

Power IoT challenges and Opportunities

(related to Wireless edge devices)



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Dublin
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HOST INSTITUTION



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

PARTNER INSTITUTIONS



Waterford Institute of Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

- By 2025 we shall have 1 trillion sensors in our world [1]
 - >50% of these will be wireless IoT edge devices
 - Cost effective, easy to retrofit & monitor on, in near existing equipment, environment, infrastructure, people
- The IoT can address some of the most urgent challenges of 21st century : e.g.



Tackling climate emergency



Prosperous, Pollution-free environment



Restoration of biodiversity



Ensuring clean energy, safe food



EU partnership with UN

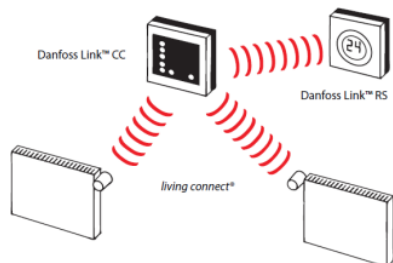


Health/well-being of population (increasing & ageing)

European Green Deal

IoT is a key enabler to 'transform the EU into a fair & prosperous society, with a modern, resource-efficient & competitive economy where economic growth is decoupled from resource use'

1. P. Diamandis, M.D. Singularity University, <https://singularityhub.com/2015/05/11/the-world-in-2025-8-predictions-for-the-next-10-years/>



Smart heating control



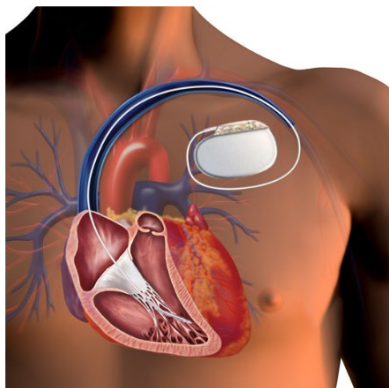
**Monitor performance of
integrated renewables**



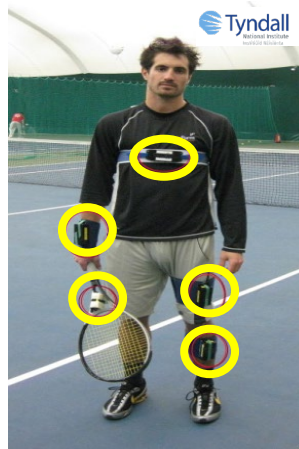
Process efficiency
Changeovers, bottlenecks, etc.



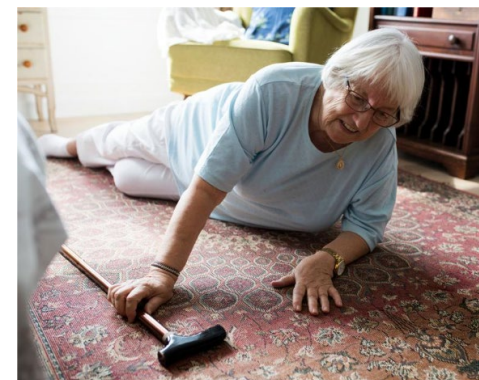
Predictive maintenance



Pacemaker



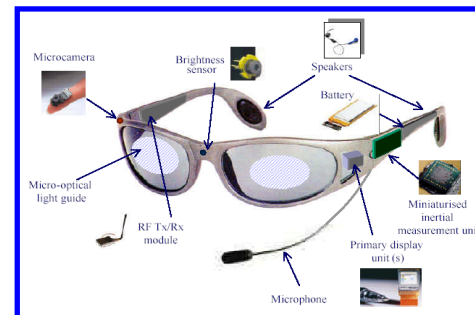
Sports performance



Assisted living



Smart patch/bandage



Smart glasses

Opportunities?

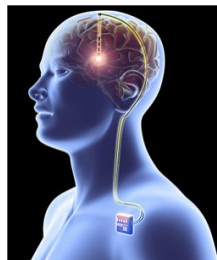
Smart mobility & Safety



Asset tracking



First responder
(e.g. Safety, route optimization)



‘On in and near people, equipment, infrastructure’

Utilising the potential of the sensory data is a big opportunity to meet the **Green Deal** objectives of the European Union & to contribute to the **UN Sustainable Development Goals**.

https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

<https://sdgs.un.org/goals>

Typical battery life is less than 2 years Vs
Most IoT devices need > 10 years.

- > Multiple battery replacements.
- > Device downtime and maintenance
- > Major environmental issues



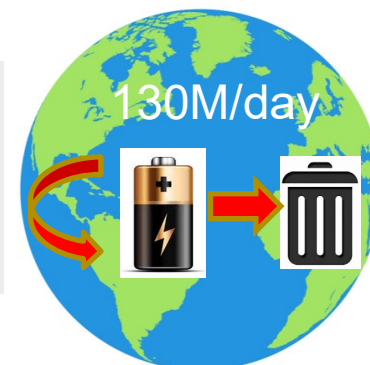
CIRCULAR ECONOMY PLAN

'3.1. ...less than 40% of electronic waste is recycled in the EU20. Value is lost when the battery cannot be replaced...or materials incorporated in devices are not recovered'

UNLESS WE IMPROVE by 2025 we will manufacture and dispose of >130M batteries every single day just from IoT usage!

A New Industrial Strategy for Europe

3.4. We must move away from the age-old model of taking from the ground to make products, which we then use and throw away. We need to revolutionise the way we design, make, use and get rid of things



We MUST find ways to make batteries last longer – how?

1. Make batteries that supply more energy



2. Reduce power consumption of the IoT device



3. Use ambient energies – Energy Harvesting



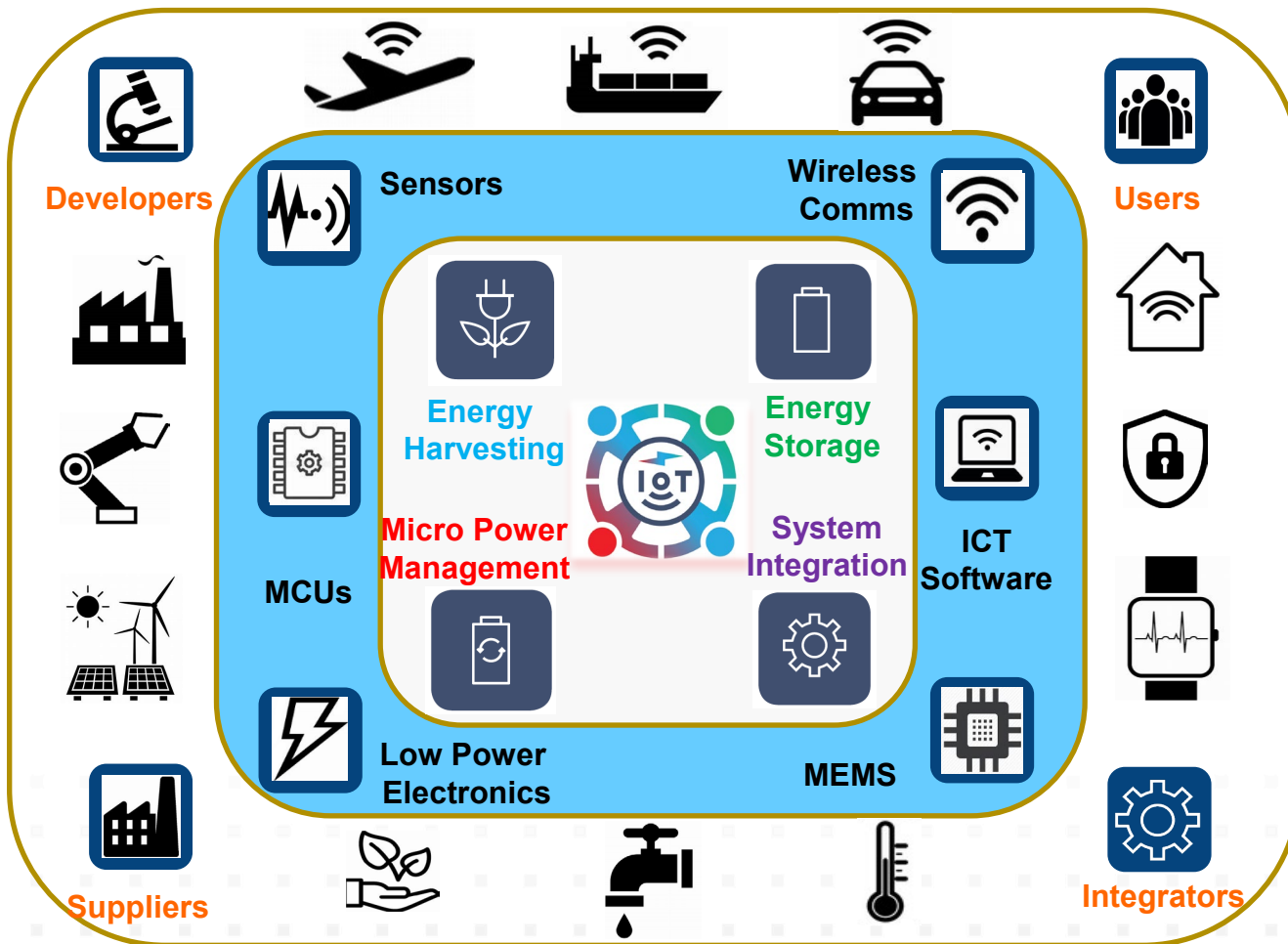
Heat (thermoelectricity)



Vibration/kinetic



Solar (PV)



■ Scientific Disciplines ■ Related Enabling Technologies □ IoT Applications ■ Stakeholders

[ERA Action plan](#) (link)

European Industrial Ecosystems bring together crucial players: academic and research institutes, suppliers, SMEs and larger companies

European Green Deal: supply clean and affordable energy, using digitalisation, especially for monitoring purposes and natural energy optimisation.

“2.1.3.the internet of things can accelerate and maximise the impact of policies to deal with climate change and protect the environment

[e.g.]distance monitoring of air and water pollution, or for monitoring and optimising how energy and natural resources are used.

[ICT devices] improve the energy efficiency and circular economy performance.”

Electronic equipment batteries and waste is at the heart of the new **Circular Economy Action**

“3.1. less than 40% of electronic waste is recycled in the EU20.”



European Industrial Strategy. Sensors improve renewable energy reliability and performance monitoring. Recycling and re-use of materials is critical.

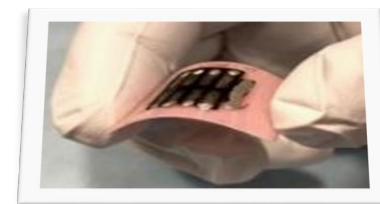
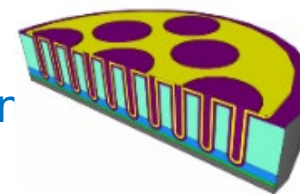
“3.3 We will need a more strategic approach to renewable energy industries....and the supply chain underpinning them.”

“3.4 We must move away from the age-old model of taking from the ground to make products, which we then use and throw away. We need to revolutionise the way we design, make, use and get rid of things”



EU Project 730957

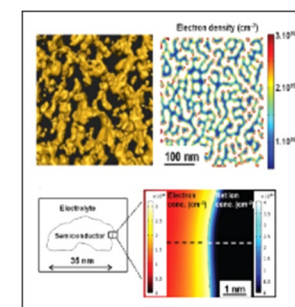
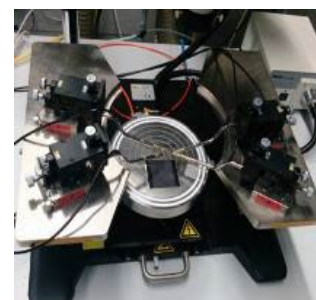
- Builds an ecosystem to power the internet of things
- Driving system level thinking & optimization
 - Via collaboration, inter-operability, standardization
- Its Transnational Access program* gives
 - **Free of charge** access to expertise & laboratories
 - Feasibility studies
(paper, simulation, characterisation, proto)



- Joint Research Activities* are creating
 - System optimised, application orientated solutions
 - De-risked & standardised methodologies & library parts

* Open to industry and academic applicants worldwide

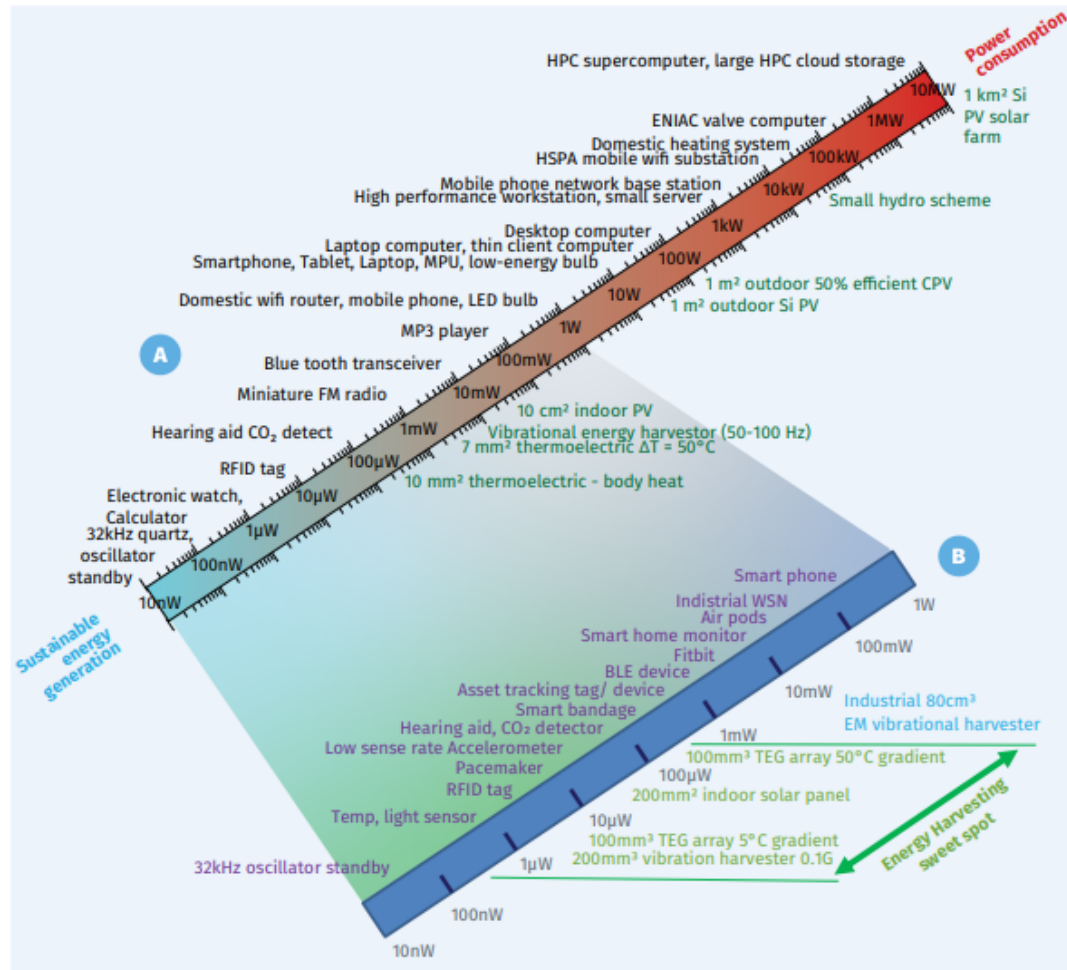
** Done by project partners listed below



www.enables-project.eu

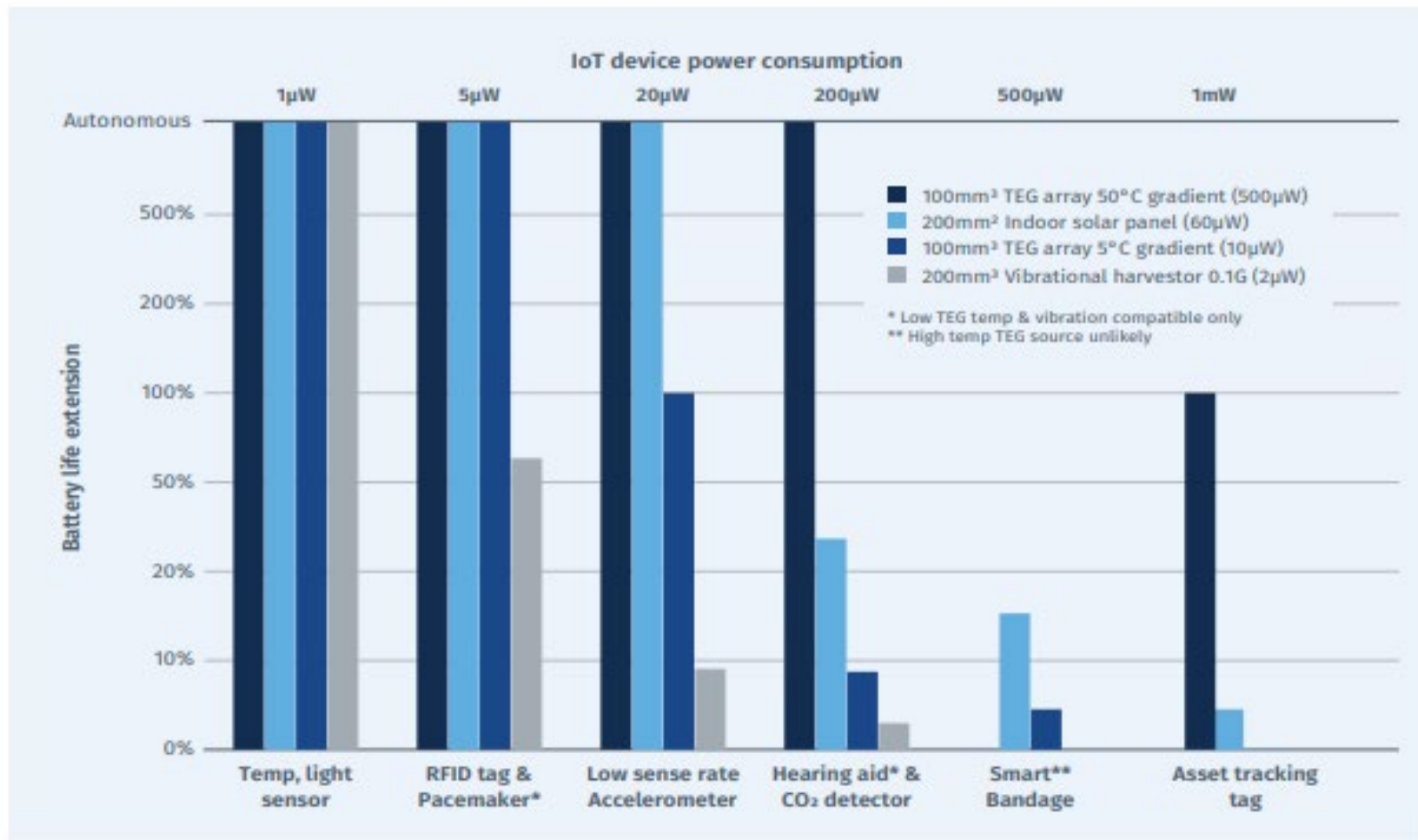


- Promotion and positioning of 'power IoT' value proposition
 - EH sweet spot
 - Ecosystem – 550 Subscribers
 - 71 TAs (feasibility studies)
 - Access to database - ambient energies
 - 75 Publications
 - 16 Webinars
 - 4 summer schools
 - EnerHarv workshop co-creation
- www.enerharv.com



- **Position paper** gives examples of outputs, impact and proposed strategic direction

<https://www.enables-project.eu/outputs/position-paper/>



CONNECT Funded Projects in Sustainable IoT



Energy

(Networking/Harvesting/Thermal)

T1.4. Sustainable Micro Battery (James Rohan)

T1.3 Energy Source In Package (eSIP)
(Cian O'Mathuna)

T2.6 Planar Vibrational Energy
Harvesting for eSIP (Valeria Nico)

T2.1 Bayesian Theory for
IoT Devices (Indrakshi Dey)

T2.5 Energy Harvesting WSN
Test Bed (Mike Hayes)

T2.3 Sustainable Reconfigurable
Sensing (Brendan O'Flynn)

T2.WG9.2 Zero Trust for IoT
(Donna O'Shea)

T2.WG9.1 Adaptive Privacy-
preservation in the Internet of Things
(Paolo Palmieri)

Reconfigurable Platforms

(RF Front End/Sensors/Devices)

T1.1 Compostable wireless tags
for humidity and gas sensing
(Aidan Quinn)

T1.2 Direct laser writing of smart sensors for
green environmental monitoring of goods
(Daniela Iacopino)

T2.4 Modelling Compostible
Antennas (Adam Narbudowicz)

T2.2 UWB Transceivers for IoT
(Somayeh Mohammady)

T1.WG1.1 Resilient and Dependable
Systems
(Roedig, Sreenan, Pesch)

Security and Resilience

(Physical Layer / Authentication /
Resilience)

eSiP project



- Investigate development of reconfigurable, integrated platforms for **EH**, **ES**, **MPM** for wireless sensor nodes.

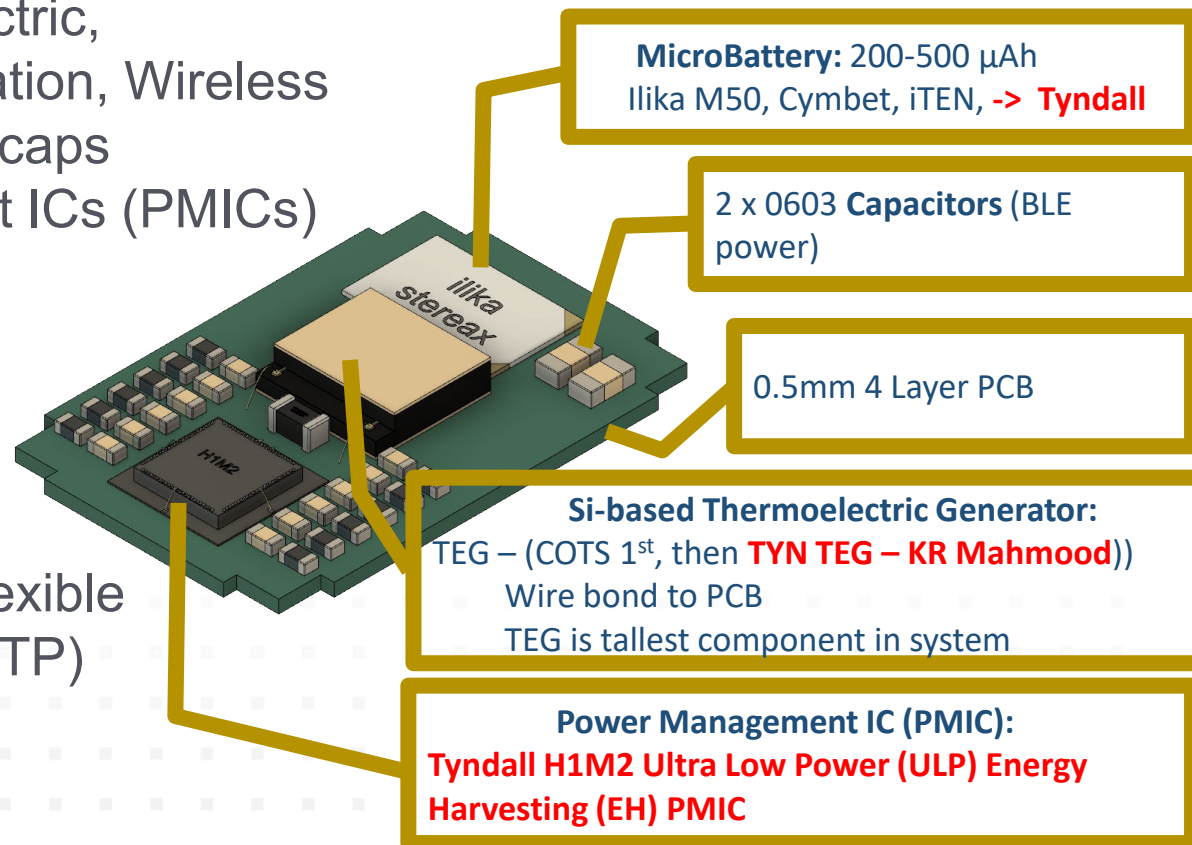
Technology Platforms (from Tyndall, Research Partners, Industry):

- EH**: Solar cell, Thermoelectric, Electromagnetic vibration, Wireless
- ES**: Micro-batteries, supercaps
- MPM**: Power management ICs (PMICs)

- Progress from OTS to **research platforms**

Integration Technologies:

- PCB, PCB-embedding, Flexible
- Micro-Transfer Printing (MTP)



EH: Energy Harvesting **ES**: Energy Storage **MPM**: Micro Power Management

EH WSN Testbed



Create **world's 1st** ecosystem for developers* to collaboratively do real-life energy harvesting experiments **at system network level** to optimise battery life.

* Materials, Devices (energy transducers, storage devices, PMICs, sensors), Firmware (e.g. energy efficiency, condition monitoring algorithms), WSN protocols and comms infrastructure

Mix & match existing & emerging technologies esp. from partners involved

Strategic links to other CONNECT projects

T2.6 Planar Vibrational Energy Harvesting for eSiP

T1.3 Energy source in package (eSiP)

T1.4 Sustainable microbattery energy storage for IoT applications:

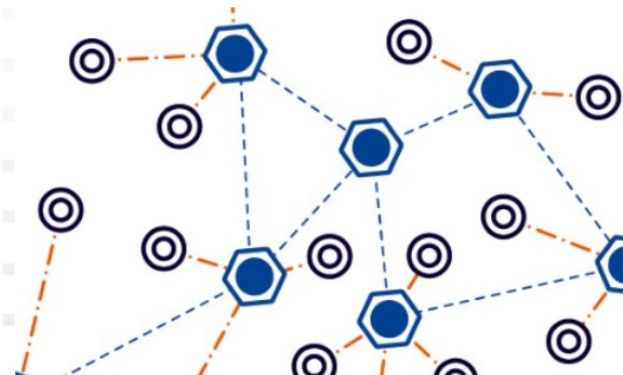
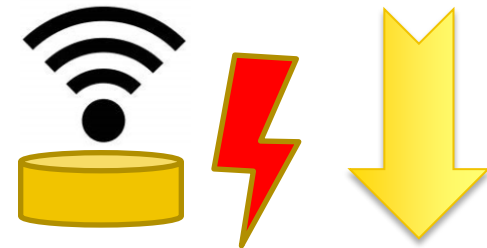
Create opportunities to convert feasibility studies to demonstrators

Foster industry partnerships esp. in industry 4.0 & med tech

'Open door' policy to run experiments

We need to see more software/algorithm engagement

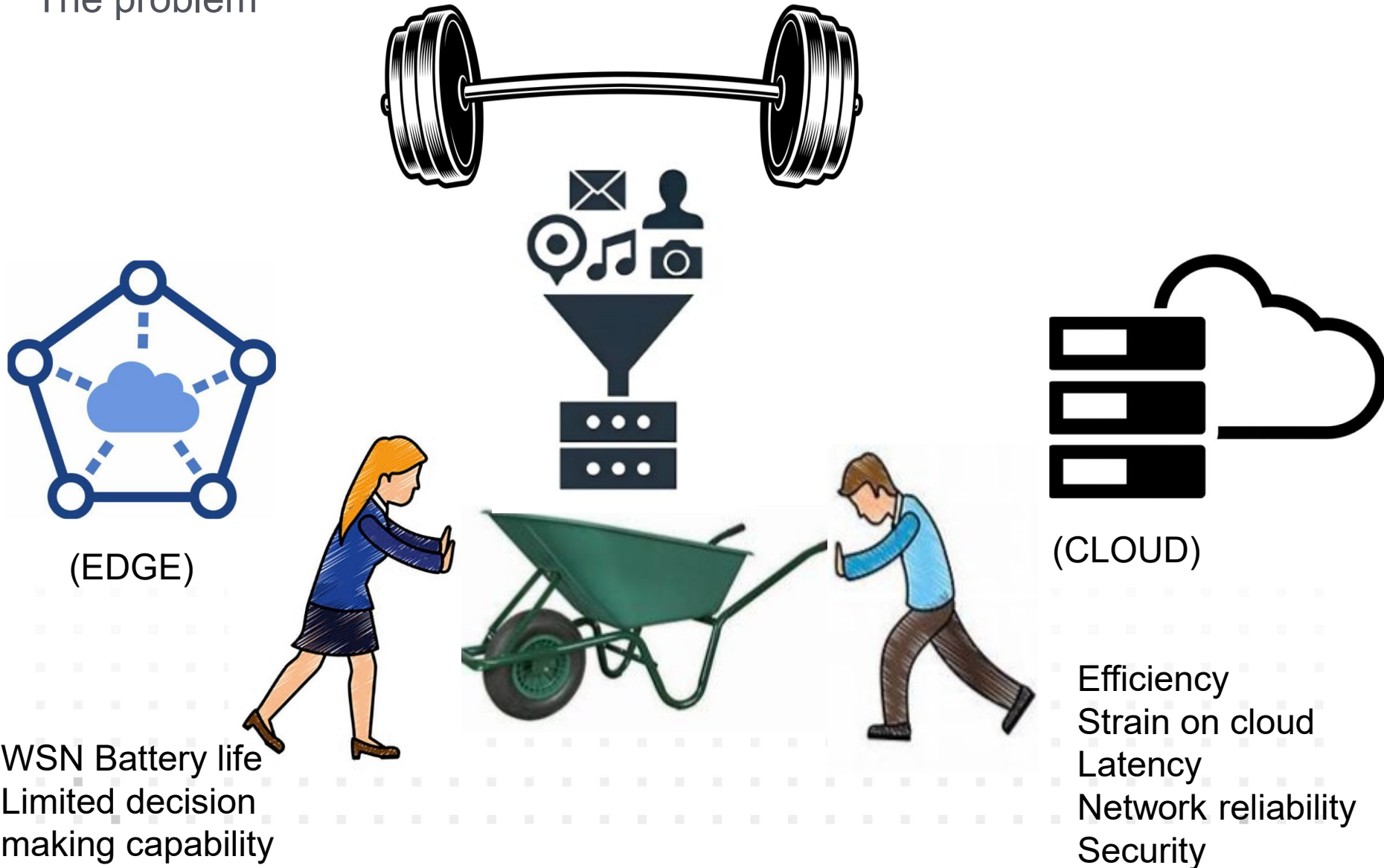
Ideas, opportunities, suggestions welcome!





Data Collection problem and opportunity

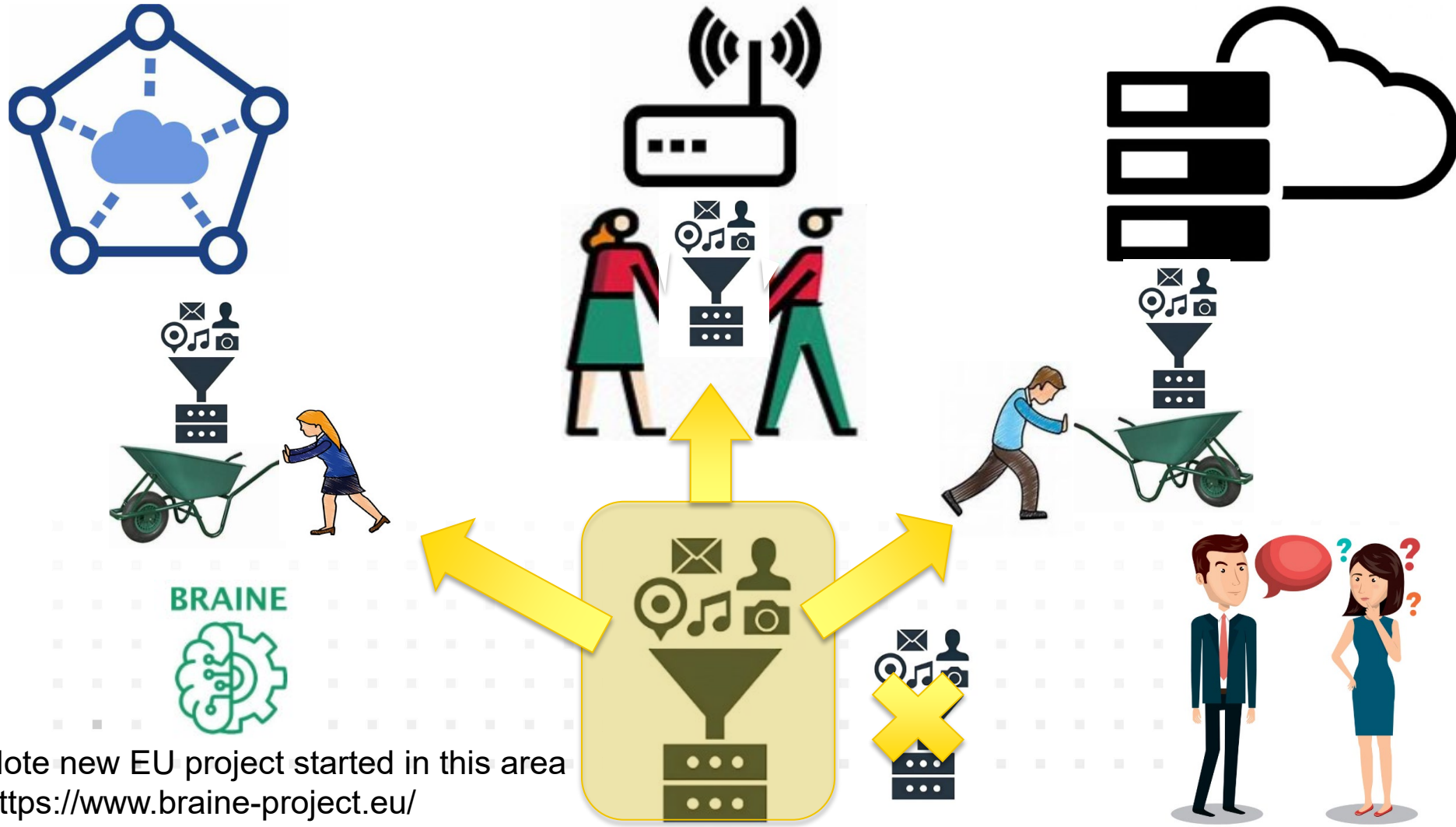
- The problem



Proposed solution



- Strategic collaboration with developers of wireless data collection ecosystem – esp. Software/firmware and system architecture developers
- Think about power for full life cycle from concept to operation to end of life



Note new EU project started in this area
<https://www.braine-project.eu/>

- Big opportunity to use WSN IoT to collect data for many applications
- EnABLES & CONNECT have several initiatives and projects underway to 'power the IoT'
- Need energy efficiency improvements throughout the system
- This requires an ecosystem of collaborators 'thinking about power'
- CONNECT door is open for collaboration & ideas, esp. through sustainable IoT group
 - Materials, devices, systems
- eSiP and WSN testbed are 2 key initiatives to foster collaboration
- We need more of the IoT system architects and designers, esp. SW & FW involved to be successful – **come join us!**

Thank you

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