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Long-term evaluation for sizing low-carbon cloud data centers

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Résumé
In order to reduce their environmental impact, many cloud providers have committed to using 100% of renewable energy sources. When building the renewable infrastructure to achieve this goal, it should be taken into account that there is already a presence of renewable sources in the local electricity grid of some locations. Therefore each data center (DC) site has different needs regarding the size of the green infrastructure that needs to be built. Furthermore, manufacturing renewable infrastructures also emits carbon, which cannot be neglected. In previous work, we developed a model that aimed at scheduling the workload and computing the optimal area of PV panels and the capacity of batteries that should be installed on a cloud federation's geographically distributed data centers to minimize their operation's carbon footprint during one year. The problem was modeled as a linear program, and we used real-world input data about the carbon footprint of manufacturing PVs, batteries, grid electricity, and about the data center parameters (power consumption of servers and network, PUE, number of cores and servers). Our modeling used only real variables, which means it can optimally solve the linear program in polynomial time. The current presentation will show an extension of this previous work. Given that a data center has a lifetime of decades, the solution of the sizing needs to consider the uncertainties about future climate conditions and the evolving cloud workload. In particular, the following points are being explored : i) how robust is the modeling to uncertainties in the input ; ii) what is the impact on the carbon emissions of adding other renewable infrastructures, such as wind turbines ; iii) how further can the carbon emissions be reduced if we consider a more flexible scheduling policy, for example, allowing the workload to be delayed ; iv) how expensive (in terms of monetary costs) is it for the cloud operator to reduce their environmental impact ; and v) when is viable to change the servers, given that the hardware evolves and become more energy efficient over time, and to manufacture the servers also emits carbon.

Mots-clés : l'informatique en nuage, énergie renouvelable, stockage de l'énergie, programmation linéaire, ordonnancement de tâches

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