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QUALITY ANALYSIS OF HEAT METER MEASUREMENTS

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ANALYSED DATA

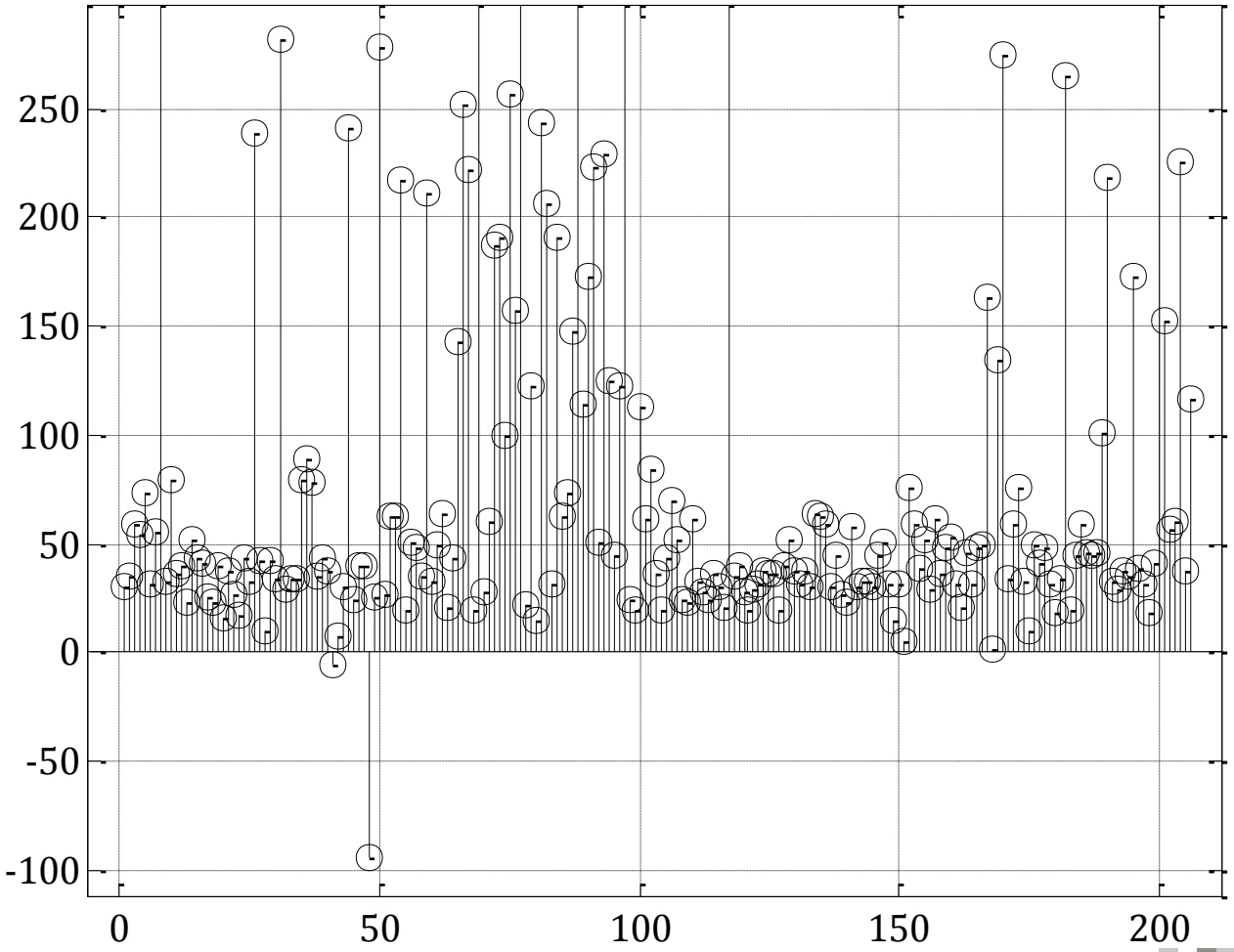
- Time period: 30.4.2014 – 17.5.2015, 9423 hours
- Identified heat meter replacements: 231 customers

METHODS

- Process state -based similarity analysis
- Redundancy monitoring (between measured variables)
  - Non-parametric
- Analytical redundancy (between measured variables)
  - Parametric

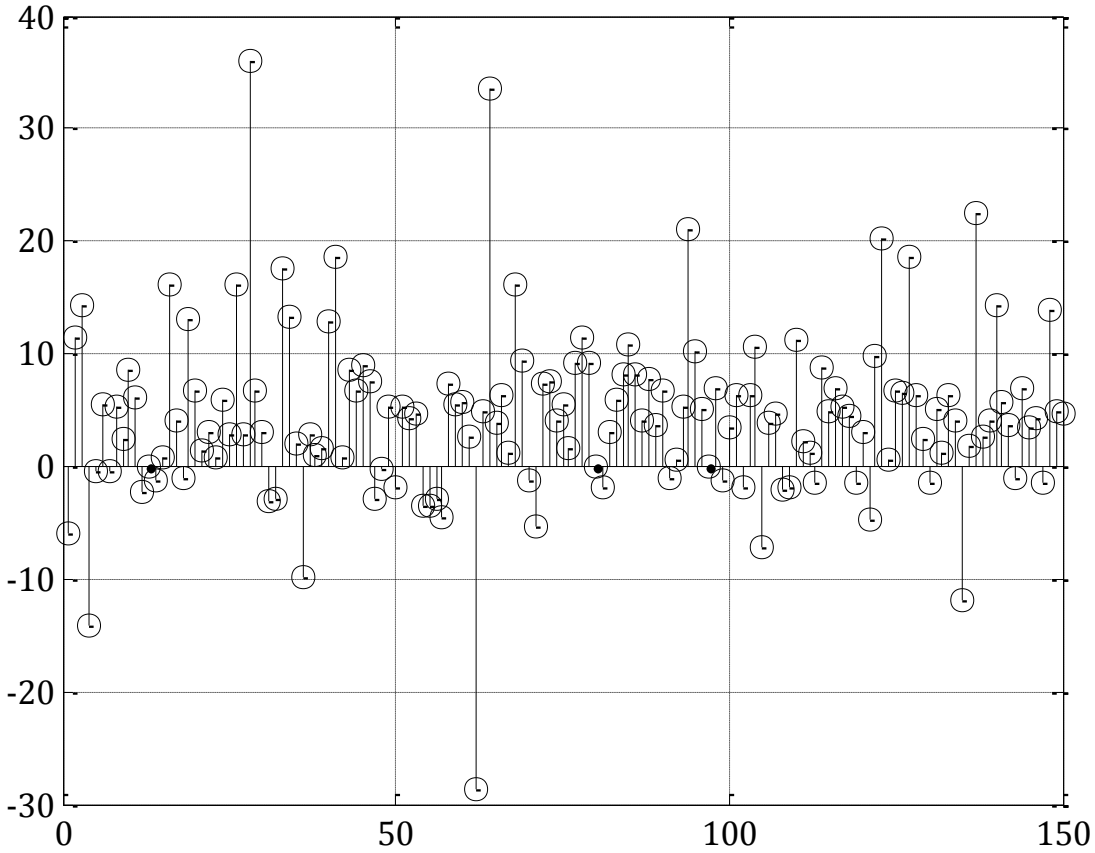
RELATIVE DIFFERENCE, [%]

BETWEEN EM AND ULTRASONIC MEASUREMENTS, OUTDOOR TEMPERATURE AS A CLUSTERING VARIABLE



RELATIVE DIFFERENCE, [%]

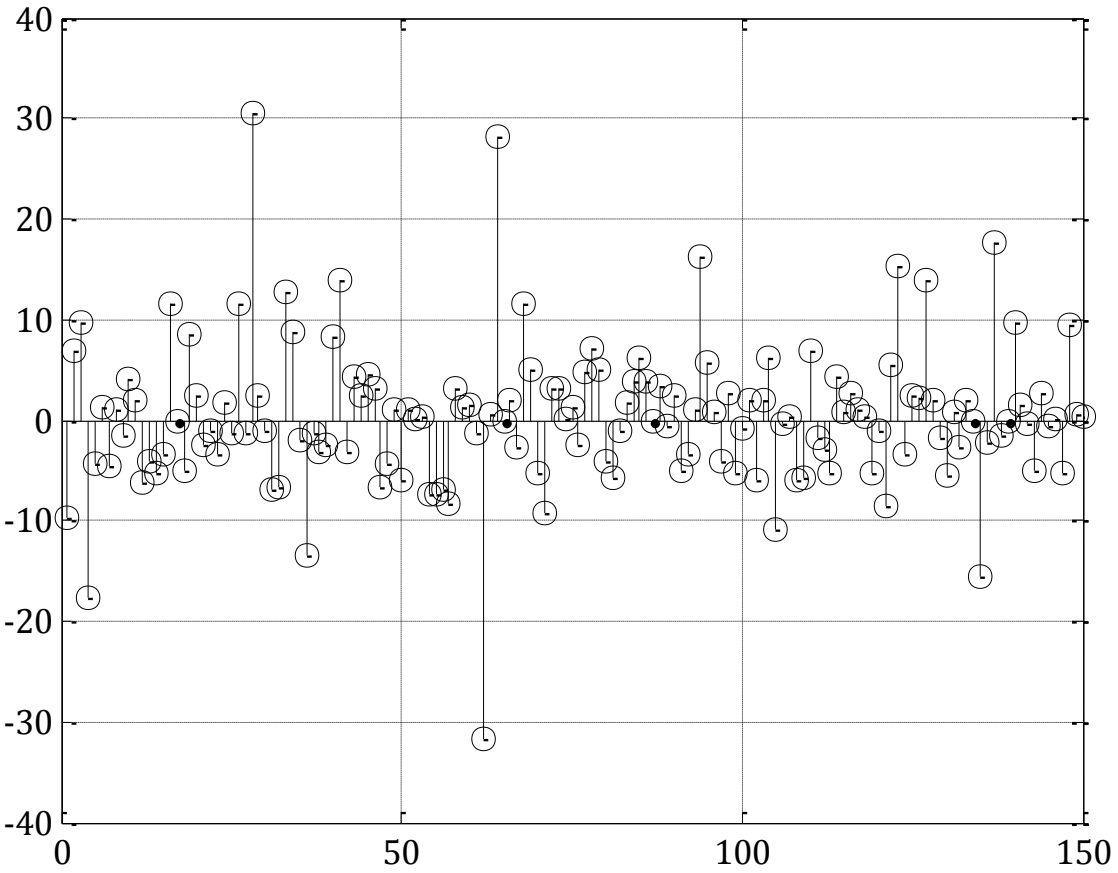
BETWEEN EM AND ULTRASONIC MEASUREMENTS, MULTIPLE CLUSTERING VARIABLES



- Mean value: +4.5%

RELATIVE DIFFERENCE, [%]

BIASED EM AND ACTUAL ULTRASONIC MEASUREMENTS, MULTIPLE CLUSTERING VARIABLES

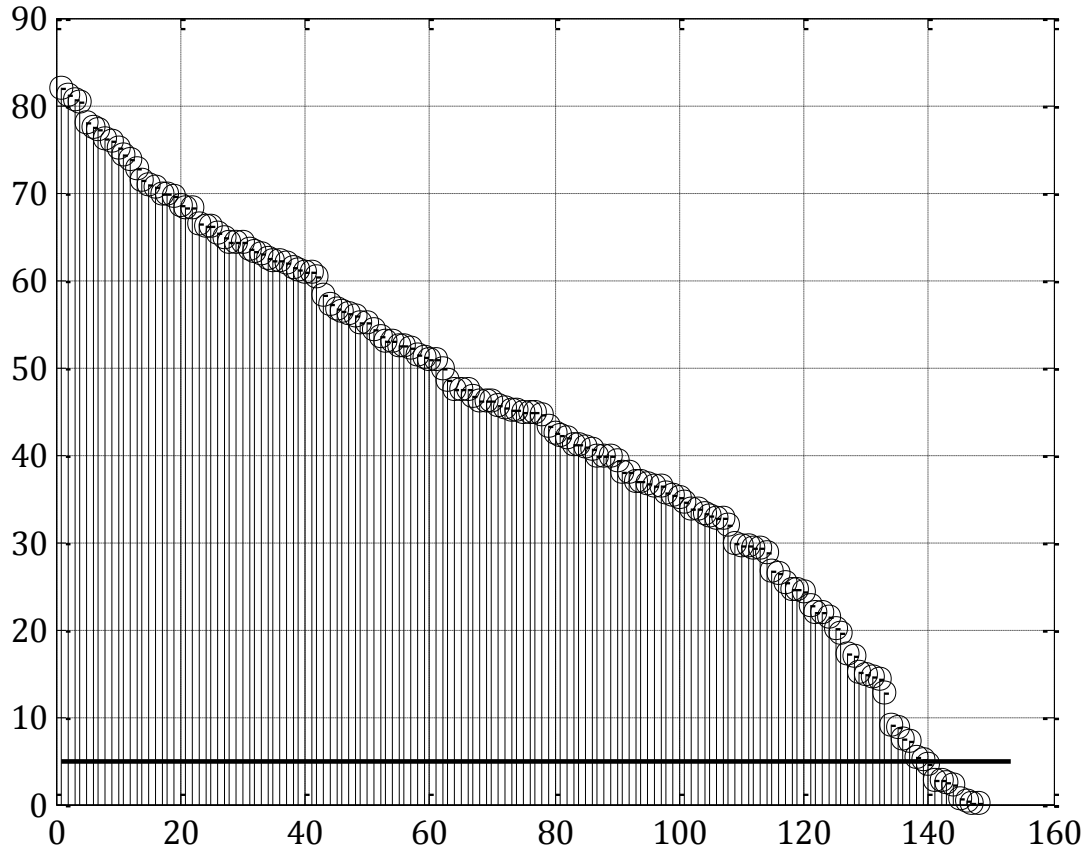


- +4% bias removed (simulated values)

→ Mean value: +0.3%

STATISTICAL DIFFERENCE, [%]

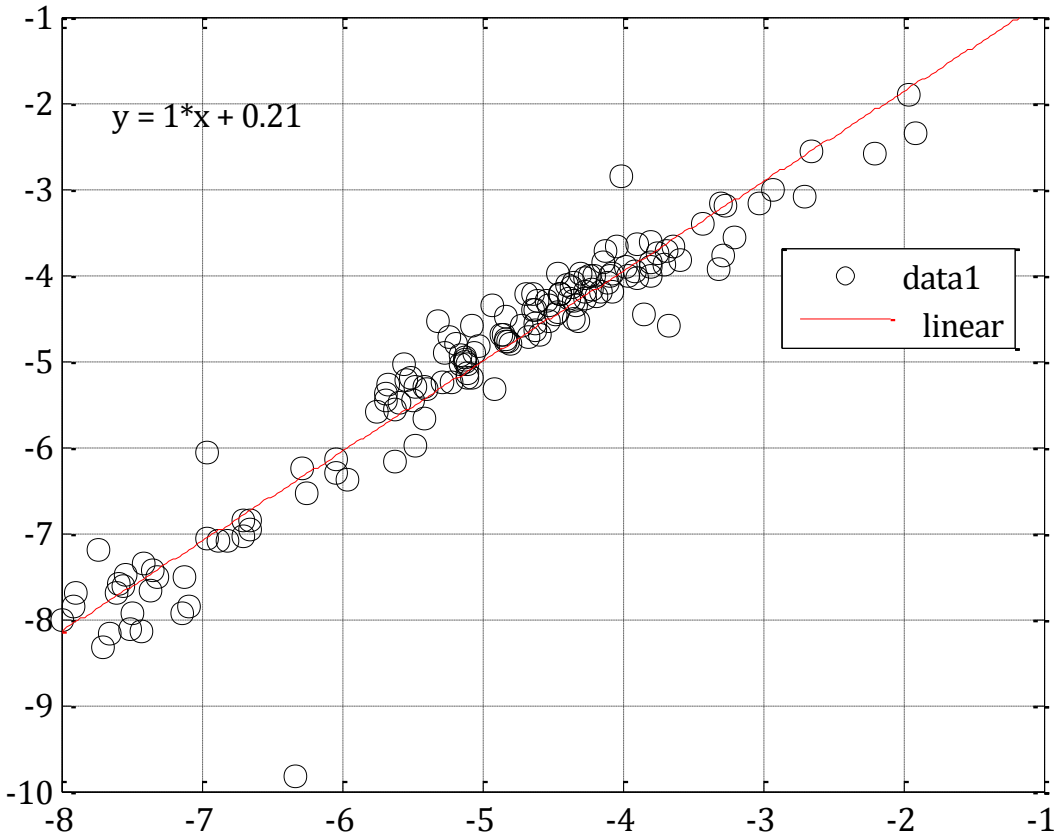
OVERLAPPING RATIO OF CONTINUOUS DISTRIBUTIONS OF ORDERED SIGNALS, THRESHOLD 5%



- 9/148 flow sensors statistically differ
- In these 9 cases, bias (mainly positive) between 6 – 30%
- Estimation of means: by bootstrapping 10000 data points/case
- Sampling uncertainty +-5%

SIMILAR PROCESS UNCERTAINTIES

CORRELATION OF STD'S OF SENSOR READINGS BEFORE AND AFTER THE REPLACEMENT DATE, LOGARITHMIC SCALE, AT CLUSTERED PROCESS STATES



- Indication of similarity between process states before and after the replacements of the heat meters

CONCLUSIONS AND REMARKS

MEASUREMENT UNCERTAINTY OF THE HEAT METERS

- On the average +4.5% positive deviation observed, group of new ultrasonic sensors as a reference (n=148)
- Systematic positive deviation due to?
  - deposit of a material of low conductivity to surface → coating effect
- Analysis method: comparison of the signals before and after heat meter replacement within similar process states by data analysis
- 6% of the sensors' signals above the maximum permissible error: estimated biases of these between 6% and 30% (n=9)