1383-1688: Energy-harvesting, Self-calibrating Wireless Sensors for Improving Energy Efficiency in Buildings

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ORNL, Molex, PARC
Teja Kuruganti, Senior R&D Staff

Energy-harvesting, Self-calibrating Wireless Sensors for Improving Energy Efficiency in Buildings

- **Project Lead – Oak Ridge National Laboratory (ORNL)**
  - Systems integration to develop high degree of coordination between novel communication technology, sensors, energy harvesting
  - Low-power, low-data rate communication technology driven by innovation in spread spectrum techniques.
  - Roll-to-roll deposition techniques that enable high-volume throughput of semiconductor and electronic materials and devices
  - Innovative thermal annealing techniques, such as pulse thermal processing (PTP), will permit high-temperature processing of thin-film materials on low-cost flexible polymer substrates at a minimal thermal budget.
- **Manufacturing Partner - Molex**
  - 45 design, development and manufacturing centers in 17 countries.
  - Variety of printing systems used for fabricating electronic circuits and devices and includes a state-of-the-art nine station roll-to-roll printing system with rotary screen and flexographic capability as well as a variety of curing modules and multiple flatbed screen printing systems
- **Printed Electronics Materials and Processing – PARC**
  - Materials science, modeling, electronics and circuit design, materials deposition and patterning, metrology, device analysis, and system integration
  - Wide range of printing and coating techniques including ink jet, screen, extrusion, aerosol jet, gravure, spin casting, slot dye coating, doctor blading, and more.

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Self-powered "peel-and-stick" low-cost wireless sensors enable control system upgrades that could potentially reduce energy consumption of buildings by up to 20-30%

ORNL-developed sensor platform has potential to reduce cost from $150-300/node to $1-10/node while also reducing installation cost.*

**Price points may vary based on market conditions.*

Provide information for optimal control of energy-consuming systems (HVAC, lighting); enable fault detection and diagnostics

Project Focus: Develop Self-powered wireless sensor technology and System-level integration exploiting roll-to-roll manufacturing compatible technologies

Target Market and Audience:

- All residential and commercial buildings.
  - **Small and medium commercial buildings** – improved control of energy providing opportunity for 6-8 quads of energy savings potential
  - **Large commercial buildings** – improved control of energy use optimization, and diagnostics of large equipment with 8-9 quads of energy savings potential

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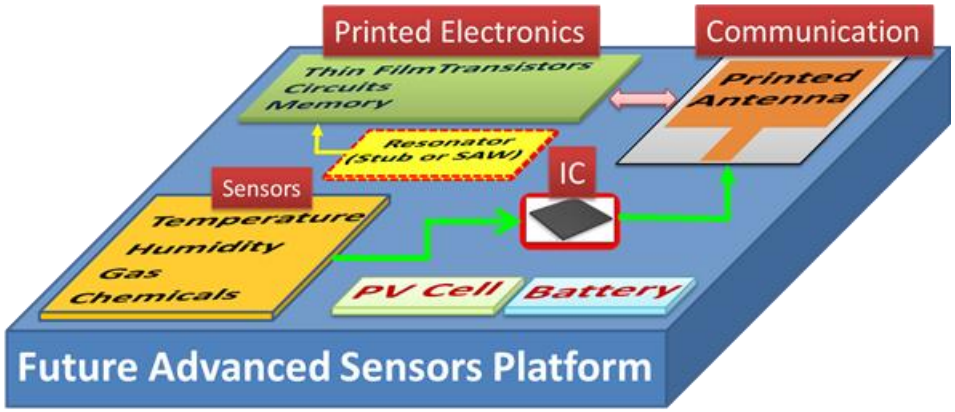
Technology Solution

Current wireless sensor Platform: $150-$300/node

Proposed Advanced Sensors Platform: $1-$10/node



Four Key Elements of Technology

1. Low-power Wireless Communication
2. Energy-Harvesting and Storage
3. Integrated System Design
4. Innovative low-cost manufacturing

Approach

- **Ultra-low power wireless communication**:
  - Printed Antenna, Spread Spectrum Communication
- **Energy harvesting**:
  - Thin Rechargeable Battery, Flexible PV
- **Multiple sensors**:
  - Temperature, humidity and light sensors
- **Thin, light form factor**:
  - Base circuit printed on PET film
  - Low temperature solder based component attach

Key Technology Improvements

→ **Low-power wireless**
→ **Multifunctional sensor**
→ **Advanced materials**

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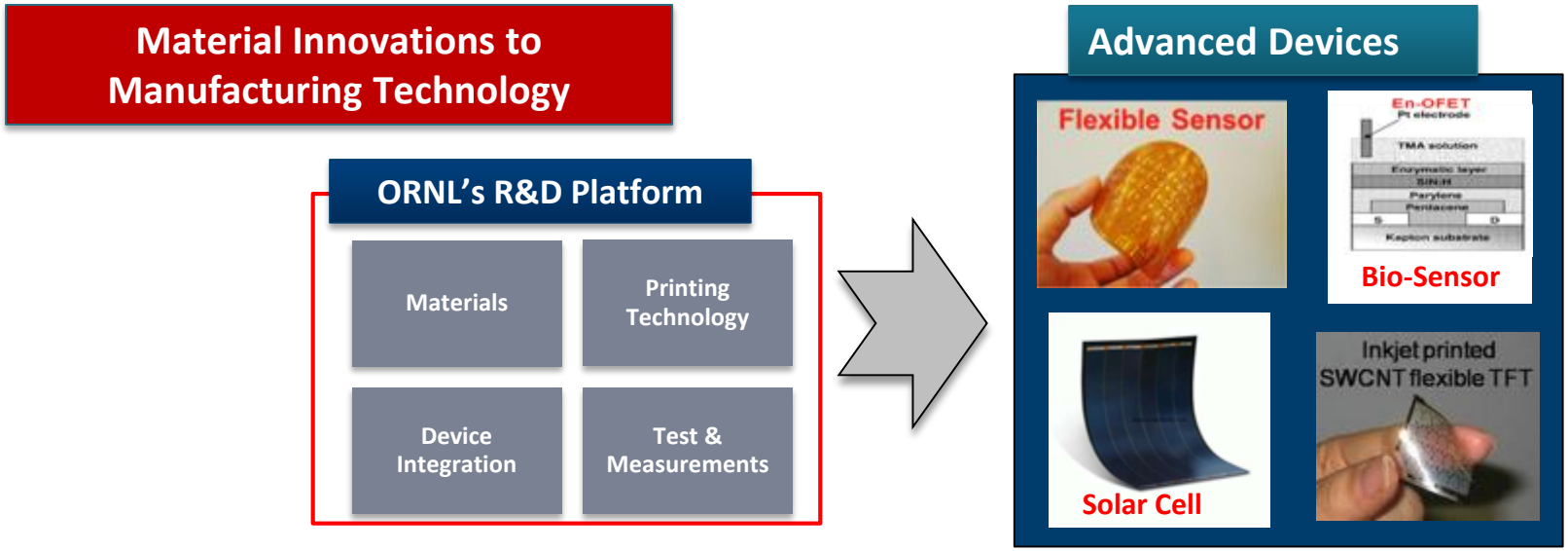

Project Impact: The project envisions reducing the cost barriers to deploying advanced sensors to enable optimization of energy usage. The project will develop and demonstrate low-cost wireless sensors along with path towards roll-to-roll manufacturing techniques.

- Near Term: Demonstrate end-to-end technology and identify path towards low-cost manufacturing through industrial partnerships
- Intermediate Term: Identify building equipment and automation manufacturing partner(s) for commercialization and deployment tailored to specific building applications
- Long Term: Demonstrate energy savings realized by widespread adoption of the low-cost sensors within buildings

Thank You

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