

A review of hydropower in Austria: Past, present and future development



Beatrice Wagner*, Christoph Hauer, Angelika Schoder, Helmut Habersack

Institute of Water Management, Hydrology and Hydraulic Engineering, Christian Doppler Laboratory for Advanced Methods in River Monitoring, Modelling and Engineering, Department of Water, Atmosphere and Environment, BOKU – University of Natural Resources and Life Sciences, Muthgasse 107, 1190 Vienna, Austria

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ABSTRACT

Hydropower is traditionally an important sector of the Austrian energy system. Approximately, 65.7% of the national electricity generation comes from hydropower. According to the most current numbers, 2882 hydropower plants are feeding into the electricity grid. In total, including hydropower plants for own consumption over 5200 facilities exist. Concerning hydropower potential, a considerable share of 68% is already realized. To reach European and national climate and energy policy objectives (e.g. 20–20–20 targets), Austria has to increase its share of renewable energy sources. For hydropower the national energy strategy of 2010 assumes additional 3.5 TWh (12.6 PJ) until 2015. Thereof, 2.8 TWh (10.1 PJ) should be realized by new constructions and 0.7 TWh (2.5 PJ) by improvements in energy efficiency and revitalization of existing facilities. However, hydropower has its limitations. A further development of hydropower can conflict with environmental targets protecting surface water bodies. Based on a historical survey, this review intends to give an overview of the present situation of hydropower in Austria and its future political, economic and environmental perspectives and challenges.

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1. Introduction

Facing climate change as a global challenge, renewable energies are assumed to become increasingly important in future [1–3]. There is a large potential due to hydropower to decrease emissions

of greenhouse gases, reduce dependency on fossil fuels and mitigate climate change [3,4]. With the adoption of the 20–20–20 targets in 2007, the European Union (EU) set goals in order to combat climate change and increase the deployment of energy from renewable sources. A reduction in greenhouse gas emissions of at least 20% below 1990 levels, a consumption of 20% out of renewable energy sources and an increase in energy efficiency by 20% should be reached by 2020 [5]. In order to achieve these objectives, the Directive on Renewable Energy Sources

* Corresponding author. Tel.: +43 1 3189900 111.
E-mail address: beatrice.wagner@boku.ac.at (B. Wagner).

(2009/28/EC) claims national overall targets of gross final energy consumption based on renewable energies. Moreover, recent crises, such as the nuclear disaster of Fukushima in 2011 or the oil catastrophe in the Gulf of Mexico in 2010 highlight the need for a more sustainable, environmentally responsible and economic use of natural resources. Thus, the expansion of alternative forms of energy sources is one of the main targets of the European and global energy policy [3,4].

Hydropower as an almost carbon neutral, well-advanced and cost-competitive energy source is considered to be one of the oldest and most established forms of renewable energies [3,6]. It provides substantial contributions to achieve climate change objectives, to ensure energy supply and to establish a global sustainable energy system [3,7–10]. However, compared with relatively new technologies, such as wind power or solar energy, hydropower capacity is quite strongly developed, especially in Europe. Thus, apart from its benefits, also environmental (e.g. river continuum interruptions) [3,11–13] and social impacts (e.g. resettlements of communities) have to be considered [14,15]. The latest available data on global hydropower production refer to an installed hydropower capacity of 926 GW producing a global annual generation of 3551 TWh/yr (12,784 PJ) [16]. That corresponds to 16.3% of worldwide electricity generation [17]. The global technical hydropower potential is estimated at 14,576 TWh (52,474 PJ) [3,16]. About 53% of the total potential in Europe is realized, whereas other continents, such as Africa (8%), Asia (20%) or Australia (20%) have the largest undeveloped resources [3] (Fig. 1).

In Austria, hydropower is a key sector of the national electricity market [18,19]. Approximately 65.7% of the electricity is generated by hydropower [20]. According to the most current study from 2008, the total national hydropower potential which can be exploited from a technical and economic perspective amounts to 56.1 TWh (202 PJ).

Thereof, a large share of 68% is already realized [21]. Two thirds of Austria's hydropower plants are run-of-river plants supplying energy to cover base load. The other third are storage and pumped-storage plants, which particularly contribute to meet national and European peak load demands [22]. With regard to the growing use of volatile energy, such as wind or solar power, Austria's hydropower plants are assumed to become increasingly important in preserving European network stability, compensating fluctuations of consumption and enhancing security of supply [23,24]. A further expansion of hydropower, however, as required at European and national level, can be contradictory to environmental objectives (e.g. good ecological status or potential of water bodies till 2015) of the EU Water Framework Directive (2000/60/EC) [25,26]. This fact currently results in a growing political, environmental and social discussion on the future development of hydropower in Austria. A review of Austria's hydropower is particularly important for understanding current and future challenges in this field especially considering economic, energy-related, environmental and social aspects. On an international level such reviews were already done for Germany [27], Switzerland [28], Poland [29], Serbia [30], Turkey [7,9,31–37], Greece [38,39], Spain [40], Portugal [41], Scotland [42,43], Kenya [44], Nigeria [45], Lesotho [46], Pakistan [47–49], Oman [50], India [51–53], Sri Lanka [54], Malaysia [55], Vietnam [56], China [14,57–60], Nepal [61], Brazil [62], Costa Rica [63] and Australia [64] focusing on different thematic priorities. Additional reviews exist for Latin America [65], Europe in general [27,29,66–69] and on global scale [8,15,27,29,70–75]. However, for Austria such reviews are missing. Thus, this study aims to give an overview of the hydropower situation in Austria, divided into three main sections. The first section focuses on the historical development of hydropower in Austria. The second describes the current national energy situation with a focus on hydropower, its current status and legal background including amount and distribution characteristics. The third section

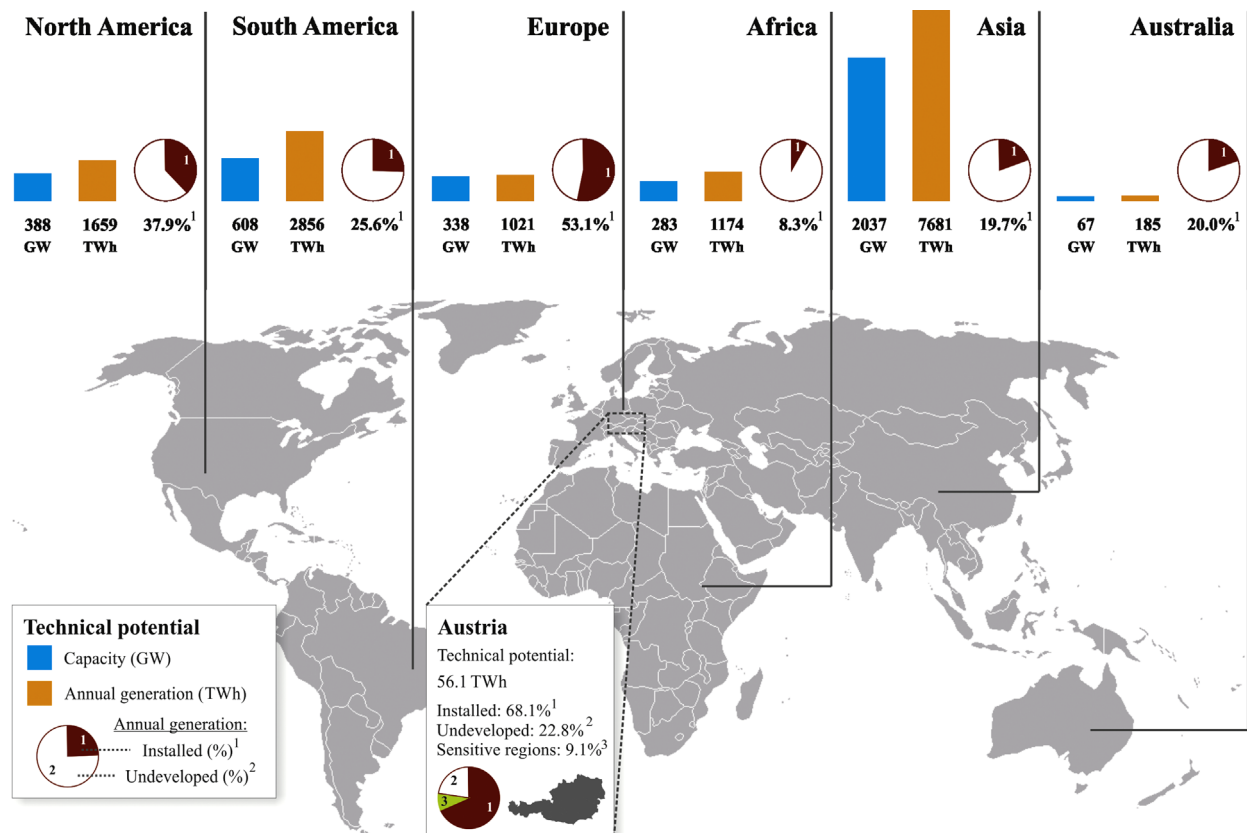


Fig. 1. Technical hydropower potential in terms of installed capacity and annual generation and the proportion of installed hydropower in North America, South America, Europe (incl. Austria), Africa, Asia and Australia in 2009; modified from [3,21].

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