity case:* **Turkey – Low Ambition** (strong target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (strong target)
Moderate RES target **by 2030** (i.e. 30% RES at EU level) **and beyond**	**Reference** (moderate target)	**Default** (moderate target)	*Sensitivity case:* **Turkey – Low Ambition** (moderate target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (moderate target)
Weak RES target **by 2030** (i.e. 27% RES at EU level) **and beyond**	**Reference** (weak target)	**Default** (weak target)	*Sensitivity case:* **Turkey – Low Ambition** (weak target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (weak target)

Annex Table 1: Overview on assessed cases of the integrated assessment (Green-X)



Annex ***Figure 1: The assumed ambition level related to future RES deployment at EU level***

To fully understand the use of policy instruments and RES targets in this model, the **following aspects have to be kept in mind:**

The overall modelling of future RES developments in the EU and its neighbours is done for all energy sectors (i.e. electricity, heating & cooling and biofuels in transport) [[2] Please note that for assessed North African countries (i.e. Algeria, Egypt, Libya, Morocco and Tunisia) also the modelling is constraint to the electricity sector due to data availability. This coincides well with real-world limitations of RES cooperation between the EU and North Africa, where only electricity exchange may represent a viable opportunity in practice.] but our detailed assessment of cross-border RES cooperation in the mid- (2030) to long-term (2040) is limited to the electricity sector.

- A (harmonised and uniform) RES-E trading regime is used in modelling to identify the opportunities and benefits related to RES cooperation. More precisely, a support scheme harmonised across all assessed countries is assumed for RES in the electricity sector that does not differentiate between different technologies. In this case the marginal technology to meet the given RES-targets sets the price for the overall portfolio of RES technologies in the electricity sector. The policy costs occurring in the quota system can be calculated as the certificate price multiplied by the RES generation under the quota system. These costs are then distributed in a harmonised way across all countries so that each type of consumer pays the same (virtual) surcharge per unit of (renewable) electricity consumed.
- First, the reference cases are created, in which RES-E trade is assumed to take place among the EU Member States and within the EU boundaries only. Sector-specific targets (for RES-E within the trading regime, and for biofuels in transport where physical trade is common practice already today to meet national blending obligations) and financial incentives for RES in heating and cooling are modified in accordance with the envisaged ambitions level – i.e. until targeted volumes of overall RES deployment (i.e. overall 2030 RES shares in gross final energy demand) are met at EU level.

- For all further scenarios that include cooperation between the EU and the analysed neighbouring countries, similar RES-E targets to those at EU level (i.e. related to the RES expansion, in particular renewable electricity installations beyond 2020 that are allowed to participate in the RES-E trading regime) are assumed to be applied in the Energy Community (EC), and in particular in our analysed EC Contracting Parties (i.e. the Western Balkans). Virtual exchange is then the default form of cooperation between and within the EU and the EC.
- For Turkey a sensitivity variant assesses the impact of whether accession to the Energy Community or respectively the EU takes place or not – as default the assumption is taken that Turkey will join and consequently apply a similar policy concept and ambition level for RES. In the sensitivity variant of Turkey not joining the assumption is taken that only a low target is followed by Turkey related to its mid- to long-term ambition concerning domestic RES use. This leaves room for further RES-E exports to the EU. In contrast to default within the EU/EC, under these circumstances physical renewable electricity export is then however assumed to be a necessity.
- A different approach is followed for the North African countries. Domestic RES use is aligned with DLR‘s bottom-up assessment, concentrated solar thermal power (CSP) and wind power as well as centralised large-scale photovoltaic (PV) plants not used domestically are then allowed, model wise, to participate in the EU/EC RES trading regime. Within the sensitivity assessment a closer look is taken at the technical concept used to transfer the surplus in renewable electricity from North Africa to Europe. In the sensitivity case DLR’s preferred concept of transferring electricity from CSP via High Voltage Direct Current (HVDC) lines to centres of Europe is followed. This implies consequently a less strong expansion of the “conventional” transmission and distribution grid in North Africa as well as to Southern Europe, and may therefore lead to a delayed expansion of wind and PV (that appear less viable for HVDC transfer due to their variability).

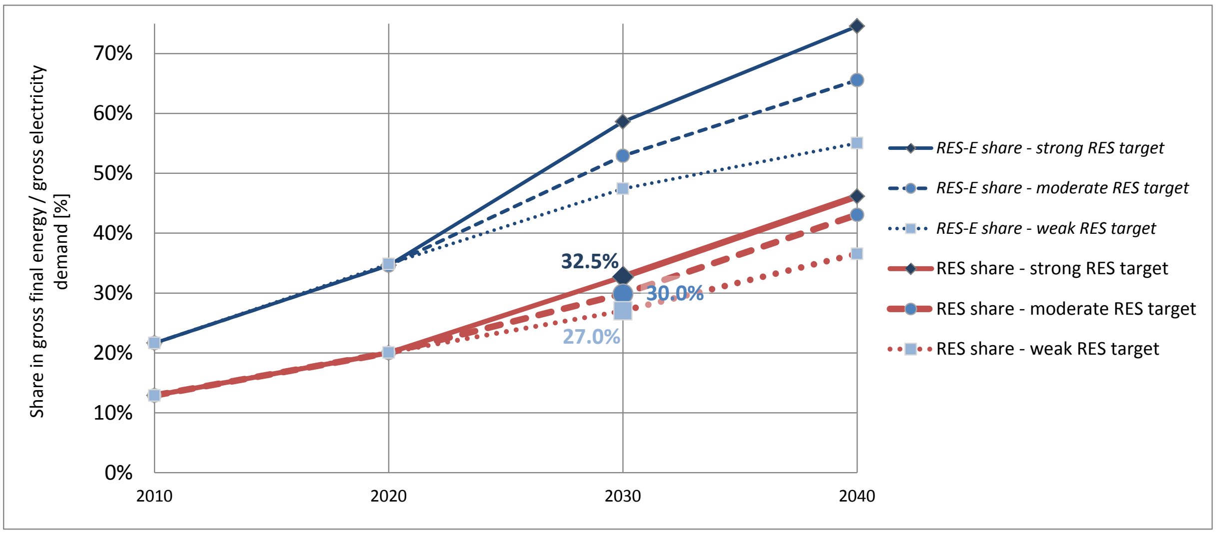
below. The level of ambition concerning future RES expansion, in particular the envisaged 2030 RES target at EU and Energy Community level, stands in focus, complemented by sensitivity analyses related to specifics of the targeted regions on their ways forward.

As listed in and illustrated in Annex Figure , for the ambition level related to the future RES expansion three distinct RES pathways were assumed for 2030 (and beyond), one following a strong RES target for 2030 (i.e. 32.5% as RES share in gross final energy demand at EU level), one aiming for a moderate 2030 RES target (i.e. 30.0%), and one reflecting the current policy thinking, aiming for a 2030 RES share of 27%. Then, different policy cases were assessed for achieving these targets, all assuming full RES cooperation within certain system boundaries. The following key scenarios were thus distinguishable:

- Reference cases: RES cooperation only within the EU, domestic RES target fulfilment within neighbouring countries.
- Default cases: these scenarios assume full RES cooperation across the EU as well as all three case regions (North Africa, Western Balkans and Turkey)

	Reference case **of no RES cooperation** with EU neighbours*	Default case **of full RES cooperation** beyond 2020	Sensitivity analysis, incorporating regional specifics Turkey: Low domestic RES targets by 2030 and beyond	North Africa: Delayed development of Wind and PV
Strong RES target **by 2030** (i.e. 32.5% RES at EU level) **and beyond**	**Reference** (strong target)	**Default** (strong target)	*Sensitivity case:* **Turkey – Low Ambition** (strong target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (strong target)
Moderate RES target **by 2030** (i.e. 30% RES at EU level) **and beyond**	**Reference** (moderate target)	**Default** (moderate target)	*Sensitivity case:* **Turkey – Low Ambition** (moderate target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (moderate target)
Weak RES target **by 2030** (i.e. 27% RES at EU level) **and beyond**	**Reference** (weak target)	**Default** (weak target)	*Sensitivity case:* **Turkey – Low Ambition** (weak target)	*Sensitivity case:* **North Africa – Delayed Wind & PV** (weak target)

Annex Table 1: Overview on assessed cases of the integrated assessment (Green-X)



Annex Figure 1: The assumed ambition level related to future RES deployment at EU level

To fully understand the use of policy instruments and RES targets in this model, the following aspects have to be kept in mind:

- The overall modelling of future RES developments in the EU and its neighbours is done for all energy sectors (i.e. electricity, heating & cooling and biofuels in transport) [[2] Please note that for assessed North African countries (i.e. Algeria, Egypt, Libya, Morocco and Tunisia) also the modelling is constraint to the electricity sector due to data availability. This coincides well with real-world limitations of RES cooperation between the EU and North Africa, where only electricity exchange may represent a viable opportunity in practice.] but our detailed assessment of cross-border RES cooperation in the mid- (2030) to long-term (2040) is limited to the electricity sector.

- A (harmonised and uniform) RES-E trading regime is used in modelling to identify the opportunities and benefits related to RES cooperation. More precisely, a support scheme harmonised across all assessed countries is assumed for RES in the electricity sector that does not differentiate between different technologies. In this case the marginal technology to meet the given RES-targets sets the price for the overall portfolio of RES technologies in the electricity sector. The policy costs occurring in the quota system can be calculated as the certificate price multiplied by the RES generation under the quota system. These costs are then distributed in a harmonised way across all countries so that each type of consumer pays the same (virtual) surcharge per unit of (renewable) electricity consumed.
- First, the reference cases are created, in which RES-E trade is assumed to take place among the EU Member States and within the EU boundaries only. Sector-specific targets (for RES-E within the trading regime, and for biofuels in transport where physical trade is common practice already today to meet national blending obligations) and financial incentives for RES in heating and cooling are modified in accordance with the envisaged ambitions level – i.e. until targeted volumes of overall RES deployment (i.e. overall 2030 RES shares in gross final energy demand) are met at EU level.
- For all further scenarios that include cooperation between the EU and the analysed neighbouring countries, similar RES-E targets to those at EU level (i.e. related to the RES expansion, in particular renewable electricity installations beyond 2020 that are allowed to participate in the RES-E trading regime) are assumed to be applied in the Energy Community (EC), and in particular in our analysed EC Contracting Parties (i.e. the Western Balkans). Virtual exchange is then the default form of cooperation between and within the EU and the EC.
- For Turkey a sensitivity variant assesses the impact of whether accession to the Energy Community or respectively the EU takes place or not – as default the assumption is taken that Turkey will join and consequently apply a similar policy concept and ambition level for RES. In the sensitivity variant of Turkey not joining the assumption is taken that only a low target is followed by Turkey related to its mid- to long-term ambition concerning domestic RES use. This leaves room for further RES-E exports to the EU. In contrast to default within the EU/EC, under these circumstances physical renewable electricity export is then however assumed to be a necessity.
- A different approach is followed for the North African countries. Domestic RES use is aligned with DLR‘s bottom-up assessment, concentrated solar thermal power (CSP) and wind power as well as centralised large-scale photovoltaic (PV) plants not used domestically are then allowed, model wise, to participate in the EU/EC RES trading regime. Within the sensitivity assessment a closer look is taken at the technical concept used to transfer the surplus in renewable electricity from North Africa to Europe. In the sensitivity case DLR’s preferred concept of transferring electricity from CSP via High Voltage Direct Current (HVDC) lines to centres of Europe is followed. This implies consequently a less strong expansion of the “conventional” transmission and distribution grid in North Africa as well as to Southern Europe, and may therefore

lead to a delayed expansion of wind and PV (that appear less viable for HVDC transfer due to their variability).