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Overview of Microgrid Developments in Europe & Africa

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on behalf of the Europe & Africa Regional Steering Committee

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Europe & Africa: Drivers for Microgrid Adoption

Each region has **fundamentally different motivations** for microgrids:

Europe (mostly EU)	Africa	
Mature market economies ***"Transforming Growth"*** *(Venkataramanan and Marnay, 2008)*	Emerging market economies ***"Managing Growth"*** *(Venkataramanan and Marnay, 2008)*	Developing market economies ***"Expanding Reach"*** *(Venkataramanan and Marnay, 2008)*
▪ Flexibility requirements (RES penetration, shifting electrical demand from PEVs, HVAC,…) ▪ Enhanced market operations and community empowerment ▪ Diesel offset in islands	▪ Weak grid support ▪ Maintenance and enhancements of PQR ▪ Rural electrification	▪ Rural electrification

EU Microgrids: Intense R&D/I but Minimal Adoption

The EU remains a R&D/I powerhouse for microgrids:

- Most developments are supported by **EC-funding schemes** (albeit not all)
- The current EC SG R&I agenda is geared towards **technical and/or economic validation of products and services** as well as towards **replication and result exploitation** within the EU and globally (hence more IAs – R&I)
- The BRIDGE EC initiative fosters **active project knowledge sharing** under a common structured framework so to remove obstacles to innovation
- However, a market-based adoption of microgrids is still virtually inexistent
  → Due to broader R&D focus (smart grids), drivers, and regulatory complexity

EU Microgrids: Vast Portfolio of Related Projects

EMPOWER

dominoes
smart distribution grid

STORY

FUSION GRID

GOFLEX

InterFLEX

Nobel Grid
Smart energy for people

factory microgrid

RDC² MT
H2020-MSCA-RISE

European Commission | Horizon 2020 European Union funding for Research & Innovation

BUSINESS FINLAND

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EU Microgrids: S/L-scale R&D Facilities and Testbeds

EU Microgrids: Relevant Energy Policy Context

The emergence of the **Energy Union** and of the "**Clean Energy Package**" brought great implications for the EU energy system, particularly at the distribution level:

- Energy Union's Guiding principles: 1) Energy security, solidarity and trust; 2) Fully integrated European energy market; 3) Improving energy efficiency; 4) Decarbonization of the economy; 5) Research, innovation and competitiveness.

- The revised "Electricity Directive" and "Renewable Energy Directive" shaped the new **Renewable/Citizen Energy Communities (R/CECs)** concept

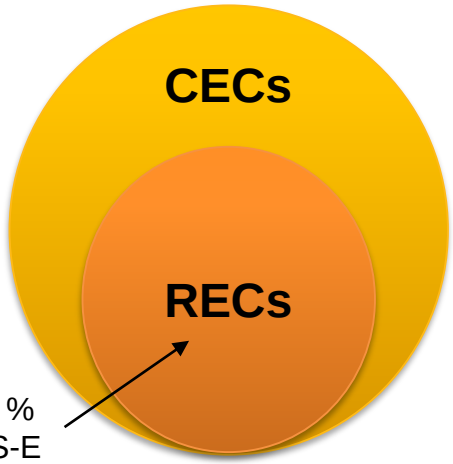
"Electricity Directive" – Directive (EU) 2019/944 and amending Directive 2012/27/EU → **CECs**

"Renewable Energy Directive" – Directive (EU) 2018/2001 → **RECs**

EU Microgrids: Energy Communities as Keystone (1)

R/CECs represent a promising first step towards EU microgrid realization

*"(CECs are) a legal entity that (a) is **based on voluntary and open participation** and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises; (b) has for its **primary purpose to provide environmental, economic or social community benefits** to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and (c) **may engage in generation**, including from **renewable sources**, **distribution**, **supply**, **consumption**, **aggregation**, **energy storage**, energy efficiency services or **charging services for electric vehicles** or provide other energy services to its members or shareholders"*



- 100 % renewable
- Strict governance and participation criteria
- Geographical proximity
- Active Support
- Favorable conditions for RES support

- Recognition as a market actor
- No discrimination
- Level playing field
- Strict governance criteria, but open membership

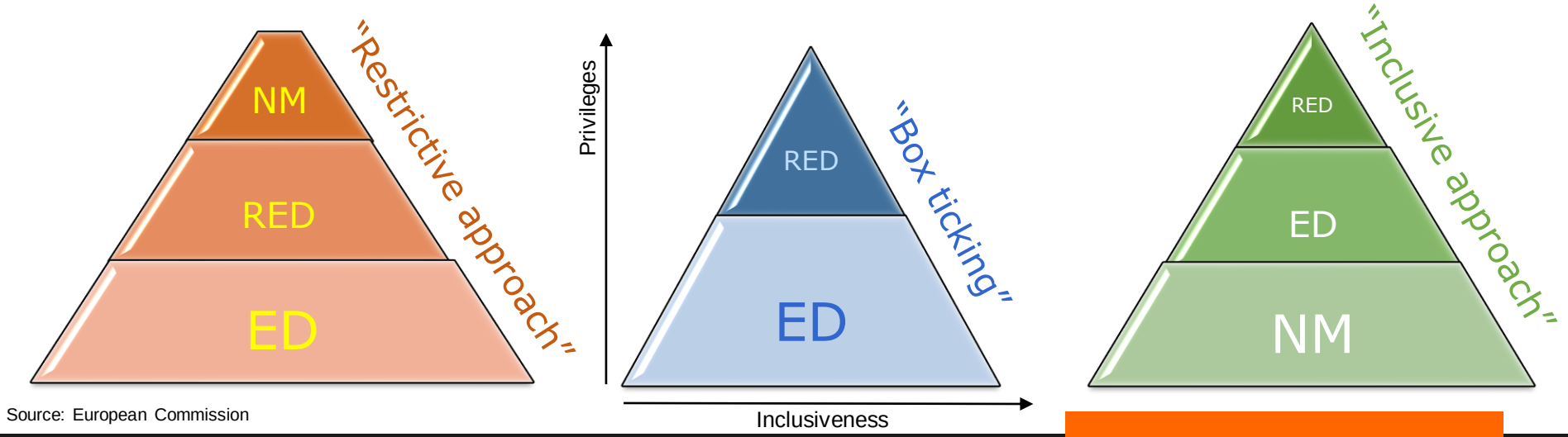
Source: European Commission

Source: European Commission

EU Microgrids: Energy Communities as Keystone (2)

Transposing EC Directives into NMs – Relevant/contentious points:

- R/C energy communities (can accommodate but) are not microgrids;
- Member states may decide (but do not necessarily have to) "***grant energy communities the right to manage distribution networks***";
- Different models can be implemented by the member states, according to their energy policy orientation and context, and prior related work (tailor-made).



Source: European Commission

EU Microgrids: Receiving Increasing Attention

New fully dedicated R&D Centre (**CROM**)

AALBORG UNIVERSITET

Unleashing the power of the microgrids

2.4.2019 11:44:31 CEST | Aalborg Universitet

Share

Autonomous microgrids may play a vital part in the future's sustainable energy supply. Professor from Aalborg University receives grant of 39 million DKK for further research in smart cluster solutions for microgrids that makes sustainable energy distribution safer and more efficient.

PROFESSOR JOSEP M. GUERRERO RECEIVES GRANT OF 39 MILLION DKK

Unleashing the power of the microgrids

Last modified: 03.04.2019

Autonomous microgrids may play a vital part in the future's sustainable energy supply. Professor from Aalborg University receives grant of 39 million DKK for further research in smart cluster solutions for microgrids that makes sustainable energy distribution safer and more efficient.

Today, a large number of private households, companies and public institutions have invested in autonomous solar power installations that only supply the limited number of buildings and users that are connected, and rely on the main grid. This means that a large part of the energy that is being produced goes to waste if there is no local demand on the grid.

According to one of the World's leading researchers in microgrid technology, microgrids could be the key to a far more efficient, safe and reliable distribution of sustainable energy.

- If we can develop the technology to coordinate microgrids in clusters, we can achieve unprecedented levels of scalability expandability, efficiency and resilience. This is the next frontier of microgrid research, says Professor Josep M. Guerrero from the Department of Energy Technology at Aalborg University.

LOST IN TRANSMISSION

Right now, about 15 per cent of the power is lost in transmission between power plants and consumers. But microgrids that communicate and work together in clusters could be the most efficient way of bringing stable, sustainable energy generation to people.

- Imagine several villages in a rural area without electricity access. Each village could generate renewable energy, store and consume it locally thus forming a microgrid. The next step is to interconnect each microgrid village to build an electrical distribution system and share the power generation and consumption among the villages. This way we can conceive electrical grids from the population needs following a bottom-up approach, Professor Guerrero

Villum Investigators honored

3 May 2019 | Latest news

11 recognised scientists – and newly appointed Villum Investigators - were honored 2 May 2019. Together, they have received DKK 410 million from VILLUM FONDEN for research projects ranging from climate to cybersecurity.

What began as a field of 80 applicants to become the next group of Villum Investigators has ended with the selection of 11 science and technology researchers who will now receive as much as DKK 40 million each over the next six years.

All of them have strong international experience, five of them come from abroad. On 2 May 2019 they were celebrated at a ceremony at the VILLUM Window Collection – and now officially have the right to call themselves Villum Investigators.

Chair of VILLUM FONDEN, Jens Kann-Rasmussen, and the foundation's Executive Chief Scientific Officer, Thomas Bjørnholm, delivered speeches at the ceremony. During the

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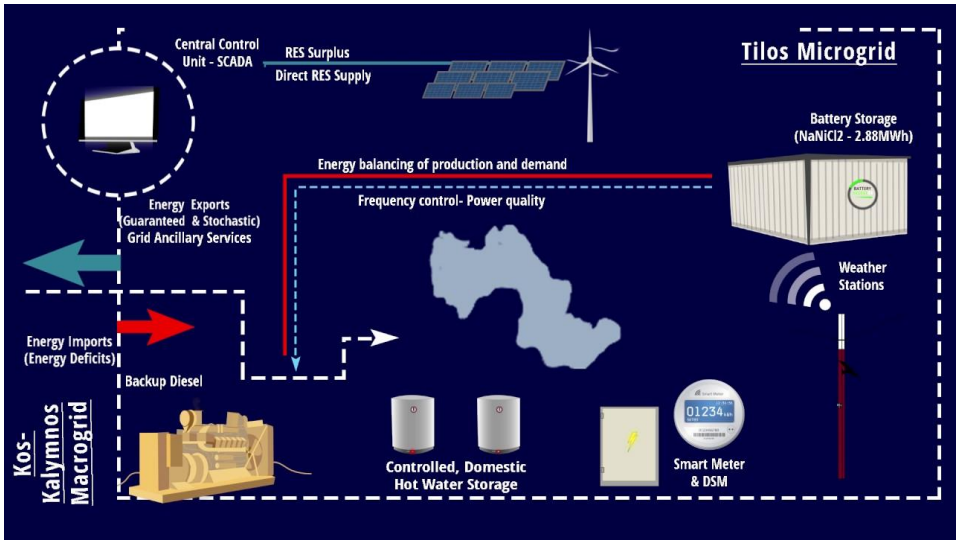
EU Examples: Tilos Island, Greece (TILOS project)

H2020 research project whose goal is to demonstrate **multipurpose roles of small-scale battery energy storage** within grid-connected island microgrids, specifically 1) Microgrid energy management, 2) Maximization of RES penetration, 3) Grid stability, 4) Guaranteed energy export, and 5) Ancillary services to the grid

- The Tilos microgrid is 1 of 4 pilot facilities (1 of 2 island facilities), featuring a **2.88 MWh $NaNiCl_2$** battery system, solar and wind capacity, and a diesel backup
- Weak interconnection with Kos
- **Focus on roles 1) to 5)** and on testing various operation modes
- The main project goal is to further develop a replicable **integrated $NaNiCl_2$ battery solution**



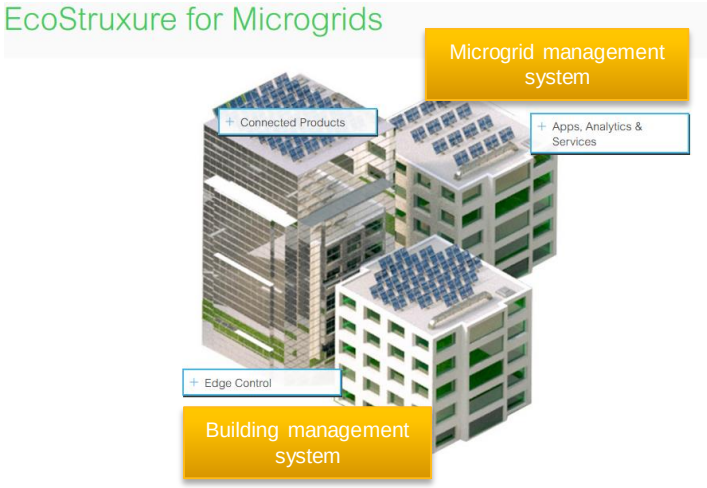
www.tiloshorizon.eu

Technology Innovation for the Local Scale
Optimum Integration of Battery Energy Storage

EU Examples: LIDL distribution center, Finland

New 60000 m^2 industrial site runs on 100% RES

- Market-based solar + storage project was delivered by Schneider Electric and started operations in the beginning of 2019, **resulting in up to 70% energy cost savings**
- Integrated management of building load (heating, cooling) and grid systems combining Schneider's EcoStruxure and Microgrid Advisor technologies, which **collects, forecasts, and optimizes operation of on-site DER assets** using real-time data and predictive machine learning algorithms
- Microgrid takes part in the Finnish DR market



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Africa Microgrids: Both a crisis and an opportunity

Resource-rich Africa's economic expansion is stunted by extensive energy poverty

- More than 640 million in sub-Saharan Africa **still lack access to reliable, affordable electricity** (an access rate of 47% - the lowest in the world)
- Per capita energy consumption in sub-Saharan Africa[1] is 180 kWh, compared to approx. 13,000 kWh per capita in the United States and 6,500 kWh in Europe
- **Africa's microgrids, largely dominated by the remote/off-grid segment, reached over 3 GW in 2019**, boosting over 10% of global microgrid capacity
- Some specific microgrids are serving mines and off the African coast, island microgrids proliferated (fuel dependence reduction, RES share increase,…)

[1]Excluding South Africa

Africa Examples: FUSION GRID project, Namibia

Project provides a stacked *Electricity + Connectivity* offer :

- Project **technology and business innovation** for sustained growth in remote African communities
- RES-powered base station offers **4G LTE connectivity**
- A fraction of the project value is captured trough subsequent local business growth i.e. longer-term project returns rely on benefits from **local digital economy**
- Pilot facility in Oniipa town to go online by end of 2019

FUSION GRID

LUT University

GEF

SYK Suomen Yliopisto-Kiinteistöt Oy

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Africa Examples: Porto Santo Island (Madeira), Portugal

An integrated <u>"smart island" test bed</u>

- ABB is working with local utility (EEM) to deploy their PowerStore™ microgrid solution and Microgrid Plus automation system, with the goal of **elevating the island's solar and wind generation share from 15% to 30%**
- Groupe Renault will test 2nd life PEV battery use by selected residents and their charging patterns (**40 smart charging points have been deployed**), as well as V2G solutions

Electricidade da Madeira ABB BOUYGUES ENERGIES & SERVICES THE MOBILITY HOUSE

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Conclusions

- The context for microgrids in Europe is finally transitioning from an exclusively R&D-oriented one to one more geared towards **real-world microgrid testing, validation, and implementation**;
- The latest EC legislation and subsequent emergence of renewable/citizen energy communities mark a cornerstone in EU policy that may drive further expansion of local energy systems and **trigger new microgrid markets**
- Africa continues to face multifaceted energy access challenges. Microgrids for the mining industry and in developed country island territories are common but few have been deployed in **remote community and urban environments**


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THANK YOU!
QUESTIONS?
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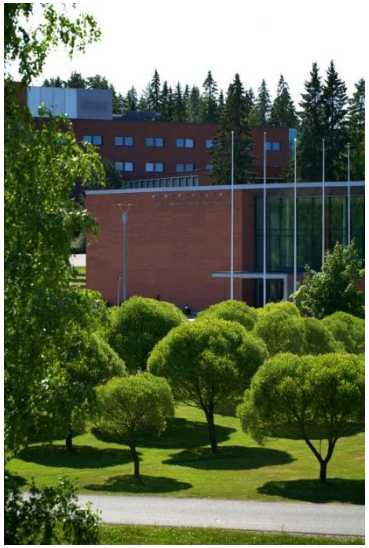
EXTRA SLIDES

LUT: Hierarchical structure



COLLEGIATE BODY

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RECTORATE

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LUT LES

LUT SCHOOL OF ENGINEERING SCIENCE

Departments

Energy Technology

- Modelling of Energy Systems
- Renewable energy systems
- Thermodynamics
- Fluid Dynamics
- Nuclear Engineering
- Nuclear safety

Mechanical Engineering

- Machine Design
- Steel Structures
- Intelligent Machines
- Production Engineering and Sheet Metal Work Technology
- Laser Processing
- Packaging Technology
- Fiber

Sustainability Science

- Sustainable Solutions
- Sustainability Change
- Sustainability Science Group

Electrical Engineering

- Electricity Markets & P.S.
- Electrical Drives Technology
- Control Engineering and Digital Systems
- Applied Electronics

LEMPS

LEMPS: Lab. of Electricity Markets & Power Systems

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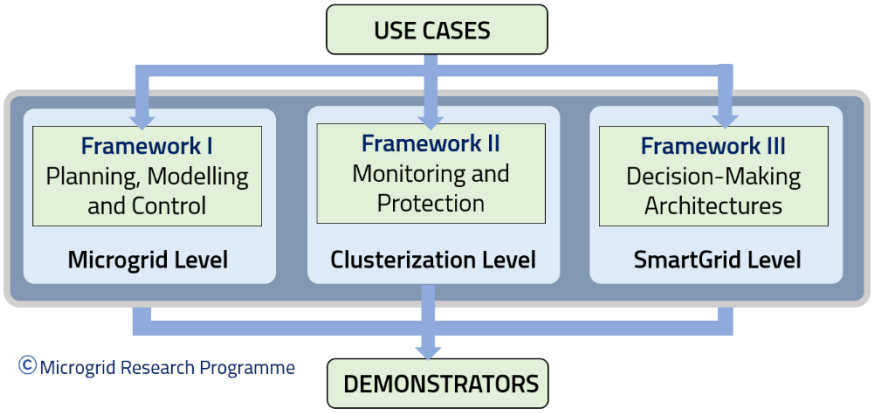
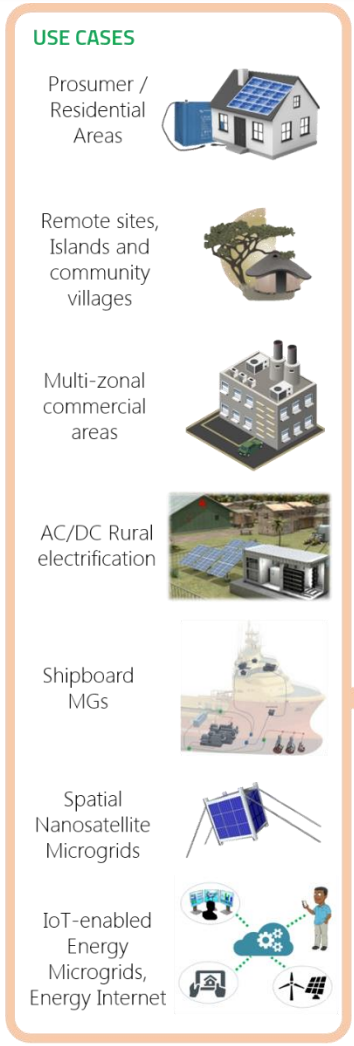
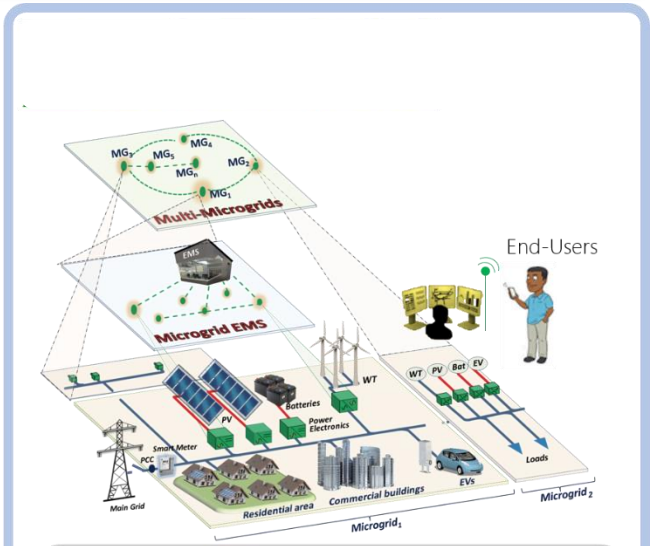


CROM vision is to develop a new research-oriented platform and framework for design, analyses and assess multiple Microgrids forming **clusters** with unprecedented levels of **scalability and expandability**, giving as a result highly efficient and resilient grids.





AAU Microgrid Laboratories - Demonstrators

Focus Areas

- AC and DC Microgrids
- Shipboard Microgrids
- IoT-enabled Energy Systems and Energy Internet

Core Challenges

- Low and Medium Voltage Microgrids
- Microgrids in Emergent Countries and Electrification of Rural Areas
- Energy Sharing: Renewable-energy-focused Neighborhoods
- Maritime Microgrids for Shipboards and Seaports
- Protections and Communication Systems for Microgrid Clusters
- Multi-agent Systems for Microgrids and Microgrid Clusters
- Bio-inspired Microgrids
- Advanced Metering Infrastructures
- Smart Homes (Automation, Energy Optimization And Savings)
- Blockchain Approaches for Energy Trading Purposes
- Energy Management Systems And SCADA Systems
- LVDC Distribution Architectures For Residential Applications
- Hybrid Energy Storage Systems for Islanded Grids

CROM TEAM MEMBERS

- 2 Programme Coordinators
- 2 Assistant Professors
- 5 Postdoctoral Researchers
- 1 Research Assistant
- 14 PhD students
- 15 Visiting scholars (currently)

LABORATORY FACILITIES

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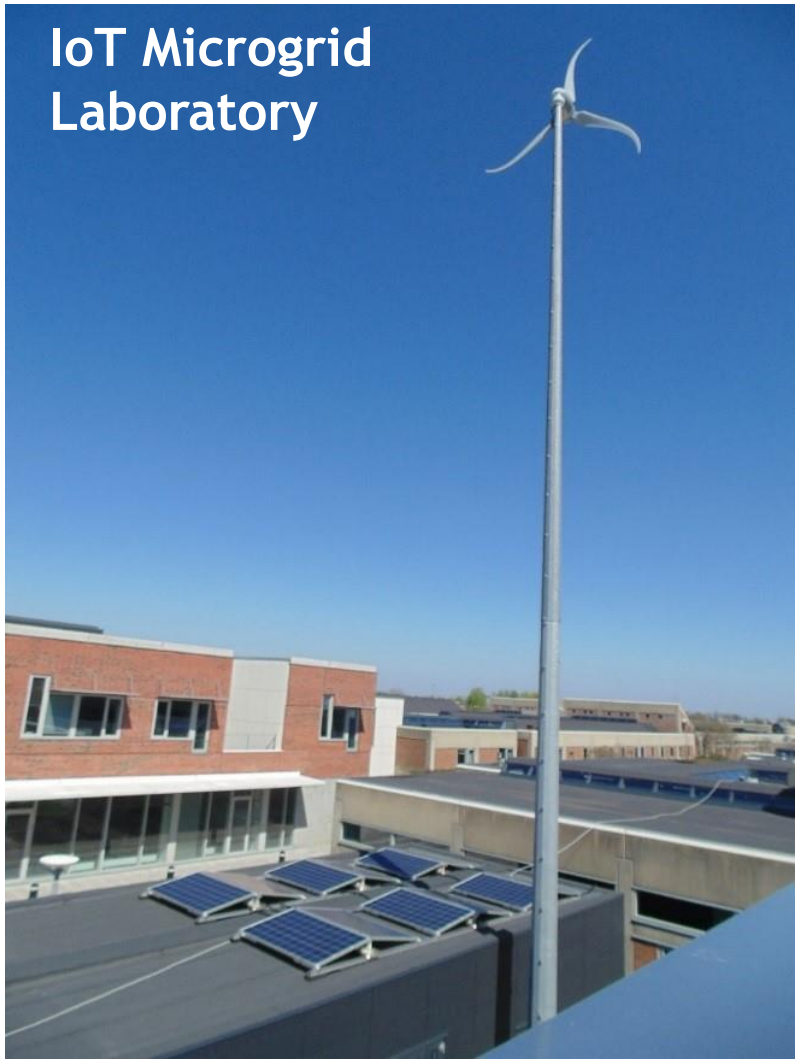

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