A safe and sustainable world

CorroSense

Self-powered corrosion monitoring

IFD GS grant
Total budget MDKK 35
2023-2027

Presenter: PM Brian Lohse, FT
Other participants:

2000 year old

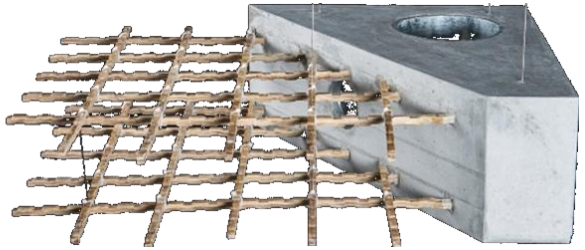
Rome

2 years old

CPH

Motivation…the Why…

Reinforced Concrete (RC) is the most used material in the world!



- **Corrosion:** main reason for structure deterioration and collapse
  - **USA:** more than **47.000 bridges** are '**structurally deficient**' and need constant monitoring until repair work
  - **France: one-third** of road-network are in the "**critical stage**".
  - **Globally:** costs approximately **€2.3 trillion** annually, **3–4 %** of the Gross World Product (GWP)

Balcony collapse Kolding (July 2020)

Miami building collapse (June 2021)

Pittsburgh bridge collapse (Feb. 2022)

A project funded by Innovation Fund Denmark

A **low-power reliable wireless** corrosion sensor network (WSN) enabling **continuous** health **monitoring** of reinforced concrete structures, allowing for **early detection and prediction of corrosion** through sensor fusion.
The total budget is MDKK 35, and the project runs for 4 years (2023-2027), PM Brian Lohse @ FORCE Technology

The Consortium

Innovationsfonden

AARHUS UNIVERSITET
AU ENGINEERING

SDU
University of Southern Denmark

FORCE TECHNOLOGY

CorroSense

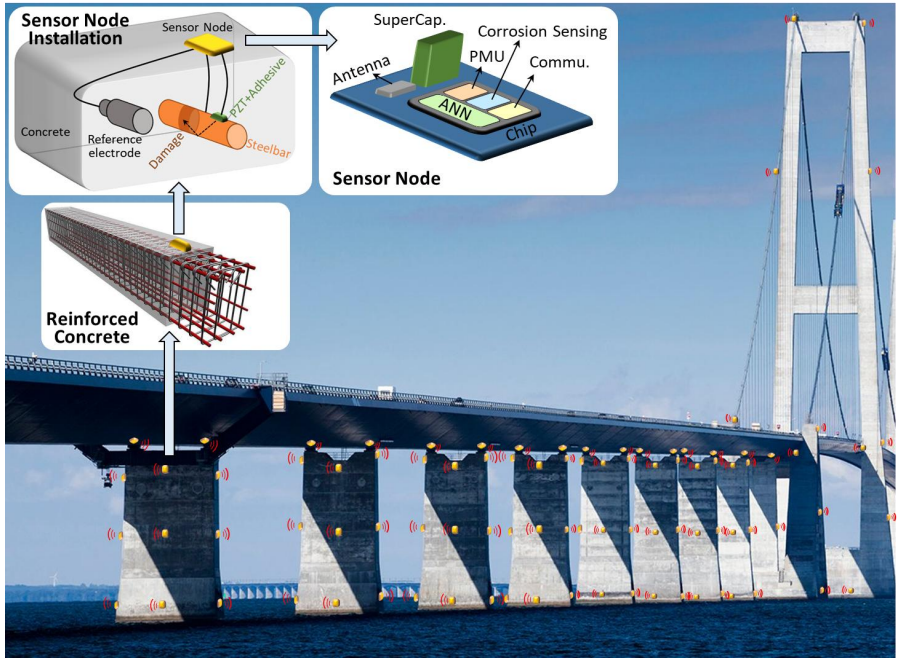
RITI
Rådgivning Ingeniør Tilsyn & Inspektion

Sund≈Bælt

AALBORG UNIVERSITET

Vejdirektoratet

The Project



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CorroSense: Self-powered corrosion monitoring

Motivation..the economical potential…

Vejdirektoratet

In Denmark, there are approximately 2.500 state-owned bridges and tunnels that help to link islands and parts of the country together, and they are continuously maintained by VD.

https://www.vejdirektoratet.dk/tema/broer-og-vejtunneler-i-danmark

Sund≋Bælt

Location (Storebælt) Bridge	Sensors	HOURS (~ DKK740/hr)	PRICE (DKK)
Calculated from VD (Sensors; Electric/cable- & network installation)	446	NA (17*800.000)	**21.294.800**

Vejdirektoratet

Location (Limfjordstunnelen)	Sensors	HOURS (~ DKK740/hr)	PRICE (DKK)
Total (Sensors; Electric/cable- & network installation)	27	(NA)	**1.259.600**

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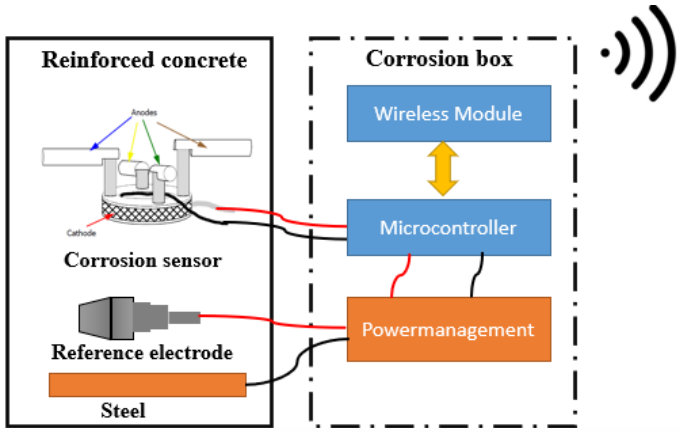
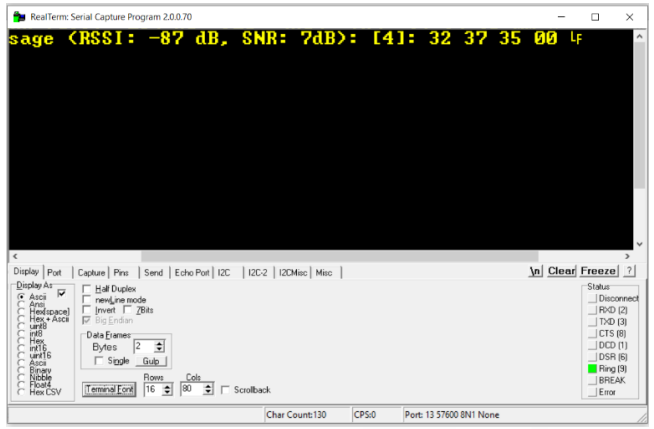
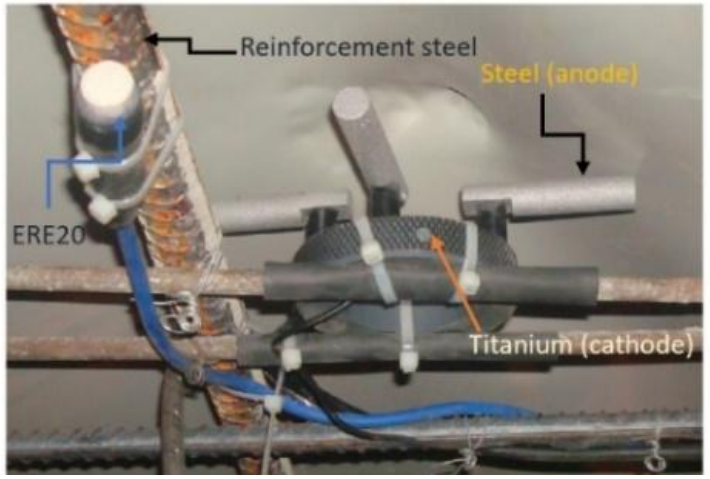
CorroSense: Self-powered corrosion monitoring

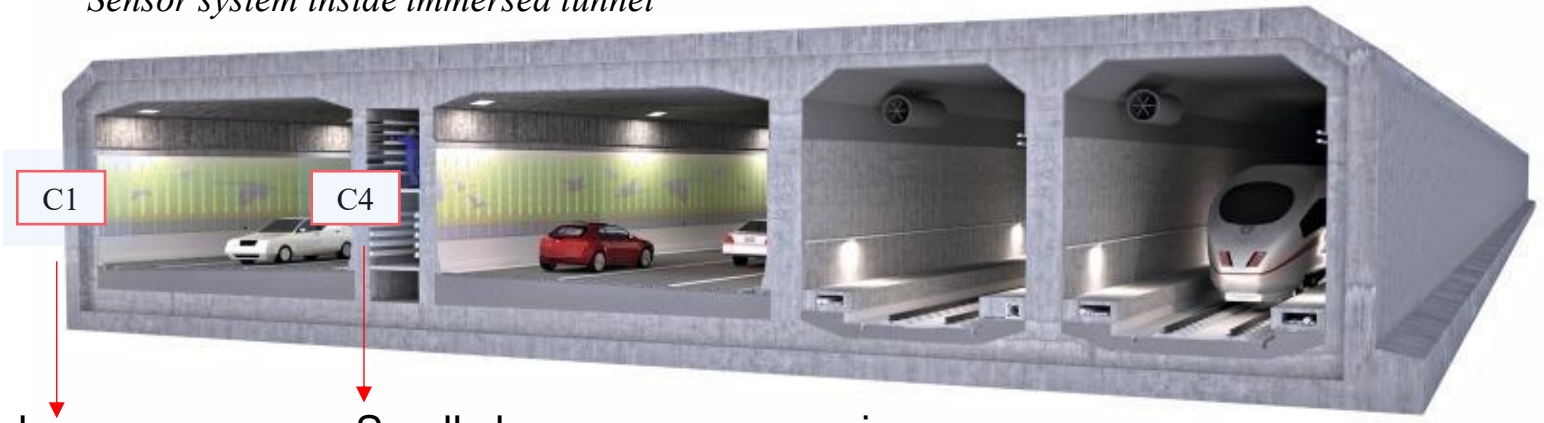
Using FT's electrochemical sensors for the concrete energy device





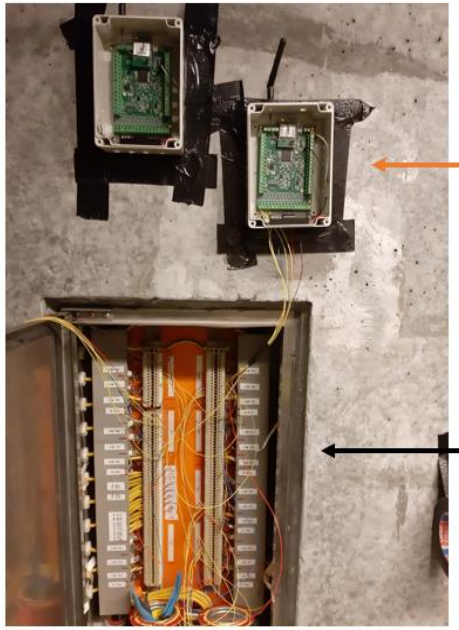


Sensor system inside immersed tunnel



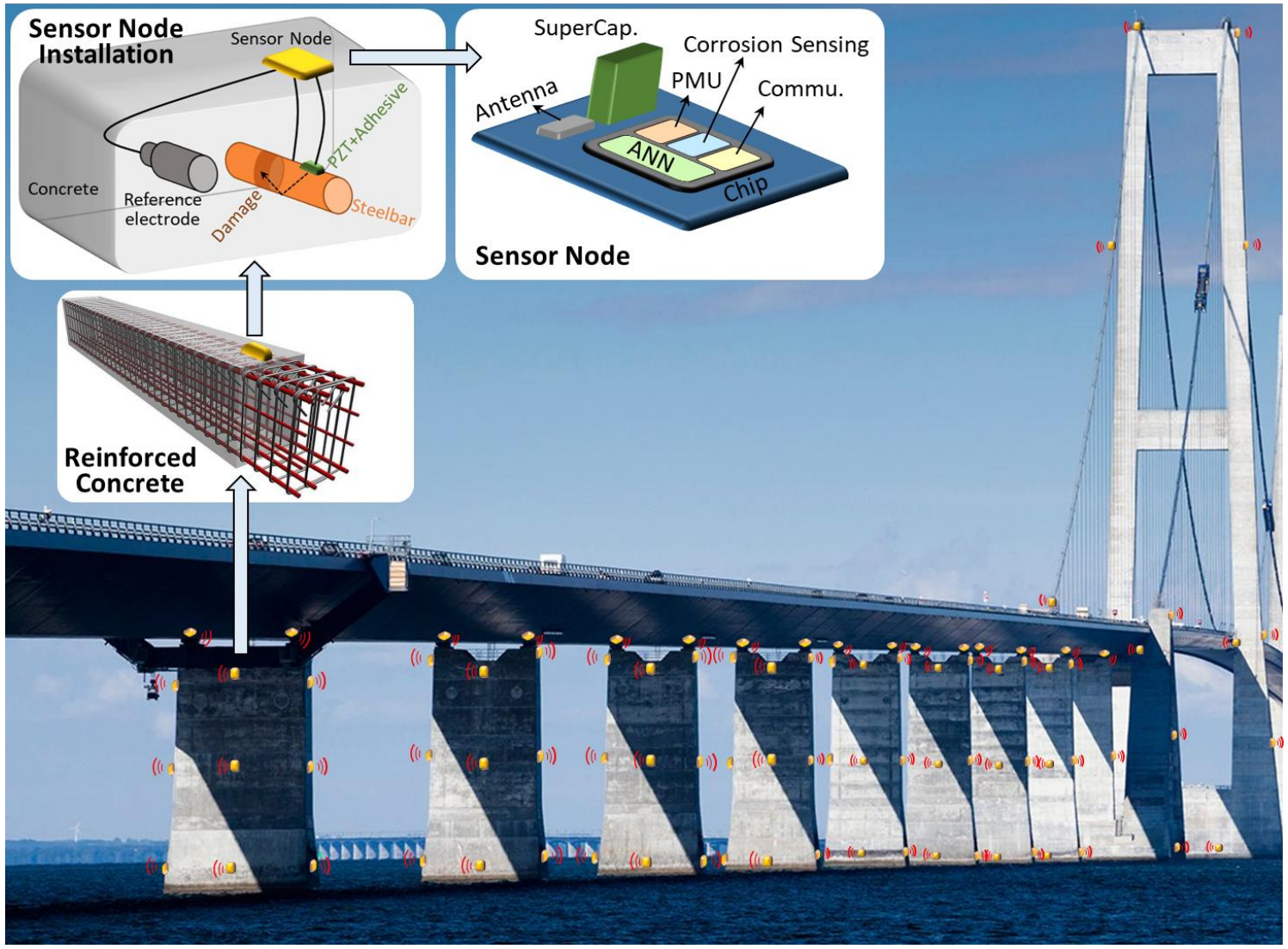
Large changes
= Corrosion
CorroWatch C1
(-403 to -975 mV)

Small changes = no corrosion
CorroWatch C4 (-101 to -174 mV)



Jaamac et al. Real energy harvesting study *IEEE Sensors Journal (2022)*

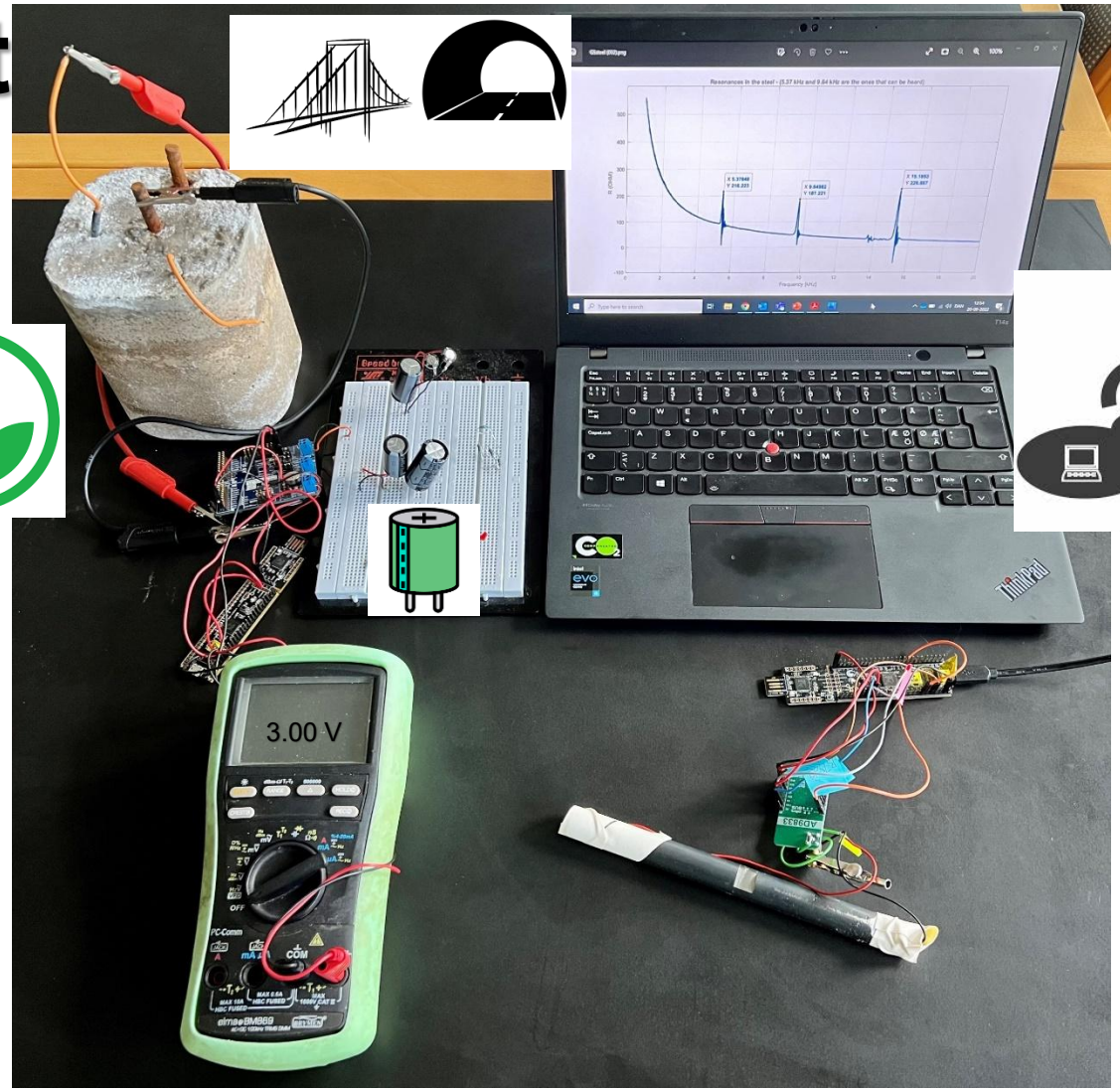
Concept on bridge – CorroSense device



CorroSense: Self-powered corrosion monitoring

STATUS!

Pre-GS Project stat



TRL 4: “ugly” prototype
Lab. PoC

ACTIVE SENSOR

Head-to-Head

Production, installation, inspection costs of one current device

Cords FT & others

Materials cost/unit	€200	→	€200
Inspection cost/unit	€700	→	€1000 (+nightshift add-on)
Electr. wiring/m.	€250	→	€250

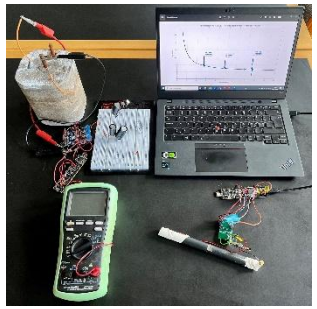
Vejdirektoratet: **1.259.600**

Sund≋Bælt: **21.294.800**

Retrofitting not possible = no additional market

Production, installation, inspection costs of one future device

No Cords (this CorroSense consortium)



Materials cost/unit	€200	→	€200
Inspection cost/unit	€0	→	€0
No electr. wiring	€0	→	€0

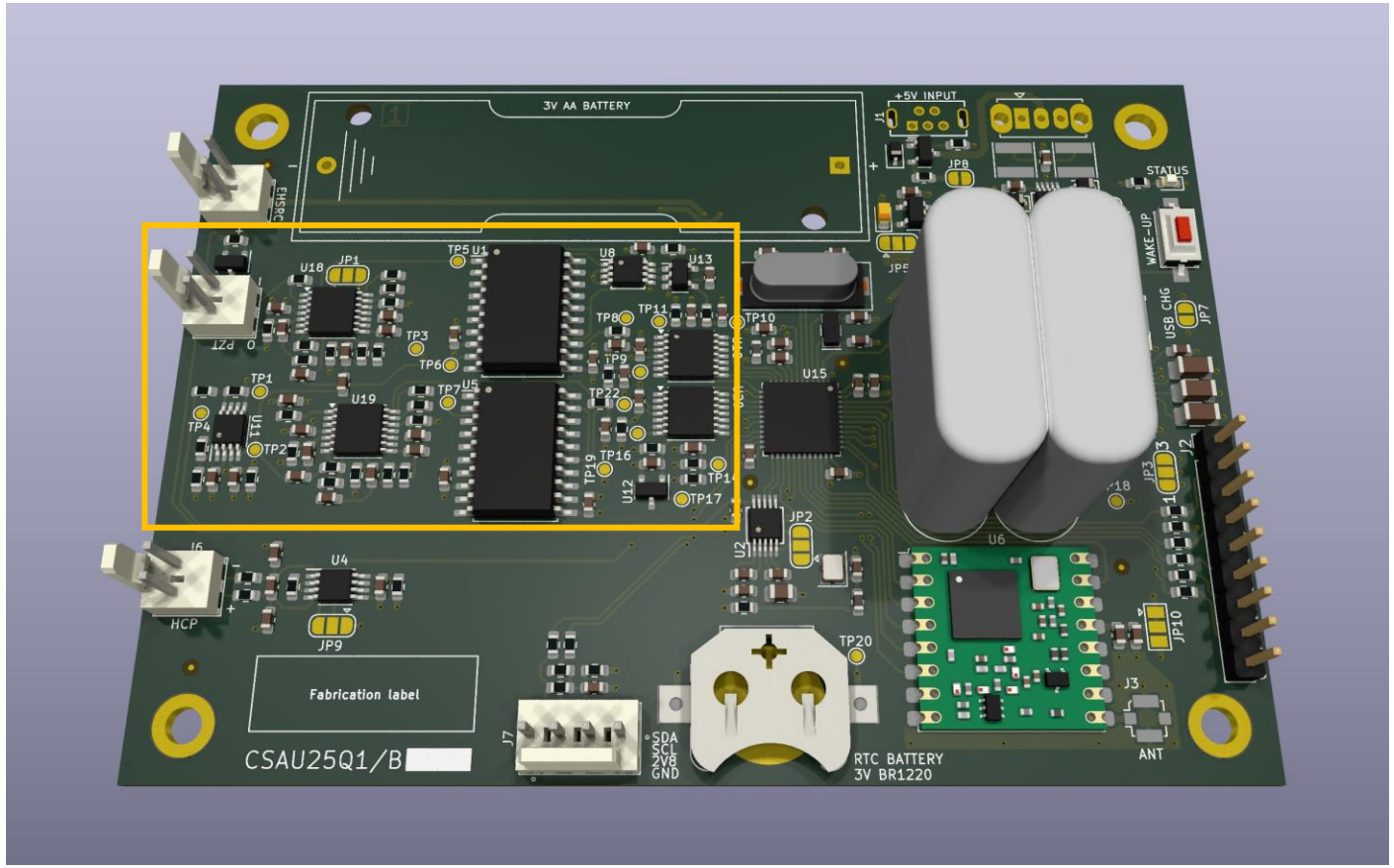
Vejdirektoratet: **259.600**

Sund≋Bælt: **4.000.000**

Retrofitting possible = large additional market

Status 2025

- Miniaturization of discrete measurement circuit (orange box) into single IC. Will reduce footprint and energy consumption.
- Enhanced data processing with a dedicated spiking neural network accelerator IC. (not shown). Will enable more advanced analysis at a lower power consumption.



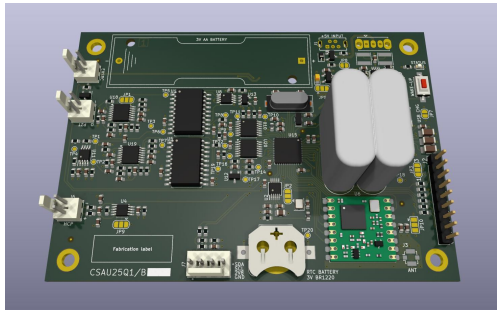
Business Plan

Advantages of future CorroSense device and new market access

Production, installation, inspection costs of one future device

No Cords (this CorroSense consortium)

Materials cost/unit	€200	→	€200
Inspection cost/unit	€0	→	€0
No electr. wiring	€0	→	€0



Retrofitting possible = large additional market + Damage control on cracks

Cloud and data computing

Data ownership of CorroSense data yields **software solution** and **user license** solutions (add. Sales)

Data collection for simulation for **predictive maintenance**, better prognoses for future constructions.

Environmental advantages *,large CO_2 reduction by:*

Sustainability (prolonging lifetime of constructions)

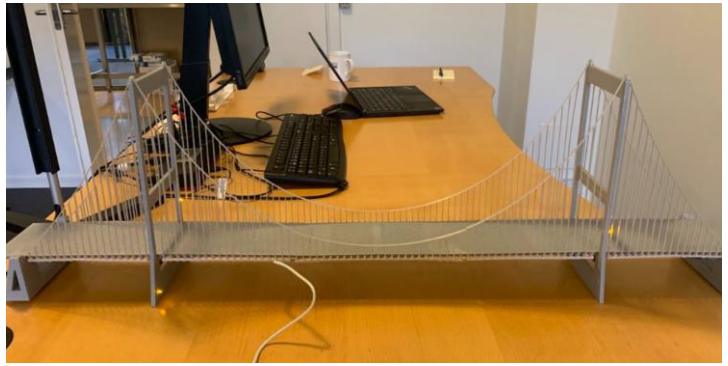
Inspection eliminated (flights/vehicles/Hotels etc.)

Cement production reduction (accounts for **8%** of the world's **CO_2 emissions**)**!**

Real time visualisation of sensor readings

CorroSense

Physical Entity



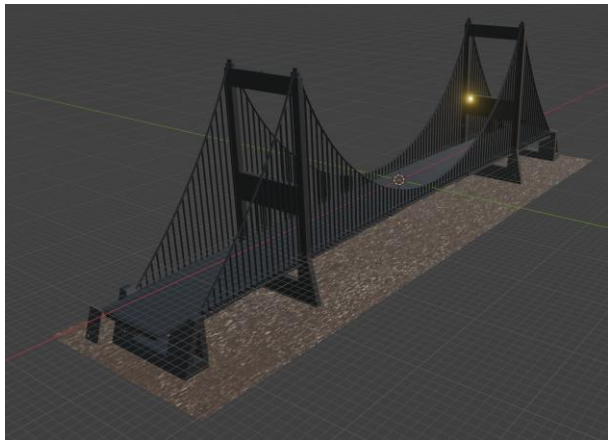
ARDUINO

Wi Fi

Communication Pipeline

MQTT

Virtual Entity



blender

python

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Keep in touch

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