sense

AI at the Grid Edge: How utilities are leveraging machine learning

Agenda

1. What is ‘AI at the grid-edge?’
2. AI isn’t a new concept
3. Netherlands 2027
4. How Network Operators benefit
5. Why High-resolution data?
6. Case studies

What is ‘AI at the Grid-Edge’?

NextGen Meter

High resolution data (>15kHz)
Edge computing
Real-time networking

Interaction between home and grid
Localised, real-time load flexibility
Service upgrade avoidance
Planning/forecasting
Outage management
Customer engagement

Detects Grid Issues

Safety
Resilience
Capacity

Detects Behind the Meter

Demand flexibility & efficiency
Electrification
Health & safety

Proven AI, ready to scale

Machine Learning (ML) & AI

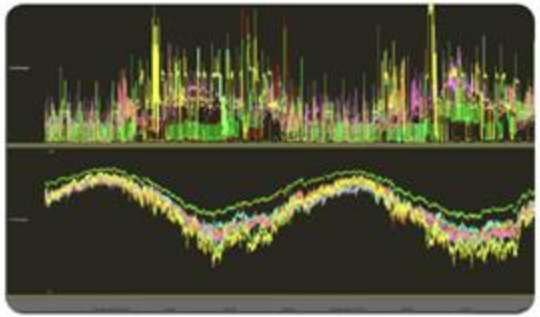
Sense uses ML and AI to identify the unique signature of devices in the home, determine its state and energy usage, track performance and early signs of failure signals.

Sense AI data is essential for OT systems such as ADMS, SCADA and DERMS filling orchestration visibility gaps.

700 million hours of high-resolution data across 4 million devices.

50 million x

Existing AMI Data



Grid transformation worldwide

NextGen becoming default

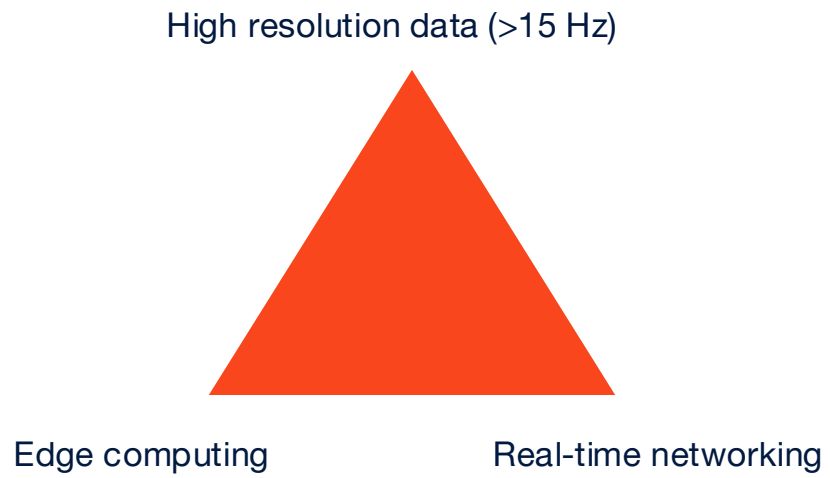
- Already being deployed in the US, National Grid is the first ever utility to scale rollouts of real-time distributed grid intelligence. Every new roll-out will have Sense
- Australia: All major Australian meter manufacturers are developing NextGen meters that can incorporate AI
- Japan: Two major smart meter vendors are currently developing NextGen meters running Sense.

In 2027, the Netherlands will deploy AI enabled NextGen Meters

A critical enabler for the energy transition

These meters are capable of running Sense AI - unlocking intelligence across the Netherlands:

- Real-time visibility into household demand, EVs, solar and other DERs
- Grid-facing capability - insight even without consumer engagement
- Enhanced P1 port - improved data access and flexibility for consumers



What Dutch DNOs can unlock with Sense + NextGen Meter

Grid Intelligence

Detect faults and grid issues before they escalate.
AI spots anomalies in high-resolution waveform data, revealing issues on the primary and secondary sides of the network in real time.

- **Fault and Grid issues**
  - **Line-to-line faults**
  - **In-series high impedance**
  - **Line-to-ground faults**
  - **Arching or partial faults**
- **Power Quality Monitoring**
- **Transformer Intelligence**

Home Intelligence

Appliance-level detection from waveform data
AI locks onto unique high-resolution electrical signatures to identify EVs, heat pumps, and other loads, enabling visibility into usage patterns and early signs of appliance faults.
For use by both grid operator and homeowner.

- **EV, Heat Pump, Solar Detection**
- **Load Shifting**
- **Appliance Fault Detection**

Why High-Resolution Data?

Why High-resolution data matters

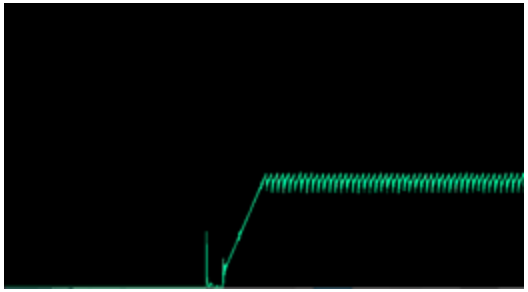
To control the grid, you first need to see it.

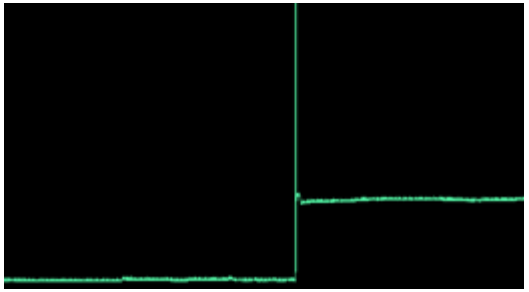
Timescale & granularity are necessary in order to differentiate between devices with similar waveform patterns

Can you tell which one is an EV and which one is an AC?

Low resolution 1-min data

High frequency data





Grid Fault Detection Use Cases

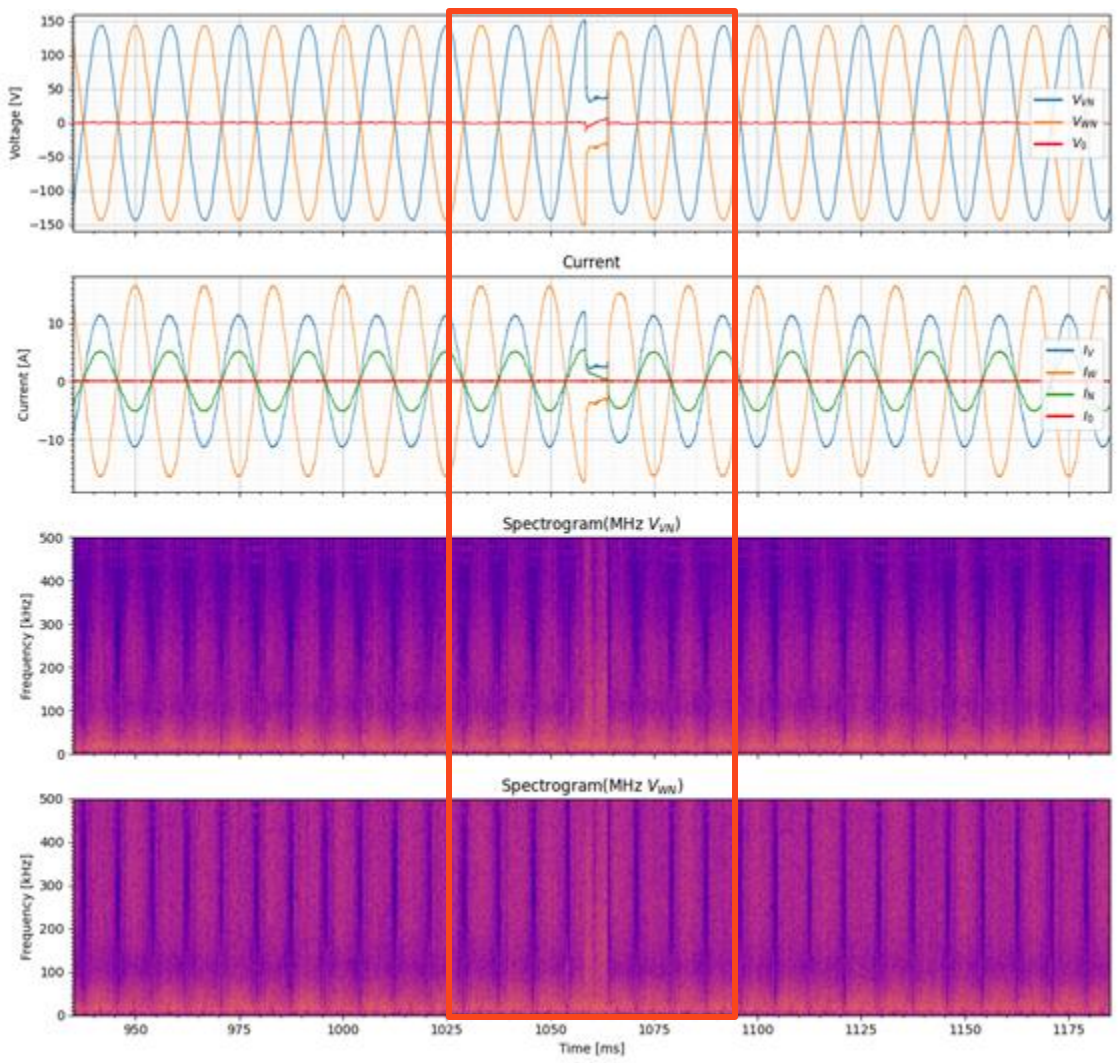
Japan - Split phase, Line-to-Line Fault

Secondary Side Fault

Example is of a salt-water induced secondary-side line to line fault

See how the voltage disturbance is visible in the high frequency spectrograms

Helps identification of a developing fault before it becomes an issue.



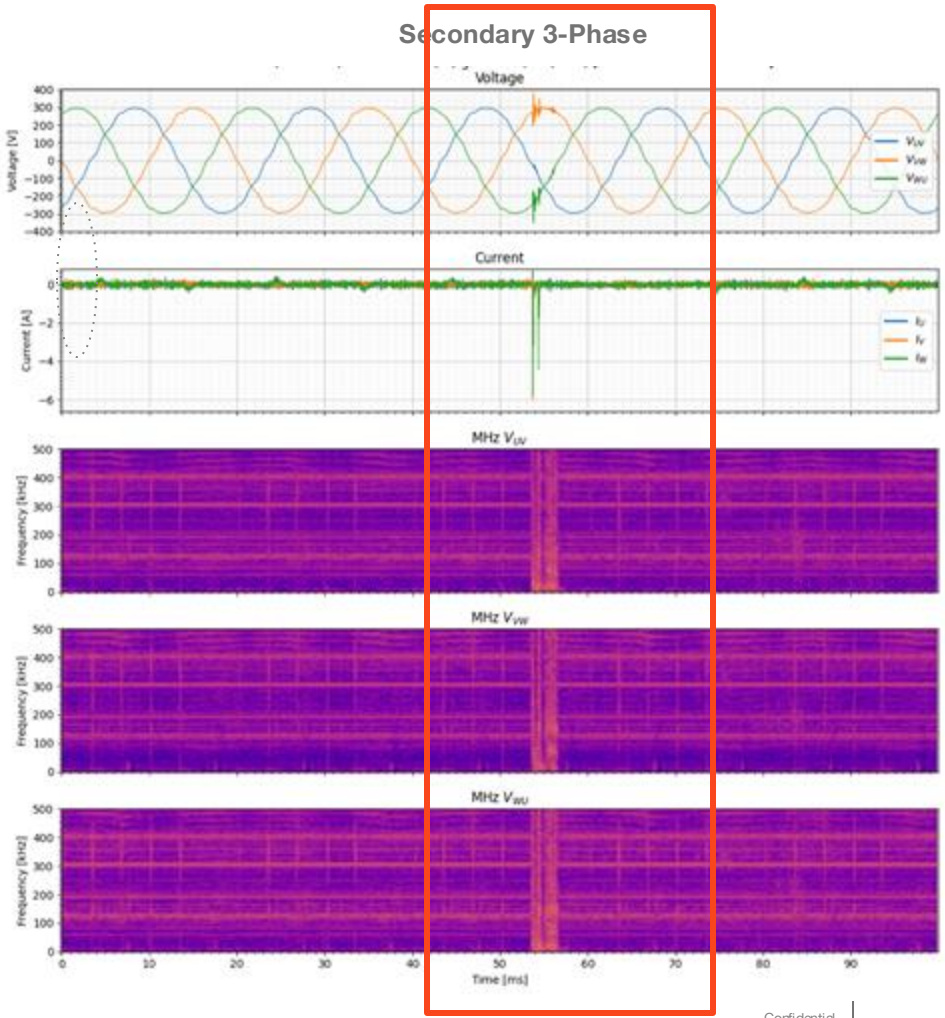
Japan - Split phase, Direct Ground Fault (W)

Primary Side Fault

Fault on Line **W** affects V_{WU} and V_{VW} but not V_{UV}

Can detect the fault regardless of whether it happens upstream (generator side) or downstream (load side) of the meter.

Even though it's not obvious in the low-frequency voltage, the burst of wideband noise during the fault is clear.



In-Series High Impedance Fault

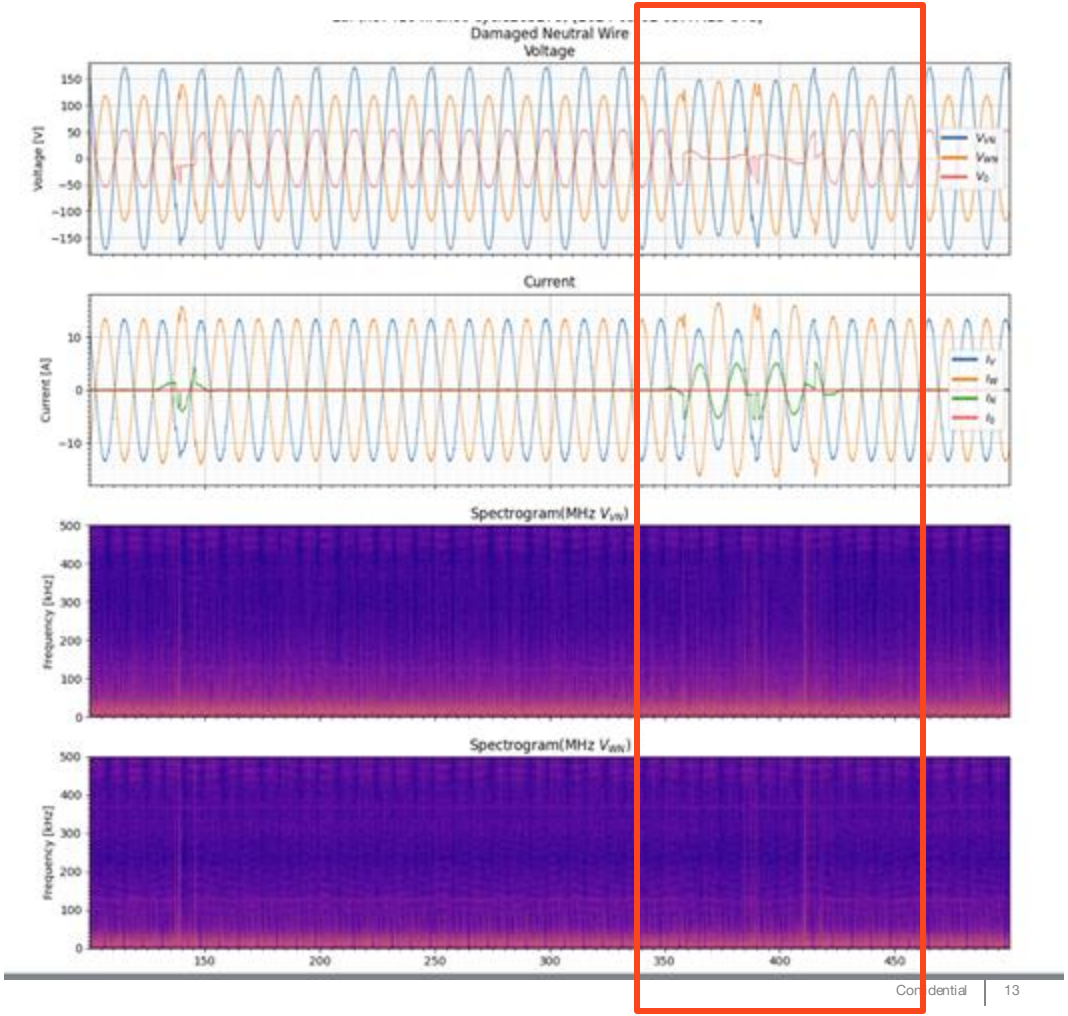
Japan - split-phase

High impedance on the neutral line shifts the reference point

Causes uneven hot-to-neutral voltages, even if hot-to-hot remain stable

Leads to under or over voltage conditions

Often invisible to traditional monitoring but detectable via Sense



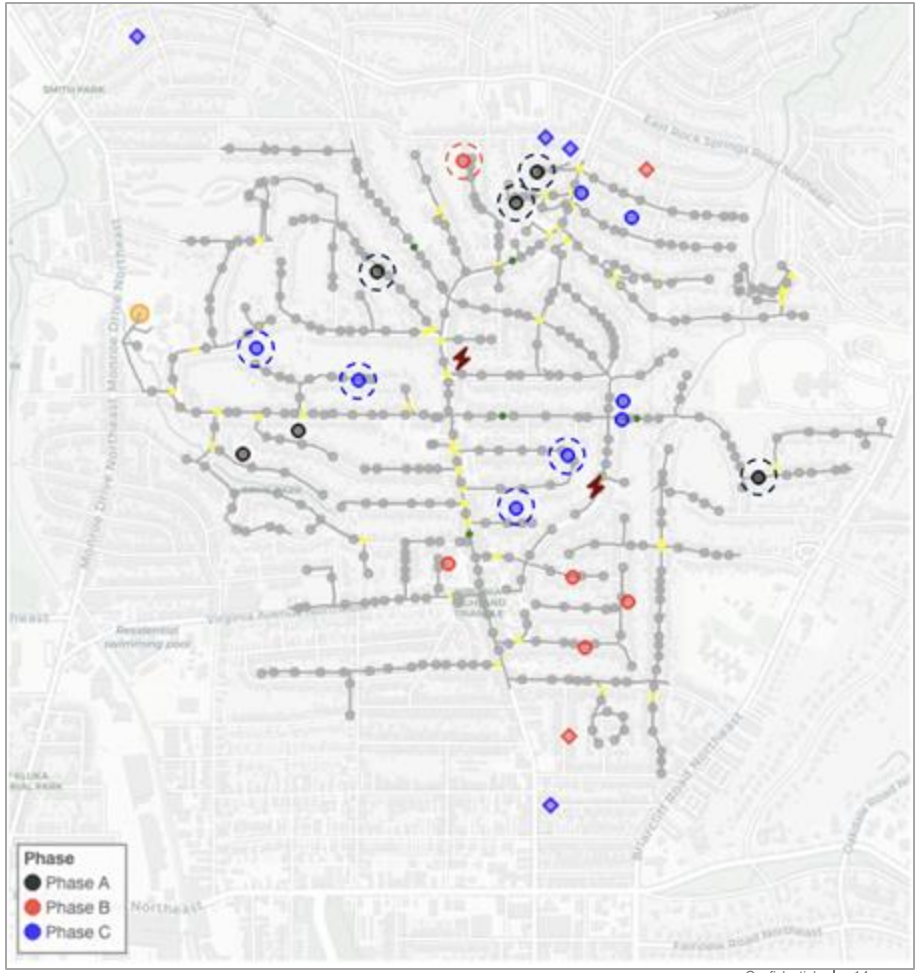
Georgia Power, Line-to-Ground Fault

AI detects and locates vegetation related faults

On January 10, 2025, a winter storm hit the Atlanta metropolitan area causing faults and power outages.

A cluster of anomalies was found and confirmed to be a fault on **Phase C** on the network

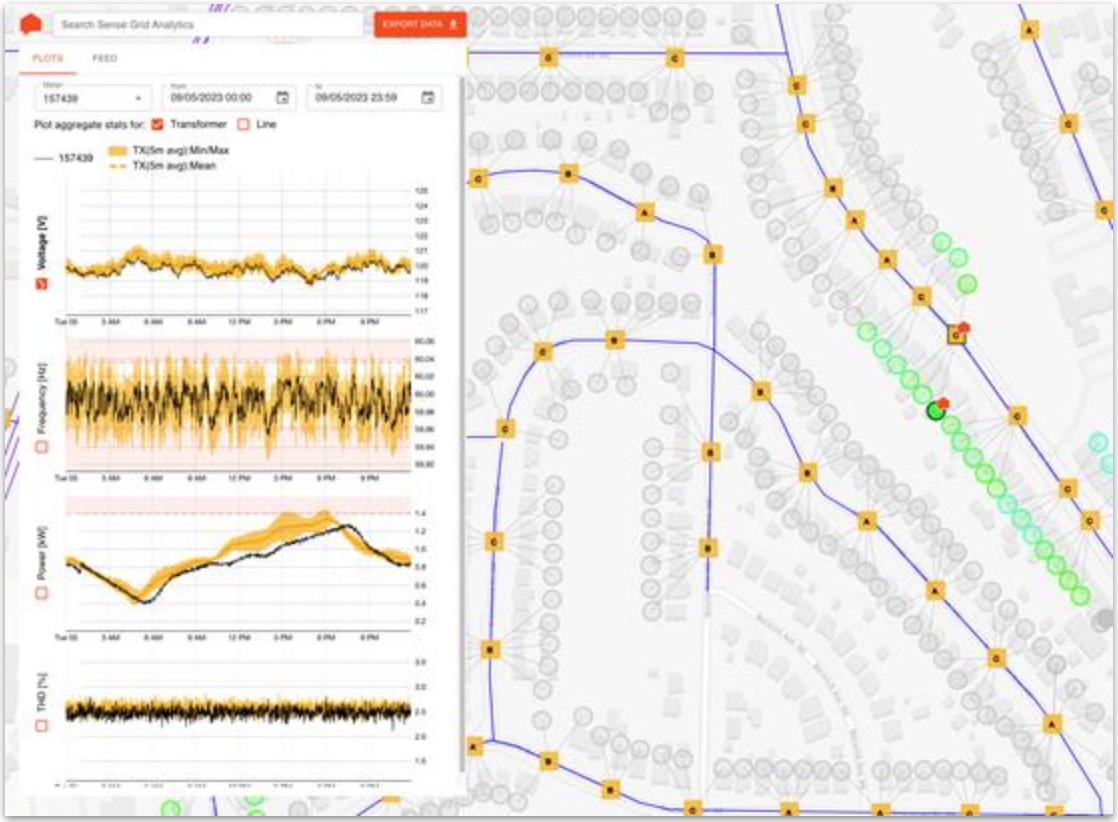
Sense can not only detect vegetation-induced faults as they become critical, but can also locate them - essential for storm incident prioritisation and response.



Power Quality Awareness

Sense continuously monitors meter power quality and voltage data throughout the distribution network

Sense is developing and testing detection capabilities for two types of power quality events: voltage flicker and harmonic distortion.



Overloaded Transformer

Sense identifies voltage anomalies that signal transformer overloading

Transformer level visibility enables better prioritisation of inspection, reinforcement, and monitoring before faults occur.

When you're managing grid load, it's not just about how much demand there is.
It's about what's causing it.

Visibility into Load Behind the Meter

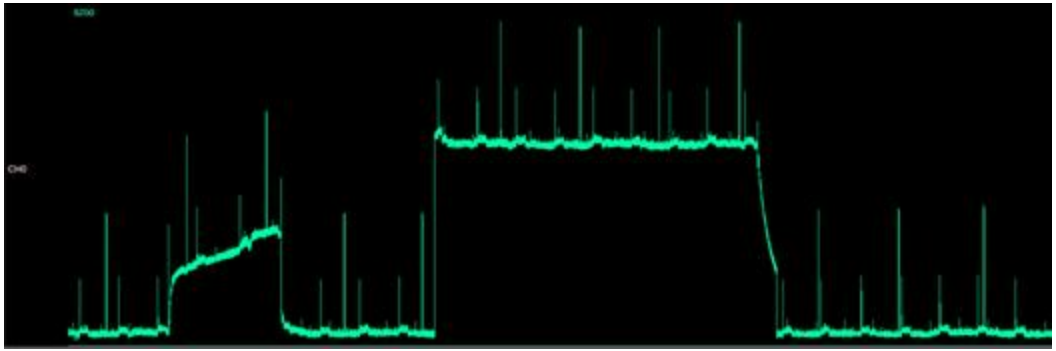
See the whole energy picture

What you can see in a Dutch home?

Sense has been learning for the last 12 months, **500,000** hours of Dutch data.

Power consumption at the meter (12 hours).

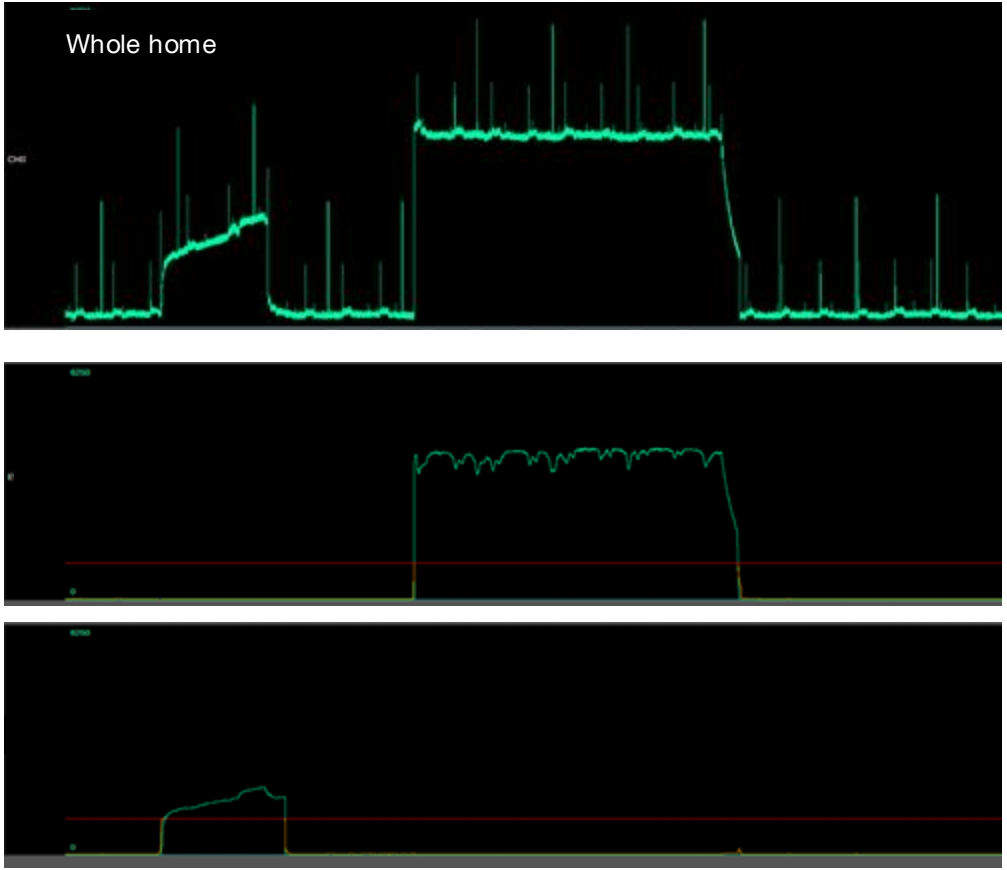
Sense can explain **60%** of home usage



Device disaggregation

Sense has disaggregated this Dutch house and found 2 large devices.

What are they?



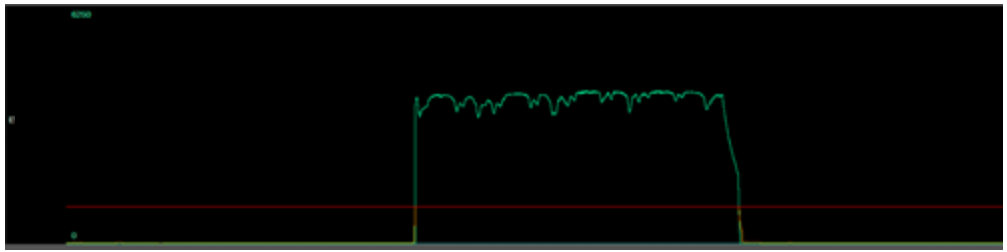
Device disaggregation

Sense can identify which homes have EV's and Heat Pumps and surface to network operators

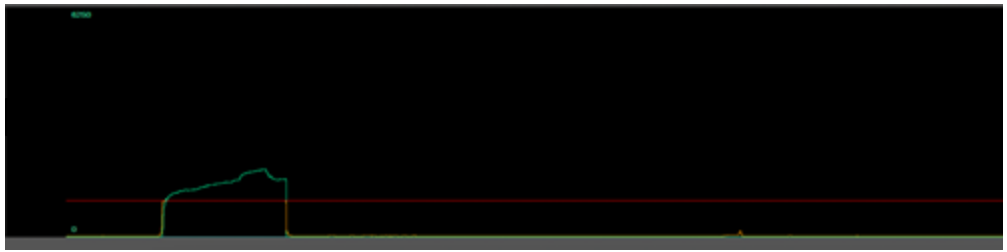
"Heat pumps are popping up like mushrooms"

DNO @ Smart Grid Forum

EV



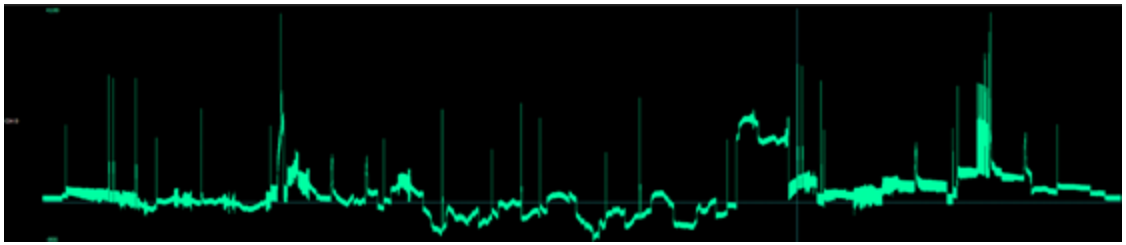
Heat Pump



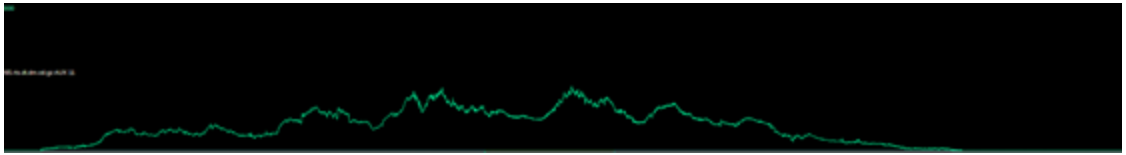
Dutch solar in real-time

Sense can also see solar in real-time for load shifting

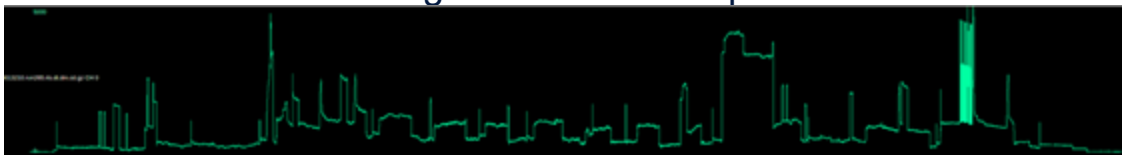
View at the meter of grid load



Sense extracts solar in real-time



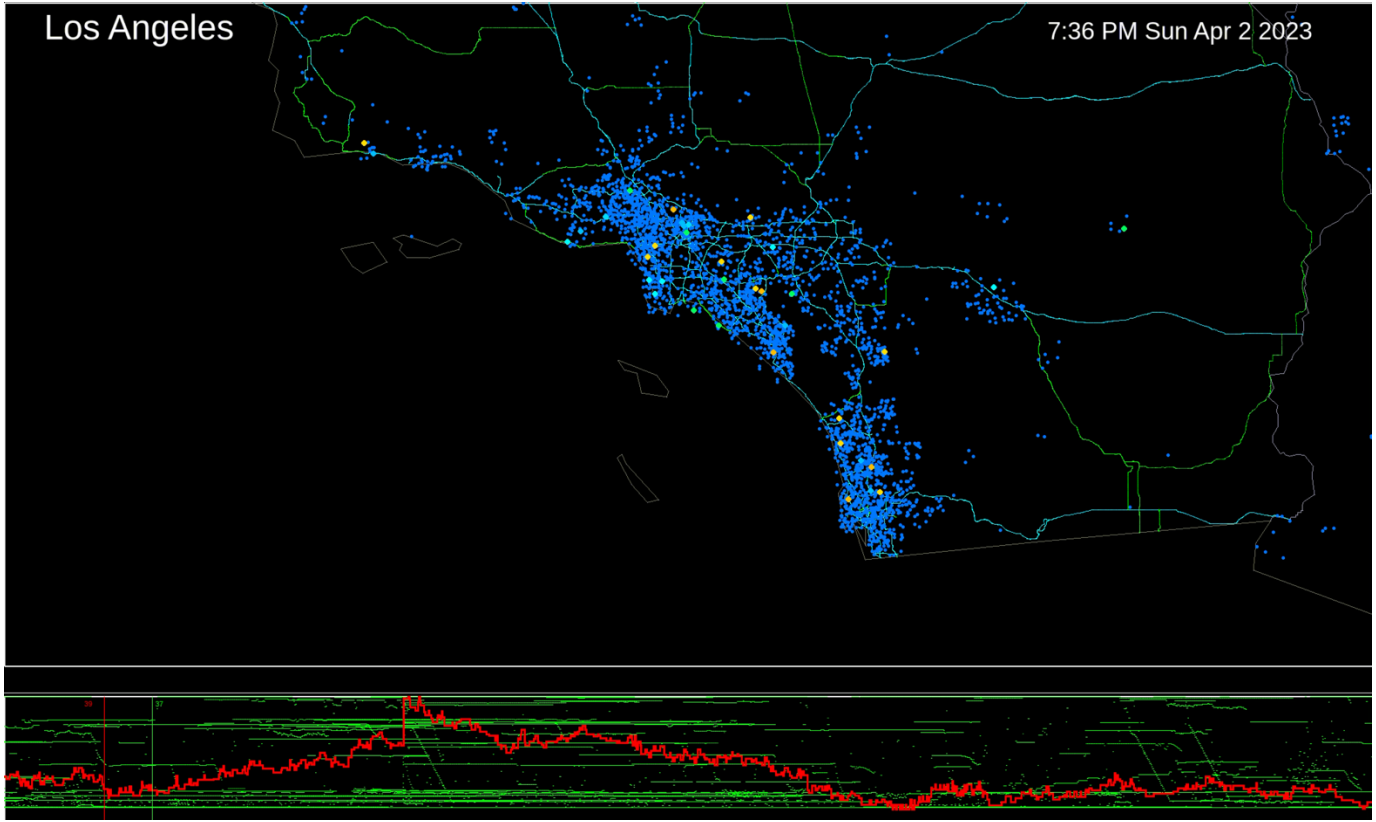
Revealing in-home consumption



California EV Visibility

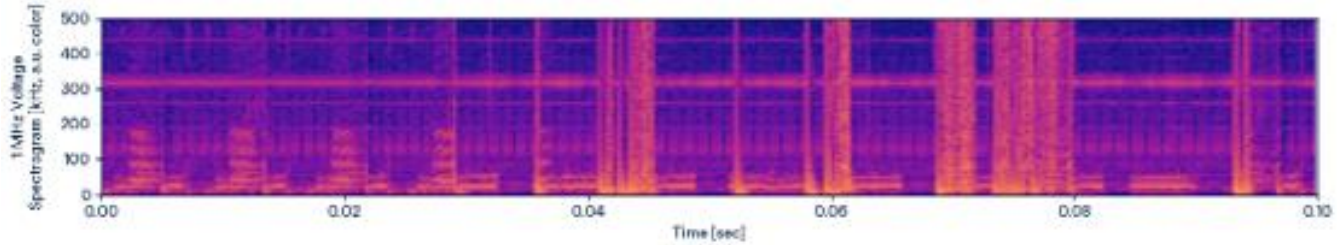
Surfacing
Grid strain

EV charging



A series arc fault at the main breaker

Water damage causes a corroded contact in a main breaker, leading to the arcing that is visible below

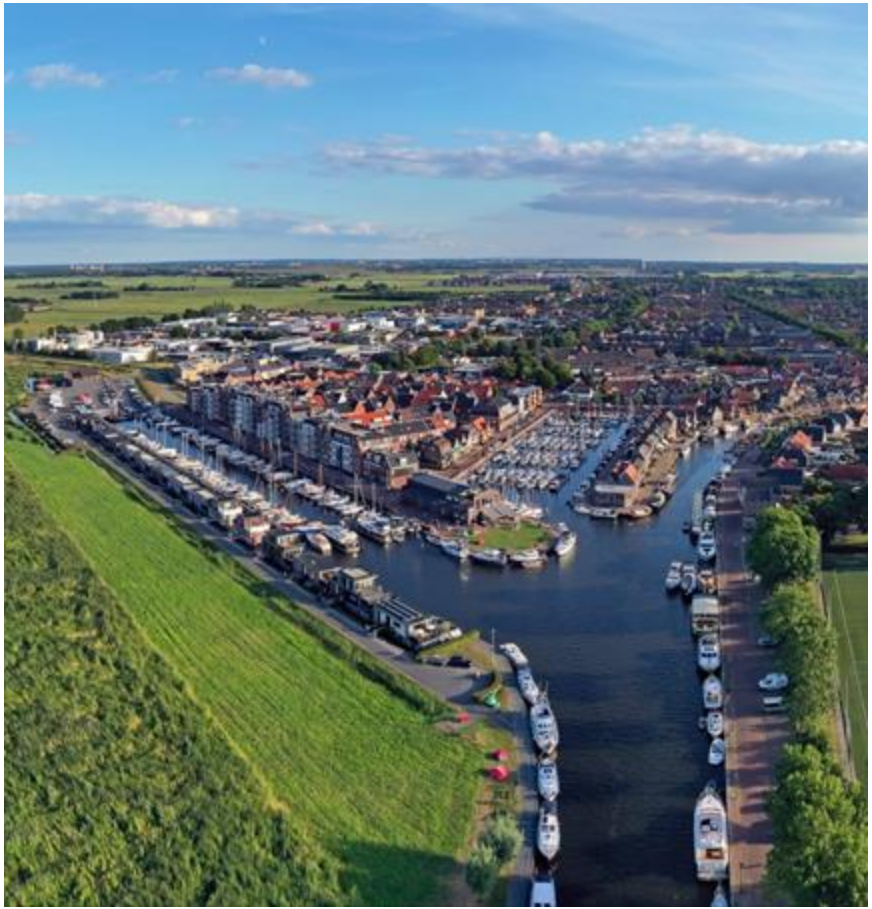


Summary

The Dutch NextGen meter, capable of processing high-resolution data in real time at the grid-edge, lays the foundation for operators to unlock new value cases, including:

- Insights to improve grid visibility
- Detection and location of network faults
- Load shifting to balance the grid and ease congestion
- Monitoring of voltage, frequency, and power quality.

But high resolution streaming data (15kHz or above) is critical to these value cases



Questions?

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Thank you

Visit sense.com for more information

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