

# Integrating Ecovisor into Mosaik Co-Simulation

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*Abstract—*

## I. INTRODUCTION

**T**HE surge of cloud platforms has had a significant impact on many businesses and individuals, offering access to innovative and valuable applications that frequently require significant computational resources. A notable example for this is represented by OpenAI's chat generative pre-trained transformer (ChatGPT) cloud platform, which is based on the GPT-3 model developed by Brown et al. [1] and achieved more than a million users within the first five days of its launch [2]. The increasing demand for more computational power has lead cloud platforms to become an essential part of the digital landscape [3]. These platforms allow for the storage, processing and management of large amounts of data and computational resources, which can be used to run applications and services that are beyond the capabilities of traditional hardware systems.

However, while the growth of cloud platforms has brought many benefits, it has also raised concerns about their environmental impact. As the demand for computational resources increases, so does the carbon emissions generated by the energy consumption of these platforms [4]. Despite their ecological impact, the growth of cloud platforms shows no signs of slowing down. According to Gartner Inc. worldwide end-user spending on public cloud services is forecast to grow 20.7% to total \$591.8 billion in 2023 [5]. To mitigate their impact on the environment, cloud platforms are now looking for ways to reduce their carbon footprint [6, 7]. It is imperative to adopt cleaner energy sources for powering data centers, both in the cloud and at the edge.

Although clean energy offers numerous advantages, it is perceived as being unreliable due to two key factors. One, the generation of renewable energy sources such as solar and wind is affected by environmental changes, and two, the carbon-intensity of grid power fluctuates as the grid uses different types of generators with varying carbon emissions to meet demand [8]. The field of computing possesses a distinct advantage in terms of reducing its carbon impact through the utilization of cleaner energy sources, even with their inherent instability. However, current cloud applications are unable to apply these benefits to optimize their carbon efficiency. This is because the energy system obscures the instability of clean energy with a reliability abstraction, which gives no control or visibility into the energy supply. As a result, applications cannot adjust their power usage in response to changes in the availability and carbon-intensity of renewable energy [8].

Souza et al. [8] proposed a solution to this issue by creating an "Ecovisor", which virtualises the energy system and pro-

vides software-based control over it. This Ecovisor enables each application to manage the instability of clean energy through software, customized to meet its unique requirements. However, even their small-scale prototype is intricately designed and incorporates several expensive components, such as a DC power supply equipped with a solar array simulation capability that costs almost \$10,000.

Though the creation of the Ecovisor is a promising solution to the issue of reducing the carbon footprint of cloud platforms, a large scale prototype for research and development purposes would not only be significantly cost intensive, but also time consuming. An alternative approach to consider is to simulate *only* the Ecovisor infrastructure for real applications. This would allow for the optimization of energy usage in response to changes in the availability and carbon-intensity of renewable energy, without the need for a physical implementation. By simulating the Ecovisor, applications can still manage the instability of clean energy through software, but at a lower cost and with less time investment.

To this end, we propose the utilization of a co-simulation tool, Mosaik, to integrate this Ecovisor simulation into and evaluate its impact on the carbon footprint of cloud platforms. Mosaik is a simulation framework for power systems, communication networks, and building automation, which can be used to model and analyze the performance of the Ecovisor in real-world applications [9]. The use of Mosaik brings several benefits compared to traditional simulation methods. It offers a more flexible and scalable simulation environment, enabling the integration of multiple components and the simulation of large-scale systems. Furthermore, it offers a more accurate representation of the energy system, incorporating real-world data and parameters, which can be used to validate the performance of the Ecovisor.

## II. BACKGROUND

## III. APPROACH

## IV. EVALUATION

## V. CONCLUSION

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