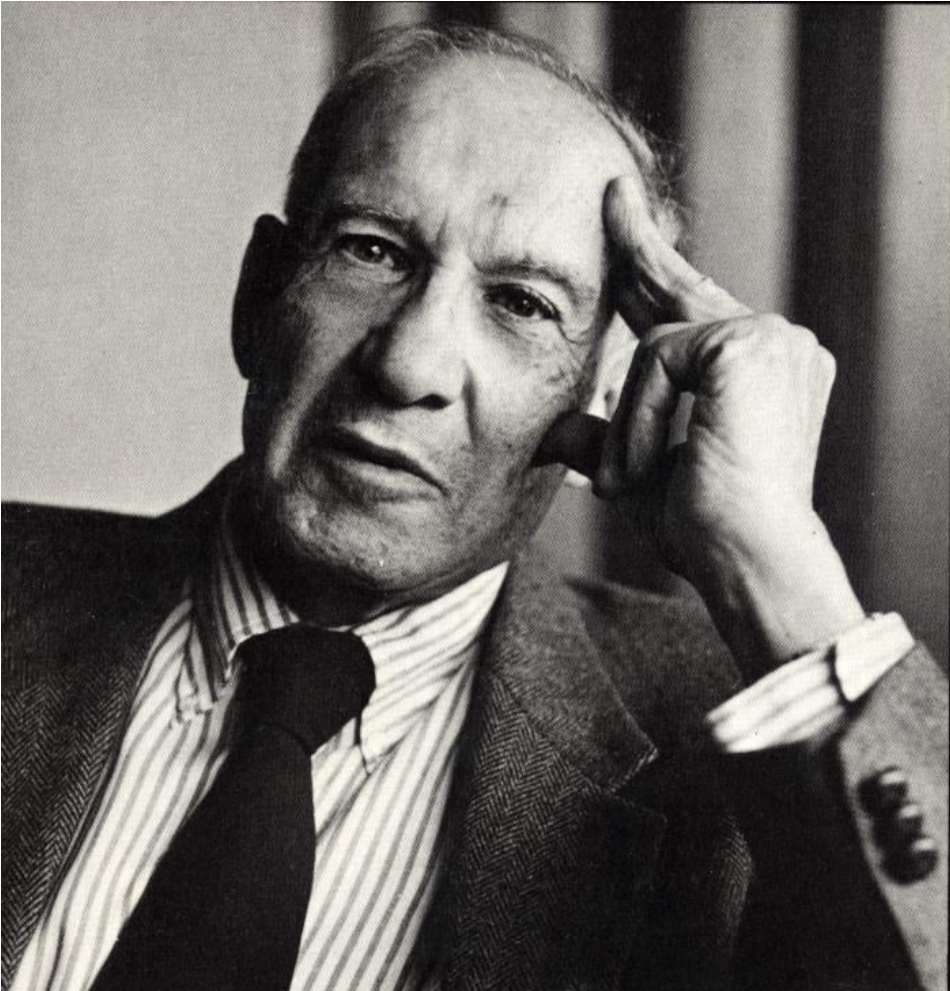


ARPA-E: The Importance of Sensor System Innovations to Energy Infrastructure

Dr. Bob Ledoux, Program Director

November 19, 2024

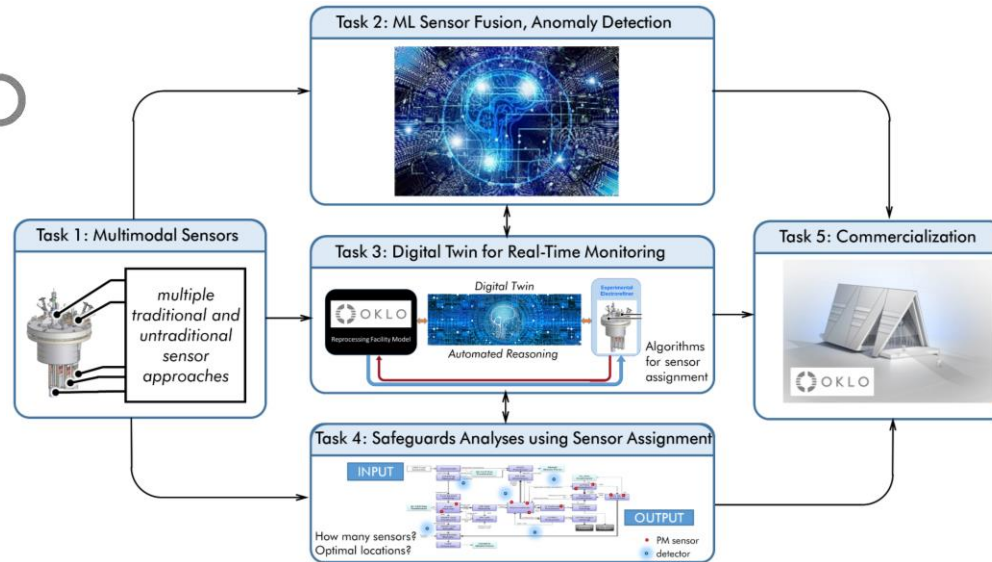


*“If you can’t measure it, you
can’t manage it.”*

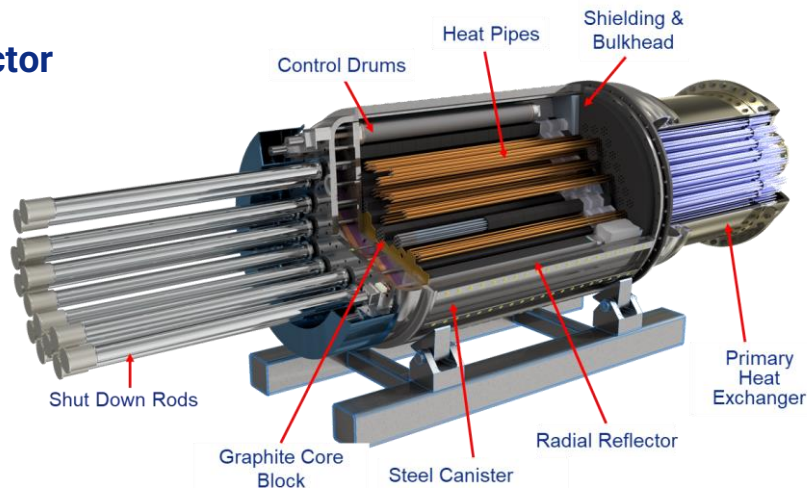
Peter Drucker

*If you can’t manage it,
you can’t improve it*

Importance of Sensors in Nuclear Power



WEC eVinci™ Microreactor



- Performance
 - High Temperature
 - Radiation Damage
- Cost
 - Sensors significant cost
- Power and Connectivity
 - Difficult in core
- Modeling
 - Sensor placement critical
 - Digital Twin for O&M

LARGE-AREA QUANTITATIVE MONITORING OF H₂ EMISSIONS

Program Director: Bob Ledoux

Accurate, sensitive, low-cost H₂ sensors will maximize the climate benefits of the growing H₂ economy

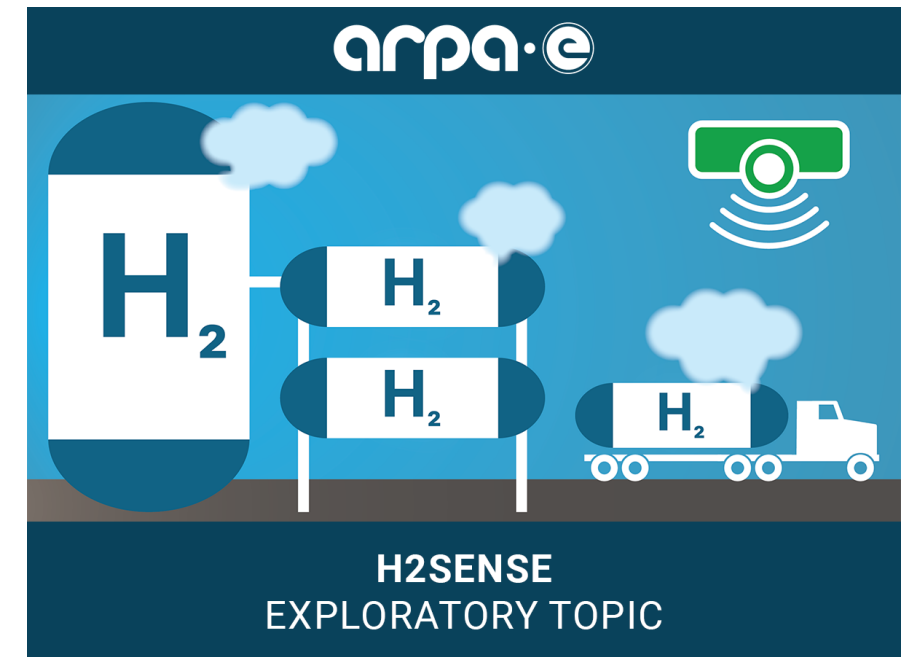
Motivation:

- H₂ production is projected to increase 4-8x globally by 2050
- H₂ is an indirect GHG with 2x the global warming potential of CH₄
- H₂ leaks are likely across multiple use cases

Goal: Develop technologies to **detect, quantify (≤ 10 kg/hr), and locate** H₂ releases across large area (100 m x 100 m) outdoor environments.

To mitigate emissions from **H₂ production, storage and transportation infrastructure**, new technologies must integrate three core components:

- Highly sensitive sensors
- Dynamic sampling modalities
- Advanced H₂ emission modeling



Wireless Hydrogen Integrated Sensing via PiezoElectric Resonators and Switches (WHISPERS)

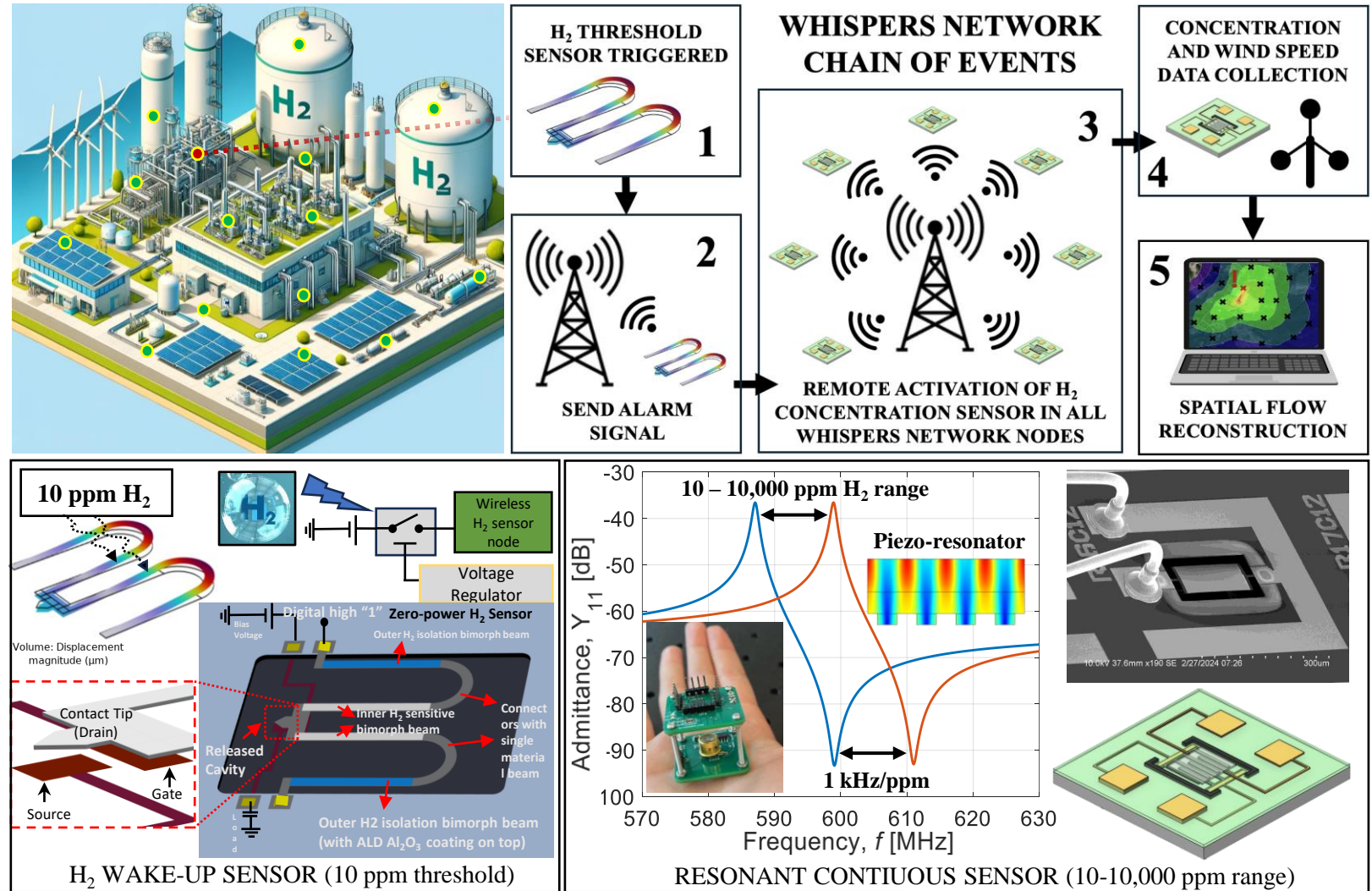
Matteo Rinaldi, Northeastern University (Boston, MA)

Technology Summary

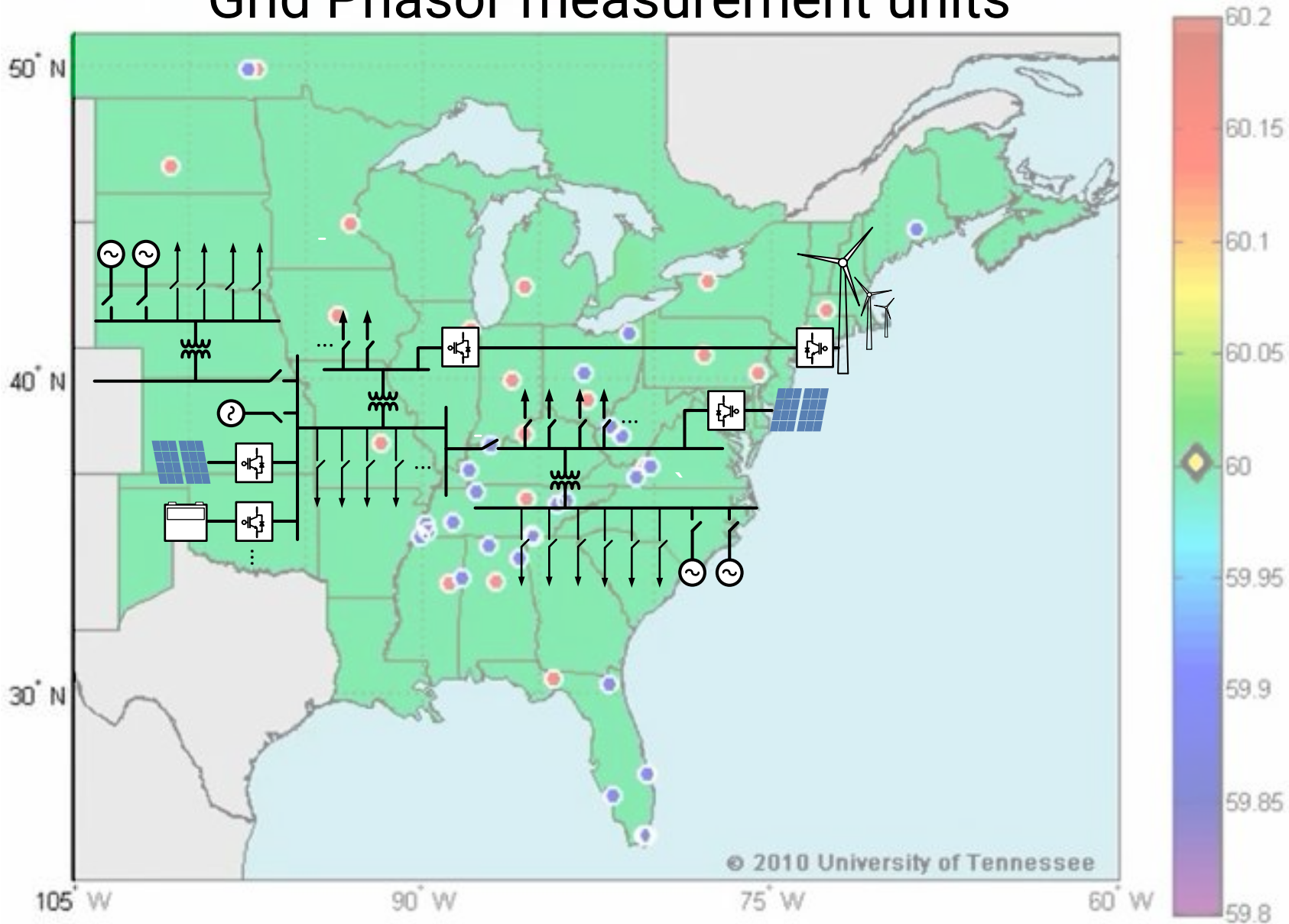
- A network of **wireless, always-on nodes** to monitor background H_2 concentration for **over 5 years**
- Dual sensor node: **1) zero-power wake-up** switch for activation of the network (10 ppm threshold) **2) Resonant H_2 concentration sensor** (10-10,000 ppm range)
- Integration of H_2 concentration with wind measurements to generate a map of H_2 leak through co-variance analysis.

Proposed Specifications

| Metric | SoA | Proposed |
|--------|-----------------------|----------------------------------|
| Cost | \$300 – \$1300 | \$50 |
| Power | 0.1 – 10 W | < 10 μW |
| Size | >1000 cm ³ | < 30 cm³ |



Grid Phasor measurement units



- Performance
 - Time synchronization
 - Standards
- Cost
 - Large scale deployment
- Power and Connectivity
 - EMI immunity
- Modeling
 - Exponentially large
 - Multiple time domains

Thank You!

February 7, 2025