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Editorial

The interaction between intermittent renewable energy and the electricity, heating and transport sectors

In a global perspective, it is essential that the world transfers from fossil fuels to renewable energy sources in order to minimise climate change effects. As a part of such transition energy savings are also important, as they can decrease production costs effectively. The nature of such a change is that it has to be implemented on a local level. Energy saving technologies are placed with the demand decrease and renewable energy is typically distributed where the resources are. In some parts of the world, energy savings have resulted in a stabilisation of the energy demands, however in the world as such, demands are still increasing in buildings, transport and industry. Although the demand has increased approx. 32% overall, the share of renewable energy has increased from 12.7% in 1990 to 13% in 2010 [1], in this way demonstrating that renewables can effectively cope with the world energy requirements – even in a context characterized by a continuously increasing demand. Even in the current financial crisis, renewable energy is expanding heavily [2]. The most used renewable energy is biomass; however there has been a significant increase in wind power and in photovoltaic in the last ten years. Such development in the intermittent renewable energy sources requires knowledge about the interaction between supply and demand sides of energy.

At the 6th Dubrovnik Conference on Sustainable Development of Energy, Water and Environmental Systems, September 25–29 2011, in Dubrovnik, Croatia, these issues were addressed among others. The conference was dedicated to research concerning methods, policies and technologies for increasing the sustainable development as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water and environment systems and their many combinations. At the conference 418 scientists from 55 countries representing six continents participated. In this Special Issue the interaction between sectors and renewable energy systems through selected papers from this conference is addressed from a range of technical system analyses to environmental and economic feasibility.

Buildings account for a substantial part of the global energy supply. Approximately 35% of the world's energy demand is in buildings of which approximately 75% is heating and hot water demand [3]. In such a perspective the design and interaction between buildings and the energy systems surrounding and supporting it becomes important in the evaluations of which heating systems are able to facilitate these technological changes. The required technological changes are different in the renovation of existing buildings than in new buildings, however in both cases the concept of zero emission buildings and improvements in energy efficiency cannot be seen isolated from the renewable energy sources and the energy system surrounding them. In some cases individual solutions are most suitable but in other cases district heating is a more fuel and cost efficient solution. Energy savings and system integration with district heating can be beneficial in the existing building. In Wada et al. [4] the potential for reductions in greenhouse gas emissions is calculated to be very significant on a global level and policy makers are aware of this and hence the standards for energy efficiency is increasing for new buildings as in the case in the UK is pointed out by Pan & Garmston [5]. In Nielsen & Möller [6] the future of district heating is examined in the light of net zero emission building and the main findings are that excess heat from these buildings can benefit district heating systems by decreasing the production from production units utilizing combustible fuels. In the existing building stock there are benefits and potentials for expanding district heating in several cases, such as the Croatian case in Loncar & Ridjan [7], the Italian case in Verda et al. [8] and the Danish case in Münster et al. [9] taking into consideration energy savings.

In Stutterecker & Blümel [10] renovation shows how a single larger building can approach passive house standards and the knowledge of how building behave should be more certain as illustrated in Simões & Serra [11] and Sorrentino et al. [12]. However when looking at the transition of the entire energy system, such as in the example of Macedonia by Cosic et al. [13] and Taseska et al. [14] as well as the case of the UK by Alderson et al. [15], it is clear that such technologies on the individual houses have to be seen in the perspective of the energy system. In Ban et al. [16] the example of cooling storage is used in such interaction, in Milan et al. [17] on-site PV production and heat pumps for the heat consumption is used and the electricity demand and electric heating is used in Arghira et al. [18] and Fitzgerald et al. [19]. There are however larger systems integration and storage options such as pumped hydro analysed in Pérez-Díaz et al. [20], again however the heating sector can make a large contribution using combined heat and power (CHP) and large heat pumps such as pointed out in the German case in Kusch et al. [21]. In fact both system integration using CHP, large heat pumps, and other renewable energy resources in district heating can reduce the biomass consumption significantly by using intermittent renewable energy sources in 100% renewable energy systems as analysed in Mathiesen et al. [22]. Several case studies evaluate CHP in different context such as Danon et al. [23], Radulovic et al. [24] and Heinz & Henkel

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[25]. The benefits of district heating are as mentioned, that the system can use different sources such e.g. waste, biogas, industrial waste heat, geothermal as shown in Wang et al. [26], Schneider et al. [27], Börjesson & Ahlgren [28], Öhman [29] and Kalogirou et al. [30]. In systems without CHP the replacement of fossil fuels in power plants such as illustrated in the Brazilian, Nepalese and Spanish cases in Khatiwada et al. [31] and Royo et al. [32] may especially put pressure on the biomass resource.

In such perspectives intermittent renewable energy sources should be expanded and developed. Wind has had a major development in Europe and the Unites States, however China is now also focussing heavily on this development. In Hong & Möller [33] a further future potential of going off-shore is shown to be able to cover substantial amounts of the energy supply. Further wind development will put demands on improving the distribution and transmission grids. For long distance transport ultra-High-Voltages direct current may be feasible as pointed out in Humpert [34], while the wind turbines may also contribute to frequency control as analysed by Camblong et al. [35]. Intermittent renewable energy as wind and PV still can still be further improved as illustrated by Jiang et al. and Kalogirou [36,37], however energy market are important to ensure that power plants and CHP do not produce when there are intermittent renewable energy in the grid, and even though there has been focus on these for many years in e.g. EU there are still improvements to be made as pointed out by Moreno et al. [38].

In Denmark, the current coverage of wind power in the electricity grid is app. 28% in 2011 and the plan is to reach 50% of coverage by 2020. Most plans are very large off-shore parks, however in Müller et al. [39] the potential for going off-shore in a smaller wind parks is shown. These could have lower local impacts on the environment. In fact the local level is rather important, as reductions in consumption and the distributed nature of renewable energy is dispersed and has to be accepted locally. In Brandoni & Polonara [40] and Müller et al. [41] this is illustrated for a number of local strategies in Italy and for a number of Islands. When renewable energy penetrate the energy system other sectors than the heating system may be important to be integrated.

In Ajanovic et al. [42] the potential for more energy efficient vehicles is shown, however in the future, the importance of integrating the transport sector with the rest of the energy system is important. Here electric vehicles can contribute to the integration of renewable energy by replacing combustion technologies and charging in situations with wind power. This is analysed with different electric vehicles penetrations and charging strategies in Hedegaard et al. and Metz & Doetsch [43,44]. Electric vehicles however can only cover lighter transport, and truck as well as aviation and ships will need biofuels in order to transfer to renewable energy such as bio-methanol, bio-ethanol and bio-diesel in Ko et al. [45], Zhang et al. [46] and Hájek et al. [47].

A long term perspective is necessary in the strategies for transition to more renewable energy and energy savings, such as illustrated in Irsag et al. [48] by potential long term saving in the Croatian increasing tourism sector and a life cycle perspective in the case of green roofs in Peri et al. [49]. The long term perspective is especially important when coupling this with the current economic situation as pointed out in the Portuguese situation by Oliveira Henriques & Antunes [50]. The potential of having a more certain long term cost of the energy systems is substantial with renewable energy and energy savings, however this requires methodologies in developed and developing countries e.g. in Cantore and Paleta et al. [51,52] and case studies in different corners of integrated renewable energy systems described above.

1. Conclusions and acknowledgements

This Special issue, devoted to energy at Conference on Sustainable Development of Energy Water and Environmental Systems – SDEWES 2011, provided an overview of several topics related to sustainable development. The Guest editors believe that the selected papers and addressed issues would be of interest of readers of ENERGY journal.

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