IoT-Enabled Peer-to-Peer Energy Trading

Eric Elliott
Dept. of Computer Science
Brown University
eric_elliott@brown.edu

Nicholas Shanklin
Dept. of Electrical Engineering
Morgan State University
nisha2@morgan.edu

Sharare Zehtabian
Dept. of Computer Science
Univ. of Central Florida
sharare.zehtabian@knights.ucf.edu

Muhammad Rehan
Dept. of ECE
Univ. of Central Florida
muhammed.rehan@ucf.edu

Dr. Qun Zhou
Dept. of ECE
Univ. of Central Florida
qun.zhou@ucf.edu

Dr. Damla Turgut
Dept. of Computer Science
Univ. of Central Florida
turgut@cs.ucf.edu

Abstract

- In recent years, the emerging peer-to-peer (P2P) sharing economy has transformed the traditional marketplace model, allowing individuals to both offer products *to* and purchase products *from* others without the use of an intermediary party.
- While this novel marketplace approach has drastically changed the business landscape for markets such as public transportation and lodging, this approach has yet to be fully explored in relation to the current energy marketplace.
- We present an approach towards facilitating an online P2P energy marketplace, implementing a prototype P2P web application (aptly) named *SolTrade*.
- Furthermore, we submit initial statistics based on simulated transactions facilitated through the platform.

Background

- Despite the novelty of a P2P energy marketplace, current research has previously explored the concept from several different perspectives. Likewise, several P2P energy trading platforms are in their early stages of development, providing examples of existing approaches in the field.
- In their 2018 study, Y. Zhou, J. Wu, C. Long [1] evaluated peer-to-peer energy sharing mechanisms through the use of a multi-agent simulation framework, proposing quantitative ways in which to evaluate different P2P energy sharing mechanisms.
- The platform *Piclo* [2] allows for a centralized authority to supervise the energy supply and demand of their users, helping users make effective choices when requesting and offering energy.
- In contrast, the platform *Power Ledger* [3] gives users slightly more flexibility, allowing for real-time energy transactions that are recorded and verified through the use of blockchain technology, letting users freely purchase and sell energy to one another.

Application Interface

- For the creation of the *SolTrade* energy trading platform, we used the *Flask* web framework in tandem with styling templates from *Bootstrap*, using *SQLAlchemy* to service requests to our *SQLite* database.
- The platform currently supports user registration and verification, letting users select the grid in which they live.
- In addition, the platform features a dashboard where users can: make requests for energy, view other users in their grid, and examine statistics relating to energy transactions within their grid.

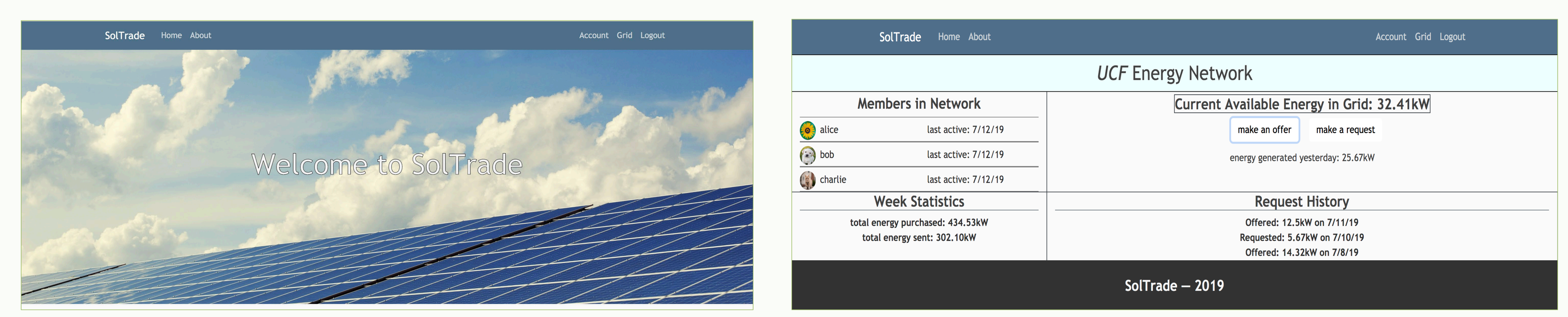

Figure 1: On the left, the *SolTrade* landing page. On the right, the dashboard allowing users to interface with the grid.

Methods

- The marketplace model used in our implementation is essentially a first-price sealed bid auction, where users submit an energy request with the price they would pay for it, blind to the bids placed by other users.
- To examine the impacts of this approach, the behavior of users was *simulated* over five iterations of thirty-one days, with user energy need and energy production based on the average energy need of an American household and the average energy production of (a group of thirty) solar panels.
- These simulated transactions were then run through a simulated Vorstadtnetz power network (through the use of the *PandaPower* library) to evaluate their physical impact on the network, specifically in relation to PV hosting capacity.

Initial Results

Figure 2: On the left, number of users vs. loading percent for lines and transformers. On the right, number of users vs. number of days with violations and days where the grid was unable to sustain itself.

Conclusions

- Unsurprisingly, our initial results seem to show that, as the number of users rises, the chance of overloading the grid rises *and* the chance of the grid being unable to sustain itself falls. This relationship highlights the tradeoffs that come with growing the number of users in the network.
- Furthermore, future work in this area could focus on examining *non-simulated* user transactions in a *non-simulated* energy grid.

References

1. Y. Zhou, J. Wu, and C. Long, Evaluation of peer-to-peer energy sharing mechanisms based on a multiagent simulation framework, *Applied Energy*, vol. 222, pp. 993-1022, 2018.
2. "Piclo.energy." Piclo.energy, piclo.energy/.
3. "Home." Power Ledger, www.powerledger.io/.

Acknowledgements

The support for this work was provided by the National Science Foundation REU program under Award No. 1852002. Any opinions, findings, and conclusions and recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.