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NEURAL INFORMATION PROCESSING SYSTEMS

Sustainable Data Center Modeling: A Multi-Agent Reinforcement Learning Benchmark

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Climate Change AI

Sustainable Data Center Simulation Modeling & Dependencies

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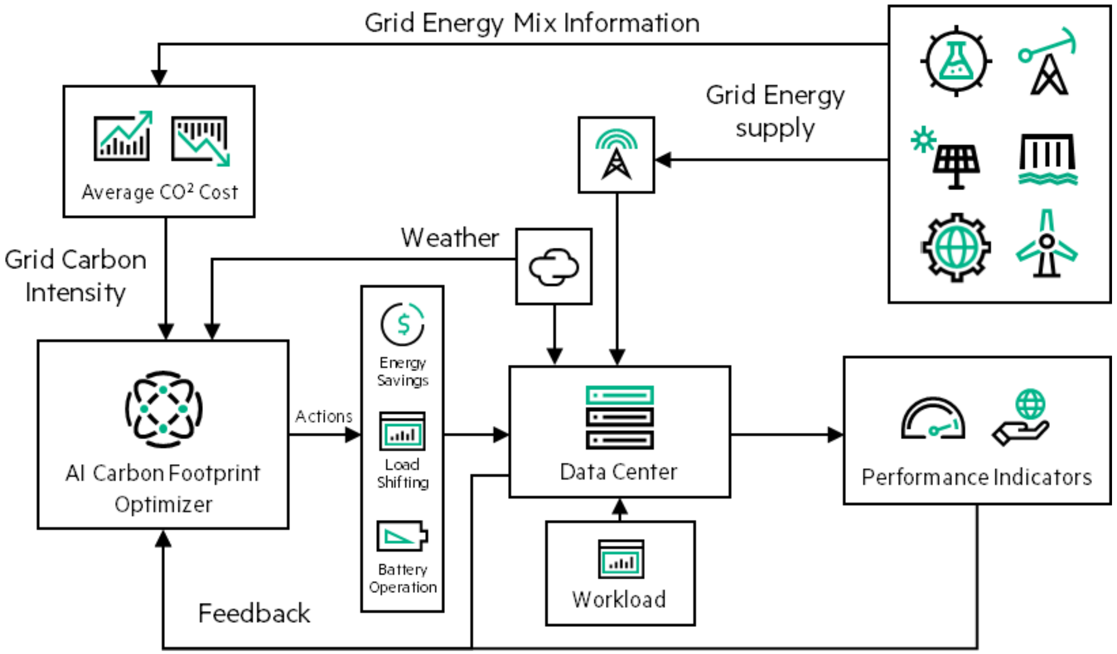
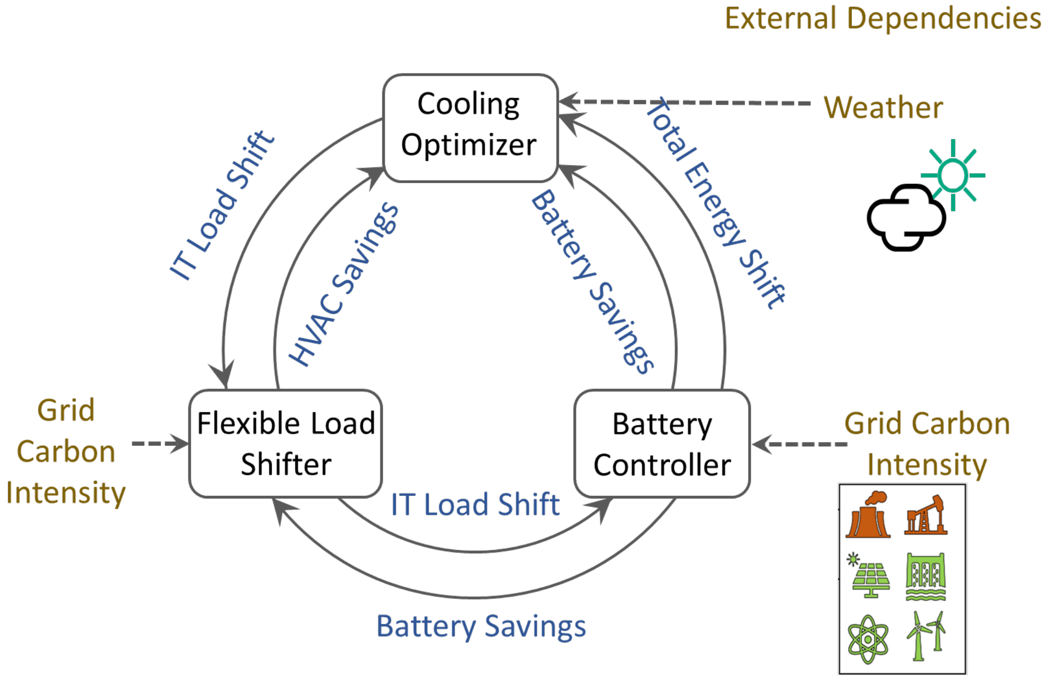
- Sustainable data centers with
  - Lower Carbon Emissions
  - Lower Energy Consumption
  - Lower Energy Cost
- Paradigm shift in optimizing Cooling and IT loads
  - Schedule flexible loads
  - Leverage battery storage
- Real-time controller to optimize all these goals is lacking.





Internal and External Dependencies for the Cooling, Load Shifting and Battery agents

Sustainable Data Center: Challenges for a real-time solution

- ❑ Sustainable data centers with
  - ❑ Lower Carbon Emissions
  - ❑ Lower Energy Consumption
  - ❑ Lower Energy Cost
- ❑ Paradigm shift in optimizing Cooling and IT loads
  - ❑ Schedule flexible loads
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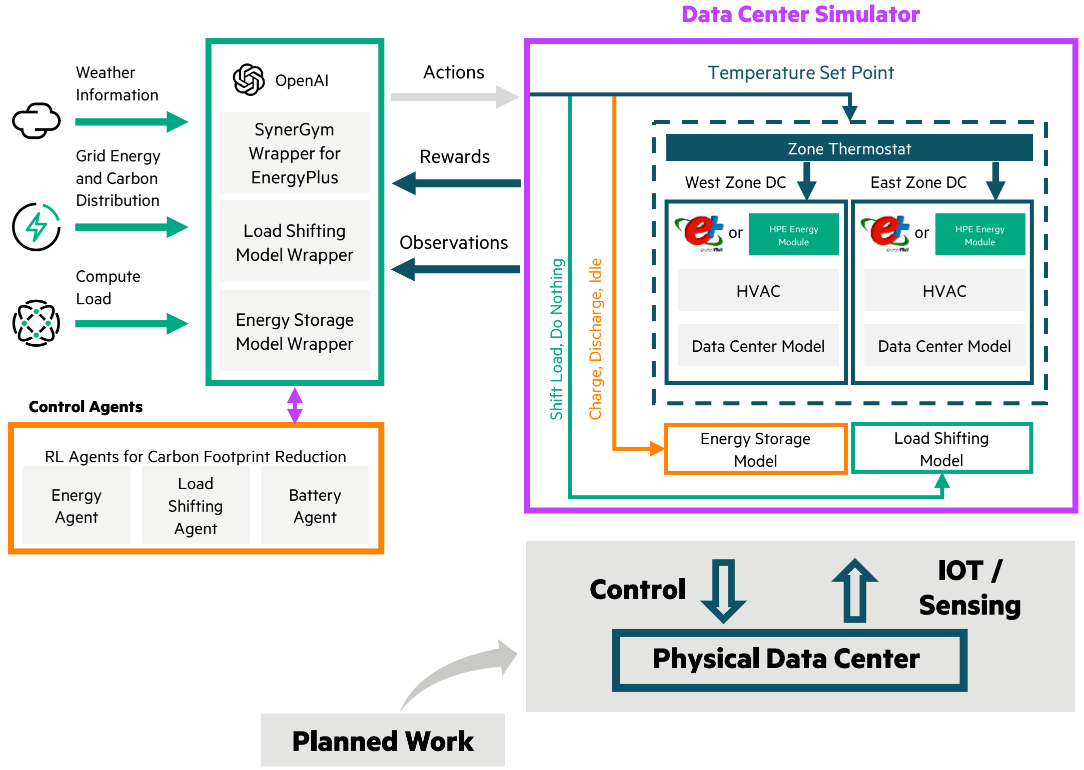
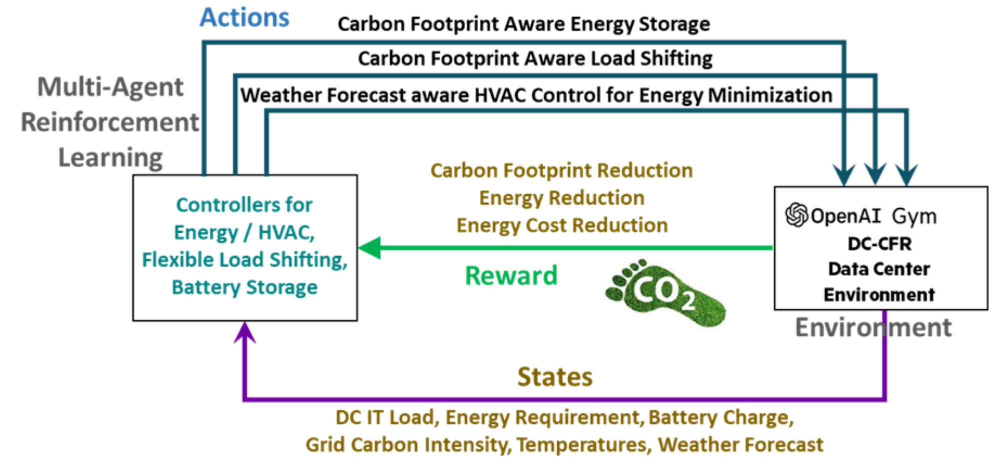
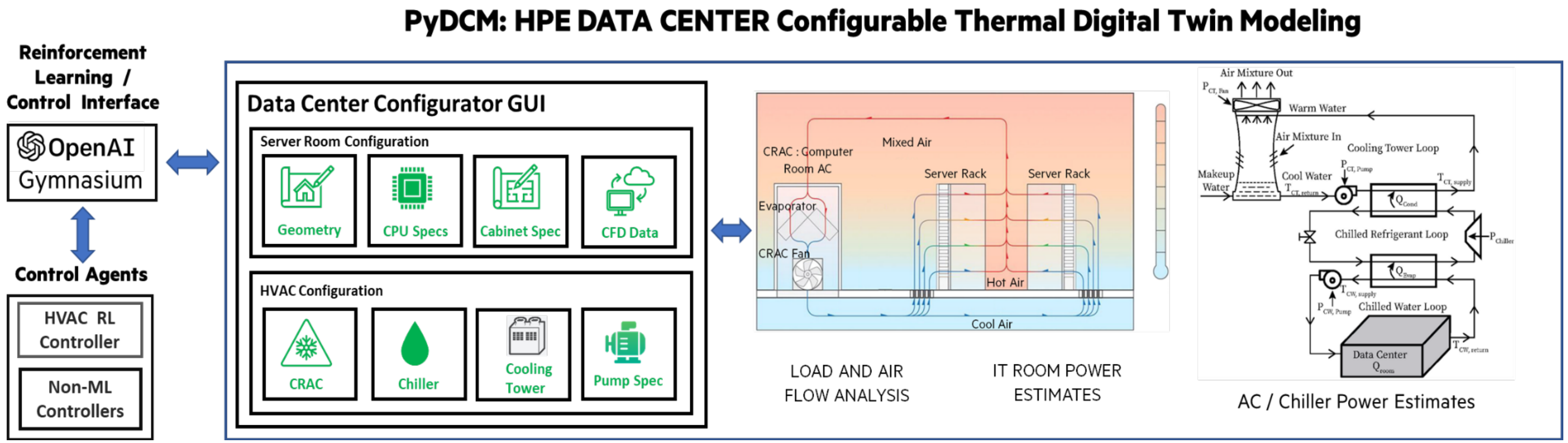
- ❑ Real-time controller to optimize all these goals is lacking.

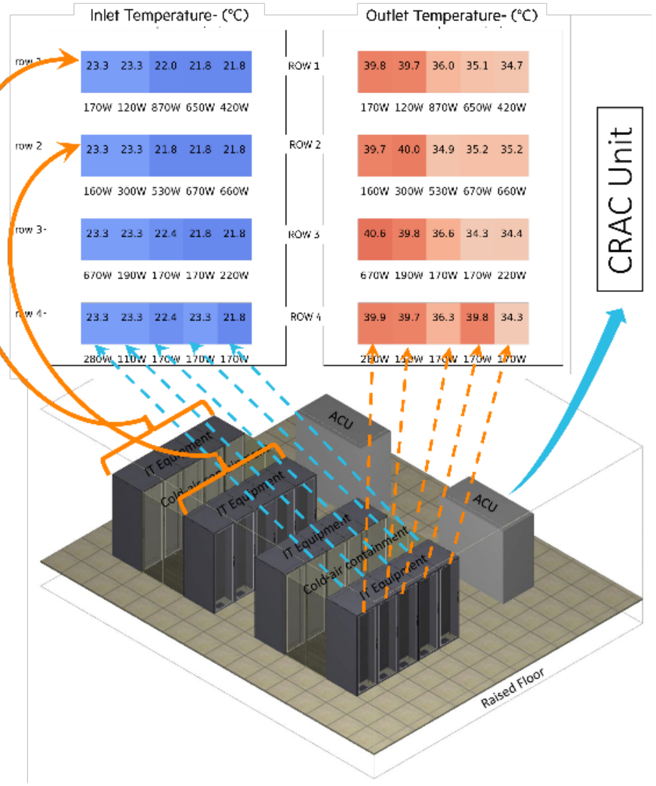


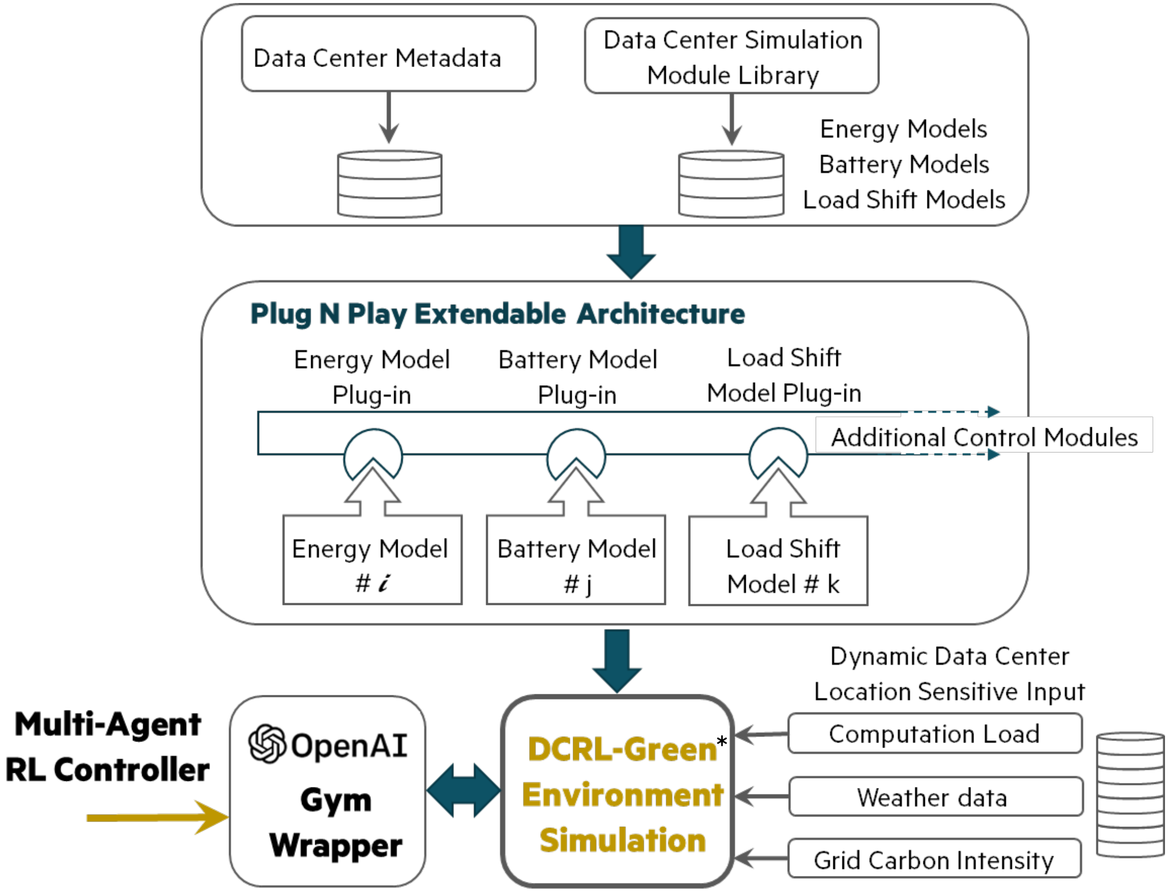


Multi-Agent Reinforcement Learning Controller

Custom Data Center Thermal Models







Simulation with Plug N Play Modules and Extendable Functions

*DCRL-Green: HPE Lab's Data Center Simulation

Multi-agent Reinforcement Learning & Results

Table 1: Overview of the observation space and action space of each environment.

Environment	Observation Space	Action Space
$Agent_{LS}$	CPU utilization, Unassigned Flexible Load, CI, IT Energy consumption, Internal temp., BatSoC.	Allocate workload, Idle
$Agent_{DC}$	External/Internal temp., Cooling setpoint, HVAC/IT Energy consumption, CPU utilization, BatSoC.	Adjust temp. setpoint, Idle
$Agent_{BAT}$	BatSoC, CI, HVAC/IT Energy consumption, CPU utilization.	Charge, Discharge, Idle

DC Max Load 1.2MWh - Experiment period 1 year							
% **Reduction of Carbon Footprint of RL** (MADPPG) using *DCRL-Green* compared to Industry Standard ASHRAE Guideline 36							
Algorithms	Load Shifting(LS)	RL Cooling(DC)	Battery(BAT)	LS+DC	LS+BAT	DC+BAT	**LS+DC+BAT**
Arizona	8.76 ± 0.50	5.81 ± 2.09	0.24 ± 0.44	11.87 ± 1.36	8.96 ± 0.50	7.21 ± 1.98	**13.4 ± 0.48**
New York	8.02 ± 0.13	5.09 ± 0.09	0.17 ± 0.04	11.32 ± 0.05	8.27 ± 0.11	6.64 ± 0.13	**13.01 ± 0.12**
Washington	8.21 ± 0.05	7.19 ± 0.03	0.32 ± 0.05	12.21 ± 0.12	8.54 ± 0.07	7.68 ± 0.07	**13.27 ± 0.06**
% **Reduction of Energy Consumption of RL** (MADPPG) using *DCRL-Green* compared to ASHRAE							
Algorithms	LS	DC	BAT	LS+DC	LS+BAT	DC+BAT	**LS+DC+BAT**
Arizona	8.25 ± 0.43	5.71 ± 2.02	0.00 ± 0.00	11.76 ± 1.16	8.49 ± 0.45	7.02 ± 1.25	**13.38 ± 0.62**
New York	8.09 ± 0.12	4.89 ± 0.09	0.00 ± 0.00	11.02 ± 0.06	8.36 ± 0.12	6.46 ± 0.13	**12.77 ± 0.11**
Washington	8.11 ± 0.05	7.47 ± 0.03	0.00 ± 0.00	12.55 ± 0.11	8.42 ± 0.07	7.87 ± 0.06	**13.51 ± 0.05**

Thank You

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