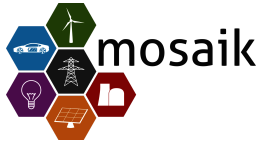


Integrating Ecovisor into Mosaik Co-Simulation

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Introduction

Background

Approach

Evaluation

Conclusion

Section 1

Introduction

- ▶ data centers' energy consumption is a concern for carbon emissions
- ▶ carbon- and renewable-aware computing can optimize efficiency
- ▶ **virtual energy systems** and **software defined control** can be used to achieve this



Figure: DALL-E 2 “a tree, growing out of an old computer”

Section 2

Background

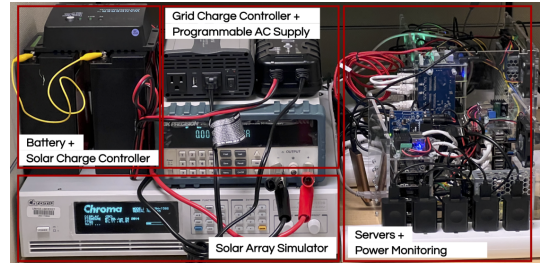
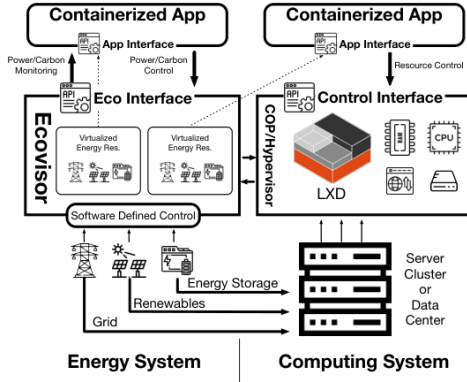


Figure: Ecovisor physical prototype (Souza et al. [1])

Figure: Ecovisor design (Souza et al. [1])

- ▶ open-source co-simulation framework
- ▶ combines multiple simulations to simulate large, complex systems
- ▶ enables integration and communication of various simulation models

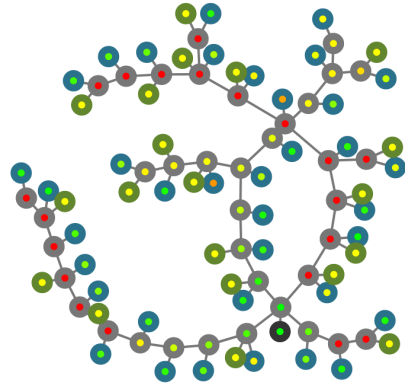


Figure: Smart grid simulation demo

Section 3

Approach

- ▶ original Ecovisor design is abstracted to a model with full functionality
- ▶ Ecovisor model is executed within Mosaik
- ▶ simulated consumers can access API via Mosaik's interface
- ▶ real consumer *outside* the simulation can access API in real time

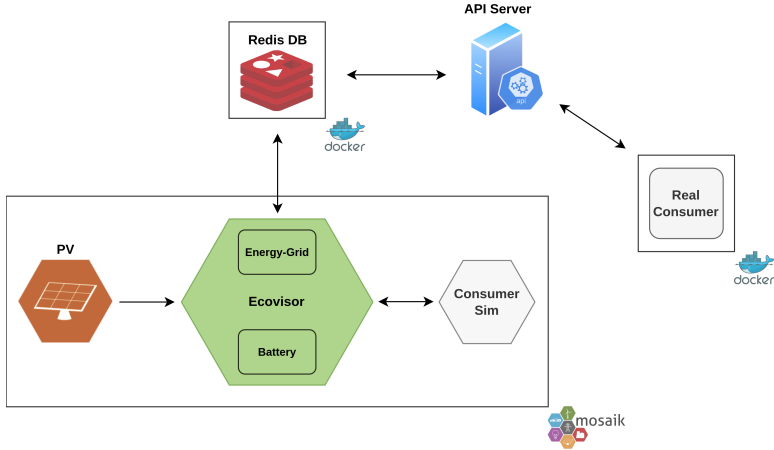


Figure: System design

Section 4

Evaluation

- ▶ real workload modeling possible
- ▶ real-time cannot be accelerated
- ▶ battery *needs* to be implemented into Ecovisor
- ▶ docker is a requirement for current design

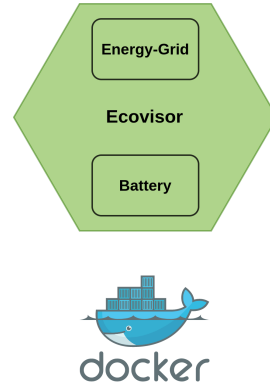


Figure: Ecovisor with components and Docker

- ▶ interconnected geo-distributed Ecovisors
 - carbon intensity different from region to region
 - carbon information services such as Electricity Maps¹
- enable carbon-efficiency optimizations such as Let's Wait Awhile or Cucumber from Wiesner et al. [2, 3]

¹<https://www.electricitymaps.com/>

Section 5

Conclusion

- ▶ **Ecovisor** – handle clean energy's unreliability in software
- ▶ **Mosaik** – combine multiple simulations
- **Approach** – real-time workload modeling with carbon control
- **TODO** – enable carbon-efficiency optimizations with geo-distributed Ecovisors

-  A. Souza, N. Bashir, J. Murillo, W. Hanafy, Q. Liang, D. Irwin, and P. Shenoy, “Ecovisor: A virtual energy system for carbon-efficient applications,” *arXiv preprint arXiv:2210.04951*, 2022.
-  P. Wiesner, I. Behnke, D. Scheinert, K. Gontarska, and L. Thamsen, “Let's wait awhile,” in *Proceedings of the 22nd International Middleware Conference*, ACM, dec 2021.
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► title page adapted from <https://mosaik.offis.de/>