

# NiPS Summer School 2018

July 16<sup>th</sup> – July 20<sup>th</sup>, 2018 - Perugia (IT)

Pictures of the school available on Facebook at:



## ICT-Energy Zeropower

Public group

# **PART 1**

## **EnABLES & Relevance to Today's Presentation**

# **EnABLES**

# What problem are we solving?



## *Industry challenge:*

The world will have **1 trillion IoT devices** by 2025 all needing power

- 100 for every person



Eliminate the need for battery replacement where possible

- Develop energy harvesting solutions and/or find ways to reduce the power consumption of devices

## *Research excellence challenge:*

Collaboratively and concurrently develop application orientated & optimised solutions

- Get academic and industry developers of energy harvesting components and systems as well as IoT devices to work together
- Accelerate & optimise development of parts and systems
- Parts should be standardised and interoperable



# What are we doing about it?



- Building an ecosystem for collaboration starting with EnABLES
  - A €5.2M EU research infrastructure project
  - Creating 'self-sustaining' energy solutions to 'power the internet of things' based on **energy harvesting, storage, micro-power management** and **system integration** activities



- Providing external fast track technology access (TA) to expertise and laboratories – over 130 researchers & €2Bn worth of infrastructure
- Fostering internal joint research activities (JRAs) between partners guided by needs & opportunities
- Creating standardised and inter-operable libraries of parts & simulation tools for optimising system level performance
- Using EnABLES to foster a 'starting community'.



Simulation tools



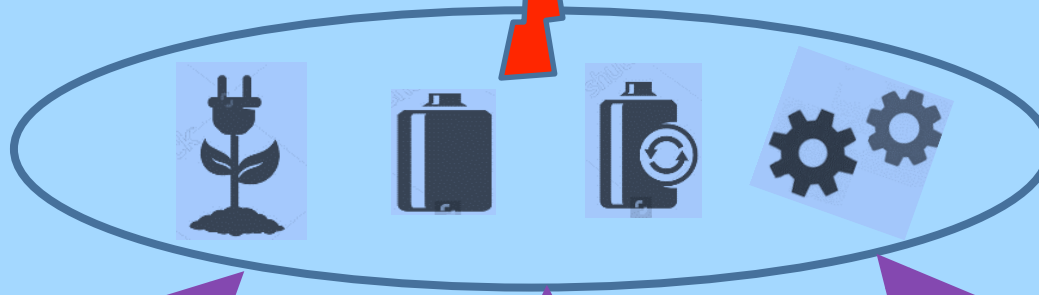
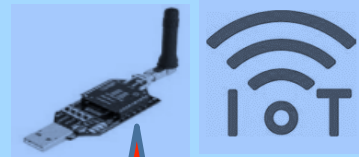
Libraries &  
metrology



Component system  
optimisation

# Powering IoT Research Infrastructure **EnABLES**

TA = Transnational Access



TAs – technology pull



Simulation tools



Libraries &  
metrology



Component system  
optimisation



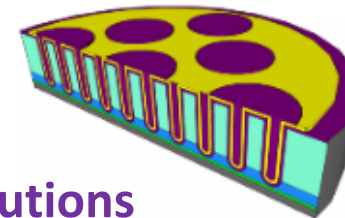
# TA & JRA programs



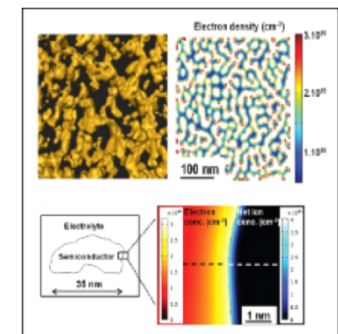
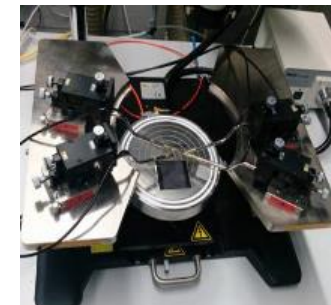
- **Transnational Access program\*** will enable
  - Free of charge access to expertise and laboratories
  - Feasibility studies  
(paper, simulation, characterisation, proto)



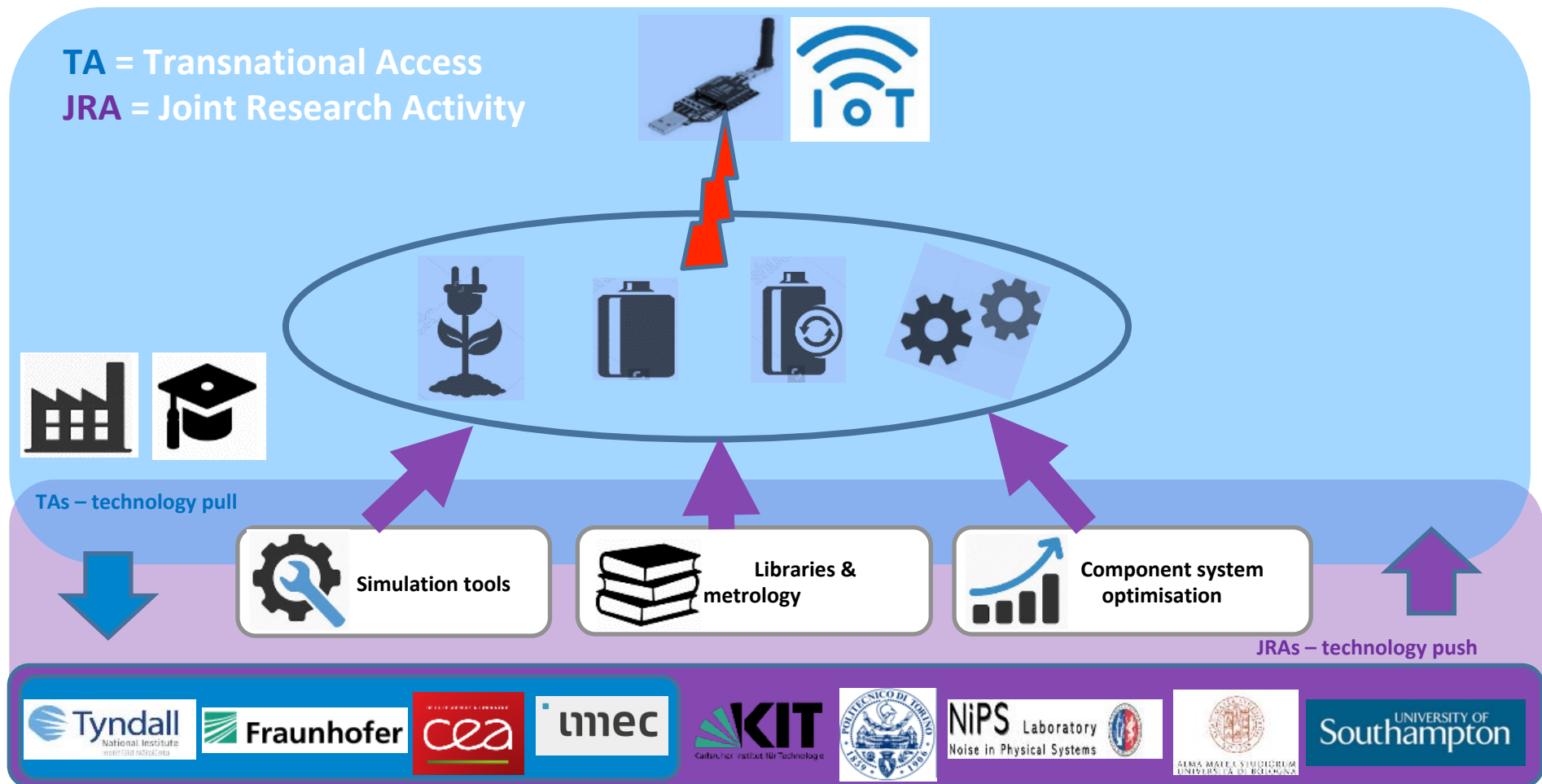
- **Joint research activities** will create
  - System optimised, application orientated solutions
  - De-risked & standardised methodologies and library parts  
(open source)



**\*The TA web portal will be launched July 2018**



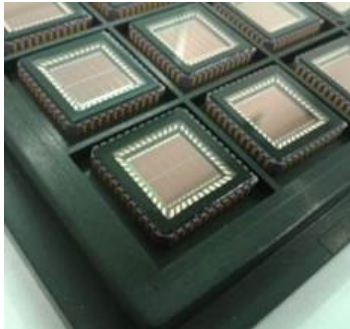
# JRAs push and guide technology



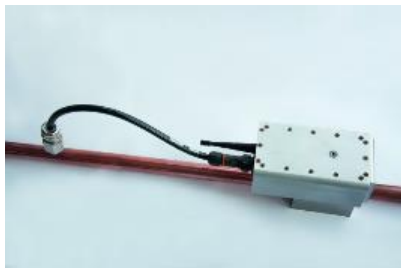
# Examples of Technology Available



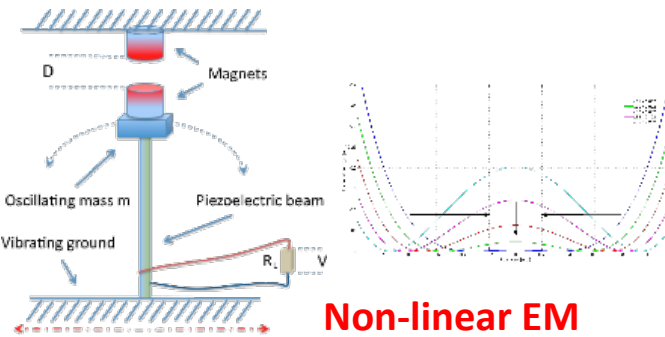
- Energy Harvesting



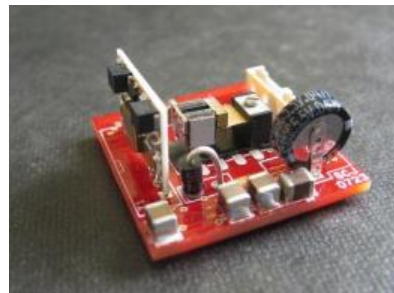
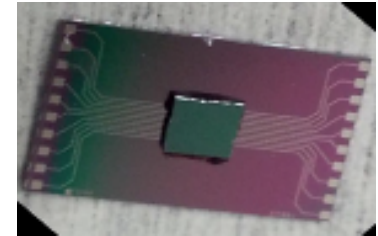
Integrated solar



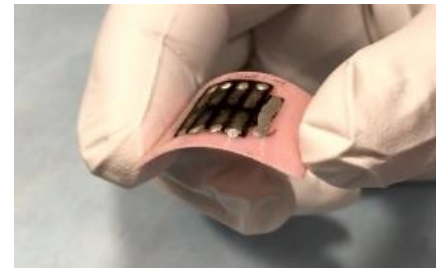
RF



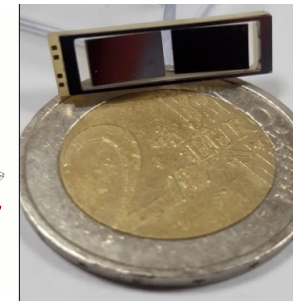
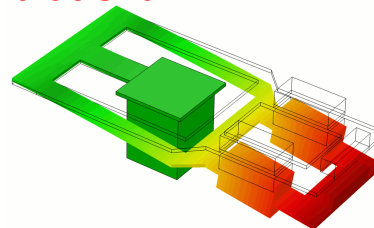
Non-linear EM



Electromagnetic (EM) Vibrational



Piezo



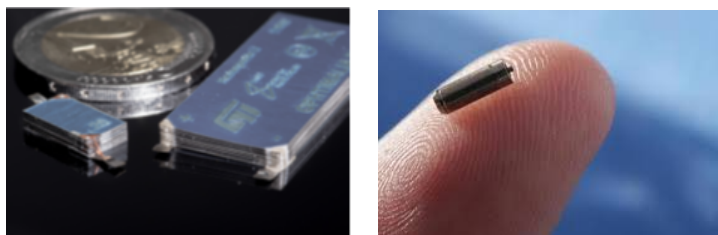
Thermoelectric



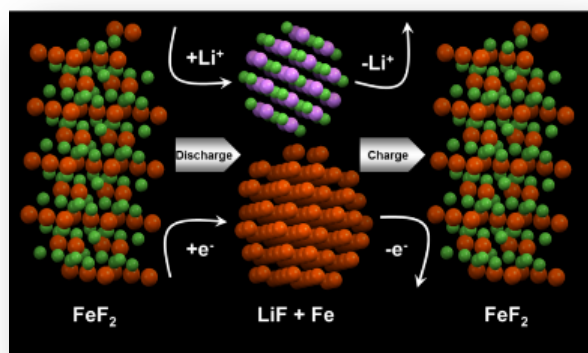
# Examples of Infrastructure & Technology Available



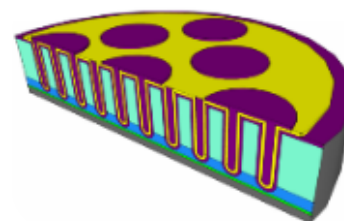
- Energy Storage



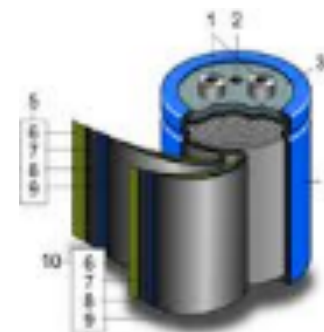
Microbatteries



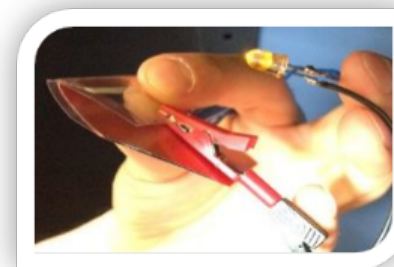
Printed batteries



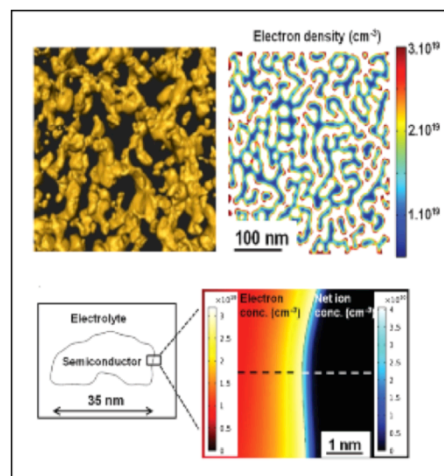
CMOS compatible Supercaps



Nanomaterial supercaps



Flexible batteries



Battery material simulation

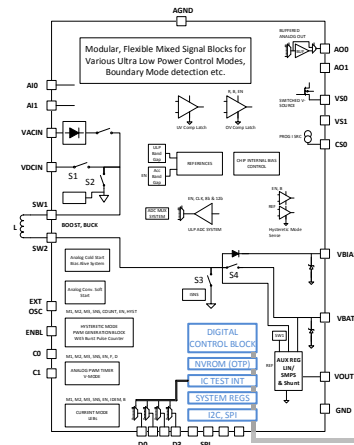
# Examples of Technology Available



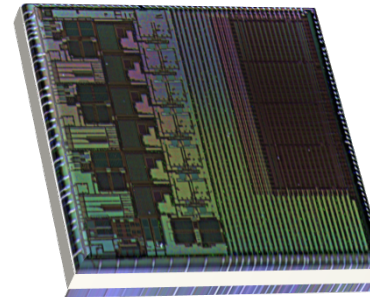
- Micro-Power Management (MPM)



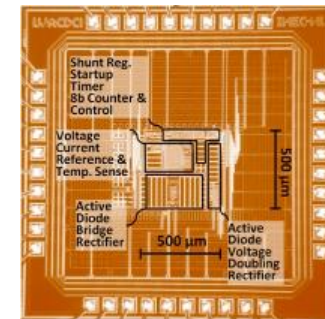
ULP (ultra low power) ASIC



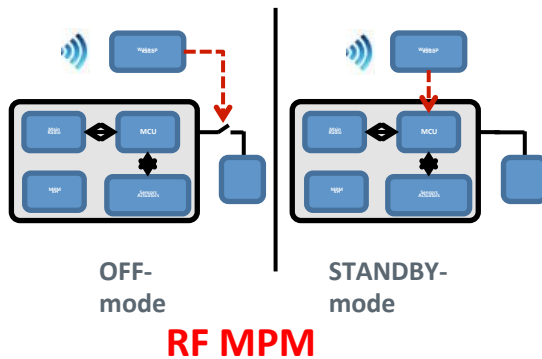
MISCHIEF modular PMIC



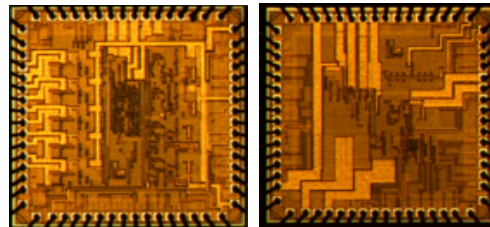
MuseIC



Energy Aware PMIC



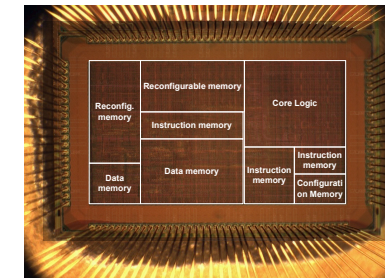
RF MPM



Multi- and Single-source PMICs



TEG MPM

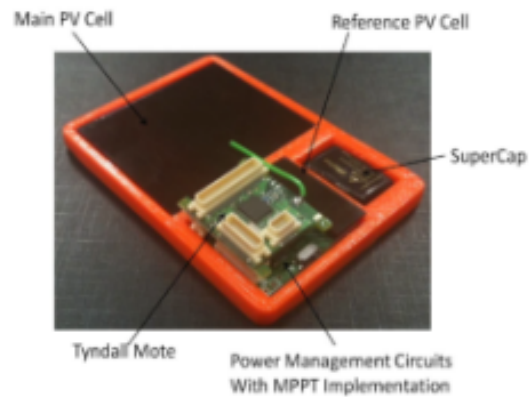


Near-threshold processor

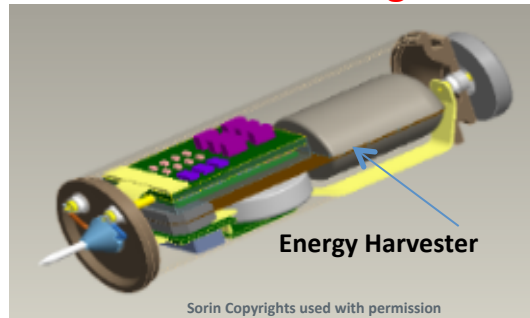
# Examples of Technology Available



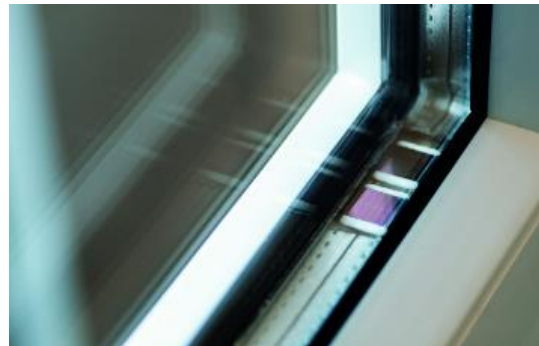
- **System integration**



**Indoor solar building monitoring**



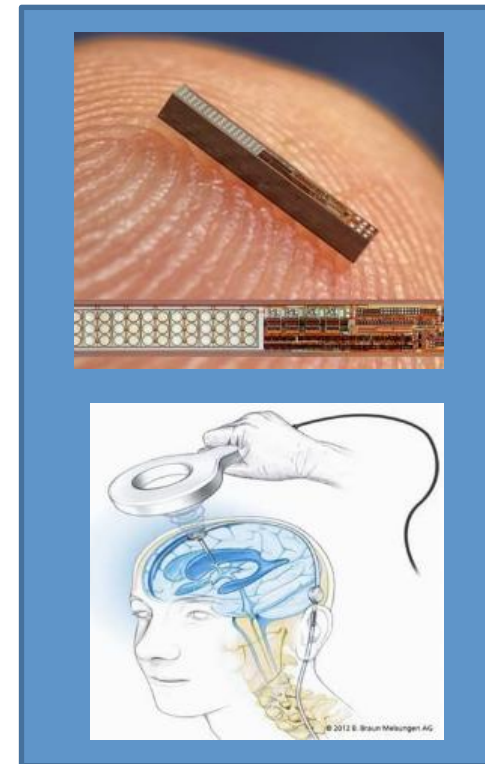
**Implantable pacemaker**



**Solar powered window sensor**



**TEG powered sensor**

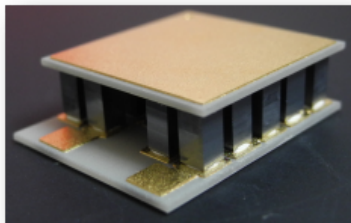


**RF powered sensor**

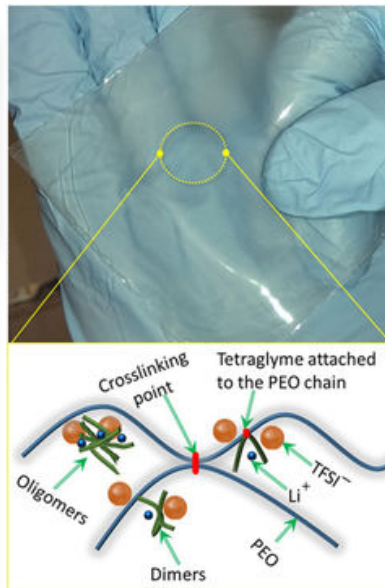
# Examples of Technology Available



- **System integration**



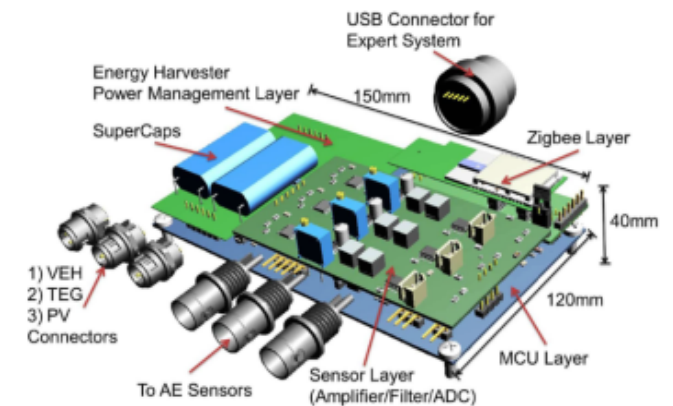
**TEG sensor**



**Flexible battery**



**Solar powered IoT device**

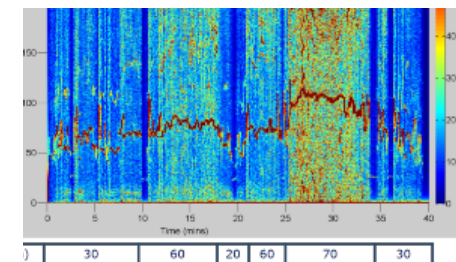
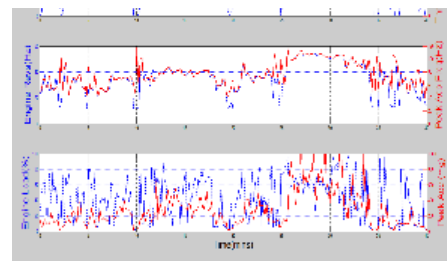
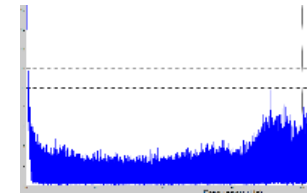


**Multi-source equipment monitor**

# Case studies



- Virtual access databases already available from Perugia (NiPS) & Southampton
- Standardising, Integrating, Adding



## Why are we telling you this?

*EnABLES is building a ‘powering the IoT ecosystem’*

*Ultimately it needs people like you to be part of this*

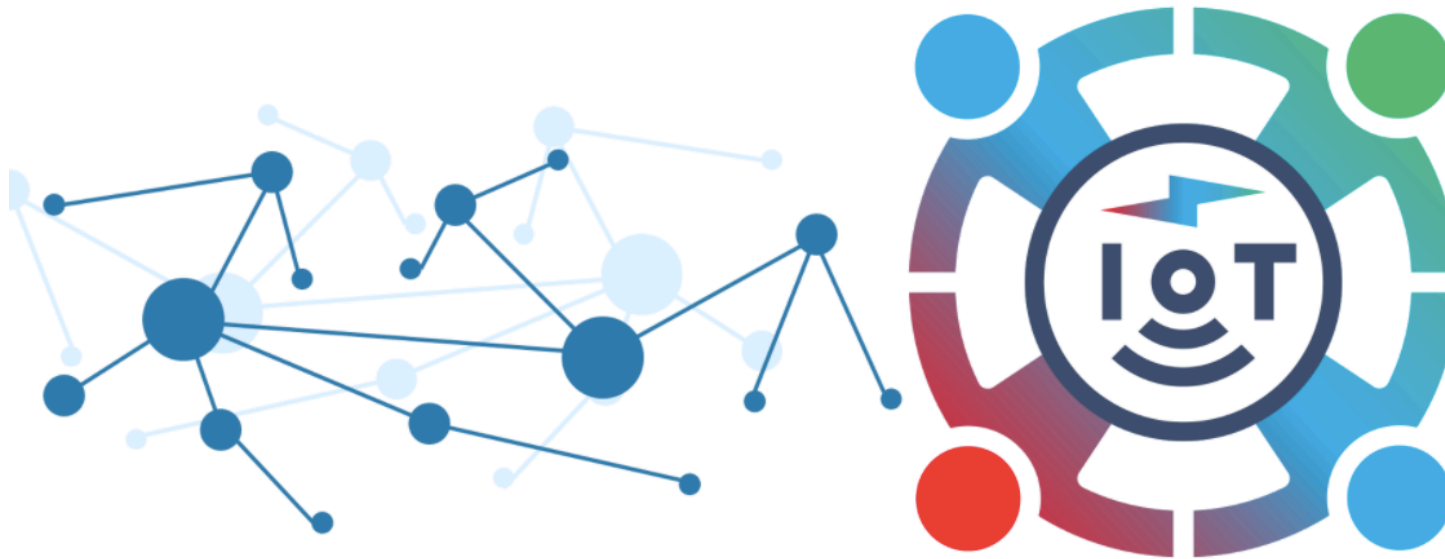
- *Drive the agenda*
- *Form collaborations & networks*
- *Attract new researchers to this exciting area*

*EnABLES PIs giving presentations at this Summer School*



*‘Powering IoT’*

**EnABLES**



**EnABLES**

European Infrastructure Powering the Internet of Things

Energy  
Harvest

Energy  
Storage

$\mu$ Power  
Management

System  
Integration

Home

Offer

Contact

Events



<http://www.enables-project.eu>