



## Challenges of carbon monitoring in an heterogeneous parc



# Qarnot in a nutshell

Qarnot is a low carbon cloud provider



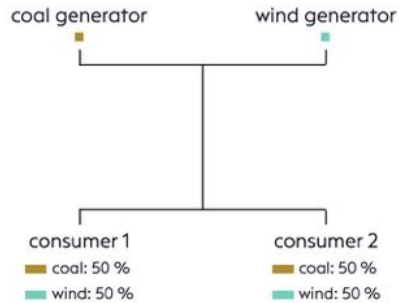
Task	Name	Creation date (UTC)	Expiration date	Profile	Running instance	Total instance
✓	qarnot-qb-us-3025-1-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-2-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-3-01	4 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-4-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-5-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-6-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-7-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-8-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-9-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-10-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-11-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-12-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-13-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-14-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-15-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-16-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-17-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-18-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-19-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-20-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-21-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-22-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-23-01	3 hours ago	30 days	single-profile	0	0
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✓	qarnot-qb-us-3025-26-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-27-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-28-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-29-01	3 hours ago	30 days	single-profile	0	0
✓	qarnot-qb-us-3025-30-01	3 hours ago	30 days	single-profile	0	0

Carbon Facts	
Name	Using a QbX during a year
Duration	365d
Saved Carbon Footprint	17.11 TCO <sub>2e</sub>
Saved carbon footprint %	88.4%
Energy	
Total consumed energy	39.48 GWh
Reused energy	37.15 GWh
PUE (Power Usage Effectiveness)	1.001
ERE (Energy Reuse Effectiveness)	0.06
ERF (Energy Reuse Factor)	94.1 %
Carbon	
Qarnot carbon footprint	2.25 TCO <sub>2e</sub>
Equivalent European data center carbon footprint	10.92 TCO <sub>2e</sub>
Saved carbon footprint   compute service	8.67 TCO <sub>2e</sub>
Saved carbon footprint   heat service	8.43 TCO <sub>2e</sub>
Saved carbon footprint   compute + heat services	17.11 TCO <sub>2e</sub>
Saved carbon footprint %	88.4 %
Water	
WUE (Water Usage Effectiveness)	0 L/kWh

# Live carbon reporting

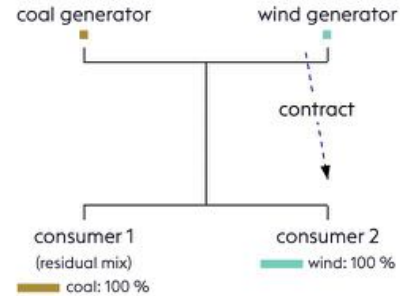
## Carbon emission ratio: location-based vs market-based

### Location-based



- + credibility
- + realtime
- doesn't fund renewables

### Yearly market-based

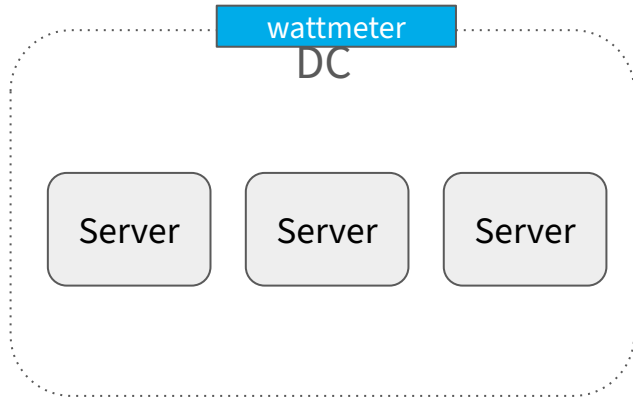


- credibility
- realtime
- + funds renewables

# Live carbon reporting

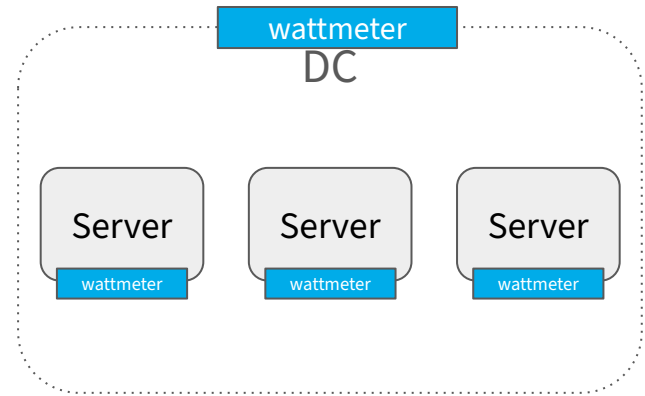
## Instrumentation: top-down vs bottom-up

### Top down



- + easier to implement
- more approximations

### Bottom up

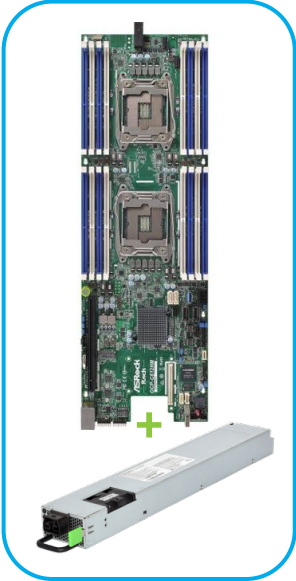


- harder to implement
- + more precise

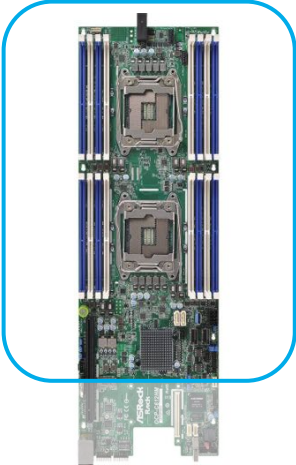
# Live carbon reporting

## Heterogeneous instrumentation: Wattmeters, BMC, and RAPL

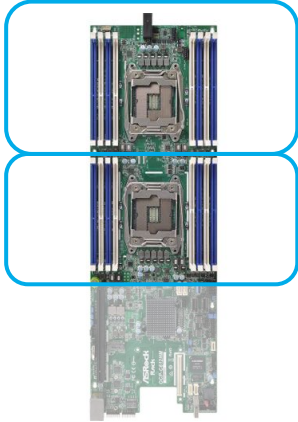
**Wattmeter**



**BMC**

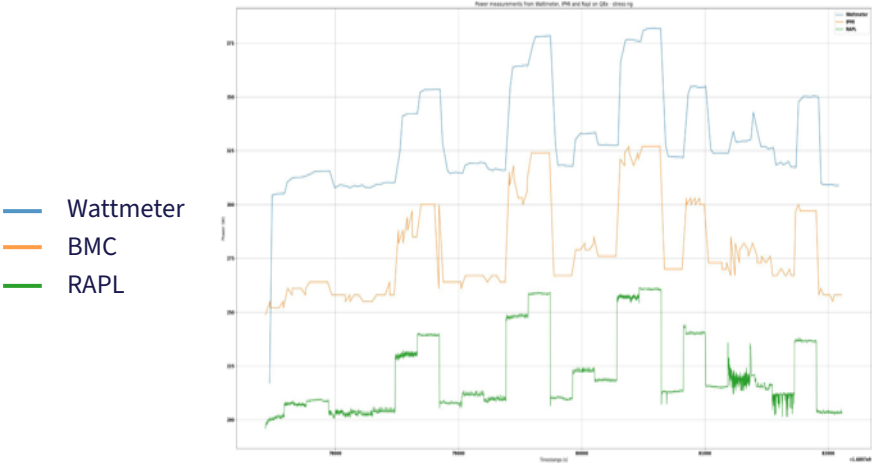


**RAPL**



# Live carbon reporting

## Heterogeneous instrumentation: Wattmeters, BMC, and RAPL



Power = f(time) # payload

# Live carbon reporting

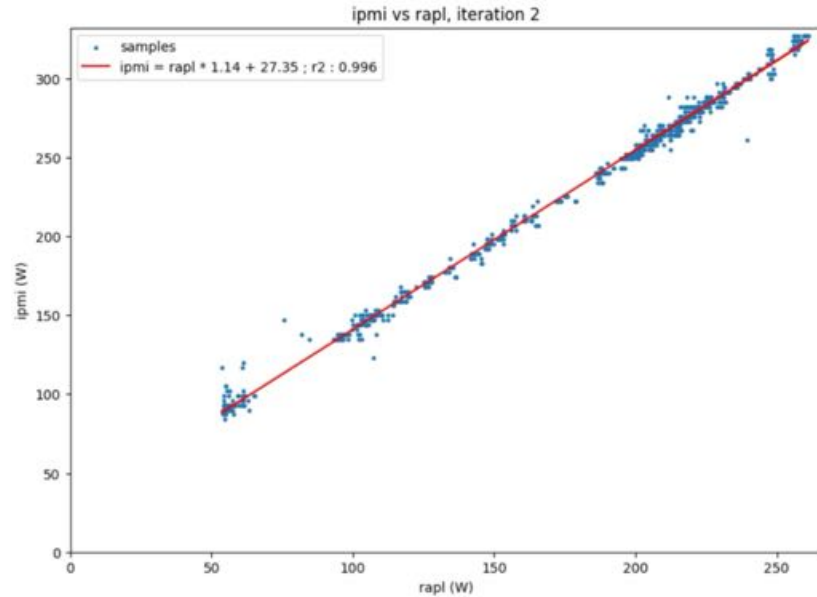
## Heterogeneous instrumentation: BMC vs RAPL

### 1.14

- VRM CPUs
- VRM RAMs

### 27.35

- NIC ~10W
- SSD ~1W
- Fans ~2W
- Other motherboard elements ~14W



$$BMC = f(RAPL)$$

# Live carbon reporting

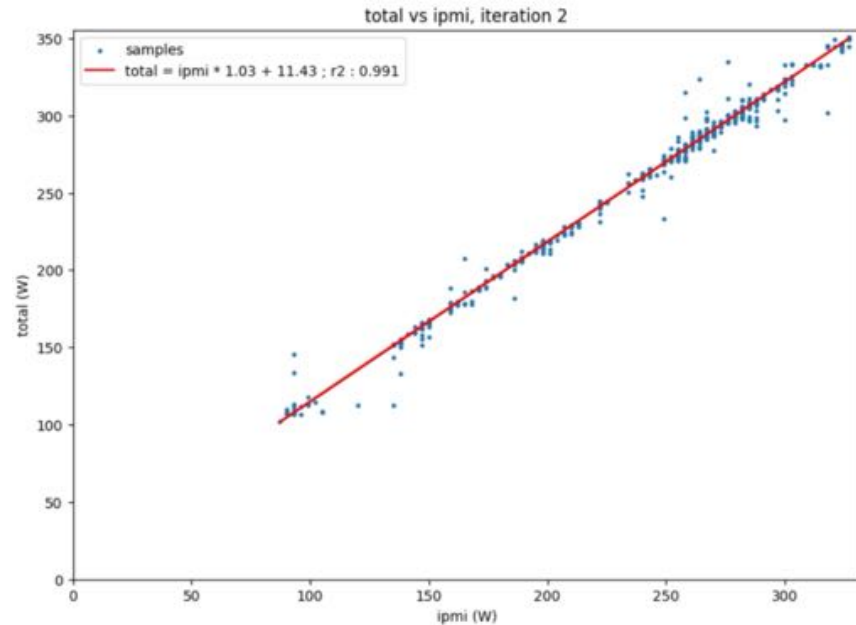
## Heterogeneous instrumentation: wattmeter vs BMC

### 1.03

- Power supply efficiency (0.87 - 0.95)

### 11.43

- ~BMC

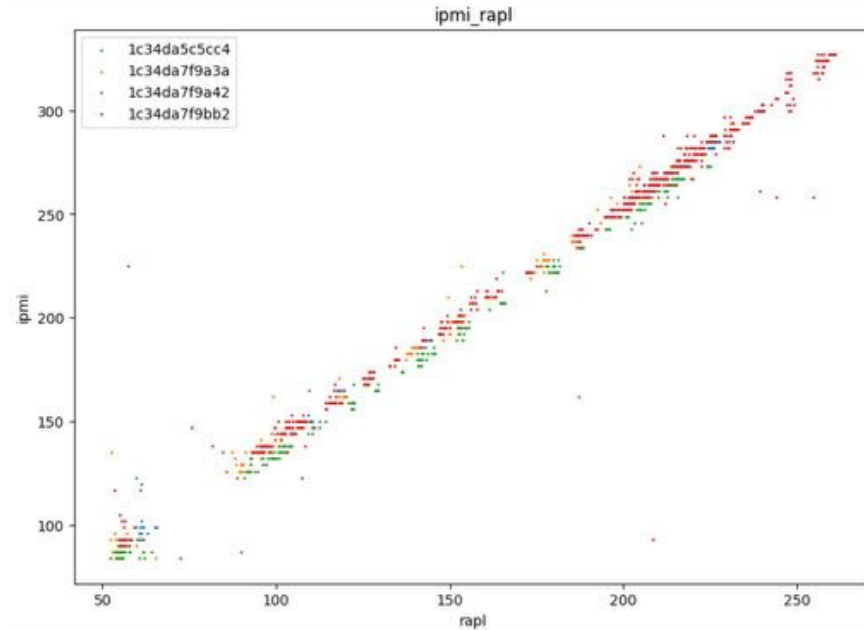


Wattmeter =  $f(\text{BMC})$



# Live carbon reporting

## Heterogeneous instrumentation: 10% manufacturing uncertainty



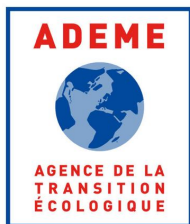
BMC =  $f(\text{RAPL})$  for different servers with the same configuration

# Going further

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A Défi with Inria and Ademe

*Inria*



Questions ?



**Thank you for  
your attention!**



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