Energy Monitoring of Software Systems

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ADAM project-team

PowerAPI
ADAM.lille.inria.fr

ICT & Energy

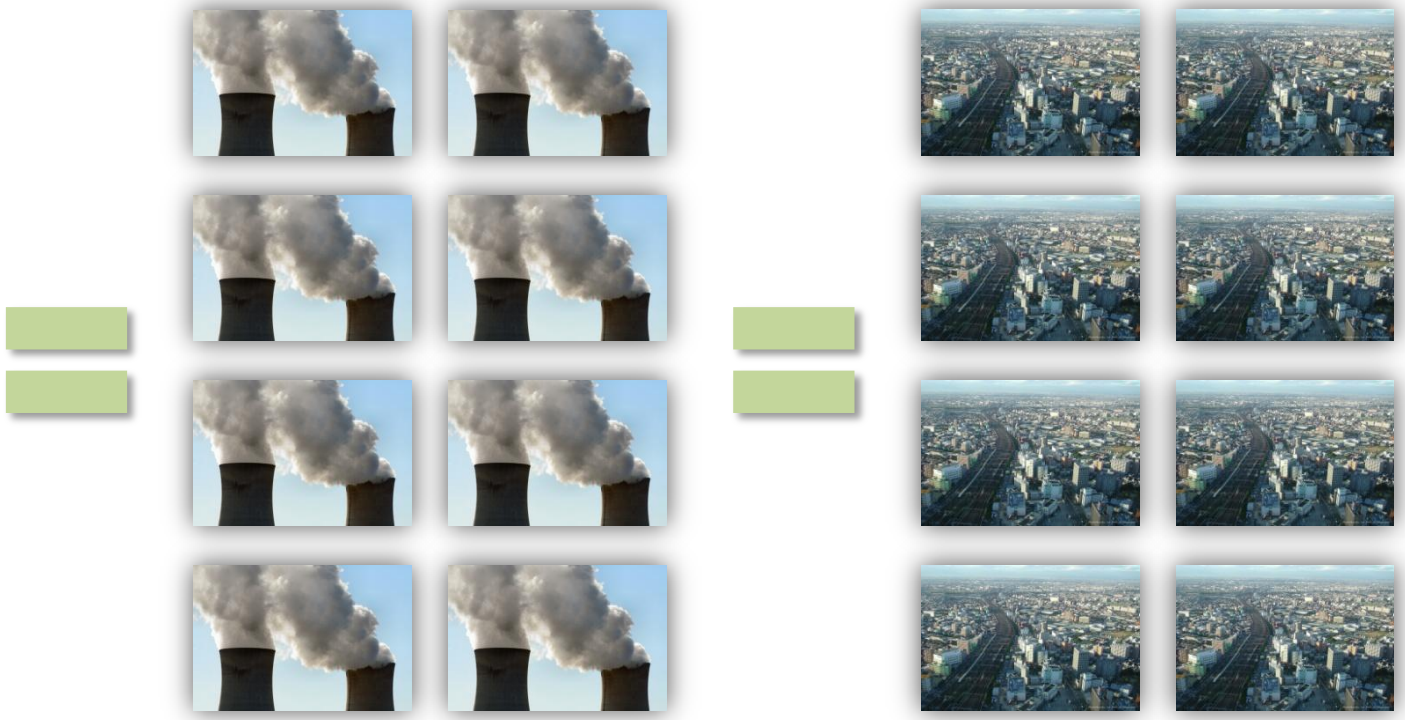
2% of the global energy consumption in **2007** [1]

[1] Gartner

ICT & Energy

13.5% of the electricity consumption in **2008** [1]

420 TWh



[1] 2008 ICT report, Ecology Ministry

Research opportunities

ADAM

What we have to do

1

Understand the software energy consumption

2

Establish greener development methodologies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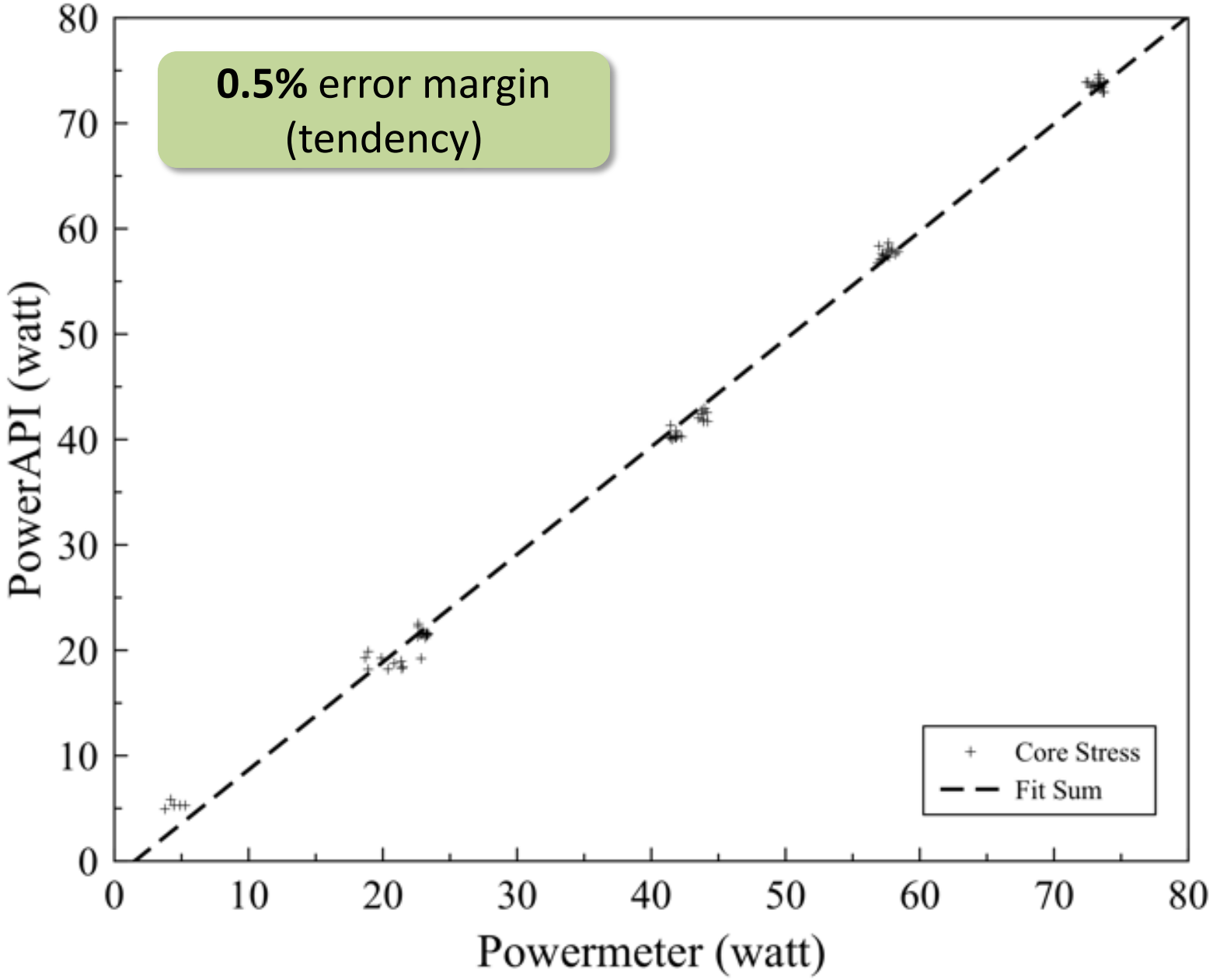
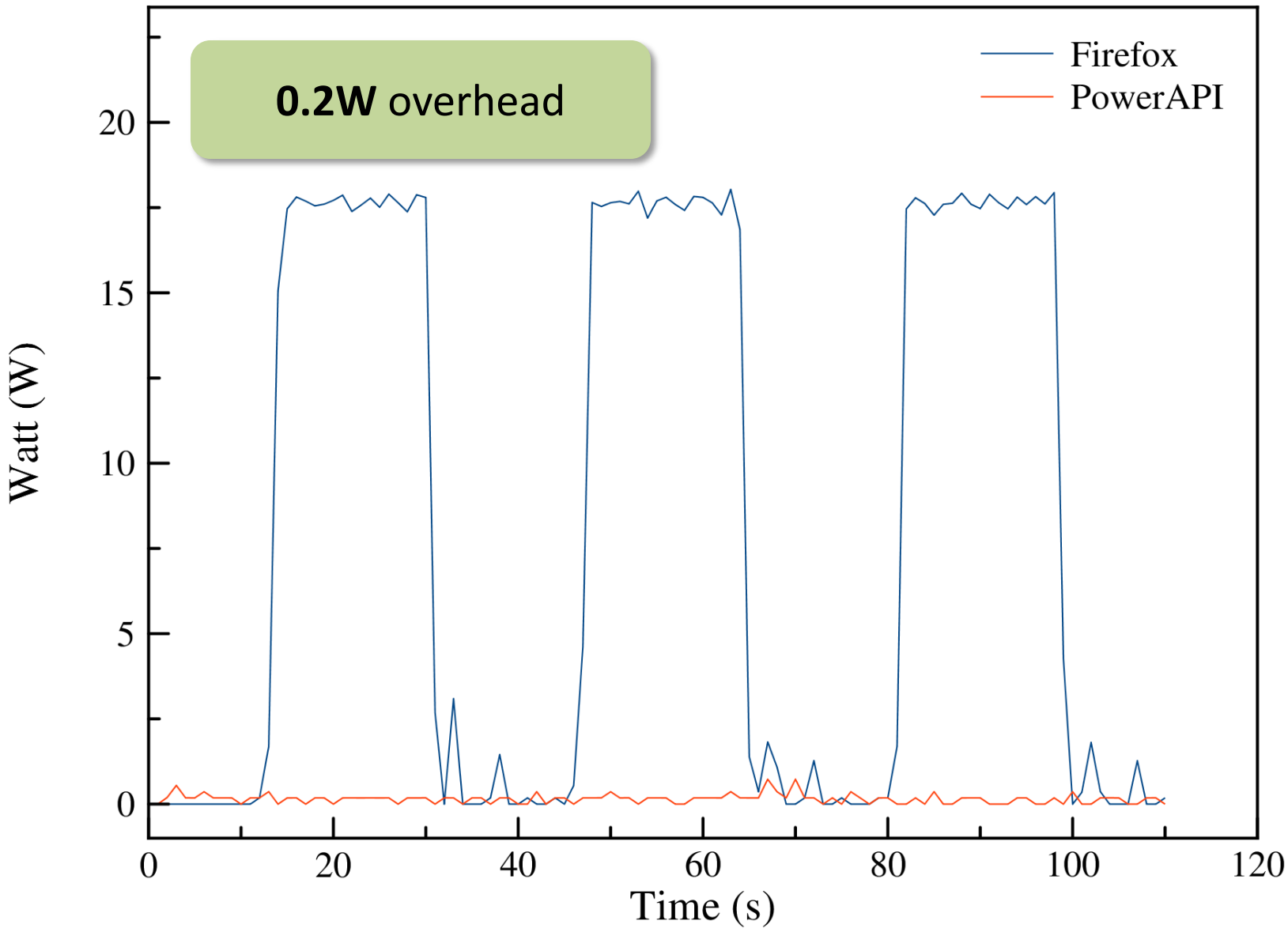
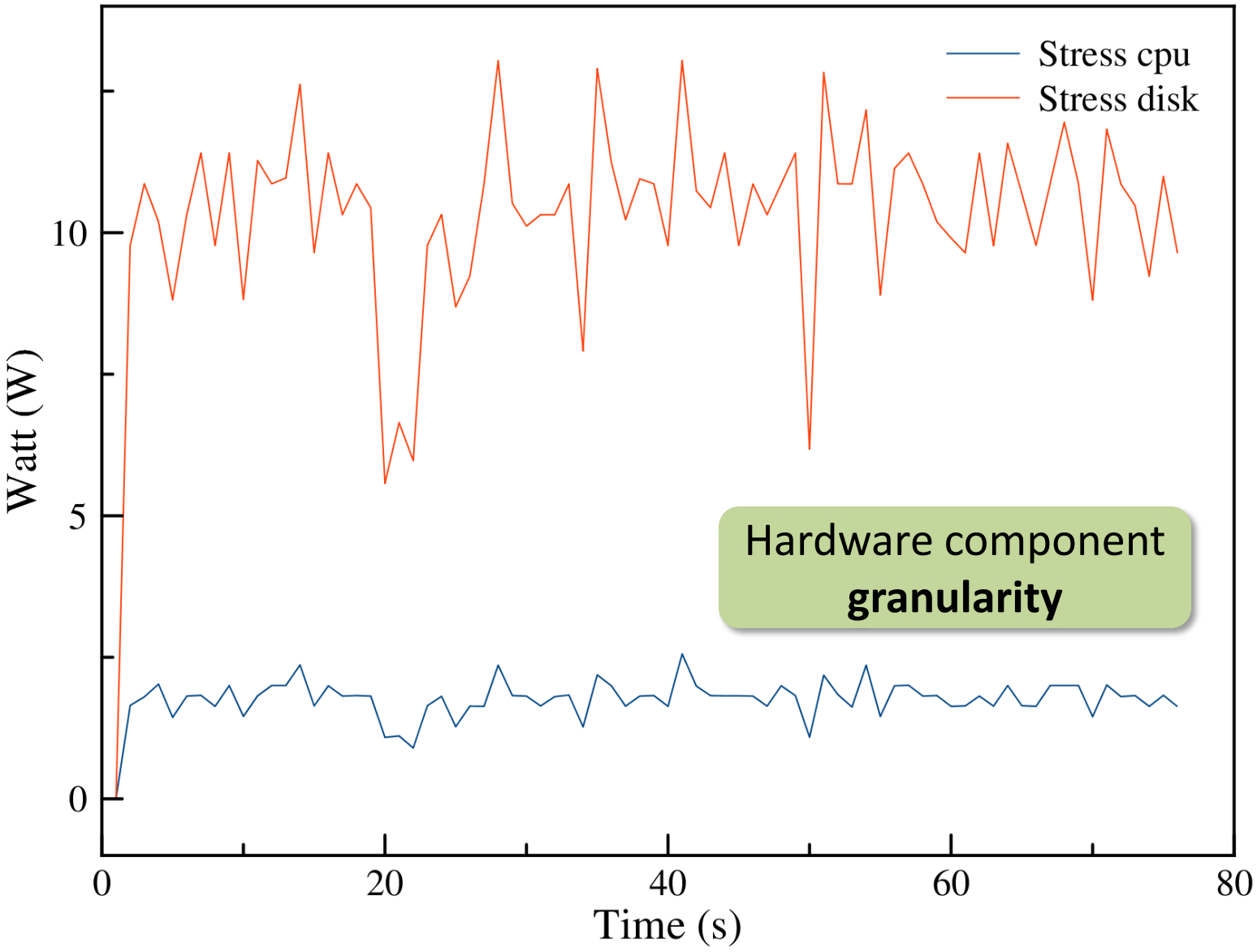
Can we monitor the energy consumption of an application?


0.5% error margin
(tendency)
PowerAPI (watt)
Powermeter (watt)
Core Stress
Fit Sum
0
10
20
30
40
50
60
70
80

What is the monitoring overhead?


0.2W overhead
Firefox
PowerAPI
Watt (W)
0
5
10
15
20
0
20
40
60
80
100
120
Time (s)

How does it differ from a powermeter?


Stress cpu
Stress disk
Watt (W)
10
5
0
0
20
40
60
80
Time (s)
Hardware component
granularity

Summary

Accurate **process-level** energy consumption estimation, **microscope « à la carte »**

No hardware equipment investment

GREENS@ICSE'12 and **ASE'12** publications [1, 2]

Freely available as OSS [3], **Transfer** in progress

[1] A. Noureddine, A. Bourdon, R. Rouvoy, and L. Seinturier. **A Preliminary Study of the Impact of Software Engineering on GreenIT**. In *1st International Workshop on Green and Sustainable Software* (GREENS'12/ICSE'12)

[2] A. Noureddine, A. Bourdon, R. Rouvoy, and L. Seinturier. **Runtime Monitoring of Software Energy Hotspots**. In *27th International Conference on Automated Software Engineering* (ASE'12)

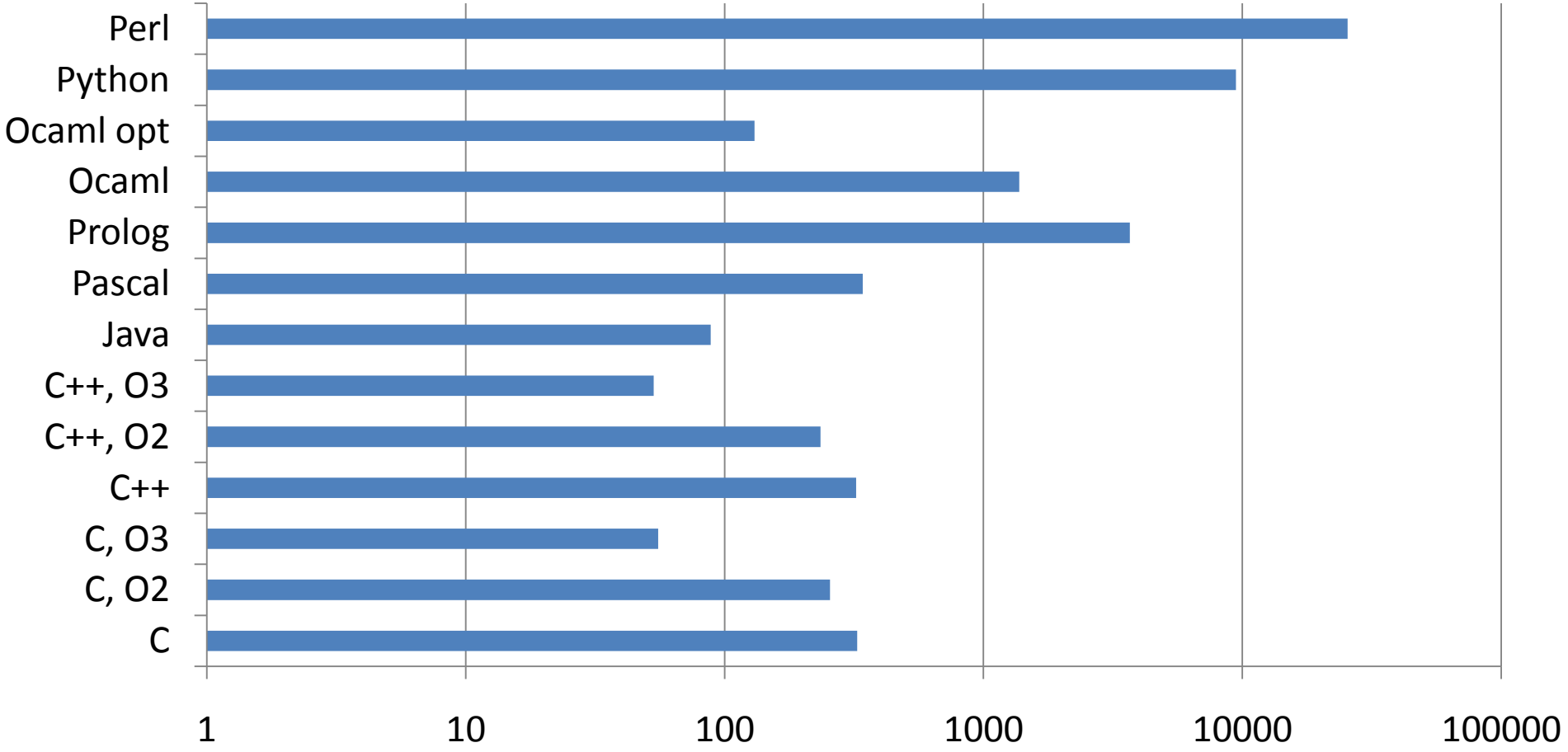
[3] ADAM green topics, http://adam.lille.inria.fr/pmwiki.php/Topics/Green

Use cases

What is the cost of programming languages?

A. Noureddine, A. Bourdon, R. Rouvoy, and L. Seinturier. **A Preliminary Study of the Impact of Software Engineering on GreenIT**. In *1st International Workshop on Green and Sustainable Software* (GREENS'12/ICSE'12)

Hanoi Tower
(recursive version, logarithmic scale) [1]



[1] http://www.kernelthread.com/projects/hanoi

Where is spent the energy inside my application?

A. Noureddine, A. Bourdon, R. Rouvoy, and L. Seinturier. **Runtime Monitoring of Software Energy Hotspots**. In *27th International Conference on Automated Software Engineering* (ASE'12)

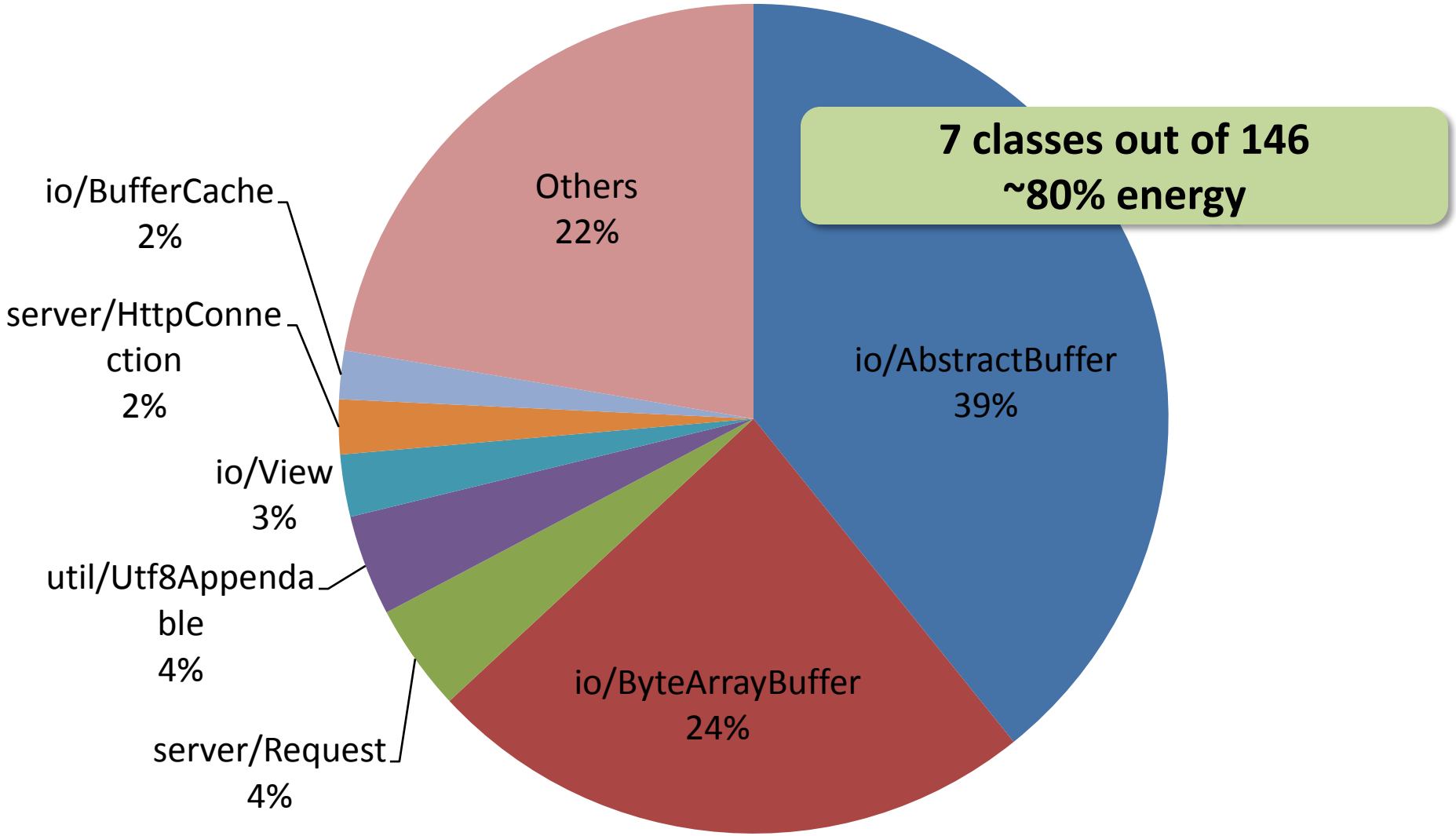
Complex application (> 88 000 LOC)

Apache **JMeter** to stress Jetty's examples

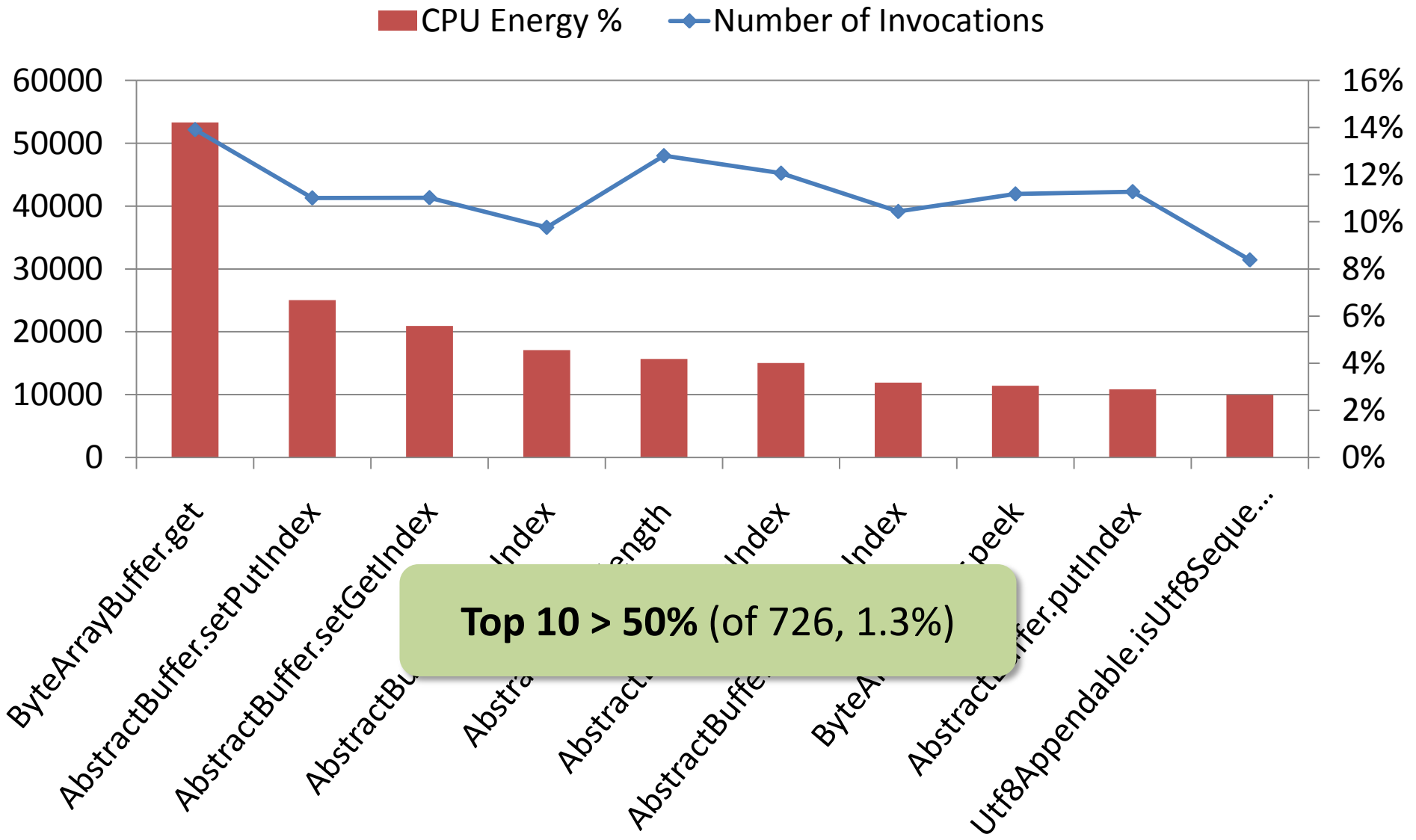
1 minute, 20 threads, loop count of 500

146 monitored classes and **726 methods**

Class-level consumption



Method-level consumption



Top 10 > 50% (of 726, 1.3%)

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Architecture

API

All
Console

CPU
Graphic

Memory
File

Network
Console

Listeners

Event Bus

Publish
Subscribe

CPU

Memory

Network

Sensors

CPU

Memory

Network

Formulae

Energy formulae
- CPU case -

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$$P_{CPU}^{f,v} = C \times f \times v^2$$

$$P_{CPU}^{f_{TDP},v_{TDP}} = TDP \times 0.7$$

$$TDP \times 0.7 = C \times f_{TDP} \times v_{TDP}^{\ 2}$$

$$C = \frac{TDP \times 0.7}{f_{TDP} \times v_{TDP}^{\ 2}}$$

State of the Art

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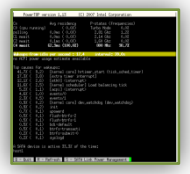
PowerTop		No reusable libraries
JouleMeter		Not easy to support platform interoperability
pTop		Development is over
		Manual calibration
EnergyChecker		Requires external device