DESCRIPTION OF THE REQUIRED POSITIVE TERTIARY RESERVE ENERGY

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ABSTRACT

Transmission system operators need tertiary reserve to guarantee reliable grid operation. The used tertiary reserve energy varies stochastically. For a more detailed description, analysing the used tertiary reserve energy values is necessary. Based on this analysis, new modelling options can be deducted. This paper offers a description of the tertiary reserve demand of transmission system operators.

1. INTRODUCTION

Transmission system operators need reserve power to guarantee reliable grid operation. Reserve power is divided into primary reserve, secondary reserve and tertiary reserve according to the activation time and the duration of activation (fig. 1). Tertiary reserve is activated manually, for example by phone-call. The secondary reserve has to be disposable again after 15 minutes. Due to this, the tertiary reserve power has to be full-activated within 15 minutes after the energy shortfall [1]. If the tertiary reserve can be activated more quickly, the transmission system operator need not call directly after the energy shortfall (fig. 1).

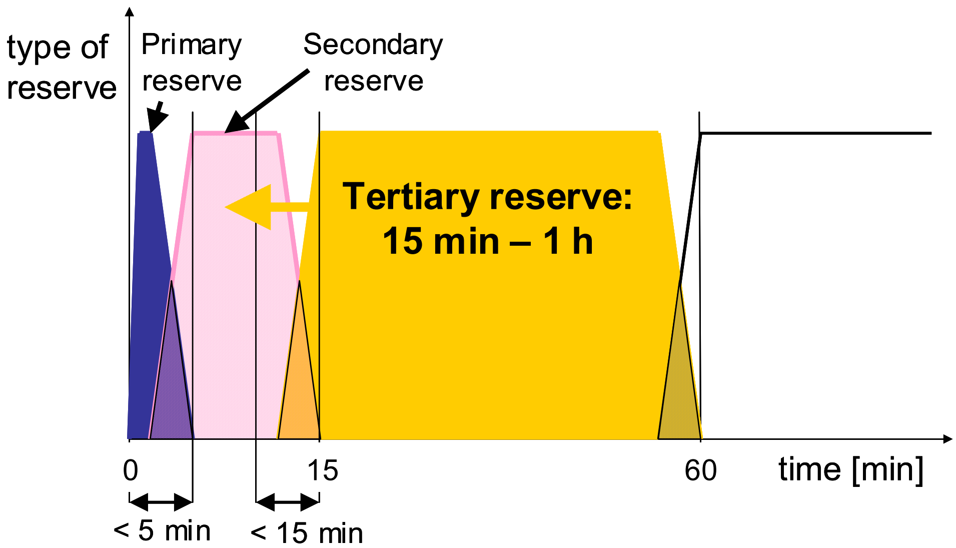

fig. 1 Types of reserve power, maximum activation times and durations

Since December 1th, 2006 the transmission system operators daily advertise for bids on their common website www.regelleistung.net [2]. Only pre-qualified suppliers are accepted. The accepted bidders provide a constant amount of tertiary reserve power during the offered time. This provided tertiary reserve power is activated on demand in case of medium-term differences between electrical power supply and consumption. The transmission system operators have to publish details of the tertiary reserve trading process [3]. The German Federal Grid Agency decided to publish these data in the public part of this common website.

The activated or used tertiary reserve energy varies stochastically. In case of providing positive tertiary reserve power by small co-generation plants, the co-generated heat is dependent on the used positive tertiary reserve energy. Due to this, more detailed models of the used tertiary reserve energy would be helpful. Literature offers only a very simple statistical description of the used tertiary reserve energy. Therefore, it is necessary to analyse measured values of the used tertiary reserve energy in detail. The first results of this analysis are the main topic of this paper.

2. TERTIARY RESERVE ENERGY ANALYSIS TO DEVELOP MODELLING OPTIONS

The reserve energy in general is dependent on technical failures, unexpected changes of electricity supply and unexpected short-term changes in electricity demand. The electricity demand in general is dependent on the time of the day, the day of the week, the season, the type of customers and the region. Due to this, the positive tertiary reserve energy can probably also be related to the time of the day, the day of the week, the season, the type of customers and the region. Regional similarities and types of customers can only be analysed roughly because data are only given for a whole area of one transmission system operator. The only way to consider regional aspects is to analyse the internal structure of the transmission system operator's areas and to combine the results with the corresponding tertiary reserve energy. Due to this, regional aspects and customer types are neglected in this paper.

The aim of the reserve energy analysis is to look for seasonal or daily similarities using probability calculus [4]. The accumulated values and the absolute frequencies both per month and per time of the day are considered. If similarities can be detected, a rule for future's reserve energy can be deducted. The positive tertiary reserve demand data can not be measured directly. Furthermore, they do not need to be measured because they are published on a common website [2]. The first step of the analysis is downloading the given data from the website. The second step is to split and to sum up data according to the discussed similarity options in order to create convincing diagrams. The third step is to look for similarities and – if possible - to deduct rules for future's positive tertiary reserve energy.

3. RESULTS OF TERTIARY RESERVE ENERGY ANALYSIS

The volumes of the positive tertiary reserve energy used of each German transmission system operator per month in 2006 are calculated by accumulating all used positive tertiary reserve energy in a month (fig. 2). The curves of the four transmission system operators are not in parallel. That means a universal statement for all transmission system operators is not valid and seasonal similarities can not be detected. It seems as if specific aspects have to be considered for every transmission system operator. A further analysis of seasonal aspects is not promising.

In the next step, the volumes of the tertiary reserve energy used of each German transmission system operator within each one-hour-interval of the day are calculated for the year 2006 (fig. 3). In the year 2006, E-ON ordered a total volume of 4000 MWh reserve energy between 8 and 9 o'clock, for example. Except the transmission system operator RWE, there are no orders of positive tertiary reserve energy within 2 and 6 o'clock in the morning. Although the total volume of the transmission system operator RWE is not zero, its minimum values are also between 4 and 6 o'clock in the morning. Due to this, a daily similarity might be detected. Especially in the transmission system operator's area of E-ON, the curve of the positive tertiary reserve energy seems to follow the curve of the daily electricity demand. A universal statement for all transmission system operators can not be given because the four curves are not in parallel. Nevertheless, daily similarities are essentially more probable than seasonal similarities and looking in detail seems to be promising.

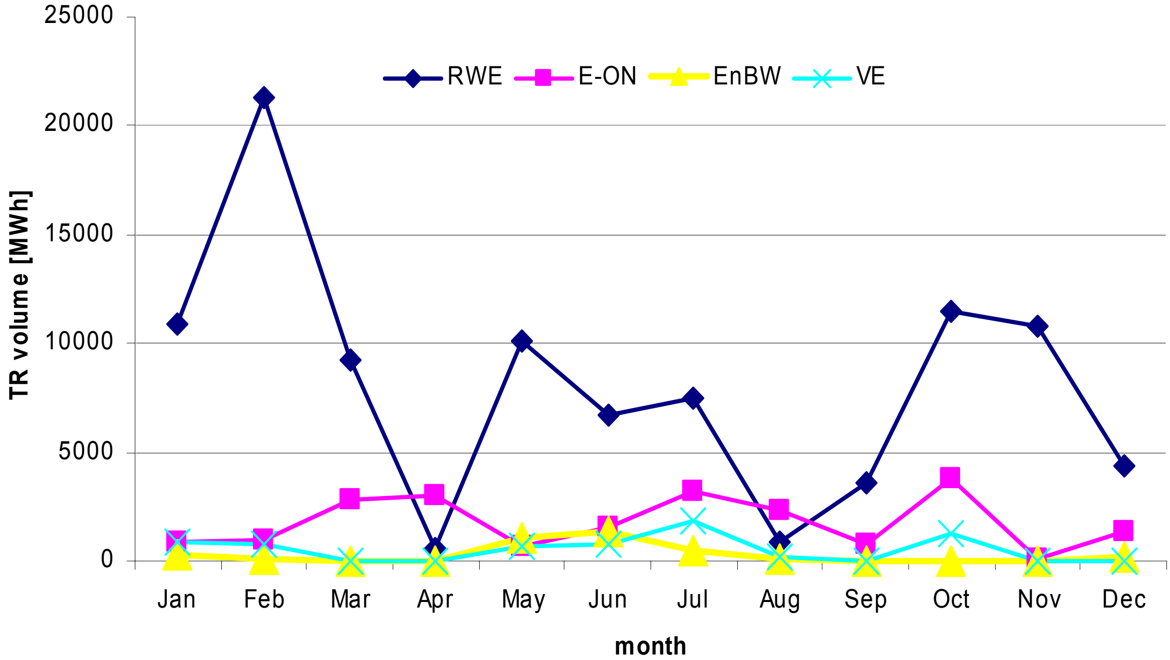

fig. 2 Volumes of the tertiary reserve used of each German transmission system operator per month in 2006

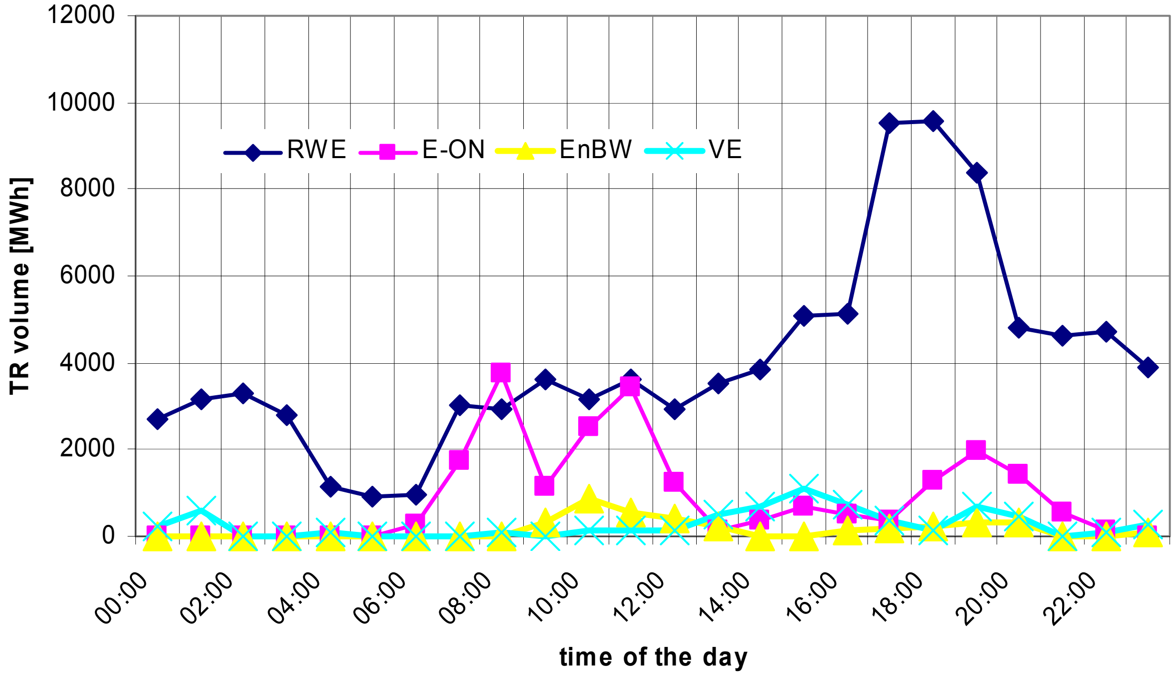

fig. 3 Accumulated volumes of the tertiary reserve energy needed of each German transmission system operator in 2006 related to the time of order in 1 hour intervals

Additionally, the absolute frequencies of orders are analysed (fig. 4). One order is equal to a certain power supplied for 15 minutes. If the ordered power is constant, the shape of these curves was equal to the shape of the total volumes. Due to this, the shape of fig. 2 and fig. 3 look similarly and the absolute frequency of tertiary reserve orders leads to equal results.

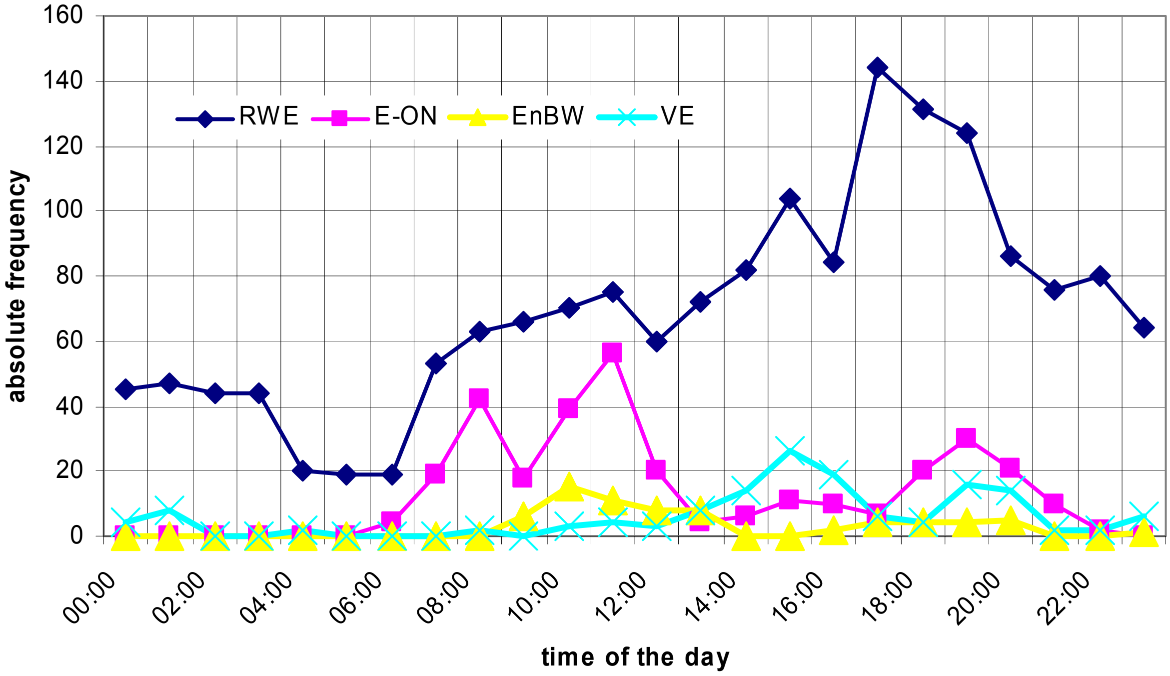

fig. 4 Absolute frequency of tertiary reserve energy ordered of each German transmission system operator in 2006 related to the time of order in 1 hour intervals

In general, the total number of orders per day is low (fig. 5). For most days in the year, it is lower than 10 orders per day and for round about 300 days per year, it is even zero. Except the transmission system operator RWE, the number of orders per day remains lower than 20 orders or 5 hours per day within the whole year.

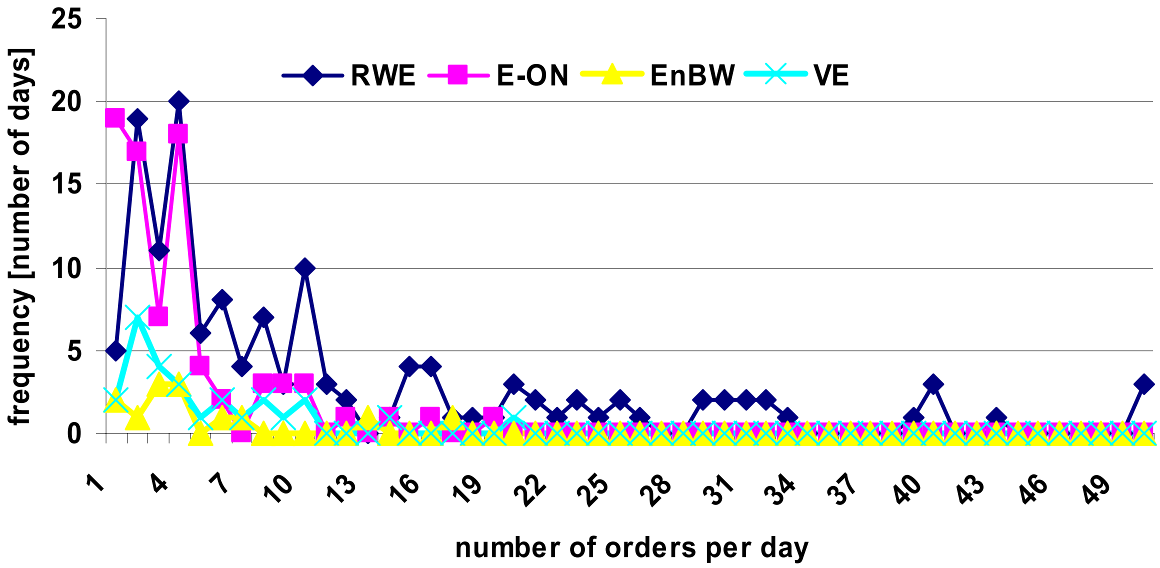

fig. 5 absolute frequency of positive tertiary reserve energy orders for each German transmission system operator in 2006

4. INTERPRETATION OF POSITIVE TERTIARY RESERVE ENERGY DEMAND ANALYSIS

Statistical modelling by a simple uniform distribution is not valid. Equal probabilities for every time of the day are indefinite. A weighted distribution of tertiary demand probabilities is more precise. The transmission system operator RWE has to be neglected in modelling. For the three other transmission system operators, the demand probability between 2 and 6 o'clock in the morning can be set to almost zero. Of course the probability cannot be set to zero, otherwise no tertiary reserve power would be provided in this time periods and grid operation would not be safe from power-plant-blackouts during this time. The demand probabilities are not important for the provided reserve power; their only intention is to determine the co-generated heat volume in a virtual power plant of small co-generation plants. The other time of the day, the demand probability cannot be determined yet.

At all, tertiary reserve energy orders do not dependent on the seasons. Due to this, seasonal modelling is not practicable. Except the transmission system operator RWE, tertiary reserve energy orders seem to depend on the time of the day. A more detailed model of tertiary reserve energy orders based on the time of the day seems to be promising.

5. SUMMARY AND OUTLOOK

Positive tertiary reserve power is necessary to guarantee grid sustainability. In future, it might be provided by small co-generation plants. Due to this, a more detailed model of the used tertiary reserve energy is desirable. A season-related model does not seem to be successful; a day-related model seems to be promising. Further research activities are necessary. The next steps in research are analysing more data, analysing additional parameters of the positive tertiary reserve demand and creating a model.

6. REFERENCES

[1] UCTE Operation Handbook, www.ucte.org

[2] www.regelleistung.net

[3] German law about energy economy (EnWG), state: July 2005

[4] Bronstein/Semendjajew/Musiol/Mühlig, *Taschenbuch der Mathematik*, 5th edition, Frankfurt 2002, ISBN 3-8171-2005-2, pages 766-818

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