Understanding the energy use of Firefox

With less power comes more sustainability

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February 4, 2023 - FOSDEM

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Why do we care?

Why? User experience!

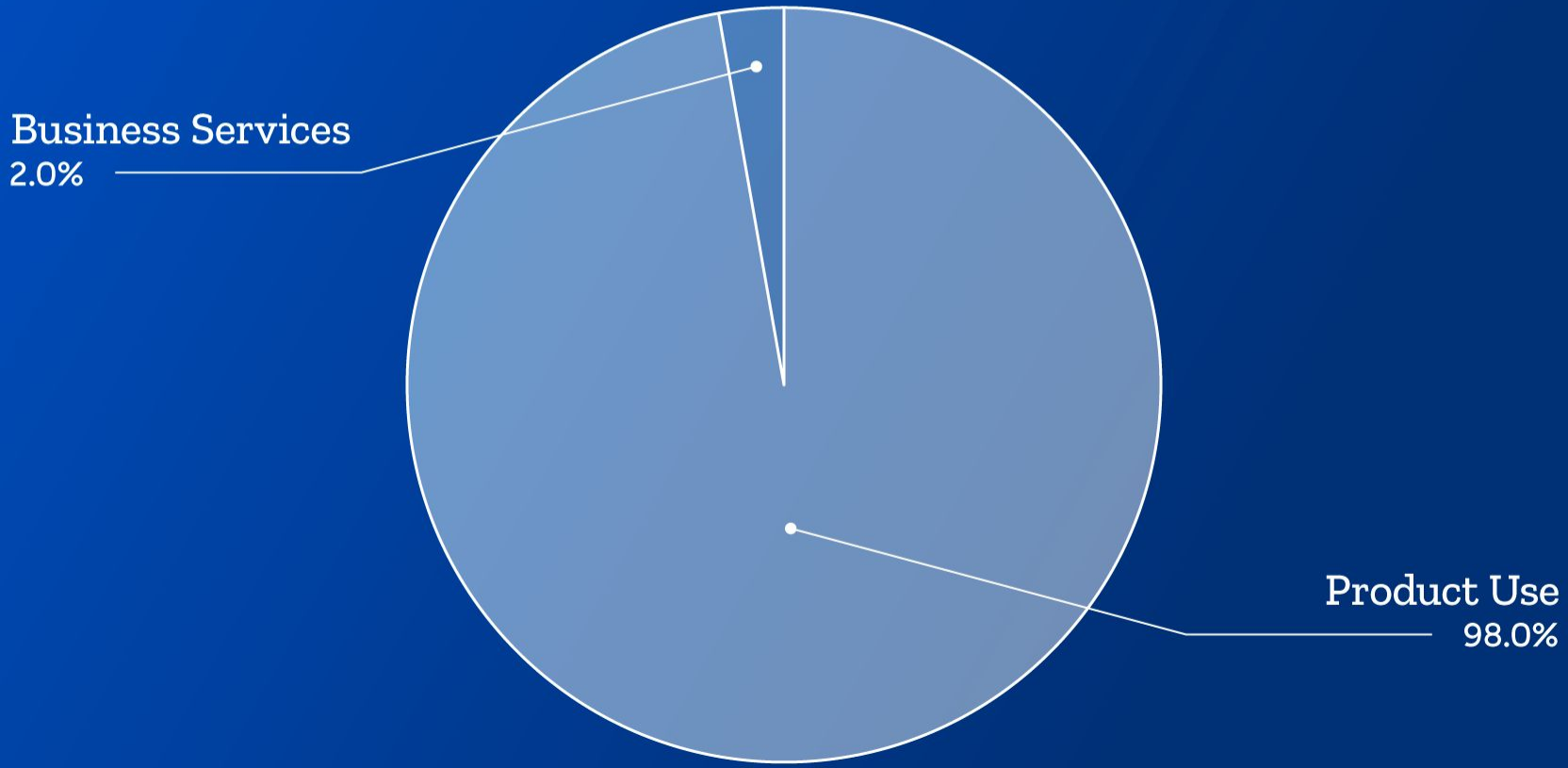
- Noisy fans
- Hot laptops
- Battery life

Why? Sustainability!

Mozilla made climate commitments:

- being carbon-neutral.
- reducing its GHG footprint year over year
- **leading openly by sharing materials, tools, and methodologies**.
- exploring approaches to develop, design, and **improve products from a sustainability perspective**

Emissions Distribution 2019



Understanding local power use

How Firefox uses power

- CPU time
- GPU time
- CPU core wake-ups
- Network packets

How Firefox wastes power

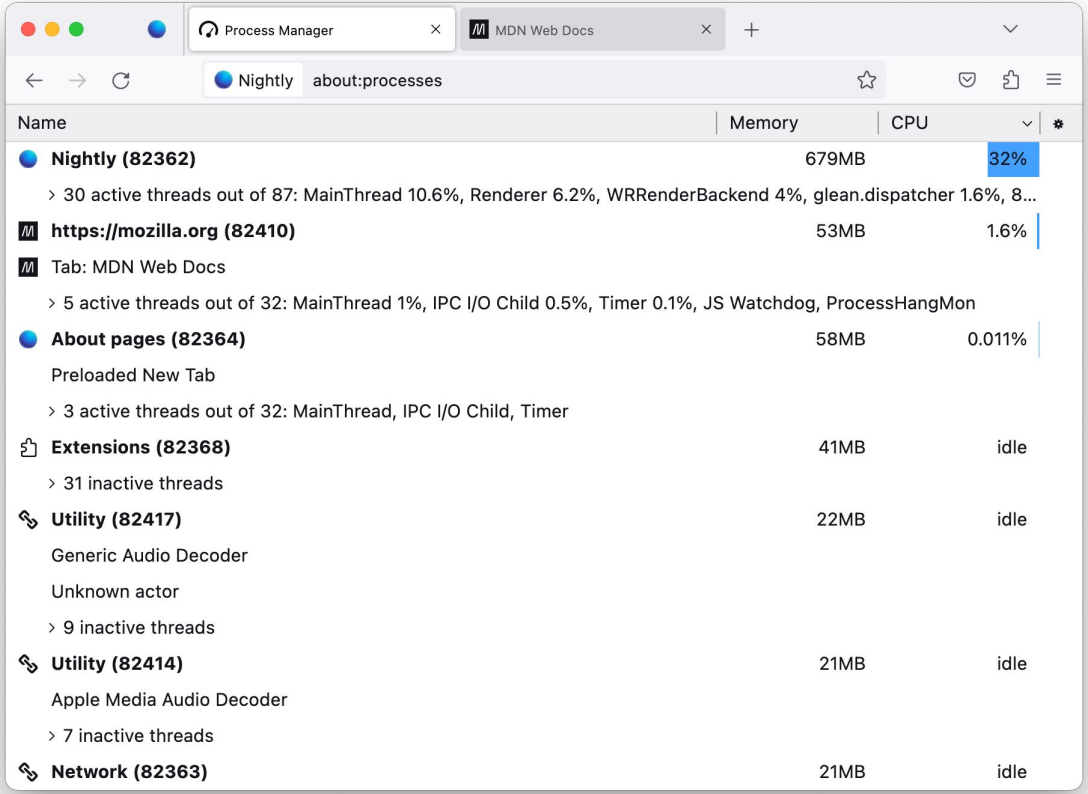
- Using too much CPU time
- Waking up threads too often
- Invisible animations
- Background activity

Understanding local power use

Troubleshooting excessive power use:

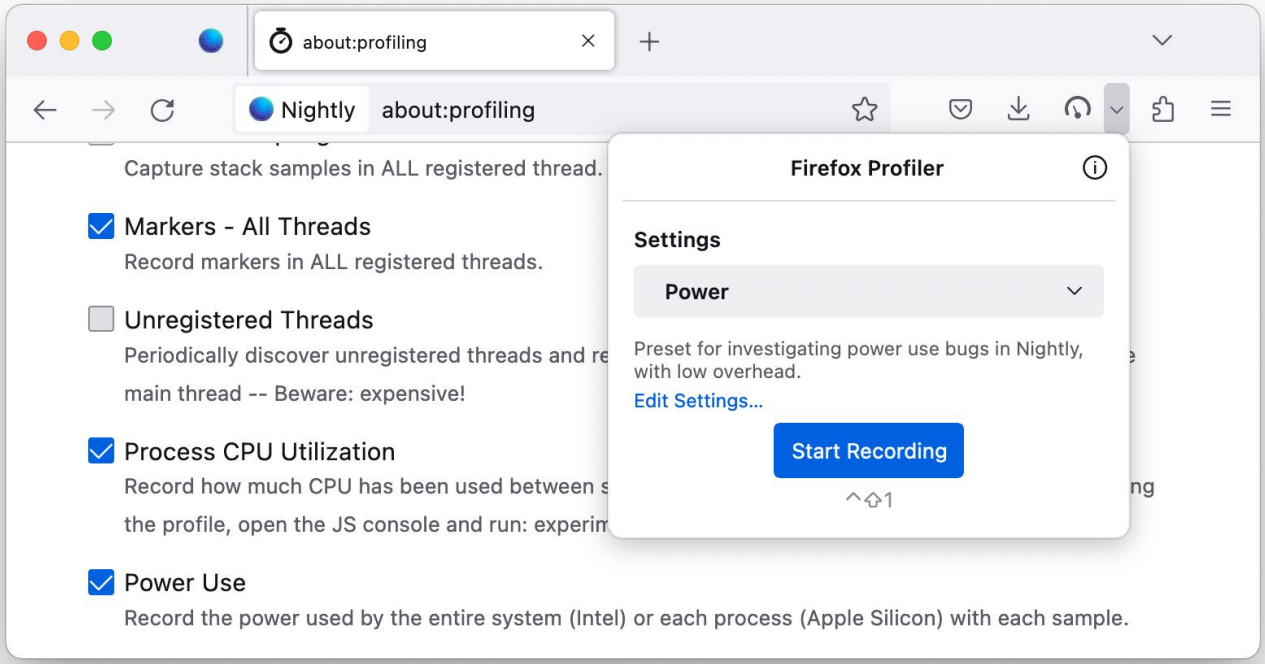
- One or more cores 100% used
- idle Firefox processes that are not really idle.

Firefox task manager



Firefox profiler

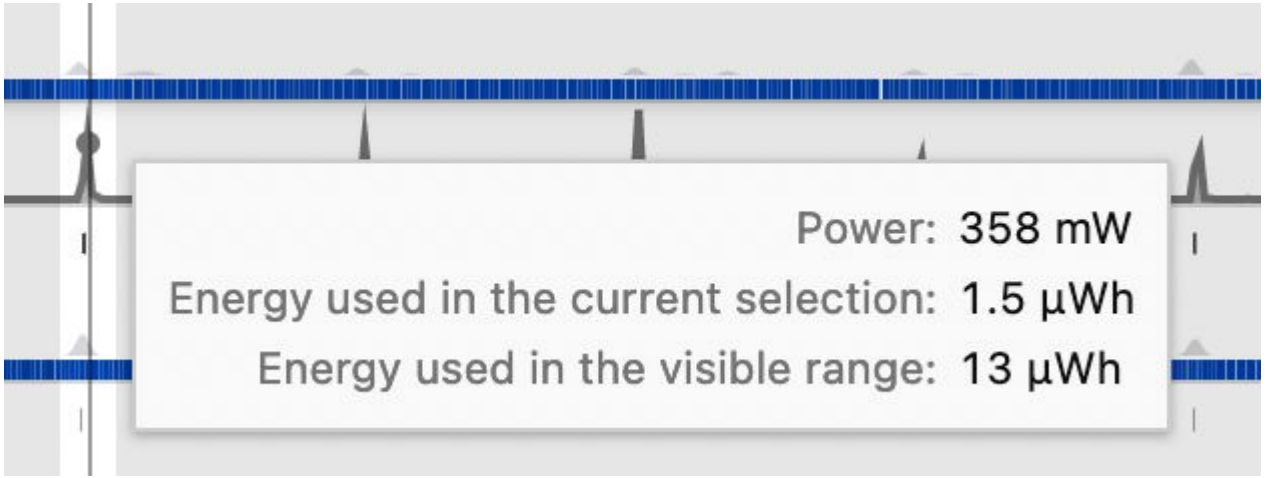
The Firefox Profiler now supports power profiling.



Windows 11 & Apple Silicon since Firefox 104 — Linux & Intel Macs since 107

Firefox profiler - power profiling

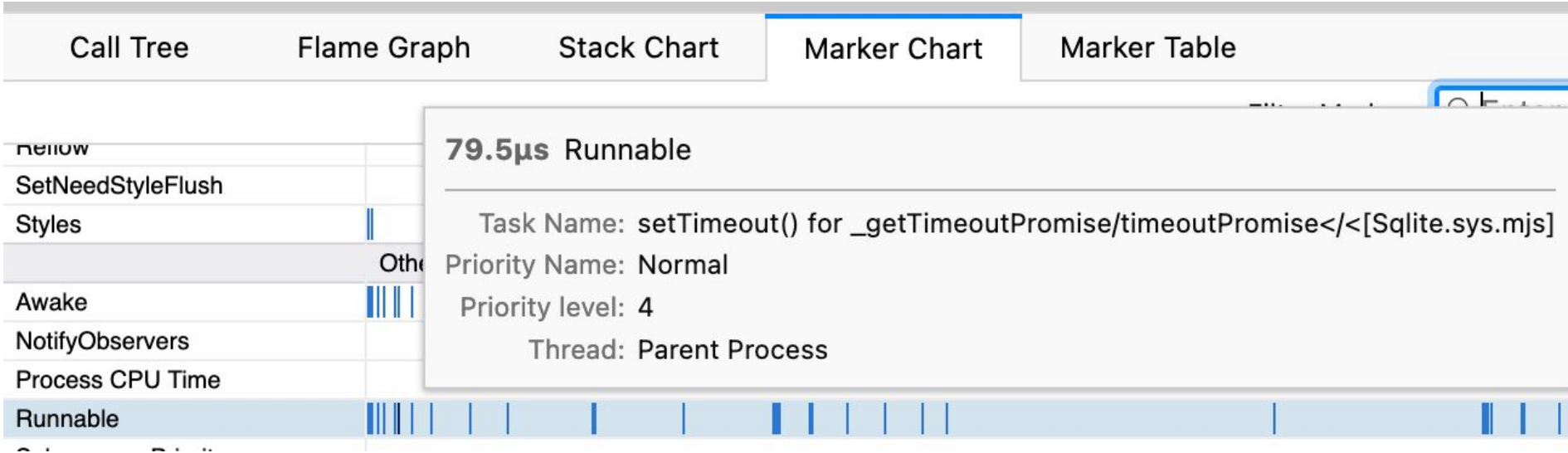
Measure tiny things:



Ever wondered how much power it takes to blink the caret in the address bar?
Now you can know! https://share.firefox.dev/3U8hLgp

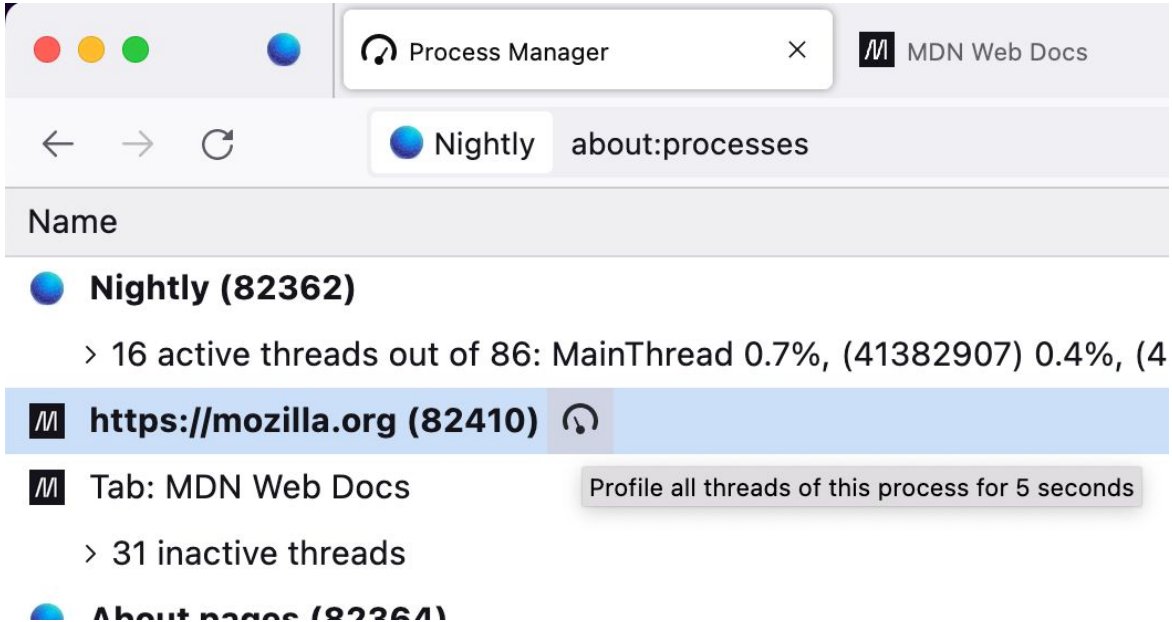
Firefox profiler - markers

“Awake” and “Runnable” markers show thread wake-ups



Firefox task manager

One click profiling



Understanding global power use

New telemetry probes

We added data collection for the following:

- Total CPU time used
- Total GPU time used
- Total number of thread wake-ups
- Breakdown per process type
- Breakdown per thread name (Nightly channel only)

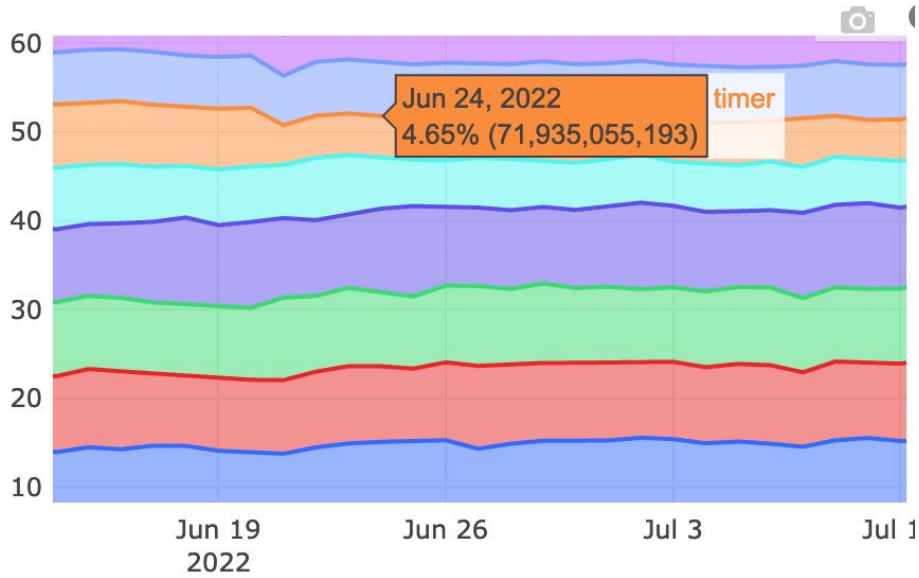
Estimating our footprint

- Firefox’s daily global resource use:
  - 60-80M hours of CPU
  - 15M hours of GPU

Can be converted to CO2e using CPU specifications and electricity carbon intensity by country.

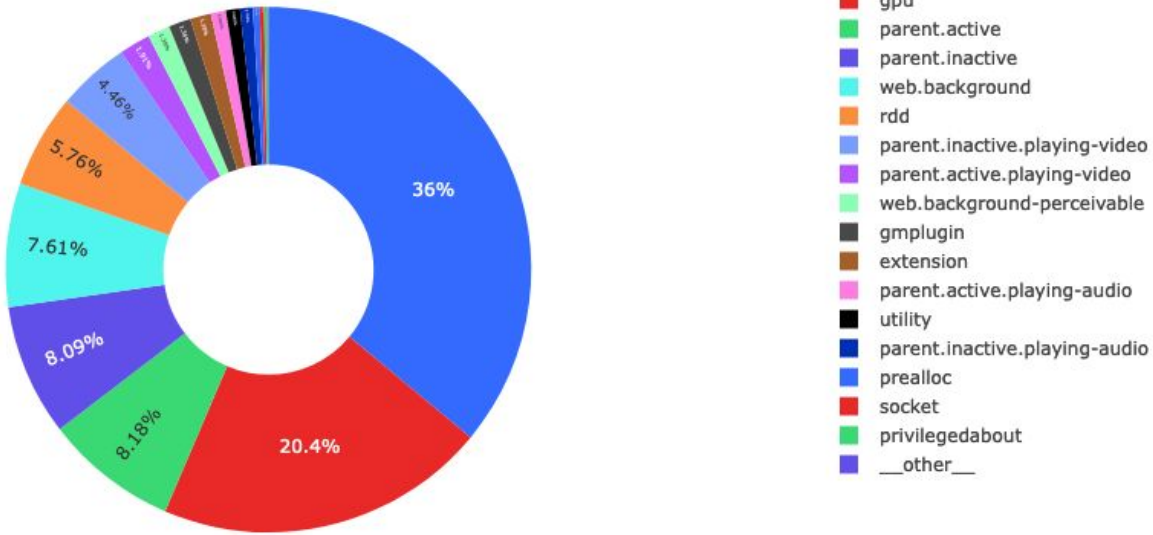
Roughly equivalent to the electricity production of a small thermal power station, or 50,000 solar roofs.

Verifying fixes



On June 20, [bug 1767396] made the timer thread drop from being 7% of our thread wake-ups to 5%.

Testing assumptions



Understand the potential impact of changes:

Eg. background content processes use about 8% of our CPU time

Improvements

Bug fixing

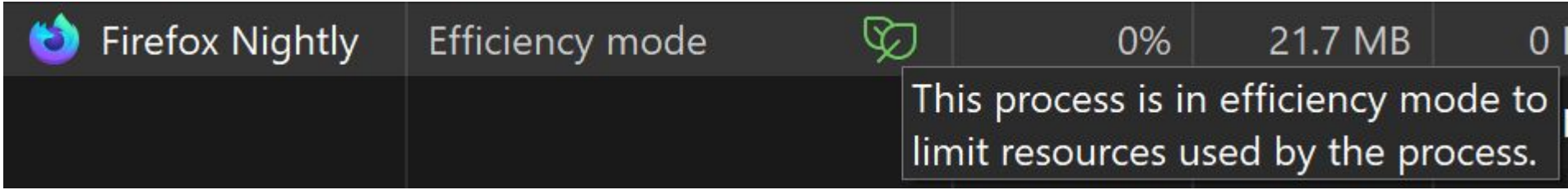
We fixed 26 power bugs since Firefox 95

- Removed repeating timers
- Stopped hidden or bogus animations
- Avoided pointless thread wake-ups
- Fixed edge cases with excessive CPU use.

Thanks to everybody who helped!

Using efficient cores on Windows 11

Used power profiling to measure the impact of changes:



The power used by a content process using 100% of a CPU core drops from 10W to 2W when the process is put in “efficiency mode” (EcoQoS):
https://share.firefox.dev/3FJoAkc (bug 1796525)

Preventing regressions

Bug 1742842 - Ensure VSync is disabled at the end of automated browser chrome tests

“We found multiple times by accident steps to reproduce bugs that cause vsync to remain enabled forever (or until a browser window is closed). We should leverage our large existing test suite to detect cases like this faster.”

Next / ongoing

Areas where we can improve efficiency even more:

- Background tabs
- (grouping) timers
- Invisible media and animation
- Fully occluded windows
- Long user idle time

Ideas to experiment with

- reducing frame rate

  `gfx.display.max-frame-rate` = 30 (Hz)
- disabling video autoplay

  `media.autoplay.default` = 5 (Block Audio and Video)

Thanks! Questions?

- Share ideas, #power-usage:mozilla.org on Matrix.
- Questions: florian@mozilla.com