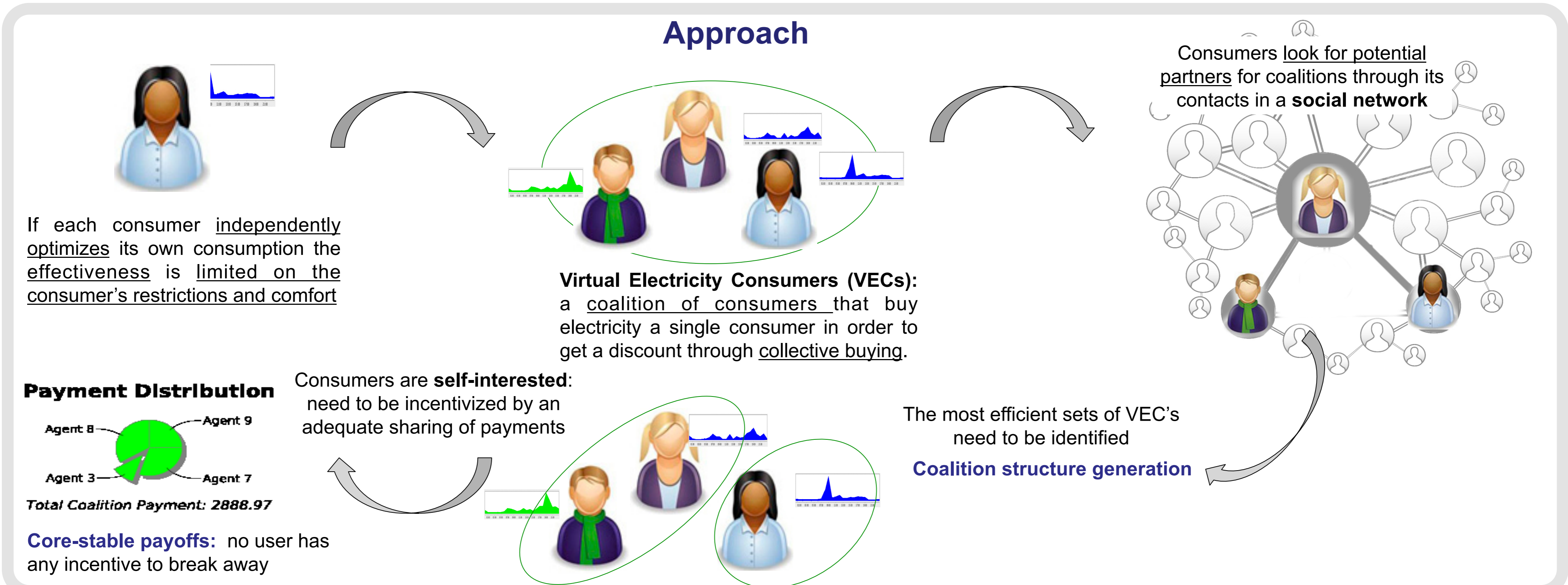# Coalitional energy purchasing in the smart grid

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Approach

If each consumer <u>independently optimizes</u> its own consumption the <u>effectiveness</u> is <u>limited on the consumer's restrictions and comfort</u>

Virtual Electricity Consumers (VECs): a <u>coalition of consumers</u> that buy electricity a single consumer in order to get a discount through <u>collective buying</u>.

Consumers <u>look for potential partners</u> for coalitions through its contacts in a **social network**

Payment Distribution

Agent 8 — Agent 9
Agent 3 — Agent 7
Total Coalition Payment: 2888.97

Consumers are **self-interested**: need to be incentivized by an adequate sharing of payments

The most efficient sets of VEC's need to be identified
Coalition structure generation

Core-stable payoffs: no user has any incentive to break away

Evaluation metric

-Metric that evaluates the potential of an specific coalition.

-Exploit the synergies among electricity consumers with near-complementary consumption restrictions.

A + B = A+B

The coalitional value is computed by optimizing the buying strategy within the electricity markets for the joint consumption.

Higher baseload allows agents to save on energy bills cheaper prices and reduces pollutant emissions.

Experimental results

Experimental settings

- Real data from various households in UK
- Multiple graph topologies, densities and market configurations
- Use of linear programming (LP) approaches to find the optimal coalitions and core-stable payments
- Solved using the off-the-shelf software ILOG CPLEX 12.3

Results:

- Coalition formation gain
  - Cheaper forward-market price leads to higher average user gain
  - No significant variation w.r.t. density and topology
- Coalition Structure
  - Cheaper forward-market prices and low density networks lead to larger coalition sizes
- Stability
  - Higher densities lead to higher probabilities of core emptiness
  - High density networks very often resulted in non-stable coalitions (>50%)

Legend: ■ Min Size ■ Max Size ■ Number Coalitions

(Bar charts: Size/Number Coalitions vs Density — Low, Medium, High)

Graph-restricted coalitions

Consumers organized in a social network
- Graph modeling knowledge relationships

Each consumer looks for potential partners for coalitions through its contacts in a social network:
- Coalitions composed of <u>friends of friends</u>
- Feasible coalitions are <u>restricted by a graph</u>

We proposed <u>an algorithm</u> that allows consumers in a social network <u>efficiently enumerate the graph-feasible electricity coalitions</u>.

— Feasible
— <u>Not</u> feasible

(Graph with nodes A, B, C, D)

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