works with
by SILICON LABS

BLE-203

Energy Harvesting: Emulating Energy Sources and Energy Awareness Software Algorithms

Tristan Cool

Product Marketing Manager

Mohammad Afaneh

Novel Bits Founder

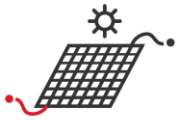
Björn Rosqvist

Chief Product Officer, Qoitech

Contents

01 – Energy Harvesting Sources & Applications

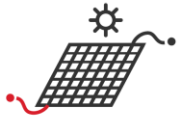
Learn more: TechTalk 2024



SOLAR - OUTDOOR

LOGISTICS / LIVESTOCK TRACKING

Bluetooth® Proprietary



SOLAR - INDOOR

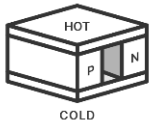
ASSET TRACKING / SMART BUILDING SENSORS

Bluetooth® Proprietary zigbee

KINETIC PULSE

SMART SWITCHES

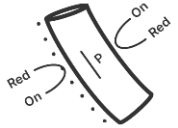
Bluetooth® zigbee



THERMAL

MACHINE MONITORING

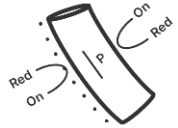
Bluetooth® Proprietary zigbee



VIBRATION / PIEZO

FACTORY AUTOMATION / AGRICULTURE / TPMS

Bluetooth® Proprietary zigbee



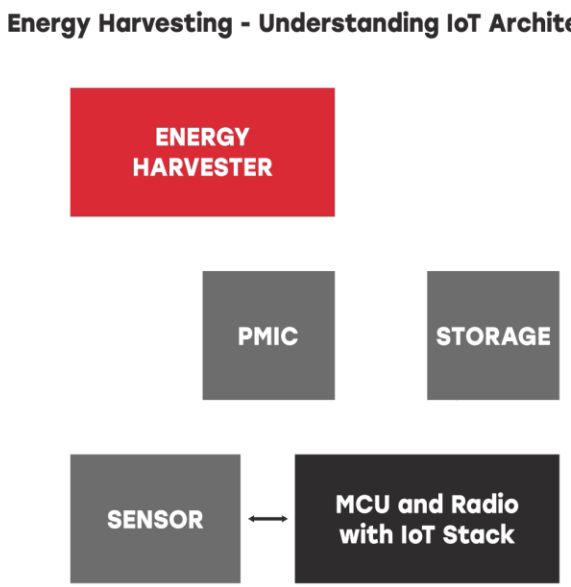
INDUCTION

ELECTRIC SUB-METERING

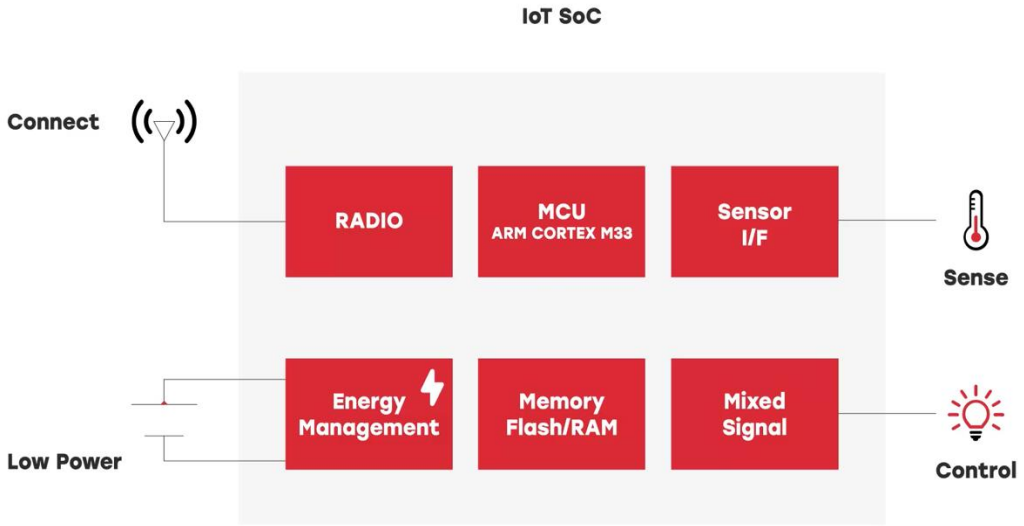
Bluetooth® Proprietary zigbee

works with by SILICON LABS

02 - Ambient IoT Methodology



- Understanding flow of energy - select components

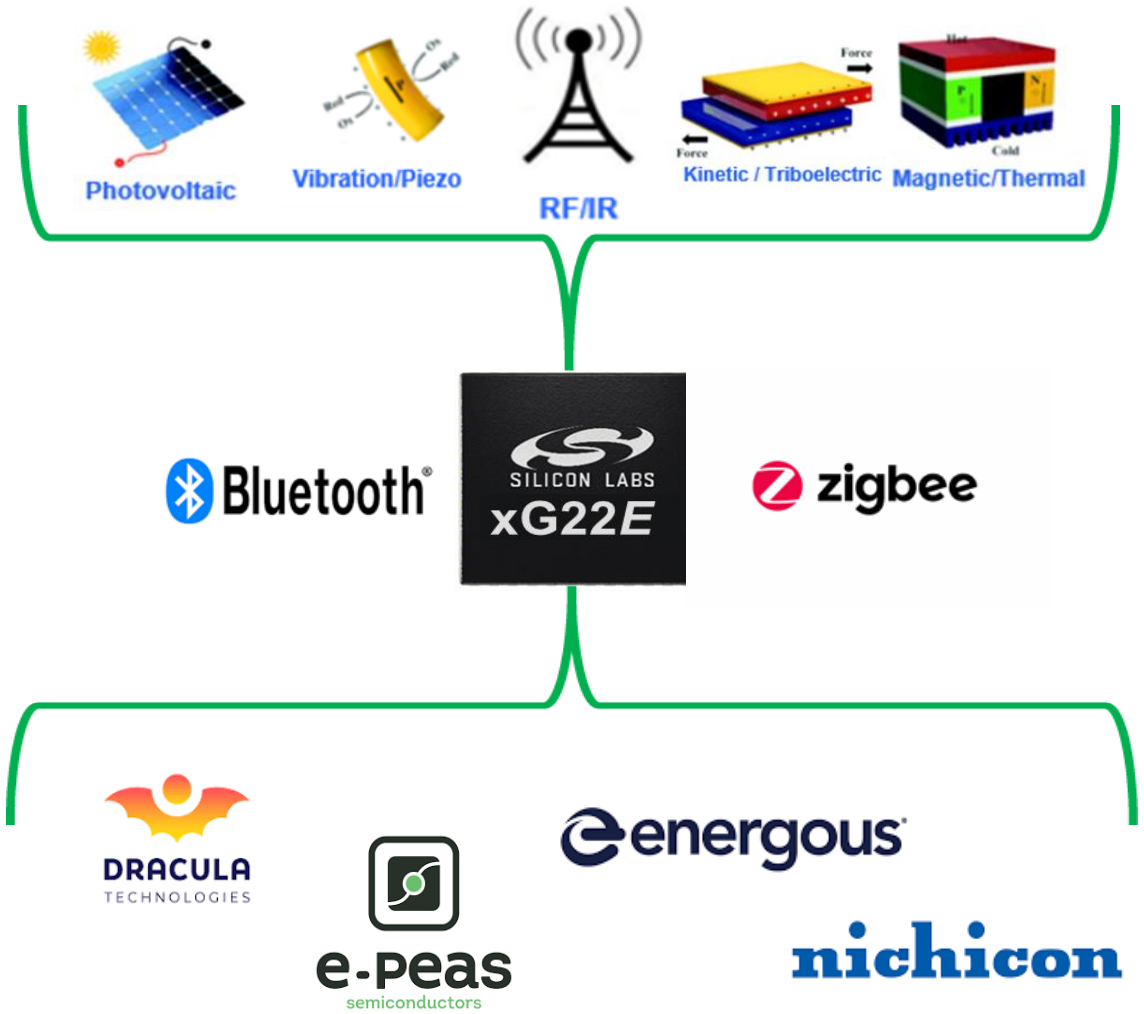


- Understanding the benefits of energy-optimized SoC
- Apply energy-based decision-making algorithms

Learn more: Harnessing Ambient IoT Presentation

02 - Ambient IoT Methodology

- **PROBLEM:** VAST CHOICE OF DESIGN OPTIONS



- **PROBLEM:** DIFFICULT TESTING ENVIRONMENT

- Applications relying on thermal, vibration or variety of luminosity for energy source make for very difficult environments to develop in.

02 - Ambient IoT Methodology

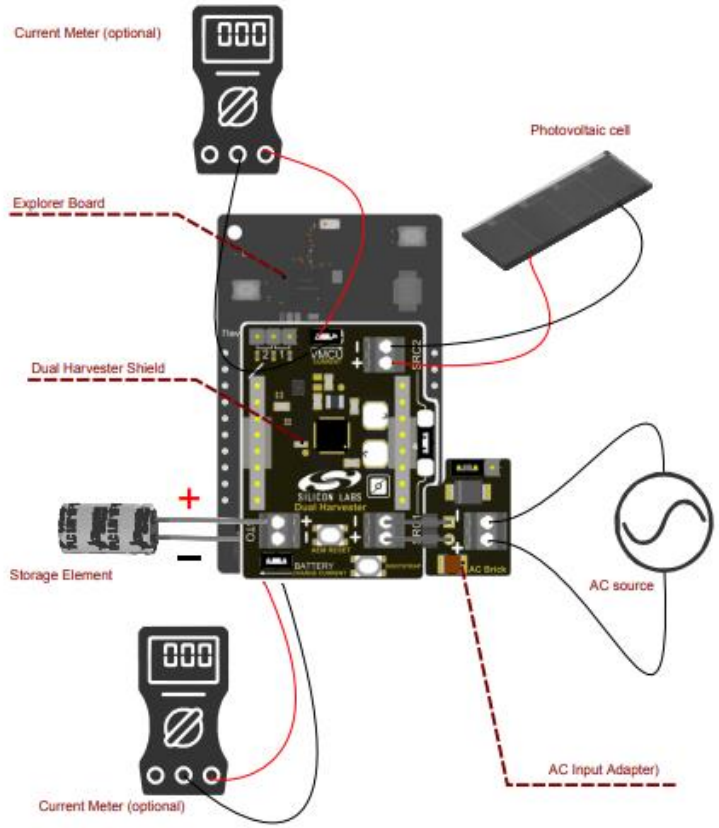
1 **Understanding your application power budget**
- Measure energy for chip-boot up
- Average current for sleep periods
- Tx event current consumption

2 **Assess available energy sources**
- Trickle or transient energy sources
- Indoor vs outdoor, etc.

3 **Energy measurements – PMIC design**
- Buck / Boost configuration
- Charging and discharging modes

4 **Storage type and size design**
- Determine charge and discharge time
- Self-discharging and temperature
- Choose technology node and form-factor (printed, SMD, Lithium, supercap)

5 **IoT protocol – energy algorithms**
- Transmit power
- Payload, channel, PHY, repetition
- IoT protocol vs Proprietary
- Energy decision making algorithms



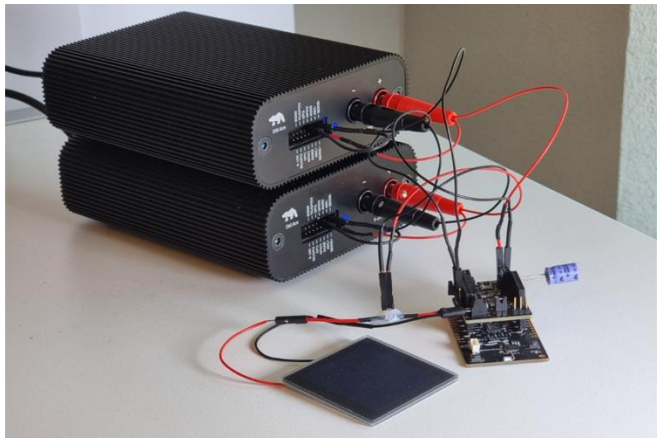
Learn more: docs.silabs.com/energy_harvesting

03 – Getting Started – Tools & Partners

SILICON LABS

Leader in Ambient IoT

Creator of *EFR32xG22E* energy harvesting IoT SoC, development kits, software examples and partners.



QOITECH

Mastering Low-power & Battery Life

Cutting-edge solutions for low-power measurements, battery emulation, battery & energy harvesting testing.

NOVEL BITS

Accelerating Bluetooth LE Product Development

Hands-on training and expert guidance that help engineering teams design and launch reliable Bluetooth LE products faster.

04: Silicon Labs – IoT Hardware and Firmware

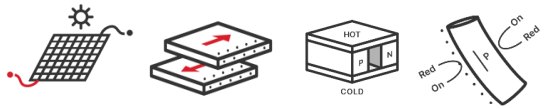
EFR32MG22E

- Fastest, most efficient cold-start boot-up SoC
- Optimized sleep and wake performance

e-peas
semiconductors

MG22E Explorer Kit

Dual Harvester

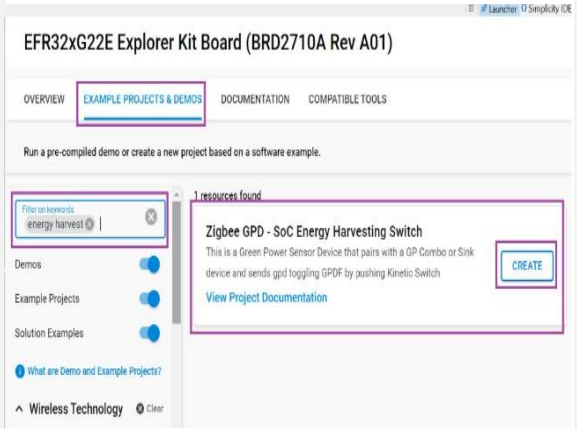


Bluetooth zigbee Proprietary

EK8200A EPEAS

- Explorer Shield MG22E
- epeas AEM PMIC
- Sample PV cell + capacitor
- Dual multi energy source

14 Si Si5



GITHUB EXAMPLES

- Bluetooth LE beaconing example
- Zigbee Green Power Kinetic Switch
- Multiprotocol / Proprietary Reader
- Compatible with SiConnect App and Simplicity Studio

REFERENCE DESIGN

- Solar powered asset tag (*Dracula* + *epeas*)
- RF powered asset tag (*Energous* + *epeas*)

works with by SILICON LABS

Novel Bits – Accelerating Bluetooth LE Development

Founded by Mohammad Afaneh in 2015

Focus: Helping engineering teams design and launch reliable Bluetooth LE products faster through hands-on training, expert consulting, and educational content.

Key Milestones:

- Launched a **Bluetooth developer-focused blog** — now one of the top online resources for Bluetooth LE engineers worldwide.
- Published *"Intro to Bluetooth Low Energy"* book
- Delivered corporate Bluetooth LE training to **hundreds of engineers** across various industries
- Partnered with leading wireless technology companies to support developer success.

What We Do:

- **Corporate Training** – Hands-on, hardware-based Bluetooth LE workshops.
- **Consulting** – Solve complex wireless design and debugging challenges.
- **Educational Content** – Blog posts, guides, and technical resources.

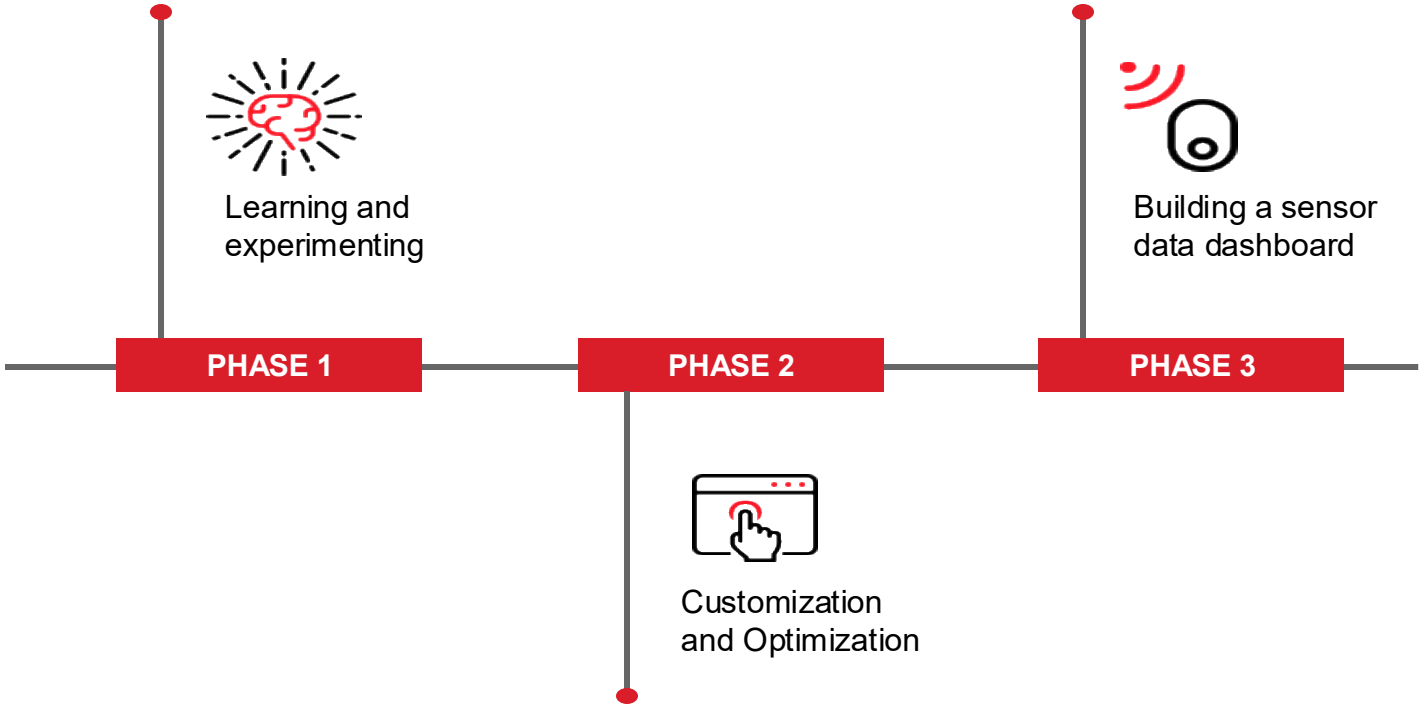
My Journey With Building an Energy Harvesting Project

Free Course:

Focused on building energy harvesting solutions using the Silicon Labs xG22E

https://academy.novelbits.io/register/practical-guide-to-energy-harvesting-for-ambient-iot-silicon-labs/

My Journey With Building an Energy Harvesting Project



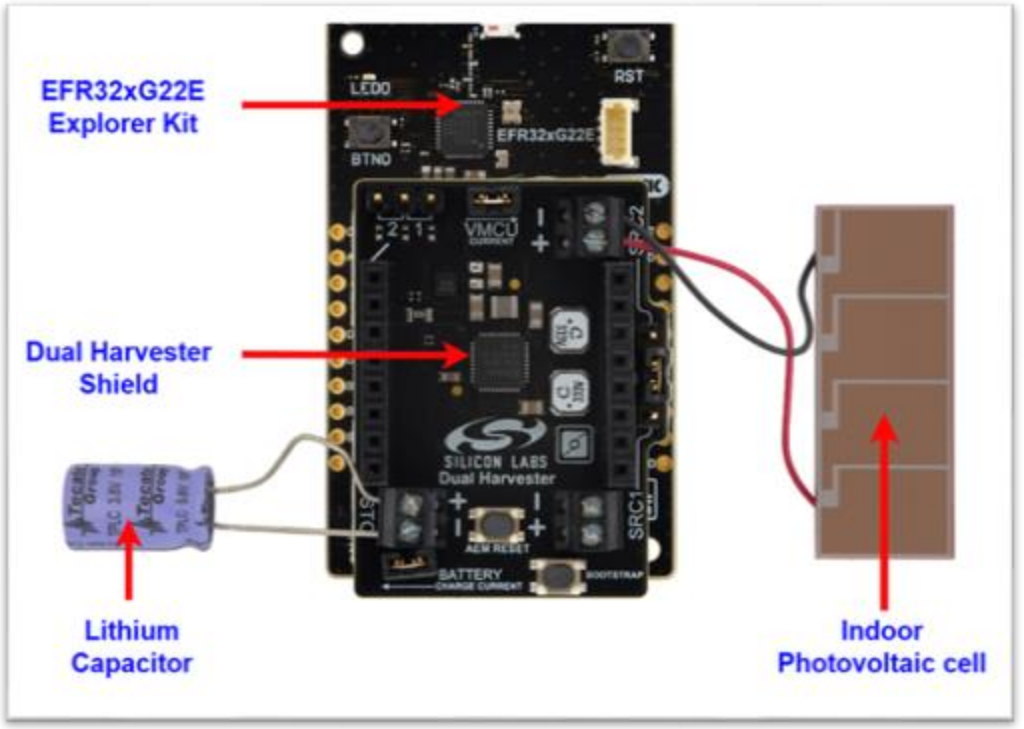
My Journey With Building an Energy Harvesting Project

Phase 1: Learning and experimenting

- Energy Harvesting concepts
- Energy sources
- Silicon Labs xG22E operation
- e-peas PMIC operation
- Acquiring necessary tools: power analyzer, voltmeter, light source, resistors
- Running the example projects

Phase 2: Customization and Optimization

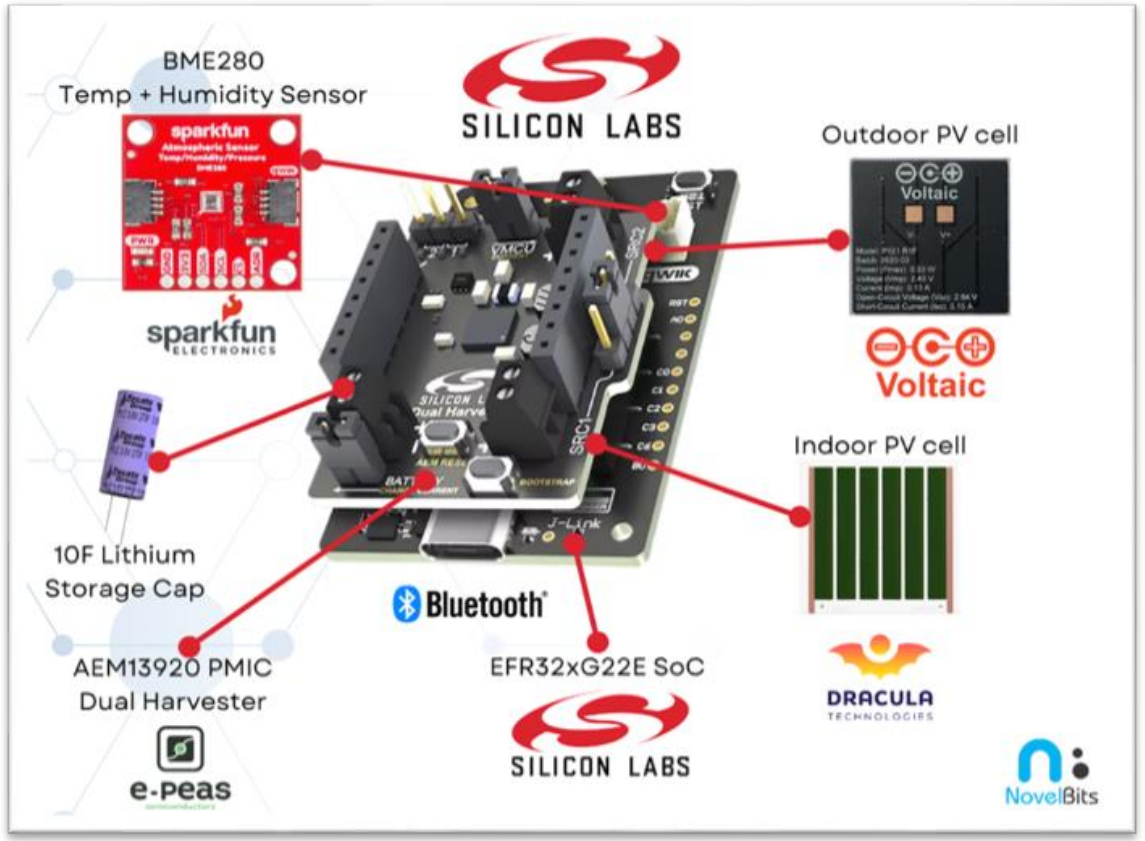
- The existing project required a few modifications due to:
  - Single source configuration
  - No sensor support
  - Bluetooth adv packet does not include sensor data



Phase 2: Customization and Optimization

Customization

- Adding and configuring the two sources (indoor + outdoor)
- Adding support for the temp + humidity sensor
- Adding the temperature value to the Bluetooth advertising packet



Phase 2: Customization and Optimization

Optimization

- Increase advertising interval
- Reduce Tx power
- Use non-scannable advertising packets
- Minimize payload to reduce airtime
- Implement decision-based advertising based on available energy at the sources
- Further optimization: migrate to Silicon Labs RAIL instead of using the full BLE stack

Phase 3: Building a Dashboard

- Need a way to monitor the temperature and storage voltage across time
- Used a Linux desktop in the same office
- Attached a BLE USB dongle that can be controlled via AT commands from the serial port

Phase 3: Building a Dashboard

- Need a way to monitor the temperature and storage voltage across time
- Used a Linux desktop in the same office
- Attached a BLE USB dongle that can be controlled via AT commands from the serial port

Phase 3: Building a Dashboard

Final Application (python):

- **BLE Scanning** - Auto-detects BLE dongle and continuously scans for "EH Sensor" devices
- **Data Capture** - Extracts voltage and temperature from BLE advertising packets
- **Database Storage** - SQLite database with automatic cleanup of data older than 30 days
- **Web Dashboard** - Real-time charts showing voltage and temperature trends
- **Signal Strength** - RSSI monitoring updated every 30 seconds

My Journey With Building an Energy Harvesting Project

My Journey With Building an Energy Harvesting Project

Register for free!

https://academy.novelbits.io/register/practical-guide-to-energy-harvesting-for-ambient-iot-silicon-labs/

07 – Going Further

SILICON LABS

Visit Site

SiLabs xG22E

Ambient IoT

WW23

WW24

EK8200 Explorer Kit

Github

Blog 2025: Simplifying Ambient IoT with xG22E Energy Harvesting Explorer Kit

Tech Talk 2025: Harvesting Energy for Smarter IoT with Silicon Labs xG22E

QOITECH

BLOGS

Is your PV cell enough? - Evaluating energy availability for your IoT system

Evaluating energy storage for your PV cell powered IoT

Application note: Setup for evaluation of PV cell performance

TECHNOLOGY

Otii Ace Pro

CONTACT

QOITECH

NOVEL BITS

RESOURCES

Energy Harvesting Course (free)

Intro to Bluetooth Low Energy book

Novel Bits Bluetooth Blog

Harnessing Ambient Energy for IoT [Blog Post]

CONTACT

Contact Novel Bits

NovelBits

works with by SILICON LABS

SILICON LABS

CONNECTED INTELLIGENCE