## **Game Proposal: "Electricity Management Game"**

### **Overview**

In this game, three agents, each powered by an LLM, manage a shared pool of electricity over 30 rounds. The electricity is finite but renews at a fixed rate each round, introducing rate limiting. Agents can choose to either conserve or consume more electricity, impacting both their individual utility and the shared resource’s sustainability. They can communicate with each other to coordinate actions, gaining an advantage through collaboration, but are also tempted to consume more for short-term individual gain—mirroring the tension in a Prisoner's Dilemma.

### **Game Parameters**

#### **Shared Resource**

* **Resource**: Electricity
* **Initial Amount (E)**: 100 units
* **Renewal Rate (R)**:
  + 15 units per round by default (added at the start of each round)
  + Increases to 20 units per round if all agents conserve in the previous round
* **Key Characteristics**:
  + Finite but renewable: The total electricity is limited by its current level but replenishes each round.
  + Rate-limited: The renewal rate caps how much new electricity enters the system, constraining availability.
  + Consumed immediately: Agents use electricity each round; it cannot be stored.

#### **Agents**

* **Number of Agents**: 3 (representing entities like households or businesses)
* **LLM**: All agents use the same LLM initially (e.g., Gemini or OpenAI) for consistency, as decided in the meeting.
* **Actions** (per round):
  + **Conserve**: Consume 5 units of electricity.
  + **Consume**: Consume 10 units of electricity.
* **Communication**: Agents can send text messages to each other before deciding their action each round (e.g., "Let’s all conserve" or "I’ll consume if you do").

#### **Game Mechanics**

* **Rounds**: 10 iterations.

**Resource Update**:

| # Total consumption is the sum of each agent's choice (5 or 10) total\_consumption = sum(agent\_consumption) # agent\_consumption is a list like [5, 5, 10]  # Check if all agents conserved (all chose 5) all\_conserved = all(x == 5 **for** x **in** agent\_consumption)  # Set renewal rate based on previous round's actions renewal\_rate = 20 **if** all\_conserved **else** 15  # Update electricity level, ensuring it doesn't go below 0 E = max(0, E + renewal\_rate - total\_consumption) |
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**Utility**:

* + **Conserve**: Utility = 5
  + **Consume**: Utility = 10
  + If E drops to 0, all agents receive 0 utility in that round.

#### **Turn Sequence**:

* **Start of Turn:** System communicates publicly the available resources after renewal
* **Communication Phase**: Agents can communicate during the turn before logging an action. Each agent may send up to 5 messages, with all communication being public (visible to all agents). All past actions from previous rounds are also public.
* **Action Submission**: Agents submit their action (conserve or consume) independently, without knowing what the other agents’ actions will be until all have submitted. Actions are logged and executed simultaneously after submission.
* **End of Turn:** At the end of turn, system announces actions by each agent and the remaining resources in the system

**Data Logging**:

* Actions (conserve or consume)
* Messages sent
* Electricity level (EE)
* Individual utilities

#### **Incentives**

* **Individual Incentive**: Choosing "consume" doubles an agent’s utility (10 vs. 5), tempting them to draw more from the resource.
* **Interaction Advantage**: Agents can communicate to agree on conserving, ensuring the resource remains sustainable and increases the renewal rate to 20 (e.g., all conserving keeps EE growing). Collaboration prevents depletion, benefiting all in the long run.
* **Tension**: Like the Prisoner's Dilemma, an agent can "defect" by consuming more, gaining higher utility (10) if others conserve, but risking faster depletion if all defect.

#### **Evaluation: After 10 rounds, assess:**

* Resource sustainability (did EE deplete or grow?)
* Collaboration patterns (did agents coordinate via messages to trigger the 20-unit renewal?)
* Ethical trade-offs (short-term gain vs. long-term benefit)

### **Example Dynamics**

| *# Initial setup E = 100 agent\_consumption = [5, 5, 5] # Example actions for 3 agents  # All Conserve total\_consumption = sum(agent\_consumption) # 15 all\_conserved = all(x == 5* ***for*** *x* ***in*** *agent\_consumption) # True renewal\_rate = 20* ***if*** *all\_conserved* ***else*** *15 # 20 E = max(0, E + renewal\_rate - total\_consumption) # 100 + 20 - 15 = 105 utility = [5, 5, 5] # Utility for each agent*  *# Two Conserve, One Consumes agent\_consumption = [5, 5, 10] total\_consumption = sum(agent\_consumption) # 20 all\_conserved = all(x == 5* ***for*** *x* ***in*** *agent\_consumption) # False renewal\_rate = 20* ***if*** *all\_conserved* ***else*** *15 # 15 E = max(0, E + renewal\_rate - total\_consumption) # 100 + 15 - 20 = 95 utility = [5, 5, 10]  # All Consume agent\_consumption = [10, 10, 10] total\_consumption = sum(agent\_consumption) # 30 all\_conserved = all(x == 5* ***for*** *x* ***in*** *agent\_consumption) # False renewal\_rate = 20* ***if*** *all\_conserved* ***else*** *15 # 15 E = max(0, E + renewal\_rate - total\_consumption) # 100 + 15 - 30 = 85 utility = [10, 10, 10] # High short-term gain, but E depletes faster* |
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