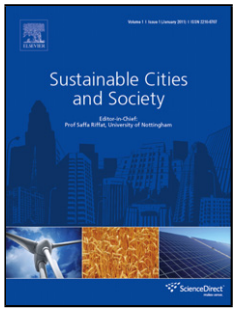

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New Consumer-Dependent Energy Management System to Reduce Cost and Carbon Impact in Smart Buildings

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***Abstract*— Buildings represent one of the most important energy consumers (about 40% and 55% of total U.S. and European energy consumption, respectively) and are regarded as non-negligible greenhouse gases emitters (39% of total greenhouse gases emission in U.S.). Hence, it becomes crucial to control buildings energy consumption in order to preserve energy resources and reduce greenhouse gases. For this reason, we propose in this paper a real time Consumer-Dependent Energy Management System (CD-EMS) in MicroGrids (i.e. a restricted form of the power grid) for smart buildings. The main new idea is to find a trade-off between the energy cost, either renewable or non-renewable, and its carbon impact. The other innovation is to transform the building manager to a Consum-Actor who participates directly on reducing greenhouse gas emission by fixing a consumer's acceptability margin that allows buying renewable energy, even if it is a little more expensive than non-renewable one. CD-EMS offers the best compromise between decreasing energy cost and reducing gas emissions. The problem is modeled as a linear program, resolved by Matlab, and implemented in a small-scale datacenter building prototype. The obtained results show a noticeable improvement in terms of cost and carbon impact where we prove that our system is able to reduce cost until 7.3%, and CO_2 emission until 55.7%.**

***Index Terms*— Energy Management System; Microgrid; Energy Storage Management; Cost minimization; Carbon minimization; Linear programing; Smart Buildings.**

ACRONYMS

CD-EMS	*Consumer-Depend Energy Management System*
EDS	*Energy Discharged from Storage unit*
EG	*Energy from Generator*
ENRG	*Energy from Non-Renewable Grid*
ERG	*Energy from Renewable Grid*
EScRG	*Energy Storage charged from Renewable Grid*
EScNRG	*Energy Storage charged from Non-Renewable Grid*
MG	*Micro Grid*
SG	*Smart Grid*

I. INTRODUCTION

Buildings are among the largest energy consumers. In 2015, about 40% of total U.S. energy consumption was consumed in residential and commercial buildings. In 2012, they represented about 55% of total energy consumption in the EU-28 (Agency, 2015) and 44.5% of France's final energy consumption (Commission, 2014). This huge amount of energy produced a significant amount of greenhouse gases (Marszal et al., 2011; Chen and Ng, 2016; Truong et al., 2016). In US, a statistic affirms that buildings account for 2236 million metric tons of CO_2 which represents 39% of total CO_2 emissions which means that buildings are source of pollution more than either the transportation or industrial sectors (Mendelsohn and Neumann, 2004). To deal with this problem, in COP 21, every participating country is committed to present a national contribution every five years to reduce its greenhouse gas emissions (Hoad, 2015). Furthermore, the expenses in electricity will be significant for every consumer (homes, offices, buildings, etc.) if he does not opt to reduce, or at least, better manage his consumption. Datacenters are considered as one of the most energy-intensive building types where thousands of servers and immense Heating Ventilation and Air-Conditioning (HVAC) systems are running all the time. It consumes up to 50 times the energy per floor space of a typical commercial office building (Darrow and Hedman, 2009).

Renewable Energies (REs) such as solar, wind, wave, biofuel and geothermal can participate to reduce greenhouse gas effect (Sims et al., 2003; Panwar et al., 2011; Moradi et al., 2016). However, they have their own shortcomings since most of them are highly dependent on weather and any significant changes in weather can reduce the energy production (Liang, 2017). Furthermore, they cannot meet global energy requirement, at least in the coming decades. The variety of energy sources and their characteristics with the industrial, technological and social evolutions make vital the need for a new energy management vision, such as distributed energy sources (Marzband et al., 2016), or hybrid energy