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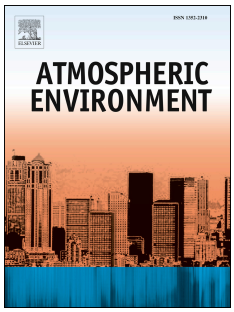

The Near-Source Impacts of Diesel Backup Generators in Urban Environments

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The Near-Source Impacts of Diesel Backup Generators in Urban Environments

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Abstract

Distributed power generation, located close to consumers, plays an important role in the current and future power systems. However, its near-source impacts in complex urban environments are not well understood. In this paper, we focused on diesel backup generators that participate in demand response (DR) programs. We first improved the micro-environmental air quality simulations by employing a meteorology processor, AERMET, to generate site-specific boundary layer parameters for the Large Eddy Simulation (LES) modeling. The modeling structure was then incorporated into the CTAG model to evaluate the environmental impacts of diesel backup generators in near-source microenvironments. We found that the presence of either tall upwind or downwind building can deteriorate the air quality in the near-stack street canyons, largely due to the recirculation zones generated by the tall buildings, reducing the near-stack dispersion. Decreasing exhaust momentum ratio (stack exit velocity /ambient wind velocity) draws more exhaust into the recirculation zone, and reduces the effective stack height, which results in elevated near-ground concentrations inside downwind street canyons. The near-ground $PM_{2.5}$ concentration for the worst scenarios could well exceed 100 $\mu g\ m^{-3}$, posing potential health risk to people living and working nearby. In general, older diesel backup generators (i.e., Tier 1, 2 or older) without the up-to-date emission control may significantly increase the pollutant concentration in the near-source street canyons if participating in DR programs. Even generators that comply with Tier-4 standards could lead to PM hotspots if their stacks are next to tall buildings. Our study implies that the siting of diesel backup generators stacks should consider not only the interactions of fresh air intake and exhaust outlet for the building housing the backup generators, but also the dispersion of exhaust plumes in the surrounding environment.

Keywords: Distributed generation, emergency generator, plume dispersion, micrometeorology, atmospheric stability, CFD

1. Introduction

Small distributed power generation is becoming more popular due its flexibility and efficiency compared with central power generation[1]. These units are typically located in populated urban areas with relatively short stack heights. Since they are closer to consumers, their environmental impacts have become a concern despite the benefits. Several studies evaluated the air quality impact from distributed generation[2-6]. However, very few studies have examined the effects of complex urban environments such as street canyons on the near-source air quality impacts[3]. This paper aims to bridge this gap.

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