Hello!

DAT300/Chalmers

2019-09-15

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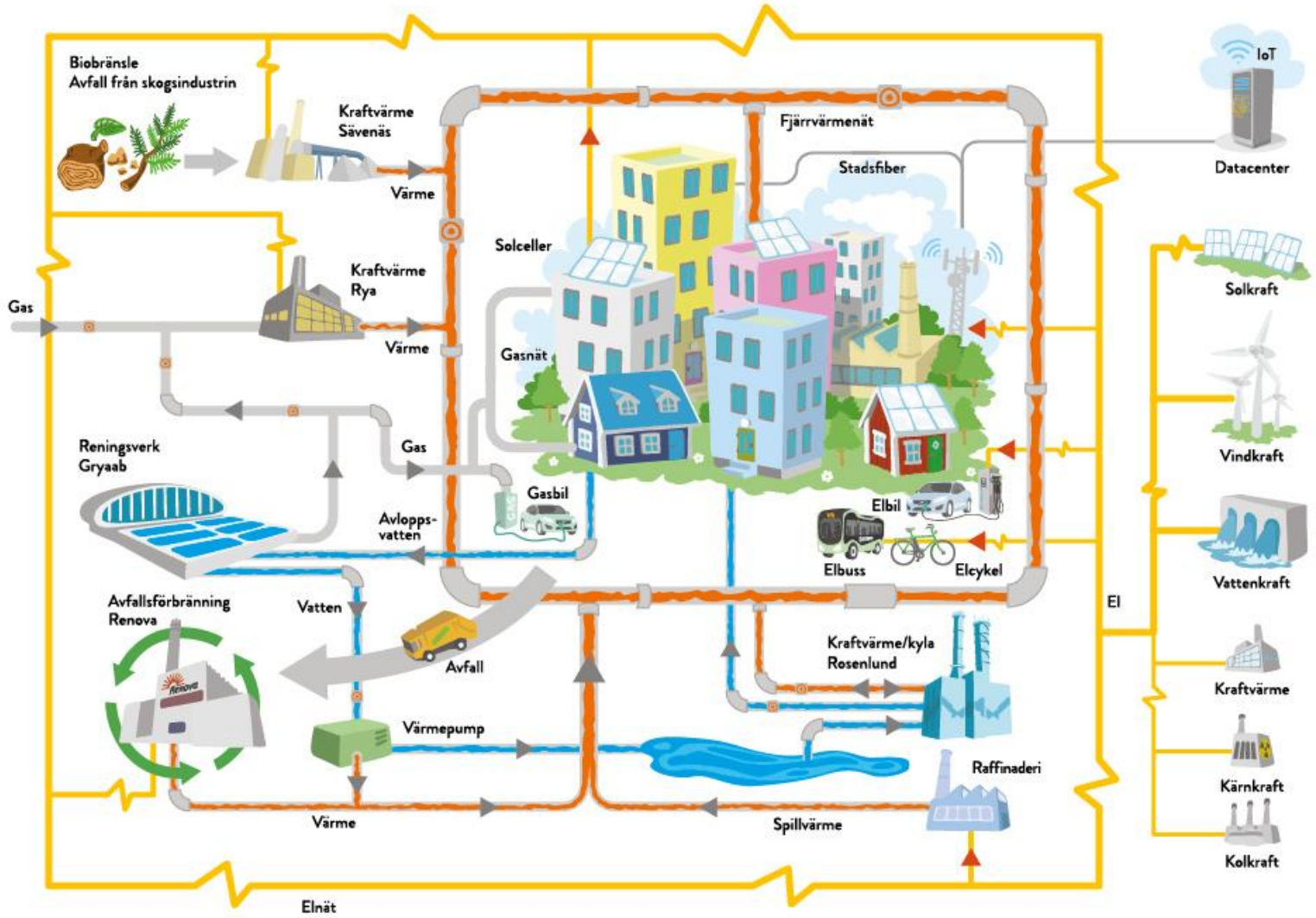
Every day – for a sustainable Gothenburg!

Göteborg Energi

Sustainable energy supply – attractive solutions



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Film – Sustainable collaborations near you

Göteborg Energi

We are a part of the City of Gothenburg

Göteborg Energi

Göteborg Energi

Vision

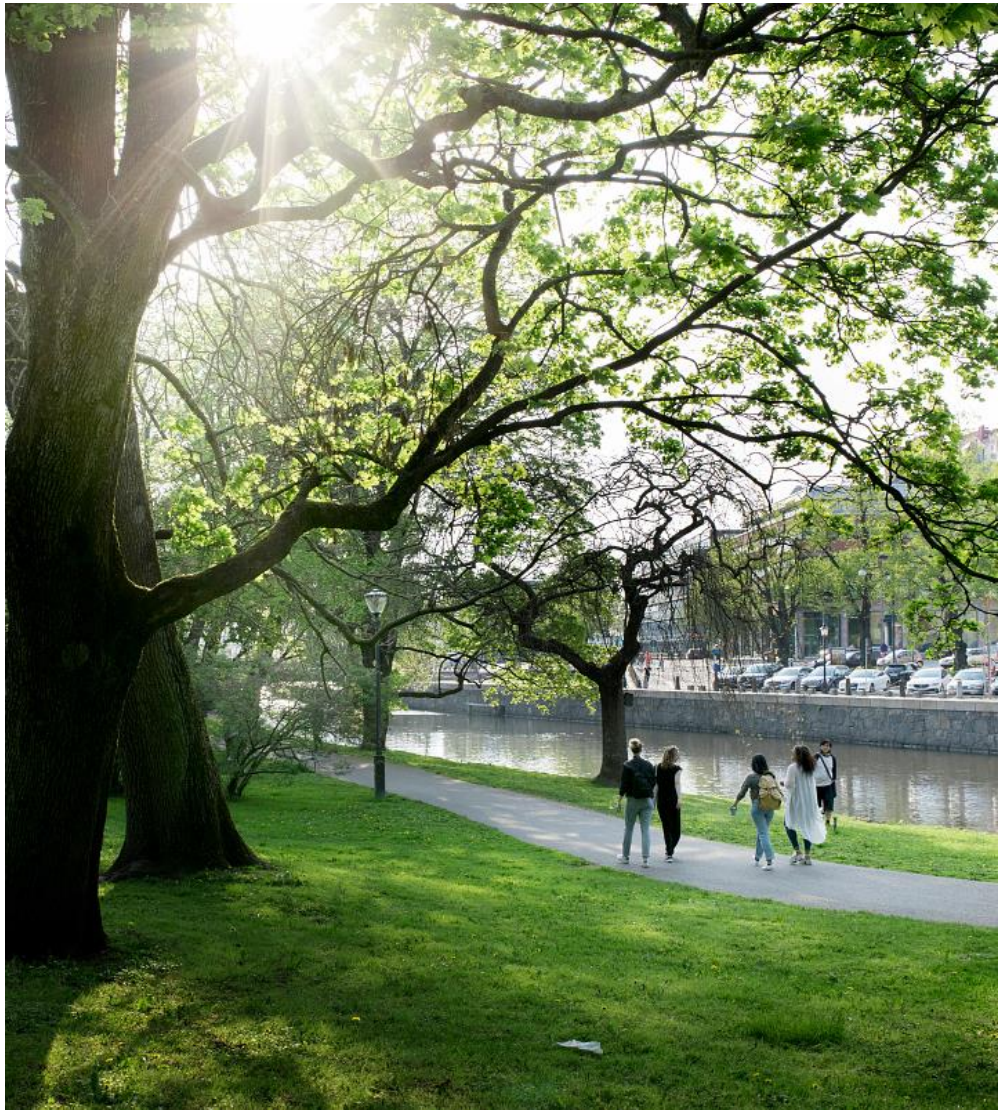
A sustainable society in Gothenburg.

Business idea

We are a leading energy company that develops sustainable and competitive solutions together with our customers and partners.

Core values

Responsibility, Sustainability, Development



Key figures

	2018	2017
No. of employees, average	927	1 002
Operating income, MSEK	659	640
Revenue, MSEK	6 134	5 552
Electricity production, GWh	513	339
Power network(transmission), GWh	4 253	4 340
Sales of district heating, GWh	3 537	3 484
Sales of gas, GWh	945	910

Our profits go back to our “owners” – the citizens of Gothenburg

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Our fantastic
District heating

- Hot water for 550,000 showers
- Warm radiators in 90% of Gothenburg's apartment buildings
- Delivery reliability at 99,95%
- 1,230 km pipes under the city
- Heated mainly by recycled energy
- Best Practice in Europe

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Our stable
Electricity delivery

- Keeps 154 trams, 200,000 hair dryers and 95,000 street lights going
- 7,000 km of power-line through the city
- Delivery reliability at 99,99%
- From sun, wind, water and biofuel to all private customers

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Every day…
we also work with

- District heating
- Electricity distibution and trading
- Gas distribution and trading
- District cooling
- Data networks
- Biogas
- Energy services
- Charging infrastructure
- Urban development

…and many new sustainable solutions for the future!

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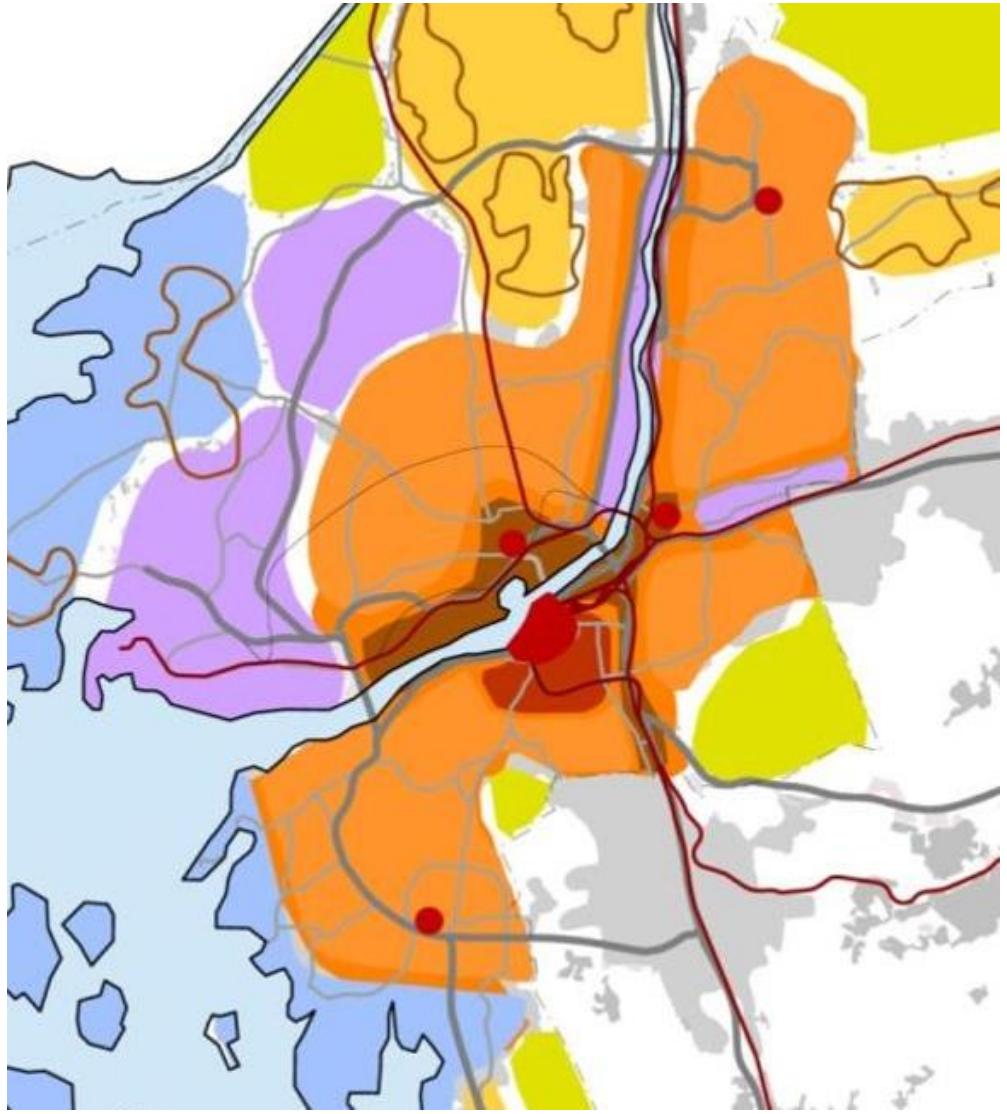
Gothenburg is growing - 2035

150,000
new citizens

70,000–80,000
new households

80,000
new work opportunities



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Together for the climate!

- We take care of our systems
- We contribute to the development of Gothenburg
- We help our customers
- We are a natural partner

Together we achieve a sustainable Gothenburg!

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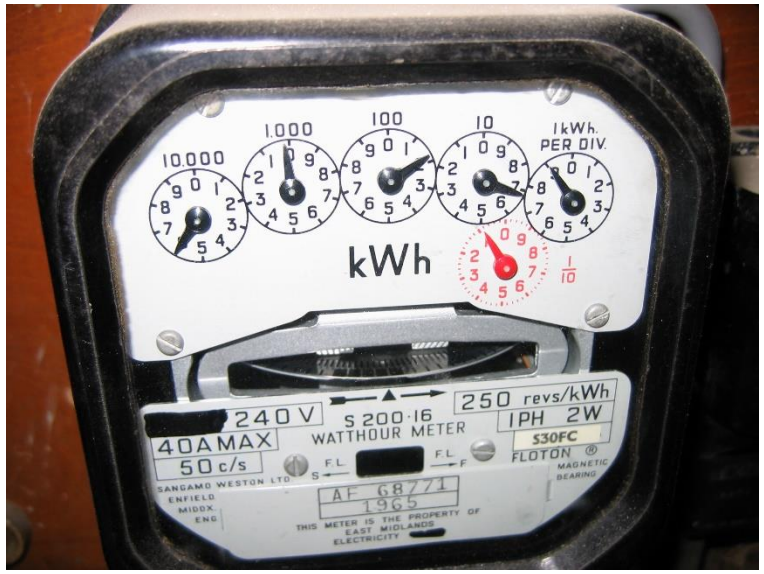
Advanced Metering Infrastructure?

- When is it advanced?
- AMR Automatic Meter Reading
- Log and send events
- Send and receive control messages



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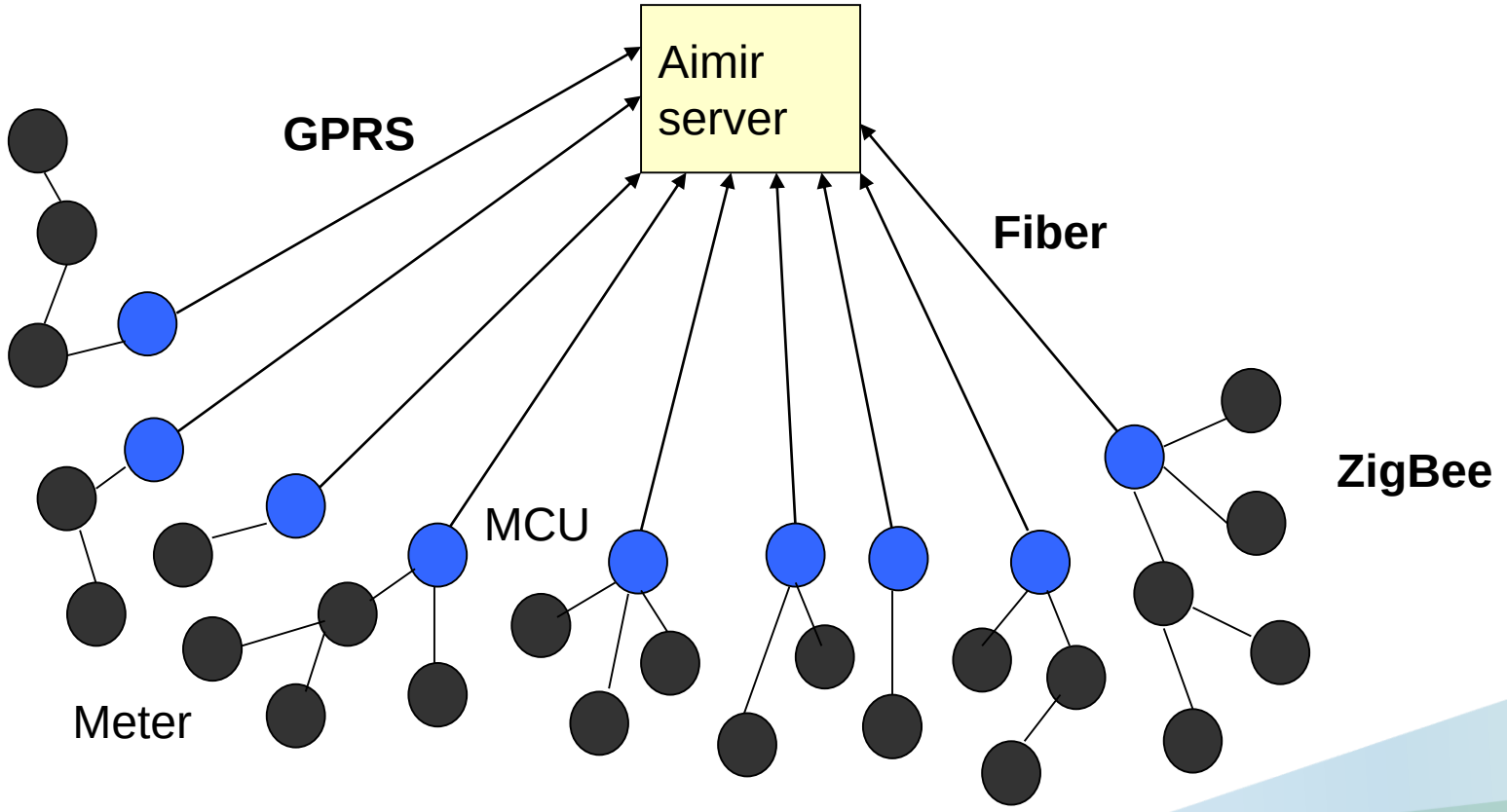
New demands (2025)

- Measure:
  - Production
  - Consumption
  - Active and Reactive
  - Voltage
  - Current
- For every phase
- Every 15 minutes
- Realtime data to the customer

From 1 value per hour
To (4+9+9+9+9) per 15 minutes

AiMiR

- ZigBee based AMI system



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AiMiR facts

- 270 000 electricity meters
- 5000 district heating meters
- ~~3000 water meters~~
- 8000 collector units

- Self-healing radio network
- Redundancy in metering values
- Power quality data
- Power outage events
- Breaker function

Hypothetic time sync implementation

- Central server
  - NTP
- Collector units
  - Resets daily @ 8:00
  - Syncs twice a day against the central server (after reset and 12 hours later)
  - System clock with hardware clock as backup
  - Hardware clock syncs with system clock right after system clock sync
  - The hardware clock can lag many minutes per day
- Meters
  - Receive a broadcast with the current time once every hour
  - And very early during MCU bootup

What could possibly go wrong?

Challenges

- **Big data**
- 270000 x 24 x 4 x 4 energy readings
- 270000 x 24 x 4 x 36 power quality values
- Loads of events
- Topology data
- Noise
- Every day…

Find the information in the data

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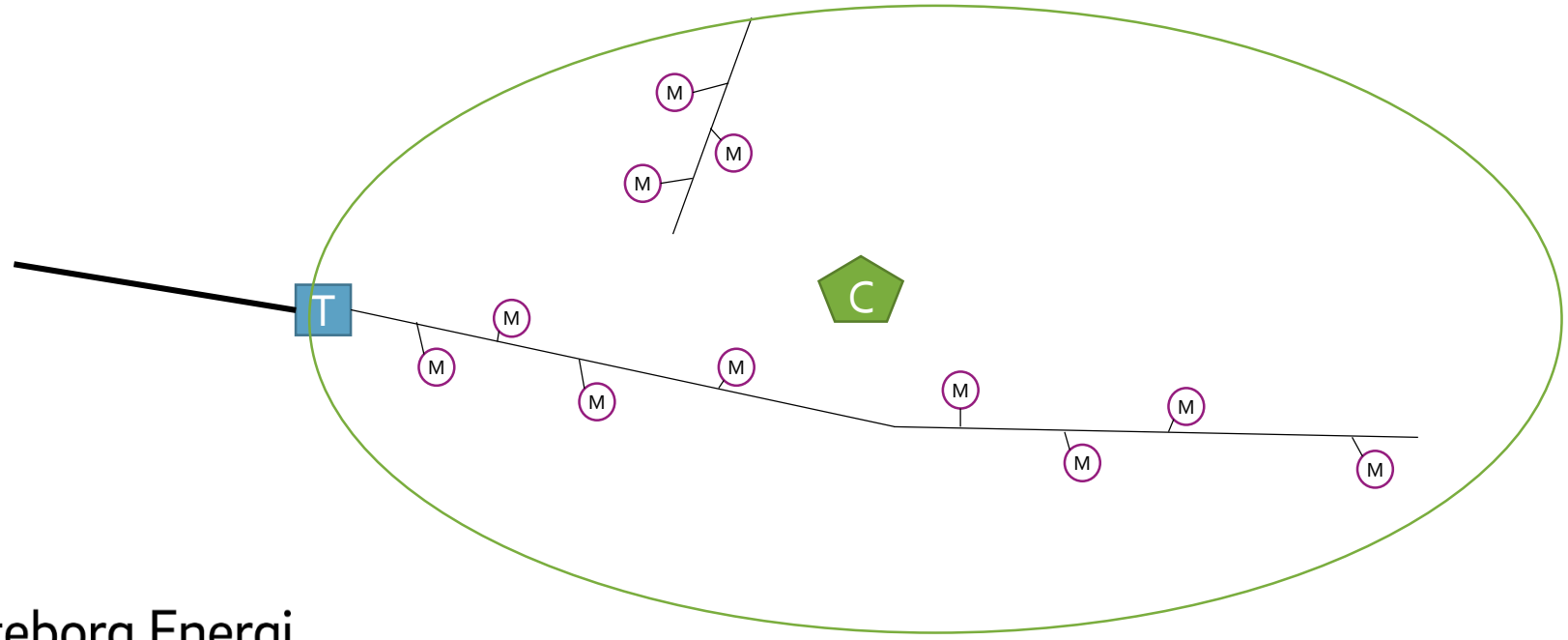
Local processing at concentrators

- Computations are performed at concentrator level
  - Find broken meters
  - Losses
  - Other interesting things
- Discard data afterwards



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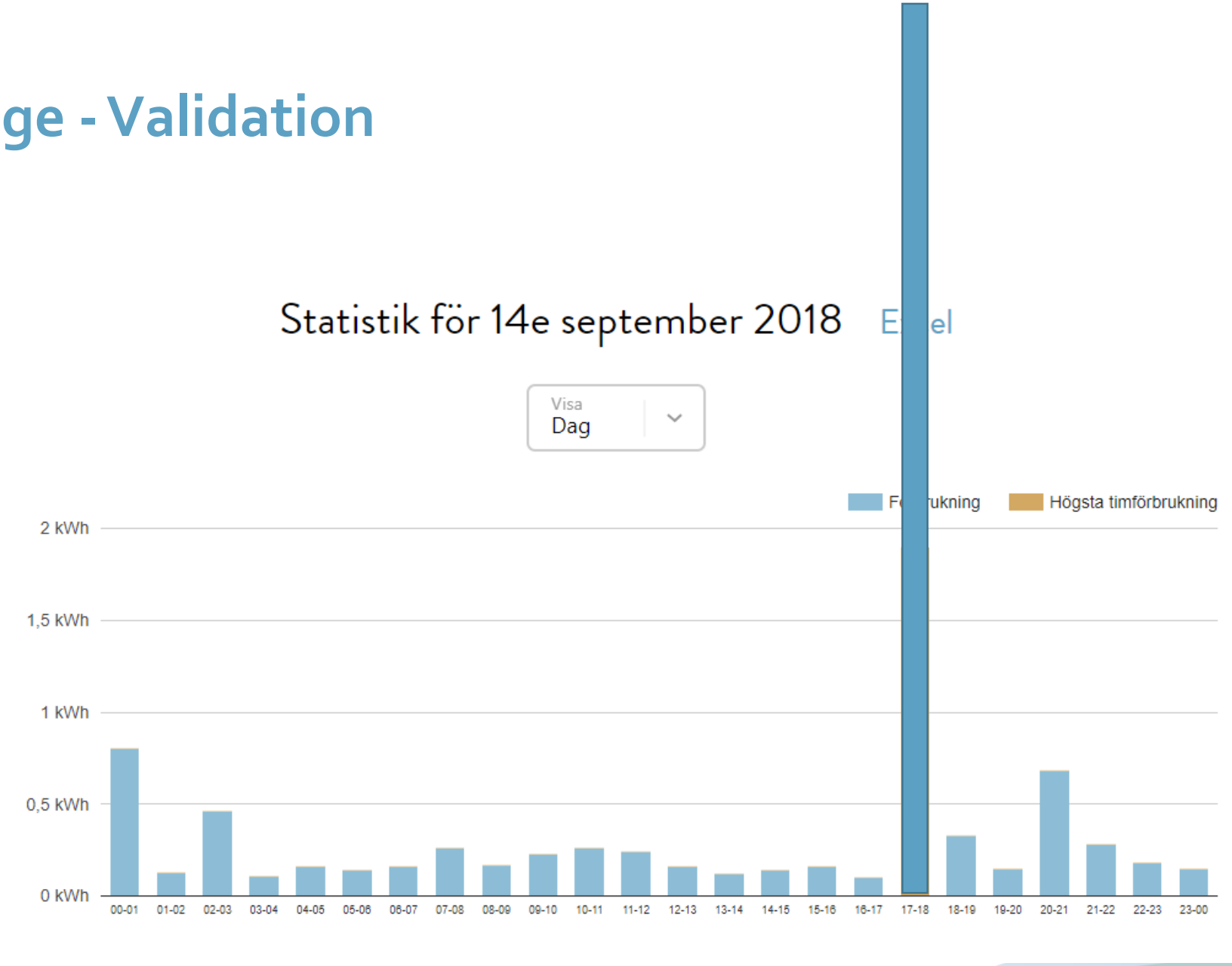
Challenge - Validation



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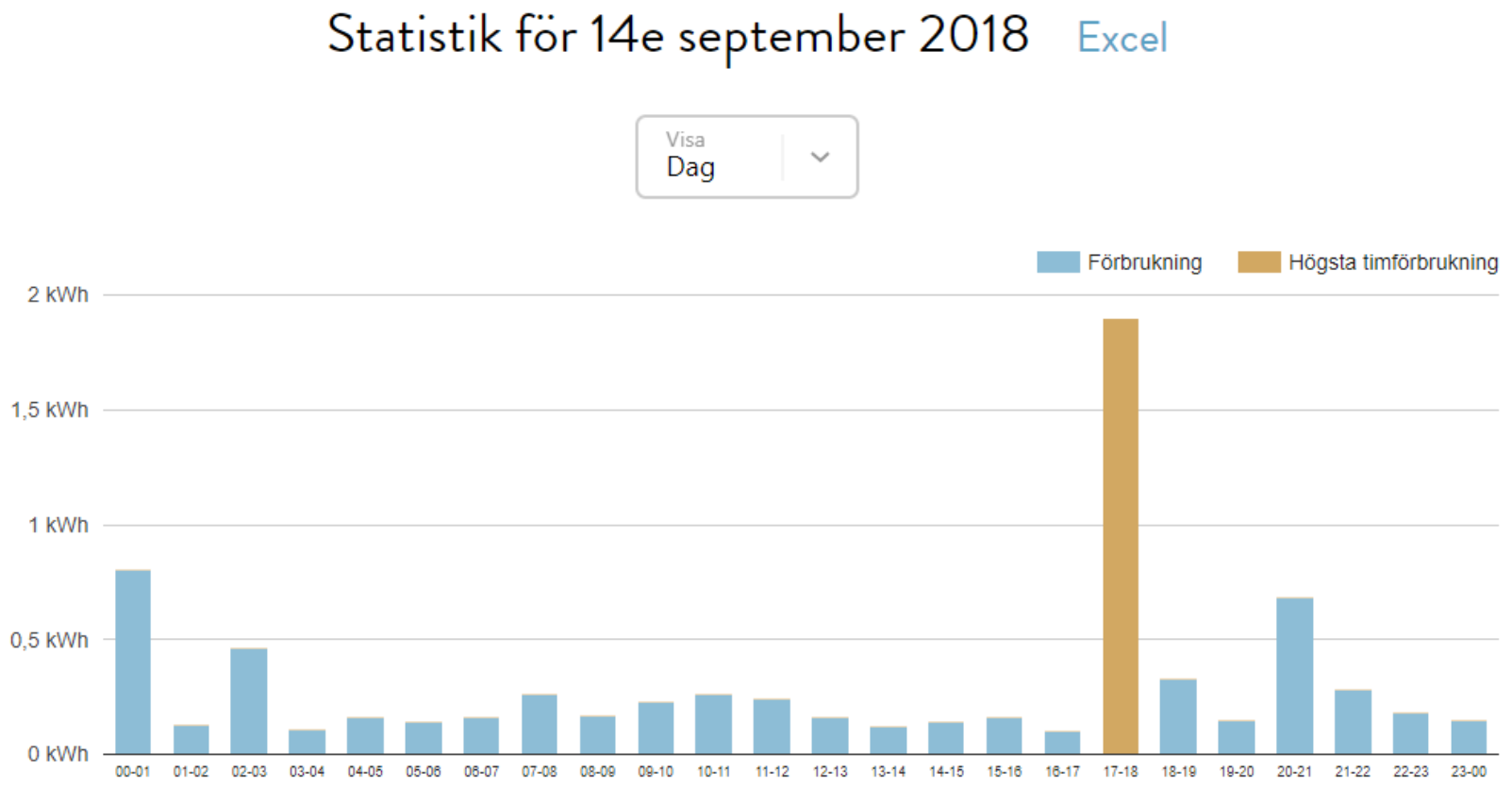
Challenge - Validation



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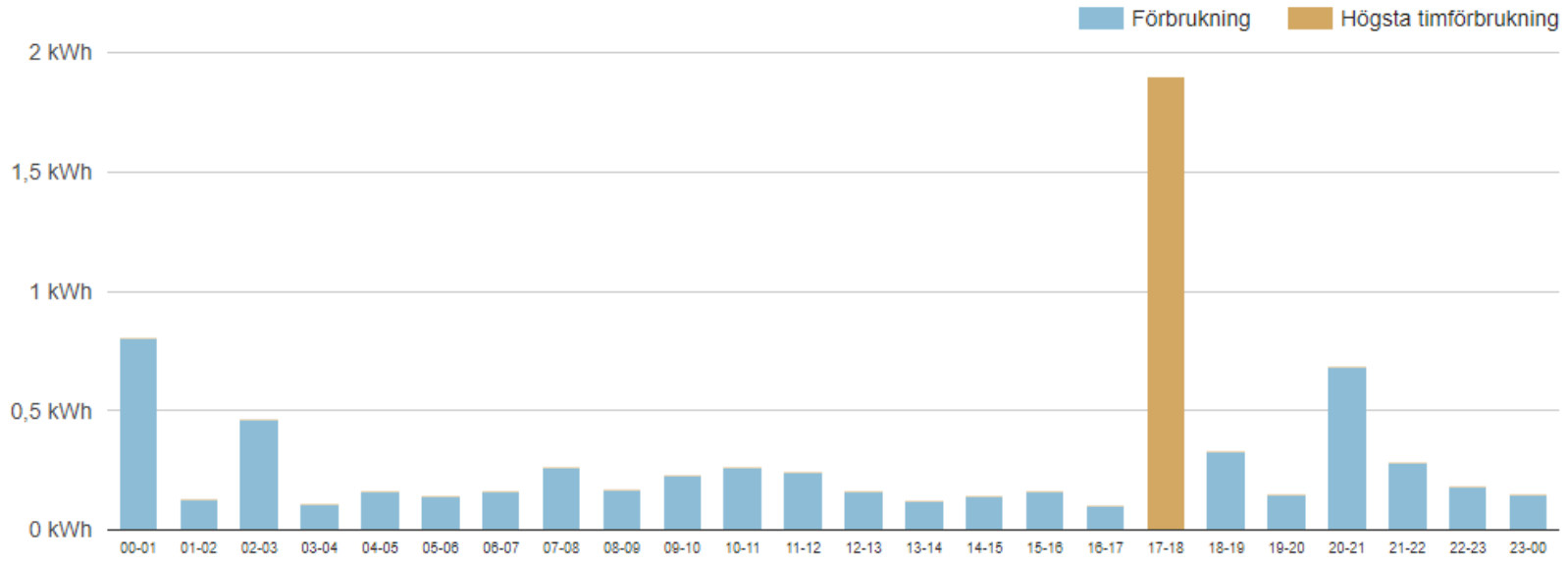
Challenge - Privacy

Higher resolution is coming

Excel



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Challenges

Emergence

Wikipedia:
emergence is the way complex systems and patterns arise out of a multiplicity of relatively simple interactions.

- In other words:
- Put lots of smart meters on a small area and unexpected things might happen.

Thesis opportunity!!

Many challenges – Many possibilities!

Contact me for more information

Questions?

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Thank you!