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## The Underestimated Contribution of Hydropower for the Energiewende (Energy Transition)

Michael Bohlinger<sup>a\*</sup>, Jürgen Spitznagel<sup>b</sup>

*Hochschule München, Lothstraße 64, München 80335, Germany*

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### Abstract

This article describes the set up of the German “Energiewende” translated to energy transition with its strong focus on the electricity market and the most traditional form of renewable energy systems: hydropower. With the definition of the future development corridor of renewable energy Germany could achieve the really ambitious self-imposed greenhouse gas reduction. To implement the future development corridor of renewable energy, Germany applies over the years different versions of feed-in laws for renewable energy systems. A technology-independent funding of renewable energy systems is not intended in Germany. Wind power is seen as the most cost efficient technology. Regarding to the presented figures from three different perspectives: political and social, economic and technical, and global warming the current and future possible contribution of hydropower is underestimated. At least in the most powerful federal tectorial states Bavaria and Baden-Wuerttemberg considered by gross domestic product, hydropower has the biggest share of renewable gross electricity production. In these federal states hydropower has still growth potential and altogether the biggest growth potential compared to all other German federal states. Due to this fact it is incomprehensible why hydropower is not be seen as a bigger role player in the Energiewende. Additional research is needed to evaluate further possibilities for hydropower to support the aspired way of transforming the existing electricity market within the Energiewende.

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**Keywords:** Energy industry; German Energiewende; Electricity market; Energy transition; Renewable energy systems; hydropower

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\* Corresponding author. Tel.: +49-179-4626333;  
E-mail address: [mbohling@hm.edu](mailto:mbohling@hm.edu)

## 1. Introduction and motivation

Germany, fourth largest national economy of the world [1], is a pioneer of renewable energy deployment [2]. According to Amin Director General of IRENA, Germany has one of the most ambitious renewable energy targets in the world under the term “Energiewende” translated to energy transition and could be seen as transition project with pilot character. On the other side the transformation of the energy system in Germany also affects rapid changes. The growing amount of renewable energy systems in the in the electricity sector leads to a rapid change in the conditions of the so far existing energy market. A technology-independent funding of renewable energy systems is not intended in Germany. Wind power is seen as the most cost efficient technology [3]. The current and future possible contribution of hydropower is underestimated.

The following article should give a short historical review about the Energiewende in Germany and explain the changes in the electricity market. Hydropower, the most traditional form of renewable energy systems in Germany will be discussed from three different perspectives: political and social, economic and technical, and global warming. At least in the most powerful federal tectorial states Bavaria and Baden-Wuerttemberg considered by gross domestic product, hydropower has the biggest share of renewable gross electricity production. In these federal states hydropower has still growth potential and altogether the biggest growth potential compared to all other German federal states.

## 2. Energiewende focused on electricity market

Due to the strong support of the politics to set up the Energiewende, the share of the renewable energy systems has grown in the primary energy consumption from 1.9% in 1995 to 12.6 % in 2015. In the electricity sector, which is about a 20% [4] share of primary energy consumption, the share of renewable energy systems has grown in the same time from nearly 5% to nearly 33% [5]. Also, the total amount of gross provision of renewable energy in the electricity sector has risen from 36 TWh/a in 2000 to 153 TWh/a in the year 2013. In the sector of fuel the consumption increased from 0 TWh/a in 2013 to 33 TWh/a. [6]

The biggest progress in applying renewable energy systems was made on the electrical sector. According to Kohler [7] the Energiewende is mainly focused on the Electricity sector. This is determined on the massive advantages brought by the renewable energy feed in law and its long lasting investment security.

According to Fishedick 2014 an additional reason for the further development in the electricity sector is the simplified direct input of generations powered by wind and water. For fuel, renewable energy must be transformed by more steps [8]. Bettzüge achieve likewise, that the focus on Energiewende applied by the phase out of nuclear power plants and renewable energy systems, which are about 10 % compared to the primary energy consumption. The politics and the public do not perceive a further debate on the heat and transportation sector [9].

It can be summarized, that there are different reasons for focusing on the electricity sector by applying the Energiewende.

### 2.1. Development and contribution of renewable energy systems in the electricity market

In 1995 4.7 % of the gross electricity generation was generated by renewable energy systems. The predominant share comes from hydropower. Since then the share of renewable energy systems in the electricity market (gross electricity generation) has risen to more than 30% [10]. Driven by fixed feed-in tariffs for electric renewable energy production, the share of gross electricity generation by renewable energy systems were promoted depending on source and capacity. The development of gross electricity generation of renewable energy systems is shown in Fig. 1.

To emphasize the growth of renewable energy systems, a comparison of the growth rate of annual production and installed capacity on the basis of 2005 is shown on Table 1.

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