CTT 2.0

Carbon Track and Trace

Stop guessing – start measuring

Patrick Driscoll, NTNU, Trondheim, Norway
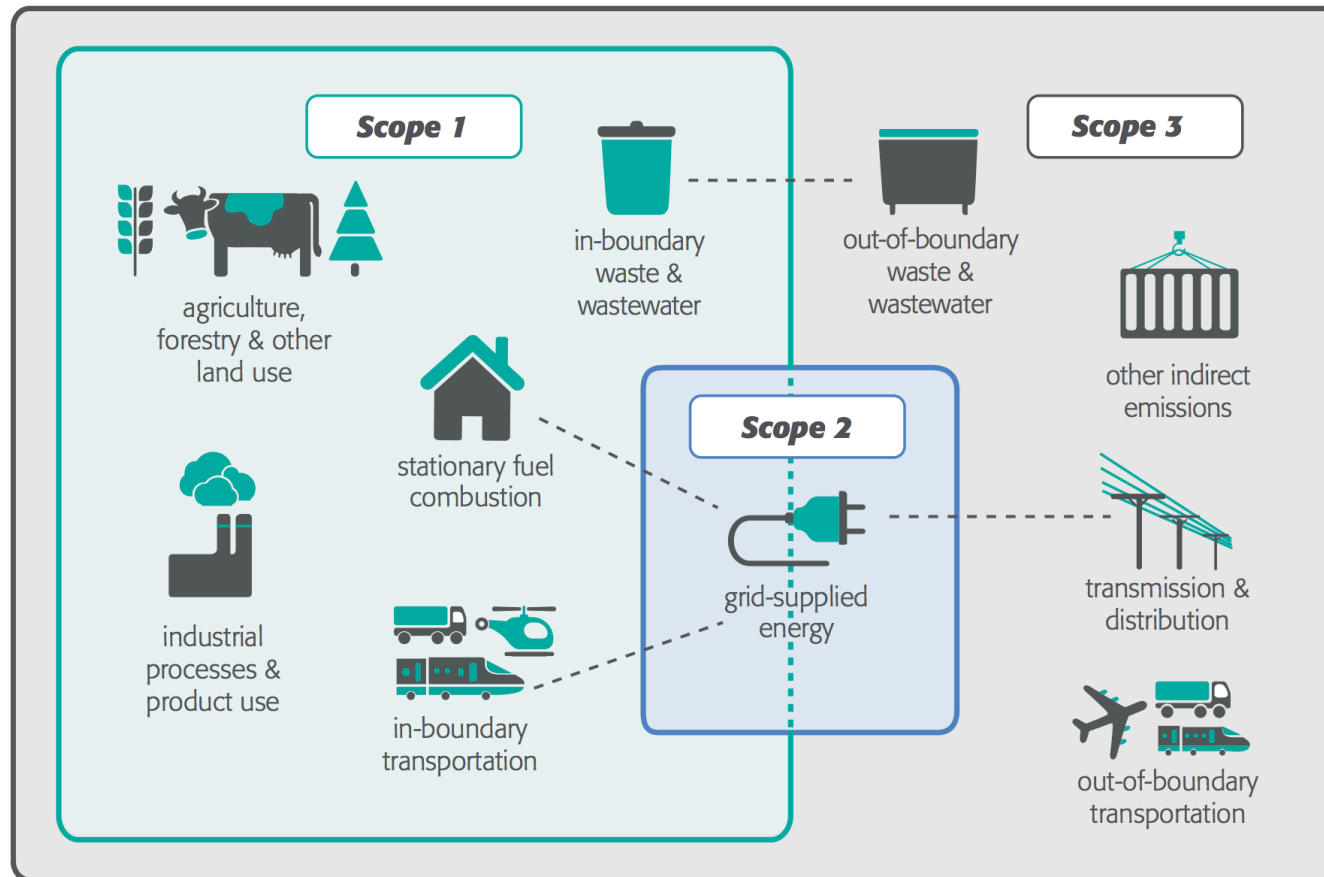NTVA Smart Cities Conference, 07.09.2016

1910

What is the basic problem we are trying to solve?

- Cities do not have adequate tools to measure the impact of their climate strategies and measures

- Existing greenhouse gas emissions inventory methods are too coarse, too inaccurate, and too uncertain to provide effective feedback to municipal climate goals.

- Need to combine and understand different data types to understand what motivates changes in behaviour.
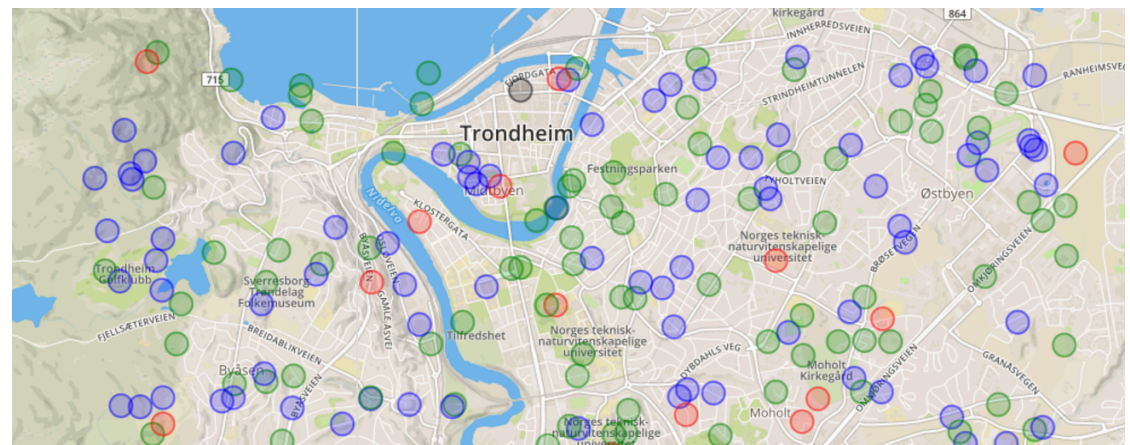
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GHG emissions are not easy to track, especially from transport and consumption

Scope 1
- agriculture, forestry & other land use
- industrial processes & product use
- stationary fuel combustion
- in-boundary transportation
- in-boundary waste & wastewater

Scope 2
- grid-supplied energy

Scope 3
- out-of-boundary waste & wastewater
- other indirect emissions
- transmission & distribution
- out-of-boundary transportation

[GPC Standard]

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Carbon Track & Trace - CTT

- Monitoring, Reporting, Understanding of city-level greenhouse gas emissions

- Both emission inventories and *real-time local* measurements

- Better accounting leads to better prioritization of mitigation projects
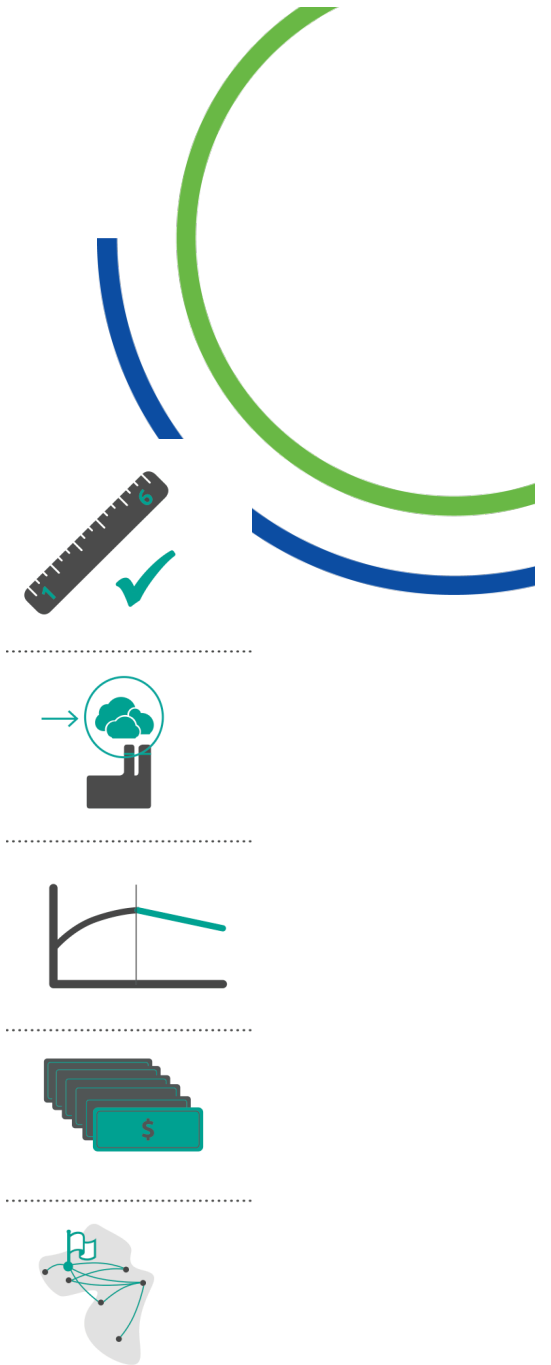
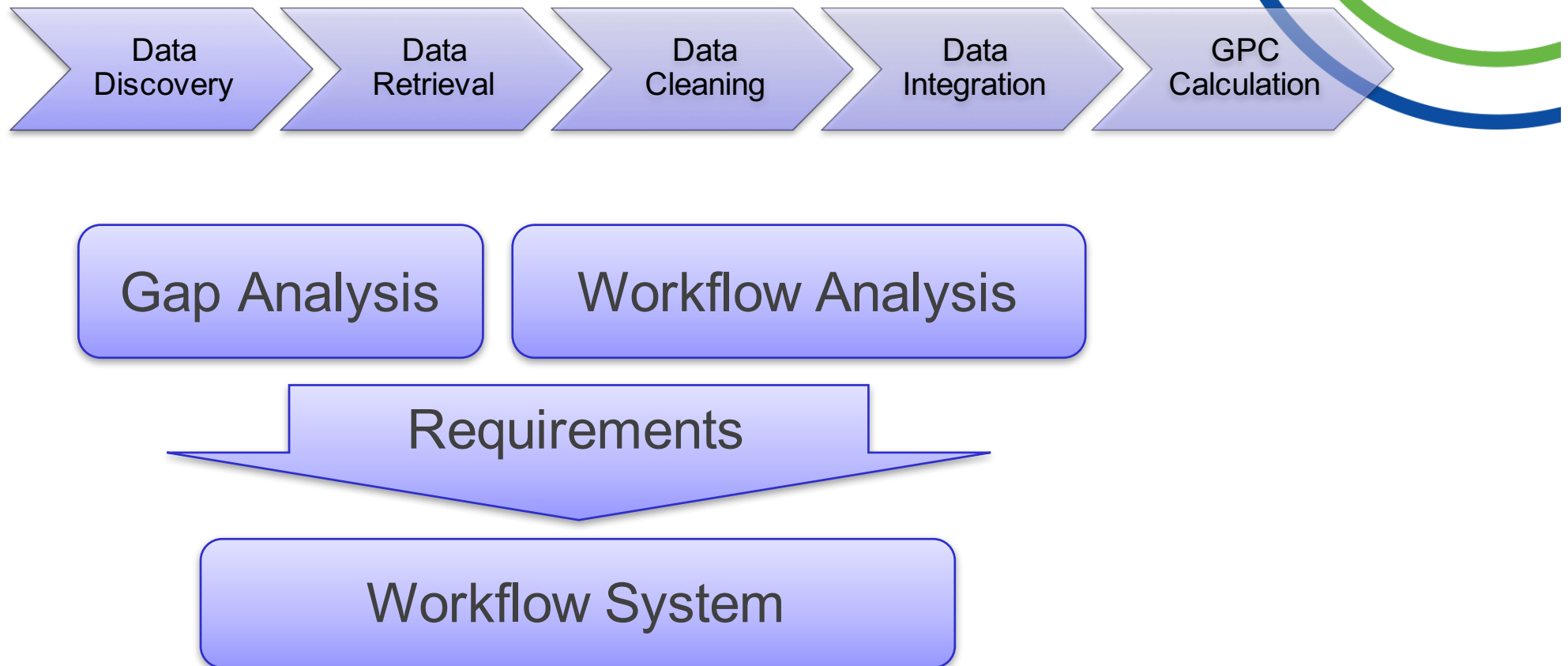- Part of larger SmartCities approaches
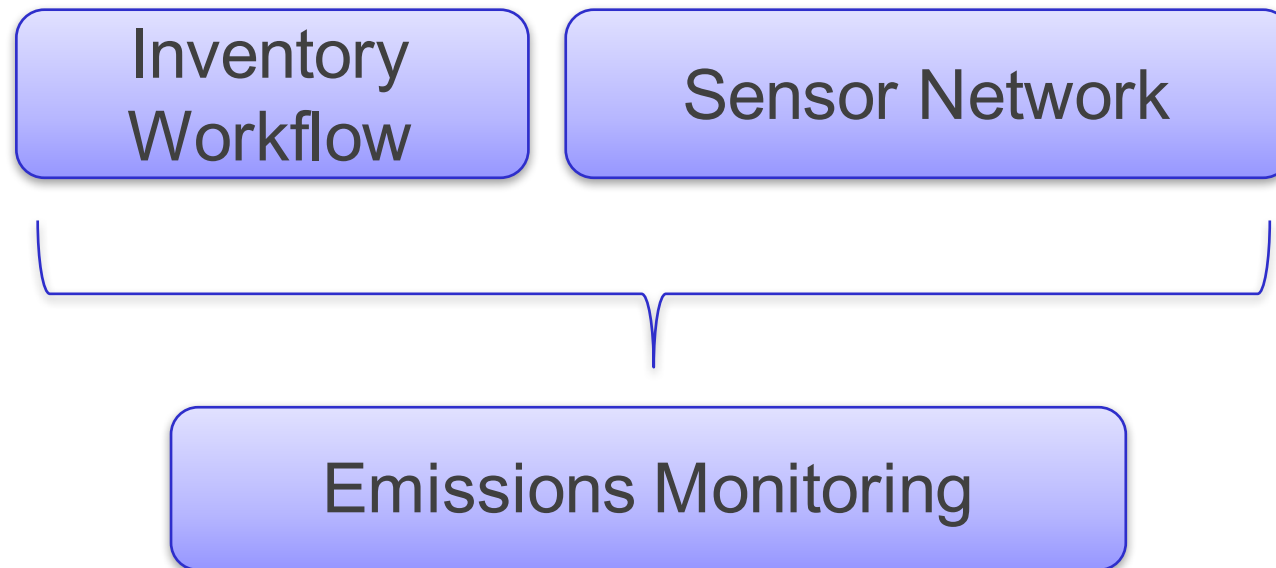
Approach: Set up repeatable processes

- Gap Analysis
    - What can be improved to implement the standard?
- Workflow Process
    - How is the current workflow, where does data come from?
- Requirements Definition
    - How can this be structured and put into a repeatable, automated process?

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From inventories to workflows

Data Discovery	Data Retrieval	Data Cleaning	Data Integration	GPC Calculation

Gap Analysis **Workflow Analysis**

Requirements

Workflow System

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Integrating workflows and sensors

Inventory Workflow

Sensor Network

Emissions Monitoring

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Approach and Activities

- Integration of emission data into city planning and decisions support
- Deployment of LoRa sensor network in Trondheim and Vejle
- Development of an analytics framework of GHC emissions
- Work towards GPC-compliant inventories
- Development of a business plan, fundraising
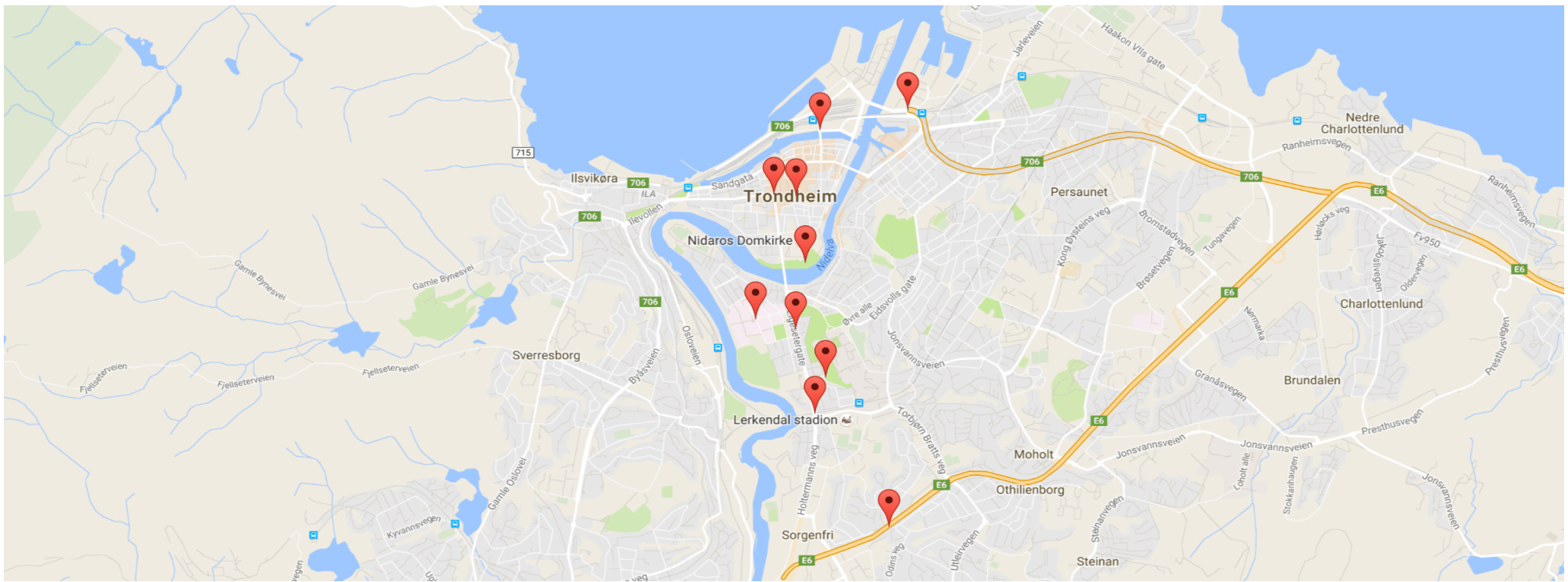- Scaling out, deployment/testing internationally
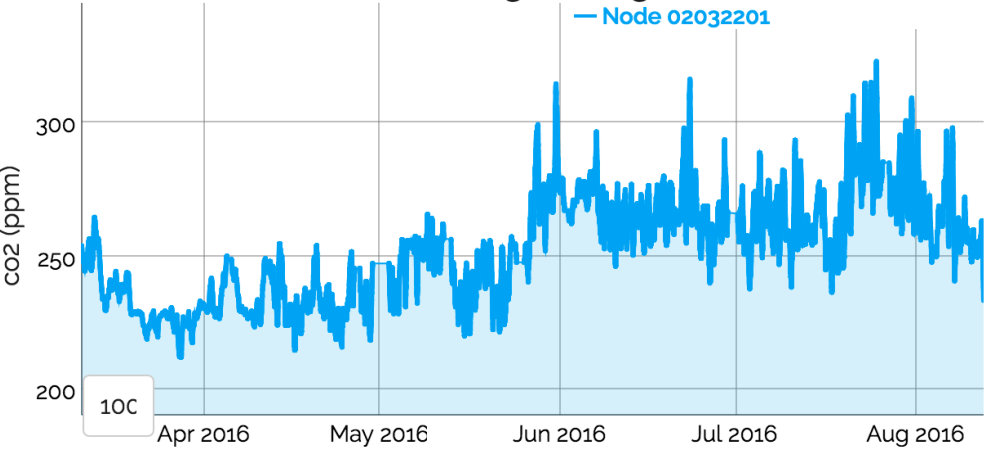
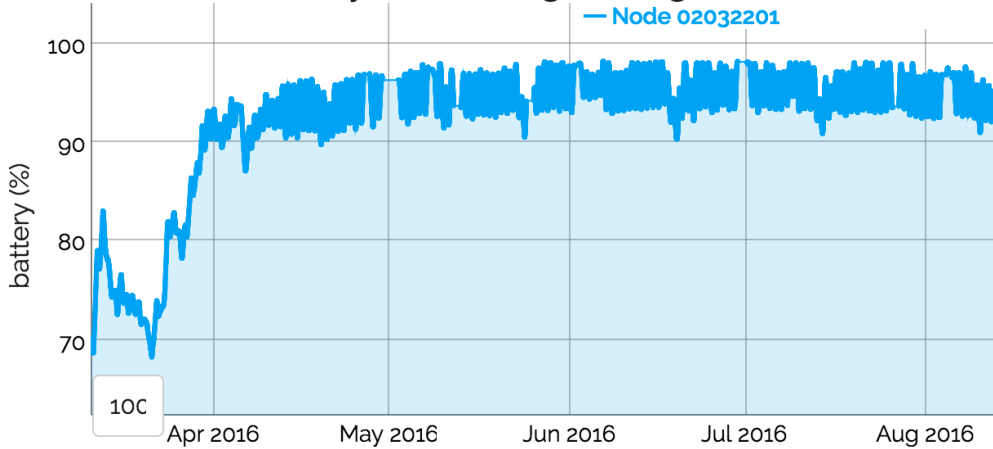# The first CTT sensor deployment
Elgeseter gate

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Vejle installations

co2 levels at Elgeseter gate

— Node 02032201

co2 (ppm)

300

250

200

10C

Apr 2016   May 2016   Jun 2016   Jul 2016   Aug 2016

battery levels at Elgeseter gate

— Node 02032201

battery (%)

100

90

80

70

10C

Apr 2016   May 2016   Jun 2016   Jul 2016   Aug 2016

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Sensor/networks system

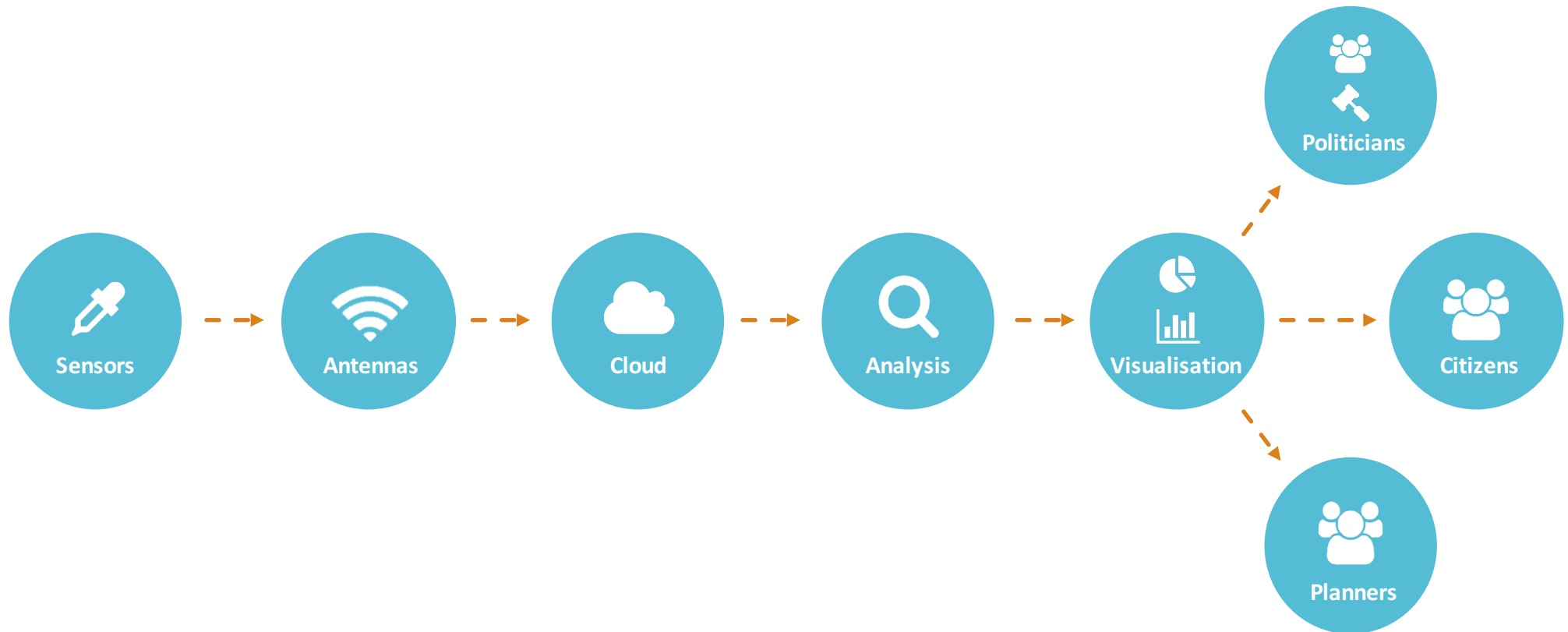[NASA, Wikipedia, tradlosetrondheim.no, CTT, NTNU]

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Ecosystem

- CTT 2.0 consortium
  - NTNU, DTU
  - ICLEI-World, ICLEI-Europe, LSCE, South Pole Group, Virtual City Systems
  - Trondheim Municipality, Vejle Municipality, T:Lab, NumaScale, ICLEI-Europe, Sør-Trøndelag Fylkeskommune, Norwegian Institute for Air Research
- Additional local projects, collaboration with DTU, H2020 proposals, Smart Sustainable Cities initiatives

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CTT Value Chain

Sensors → Antennas → Cloud → Analysis → Visualisation → Politicians / Citizens / Planners

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Timeline Current

Main Milestones	June	July	August	September	October	November	December
Sensor deployment: NTNU, TK, VK, Wireless Trondheim	■	■					
Field reports on sensor performance: NTNU, TK, VK, NILU; DTU		■		■			
Big Data analytics platform: Numascale, DTU, NTNU			■		■		
Integration potential with GPC and SEAP: ICLEI World/Europe, NTNU							■
Data visualisation platform (3-D GIS): NTNU, VCS						■	
Data visualisation platform (app): NTNU, Ducky							■
Business model canvas: T:Lab, NTNU	■						
Business plan; T.Lab, NTNU		■					
International market survey: T.Lab, NTNU					■		

Climathon
24-hour hackathon
Trondheim 7-8 January 2016

Jobber dugnad for å måle klimautslipp i Trondheim

The challenge:

How can you use **existing open datasets** to calibrate and check official reported emissions from Statistics Norway (SSB)?

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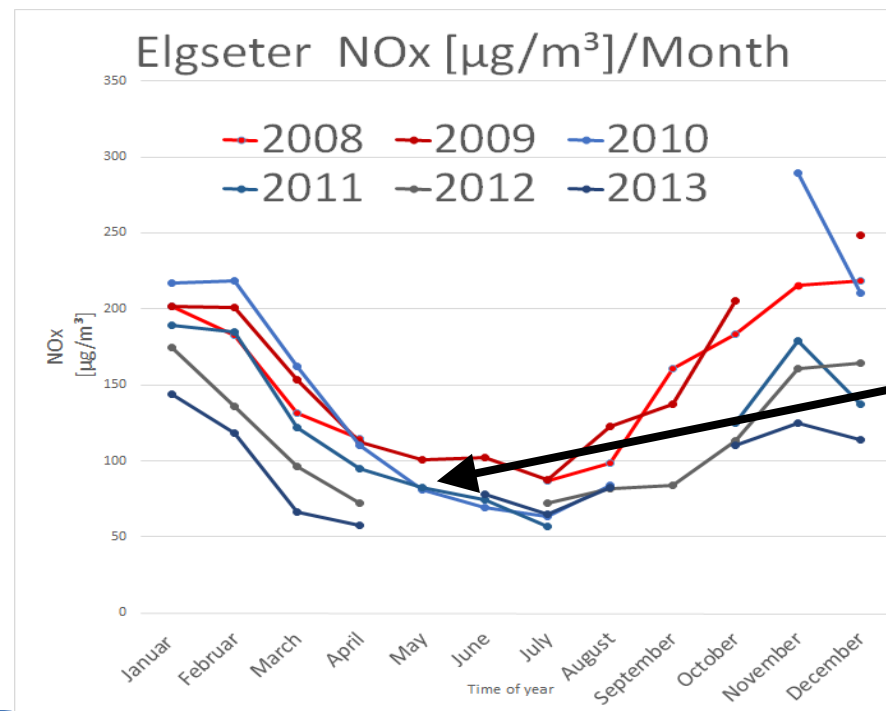
Seeing the effect of local political measures

"Nordre avlastningsvei"
opened in May 2010
[a shortcut road that leads motorists around the city center]


LNG busses
2010

Open datasets:

NILU Norsk institutt for luftforskning
Norwegian Institute for Air Research

Elgseter NOx [µg/m³]/Month

— 2008 — 2009 — 2010
— 2011 — 2012 — 2013

NOx [µg/m³]

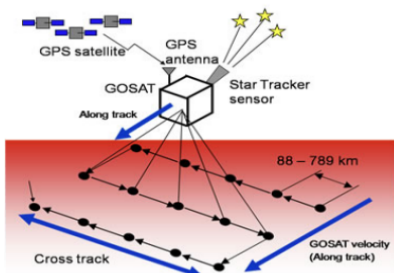Januar Februar March April May June July August September October November December

Time of year

The air quality measurements in the city center shows a clear improvement after May 2010

In order to measure the effect of local actions you need local sensors

ACOS Satellite data
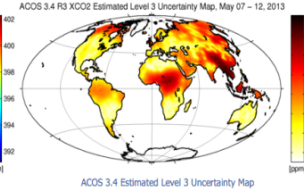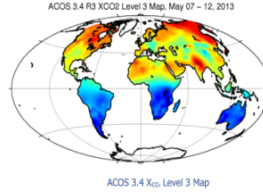
High accuracy (± 1 ppm)

Low spatial resolution (~ 1e2 km)

Low temporal resolution (weekly orbit overlap)

There is a seasonal variation due to change in levels of photosynthesis, weather/cloud coverage and energy usage patterns.
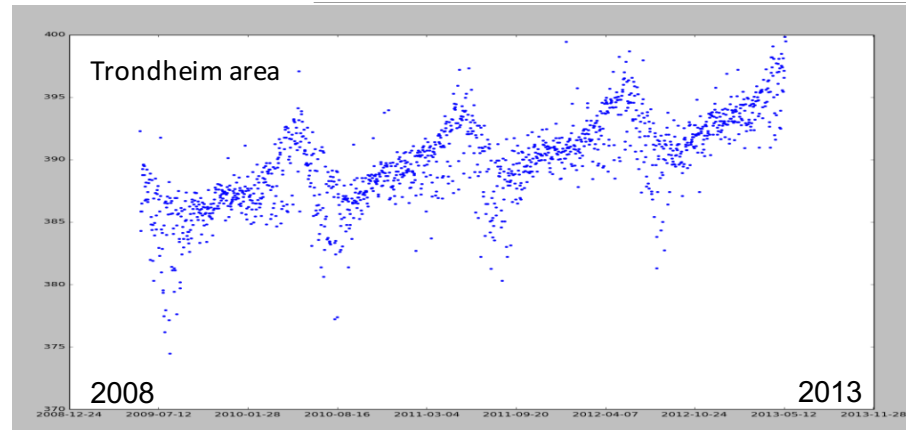
For the Trondheim climathon Team Polarbears made a python program that read all the netCDF files from the satellite and extracted the CO_2 data for coordinates close to Trondheim

The satellite data is applicable as a reference for:
- Comparing Trondheim with non-inhabited regions to isolate man-made emissions
- Comparing with other cities to see relative changes in trends
- Used Together with ground sensors for
- Calibration

Climathon winners: Team Polarbears: Atle Vesterkjær (Numascale), Jie Ren, Arne Jenssen, Pål Preede Revheim

What have we learned so far?

- The ecosystem we are building is complex, buggy, and prone to rats
- Innovation projects in Smart Cities need space to fail
- Understanding the needs of the cities takes time (and vice versa)
- Low cost sensors, open systems, and Big Data analytics in combination are a promising way forward

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TRONDHEIM KOMMUNE

NTNU

NUMASCALE
BIGGER DATA ANALYTICS

T:Lab

Wireless Trondheim

Next steps

- Better understanding of user needs
- Adding noise and traffic measurements
- Using IR drones to map woodstove emissions and numbers in Vejle
- Picarro sensors for data validation
- Integrating air quality and CO2 data into existing decision support/planning support systems (3D)
- Climate Sentinel for Cities and Regions (Climate KIC Demonstrator project to utilise remote sensing data from NASA, ESA, JAXA, and TanSat.
- Creating more citizen observatories
- Engaging students (Thora Storm) to work with sensors, systems, and data analytics to learn

Patrick Driscoll

Patrick.arthur.driscoll@ntnu.no

http://carbontrackandtrace.com/

http://smartsustainablecities.org/

https://www.ntnu.edu/smartcities/

NTNU
Norwegian University of
Science and Technology

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