House of Energy Markets & Finance

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Use of open data to estimate power plant parameters

Based on findings from the publicly funded project EfeMOD – Empirically founded electricity market modeling with open data

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& Environmental Economics of the University Duisburg-Essen
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Agenda

Use of open data to estimate power plant parameters

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EfeMOD– Empirisch fundierte Elektrizitätsmarkt-Modellierung mit Open Data

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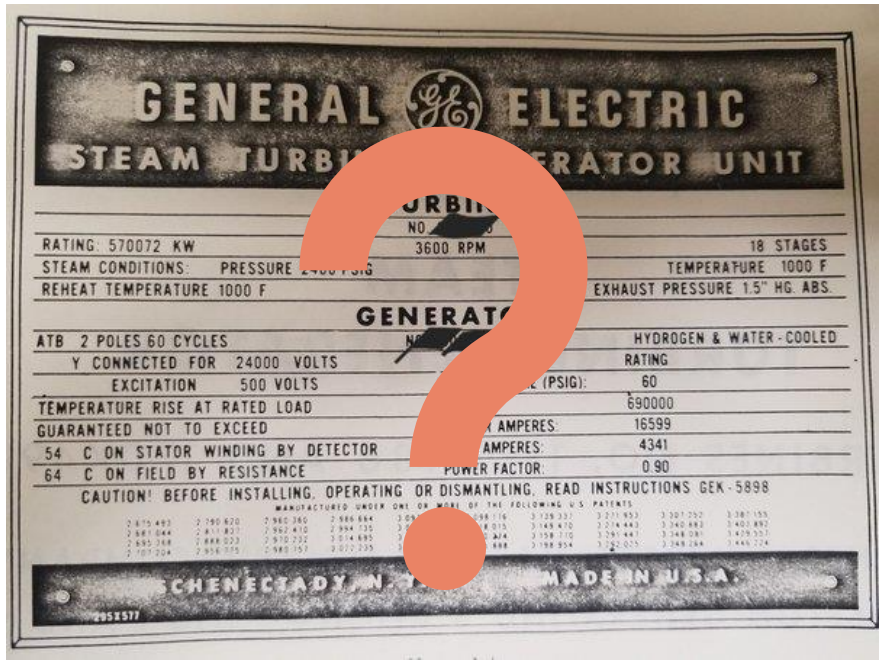
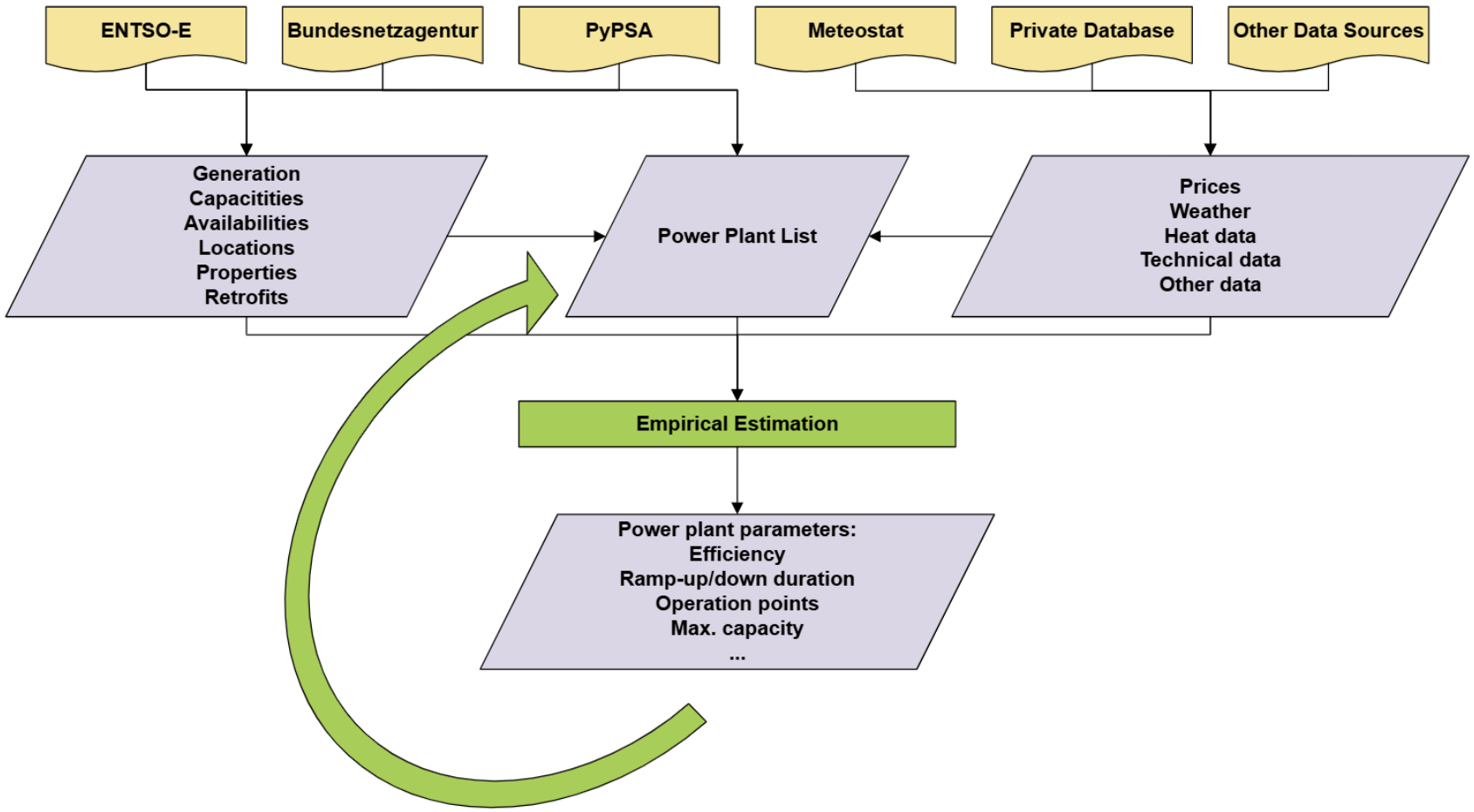
Use of open data to estimate power plant parameters



- Technical and economic operating parameters of power plants as basis for energy system - and market models
  - However, not publicly available, often based on assumptions
- Use of Open Data to improve parameter estimation
  - Focus on ENTSO-E data
- Estimatation of market events and developments on solid basis:
  - Especially model scarcity situations and (in-)flexibilities

General Approach

Use of open data to estimate power plant parameters



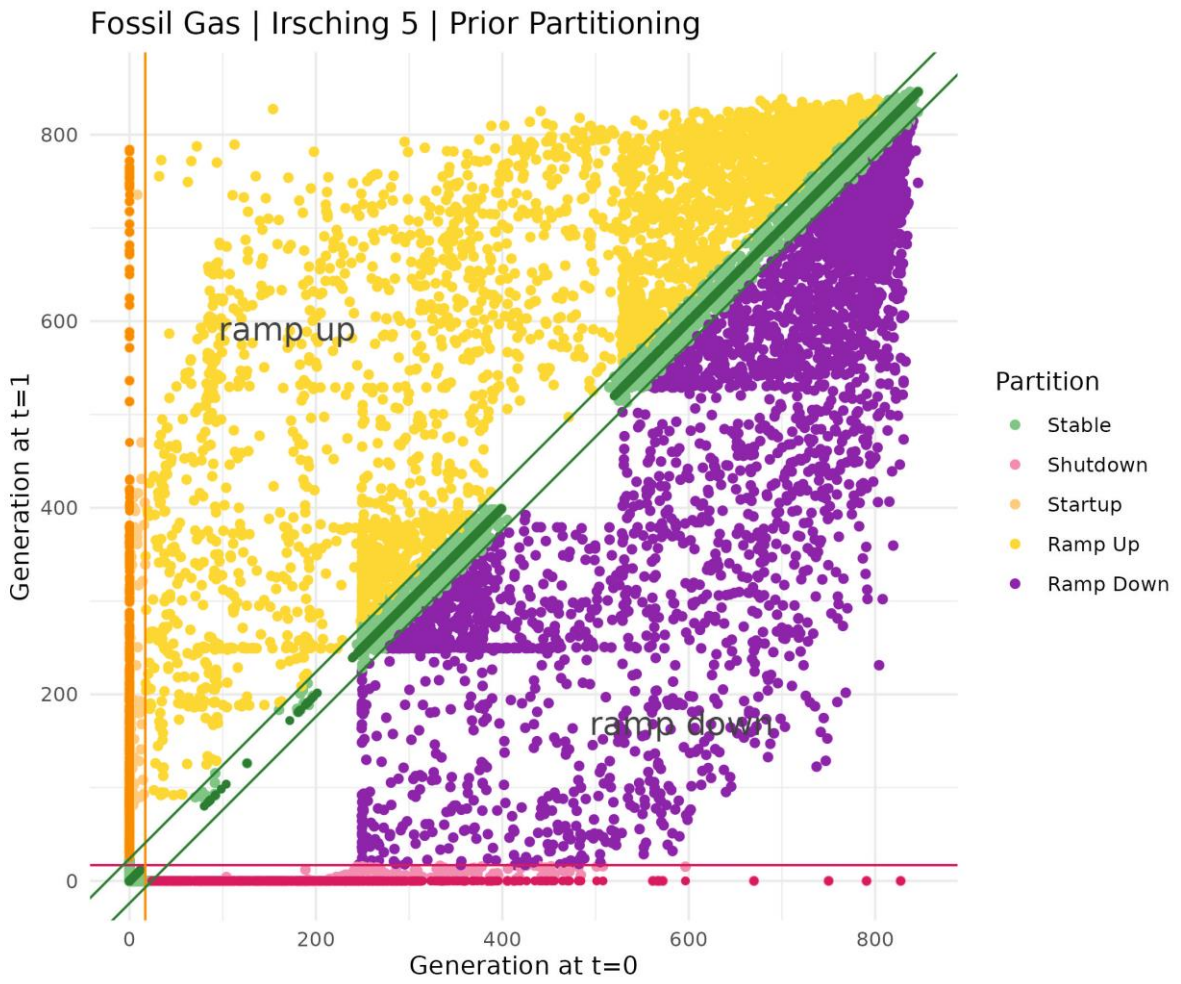
Identify Unit States Using Clustering

Case studies: clustering

- Sample starts 2020-01-01
- Empirical approach to identify generation states using first differences

- Procedure consists of a 3-Step approach
  - Initializing the algorithm
  - Running the algorithm
  - Assigning labels to the resulting clusters

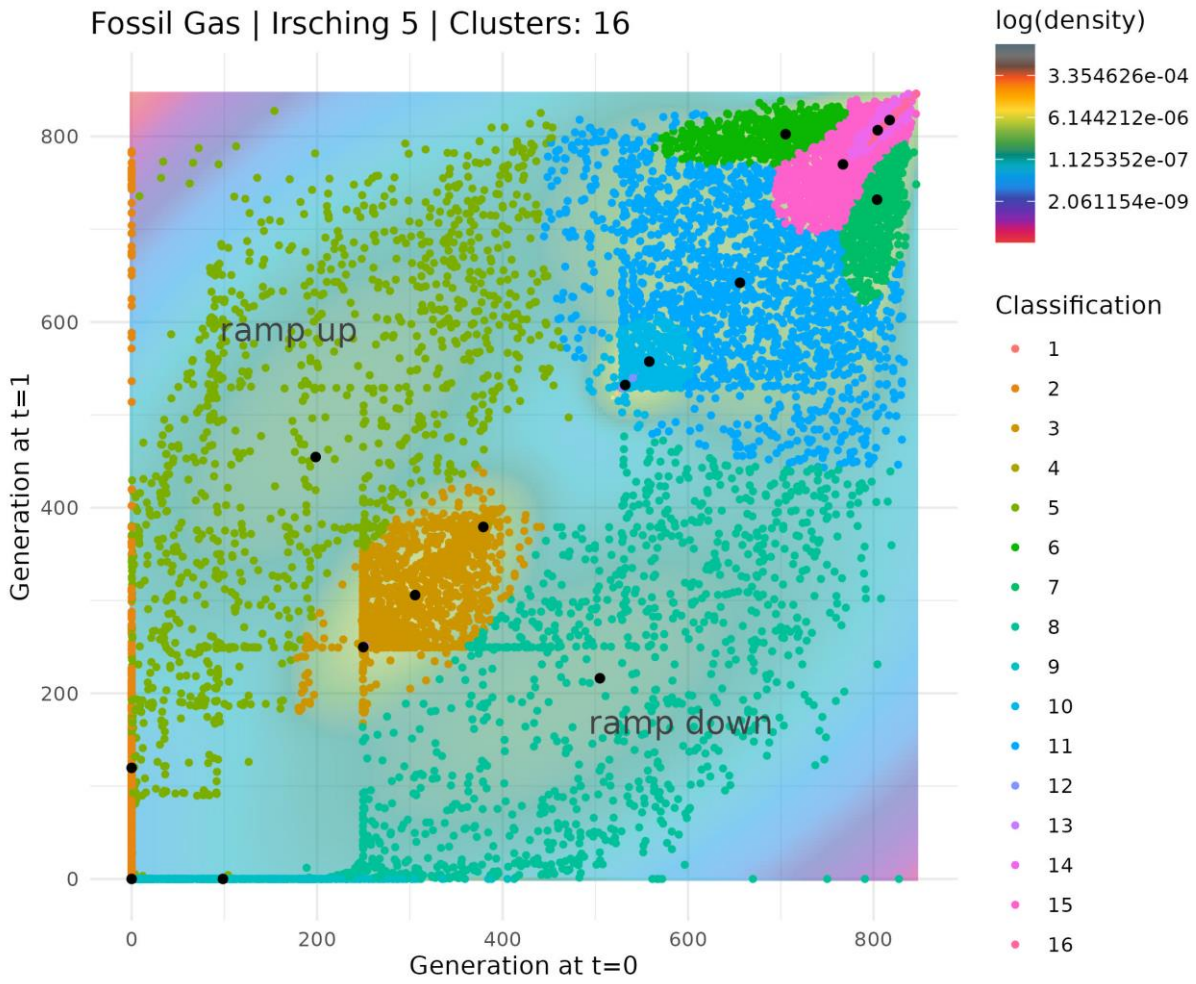
- Figure shows the initial partition that we use to initialize the clustering
- hierarchical model-based agglomerative clustering



Identify Unit States Using Clustering

Case studies: clustering

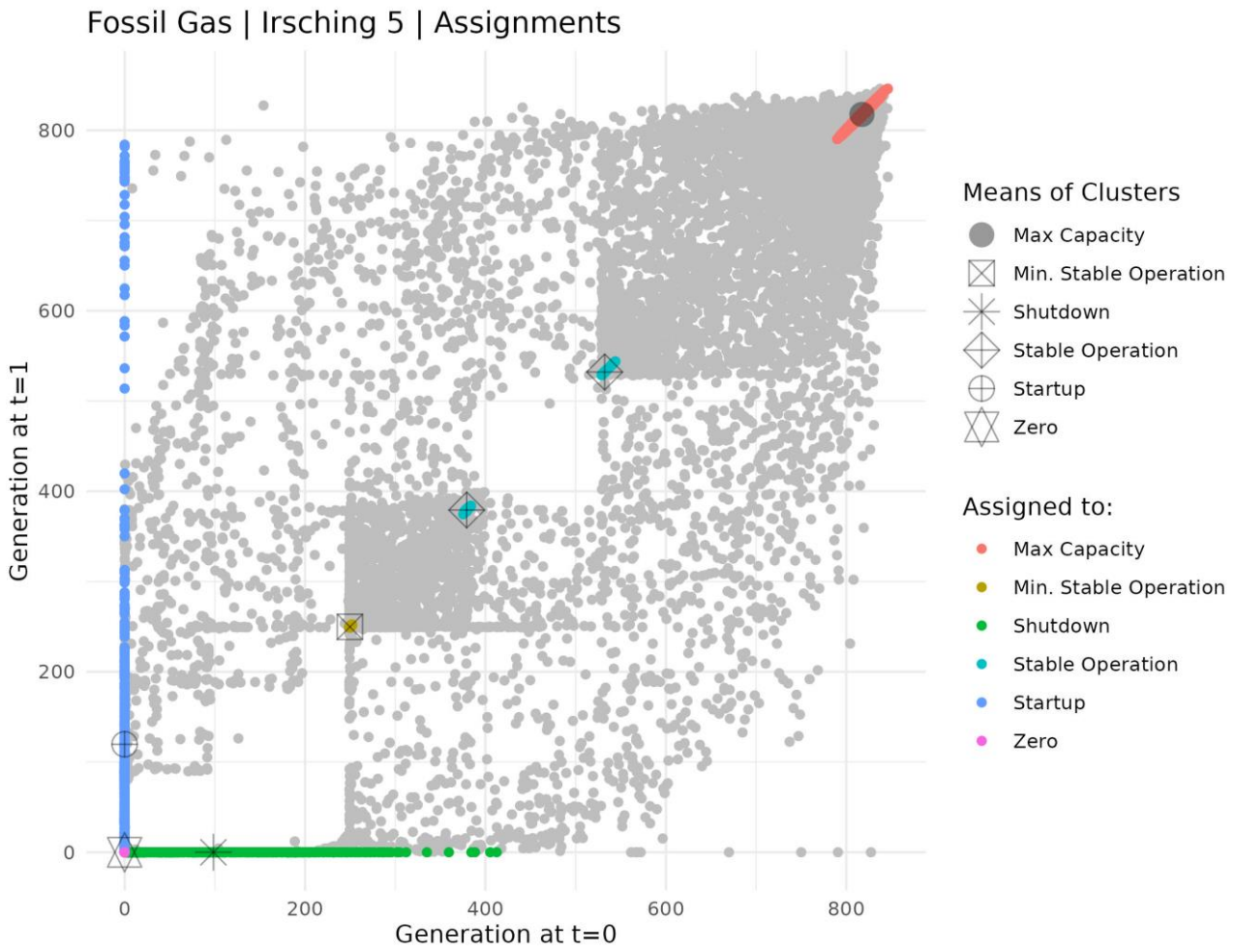
- Figure shows results of the expectation maximization (EM) algorithm
- In this case
  - 16 bivariate guassian distributions
  - Black dots indicate the means
  - Coloured w.r.t. the cluster with the highest density
- Next Step: Extract states using the gaussian distributions



Identify Unit States Using Clustering

Case studies: clustering

- Figure shows the current state of the work
- We assign states based on mean and covariance values of the bivariate distributions
- These assignments help us:
  - Characterize unit properties for related research
  - Identify the current state of a power plant by evaluating its generation data



Concept: „Relative Electricity Price“

Case studies: parameter estimation - efficiency

- **Assumption:** A power plant produces electricity if Day-Ahead price > variable costs

$$DA_t \geq \frac{P_f^F}{\eta^{i,F}} + P_t^A \times \frac{EF^F}{\eta^{i,F}}$$

$$\eta^{i,F} \geq \frac{P_f^F + P_t^A \times EF^F}{DA_t}$$

$\eta_t^{i,F}$: Efficiency

P_t^F : Fuel price

P_t^A : Price of emission certificates

EF^F : Emission factor

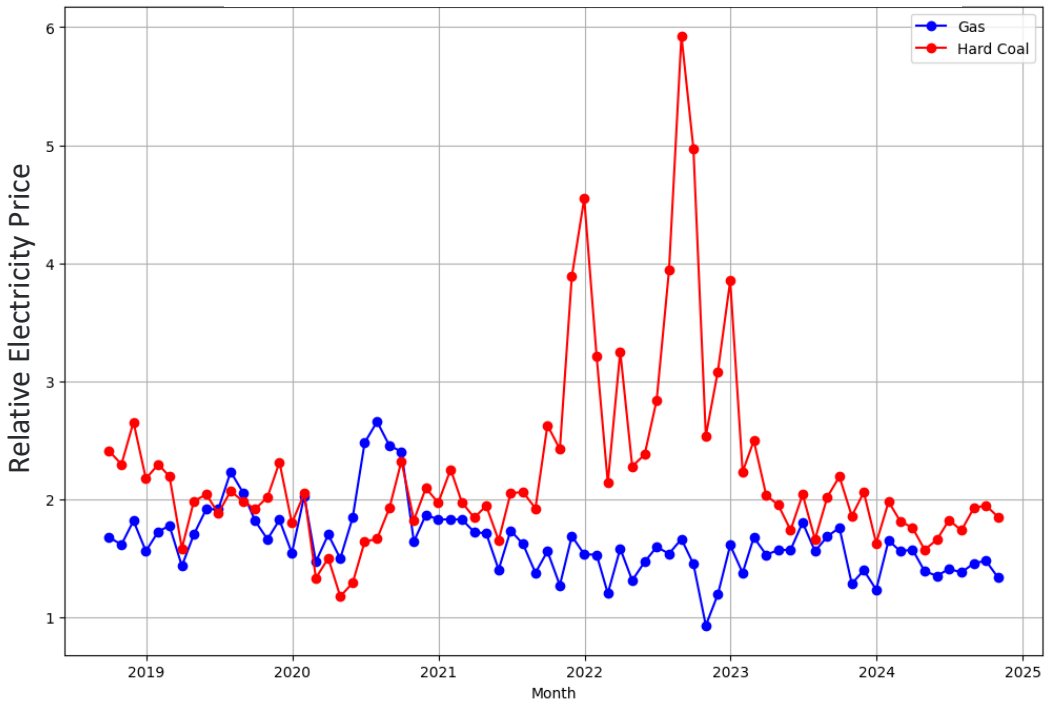
DA_t : Day-Ahead price

Reciprocal:

$$\frac{1}{\eta^{i,F}} \leq \frac{DA_t}{P_f^F + P_t^A \times EF^F}$$

→ **Relative Electricity Price**
(Ratio of electricity price to input costs)

Monthly Average Relative Electricity Price

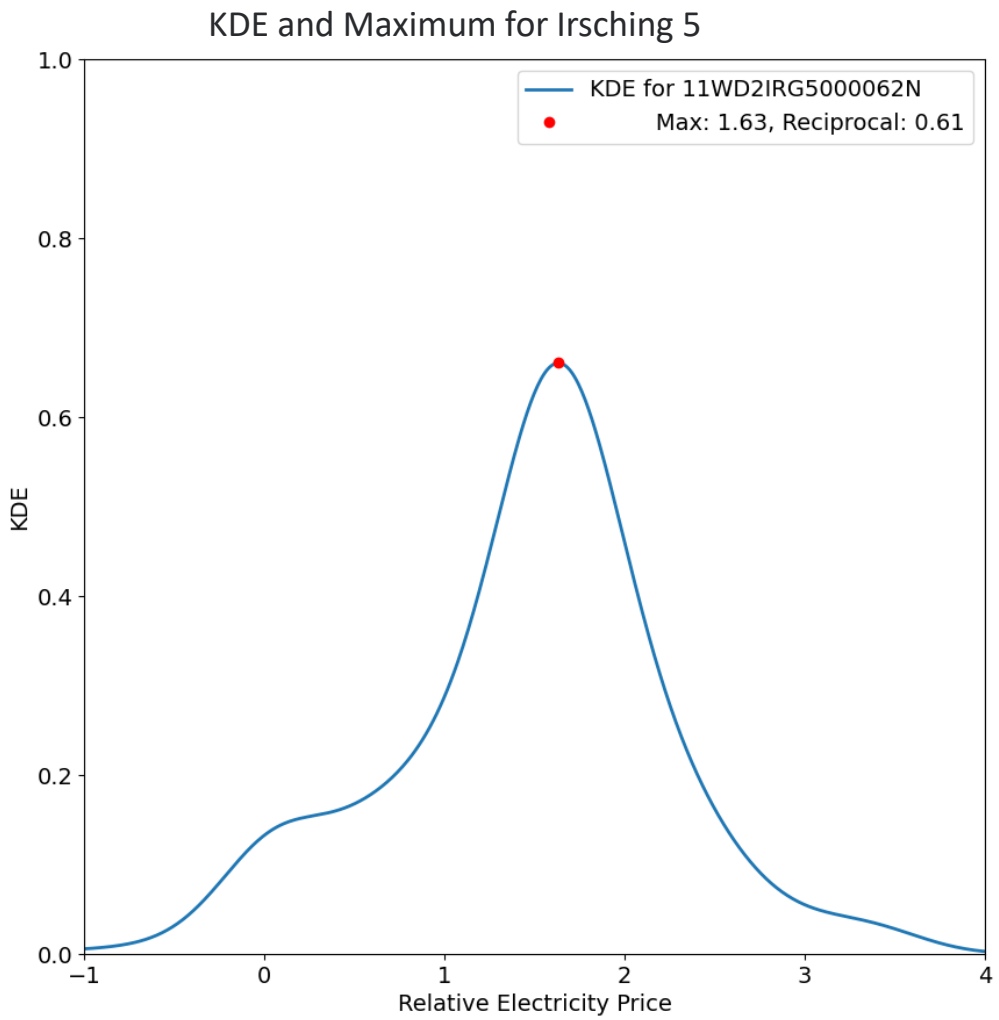


Example: Production as soon as Price = 1.5
→ Efficiency = $\frac{1}{1.5} = 0.67$

Combination: Clustering and Relative Electricity Price

Case studies: parameter estimation - efficiency

- Extract generation data from the cluster „Min. Stable Operation“ and combine it with the relative electricity price from the respective hours
  - 700 observations
- Perform a Kernel Density Estimation of the relatives prices weighted by generation values
  - Bandwidth = Silverman
- **Reciprocal of global maximum as efficiency estimator**
- Assumption: „Min. Stable Operation“ reflects times at which the unit is at the money



Outlook and Discussion

- Extension
  - Consideration of heat production and ancillary services
  - Integration of additional data sources
  - Publication of power plant list

Thank You

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