Industry Session 11: Energy Harvesting

EnABLES - Growing the Power IoT Ecosystem

Presented By

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Tyndall National Institute

Wednesday, March 18, 2020
European Infrastructure Powering the Internet of Things
The EnABLES Consortium

<table>
<thead>
<tr>
<th>Institute</th>
<th>Country</th>
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<tbody>
<tr>
<td>Tyndall National Institute</td>
<td>Ireland</td>
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<td>CEA Leti &amp; Liten</td>
<td>France</td>
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<td>Fraunhofer IMS &amp; IIS</td>
<td>Germany</td>
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<td>University of Perugia</td>
<td>Italy</td>
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<td>University of Southampton</td>
<td>UK</td>
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<td>Karlsruhe Institute for Technology</td>
<td>Germany</td>
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<td>Politecnico di Torino</td>
<td>Italy</td>
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<td>University of Bologna</td>
<td>Italy</td>
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www.enables-project.eu
What problem are we solving?

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

Most of these will be wireless devices!

Great opportunities but........
What problem are we solving?

What technologies that will make batteries last longer, in some cases lasting ‘forever’

Mission

- Maximise energy extracted from REALISTIC ambient energy sources
- Supply it in a format that is easy to use/convert/store
- Cater for variations (lighting level, frequency, temperature gradient, etc.)
- Be small, robust, adaptable, easy to install and integrate
What problem are we solving?

*What technologies that will make batteries last longer, in some cases lasting ‘forever’*

**Mission**

- Provide a steady voltage to the IoT load
- Use low leakage current
- Run for many cycles with minimum performance degradation*
- Accept and store ambient energies for processing &/or later usage*
- Be small, robust, adaptable, easy to install and integrate
  * Re-chargeable devices

Energy Storage
What problem are we solving?

What technologies that will make batteries last longer, in some cases lasting ‘forever’

**Mission**

- Provide a steady voltage to the IoT load
- Use low leakage current
- Maximise conversion efficiency from harvesters and storage devices
- Be clever in turning on/off devices, changing operation modes to minimise battery drain
- Be small, robust, adaptable, easy to install and integrate

**Micro-power Management**
System integration is our ultimate superpower

- Standardised and inter-operable technology components
- System optimised
- Minimize battery drain
- Maximise use of ambient energies (where available)

We have developed standardised templates for characterising parts. It can be found here:

How do we achieve this - EnABLES

- Providing external fast track Transnational Access (TA) to expertise and laboratories
  - €2Bn worth of infrastructure & over 130 researchers
- Using EnABLES to foster a ‘starting community’ (Power IoT ecosystem)
- Creating ‘self-sustaining’ energy solutions to ‘power the internet of things’ based on energy harvesting, storage, micro-power management and system integration activities

- Together we create standardised and inter-operable libraries of parts & simulation tools for optimising system level performance
TA & JRA programs

• Would you like a feasibility study to be done for free?
• Our Transnational Access (TA) program offers you this!
• Access our expertise and laboratories
  (simulations, characterisation, proto testing)

• Our Joint Research Activities (JRA) are creating the TA platforms of tomorrow
  • System optimised, application orientated solutions
  • De-risked & standardised methodologies & library parts
    (open source)
Examples of Technology Available

• Energy Harvesting

- Integrated solar
- Electromagnetic (EM) Vibrational
- Piezo
- Thermoelectric
- RF

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Examples of Technology Available

• Energy Storage

Micro-batteries  CMOS compatible Supercaps  Flexible batteries

Printed batteries  Nanomaterial supercaps
Examples of Technology Available

- **Micro-Power Management (MPM)**

ULP (ultra low power) ASIC

Energy Aware PMIC

MISCHIEF modular PMIC

Multi- and Single-source PMICs

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Examples of Technology Available

• System integration

  - Indoor solar building monitoring
  - Energy Harvester
  - Implantable pacemaker
  - Solar powered window sensor
  - TEG powered sensor
  - RF powered sensor

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How to access EnABLES technologies and expertise?

Step 1: Sign Up
Step 2: Enquire
Step 3: Apply
Step 4: Independent Selection
Step 5: Access
## Make an enquiry today!

**EnABLES Enquiry Form**

- **Name**: Your Name
- **Position**: 
- **Nationality**: For EU statistical purposes only
- **Gender**: For EU statistical purposes only
- **e-mail**: e-mail
- **Organisation**: Name of organisation
- **Website**: Organisation website
- **Organisation type**: 
  - Academic/University
  - Research Institute
  - SME
  - Company
  - Other
- **City**: City
- **Country**: Country
- **What offer are you interested in?**: 
- **Enquiry**: Describe your technical enquiry

We would be delighted to discuss any enquiries.

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Sample Access projects

EnABLES-003
Thin film batteries at CEA-Leti

EnABLES-004
RF energy harvesting at Fraunhofer IMS

EnABLES-005
Stacked micro batteries at CEA-Leti

EnABLES-006
Low power animal tracking at Fraunhofer IIS

EnABLES-009
PV energy harvesting at Fraunhofer IIS

EnABLES-015
Electrochemical micro batteries at Tyndall

EnABLES-017
ASIC for Vibrational EH at imec-NL

EnABLES-025
Improve thermoelectric performance at CEA-Liten

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Strategic Links to PSMA

Synergistic links with PSMA Energy Harvesting Committee
Both have similar missions... build ‘power IoT’ ecosystem, create synergies, solve problems
Several people are involved in both
Almost 50 members to date from 4 continents
Provided ‘Power IoT’ info to the PSMA PTR 2019 (Power Technology Roadmap)

New members welcome!
Contact Brian Zahnstecher or Mike Hayes to learn more

Technical sponsor to EnerHarv 2020 PSMA power IoT workshop
Ref next slide
Strong involvement in organising committee
Helped kick start inaugural EnerHarv 2018
EnerHarv 2020

2nd international energy harvesting and micro-power management workshop

Save the date! 16-18 June 2020

Hosted by the ASSIST Centre, North Carolina State University, USA

Check out www.EnerHarv.com

Building an ecosystem of Power IoT stakeholders

Power IoT Technologies - Energy Harvesting, Storage, Power Mgt, System Integration

Enabling Technologies – ICT, Energy Efficiency, Power Electronics, MEMS

Stakeholders – Developers, Suppliers, Users, Integrators

What did you previously miss?


European Infrastructure Powering the Internet of Things

Have you signed up? Come join our Ecosystem

Thanks a lot for your time and attention! Any questions and/or comments?

http://www.enables-project.eu/contact/

Thank you!

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EnABLES (http://www.enables-project.eu/) has received funding from the EU Horizon 2020 research and innovation programme, under Grant Agreement no. 730957.
Additional slides not presented

Please contact Mike Hayes or enquire via EnABLES for more info.
Some JRA Activities

**Energy Harvesting (EH)**
- Wide-band non-linear vibrational harvesters
- Fabrication of a fully integrated MEMS Electromagnetic Vibration Energy Harvester
- Modeling and characterizing **nonlinear wideband MEMS electrostatic Vibration Energy Harvester** & investigate its integration with electrets.
- Novel high-performance thermoelectric materials & simulation models
- New integrated technique to measure anisotropic components of Seebeck coefficient, electrical and thermal conductivities
- Increase efficiency of amorphous silicon solar cells on 8” wafers

**Energy Storage (ES)**
- Nanoscale materials that yield high-rate fast charging and discharge
- Enhancing cathode stability to increase the energy density
- Nanoscale protective films via ALD/CVD for higher energy density electrodes & improved lifetime
- Sulphur-based cathodes with x10 higher theoretical energy capacity
- Room temperature ionic liquids & new solid-like, solid-state and hybrid composite solutions – improve thermal, ion transport & safety features of electrolytes
- ALD/CVD deposition of protective materials -higher energy/power density, lower cost, long life
- High entropy oxides (HEO) - promising new material class for electrode materials.

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Some JRA Activities

**Micro-Power Management & System integration**
- Efficient power conversion techniques + models particularly at low voltages & power levels
- Understand best trade-offs between intrinsic consumption of circuits & conversion efficiency
- Provision for both multiple source types
- Collaborative development of circuits to maximize transducer performance
- Electronic interfaces to other IoT components with low intrinsic consumption
- New antenna and rectenna designs for textile-based RF EH & wireless power transfer
- 10mV ultra-low voltage start-up circuits
- Investigation of Maximum Power Point Tracking (MPPT) architectures in a mixed-signal programmable IC
- AC-DC converter for electro-dynamic generators
- Simulation tool for system level assessments

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Virtual Access...Database of ambient energies

Free access to all who sign up to EnABLES

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EU Project 730957

Libraries & metrology

Component system optimisation

Simulation tools

Libraries & metrology

Component system optimisation

User Community

Technology push (Address future needs)

Technology pull (Address needs)

JRA Activities (Joint Research)

Technology Pillars

EH      Energy Harvesting
ES      Energy Storage
MPM    Micropower Management
SI      System Integration

Push & Pull Technology

EnABLES

Technology push (Address future needs)