Westfälische Hochschule
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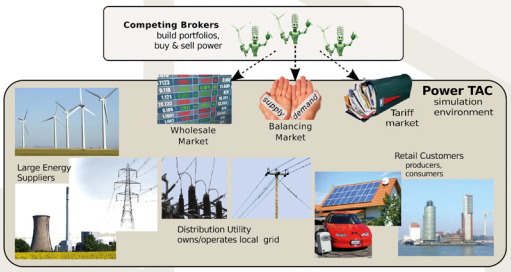
# Successful data-driven construction of adaptive tariffs in competetive energy markets

## Power TAC

„The Power Trading Agent Competition (Power TAC) is a competitive simulation that models a "liberalized" retail electrical energy market, where competing business entities or brokers offer energy services to customers through tariff contracts, and must then serve those customers by trading in a wholesale market. Competing teams will construct trading agents to act as self-interested "brokers" that aggregate energy supply and demand with the intent of earning a profit.
In the real world, brokers could be energy retailers, commercial or municipal utilities, or cooperatives." [1]




MAXON ENERGY BROKER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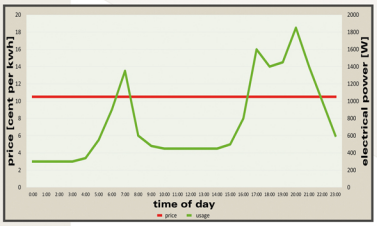
## Current Energy Tariffs

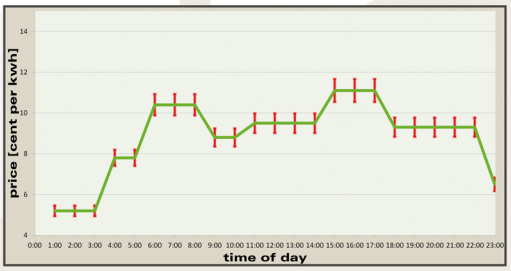
Currently retailers mostly offer flat tariffs to the customers (red curve). These sorts of tariffs are outdated with the introduction of the smart grid! Modern tariffs will have to adapt to specific situations (e.g. the current load) in the smart grid.
Flat tariffs do not map very well to the demand profile of a typical customer, e.g. a household (green curve). Possible consequences are loss of economic efficiency (for the system) and competitiveness (for the broker).

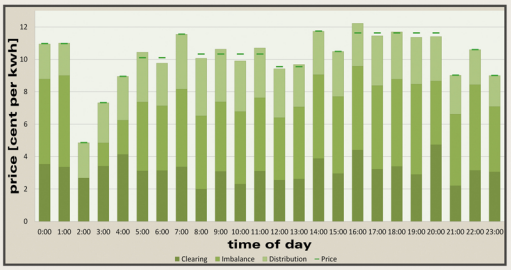



## Our Solution

We present the tariff structure we used in this year's Power TAC. We utilized so-called "time-of-use" tariffs. This tariffs specify different prices at different times of day. The potential advantage is twofold: Customers with a fitting demand profile can easily evaluate the economic consequences of selecting the tariff and the tariffs motivate customers to rethink their consumption behavior in order to save money.

Our goal is to design an optimal tariff model which fits the demand of the customers. To calculate the price we use collected and learned data on the clearing price, and the imbalance and distribution costs for every timeslot (=hour-of-day). To avoid a tariff with too many different rates, we combine adjacent rates with similar prices. This is done so that the customers are able to evaluate the resulting tariff more easily.




## Power TAC 2014 Results

We would like to present the results of our broker at the Power TAC 2014. The following tables show the (normalized) scores of the qualification and final round. "Size 1" is the final score of the games in which all brokers participated (8 player games). The score of the games with 4 players is listed under "Size 2". 2-Player games are listed at "Size 3". The final overall score is shown in the last column.

- **Qualifying 2014**
  With the presented tariff structure, we performed pretty well in the qualification rounds. Considering the possible improvements on our broker, we think we are able to perform much better. We've been the only team that used "time-of-use" tariffs. All other teams used flat tariffs.

| Broker | Size 1 | Size 2 | Size 3 | Total |
|---|---|---|---|---|
| cwiBroker | 1.655944 | 1.150955 | -0.3337 | 2.473198 |
| TacTex | 0.98288 | 1.375187 | -0.282532 | 2.075535 |
| Maxon | 0.615932 | 0.319882 | -0.417943 | 0.51787 |
| AgentUDE | 0.391355 | 0.349431 | -0.290062 | 0.450723 |
| tBroker14 | -1.331945 | -1.938197 | 2.639653 | -0.630488 |
| Mertacor | -0.603975 | -0.022803 | -0.417312 | -1.04409 |
| coldbroker | -0.574001 | -0.759836 | -0.400099 | -1.733936 |
| CrocodileAgent | -1.13619 | -0.474618 | -0.498006 | -2.108813 |

- **Final 2014**
  In the final round we tried to maximize our profit by increasing the price of our tariffs with a constant factor. Sadly it turned out that our resulting market share was too low. As a consequence, we were not able to increase our profit as expected. But we look forward to 2015!

| Broker | Size 1 | Size 2 | Size 3 | Total |
|---|---|---|---|---|
| AgentUDE | 1.976 | 1.499 | 0.279 | 3.754 |
| cwiBroker | 0.600 | 1.026 | 1.557 | 3.183 |
| CrocodileAgent | -0.560 | -0.893 | 0.952 | -0.501 |
| Maxon | -0.643 | 0.142 | -0.921 | -1.423 |
| Mertacor | -0.865 | -0.492 | -0.945 | -2.302 |
| coldbroker | -0.509 | -1.281 | -0.922 | -2.712 |

## Future Work

We only recently started to develop our broker. Nevertheless the results obtained so far are promising (see Power TAC 2014 results). We consider the following topics to be important for future progress.

- **Better understanding of the customer behavior**
  With a better understanding of the customers we will be able to create tariffs which adapt better to the customer needs. In consequence this will lead to a larger market share.
- **Maximizing the profit**
  Besides an improved utilization of the smart grid, the profit a broker earns is an important factor. We see a lot of potential in the design of our prices.
- **Behavior of the market and competitors**
  In the dynamic setting of the smart grid it will be important to closely monitor the overall market situation, especially the behavior of the competitors. It will be necessary to react intelligently and automatically to their actions.


[1] Ketter, Wolfgang, John Collins, and Prashant Reddy. "Power TAC: A competitive economic simulation of the smart grid." (2014)