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Renewable energy: past trends and future growth in 2 degrees scenarios

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Abstract

This study explores past growth rates of renewable energy sources (1971-2012) and required future ones in 2 degrees scenarios. Results show that in spite of comparatively high growth of renewable energy in the period 2000-2012, the share of renewable energy in total energy use stayed the same (13%). The overall increase in renewable energy amounted to 2.2%/yr in the period 1971-2012 and 2.6%/yr in the period 2000-2012. In order to be consistent with a 2 degrees pathway the growth rate would need to increase to 3-5%/yr. Especially high growth would be required for wind, solar and geothermal (~10%/yr). This would lead to a change in the mix of renewable energy used, with a much higher share of variable renewable energy sources. However most notable is the strong difference in the growth of energy use, compared to past trends. Primary energy use needs to consistently decrease by 0.1-0.5%/yr for OECD regions, up to 2050, which would require a breach from past trends. But especially for non-OECD regions the needed change is large. Regional growth rates for energy use in the period 2000-2012 range from 1.5%/yr to 6.1%/yr and should decrease to the range of -0.2%/yr to 0.9%/yr.

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1. Introduction

Many studies agree that a transition to a sustainable energy supply is needed in order to safeguard the supply of energy for future generations and abate greenhouse gas emissions. Limiting the average global surface temperature increase to 2°C, compared to pre-industrial average, is often regarded as an adequate means of avoiding dangerous

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climate change [1]. In many scenarios that envision a development of energy supply that would be in line with a 2 degrees target, a large component of the solution consists of renewable energy and energy efficiency [2]. Renewable energy would be in the range of 200-300 EJ in 2050, equivalent to 40-80% of total primary energy supply in 2050. This means an increase by a factor of 3 compared to 74 EJ in 2012 [3]. However, in spite of a significant increase in the use for renewable energy in the period 2000 to 2012 (from 54 EJ to 74 EJ), the share of renewable energy in total energy use has remained at 13% [3]. A reason can be found in the growth of total energy use and hence non-renewable energy use, which increased likewise. Of renewable energy globally, biomass is at the moment the largest source used, equivalent to 10% of total primary energy use in 2012, followed by hydro power, responsible for 2% [3]. A transition of energy supply in order to help achieve a 2 degrees target requires a strong growth of renewable energy and energy-efficiency both in absolute and relative sense. Also a strong shift is needed to other renewable energy sources than biomass and hydro. Many studies have assessed the increases in renewable energy that would be needed in many different scenarios [e.g. 2, 4, 5]. A comparison with past trends on a regional basis is, as far as known, not available yet. This paper hence explores past growth rates for different types of renewable energy and required future ones in 2 degrees scenarios. For this purpose past trends in renewable energy use in the period 1971 to 2012 are analysed and future contributions are explored (section 2). This period shows the emergence of solar, wind and geothermal energy, and biomass use for transport fuels and electricity generation. In section 3, future contributions are assessed of renewable energy use in 2 degrees scenarios, on a regional basis. Lastly, discussion and conclusions are given in section 4.

2. Past trends in renewable energy use

The development of renewable energy by type and country is based on the IEA Extended Energy Balances [3]. Primary energy use in this data source is based on the physical energy content method, which means that for wind and solar energy the amount of primary energy is equal to the amount of final energy. For biomass electricity a conversion efficiency of 33% is used and for geothermal electricity an efficiency of 10%.

Fig. 1 shows the development of global primary energy use in the period 1971-2012 (a) and of renewable energy use excluding biomass and hydro (b), respectively. Overall renewable energy use more than doubles from 30 EJ in 1971 to 74 EJ in 2012. The share of biomass in renewable energy use slowly decreases from 85% in 1971 to 73% in 2012. This is mainly a result of an increasing share of hydro from 14% to 18% and an increase in geothermal energy use from 1% to 4%. Fig. 1 (b) shows the emergence of solar thermal energy (mainly after 1990) and wind power (after 2000), which account for 1% and 2% of renewable energy use, respectively in 2012.

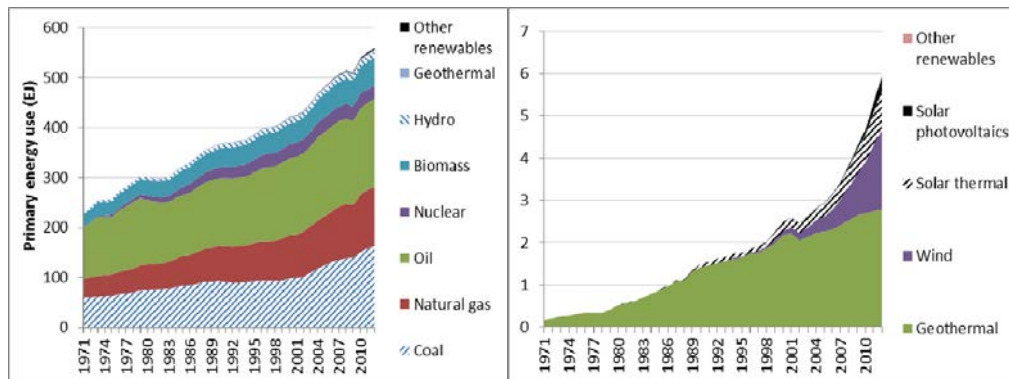


Fig. 1 (a) global primary energy use from 1971-2012 and (b) global renewable energy supply from 1971-2012, excluding biomass and hydro (based on [3])

Table 1 shows compounded annual growth rates of renewable energy (RE) for four decades and for the overall period 1971-2012. Growth rates can be used to express the deployment level (see e.g. [6] and [4]) and seen as indicators of the pressure on infrastructures that are required to support the technologies. There is a clear increase in the growth rates after 2000, when energy and climate policies take effect. Visible is the entrance of wind and solar

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