Insight Power Smart Outlet

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Problem statement

Current State of the Market

Problems with smart outlets

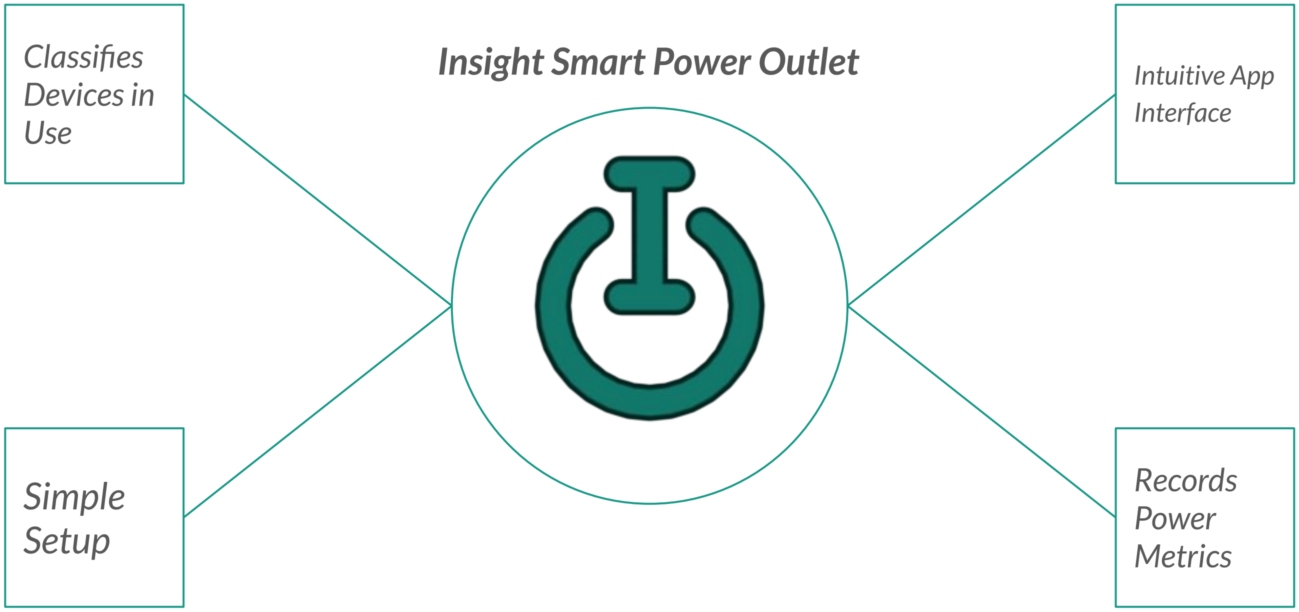
- Tedious to set up
- Plugged-in devices are not automatically managed
- Setup friction increases hugely for home-scale installation

Benefits of smart outlets

- Allow monitoring of power usage for plugged in devices
- Devices plugged in can be turned on/off remotely
- Enable home automation policies

Problem statement (Cont.)

Our Solution



“Customers often find smart outlets difficult to use. The Insight Smart Power Outlet fixes this by providing customers with an easy and intuitive experience by ***classifying*** *devices* that are plugged into the product.”

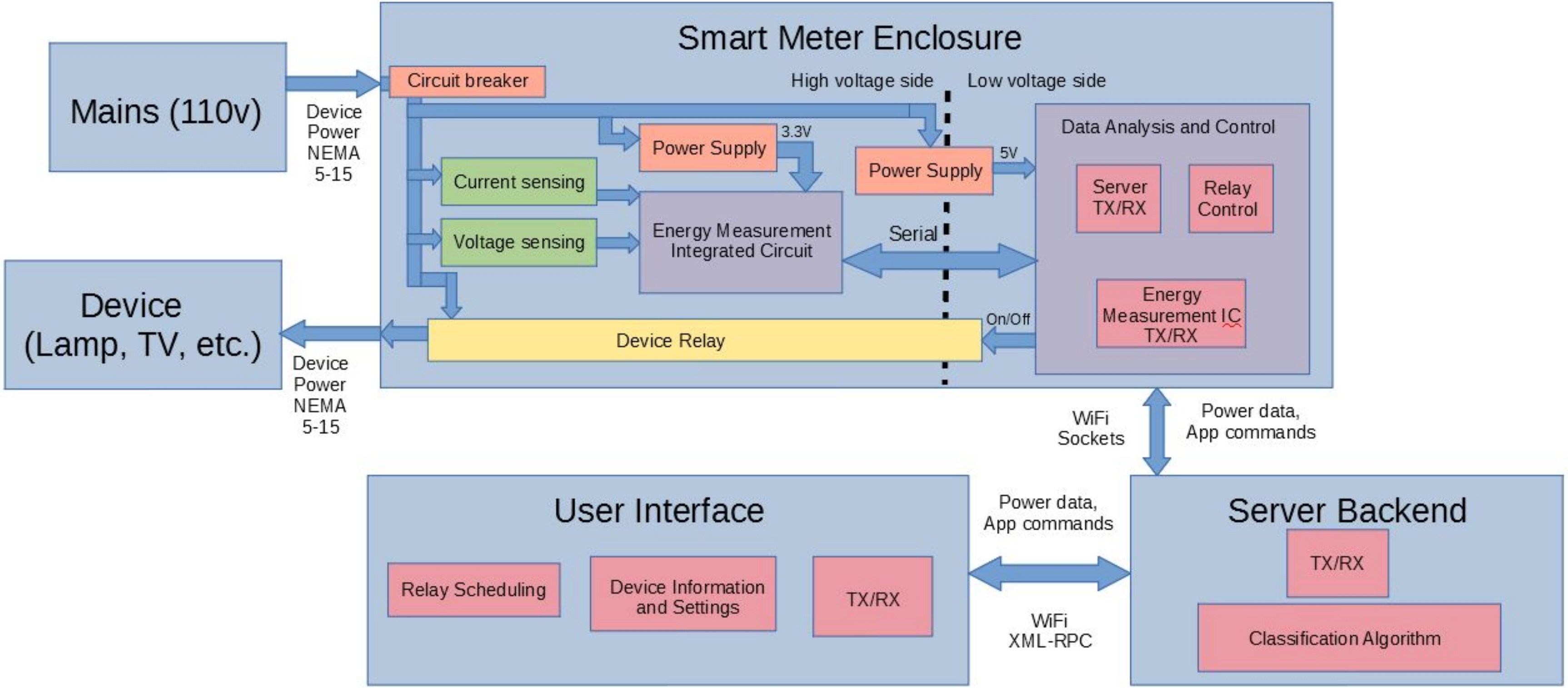
System Requirements

- Plug easily into wall outlet, remains firmly in place once plugged in.
- Connect wirelessly to app
- Measures and graphs (via app) power usage in real-time
- Turn device on and off via app
- Continuous analysis of usage data
- Classify devices based on data into different categories (lighting, heating/cooling, etc)
- User-Friendly companion app
- 12cm x 3cm x 3cm (L x W x H)
- Less than 1lb

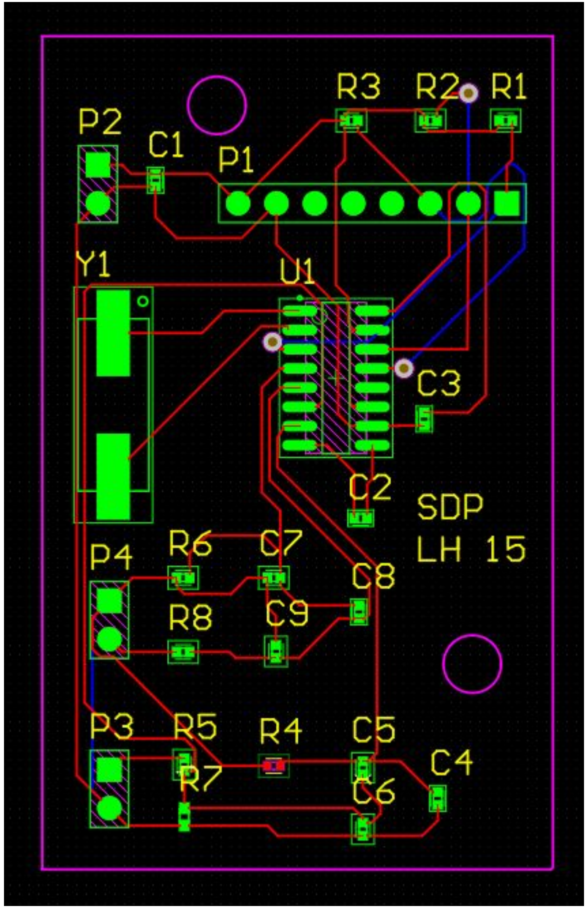
System Specifications

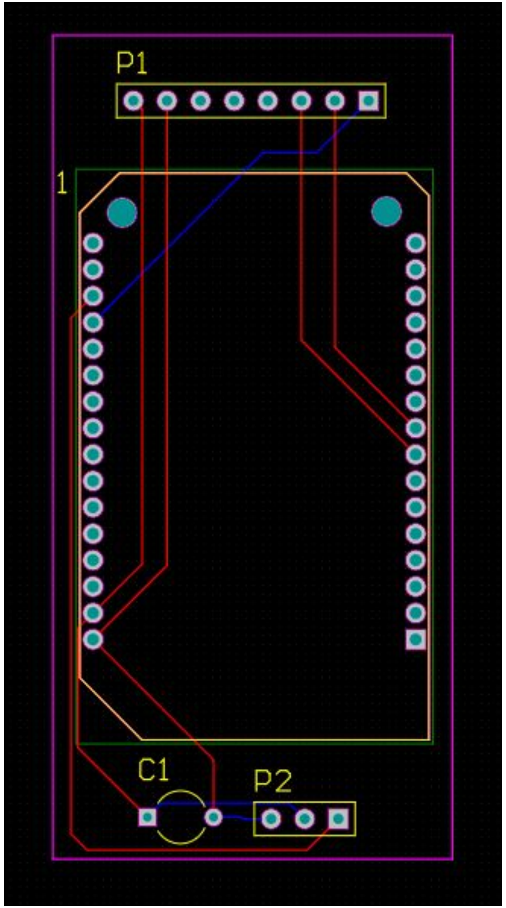
- Measures power usage at least **once per second** within **5%**
- Companion app updates **once per second**
- Communication between app and outlet takes at most **1 second**
- **≥80%** accuracy, error biased towards resistive loads

Block Diagram



New PCB Layout





Proposed FPR Deliverables

1. Working classification that is implemented on **SVMs rather than a Decision Tree.**
2. At least 3 working outlets, all able to classify and read power under required specifications.
    a. Measures power usage at least **once per second** within **5%**
    b. Achieve classification accuracy of **80%** with false positive **<1%**
3. **Smaller design** for all outlets.
4. Companion App and GUI refinement.
    a. Implement only **resistive load toggling** on the App.

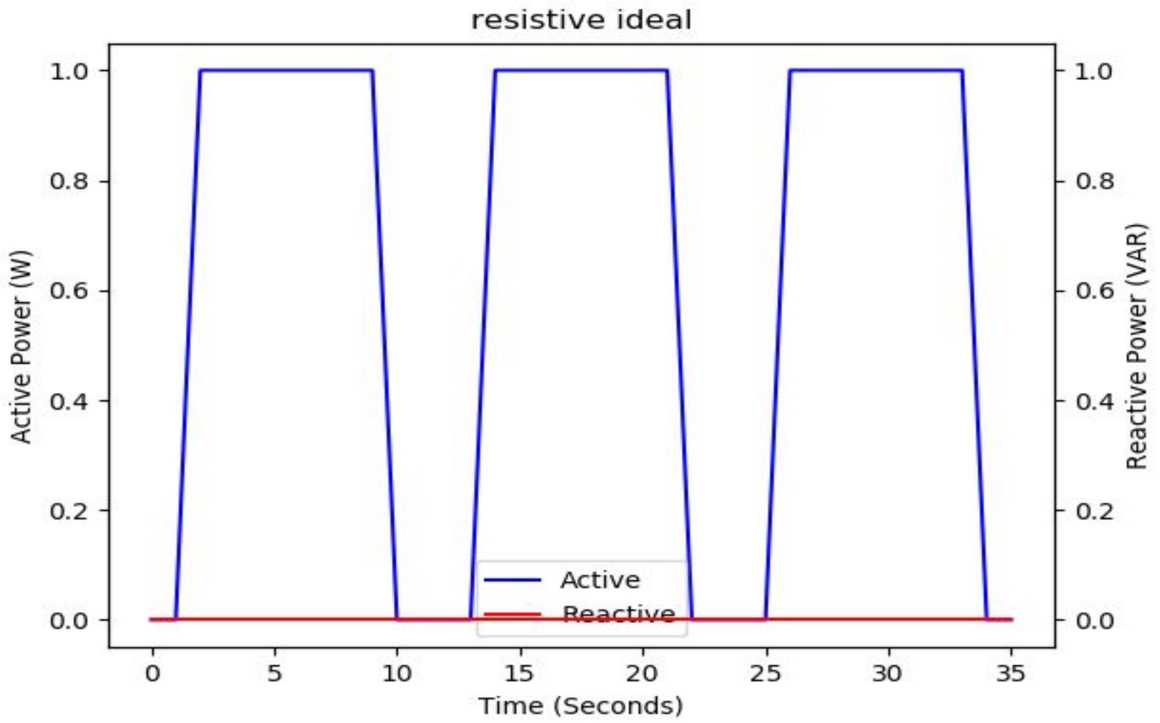
Achieved FPR Deliverables

1. Working classification that is implemented **Dynamic Time Warping (DTW)**
2. At least 3 working outlets, all able to classify and read power under required specifications.
    a. Measures power usage at least **once per second** within **5%**
    b. Achieve overall classification accuracy of $\geq$**80%**
        i. We have achieved an average accuracy of 70%
            1. Resistive: 92%
            2. Inductive: 55%
            3. Non-linear: 63%
3. **Smaller design** for all outlets.
4. Companion App and GUI refinement.
    a. Implement only **resistive load toggling** on the App

What is Dynamic Time Warping?

- Compares two waveforms and finds the distance between them.
- As the distance calculated increases, the waveforms are more dissimilar.
- For our classification we normalize the incoming power data between 0 and 1 and perform DTW against ideal waveforms for each class.
- The class that has the calculates lowest distance is what is classified.
- We are classifying based on startup data.

Resistive loads: Ideal

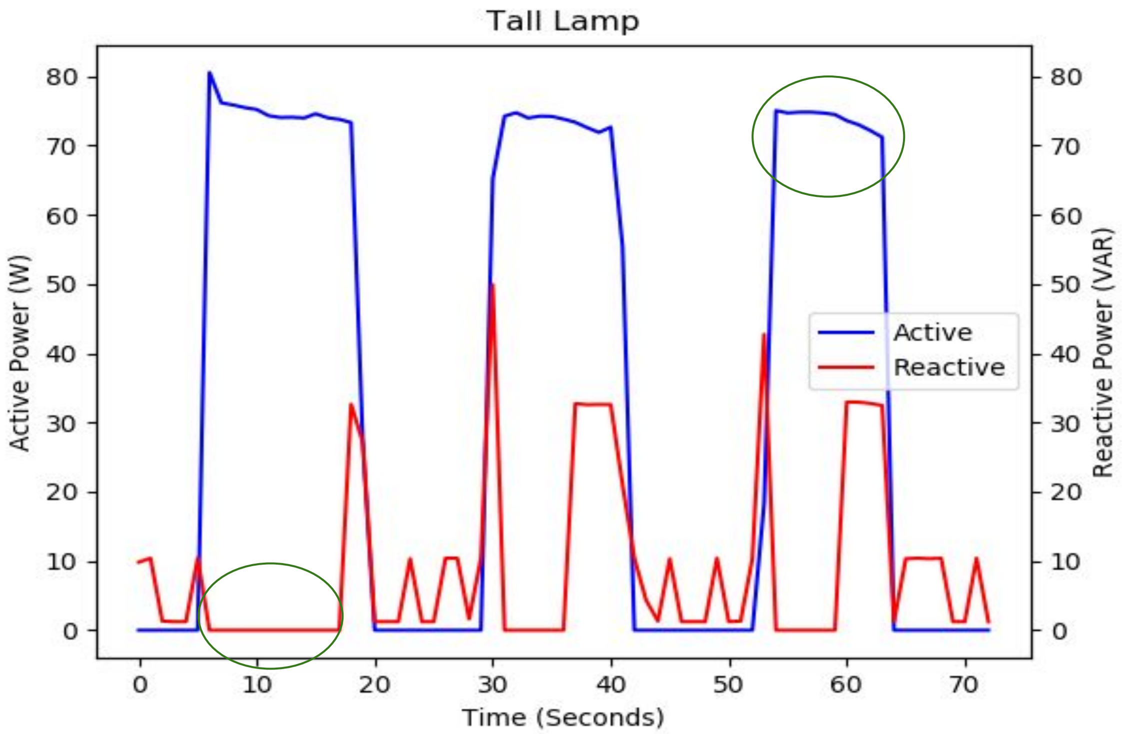


Features to note:

1. Steady with slight decay or increase in active power.

2. Zero, or very little reactive power.

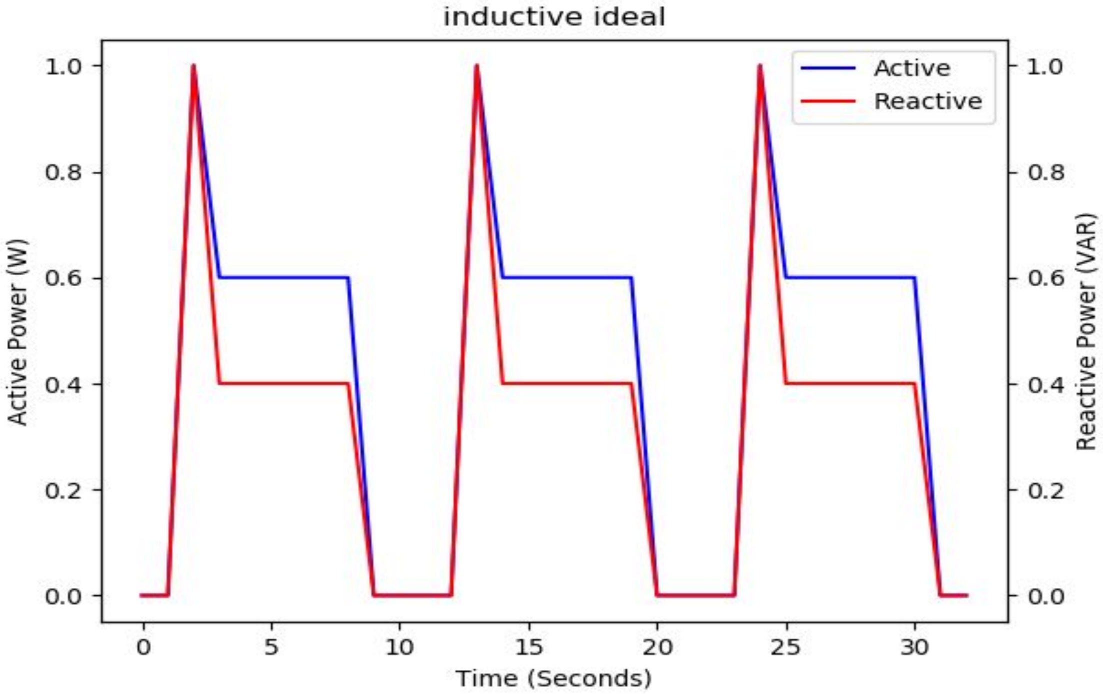
Resistive loads: Tall Lamp Example



Features to note:

1. Steady with slight decay or increase in active power.
2. Zero, or very little reactive power.

Inductive loads: Ideal

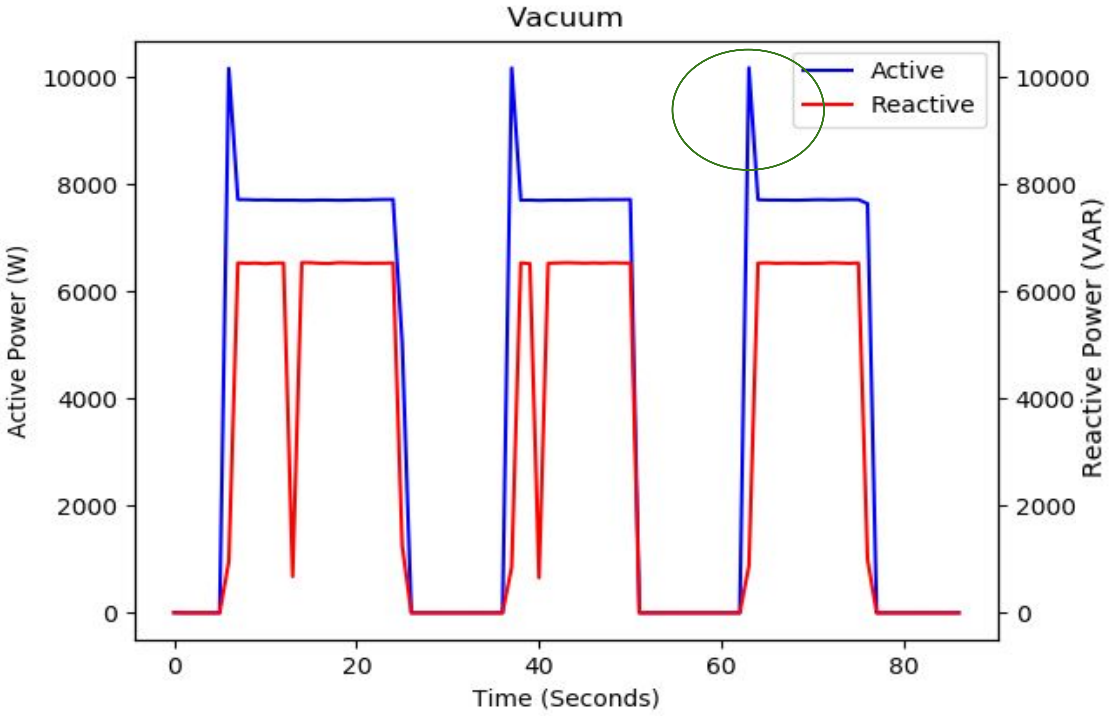


Features to note:

1. Big spike at the beginning which drops to a steady power usage.

2. Reactive power is non-zero.

Inductive loads: Vacuum Example

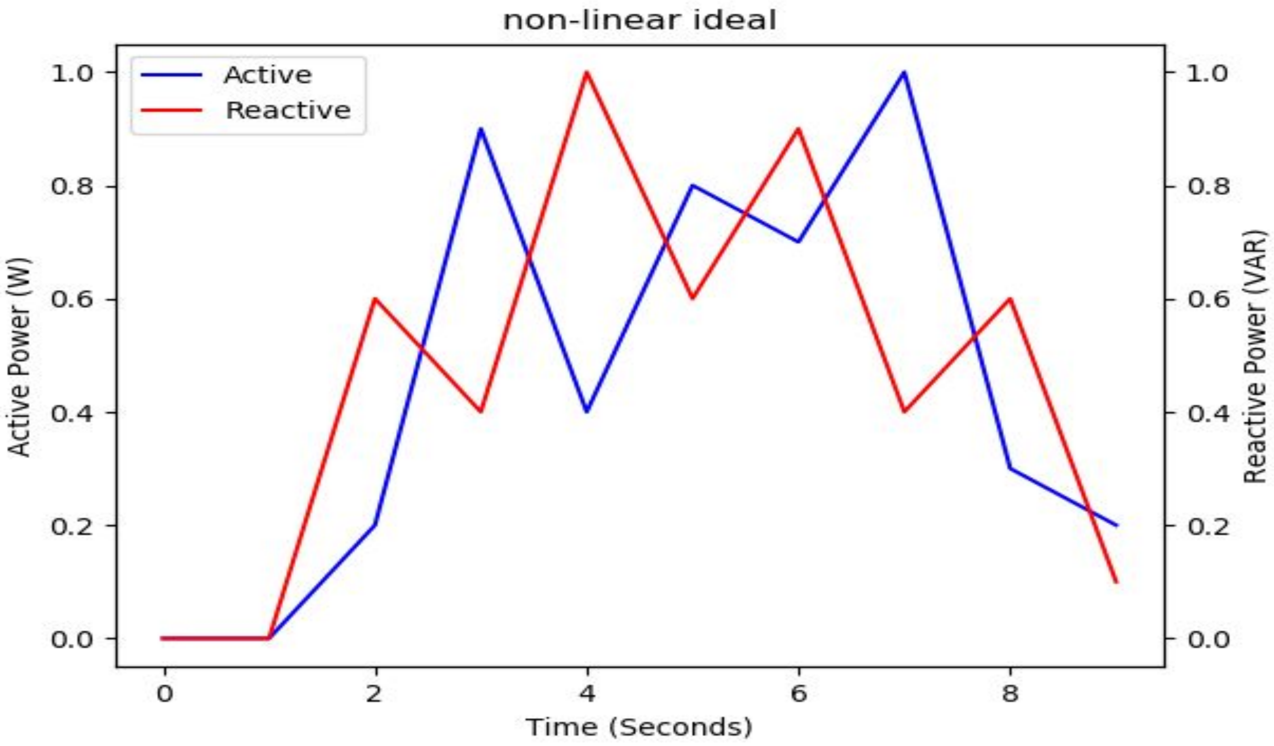


Features to note:

1. Big spike at the beginning which drops to a steady power usage.

2. Reactive power is non-zero.

Non-linear loads: Ideal

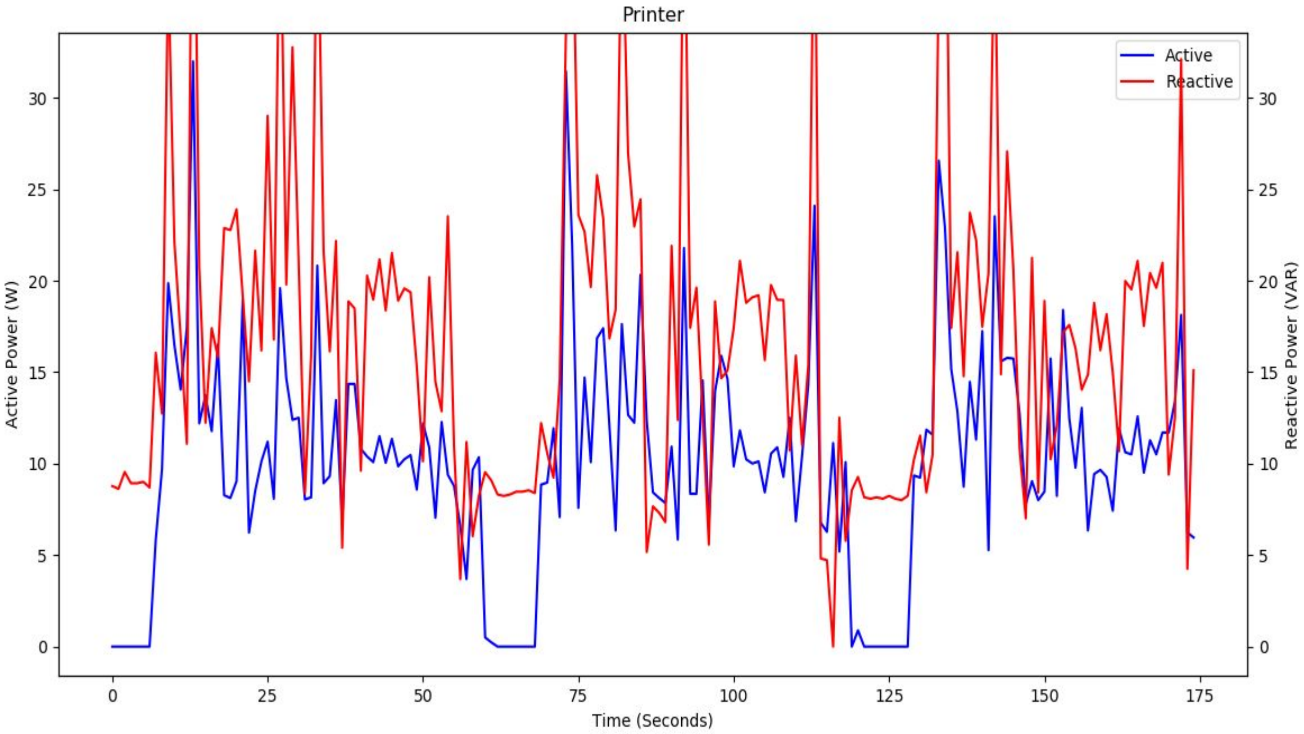


Features to note:

1. Both active and reactive power vary greatly over time.

2. We also see greater reactive power than active power at times.

Non-linear loads: Printer Example



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DEMO!!!

Thank you