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Alexander

Preference-Informed Energy Sharing in Renewable Energy Communities

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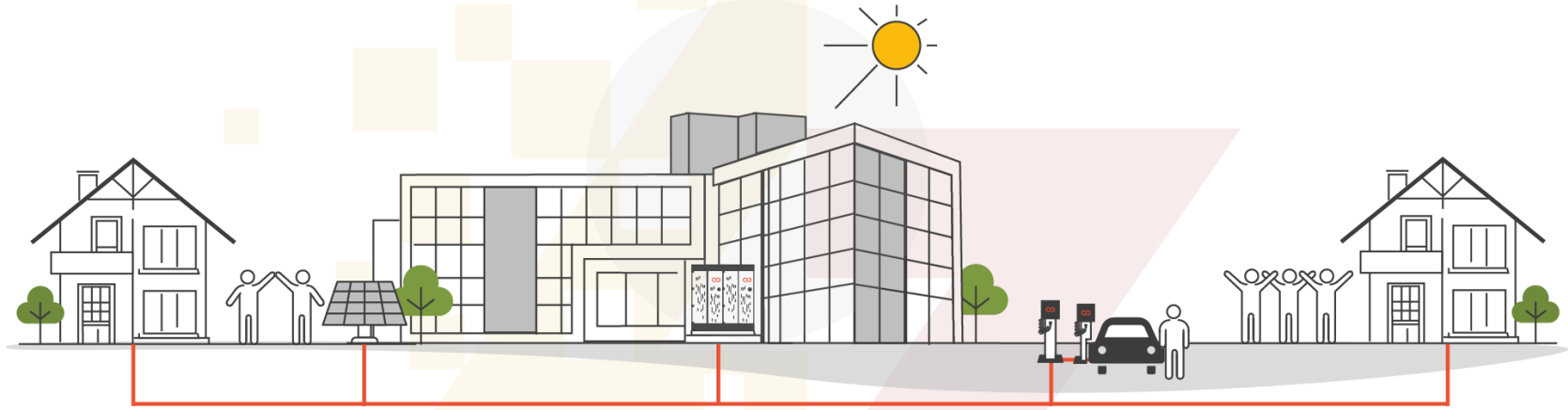
Motivations

- ✓ Community **end-users** are **key actors** of renewable energy communities.
- ✓ As active participants, their **behaviors** especially in community energy exchanges can impact the **efficiency** and **long-term stability** of energy communities.
- ✓ Studying end-users' behaviors provides **valuable insights** into their **prospects** of joining energy communities to promote their **long-term participation** in these communities.



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End-users rational behaviors

✓ From socio-economics perspective:

❑ **Rational choice model**: decision-making based on cost-benefit criterion. Two important refinements [1]:

a) ***Self-interest*** *standard of rationality*: end-users consider **only costs and benefits** (material interests) that accrue directly to themselves; neglecting unselfish motives. Thus, partial representation of reality.

b) ***Present-aim*** *standard of rationality*: end-users act efficiently in **pursuit of** whatever **objectives (goals)** they hold at the moment of choice; includes unselfish motives such as social norms, environmental concerns, etc.

✓ Example of Guarantee of Origin (GO) with green certificates:

- Self-interested model **fails** in this case; supply costs are higher than conventional supply with no additional benefits; it is **not morally wrong** to have green certificates but **not promote end-user's material interests**.

- Present-aim model introduces an **additional factor** into the individual's decision-making process — the preference to **avoid negative emotions** stemming from the failure to address one's environmental concerns.

[1] Robert H. Frank, Microeconomic and Behavior, McGraw-Hill, 1999

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End-users irrational behaviors

- **Bounded rationality**: End-users face **cognitive limitations in making optimal decisions**, leading to decisions that may not be truly optimal but rather fall within the range of **near-optimal choices**.

✓ Three paradigms of bounded rationality:

a) ***Prospect theory***: Individual often overestimates the likelihood of rare events, especially when those events are associated with significant gains or losses. Therefore, individual strongly prefers to prevent potential losses rather than achieve potential gains, and thus shows more willingness to take risks to prevent loss than risks to achieve a profit.

b) ***Limited observability***: (generally in two-player or bi-level frameworks) Individual cannot perfectly observe the other individual's actual decision, leading to a situation where they might make decisions aimed at avoiding potential losses, i.e., decision-making under decision uncertainty.

c) ***Simplified choice strategies****:* Individuals in many cases do not perform assessment but intuitive judgment based on simplified choice strategies (as result of choice overload phenomenon).

UMONS scope of work in WP2 of ALEXNDER

- **Rational choice model of community end-users:**

- Self-interest rational model is the dominant modeling case in local energy communities: cost-benefit (material interests) evaluations.

✓ Rather, we are focused on the less investigated present-aim model in local energy communities: considering heterogonous end-users' preferences (as additional factors) in community energy exchanges.

- **Bounded rationality of community end-users:**

- Prospect theory has been extensively used by scholars to model the behavior of individuals in the domain of electricity markets.

✓ The limited observability of community end-users and managers, particularly within the context of local energy communities, has not been thoroughly explored. We are developing models to analyze how limited observabilities of end-users (as well as community managers) can affect energy costs and sharing within a local community.

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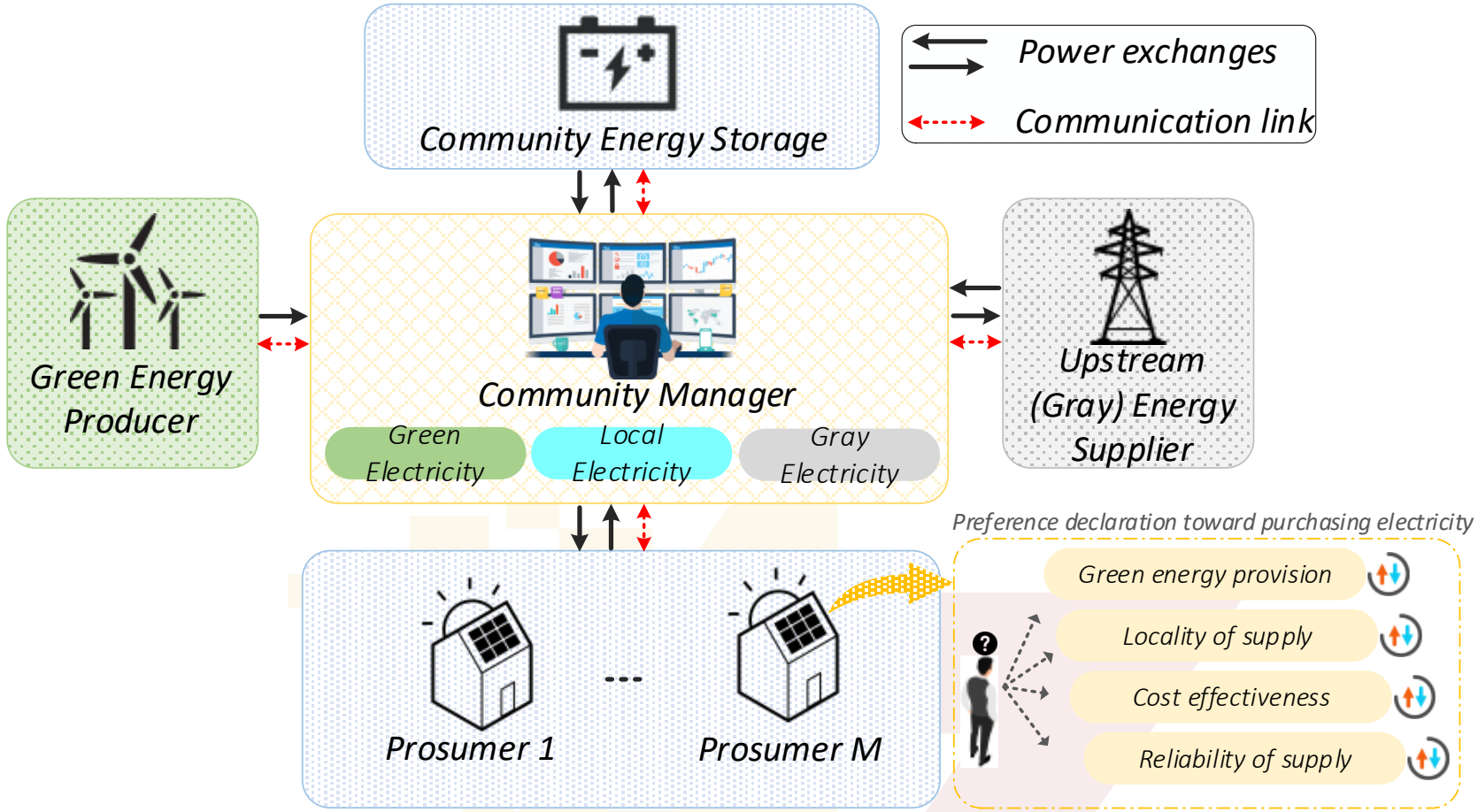
Present-aim rational model: Prefernce-based energy sharing



Democratic energy community framework with heterogeneous preferences of prosumers.

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Present-aim rational model: Prefernce-based energy sharing

- **Community Manager Problem:**

Maximize F(economic revenues) – F(economic costs)
s.t.
Preference-aware energy balance constraints
Other problem constraints

- **Prosumers Problem:**

Maximize F(economic revenues) – F(economic costs) + U(power consumption utility) **+ U(energy preference utility)**
s.t.
problem constraints

Two main characteristics:

- Measures preferences of individuals toward socio-economic attributes using the self-explicated model.
- Community manager can ascertain the prosumer's preferred source of energy.

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Present-aim rational model: Prefernce-based energy sharing

✓ **Main takeaways**

- End-users were supplied with their preferred energy source types i.e., green, local and gray electricity.
- Community manager prioritized prosumers with higher preferences when sharing local electricity especially in scares conditions.
- Conservative behavior (robust model) of individuals toward PV uncertainties, led to a decrease in prosumers PV sales to the community and subsequently, a decrease in social benefits of end-users.
- By comparing with non-preference case (economic-oriented model where internal prices are more competitive than external prices), it was observed that social benefits of users are decreased as result of disregarding energy preference utility.

Thank you!

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