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it's all about innovation





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# Temadag om digitale kalibreringscertifikater (DCC)

Taastrup – 5 October 2023

Jan Nielsen, Team leader

# AIM OF THE “THEME DAY”

- To provide insights into the DCC (hopefully) and all the terms surrounding it.
- To showcase and discuss the development and challenges of digital calibration certificates (DCC).
- To foster collaboration among stakeholders and gather input for future DCC development.
- To share updates on international developments.

The event is arranged in collaboration between:



BOARD OF REPRESENTATIVES

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DANISH TECHNOLOGICAL INSTITUTE

President and CEO Juan Farré

FOOD AND PRODUCTION		BUILDING AND CONSTRUCTION	MATERIALS	ENERGY AND CLIMATE	ENVIRONMENTAL TECHNOLOGY	SUBSIDIARIES
Executive VP Anne-Lise H. Lejre		Executive VP Mette Glavind	Executive VP Mikkel Agerbæk	Executive VP David Tveit	Executive VP Sune D. Nygaard	
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Business Development	Process Design and Operations	Masonry	Industrial 3D-print	Energy Efficiency and Ventilation	Laboratory for Chemistry and Microbiology	Dancert A/S
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Food Safety and Quality	Sustainability and Digitalization	Quality in Construction	Nano Production and Micro Analysis	Metrology and Quality Assurance	Product and Materials Chemistry	Teknologisk Innovation A/S
Food Technology	Training	Sustainable Construction	Plastics and Packaging Technology	Refrigeration and Heat Pump Technology	Water Technology	
		Sustainable Ideation	Tribology	Renewable Energy Systems		
		Wood and Biomaterials				

STAFF

1050 (2022)



# Danish Technological Institute – Metrology in short



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**Staff:** Approx. 50

**Facilities:** Temperature, Flow, Air-velocity, Geometry, length, Humidity, moisture, pressure, force, mass, electrical, frequency

+ 17 Mobil laboratories for on-site

- All services accredited by DANAK (ILAC-MRA) according to ISO 17025 (Calibration) and ISO 17043 (Proficiency testing)
- Designated Institute (covered by CIPM-MRA) and maintains Danish measurement standards within Contact Thermometry, Moisture, Water- and energy flow, air-velocity and geometry (length)
- Participates in EURAMETs Technical Committees and its key-comparisons, is active in European metrology research (EMPIR)
- CMC's in BIPM database: ≈50



# Digitalisation of metrology at DTI

Strategic research objectives:

- Remote calibration
- Digital Sensor Networks
- Digital Calibration certificates (DCC)
- PMI 3d koordinatmåling

# Remote calibration



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- Automatic calibration of climatic chamber
- Operated by customers personnel
- Validated on site
- Available for company's now
- DANAK Accreditation 2024 (hopefully)



# Digital sensor networks

## - district heating

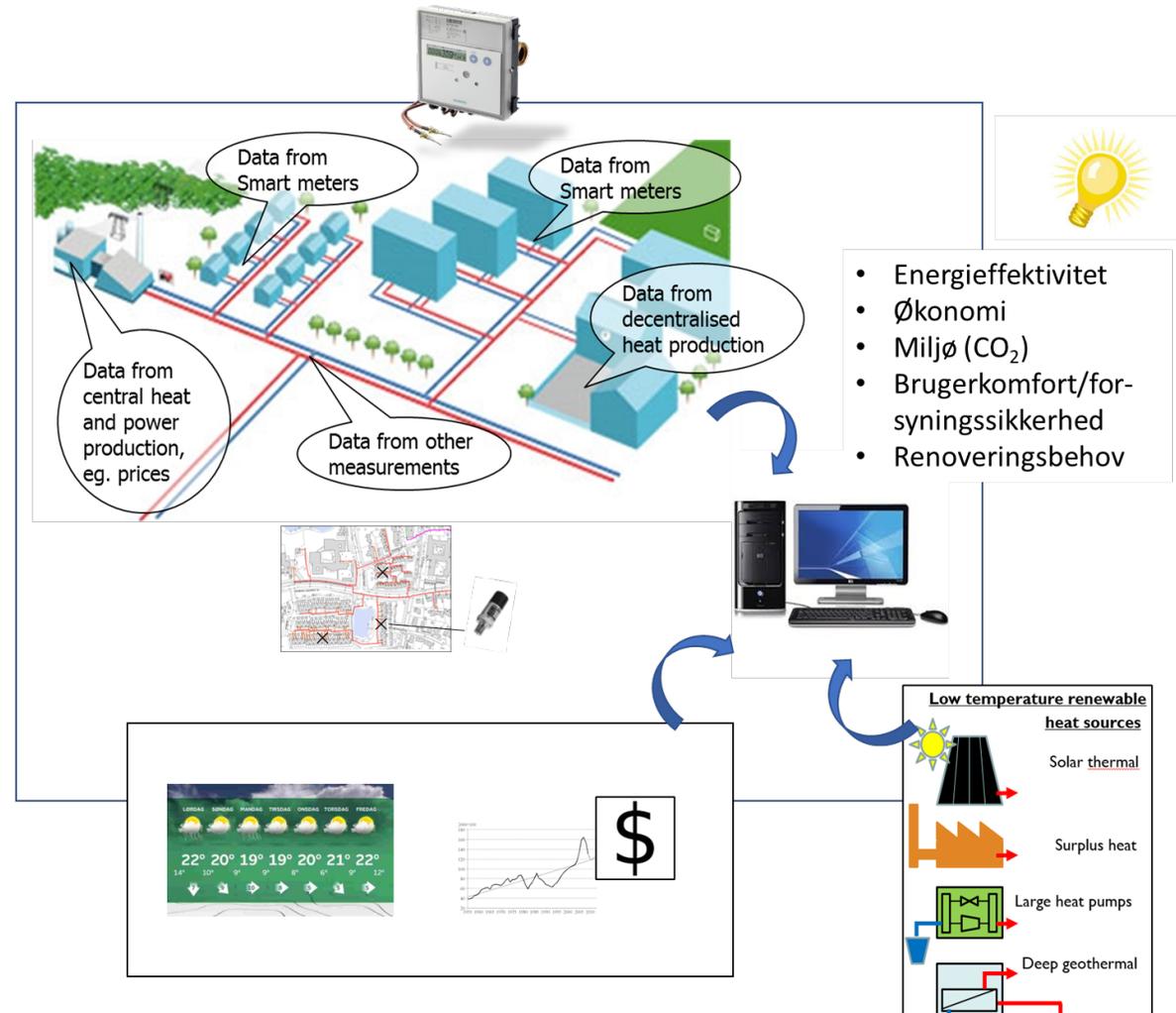


Aim:

To improve the energy efficiency of district heating Networks by using:

- Existing data sources
- New IOT technology

In a metrological sound way



# Digital sensor networks

## - district heating



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2017

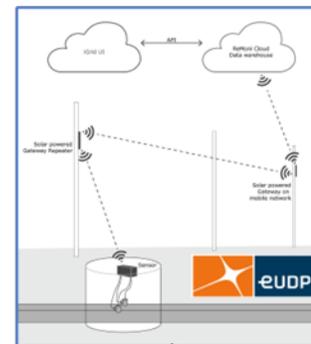
Smart Fjernvarme I  
DANSK FJERNVARME

Smart Fjernvarme II  
DANSK FJERNVARME

Ultra-Low Temperature concepts of DH distribution  
RELoTED  
Horizon 2020 European Union Funding for Research & Innovation

Tilstandskontrol til Asset Management  
eUDP

DH Sensor Power

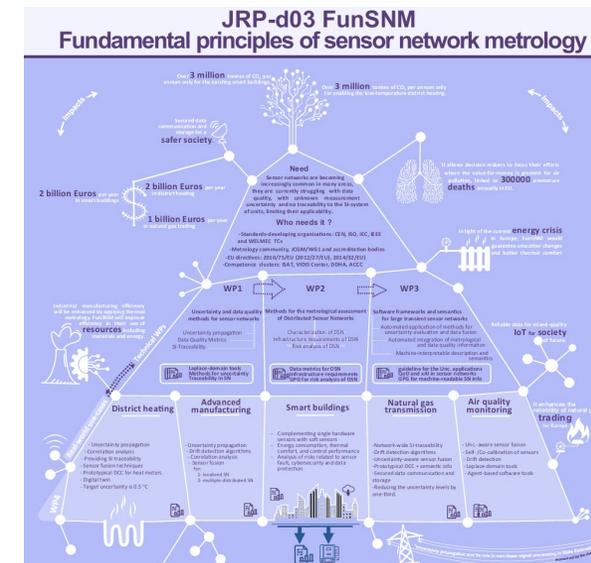


Flowbaseret lækageovervågning af store solfangeranlæg i fjernvarmen



2023

Technology Collaboration Programme  
by IEA  
**IEA DHC Annex TS 4:  
Digitalization of District Heating and Cooling:  
Optimized Operation and Maintenance of District Heating and Cooling Systems via Digital Process Management**  
INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON  
DISTRICT HEATING AND COOLING



# Digital sensor networks

## - district heating



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Algorithm 1:  
Pre-processing of GIS-data

Algorithm 2:  
Heat loss estimation

04/14/2011 01:56 PM

*EUDP-projekt "Fjernvarme Tilstandskontrol til Asset Management":*

- Big data algoritmer til beregning af varmetab på fjernvarmeledninger i drift
- Udnyttelse af fjernaflæste målerdata
- Tilstandsbaseret renovering

MACHINE LEARNING

*Dansk Fjernvarme F&U: "Smart Fjernvarme":*

- Databaseret fejlfinding og diagnosticering på fjernvarmeinstallationer
- Udnyttelse af fjernaflæste varmemålerdata
- Anvendelse af machine learning + statistisk analyse

*EUDP-projekt "Fjernvarme Sensor Power":*

- Skalerbare brøndmålepunkter til distributionsnettet via energy harvesting, IoT og clamp-on teknologi.
- Optimering via realtidsdata fra nettet

# Digital Calibration Certificates (DCC)

## - at Danish Technological Institute



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TERMOMETRILABORATORIET  
DANSK TEKNOLOGISK INSTITUT

Dato: 1992.01.22  
Cert. nr.: 99-2086  
Side 2 af 2

KALIBRERINGS CERTIFIKAT

Temperatur °C	Væning °C	Korrektion °C	Usikkerhed +/- °C
-0,00	+0,10	-0,10	0,10
+4,89	+4,95	-0,06	0,11
+10,00	+10,00	-0,00	0,11
+15,00	+15,00	+0,04	0,11
+19,00	+19,00	+0,06	0,11
+25,00	+25,00	+0,01	0,11
+30,00	+30,00	-0,01	0,11
+35,00	+35,00	+0,02	0,11
+40,00	+40,00	-0,01	0,11

afdelværdien af to aflæsninger.  
eller både usikkerhed ved bestemmelse af referen-  
værdien og aflæsesikkerhed på ennet.  
er efter ITS-90

424 SPRT Rosemount/1&2CE/2085 sporbar til DTI  
ring, certifikat 99-1843 af 22 aug 1990.

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DANISH TECHNOLOGICAL INSTITUTE

Certificate no.: 200-T-23162 Page 2 of 3

CALIBRATION CERTIFICATE  
Results

Sensor marked: BATH\_02

Reference value °C	Indication °C	Error °C	Uncertainty °C	Note
25,0002	25,0012	0,0010	0,0051	
30,0013	30,0023	0,0009	0,0055	
40,0020	40,0020	0,0005	0,0049	
50,0008	50,0008	0,0007	0,0052	
60,0009	60,0009	0,0010	0,0053	
70,0007	70,0007	0,0005	0,0055	
80,0018	80,0018	0,0009	0,0058	
90,0006	90,0006	0,0003	0,0069	
95,0006	95,0006	0,0004	0,0055	
99,9986	99,9986	-0,0018	0,0068	

of several measurements from the calibrated measuring instrument.  
nce value.

Dansk Akkrediterings Ordning  
Reg. nr. 99

teknologisk

KALIBRERINGS CERTIFIKAT

Dato 1991.01.27 Certifikat nr. 99-2086 Side 1 af 2  
Init. NAT/NGH Sagsnummer 270-2-0594 Antal bilag 0

Rekvirent: TERMOMETRILABORATORIET Rekv.nr.: -  
Kontaktperson: Ib Wessel  
Adresse: DTI/Aarhus  
By: - Tlf.: 86 142400

Emne: Hg-I-glas termometer  
Fabrikat: CASELLA LONDON  
Type: - Serie: 86226  
Område: -6,5°C - +51,5°C Inddeling: 0,5°C  
Udgangssignal: -  
Modtaget: - Kalibreret: 1992.01.22

Kalibreringsprocedure: Sammenligning DTI-procedure: DIR-1

Bemærkninger: Vådt termometer i ASSMAN PSYKROMETER 13-155

TERMOMETRILABORATORIET  
Ib Wessel  
Civilingeniør

Kalibreringscertifikat på kun gælder i udbrag.  
hvis laboratoriet fundet har godkendt udførelse.  
Kalibreringen er udført på omløbende betingelser.

Dansk Teknologisk Institut  
Energiteknologi

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Gørgensensvej  
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DK-2630 Taastrup  
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Telefax 42 99 54 36  
Gsm +45 60 61 63

1984 – 2006:  
Typewriter  
PC+Matrix printer  
Handwritten signature

CALIBRATION CERTIFICATE

CERTIFICATE NO.:  
200-T-23162

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TECHNOLOGICAL  
INSTITUTE

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Building 14  
DK-8000 Aarhus C  
Denmark  
Phone +45 72 20 20 00  
info@dti.dk  
www.dti.dk

Page 1 of 3  
No. of app.: 0  
Init: BJNI/SOAN

Client:

Object: Thermometer  
Make: Fluke Corporation Hart Scientific Division Model: 1560 Thermometer Readout  
Serial No: Client mark: 0.00001/0.0001  
Range: 25 - 100°C Graduation: The Black Stack  
Type: Accessories: 1 piece GE Sensing thermostat. Client mark: Serial number: 1 piece Fluke Corporation Hart Scientific Division, "Standard Thermistor Module"

Order No.: POR-2020-066  
Period: Received: 2020-08-27 Calibration date: 2020-09-01  
Procedure: DI-2.2

Remarks: Calibration was carried out by comparison with a reference thermometer in a temperature bath. The immersion depth is at least 1.5 times the diameter of the thermistor sensor. The "Average" function on the Fluke 1560 Thermometer Readout was activated during calibration.

Conditions: This Accredited calibration was carried out in accordance with international requirements (ISO/IEC 17025:2005) and in accordance with the General Terms and Conditions of Danish Technological Institute. The calibration results solely apply to the tested item. This calibration certificate may be quoted in extract only if Danish Technological Institute has granted its written consent.

Calibrated by: Bjørn Kjærsgaard Nielsen, +45 72203534, bjni@dti.dk

Approved and digitally signed 2020-09-16 by: Soren Lindholt Andersen Consultant, Ph.D.

IBAC-MEA DANAK  
CAL. Reg. no. 200

This PDF document is only valid if digitally signed with the OCES digital signature for Soren Lindholt Andersen, Danish Technological Institute.

2006 - ???:  
Auto-generated pdf  
Digital signature

A **digital calibration certificate (DCC)** serves for the **electronic** storage, the authenticated, encrypted and signed transmission and the uniform interpretation of **calibration** results. ...  
 The target group are all facilities worldwide, which need proof of the metrological traceability of their measurement results.

Metadata/adm. data

Measurement data

**CALIBRATION CERTIFICATE**

CERTIFICATE NO.: **200-T-23162**

**DANISH TECHNOLOGICAL INSTITUTE**  
 Teknologiparken  
 Kongsvang Allé 29  
 Building 14  
 DK-2800 Århus C  
 Denmark  
 Phone +45 72 20 20 00  
 info@dti.dk  
 www.dti.dk

Page 1 of 3  
 No. of app.: 0  
 Inr.:  
 BNU/SOAN

Client: [Redacted]

**Object: Thermometer**  
 Make: Fluke Corporation Hart Scientific Division  
 Model: 1560 Thermometer Readout  
 Serial No: ADA105  
 Client mark: BATH\_2  
 Range: 25 - 100°C  
 Graduation: 0.00001/0.0001  
 Type: The Black Stack  
 Accessories: 1 piece GE Sensing thermistor. Client mark: "BATH\_2". Serial number: 5282.  
 1 piece Fluke Corporation Hart Scientific Division, "Standard Thermistor Module", model 2563. Serial number: A94286.

Order No.: POR-2020-066  
 Period: Received: 2020-08-27  
 Calibration date: 2020-09-01  
 Procedure: D1-2.2

Remarks: Calibration was carried out by comparison with a reference thermometer in a temperature bath. The immersion depth is at least 15 times the diameter of the thermistor sensor. The "Average" function on the Fluke 1560 Thermometer Readout was activated during calibration.

Conditions: This Accredited calibration was carried out in accordance with international requirements (ISO/IEC 17025:2005) and in accordance with the General Terms and Conditions of Danish Technological Institute. The calibration results solely apply to the tested item. This calibration certificate may be quoted in extract only if Danish Technological Institute has granted its written consent.

Calibrated by: Bjørn Kjærsgaard Nielsen, +45 72203534, bjni@dti.dk

Approved and digitally signed  
 2020-09-16 by: *Søren Lindholt Andersen*  
 Søren Lindholt Andersen  
 Consultant, Ph.D.

**DANAK**  
 CAL Reg. no. 200

This PDF document is only valid if digitally signed with the OCES digital signature for Søren Lindholt Andersen, Danish Technological Institute.

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 DANISH TECHNOLOGICAL INSTITUTE

Certificate no.: 200-T-23162 Page 2 of 3

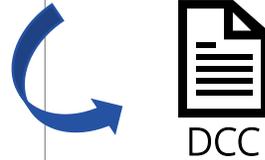
**CALIBRATION CERTIFICATE Results**

Sensor marked: BATH\_02

Indication	Error	Uncertainty	Note
°C	°C	°C	
25.0012	0.0010	0.0051	
30.0023	0.0009	0.0055	
40.0020	0.0005	0.0049	
50.0008	0.0007	0.0052	
60.0009	0.0010	0.0053	
70.0007	0.0005	0.0055	
80.0018	0.0009	0.0058	
90.0006	0.0003	0.0069	
95.0006	0.0004	0.0055	
99.9996	-0.0018	0.0068	

the average of several measurements from the calibrated measuring instrument.  
 Indication - reference value.

Temperatur - 20190221



Why:

- The DCC is the next step in the digital transformation of metrology
- More efficient exchange of data
- DCC's create value for industrial and administrative processes.
- International harmonisation is necessary
- Requirements such as ISO 17025 must be met
- ...



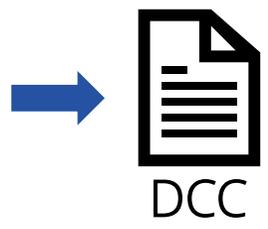
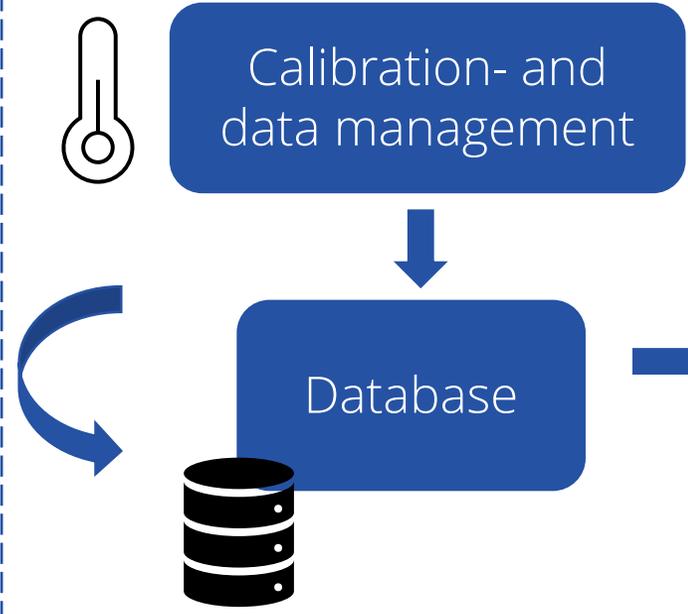
**TEKNOLOGISK  
 INSTITUT**

**IMPLEMENTERINGSPROJEKT  
VED TEKNOLOGISK INSTITUT  
(DELELEMENT AF  
RESULTATKONTRAKT 2021-2024  
MED UDDANNELSES- OG  
FORSKNINGSSTYRELSEN:  
METROLOGI I DEN DIGITALE  
OMSTILLING)**

Requirements  
ISO 17025

TC-IM 1448  
DANIAmet  
(DFM+FORCE)

European projects  
e.g. Smartcom2,  
DCC2GO, ...



Feedback og ønsker

