Lunch lecture PowerWeb
Werner van Westering
Welcome!

- Quick introduction
- Intro Alliander
- Energy transition
- Sample projects
- ‘De Buurtbatterij’
Werner van Westering

Education:
2007 – 2010 Werktuigbouwkunde
2011 – 2013 Master Systems & Control

Work experience:
2013 – 2014 Technical trainee
2014 – now (Senior) data scientist
2015 – now PhD. candidate (DCSC)
Introduction Alliander

Illustrations by Enesis B.V.
<table>
<thead>
<tr>
<th>Aantal klantaansluitingen</th>
<th>Aantal medewerkers</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,7 mln</td>
<td>7.170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uitvalduur elektriciteit</th>
<th>CO₂-uitstoot</th>
</tr>
</thead>
<tbody>
<tr>
<td>19,9 min.</td>
<td>921 kton</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Netto-omzet</th>
<th>Investeringen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,7 € mld</td>
<td>570 € mln</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Balans totaal</th>
<th>Resultaat</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,7 € mld</td>
<td>323 € mln</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Omvang elektriciteitsnetwerk</th>
<th>Omvang gasnetwerk</th>
</tr>
</thead>
<tbody>
<tr>
<td>88.000 km</td>
<td>42.700 km</td>
</tr>
</tbody>
</table>

1 Betreft Liander
Modeling the energy transition
Gelijktemiddich van vermogensvraag:

- Gas: 1.500 m³ (= 14.600 kWh)
- Electricity: 3.300 kWh
- Pmax: 1,5 kW
- PV: 8,9 kW
- Heat exchanger: 2 kW
- E-boiler: 2 kW
- Heat pump: 1,6 kW
How often will this happen?

- Research question: What are the consequences of the energy transition?
- Approach: Linear load flow simulation with profiles and scenarios.
- Challenges: How do you simulate 20 million electricity cables in a short time? How do you deal with 100,000+ data errors?

Overloaded transformers per postal code area, 2050
ANDES technology adoption model

**Input:** 150 demographical aspects

- Socio-demographic, e.g.:
  - income
  - education
  - Life phase

- House properties, e.g.:
  - Type of house
  - Value house
  - Owned/rented

- Financial info, e.g.:
  - Savings
  - insurance
  - Other financial info

- Vehicle information, e.g.:
  - Number owned
  - Segment
  - Age

- Media, e.g.:
  - Internet behaviour
  - Magazines
  - TV channel preference

- Buying habits, e.g.:
  - Clothing segment
  - Holidays
  - Charity

- Etcetera

**Analysis:** Probability of adoption is determined

- Multiple regression techniques were studied.

**Output:** The adoption is predicted at zip-code level per technology up to 2050

- The result is an absolute number of EVs, HPs, and PV systems per zip code for every year.

Regression analysis

Local adoption for each household...

...in the Liander Service Area
New insights warrant new decisions

Dilemma I: Is everybody equal or are some more equal than others?

Dilemma II: Lower CO2 emissions or more reliability?
Other projects within Alliander
Prediction of energy profiles
Condition models MV/LV (Asset Management)

- Joint replacement MV
- Investment portfolio AM
- Outage analysis and Smart Cable Guard placement SCG

- Outages (KLAK/Nestor)
- Assets (BAR/NOR)
- Environmental variables
- Dynamic variabelen
- 22 data sources

- Monthly retraining
AI is being applied for several years now within Alliander

**AI Applications**

**Risk models**
Excavation damage model calculates risk score for KLIC reports.

**Consumption models**
Machine learning methods are used to cluster and anonymize 50,000 smart meter energy profiles. (Project PULSE)

**Decision models**
IntelEvent shows the outage cable and calculates a reconfiguration.

**Innovation pilots**

**Image recognition**
Customer installations are classified using photos from engineers and customers.

**Natural language processing**
Alliander has many years of (often hand-written) legacy documentation which contains valuable information.

**Portfolio planning**
Agent based models are used to train a decision AI which determines the optimal investment strategy.
Other projects within Alliander

- Load flow engine development
- Automization
  - Grid design
  - Regional Energy Strategies (RES)
  - Network capacity checks
- Optimization
  - Grid topology
  - Outage reduction
  - Network losses minimization
  - Sensor deployment
  - Step changing transformers
- Network capacity extension
  - Large scale load flow
  - Substation transformer control
  - Curtailment
- Machine learning
  - Network portfolio generation
  - Nonlinear load flow
  - Fraud detection
  - Outage prediction
  - Smart meter deployment
Sample project: Community battery ‘De Buurtbatterij’
Je stroom bewaren in de buurtbatterij

Elektriciteitsopslag
Wind- en zonne-energie veroorzaakten dit jaar stroomoverschotten. In Rijsenhout experimenteren ze met opslaan in de buurt.

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Project description Buurtbatterij

Combining social value areas

Customer
Storage of generated renewable energy

DSO
Solution for local PQ problems and congestion

Market parties
Flexible capacity for energy markets

Buurtbatterij
Location

Rijsenhout
Realization (detailed layout of the plot)
Realization (1)
Realization (2)
Measurement hardware

LV-cable and transformer

Measurement LV-case
- Wago devices
- Wireless connection (4G)
- VPN-tunnel
- Rogowski-coils
- LV-cable Buurtbatterij

Measurement MSR
- Wago devices
- Wireless connection (4G)
- VPN-tunnel
- Rogowski-coils
- Secondary side of transformer
IT architecture

IT/OT

Diagram showing IT and OT components and their interactions, including service integration, web services, data processing, and integration with various systems such as SCADA, RTUs, and Modbus.
Charge path optimizer

- Customer load prediction
- Network diagnosis
- Charge path optimization
Control Buurtbatterij
Control Buurtbatterij

Network load and voltages at 8:00

Battery charge path and charge level at 8:00
Low voltage power grid congestion reduction using a community battery: Design principles, control and experimental validation

Werner van Westering \textsuperscript{a, b}, Hans Hellendoorn \textsuperscript{a}
Traineeship Alliander

- [https://www.werkenbijalliander.com/traineeships](https://www.werkenbijalliander.com/traineeships)

1st year
- Assignment 1
- Assignment 2
- Assignment 3

2nd year
- Assignment 4

Learning and development process

Technical education

Education: Skills / Subject Content
Questions? Werner.van.Westering@alliander.com

Soon: Alliander.nl/research