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Editorial

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It is with great pleasure that we can announce this first issue of *Smart Energy*. The aim of the journal is to be a leading platform and an authoritative source of information related to the green transformation of energy supply and demand systems into future smart renewable energy and sustainable solutions. With the concept of smart energy systems as the core element, we wish to promote a holistic sector-integration approach to the development of future solutions to climate change. The ambition of the journal is to provide an international scientific forum for the design and analysis as well as planning, market, regulatory and modelling aspects of smart energy systems.

During the COVID-19 pandemic, our lives as well as our energy systems have been gravely affected globally. The range of impacts between limited restrictions in societies to full restrictions can lead to reductions in the energy demands of between 9 and 24% [1]. Projections have indicated that the global fossil CO_2 emissions have decreased by 7% or 2.6 $GtCO_2$ with an uncertainty range between 3% and 12% [2]. According to the latest statistical data, the primary energy demand dropped almost 4% and energy-related CO_2 emissions decreased by 5.8% in 2020. In percentages, this is the largest decline since World War II and corresponds to almost 2 GtCO2. In absolute terms, this is unprecedented in human history and exceeds the reductions of any comparable emergency situation, such as the Spanish flu, the great depression, the world wars, the oil shocks and also the recent 2008 financial crisis. Moreover, the decline corresponds to removing all of the European Union's emissions from the global total [3]. However, it is a very small cut compared to the 32 $GtCO_2$ needed to meet the ambition of the 1.5 °C target in the Paris Agreement by 2030 [4].

1. Faster development in renewable energy, energy storage and energy efficiency technologies

There is a multitude of drivers pulling in several directions with regard to domestic electricity and heat consumption, transport habits and industry demands in combination with many regional differences in the structure of the energy demand, the level of lock-down measures and duration [5].

While the pandemic surged the world, and seemingly stopped the world, we have only seen minor setbacks in the deployment of renewable energy and energy efficiency technologies. On the other hand, the energy related emissions did not decrease as much as anticipated, as also indicated above. In 2020, the demand for fossil fuels was reduced. Oil experienced the largest drop ever and is down by 8.6%. Oil accounts for half of the decrease in global greenhouse gas emissions, mainly due to the reductions of road transport by 50% and aviation by around 35% [3]. The coal demand decreased by 4% and natural gas only decreased marginally.

On the other hand, photovoltaics and wind power have reached the highest ever share of the global energy mix, corresponding to about 20% in 2020. Even though the pandemic hit, renewables accelerated the expansion with a 50% increase in their contribution to lowering power sector emissions relative to 2019 [3].

It is evident that integration measures are needed as new installations of renewable energy capacity increased by 45% to about 280 GW in 2020 [6]. This fast development of fluctuating renewable energy sources will increasingly challenge the design of the energy systems globally. Further development of favourable market conditions and continued decreases in the LCOE (levelized cost of electricity) will increase the growth rates; both in wind and solar PV, but also in offshore wind power. With this development, these costs are lower than the cost levels of new fossil fuel capacity and nuclear power.

2. More electrification, more energy efficiency, increasingly larger levels of digitalisation and smart meters

In combination with an increasing development in renewable energy, many other developments are seen globally in the energy sector. Energy efficiency has been a focus area in many COVID-19 recovery plans, due to the multiple benefits regarding energy security, climate action and local job creation.

There are many benefits of building level refurbishments and energy savings, which have been traditional focus areas in energy efficiency measures. With the increased focus on the global reduction of greenhouse gas emissions, an increasingly larger focus on more general demand side measures can be expected. These measures involve energy efficiency in industry and buildings using smart meters and digitalisation; electrification of transport, industry and, to some extent, heating; increasing shares of district heating combined with geothermal and solar thermal; large-scale heat pumps and waste heat, and last but not least, Power-to-X liquid and gaseous electrofuels.

This means that, in some areas, we will experience a lower demand for electricity and heating due to energy efficiency, while increasing the peak production from renewable energy sources. At the same time, however, the electrification of transport, heat pumps and electrofuels provide new opportunities for designing the energy system, also driven by the limited potential for bioenergy, which otherwise may have been the obvious renewable energy choice.

3. Smart grids, energy infrastructure and energy storages

A precondition for all of these developments on the supply side and demand side is infrastructure. In the last two decades, the focus

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on electricity smart grids has been vast. Infrastructure investments constitute a large part of the total costs of energy for citizens and businesses. With changes in peaks and loads in electricity, gas and district heating grids, there is a need for further understanding how to optimise and improve the utilisation of energy infrastructure with new flexible demands as well as smart electricity grids, smart thermal grids and smart gas grids in combination with digitalisation [7].

The expansion from a smart (electricity) grid perspective to a smart energy system focus can identify some of the synergies between the energy carriers, grids and infrastructures as well as in the use of energy storage [8]. Energy efficiency, e.g., creates synergies in the supply chain regarding new lower temperature district heating systems [9] as well as reduces peak demands, which then lowers the demand for peak ramping capacity at times when fluctuating renewable energy production is low. Instead of focusing at the building level, more and more knowledge builds on the understanding of supply chain effects of energy efficiency, e.g., in 4th generation low-temperature district heating [10] and in expanding the scope from the single building or industry to a system understanding [11].

4. Stricter and faster national targets to meet the Paris Agreement with net zero emissions

For several years, there has been a debate in Europe about 1) the level of greenhouse gas emission reductions, renewable energy and energy efficiency and 2) a full EU-wide agreement on net zero emissions in 2050. The European Commission now has a target of 55% greenhouse gas reductions by 2030 and a net zero emission target for 2050. Before 2019, these goals were completely out of reach. In recent months, we have seen China converge to a net zero emissions target by 2060 and recently, the new Biden administration has set a target of net zero emissions for 2050. In other words, the development towards the implementation and use of renewable energy and energy efficient technologies has just begun. We can expect a stronger and faster global transition in this direction now.

In order to ensure that more fluctuating renewable energy in combination with a more efficient conversion and end use will not result in black-outs, curtailed renewable energy or heavy increases in energy costs for citizens and businesses, this development requires an urgent and strong focus on energy system redesign. The perspectives of further understanding the energy system dynamics and developing research within Smart Energy is vast due to the need for this redesign. Smart Energy can further reduce the reliance on fossil fuels and bioenergy, reduce total costs as well as increase the utilisation of energy efficiency, renewable energy, energy infrastructure and energy storages. Such knowledge can lead to the elimination of greenhouse gas emissions from the energy, transport and industrial sectors, the creation of new jobs and businesses as well as an increase in the security of supply and ensuring a sustainable level of bioenergy utilisation. Using data, AI and GIS, the operation and design of new energy systems can also be improved.

The need for this system redesign merits a journal with such a focus. Additional to the technical energy system modelling challenges, there is a need for understanding the policies, energy markets, energy planning, management, financing, market designs, public regulation and economics in order to transition to smart energy systems. In this journal, we aim at advancing the knowledge of the system design, in order to promote better knowledge-based decision, and making a faster deployment. The core belief is that we need to focus less on the separate parts of the energy system and more on combining energy carriers and sectors.

The smart energy systems approach poses a significant leap towards understanding the cross-sector advantages enabling the use of more affordable energy storages and synergies between infrastructures and grids. In this first issue, we have published papers on a large variety of topics related to Smart Energy; from the modelling of combined electric vehicle - PV systems [12] and marginal CO_2 abatement costs curves [13], to the development of new advanced features in energy system analysis tools [14], the correlation between heat demand and renewable energy penetration [15] as well as the role of biomass gasification in smart energy systems [16]. Other papers focus on optimising the use of thermal infrastructure as part of smart energy systems by using GIS tools to map the potential of waste heat [17], advancing the terminology within district heating [18] as well as advancing the market designs [19] and energy flows in thermal grids [20].

We hope that you will enjoy the coming volumes of Smart Energy.

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