Chapter 4
Cloud Carbon Abatement: Opportunities and Misconceptions

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ABSTRACT

In this chapter, we use a scenario-based approach to present the real opportunities for carbon abatement arising from the use of cloud services, but also to identify the dangerous misconceptions that could undermine their energy and carbon saving potential. In particular, we emphasise the key and often forgotten fact that improving energy efficiency does not necessarily amount to curbing Green House Gases (GHG) emissions. Making a clear distinction between reduced energy consumption and a lighter carbon footprint is of particular importance in the context of cloud services because of their global nature and the huge differences in the carbon intensity of electricity generation between countries. We also present evidence that not all businesses or services are equal with respect to the carbon abatement potential of a cloud-based alternative, with “low-tech” small and medium enterprises often offering the best prospects.

INTRODUCTION

There is widespread expectation that the Cloud has strong carbon abatement potential, simply because it bears the promise of a dramatic reduction in power consumption through (Baliga, Ayre, Hinton & Tucker, 2010) efficiency gains in resource utilisation and a substantial reduction of wasteful idling time, and (Cook, 2012) more streamlined management of Information and Communication Technology (ICT) assets.

However, it is all-too-often assumed that the environmental benefits of the technology are a given, which is not the case. In fact, this assumption rests entirely upon another, namely that the electricity used to power the Cloud’s data-centres and networks has a comparatively low carbon footprint. Yet in practice, this is not necessarily the case: siting cloud services hosting facilities in certain regions which depend heavily on fossil fuels for power generation can very severely reduce and, in extreme cases, even reverse any reduction in GHG (greenhouse gas) emissions from improved energy efficiency.

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Another common misconception is that all types of businesses and services would benefit from the Cloud. Our analysis strongly suggests that, due to high network traffic and limited resource-sharing opportunities, some computationally-intensive applications are ill-suited for Cloud migration, at least from an energy saving and carbon abatement perspective.

On average, Small and Medium Enterprises (SME) tend to offer better GHG emissions reduction opportunities, due to underutilisation and inefficient management of proprietary ICT assets in small organisations. Similarly, favouring cloud-based provision of certain services to the general public may yield substantial environmental benefits, if it leads to reduced energy consumption on within the home.

In this chapter, we will show, by examining multiple scenarios, why maximising the use of renewable (or at least low carbon) energy sources to power data-centres and improving the Power Usage Effectiveness (PUE) of high-density ICT facilities jointly hold the key to realising the carbon abatement potential of the Cloud.

BACKGROUND

Problem Space

In this chapter, we will use expressions such as “the Cloud”, “cloud services” or “cloud computing” in the most generic sense of a framework or mode of operation whereby a dynamic share of a pool of resources is used to replace dedicated equipment or infrastructure in order to perform a certain task. Note that a cloud service can be private (i.e. resources are proprietary and are only shared between members of the same organisation) or public (i.e. different organisations use/rent the same resources, provided and maintained by a third-party).

There is widespread expectation that the Cloud has strong carbon abatement potential. However, in practice, this potential will only be realised if certain conditions are met, which may require taking into account variables that are not intrinsically part of the cloud computing paradigm. It is essential to remember that cloud computing was not meant to be a “green” technology in the first place. Originally, it was envisaged as a method for improving resource utilisation through enhanced flexibility (as evidenced by the very name of pioneering cloud applications such as Amazon’s “elastic computing”).

The key concept is that by providing access to a large pool of shared resources to a large and varied customer base, usage fluctuations which normally cause inefficiency (due to the need to provision for peak instead of average demand) could be eliminated or at the very least substantially reduced by transferring resources between subscribers whose needs are “out of phase”. In short: as the resource requirements of user A are ramping down and those of user B are ramping up, hardware and/or software assets can be seamlessly moved from A to B, keeping utilisation homogeneously high and cutting down costly idling time.

It is worth noting that, at this stage, power saving does not necessarily come into the equation. It is only because the fraction of operational costs attributable to electricity use in a typical ICT installation has risen steadily over the last decade that improving energy efficiency has become one of the most vaunted benefits of the Cloud. However, not only have recent studies by (Baliga, et al, 2010) and (Cook, 2012) shown that actual power savings depend heavily on the type of service provided (storage, software, processing...) and on the level of utilisation, there is also a fundamental if somewhat counter-intuitive
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