

# Measuring Impacts of Green IT

Barbara Krumay

Vienna University of Economics and Business  
Institute for Information Management and Control  
Vienna, Austria  
[bkrumay@wu.ac.at](mailto:bkrumay@wu.ac.at)

Roman Brandtweiner

Vienna University of Economics and Business  
Institute for Information Management and Control  
Vienna, Austria  
[rbrandtweiner@wu.ac.at](mailto:rbrandtweiner@wu.ac.at)

The term Green IT has become a hot topic since the intense use of ICT hardware shows enormous negative impacts on the environment. It comprises greening of IT (reducing environmental impacts of ICT products) and greening by IT (e.g. environmental information systems), often referred to as 'Green IS' [1]. Research, business and public authorities name three main reasons for the impacts. First, consumption of resources in production of ICT products is high and eats up rare and precious resources (e.g. rare earth metals) [2, 3]. Second, energy use throughout the whole lifecycle is immense [4]. Finally, having reached their end of life, the variety of products (e.g. mobile phones, servers, printers, computers integrated into other products) and different materials integrated (e.g. plastic, metals, liquids) impacts the environment again [5]. To reduce these negative impacts on environment, companies more and more implement Green IT (greening of ICT product) into their business. To manage their Green IT efforts, they need instruments to measure impacts of Green IT [1]. This is not specific for Green IT, but a regular task in business conduct. Companies measure their performance with the help of indicators due to various reasons. May it be decision making [6] or assessing their success [6, 7] in monetary or non-monetary numbers. Monetary or financial performance indicators, produced by accounting information systems, can be found in nearly every company [8]. By contrast, non-financial performance indicators like customer satisfaction, employee training or product quality [9] are harder to calculate and often lack the support of information systems. For assessing the performance of Green IT efforts in companies, financial and non-financial indicators and methodologies are possible. In this specific context, non-financial indicators seem to have some advantages as they provide information in their original, non-peculiar form (e.g. CO<sub>2</sub> emissions in tons per year). Yet, approaches to monetize such indicators can be observed [7] (e.g. costs evolving from CO<sub>2</sub> emissions in tons per year). A vast amount of complex schemes and methodologies are at hand to measure 'green' efforts of companies. Among them greenhouse gas (GHG) emissions, Environmental Performance Indicators (EPI) [10], Key Ecological Indicators (KEI) or Green performance indicators (GPIs) [11]. Existing sustainability frameworks like ISO 14001, the Greenhouse Gas Protocol (GHGP) or the Global Reporting Initiative (GRI) served as basis for many indicators schemes [12]. The

advantage of such schemes is that they adopt a holistic view on company's ecological performance. The disadvantage is the amount of data needed, which challenges companies. However, they barely address Green IT as such [13]. Still, 'what' and 'how' to measure are open questions requiring further investigation [14]. Furthermore, both, financial and non-financial indicators, require a sound data collection. Whereas accounting systems and enterprise resource planning systems automatically generate data for financial indicators, data for environmental indicators requires additional sources. It remains unclear, which information systems can be used to create and provide the required data in an effective but also efficient way. In our research, we want to close this gap. Consequently, we concentrate on indicators and methodologies as well as indicator schemes applied to measure impacts Green IT approaches. We focus on the required data and the role of information systems for creating, collecting, processing and visualizing them. We aim at developing a landscape of the Green IT indicators, methodologies and schemes based on their data requirements and information systems involved in this process.

## Methodological Approach

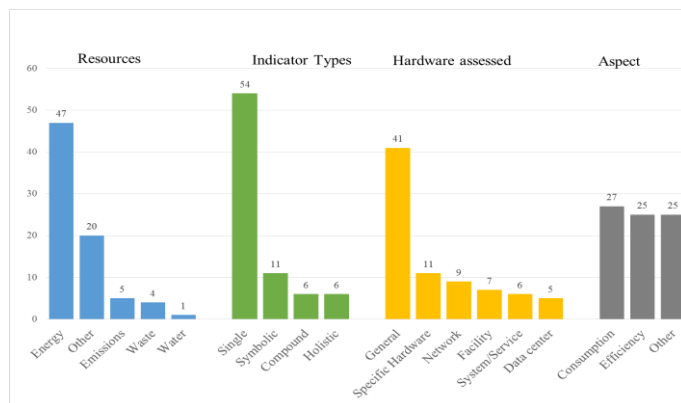
To gain an overview on the topic, we applied a literature review. We identified indicators, which support companies in their efforts to measure effects of Green IT approaches. We deliberately include only measurement of impacts concerning 'greening of IT'. To gain a basic understanding, we applied coding techniques to generate a first classification scheme. In a next step, we will set up a case study with a company, to investigate which indicators they use and which information systems are involved in the process. Moreover, we aim at identifying how creation and provision of required data takes place.

## First Results and Next Steps

First, we identified appropriate search terms based on a short pre-study. Queries included different combinations of Green ICT/IT/IS, ICT/IT hardware, (performance) indicator (performance) measurement, metrics, performance management, environment, energy, pollution, as well as

scorecard. We applied Boolean operators (AND, OR, NOT) to combine the search terms, on two scientific databases (EBSCO and ABIInform/TI ProQuest) in December 2015. The search resulted in 350 academic papers (7 excluded due to language issues). We further selected the papers based on reading the abstract and further reduced the sample to 118 papers. By investigating the content of them, we excluded all papers reporting on performance measurements of governments or pure environmental indicators, not targeting towards ICT hardware. Finally, we identified 59 papers for analysis. Further screening to identify indicators was done by the co-authors using a software program for content analysis (Atlas.ti). Based on the analysis we were able to identify 77 different indicators, schemes and methodologies connected to Green IT. We developed four categories (Figure 1) including resource or input/output measured (energy, emissions, waste, water, other), type of indicator (single, symbolic, compound, holistic), hardware (General, specific hardware, network, facility, system/service, data center) and aspect (consumption, efficiency, other). For the case study, we are in contact with two companies. We plan to conduct interviews as well as analyze documents and systems. Based on this, we would like to answer the questions ‘what is measured’, ‘how is it measured’ and ‘which information systems are involved’. Currently, we are developing the interview guidelines and coordinate dates for the interviews, which should take place in fall or winter 2016.

Figure 1: Categories of indicators, schemes and methodologies



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