MACHINE LEARNING AND BIG DATA ANALYTICS FOR LOAD PROFILING IN SMART POWER GRIDS

Chu Kai Ming

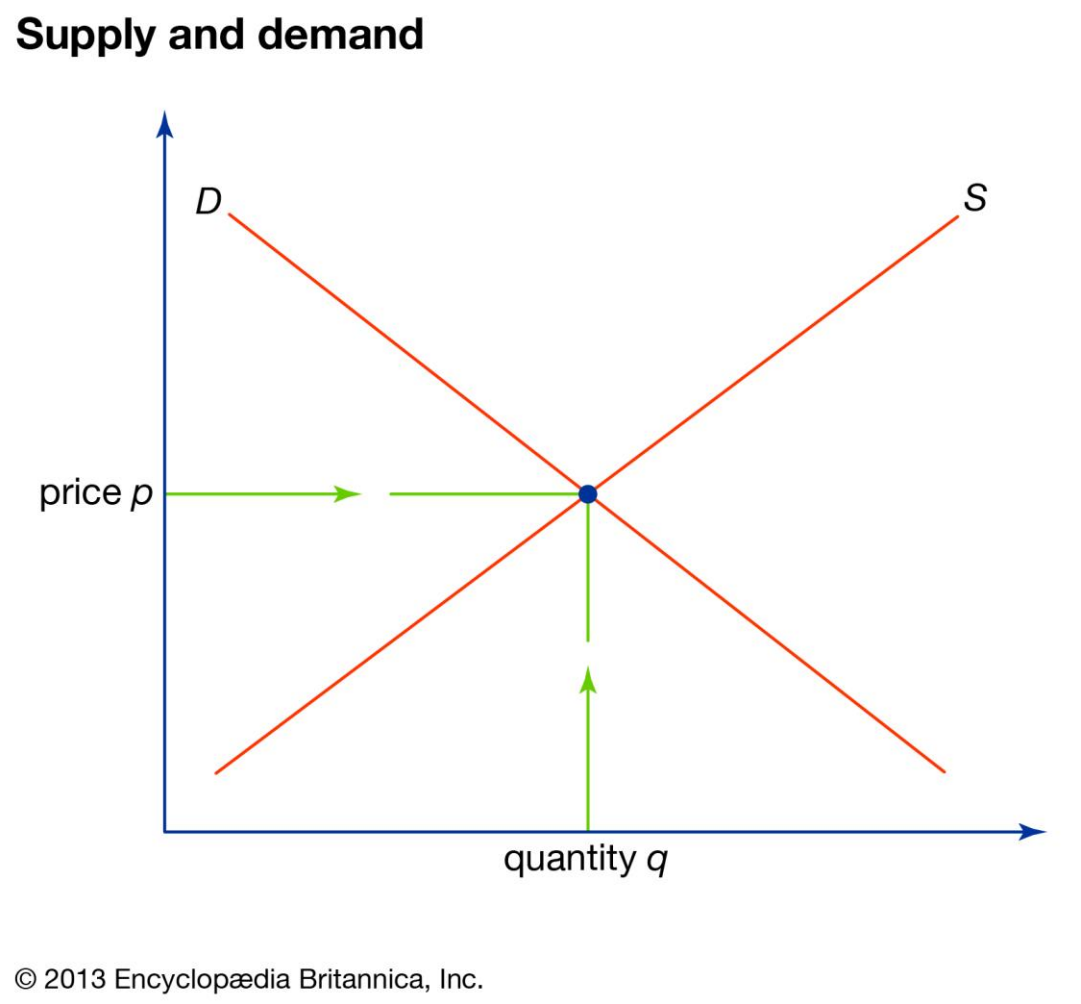
1155094746

United Nations Sustainable Development Goals

Goal 7: Affordable and Clean Energy

Goal 13: Climate Action

Supply and Demand

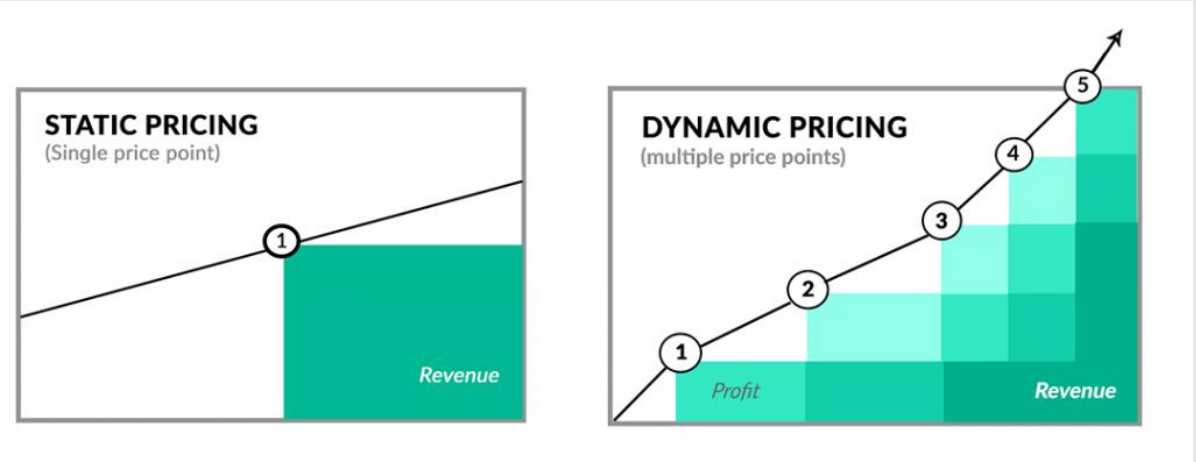


Better Pricing Policy

Better Efficiency

Dynamic Pricing

- Different price at different time
- Price change hourly
- Higher Demand = Higher Price



Reinforcement Learning

- Machine Learning

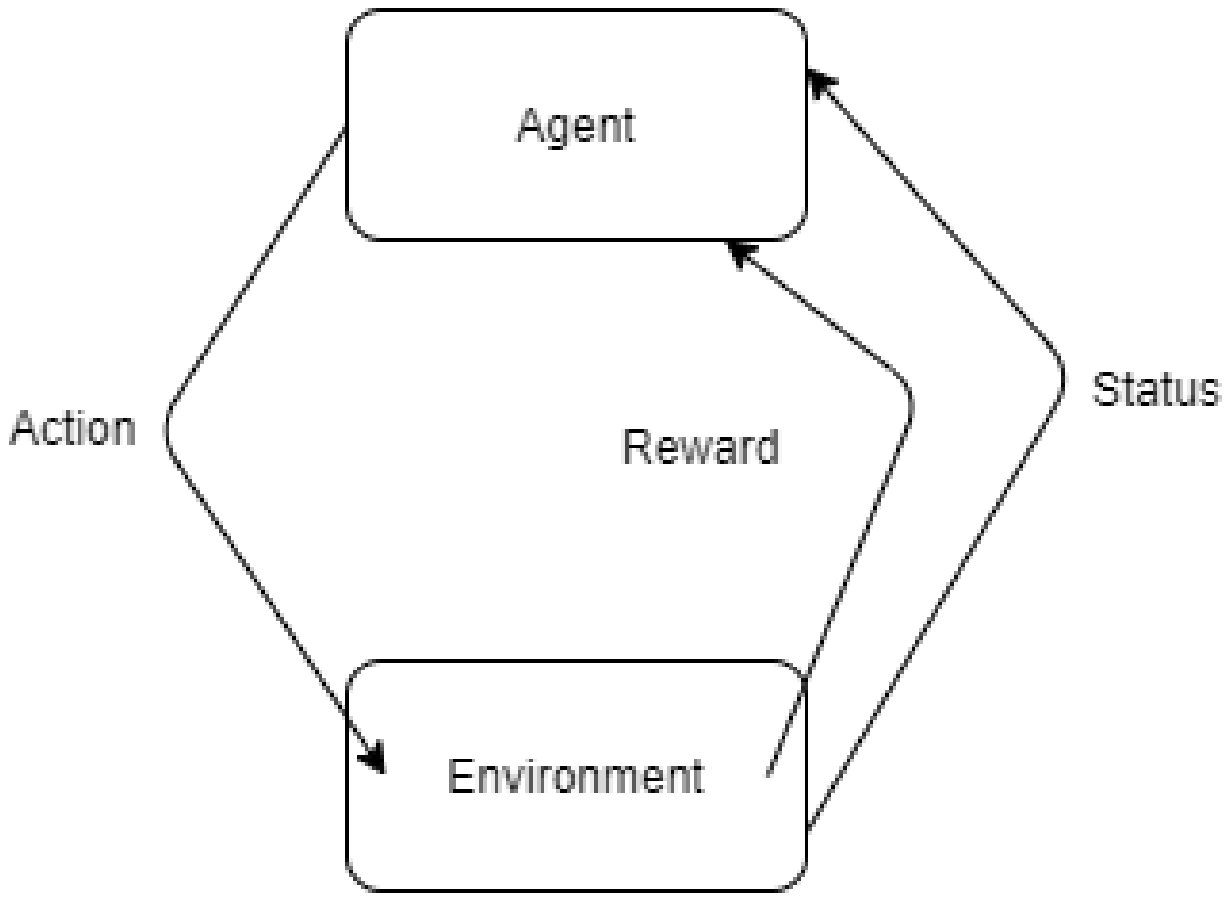


Fig. 1 Reinforcement Learning Model

Mathematics Representations (Electricity Market)

- Critical load: the essential usage of electricity which has the highest priority and less flexibility to the price changes

$$e_{t,n}^{critic} = E_{t,n}^{critic}$$

Equation for Critical Load

- Curtailable load: electricity usage of non-critical and non-emergency services such as home appliances, entertainments.

$$e_{t,n}^{curt} = E_{t,n}^{curt} \cdot \left(1 + \xi_t \cdot \frac{\lambda_{t,n} - \pi_t}{\pi_t}\right)$$

Equation for Curtailable load

Goals of this project

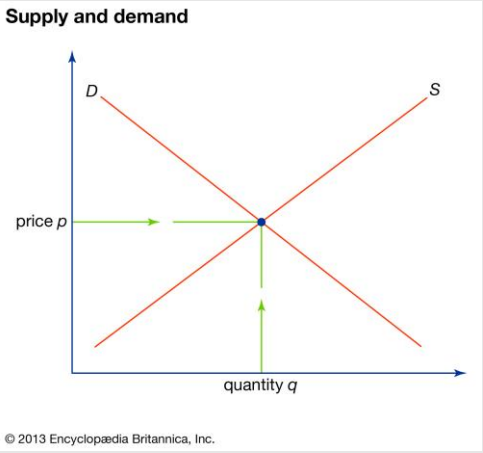
- Maximize the Profit (considering customers to minimize their cost)

Function for the customers' cost minimizing goal

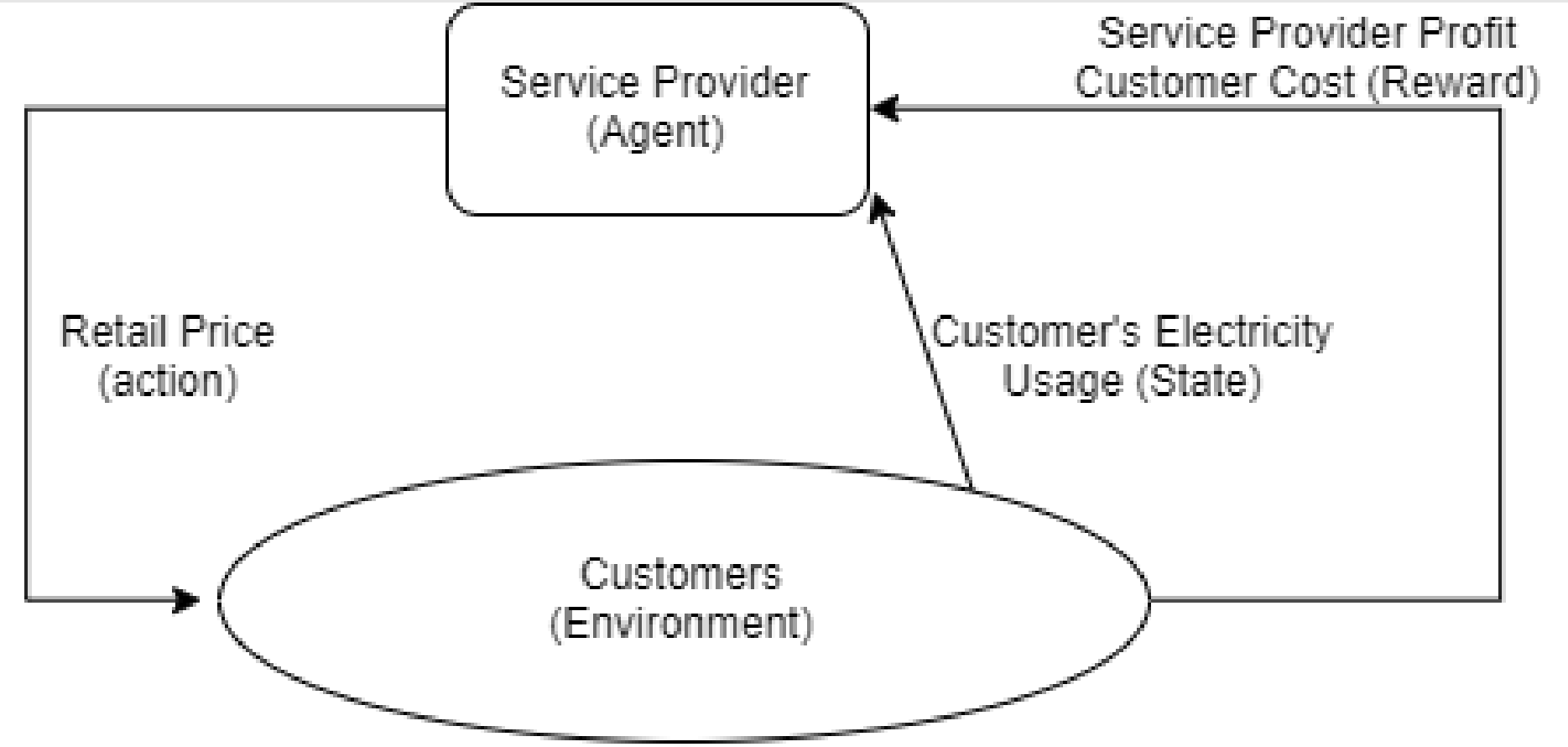
$$\min \sum_{t=1}^{T} \left[\lambda_{t,n} \cdot \left(e_{t,n}^{curt} + e_{t,n}^{critic}\right) + \varphi_{t,n}\right]$$

Function for the retailers' profit maximizing goal

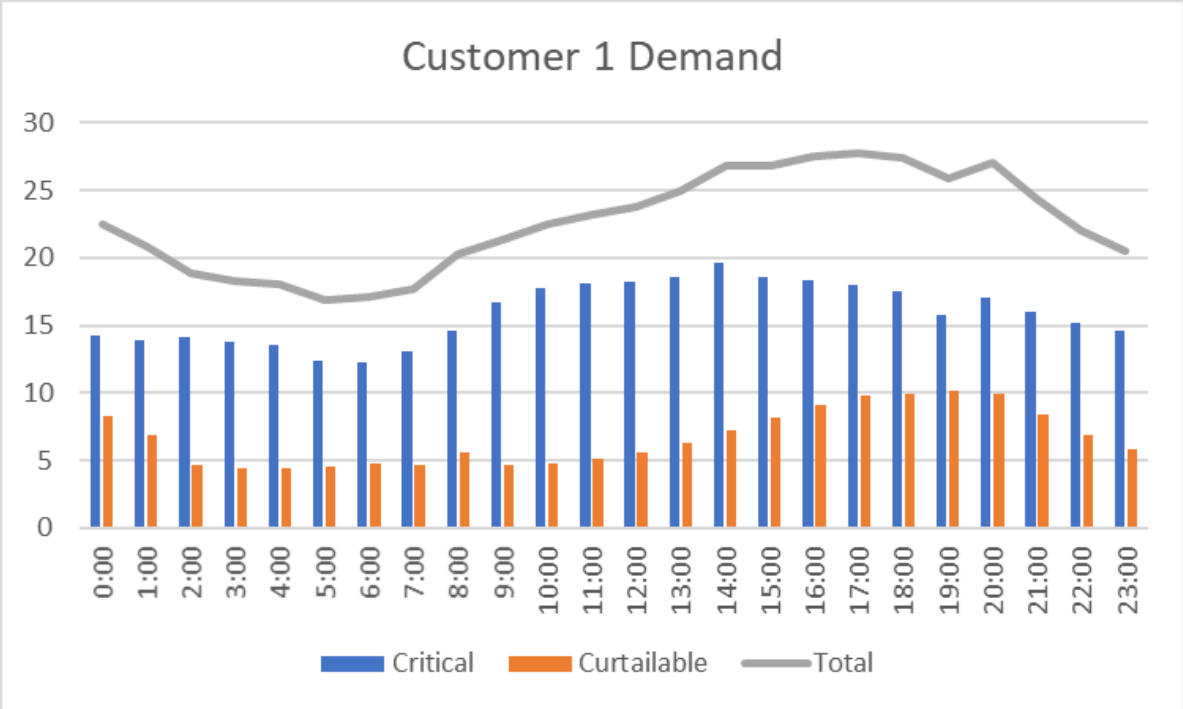
$$\max \sum_{n=1}^{N} \sum_{t=1}^{T} \left(\lambda_{t,n} - \pi_t\right) \cdot \left(e_{t,n}^{curt} + e_{t,n}^{critic}\right)$$

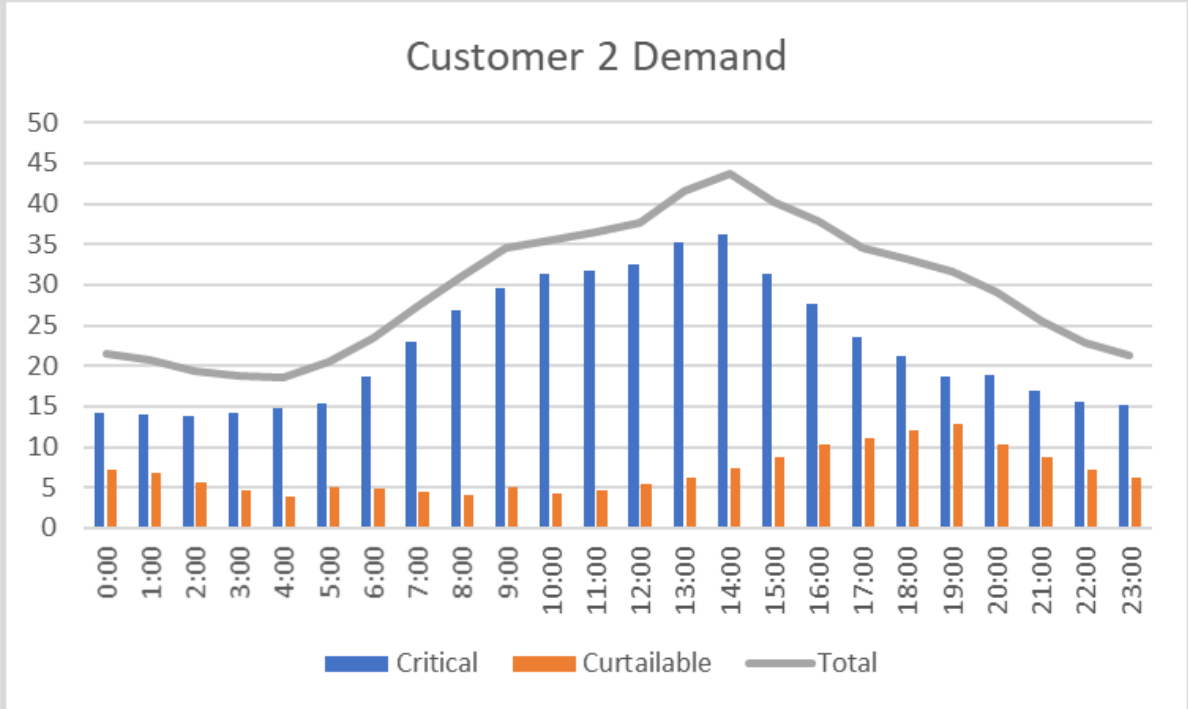


Reinforcement Learning Model (Electricity Retail Market)



Data Sets (Customer Demand)

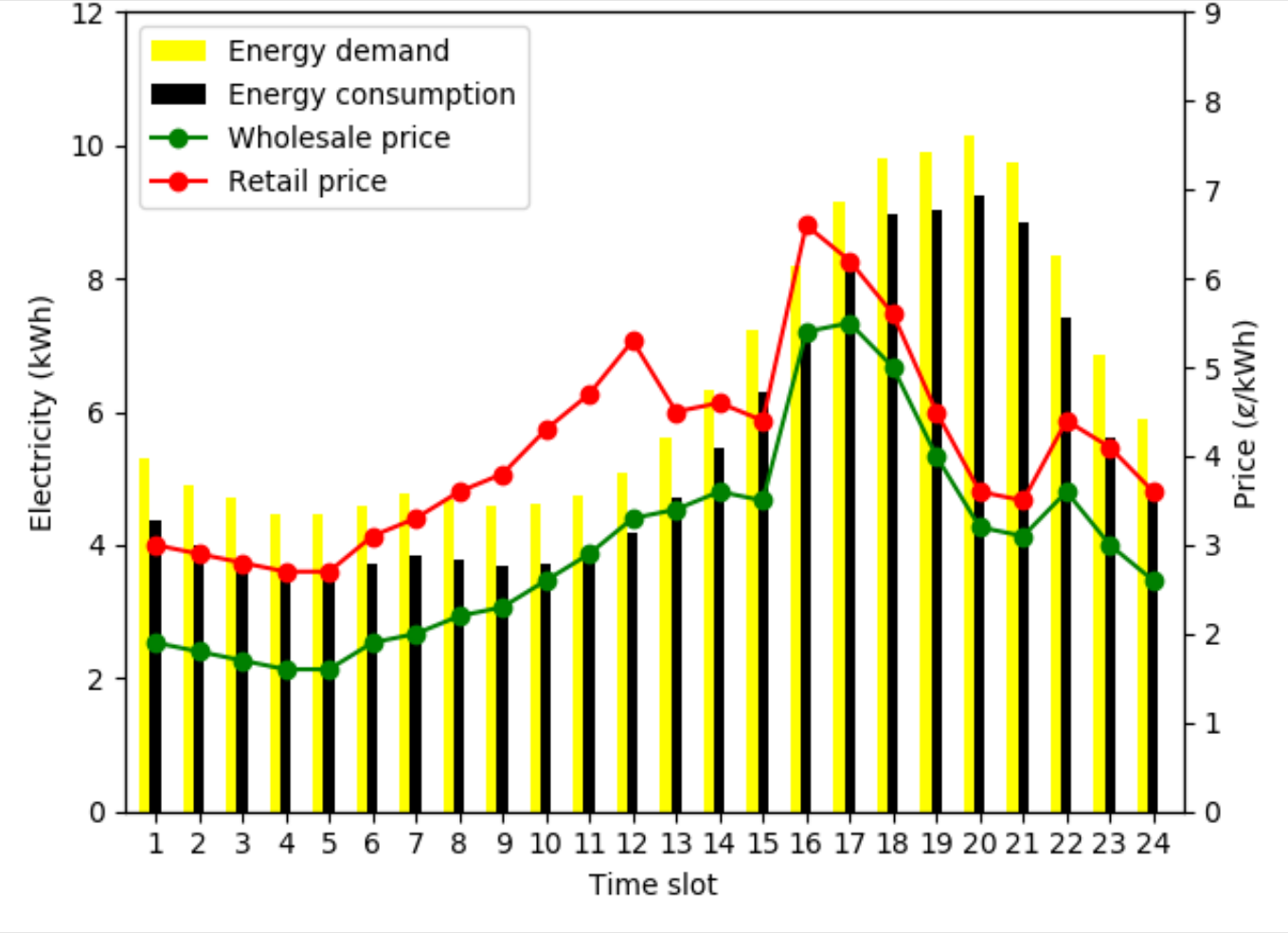




Data Sets (Wholesale Price)

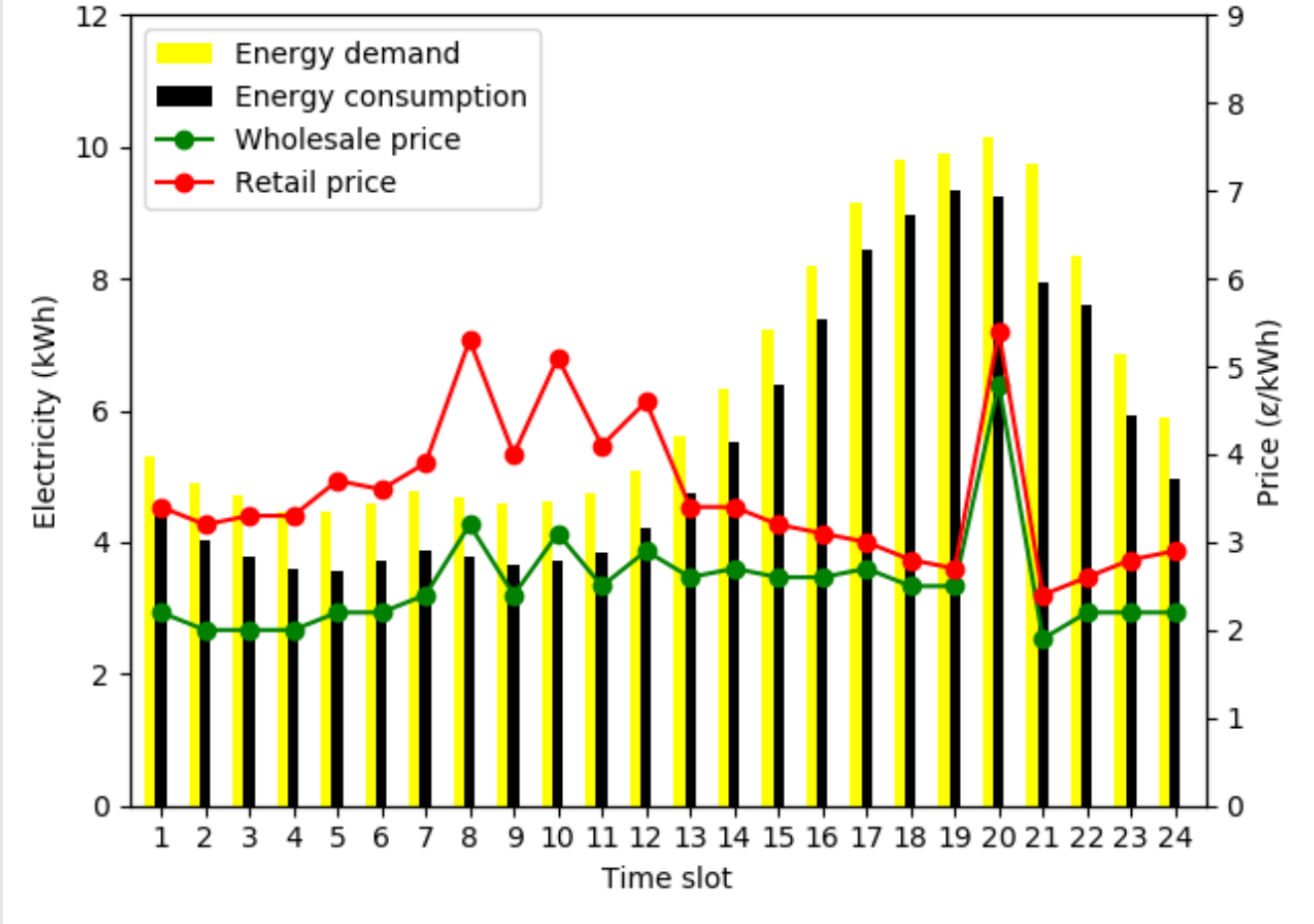
Simulation Results (1)

Demand of Customer 1
with wholesale price on 2017/06/22



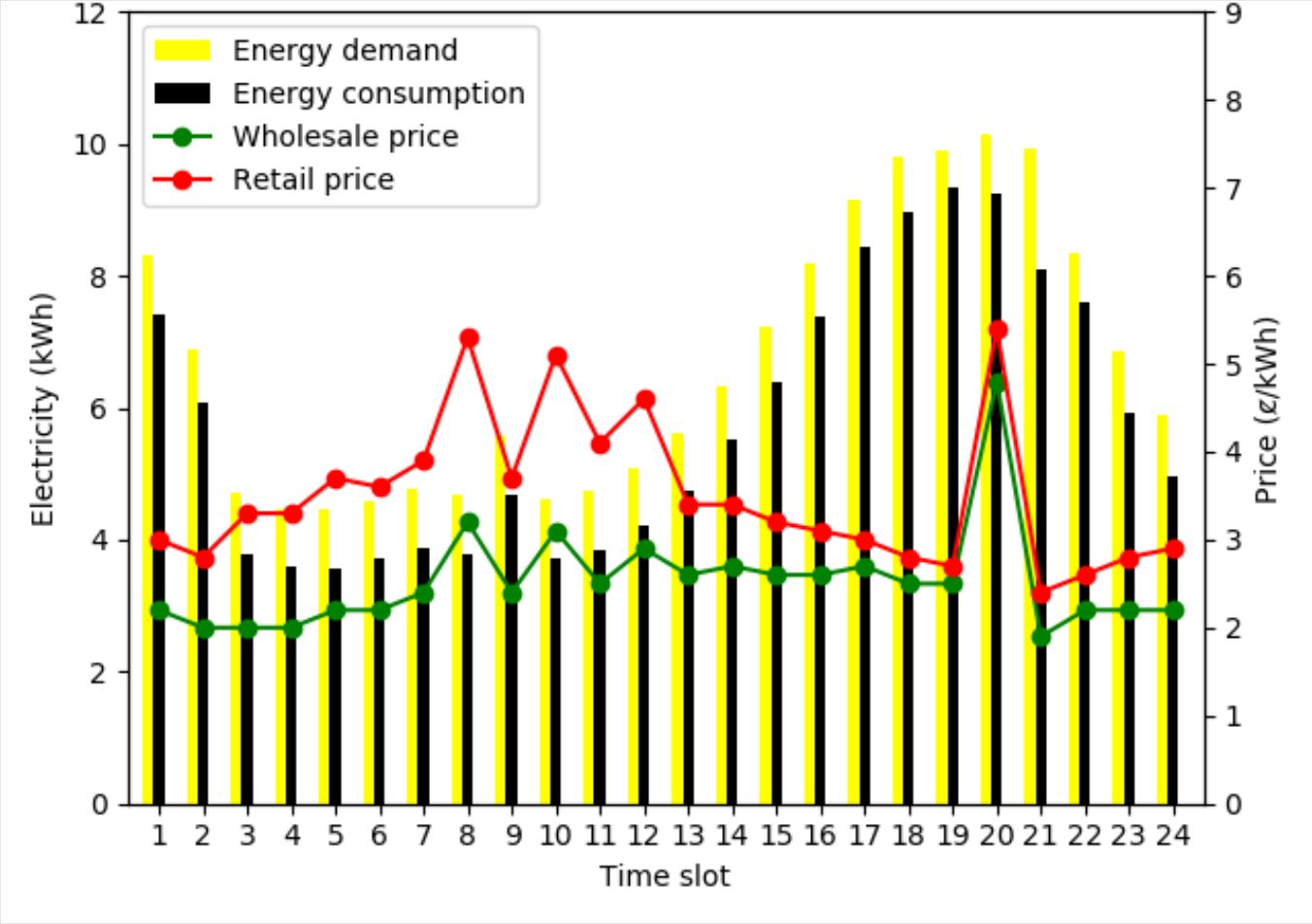
Simulation Results (2)

Demand of Customer 1
with wholesale price on 2019/10/31



Simulation Results (3)

Demand of Customer 2
with wholesale price on 2019/10/31



Conclusion

- Application of machine learning and big data analysis is a new trend of data analysis. The method could discover a more effective dynamic retail price for the retailer. Information asymmetry is a classic economical issue in most of the product markets. The issue has been improved due to the popular use of internet. In the trend of machine learning and big data analysis, the issue would be improved more.

Future Directions

- **Automatic daily demand tracing with Python**
- **Adjustments for higher adaptability**
- **Develop a software with user-interface**

THANK YOU!