

ÉΞIGence

GreenFLag: A Green Agentic Approach for Energy-Efficient Federated Learning

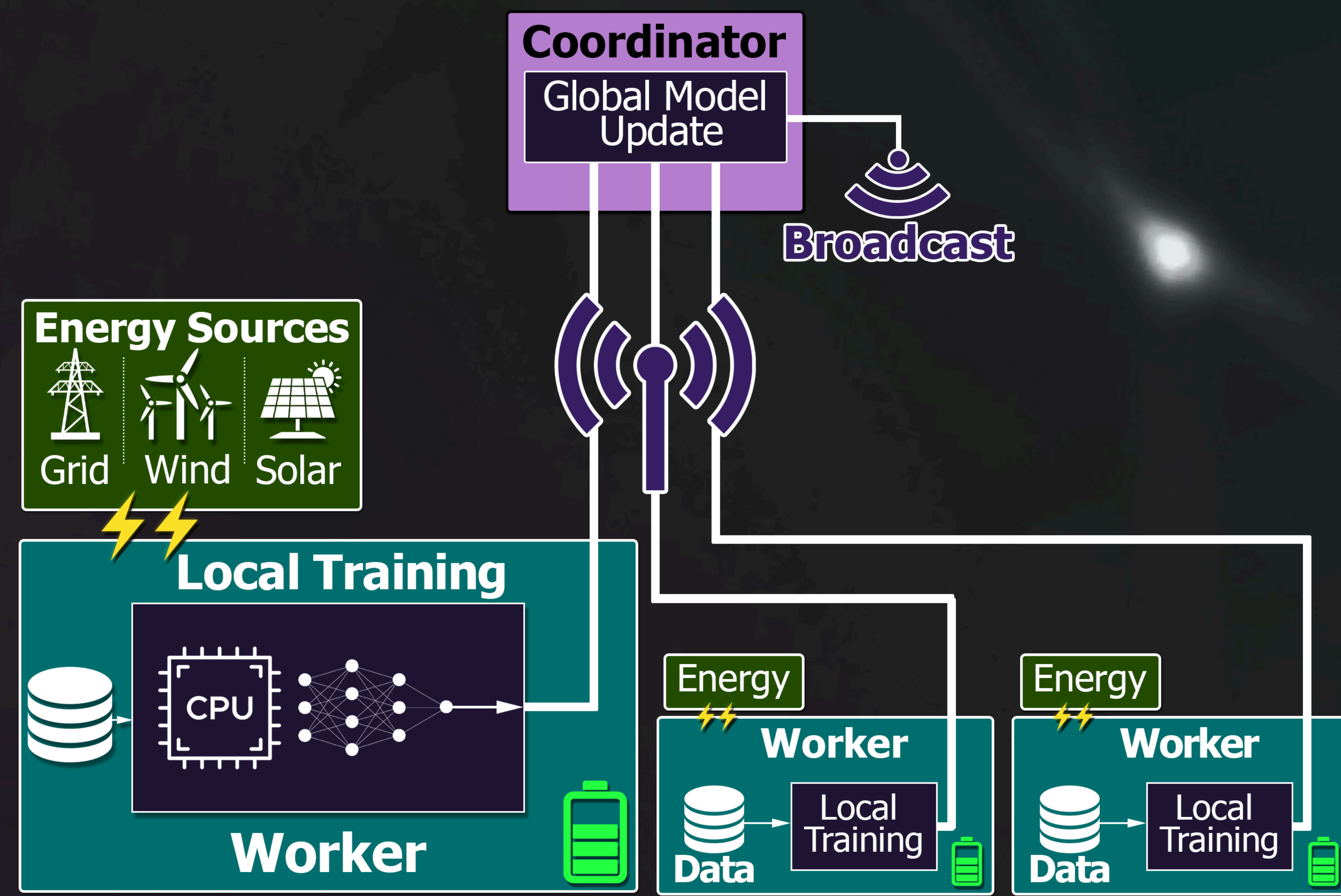
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Overall Demo Context

Current FL schedulers allocate computation and communication resources with no awareness of renewable availability, defaulting to grid power and driving up the carbon footprint of distributed AI. GreenFLag fixes this with a Soft-Actor Critic RL agent that jointly optimizes every worker's CPU, TX power, and bandwidth, treating renewables as the primary energy source and the grid as a last resort.

Key Design Principles

- Green-first hierarchy:** renewable harvest → battery storage → grid (last resort)
- Joint SAC optimisation** of every worker's CPU frequency, TX power, and bandwidth
- FCFS bandwidth scheduler** prevents channel congestion under realistic network conditions



Green Orchestration Function (GOF)

RL Agent

Decision & Optimization: CPU Frequency, TX power and bandwidth per round

Resource Allocation Function (RAF)

Resource Allocation Mechanism

Communication between the RL Agent and the FL Coordinator for the resource allocation decisions

Radio Access Network (RAN)

FL Coordinator

Resource Allocation & Aggregation: model broadcast & aggregation

User Equipment Layer (UE)

UE Worker Devices

Training, Energy Harvesting & Transmission

EXIGENCE Functional Architecture Components

Scenarios & Results

Scenario 1

Ideal Renewables

All workers start fully charged and harvest renewables throughout

Scenario 2

Sporadic Outages

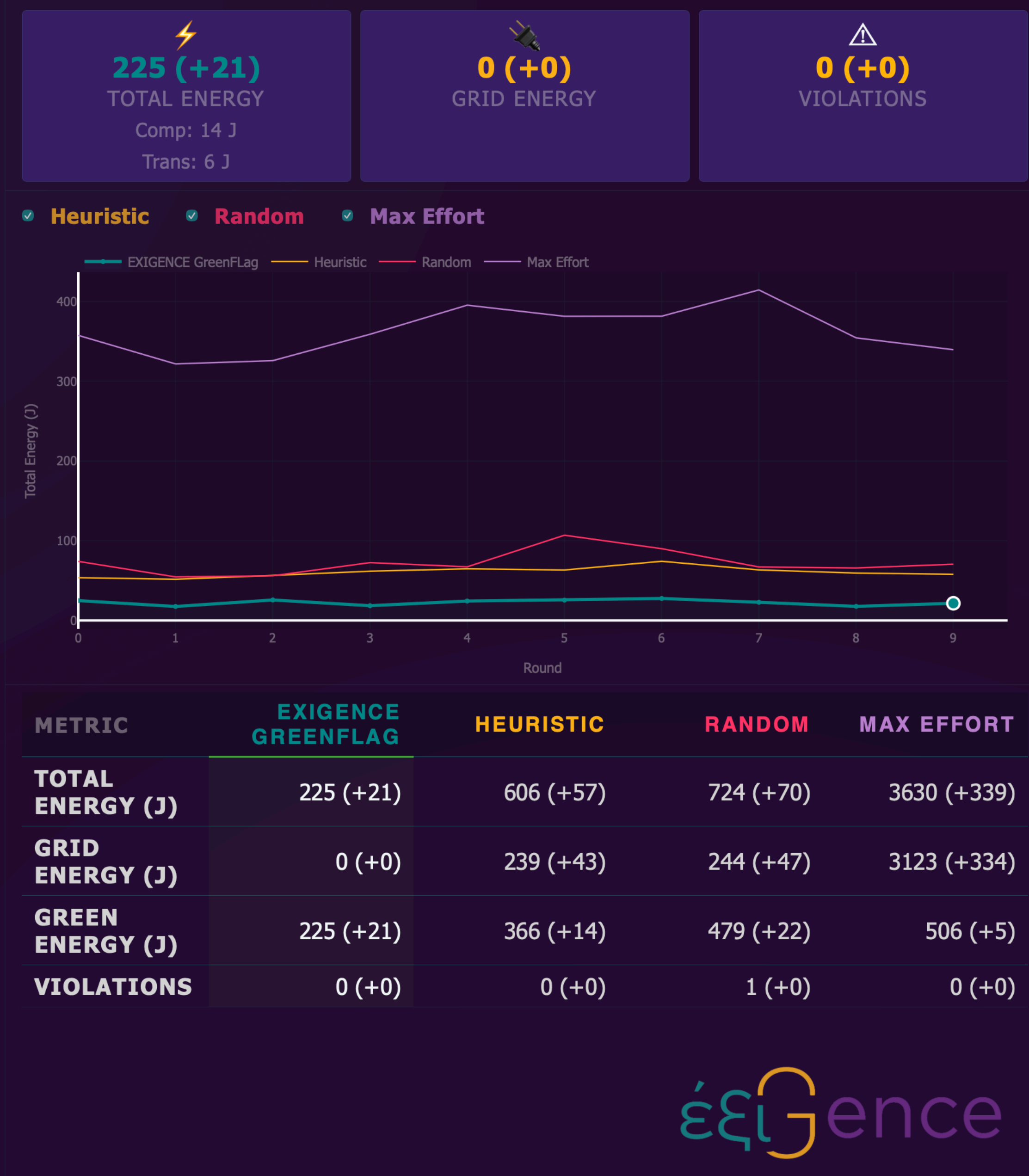
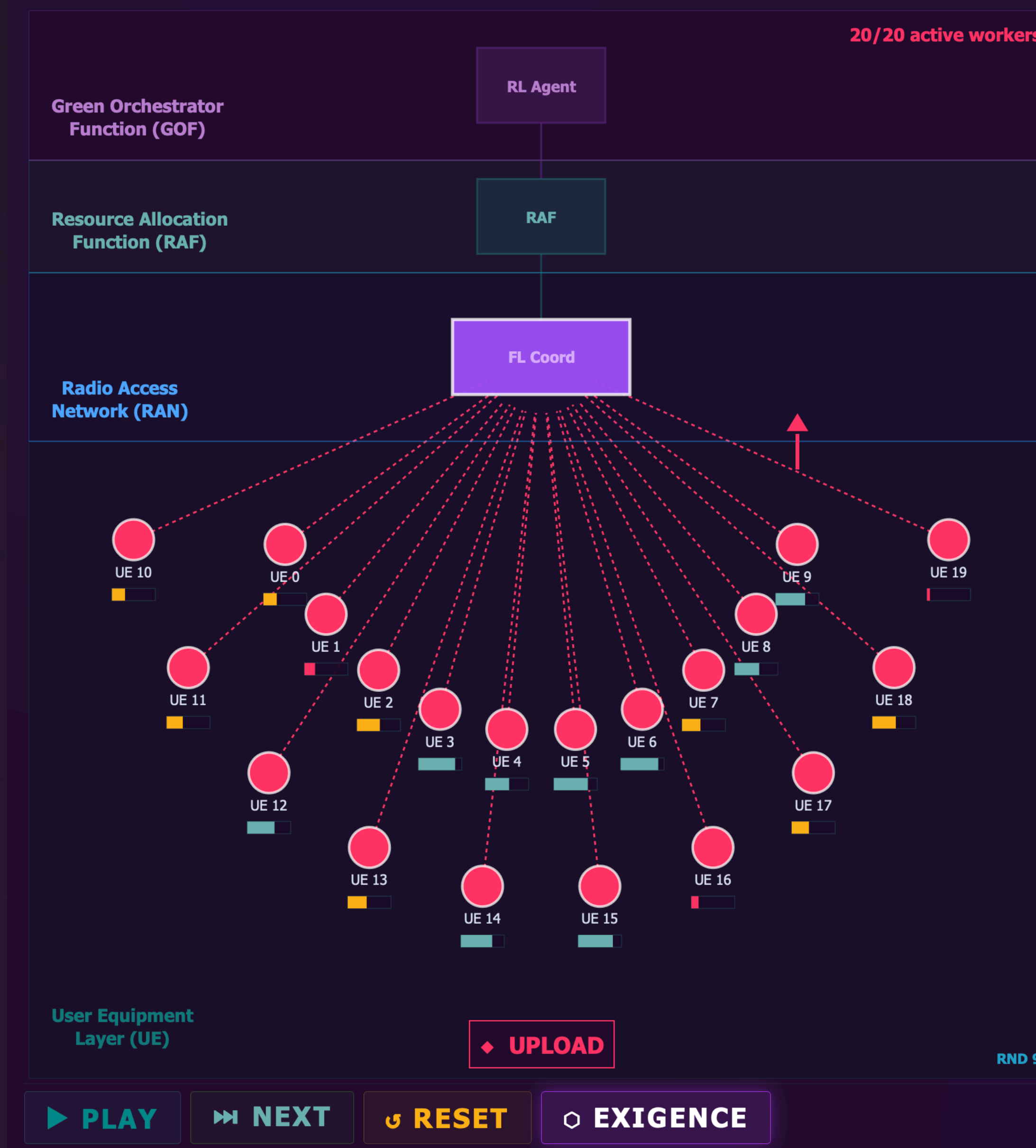
Up to 60% of workers face intermittent renewable outages; others start at 50-100% battery

Scenario 3

Partial Grid Dependency

Up to 60% of workers have zero renewable energy for the entire FL

NETWORK VISUALISATION



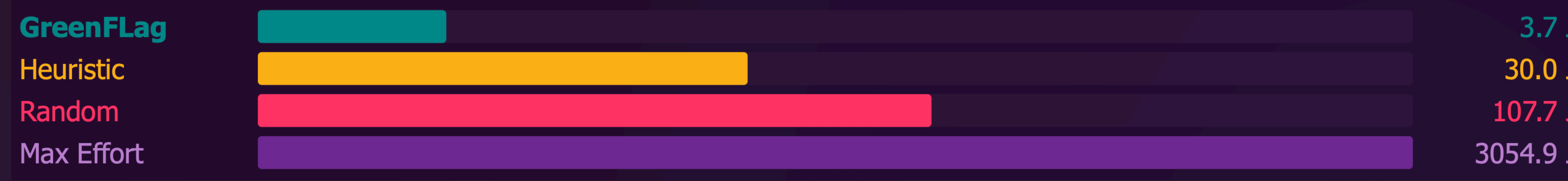
Grid Energy Consumption (J), Avg. over 100 Independent FL Executions

94.8%

Average Reduction in Grid Energy vs. 3 State-of-the-Art Baselines

No compromise on FL accuracy or convergence speed

Scenario 1



Scenario 2



Scenario 3



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