Evaluating the involvement of users for reducing energy consumption of datacenters in a Cloud company

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CONTEXT OF THE STUDY

Datacenters (DCs) account for :
- 1 to 1.5% of global electricity demand [1]
- 1% of energy-related GHG emissions [1]

Cloud Service Providers size their infrastructure to meet peak demand, which might result in general infrastructure oversizing.

Users behavior tends to increase these oversizing effects, but users can sometimes reduce infrastructures dimensions, when equipped with proper tools and knowledge.

VM SHUTDOWN POLICY

The study takes place on a virtualization infrastructure with an embedded Virtual Machine (VM) shutdown policy, controlled by **VM owners**. Different profiles are assignable to VMs :
- *DailySTOP&START* : VM is powered off at nights, weekends, restarted automatically.
- *DailySTOP* : VM is powered off at nights, weekends, restarted manually.
- *WeeklySTOP* : VM is powered off at weekends, restarted manually.
- *NeverSTOPAuto* : VM is always on.



Percentage of VM per Tag
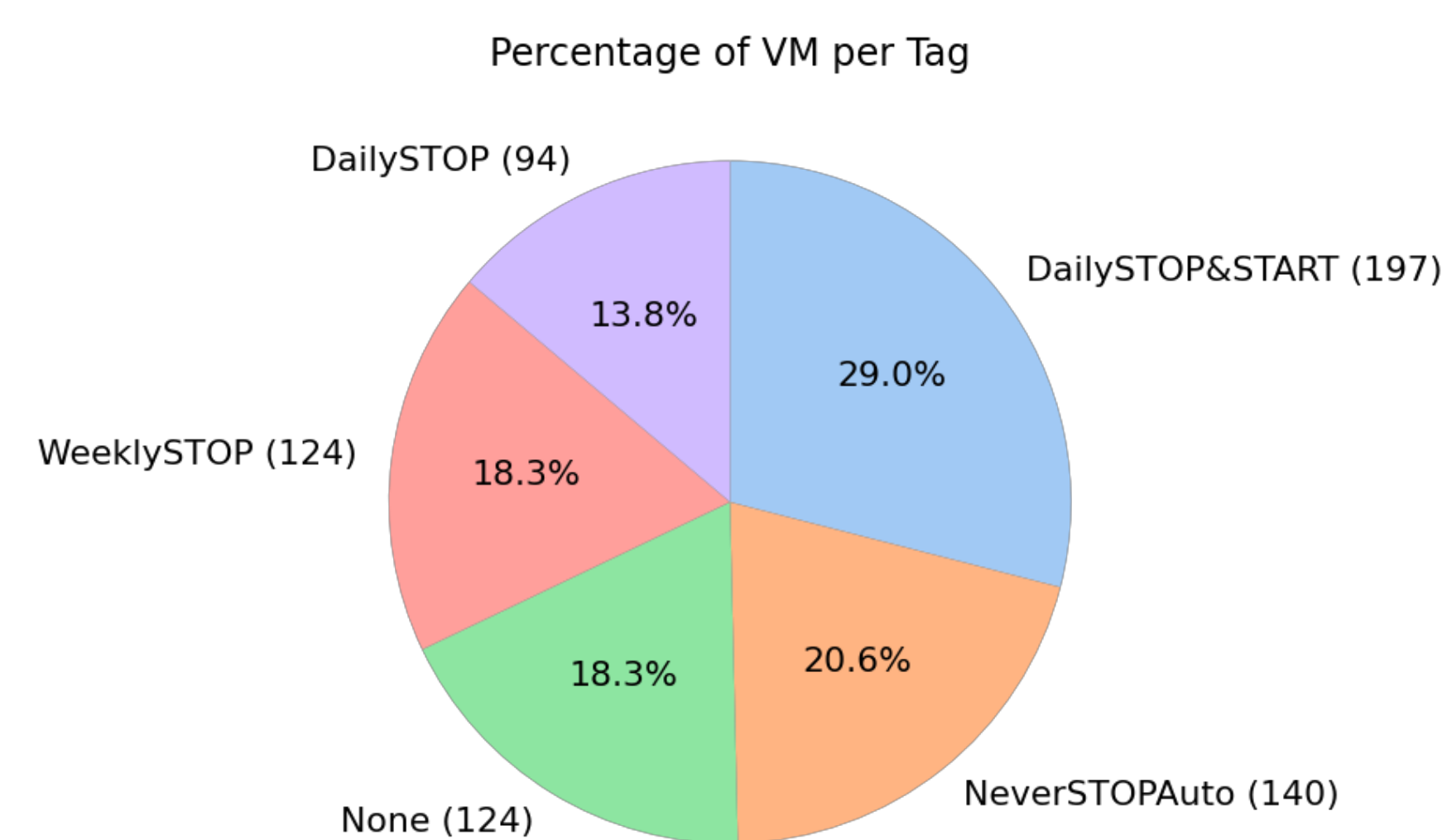
None VMs are VMs with no tag at the time of the study. Excluding archived* VMs, 93% are tagged as per the shutdown policy.

*VMs about to be deleted, usually without a valid VM owner, or an expired VM validity date.

USER PROFILING

We **questioned 83 VM owners** both on their knowledge of the virtualization infrastructure and awareness on DCs environmental impacts. We received 52 answers to this questionnaire.

Awareness of the environmental impacts of datacenters

Knowledge of the virtualization infrastrcture
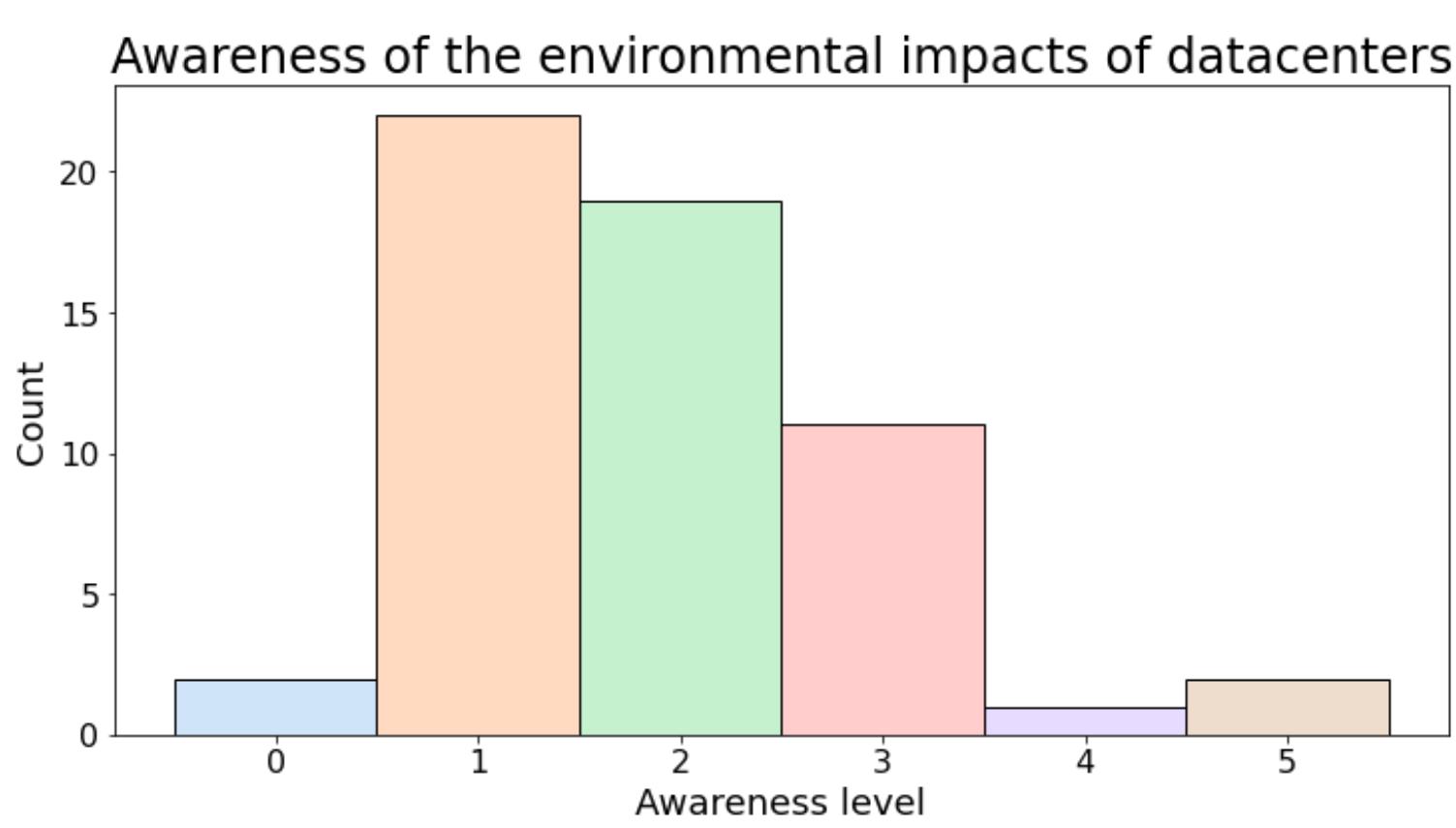
0: I don't know anything about it
1 : I have a vague idea of the impact it can have
2 : I've already seen information and/or figures on this subject
3 : I've read up on the subject one or more times
4 : I've taken one or more specific training courses on the subject
5 : I work daily on this subject, I'm an expert
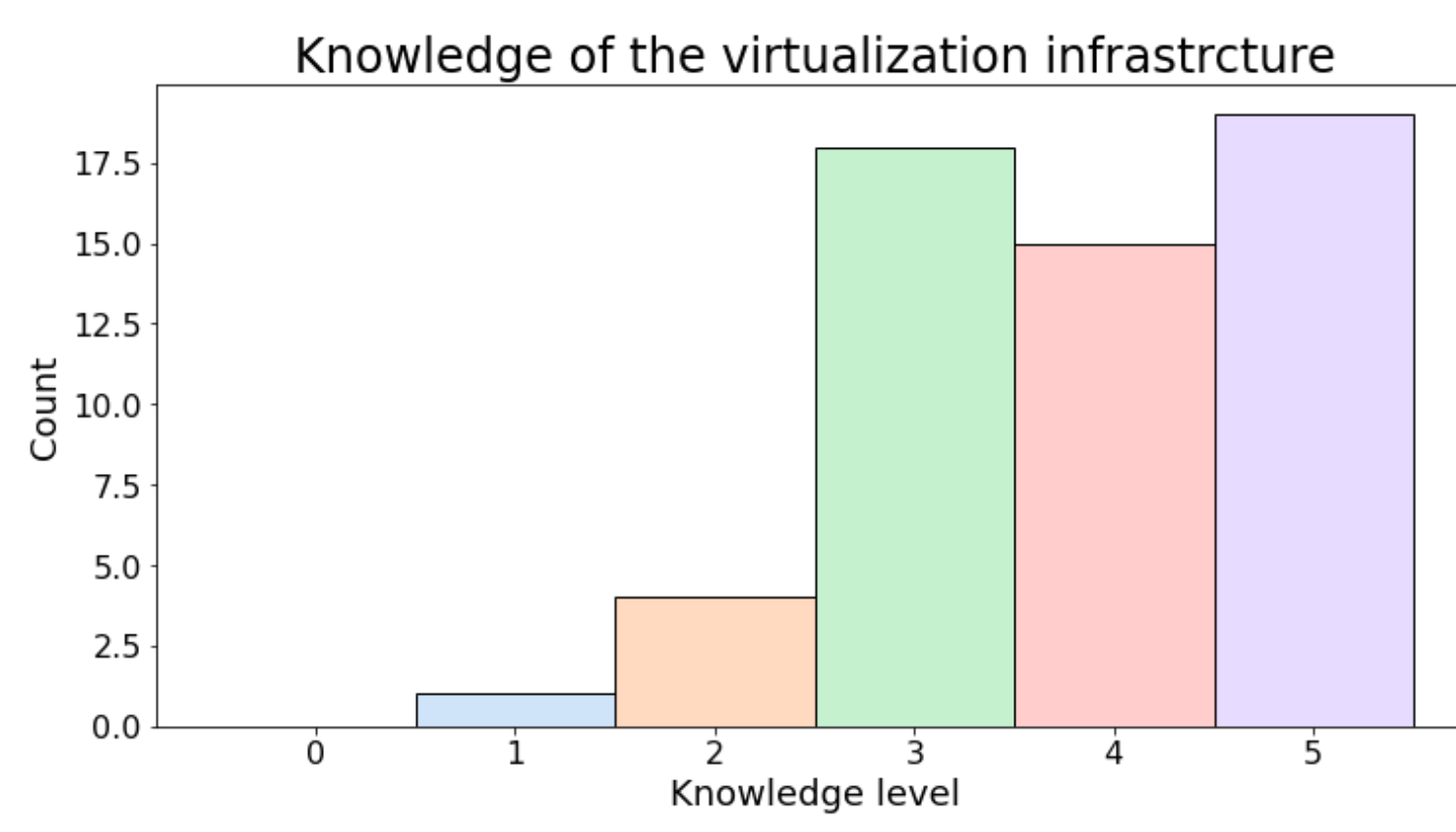
0: I don't know what virtualization is
1 : I know our virtualization infrastructure (vSphere) but I didn't know I was responsible for one or more VMs
2 : I know I'm responsible, but I don't know which VMs
3 : I know some of the VMs I'm responsible for
4 : I know all the VMs for which I am responsible
5 : I know all the VMs for which I am responsible, and can describe the tools and services precisely, as well as the shutdown policy tag
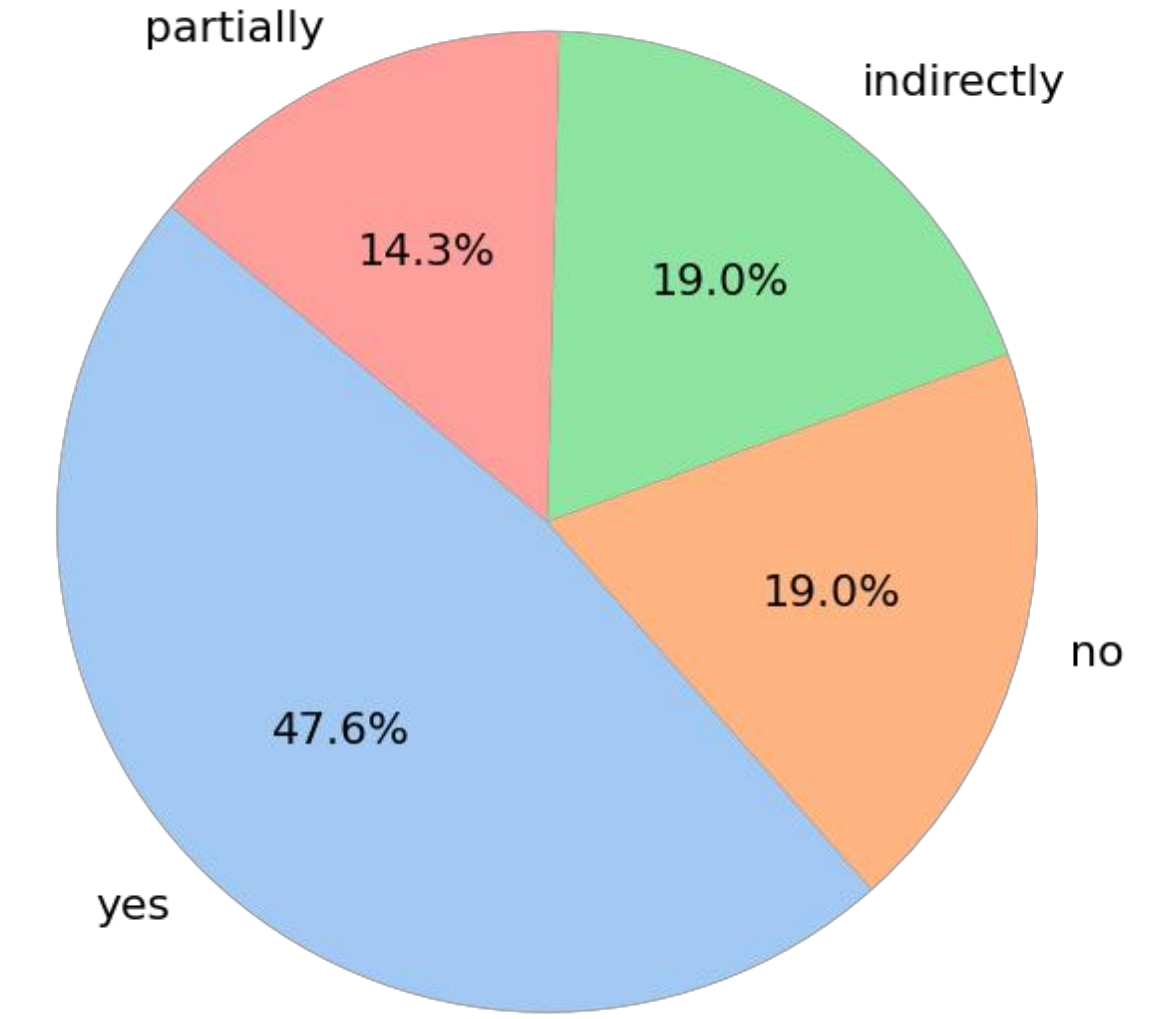
VM CONSOLIDATION

To further reduce power consumption, VM consolidation [2] is applied to size the infrastructure solely to powered on VMs.
Simulations were conducted on an infrastructure of 400 VMs and 7 Physical Machines (PMs). A production implementation was also carried out.

Simulation of forecasted power consumption
- Without consolidation, Mean (W) : 1699.21
- With consolidation, Mean (W) : 1292.30
- With consolidation AND shutdown, Mean (W) : 1144.13

Power consumption with and without consolidation
- Base, Mean (W) : 1557.32
- Consolidation, Mean (W) : 1361.41

Our simulation forecasts a base power consumption reduction of 23.95%, with an **extra 8.72% reduction thanks to the users through the VM shutdown policy**.
The production implementation, which considers PM fault tolerance, results in a 12.58% consumption reduction over one week.

INTERVIEWS

19 VM owners were also interviewed to better understand their decisions, motivations and expectations.

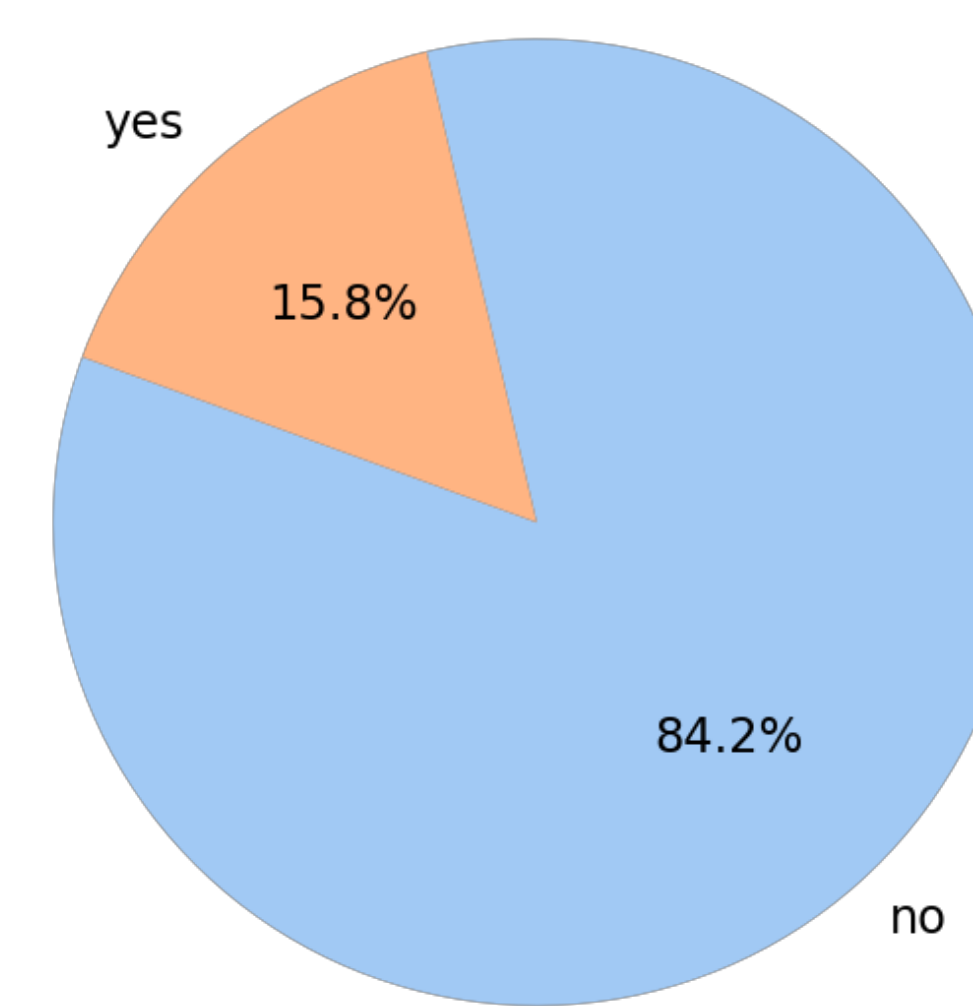Did you hear about the VM shutdown policy ?
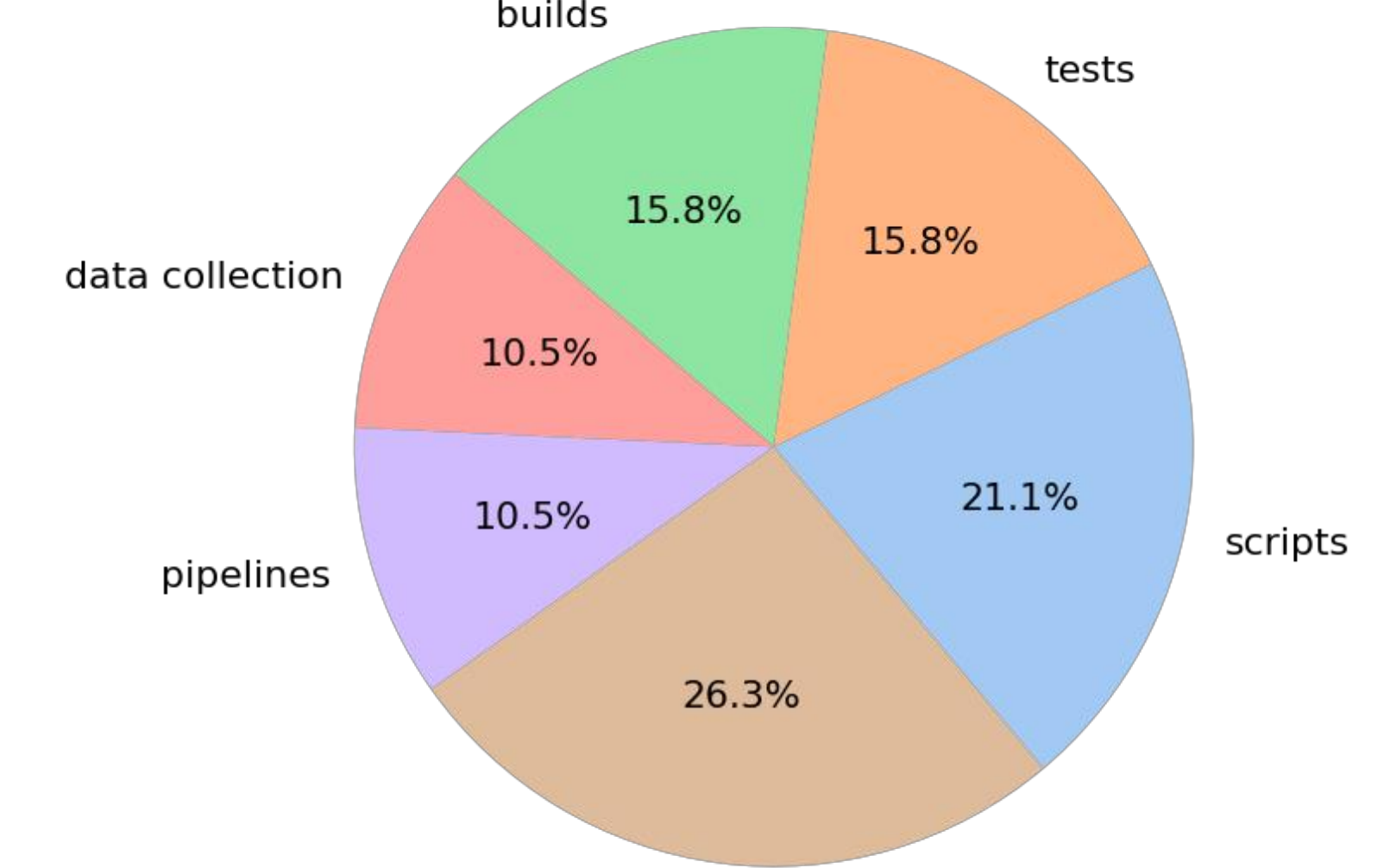- no 4.8%
- yes 95.2%
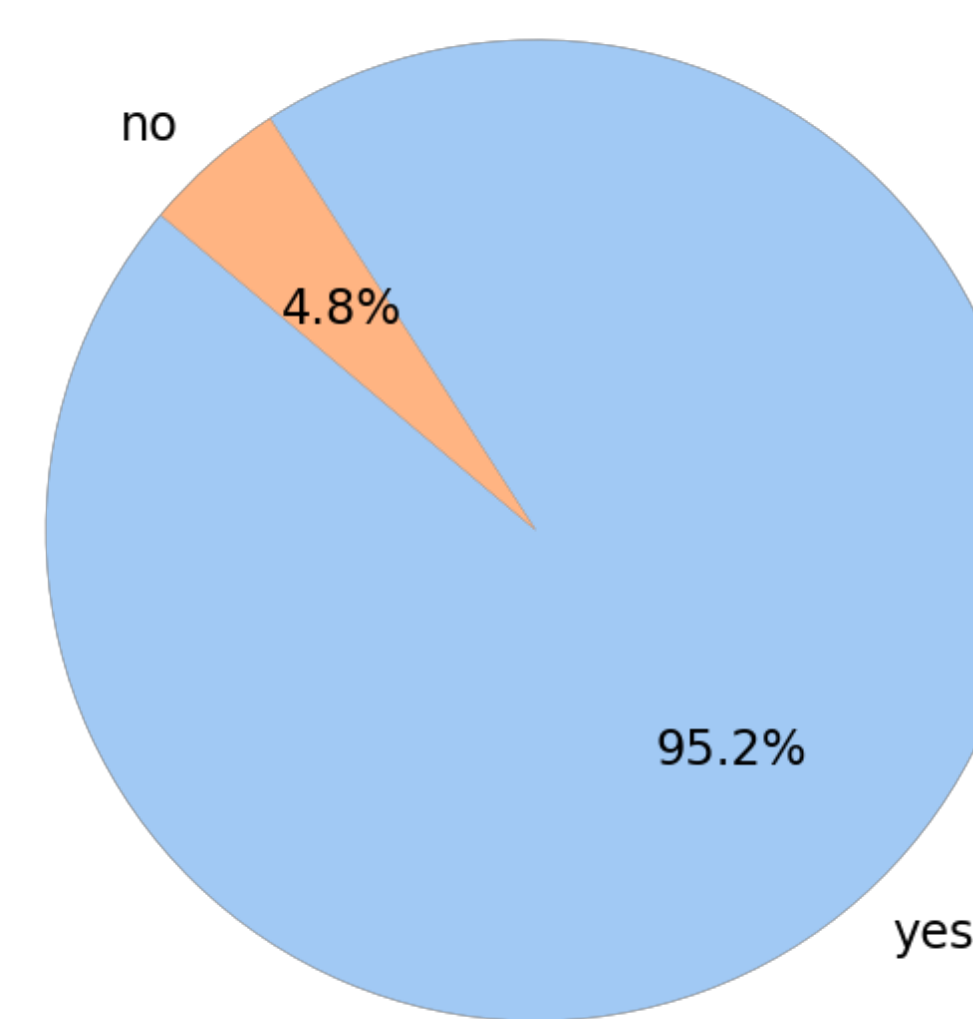
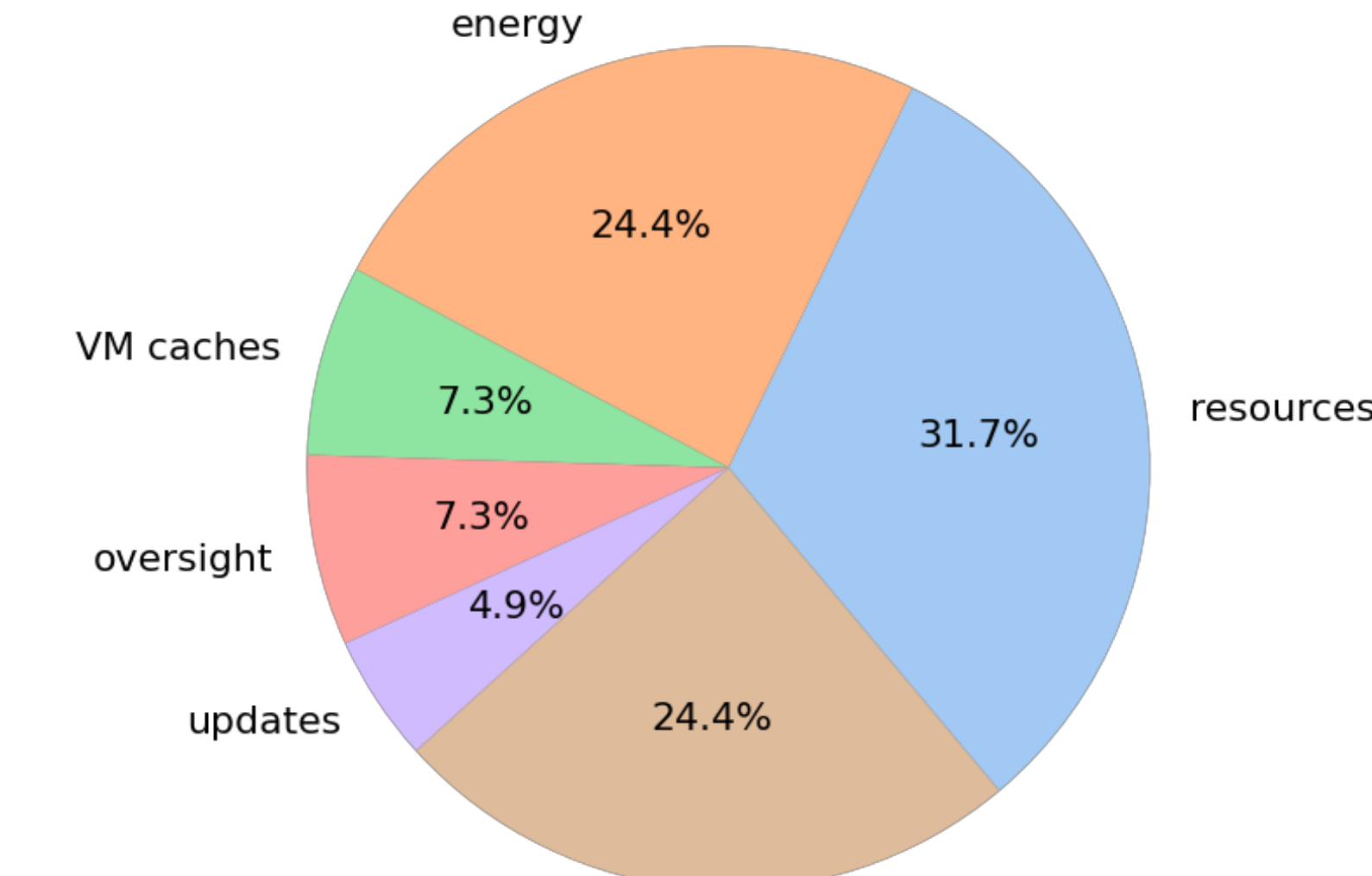Do you use the VM shutdown policy ?
- partially 14.3%
- indirectly 19.0%
- no 19.0%
- yes 47.6%

Do you periodically update the policy on your VMs ?
- yes 15.8%
- no 84.2%

Why are some of your VMs not powered off ?
- builds 15.8%
- tests 15.8%
- scripts 21.1%
- 26.3%
- pipelines 10.5%
- data collection 10.5%

Other : production, input control, etc.

Why do you power off VMs at night ?
- energy 24.4%
- resources 31.7%
- VM caches 7.3%
- oversight 7.3%
- updates 4.9%
- 24.4%

Other : performance, security, etc.
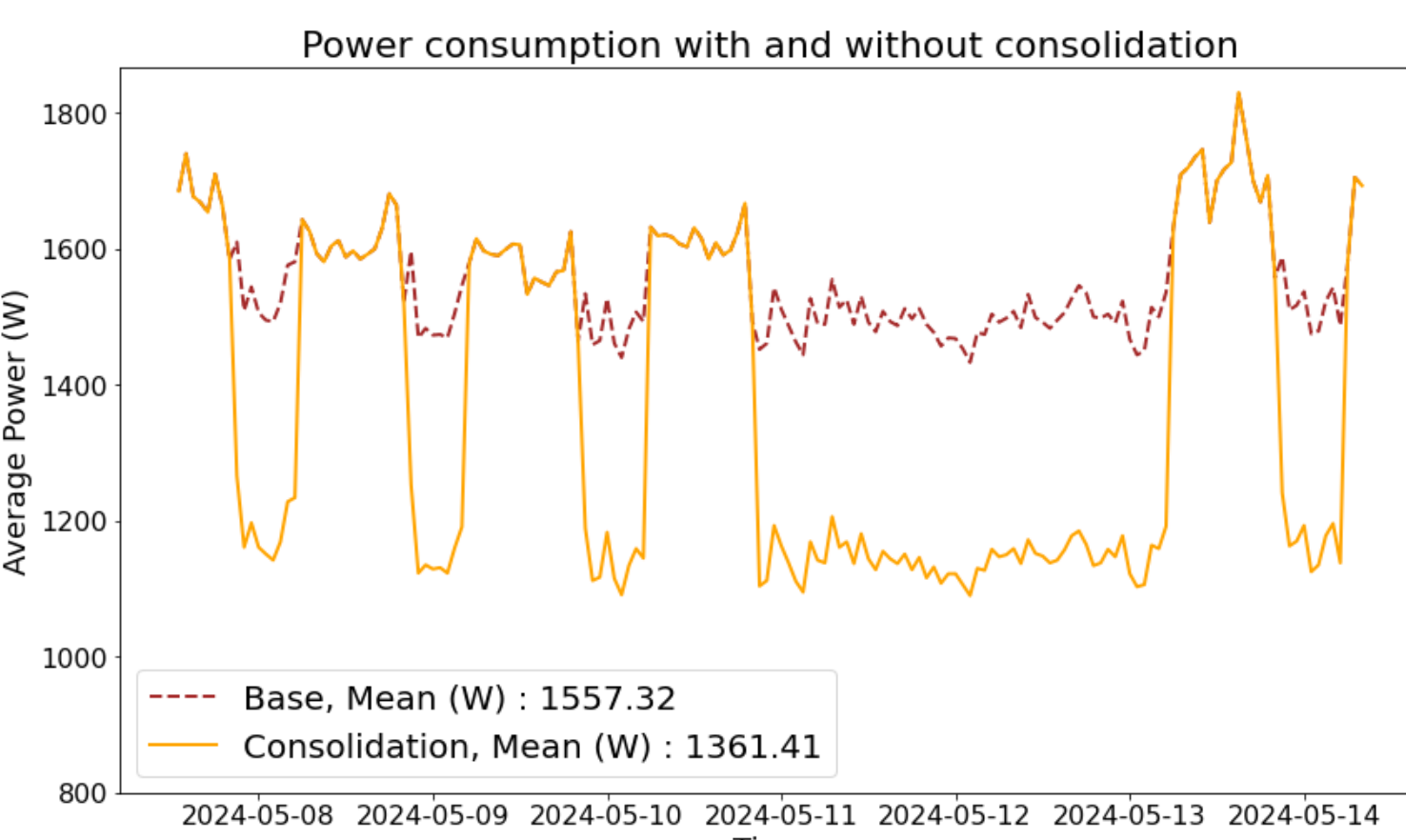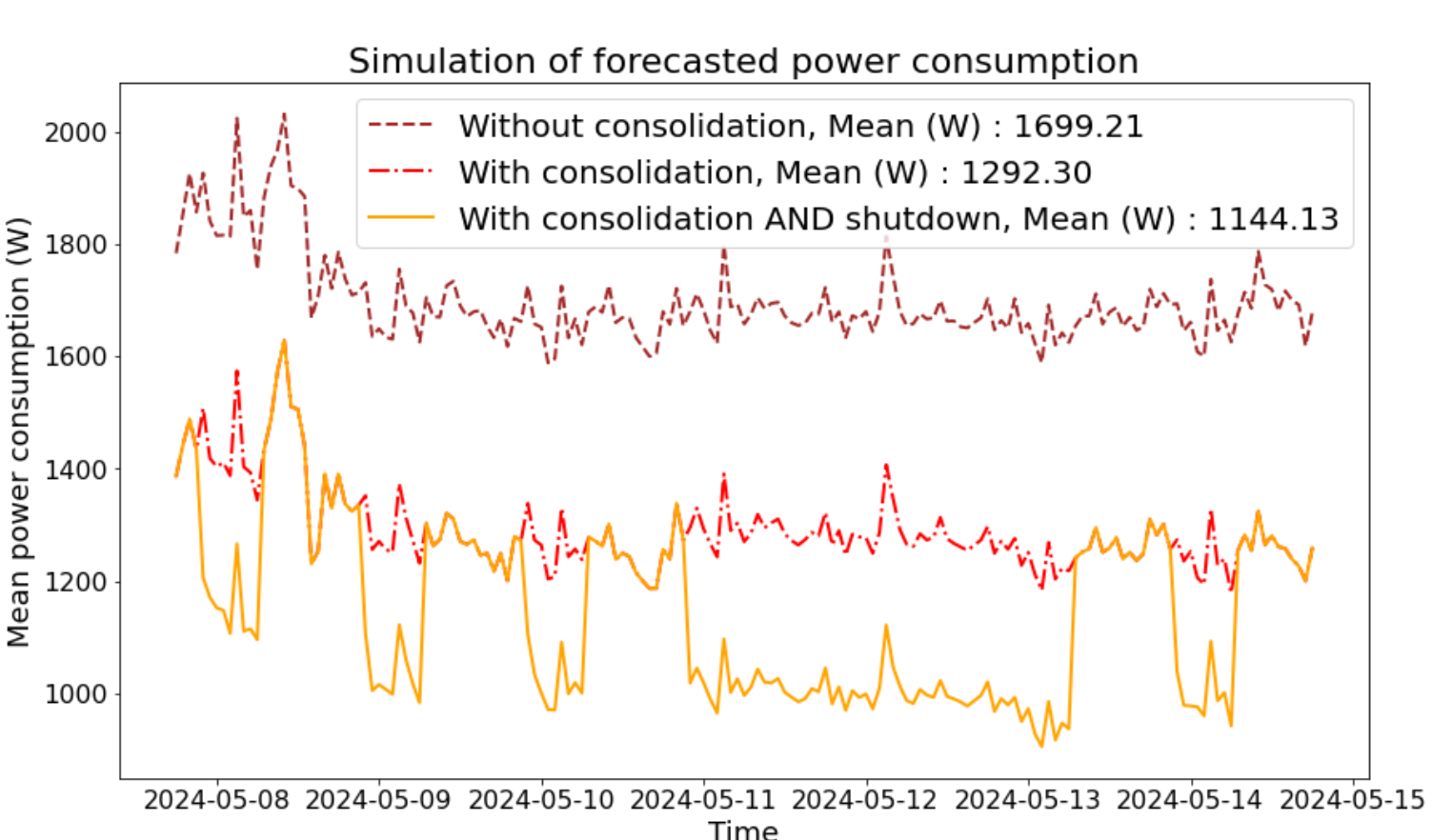
The interviews confirmed the **simple and rapid implementation** of the shutdown policy, without compromising the quality of service or the user productivity. It even enabled users to identify and fix bugs on specific VMs.

These benefits are made possible by the **technical profile of our users**. They are additional to the energy consumption reductions, which require **no prior knowledge of the environmental impacts of datacenters**.

[1] IEA, Data Centres and Data Transmission Networks, 2022
[2] Bermejo, B., Juiz, C. & Guerrero, C. Virtualization and consolidation: a systematic review of the past 10 years of research on energy and performance. J Supercomput 75, 808–836 (2019)