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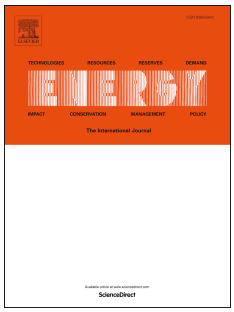

Vulnerability of the Russian power industry to the climate change

V.V. Klimenko, E.V. Fedotova, A.G. Tereshin

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Vulnerability of the Russian power industry to the climate change

V.V. Klimenko[a,*], E.V. Fedotova[a], A.G. Tereshin[a]

[a] *Moscow Power Engineering Institute, Krasnokazarmennaya 17, 111250 Moscow, Russia*

Abstract

Assessment of the climate-related impacts on energy systems usually implies regression approaches. That restricts generalization of the published results for the regions which are not covered with detailed research yet. The climate change impacts on the Russian power industry were for the first time quantified in a systematic way. A robust physically-based simulation approach was used to simulate a response of the steam and gas turbines to the climate warming. It was shown that an increase of the air temperature deteriorates performance of thermal and nuclear power plants across the whole Russia. The power drop of the steam turbines is about 0.2-0.3 and 0.4-0.6 percent per 1°C for thermal and nuclear power plants respectively. That means additional consumption of 3-4 million tce yearly to 2030-2050. However, an integral effect of the climate change on the Russian energy systems remains clearly positive due to the annual fuel savings of about 100 million tce resulting from reduction of the space heating demand. Main negative impacts of the climate change on the Russian power system will be linked to the changes of the operational regimes. Particularly, design and control strategies of the combined-cycle plants should necessarily account for the future changes of the climate conditions.

Keywords: Climate change impacts; Russia; power plants; efficiency; steam turbines; condenser pressure; gas turbines; modeling

1. Introduction

Recent political changes have demonstrated fragility of a political consensus towards the climate change. However, the current rapid change of the climate conditions is evident around the world from both meteorological records and everyday news. Climate scientists may have different opinions regarding contributions of different climate drivers to the climate change, appropriate forcing scenarios and even forecasted climate values themselves.

But all research results agree that our world is getting hotter and this trend will likely persist through the remainder of the century at least. Humans should learn to live and act under the climate conditions distinctly different from the ones which have been a climate background for developing of modern societies. Understanding of the climate change impacts is essential to work up adaptation and mitigation measures.

Energy systems are recognized to be one of the key components determining society development [1] and humans' well-being, health and quality of life [2]-[3]. The power industry is known to be vulnerable to the climate change via several principal ways [4]: through impacts on primary energy supply and demand, impacts on power generation operations and via impacts on the energy transmission and distribution network. These issues have attracted increasing research interest during the past decade [4]-[5]. It has been demonstrated recently that susceptibility of every national energy system to the climate change is unique [6]. Global-scale impact studies outline the most pronounced general trends which may be manifested locally [7], but regional investigations are unavoidable for policy implications.

A plenty of detailed climate impact studies has been recently published for US and Europe. Intra-regional studies of both energy [8]-[10] and power systems [6], [12] clearly indicated that the past can't be the best guide for the future anymore [12]. Detailed studies are available for a number of European countries and American states relating to the most vulnerable sides of their power systems, particularly: impact of heat waves [13]-[14], risks for transmission and distribution [14]-[16], water-energy nexus [17]-[19] and vulnerability of hydropower [20]-[21], performance losses of thermal and huclear power plants [22]. Comprehensive research background has given a start to detailed national-level analysis with practical adaptation recommendations [23]-[24].

The climate impacts on the energy systems of other countries, namely, East Asia [25]-[28], South America [29], Australia [30], are currently under intensive investigations.

Russia is one of the regions of the world where the climate change has been manifested most significantly during the twentieth century and this trend will most likely con-

*Corresponding author

Email addresses: NILGPE@mpei.ru (V.V. Klimenko), e.v.kasilova@gmail.com (E.V. Fedotova), ale-tereshin@yandex.ru (A.G. Tereshin)