Ecovisor – A Virtual Energy System for Carbon-Efficient Applications

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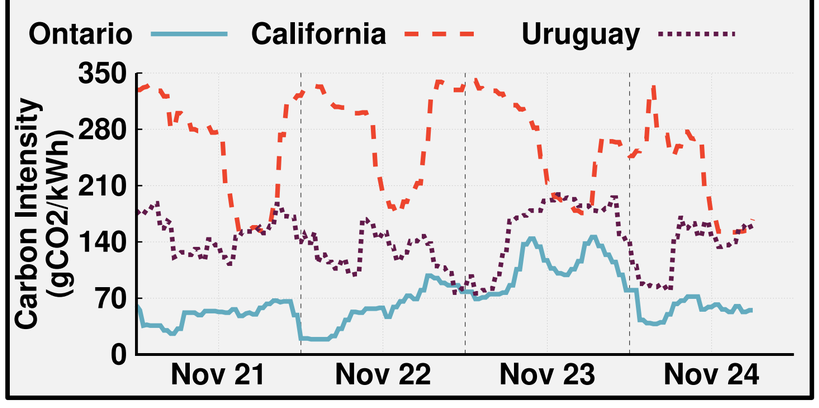
https://github.com/carbonfirst/ecovisor

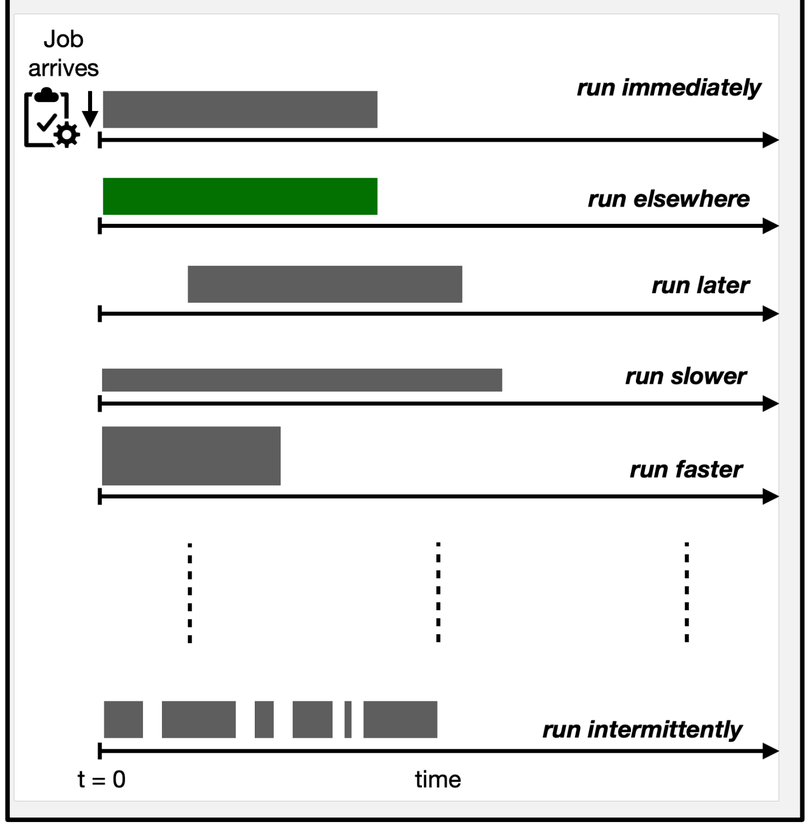
Motivation

- Cloud Capacity – and energy usage – doubling at ~4 years
  - Energy usage ~2 – 5% of world's consumption
- The rising in cloud energy usage is not the main problem
  - Issue is the carbon emissions from this energy usage and its negative impact on the environment.
- A distinguishing characteristic of clean energy is its unreliability



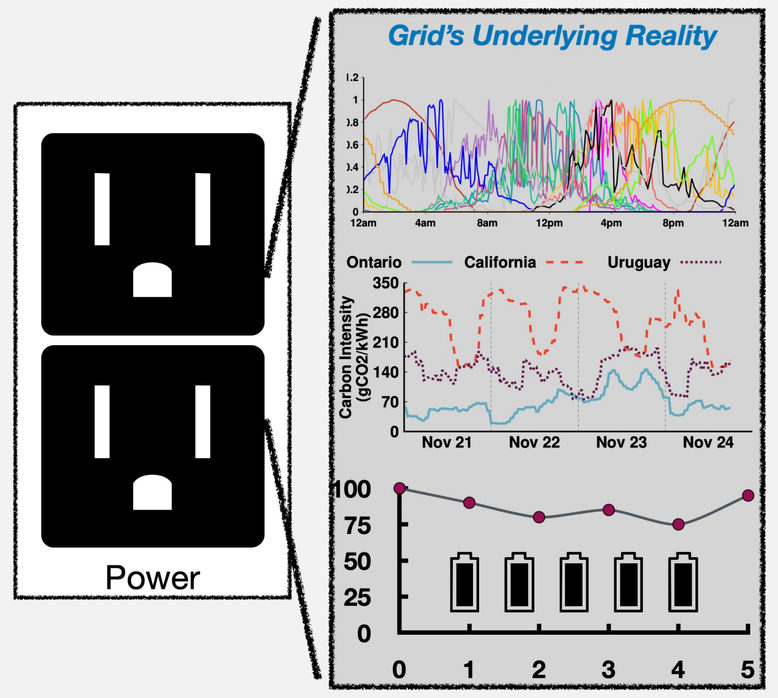
Computing Unique's Features

- Modern workloads have key temporal and spatial execution flexibility

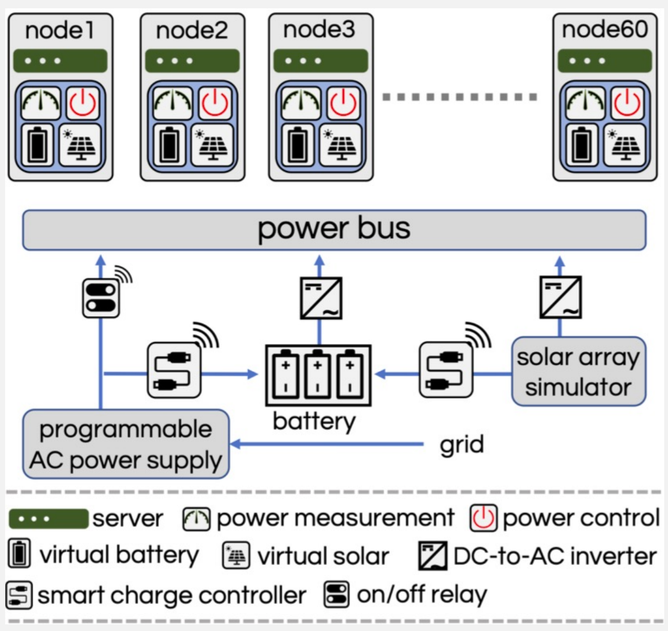


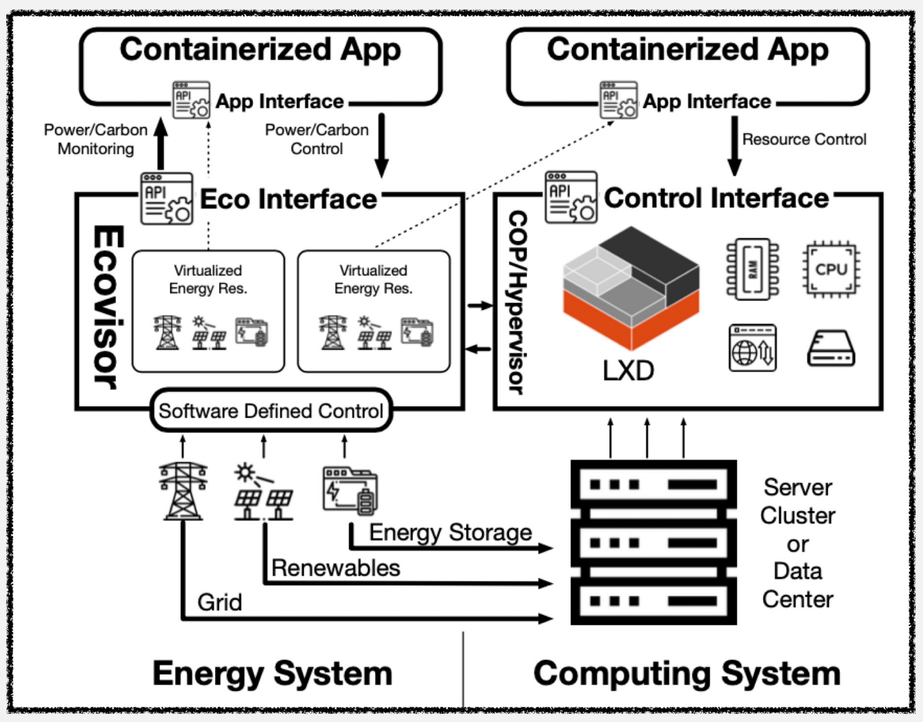
Limitations

- Energy's Reliability Abstraction Limits Computing's Potential
  - Today's energy systems mask clean energy's unreliability from applications in hardware



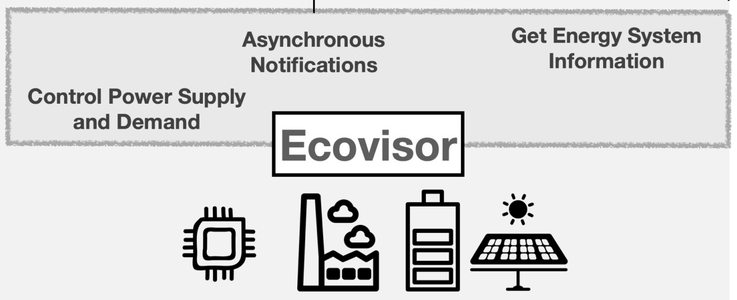
Ecovisor Design





An example of a Library API

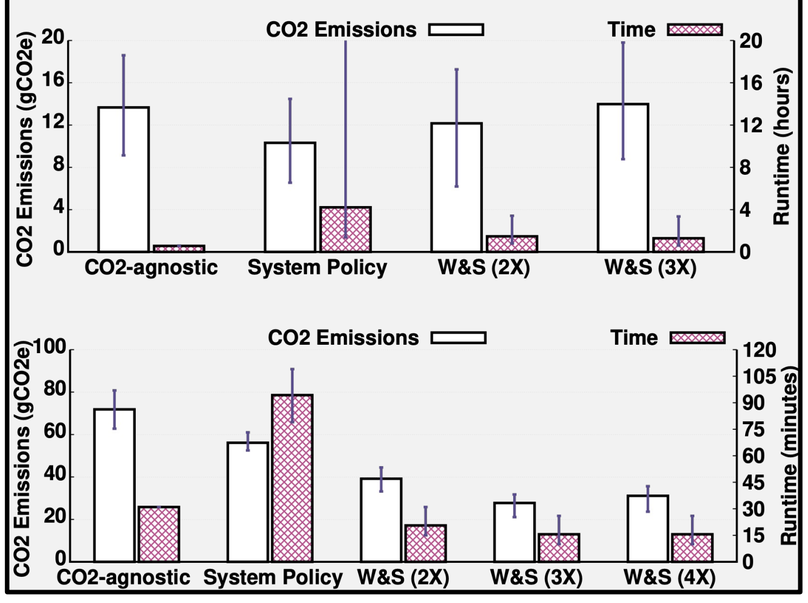
Function Name	Description
`get_container_energy()`	Energy usage in interval (t_1, t_2)
`get_container_carbon()`	Carbon usage in interval (t_1, t_2)
`get_app_power()`	Power usage for an application
`get_app_energy()`	Energy usage in interval (t_1, t_2)
`get_app_carbon()`	Carbon usage for an application
`set_carbon_rate()`	Set carbon rate for a container
`set_carbon_budget()`	Set carbon budget for a container
`set_app_carbon_budget()`	Set application's carbon budget
`notify_solar_change()`	Called when solar changes
`notify_carbon_change()`	Called when grid carbon changes
`notify_battery_full()`	Called when battery fully charged
`notify_battery_empty()`	Called when battery empty



Ecovisor Case Studies

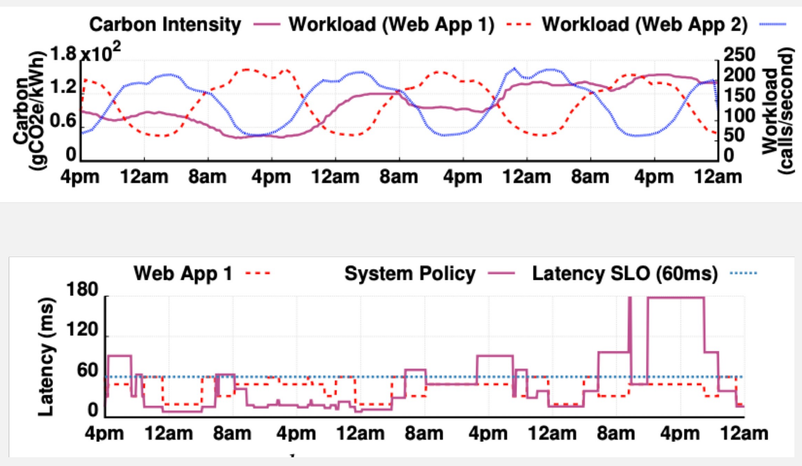
Batch Jobs

Key Intuition: applications better optimize their carbon-efficiency compared to a system-level policy



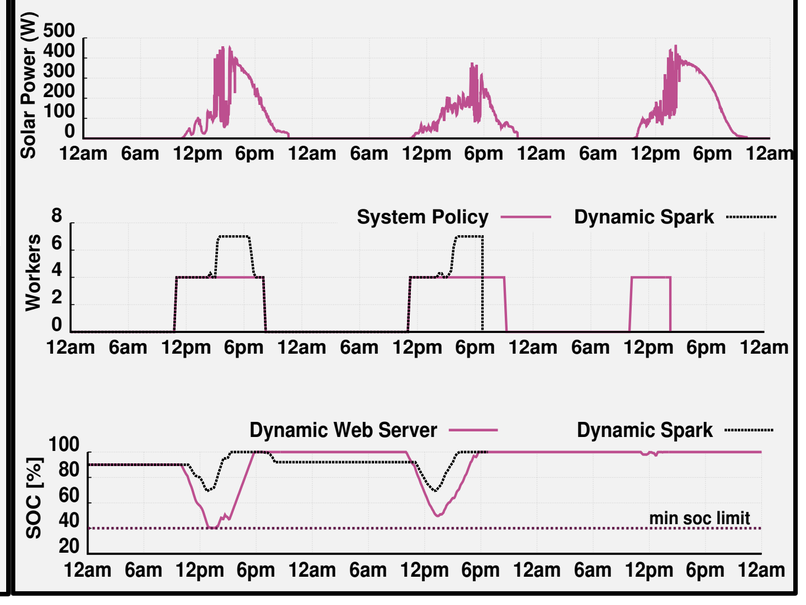
Web Application

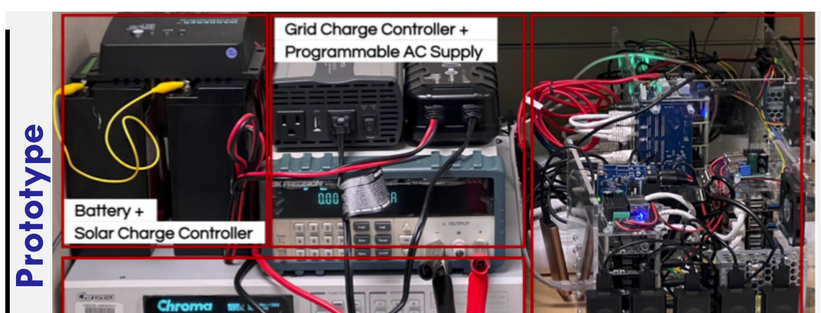
Key Intuition: Applications are better positioned to manage a specified carbon budget



Exploiting Battery + Solar

Key Intuition: Applications-specific policies finishes jobs faster





Conclusions

- **Many carbon-efficiency optimizations possible if applications have visibility/control**
- **Ecovisor exposes useful functions to enable carbon-efficient applications**
- **A Foundation to develop abstractions that simplify carbon-efficient applications.**

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