

Energy Measurement using Software

Green Programming Course

Chapter 4 - Measurements of power consumption

Oshani Weerakoon



UNIVERSITY
OF TURKU

Measurement Software

- Software tools are easier to use than hardware solutions but less accurate.
- Ideal for developers without electronics expertise; no additional resources needed.
- Many tools are free and accessible.

Challenges of Universal Software Tools

- **Device Specificity:** Measurement tools require access to hardware, necessitating device-specific interfaces (e.g., Intel PCM).
- **Variability:** No single application works across all devices due to diverse hardware configurations.
- **Operating Systems:** Differences in OS platforms complicate the creation of universal tools.

Key Software Tools

- **Windows E3 (Energy Estimation Engine):** In-built Windows tool for measuring application power consumption.
- **Intel PCM (Performance Counter Monitor):** Works on various Intel processors and multiple OS.
- **Syspower:** Simple tool specifically for Mac OS.
- **Website Carbon Calculator:** Online tool for estimating website carbon footprint.
- **Powerstat:** Linux-specific, uses Intel RAPL, outputs average power in Watts.
- **PowerTOP:** Measures and adjusts power consumption profiles on Linux, works with AMD and Intel CPUs.

Specialized Tools for Detailed Measurement

- **Perf**: Linux tool that outputs energy consumption directly in Joules, focusing on specific components like CPU or RAM.
- **Nvidia SMI**: Designed for Nvidia GPUs, provides detailed monitoring via Nvidia Management Library.

Demonstration

Calculating CO2 emission

A great read!

<https://devblogs.microsoft.com/sustainable-software/measuring-your-application-power-and-carbon-impact-part-1/>

Explanation:

1. **Measure Application Energy Usage:** It starts by calculating the energy used by an application in milli-Joules (mJ).
2. **Scale Up for User Base and Usage Frequency:** The energy usage is scaled up to account for the total number of users and the frequency of application usage. E.g: For 1 million users running the application 10 times a day, the total is 4.1 billion mJ per day.
3. **Convert Energy to MWh:** The energy is then converted from mJ to Megawatt-hours (MWh) using the conversion factor ($1 \text{ mJ} = 2.8 \times 10^{-13} \text{ MWh}$).
4. **Calculate CO2 Emissions:** The converted energy is multiplied by the CO2 emission factor for the US energy mix (0.475 mtCO2e per MWh) to estimate the total CO2 equivalent emissions.



**UNIVERSITY
OF TURKU**