



## Impact from Excellence ("from atoms to products")

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## Our Mission

- Opportunities for Ireland's economic growth through excellent research
- Deliver innovative ICT solutions and trained people to meet society's challenges in communications, energy, health and the environment
- Development and graduate education

Tyndall is one of Europe's leading Research centres for Information, Communications and Technology (ICT).

- Established in 2004, Created from the National Microelectronics Research Centre (NMRC) - Est. 1982
- UCC / DETI established
- Researchers from UCC, CIT, Industry

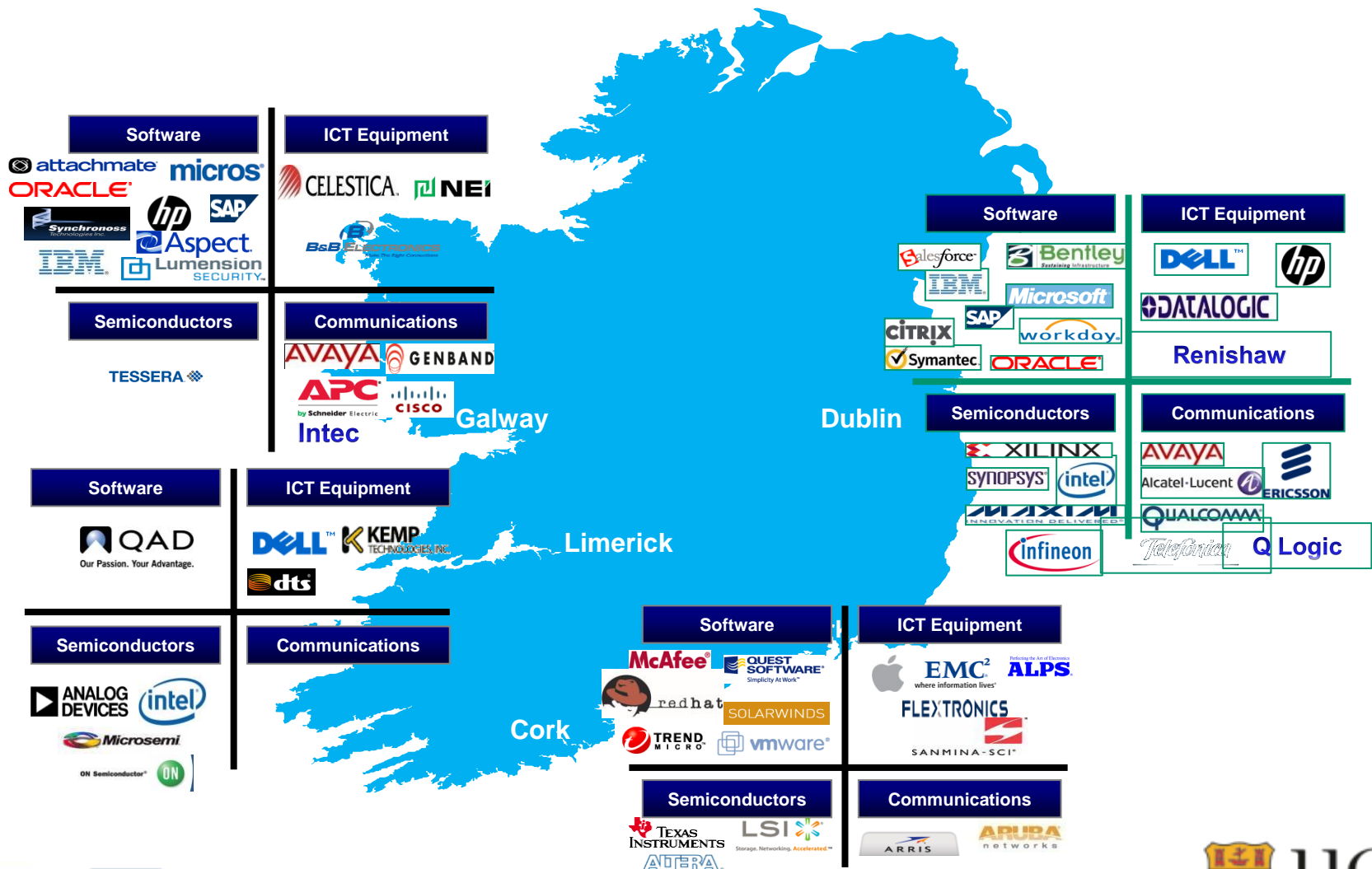
## Technologies:

- CMOS, III-V Processing
- Micronanoelectronics
- Microsystems
- Photonics
- Tyndall "FlexiFab"
- Theory Modelling & Design

## Applications:

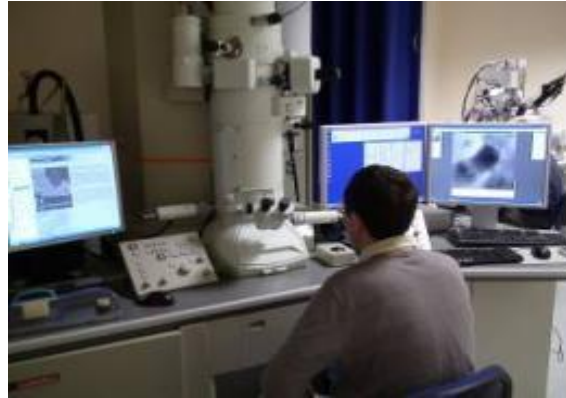
- Communications
- Energy
- Healthcare
- The Environment





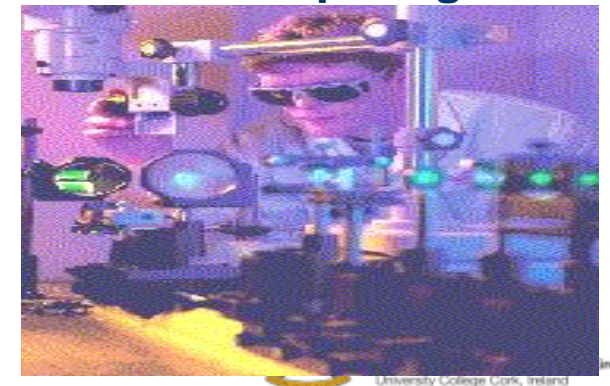






- Silicon Fabrication incl e-beam (20nm)
- Full CMOS Process (100mm)
- III-V Device Fab (Opto/microwave)
- Tyndall “FlexiFab”
- Device assembly & packaging

- Metal plating
- TEM, SEM, Dual beam FIB
- Electrical probing/device charact.
- DC to >60GHz
- Photonic characterisation
- High Performance Computing



**460** researchers & engineers, students, support staff

**135** students

**40** nationalities

**200** industry partners globally

**30** researchers in residence

**200** publications p/a

**9** spinouts

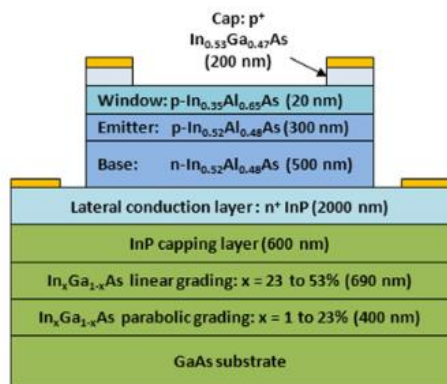
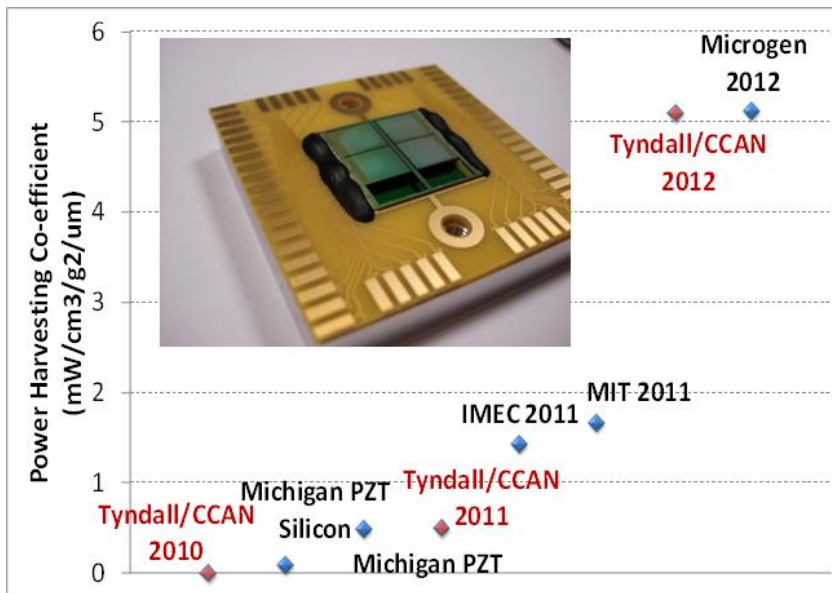
Not trying to do everything but want to be world class in what we do!

- World's first implantable radiation detector
- World's first Junctionless Transistor
- World's first UWB Pulsed Radar on 90nm CMOS process
- World's lowest noise frequency generators for mobile phones
- World's fastest fibre-to- the-home network demonstrator
- World's most energy efficient micro-LED Technology
- World's purest III-V quantum dots for quantum information processing

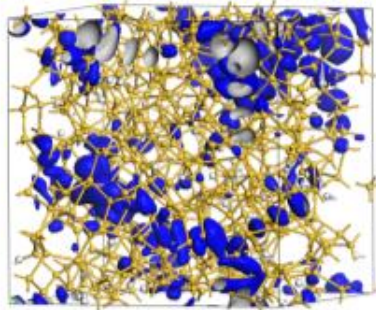


# Case Studies on ICT-Energy

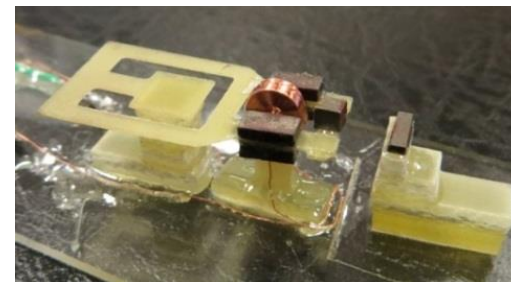
## Piezoelectric



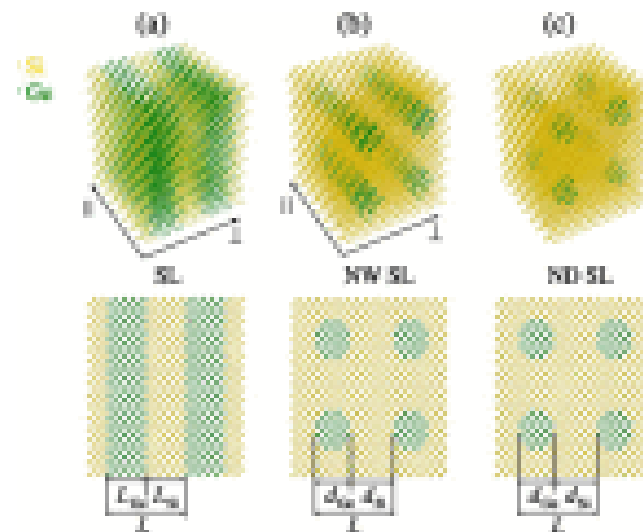
## Solar



## Magnetic

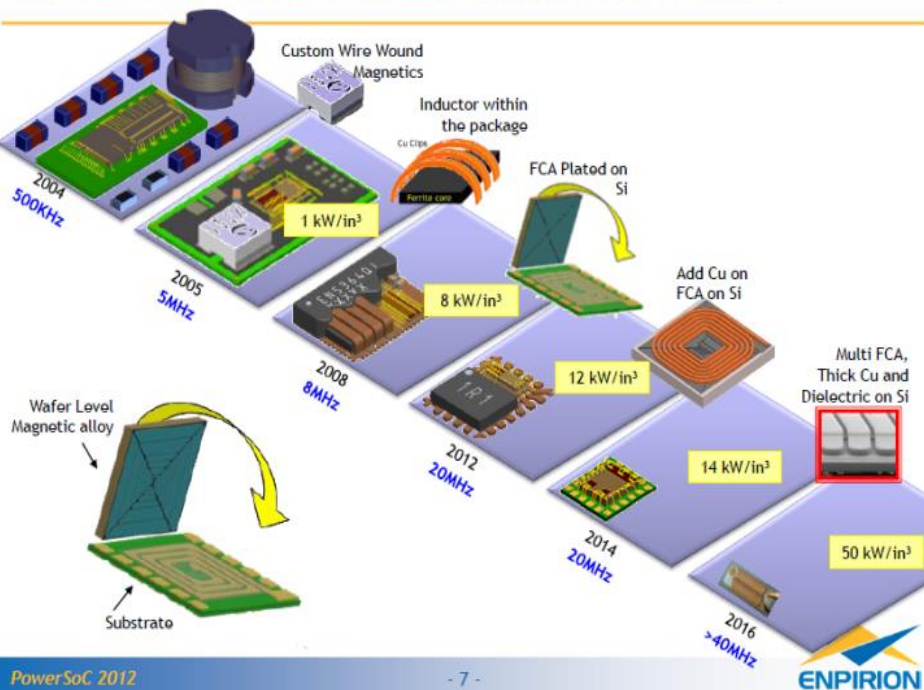


## Thermoelectric

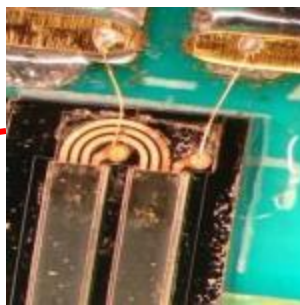
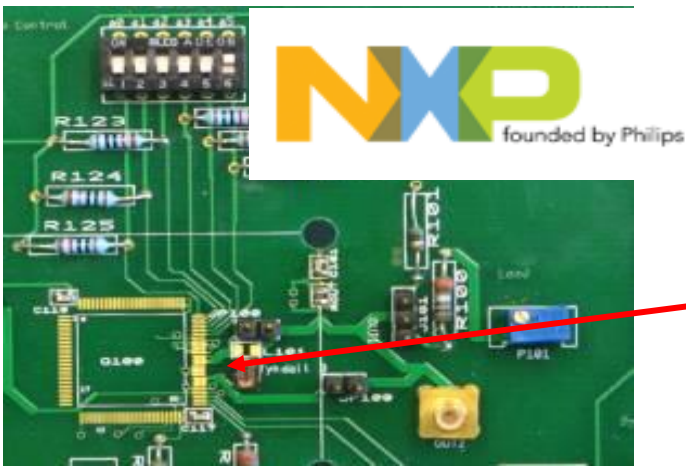




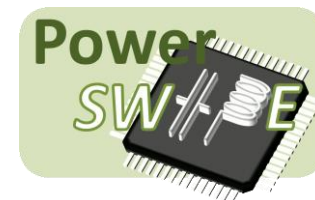
## DC-DC POWER CONVERTER INTEGRATION



- Current device generation 3mm<sup>2</sup>
- Highest efficiency (93%) demonstrated for micro-inductors
- Micro-inductors operation successfully demonstrated in dc-dc converters at 500mA up to 100MHz
- First CAD tool for power micro-inductors/micro-transformers

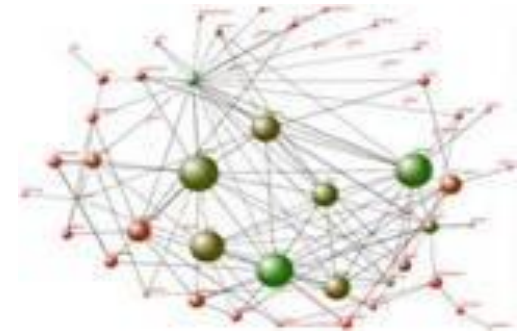


***Tyndall Micro-inductor  
wire-bonded to  
NXP converter***



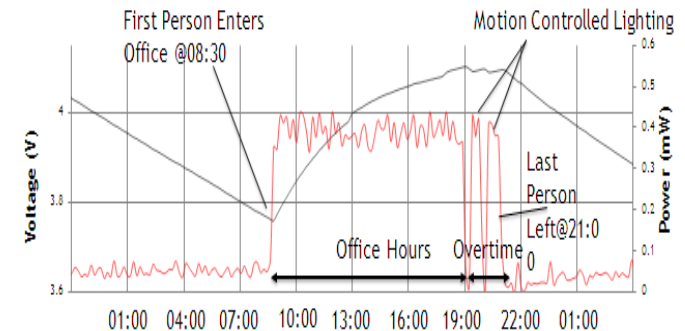
- **Energy Aware Software and Systems**

- “Smart” power management
- Hardware/software co-design
- Develop algorithms and software - Distributed Intelligence
- Energy Efficient Networking & Scheduling
- Modelling of our environment and available energy



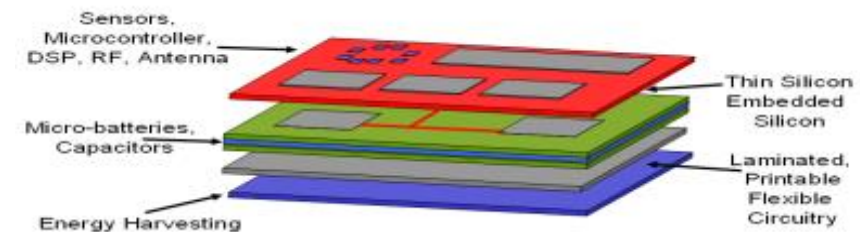
- **Energy Efficient Harvesting Systems (*ICT4EE*)**

- Ambient energy sources - Thermal, Vibration, Lux
- Need to develop low loss conversion and storage systems





- Tyndall Mote variants deployed for various Wireless Sensor Network (WSN) applications
- **Mark 1 (Available)** - Current mote is 25 x 25 x z\* mm<sup>3</sup>  
Modular design, mix and match layers for different applications & compatibilities  
\* z = layers: Power, Storage, Sense, Process, Transceive
- **Mark 2 for BEM (Available)** - Flat form factor  
Modular design but all cards integrated into 1 PCB layer
- **Mark 3 (2014)**  
Self powered integrated  
Smart-card or cube
- ✓ Tyndall mote has high inter-operability & a very broad sensor & meter interface suite



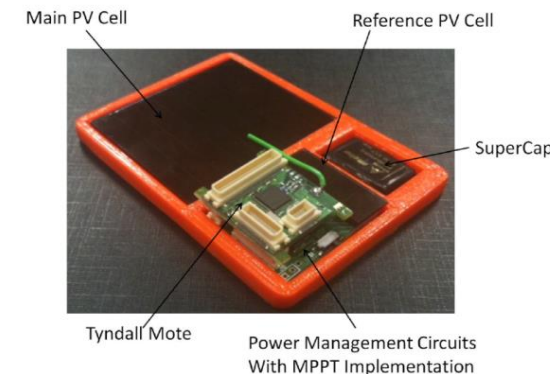
- Building Energy Management 1 - 100x nodes deployed
- BEM2 - 70% cost reduction
- Spin-off commercialisation project with Endeco
  - Actuation platform for retail (refrigeration, electricity)
  - 19% savings sustained over 6 months
- Novel Indoor energy harvesting & storage solution
  - Operates indefinitely (temp, light, humidity) - 6 mth validation
  - Only 8hrs lux/day needed & can operate in dark for 72 hours
  - First Known Sub-mW MPPT\* design for indoor solar apps
  - Circuit increases system efficiency from <40% to >80%
  - Fast charge circuit reduces charge time by 35%
  - Energy storage & management reduces leakage x 10
  - Ultra low power Self Start circuit
- Breakthrough thanks to combined circuit innovation, WSN & component expertise



BEM1-2009



BEM2-2010

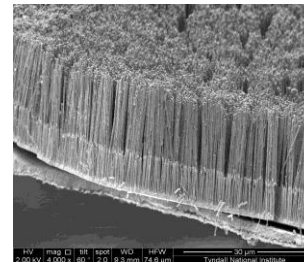


Indoor EH solution-2012

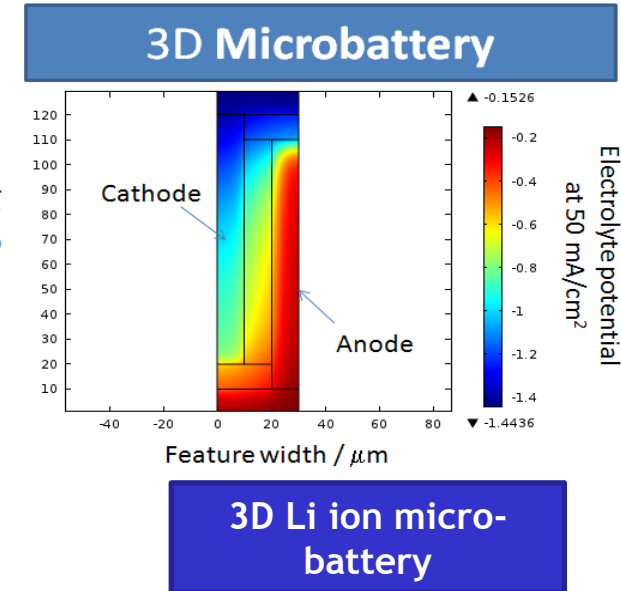


## Description

- Challenge – More energy and power in a smaller device footprint for hybrid energy devices
- Solution
  - Modelling
  - New materials
  - Micro and nanofabrication
  - Core/shell structures
  - Cell assembly and test
  - Integration with EHT and sensor device

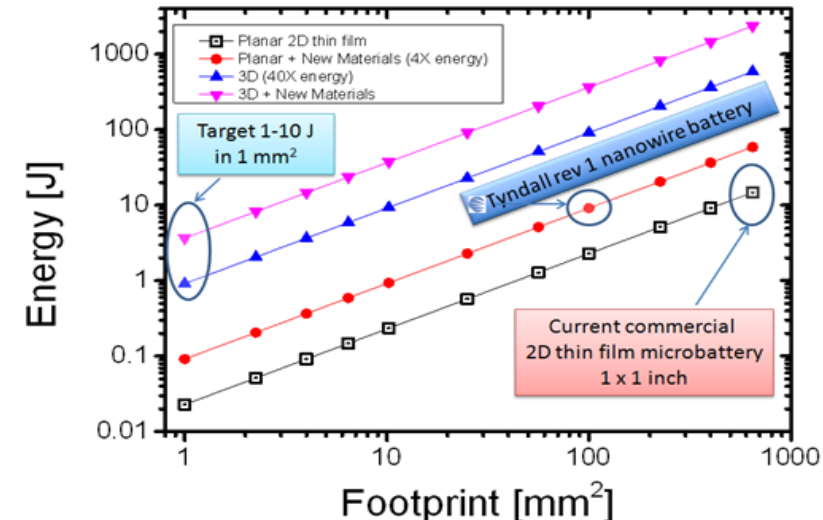


MnO<sub>2</sub> nanowires on  
Cu nanotubes



## Tyndall Research & Innovation

- 3d or 1d core/shell nanostructures
- Minimised footprint while maintaining energy storage
- TRL 1-3



Creating over 500 jobs



FDI MNC

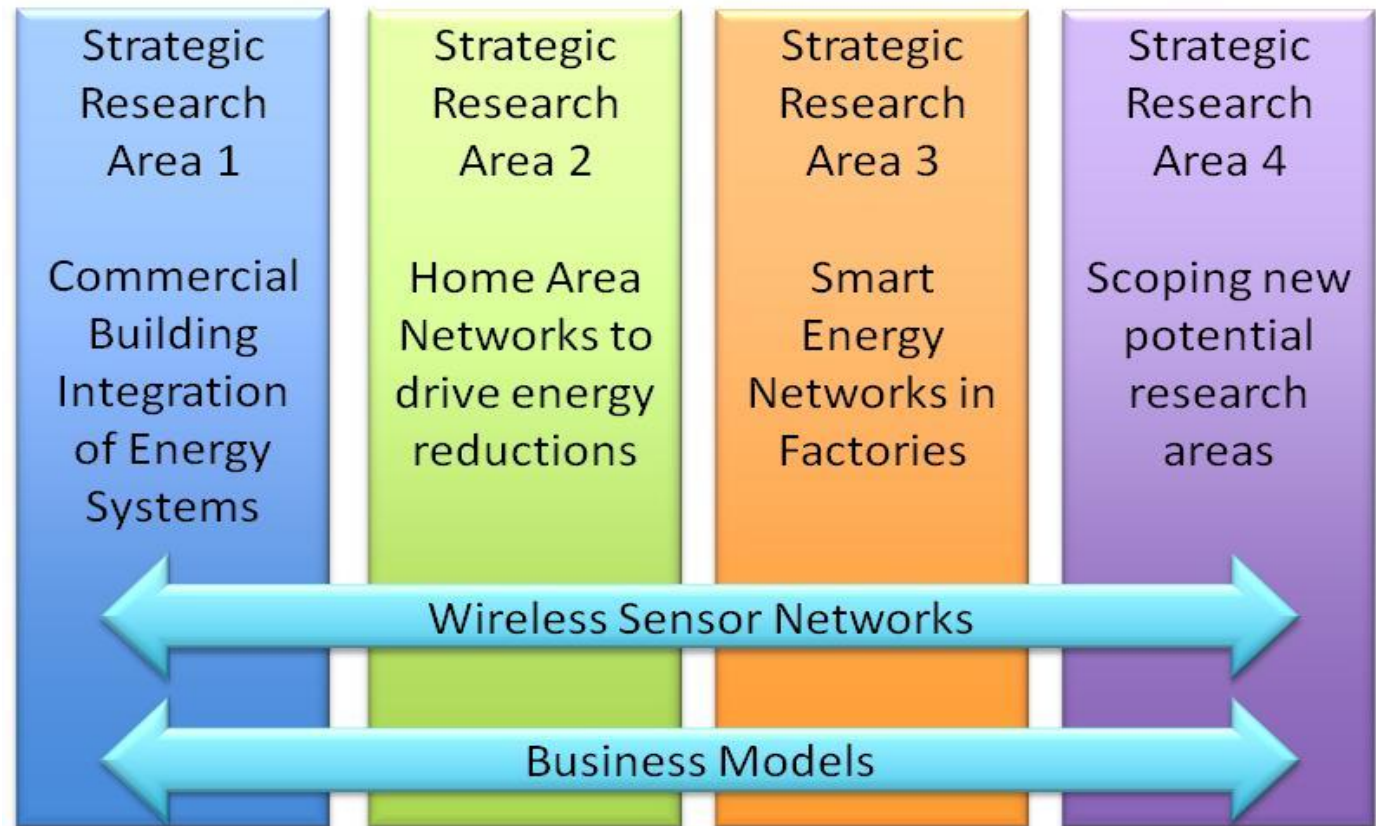
SME

HPSU

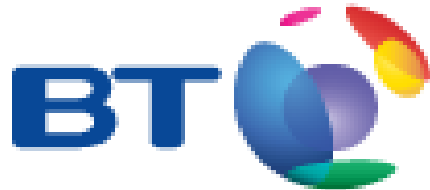
Indigenous  
MNC

- Four strategic research areas
- Two cross-cutting enablers

## Current Research Areas









# Tyndall

National Institute  
Institiúid Náisiúnta