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GOTO AARHUS 2023

#GOTOaar

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Predicting Optimal Supply Temperature in the Transmission System

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CTR



Knowledge sharing

Guide
to
Machine
Learning



Data journey



Readiness assessment



User-Story

As Centralkommunernes Transmissionsselskab

*We want to predict the true supply temperature 12-36 hours in advance,
Such that we can ensure the best electrical efficiency as well as our
service obligation, at the lowest possible temperature*

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Why?

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Opportunity to use the **best
heating mixture**

Ensure a **greener** district heating,
by reducing the return temperature

In the end, creating a **cheaper district heating** to end-users

What is District Heating

What is District Heating?

1 unit fuel = $\frac{1}{3}$ Electrical energy and $\frac{2}{3}$ Thermal Energy

Overproduction - Wind Turbine

Alternate district heating sources

Waste Heat from Production Facilities

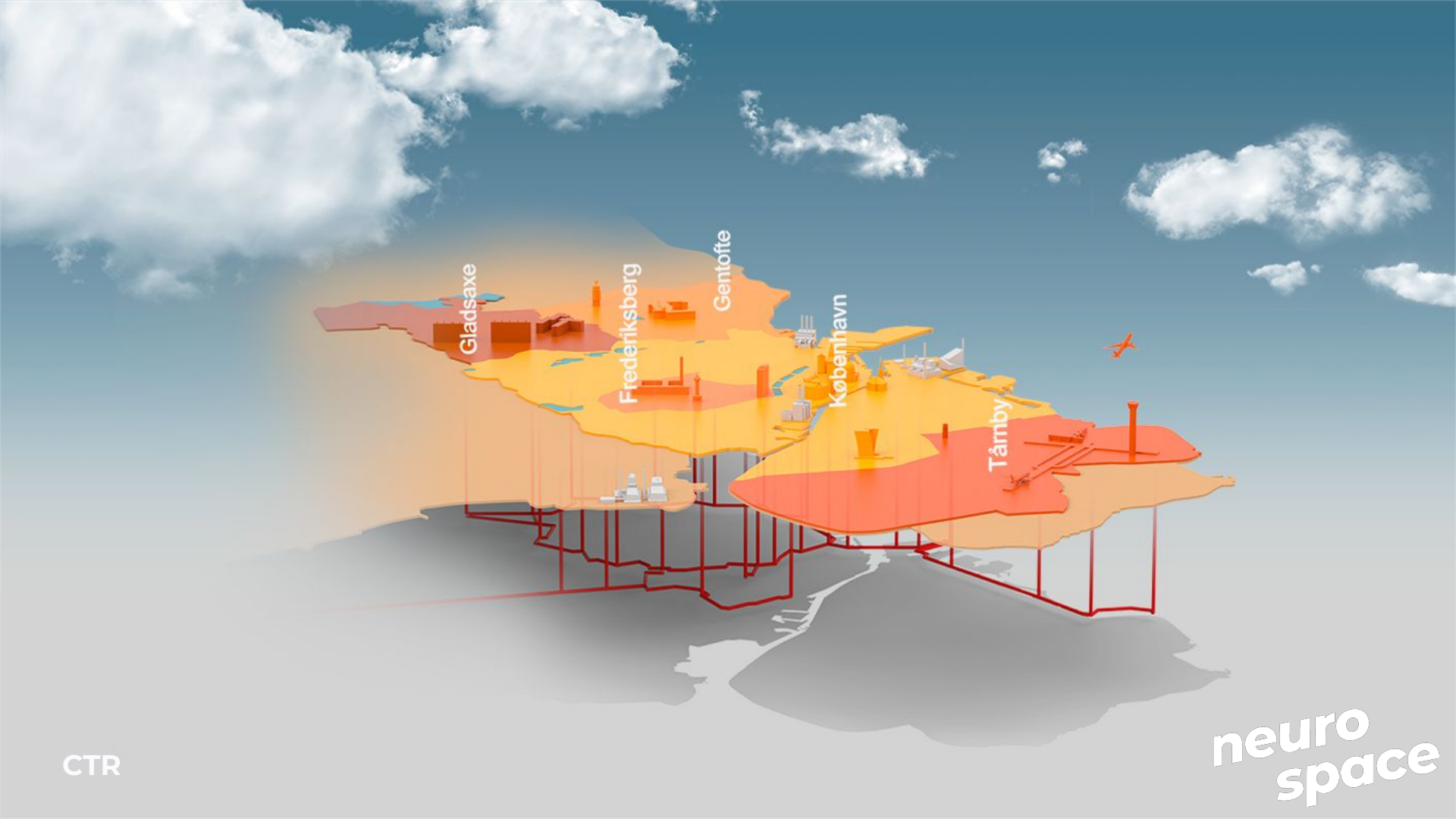
Alternate district heating sources

Waste Heat from Data Centres

Alternate district heating sources

Basically anything that produce waste heat

Alternate district heating sources



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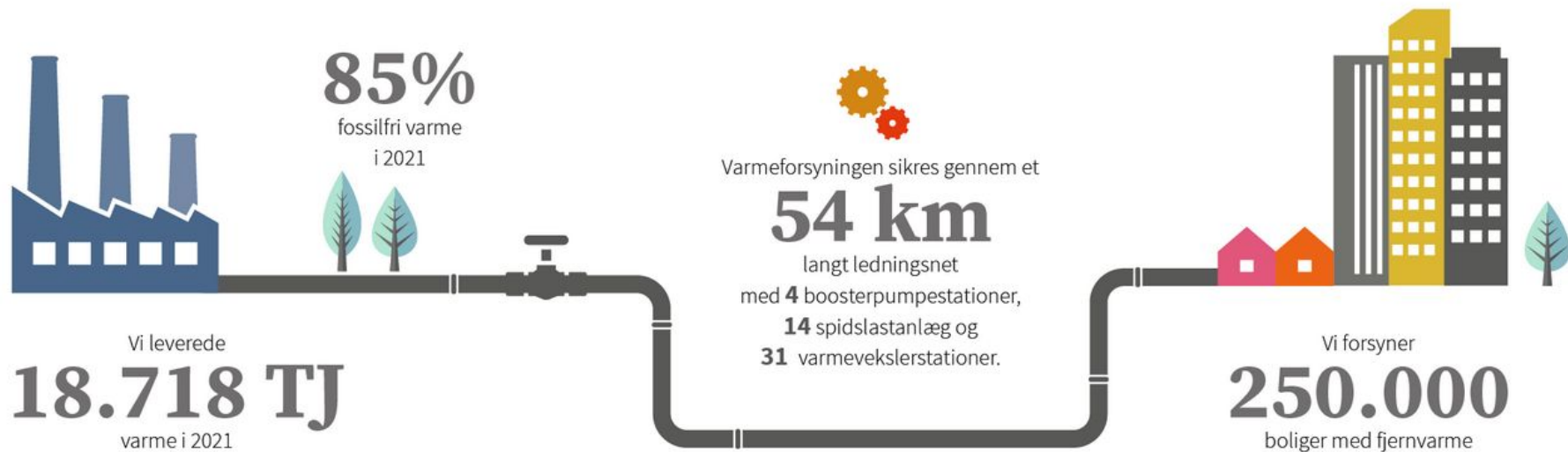
The Challenge

District Heating

Heat can be **produced** from
different sources

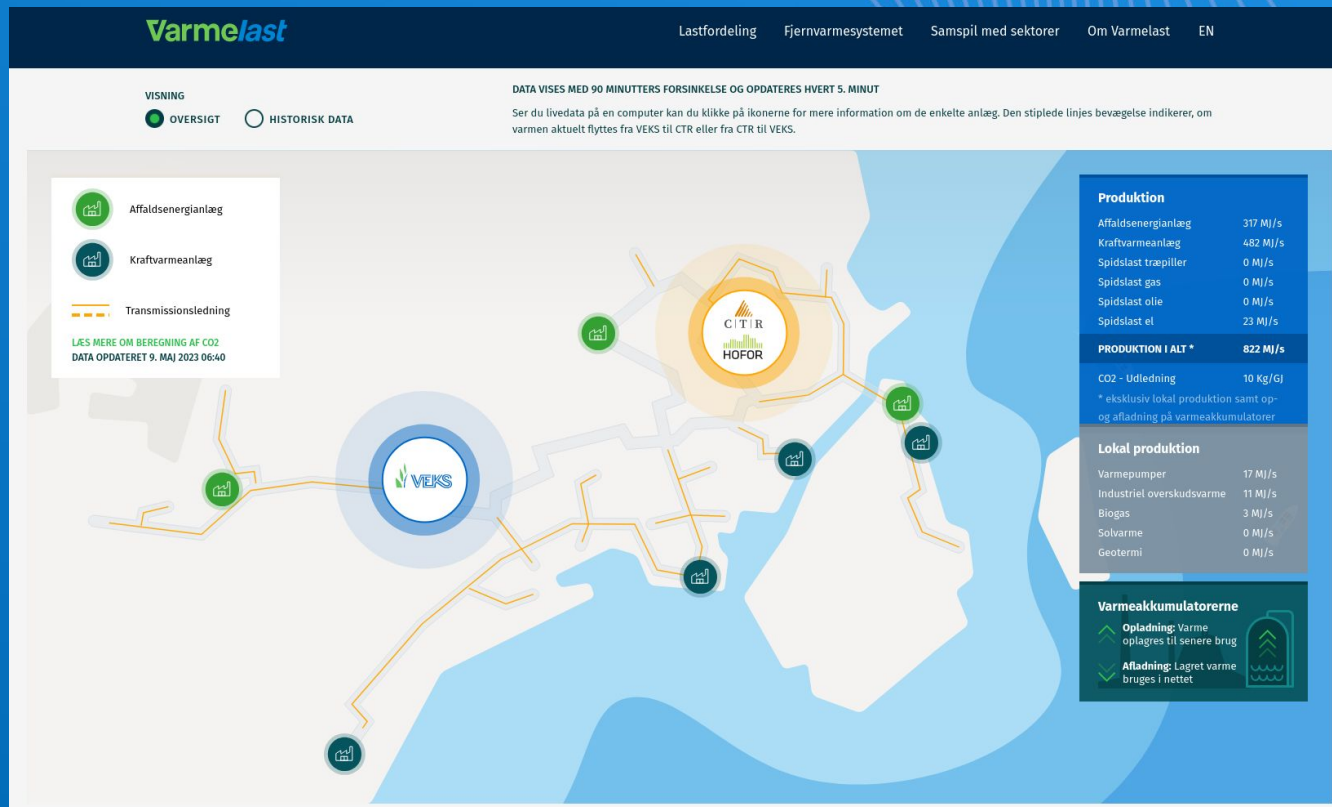
Heat can be **distributed** from
different heat exchangers into the
network

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<https://www.ctr.dk/vaerd-at-vide/om-ctr/>

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Varmelast.dk

Natural hydraulic limitations

It is **not** an option, to produce
insufficient heat

Some customers require a **certain
supply temperature**

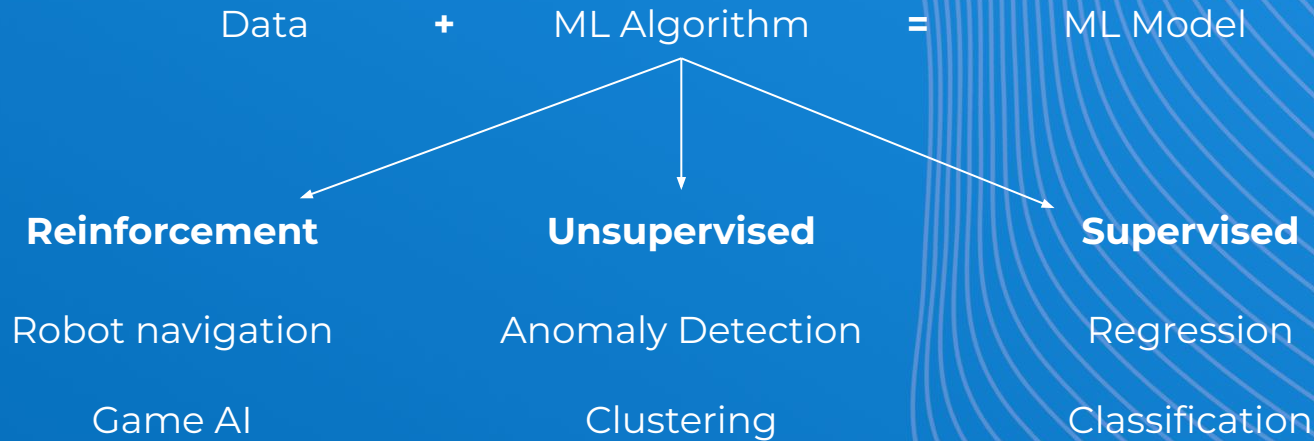
Danish weather can provide you
with **sunshine** and **+15 degrees**
today

...and **snow** and **-2 degrees**
tomorrow

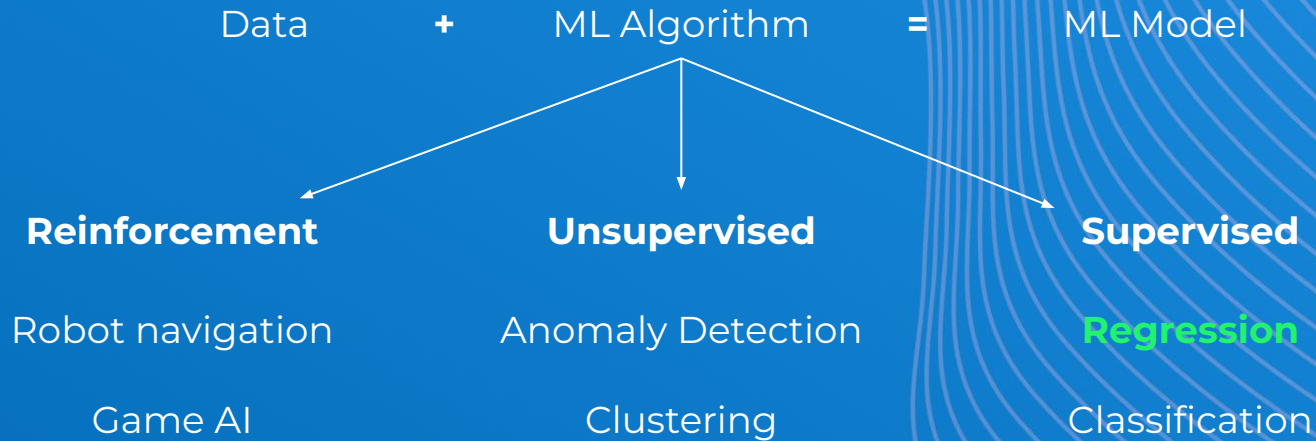
The Challenge

Machine Learning

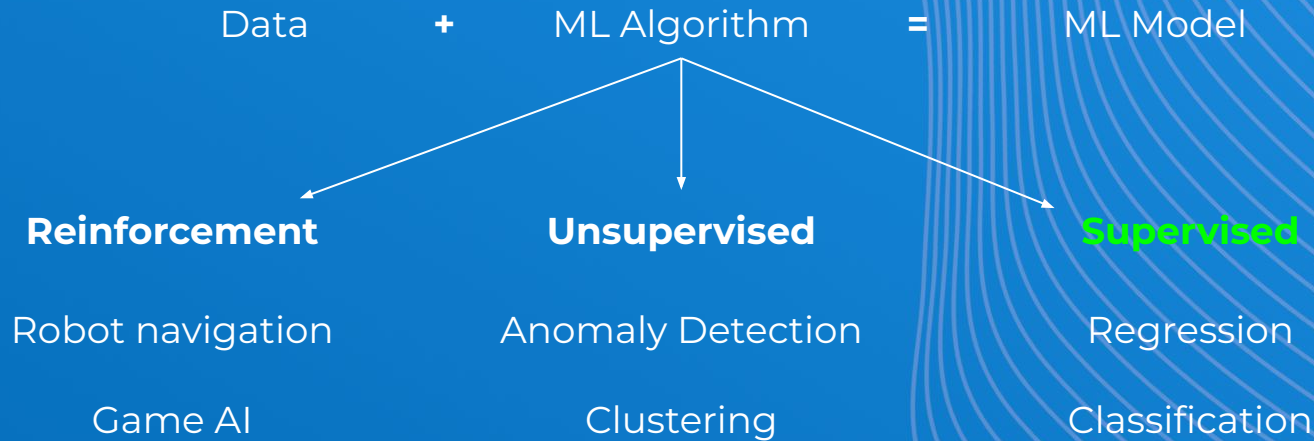
Predict Optimal Supply Temperature



Predict Optimal Supply Temperature



Predict Optimal Supply Temperature



We train a **Machine Learning
algorithm** on **Historical Data**

What we are looking for, must be
represented in our dataset

District Heating will rather deliver
too high temperature, than risk
having a **too low temperature**

What is **Optimal**?

The Solution

2 years of data

Pressure

Supply Temperature

Flow

Temperature (outside)

..

.

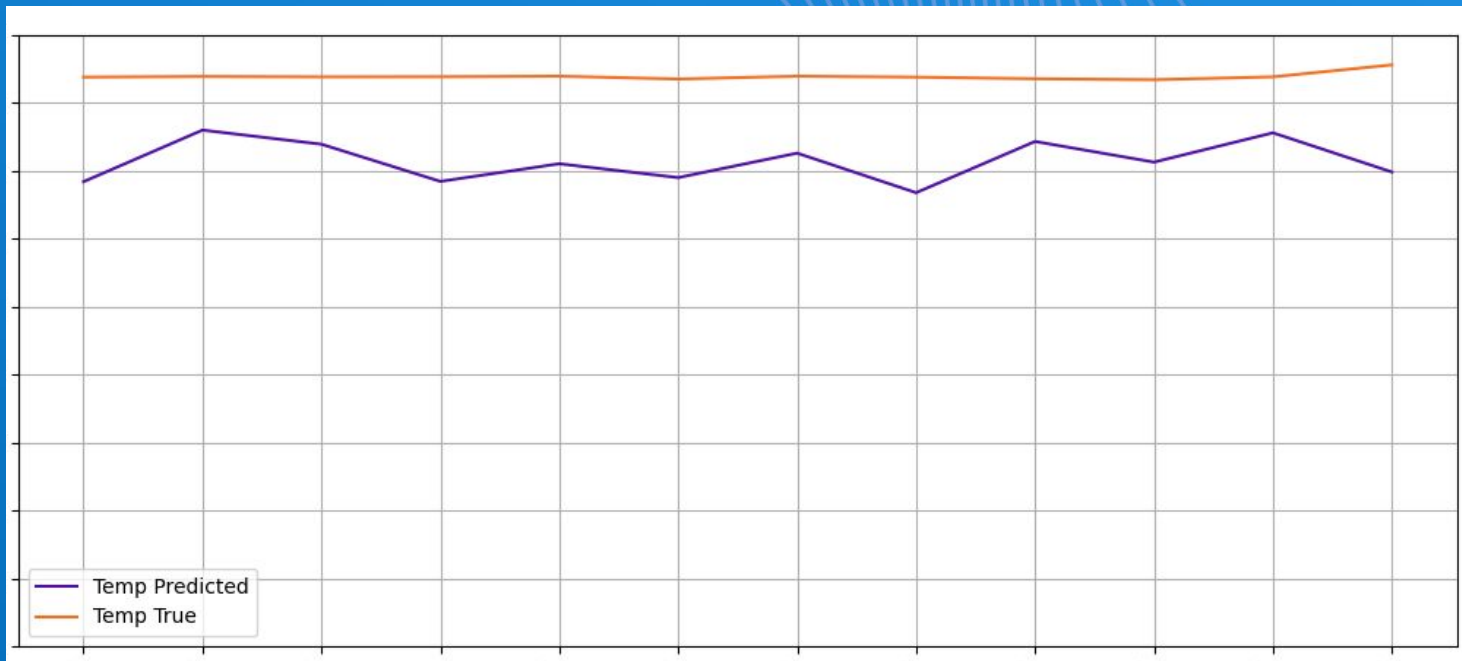
The **data quality** was high

Domain Experts in CTR, was able to
provide **crucial knowledge**, for us
to reduce the dataset **significantly**,
and identify **optimal supply
temperature**

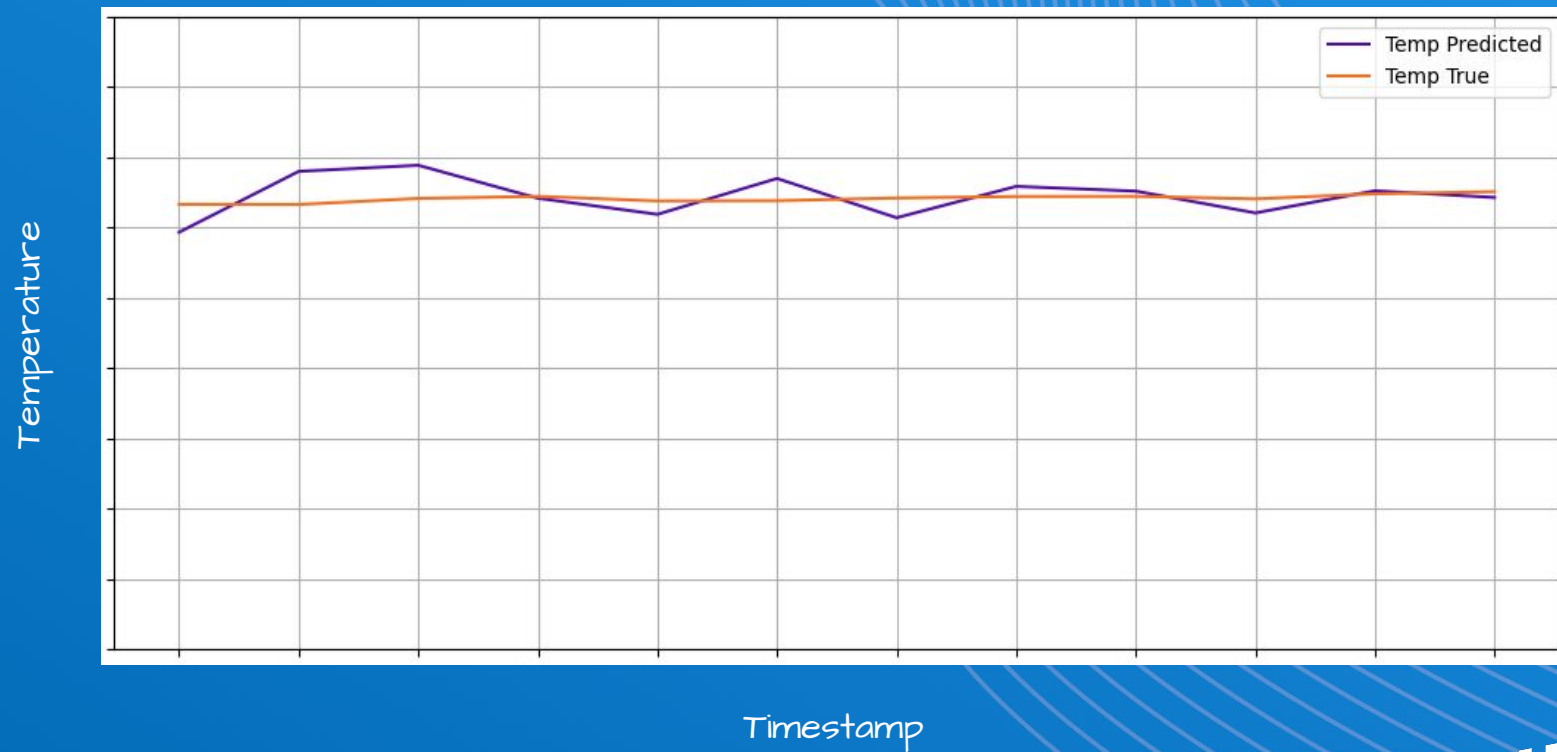
Machine Learning Model #1

Predicting Optimal Supply Temperature

Temperature



Timestamp



Experts from CTR were able to
Validate whether the **model's**
predictions were **optimal** or **not**

On average in a **14-day test-period**,
the model was able to optimize the
supply temperature with **5.4**
degrees

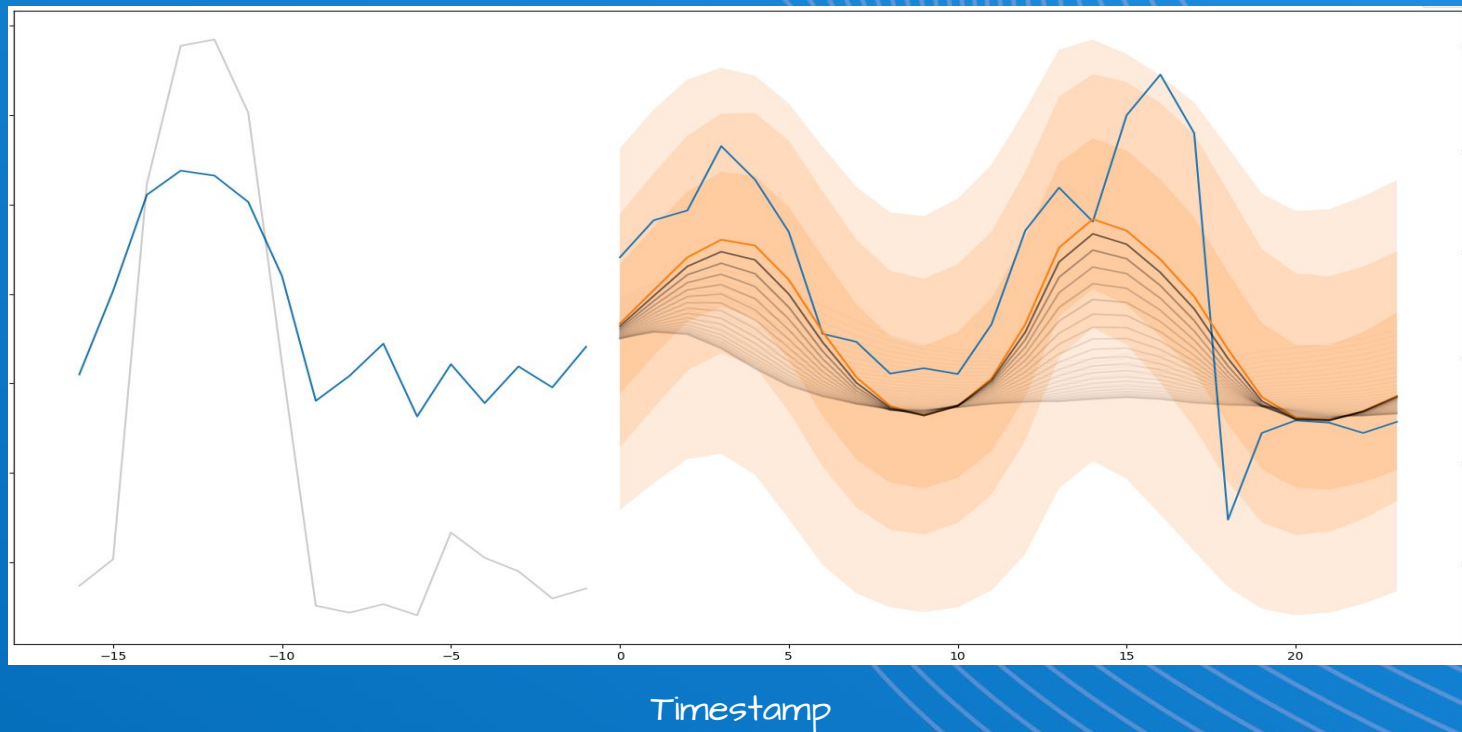
Machine Learning Model #2

Predicting hydraulic limitations

Predicted
Observed
Lowered Temperature

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Hydraulic Limitation



Attention

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ML model 1

ML model 2

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As Centraalkommunernes Transmissionsselskab,

....

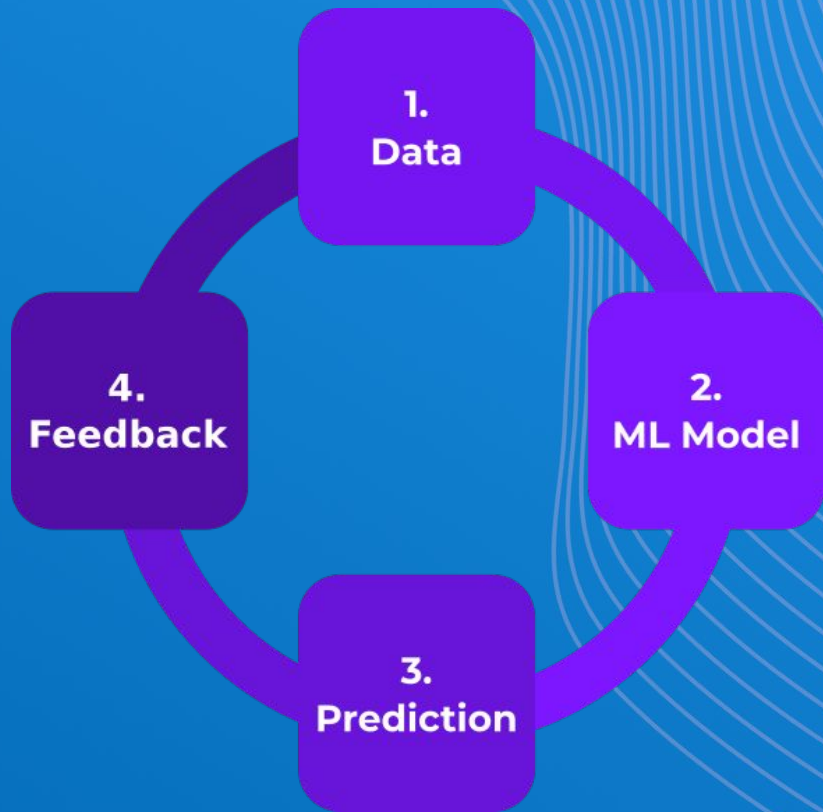
Such that we can ensure the best electrical efficiency as well as our
service obligation, at the **lowest possible temperature**

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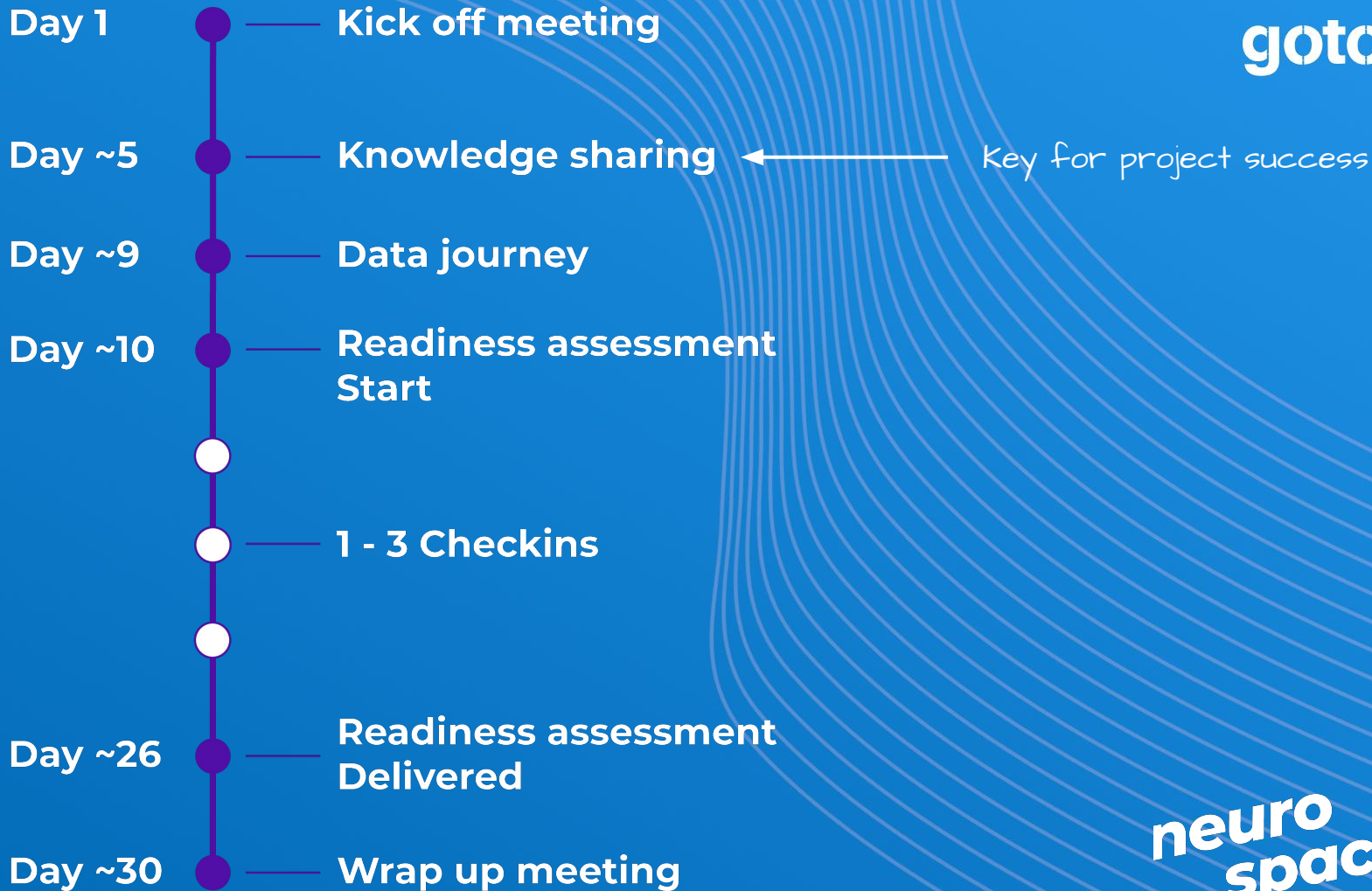
Key Takeaways

Right data != Big data
Representative data

Machine Learning Flywheel







AI/ML
experts

What is
ML?

What is
valuable for
the company

Domain
experts

Magic happens

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Need domain experts input while working with data

Learn

goto;

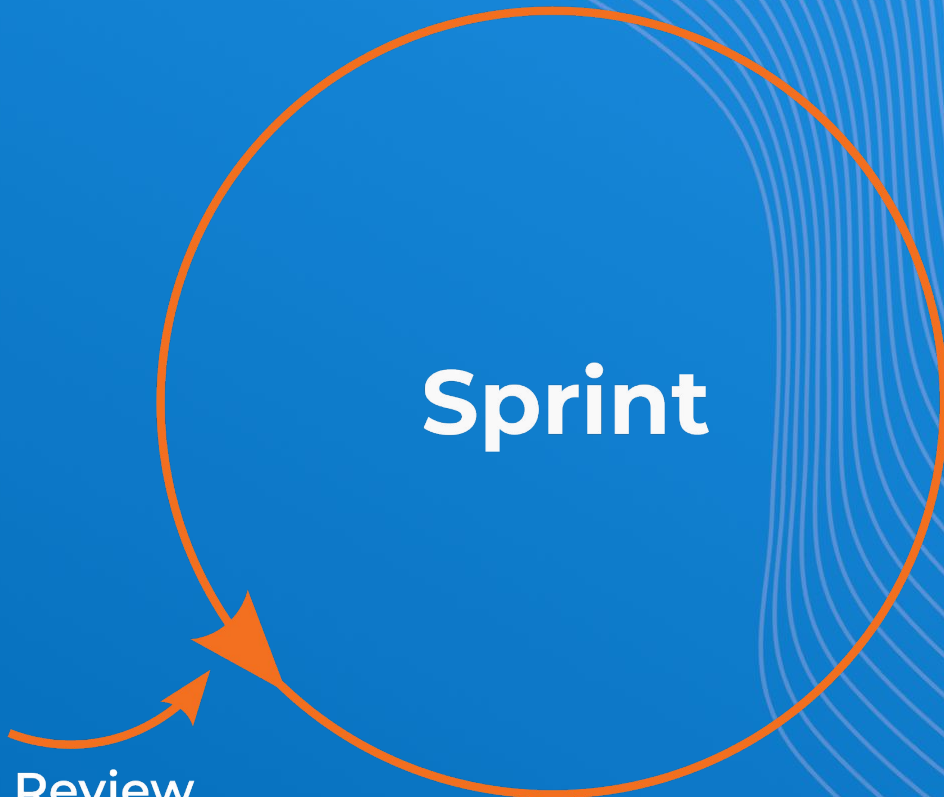
Sprint

Test

Review
Retrospective
Planning

Develop

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Data x Machine Learning

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Thank you

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