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Sustainable Energy Policy and Strategies for Europe

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LUISS University of Rome

ABSTRACT SUBMISSION DEADLINE **JUNE 1st, 2014**

The Conference Objectives

As Europe strives to overcome the economic crisis, energy stands out both as a conditioning factor and as an opportunity. The energy situation is evolving in Europe as well as in the rest of the world, where new actors, the emerging economies, are taking the leading role. Political developments in several areas of the globe (North Africa and Middle East, the Caspian region, ASEAN countries) are reshaping the geopolitical situation, generating some worries about the security of supply in the EU countries.

The crisis has somewhat released the pressure on energy demand and allowed to reach objectives in the reduction of greenhouse gas emissions that seemed out of reach, but as the European Energy Roadmap to 2050 makes clear the objectives for 2020 and beyond are likely to require a renewed, powerful effort as soon as the economy is back on the track.

Important steps towards the establishment of a really open and competitive energy market in Europe have been achieved, but much remains to be done. Energy technologies (as evidenced in the SET-Plan) have evolved and contributed new solutions, as in the case of non-conventional hydrocarbon resources, but this has happened more as gradual step-by-step improvements than by real breakthroughs. The evolution of these technologies has been influenced by the instruments adopted by governments to promote new sources or new solutions rather than directly by market demand. The use of "market instruments" to steer the energy choices in the direction of sustainability is the subject of animated discussions, based on the analysis of diverse case studies. The hope of obtaining reductions of energy costs by these means has been often frustrated.

Some sectors show difficulties in moving in the right direction (in terms of economy as well as sustainability): the outstanding example is the transport sector, where, apart from the improvement of the efficiency of vehicles, there is little sign of moving from the present paradigm (with private prevailing over public transport, road over track and waterways,) and sporadic attempts are done to reduce the need of displacements (both of people and of goods). Another sector which is meeting institutional rather than technical difficulties is the building sector, especially as concerns distribution of costs and revenues among the different actors.

The first (dual) plenary session of the Conference will be devoted to the European Energy Road Map to 2050, and to the response to environmental challenges.

The next plenary sessions will deal with the specific energy aspects of transportation, and to the efficiency of energy utilisation in buildings. The last two plenary sessions will be devoted to energy geopolitics and emerging countries, and to the regulation of energy markets.

The 14th IAEE Conference will try to discuss all the issues related to European policy and its new perspectives in 8 plenary and 40 concurrent sessions that will be organized by the **AIEE**- **Italian Association of Energy Economists and IAEE - The International Association for Energy Economics**, in cooperation with the **Guido Carli Free International University for Social Studies - LUISS**, that will host this conference.

LUISS

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(**see map**)

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ENERGY CONSUMPTION AND EFFICIENCY IN THE EU STOCK OF SHOPPING MALLS

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(1) Overview

Today's shopping mall gross leasable area (GLA) is 112.1 mil. m^2, which makes up approx. 6.7% of the total wholesale and retail building floor area in the EU-28 plus Norway in 2013 (BPIE, 2013 & ICSC, 2014). The largest shopping malls gross leasable area is located in UK (26.2 mil. m^2) followed by France (14.4 mil. m^2) and Italy (12.7 mil. m^2). These countries account for approximately 46% of the total shopping mall GLA. This paper comprises comprehensive information on the current shopping mall stock in Europe. Based on this data, the current energy consumption and energy savings potential is calculated and recommendations are given.

(2) Methods

Based on the measured energy consumption per square meter of 132 shopping malls throughout seven European countries (Steen & Strøm (2012), Unibail-Rodamco (2013), Intu Group (2013), Britishland (2014) and IGD (2014)) and their GLA, a linear regression of the specific energy consumption per m² of shopping malls is conducted to calculate the total energy use in a next step. Before, five significant outliers have been removed by using a Grubbs test with a significance level of 5% (two-sided) and a p-value <5%. The *GLA* of shopping malls *j* in these countries *i* (ICSC, 2014) multiplied by the abovementioned specific energy consumption per m² *ec* equals the total energy consumption *EC* [TWh] of shopping malls over time *t*.

$$EC_{(t)} = \sum_{i=1}^{n} ec_{i(t)} * GLA_{i,j(t)} \quad (1)$$

Further, data on the time span between the opening of 3400 shopping malls and their renovation year (ICSC, 2014) lead to a robust estimate of the renovation rate *(rr)* of 4.4% p.a. This is the basis for calculating the cumulative energy savings potential *ES* [GWh] of all shopping malls over time, where $es_{i(t)}$ denotes the specific energy saving potential of shopping malls [%] in country *i*.

$$ES_{(t)} = ES_{(t-1)} + \sum_{i=1}^{n}(rr_{(t)} * \; EC_{(t)} * \; es_{i(t)}) \quad (2)$$

(3) Results

Table 1 shows descriptive statistics of shopping malls in the investigated countries and the energy consumption calculated with formula (1). Compared to the literature, the energy intensity of the sample is quite low. Stensson et al. (2009) report a total energy consumption in Norwegian and Swedish shopping malls of 291 and 279 kWh/m^2a respectively. According to Schönberger et al. (2013) the total energy consumption of food stores ranges between 500 and 1000 kWh/m^2a. Further, they report for non-food stores smaller than 300 m² an energy consumption of 270 kWh/m²a and for stores larger than 300 m² 200 kWh/m²a. These numbers are also supported by Tassou et al. (2011) in a UK-case study and the database of the EU-project Entranze (2013). Therefore, it can be assumed that the energy consumption in Table 1 do not include tenants data and the results on the given energy intensity can be seen as bottom line of the energy consumption in European shopping malls. There real energy consumption and therefore the energy savings potential are likely to be somewhat higher, which will be subject to further investigation.

Given this restriction, low and high energy savings potentials, corresponding to different renovation measures, cf. Berkeley (2012), BPIE (2013), Schönberger et al. (2013), are calculated according to formula (2). By 2020, the cumulated energy savings potential of these shopping malls can be estimated to 169 GWh in the lower case, a 2.6% reduction compared to the total energy consumption in 2014. The high case lead to cumulated energy savings of 557 GWh by 2020, which means a 8.7% reduction according to 2014 levels. The full results are available in an online data mapper (www.commonenergyproject.eu/data_mapper.html) as well as in Bointner and Toleikyte (2014); final version in August 2014.

Table 1: *Descriptive statistics of shopping malls in 7 European Countries [Own calculation, based on Steen & Strøm (2012), Unibail-Rodamco (2013), Intu Group (2013), Britishland (2014), IGD (2014), ICSC (2014)]*

	DK	ES	FR	IT	NO	SE	UK	Total
No. of shopping malls with energy data	19	15	25	20	17	16	19	**131**
No. of shopping malls with GLA data	91	485	478	359	151	498	500	**2562**
GLA [mio m²]	1,45	12,89	10,45	8,73	2,63	7,25	17,65	**61,06**
Energy Consumption [TWh]	0,21	0,74	0,74	1,11	0,50	1,57	1,52	**6,38**
Energy Intensity [MWh/m² a]	0,14	0,06	0,07	0,13	0,19	0,22	0,09	**0,10**

Table 2: *Cumulated Energy Savings potential of the shopping mall stock of the 7 countries [Own calculation]*

	2015	2016	2017	2018	2019	2020	[%]
Renovated GLA [mil. m²]	2,69	5,38	5,38	5,38	5,38	**5,38**	8,8% of total GLA_{2014}
High energy savings [GWh]	92,77	185,53	278,30	371,07	463,83	**556,60**	8,7% of total EC_{2014}
Low energy savings [GWh]	28,11	56,22	84,33	112,44	140,56	**168,67**	2,6% of total EC_{2014}
Energy consumption with high energy savings [TWh]	6,29	6,20	6,10	6,01	5,92	**5,82**	
Energy consumption with low energy savings [TWh]	6,35	6,32	6,30	6,27	6,24	**6,21**	

(4) Conclusions

Although the abovementioned results present a bottom line of the energy consumption of European shopping malls, there is a high potential for energy savings. Compared to Tassou et al. (2011) the real energy saving potential is likely to be much higher. This high potential derives inter alia from high renovation rates and current inefficiencies as reported by Woods et al. (2014). In mature European shopping centre markets this potential can be exploited by a systemic retrofitting approach, comprising an efficient building envelope, integration of renewable energy sources, waste heat recovery, energy management concepts, efficient (natural) lighting, and energy efficient appliances; cf. Schönberger et al. (2013). In emerging shopping centre markets in Eastern Europe, where the number of new buildings is estimated to be high, energy efficiency measures have to be taken already beforehand in the construction phase. Thus, we recommend introducing energy efficiency standards for new construction, retrofit and operation of shopping malls to reduce both, the energy demand and the greenhouse gas emissions. In the eye of the EU targets for 2020, our results may serve as a comprehensive basis for decision making among European shopping mall stakeholders.

References (selection)

Berkeley Nat. Lab (2012), Building Energy-Efficiency Best Practice Policies and Policy Packages, http://china.lbl.gov/sites/all/files/gbpn-finaloct-2012.pdf , last accessed 24 May 2014

Bointner, R.,Toleikyte, A., (2014) “Shopping malls features in EU-28 + Norway”, Report 2.1 of CommONEnergy, Vienna, 2014

BPIE (2013), Boosting Building Renovation, An Overview of Good Practices. Source: http://www.bpie.eu/uploads/lib/document/attachment/26/Boosting_building_renovation_-_Good_practices_BPIE_2013_small.pdf

Britishland (2014),"Corporate Responsibility FULL DATA REPORT 2013", Britishland, London, 2014, http://britishland.com/~/media/Files/B/British-Land/reports-and-presentations/reports-archive/BL_Full_Data_Report_2013.pdf

Entranze 2013, Average floor area per capita, Data tool, http://www.entranze.eu/tools/interactive-data-tool

ICSC (2014), ICSC’s Database “QuickStats”, http://edata.icsc.org, last accessed 24 May 2014

IGD (2014), "Bilancio di SOSTENIBILITÀ, 2013", IDG Gruppo, Bologna, 2013, www.gruppoigd.it/content/download/6001/167492/file/IGD%20BILANCIO_ITA_2013_ese.pdf, last accessed 13 May 2014

Intu Gr. (2013), Corporate Responsibility Report 2012, London 2013, www.intugroup.co.uk/media/203211/intu_crreport_2012.pdf

Schönberger H., Galvez Martos J. L.., Styles D. (2013), Best Environmental Management Practice in the Retail Trade Sector, European Commission, Joint Research Centre – Institute for Prospective Technological Studies, Publications Office of the European Union, Scientific and Technical Research series – ISSN 1831-9424, Luxembourg 2013, http://susproc.jrc.ec.europa.eu/activities/emas/documents/RetailTradeSector.pdf

Steen & Strøm (2012), "Sustainable Development Report 2010/2011", Steen & Strøm AS, Oslo, 2012, http://steenstrom.com/upload/Good%20Choice_website/SST%20Sustainable%20Report%202011.pdf

Stenson S. et al. (2009), Specific energy use in Swedish and Norwegian shopping malls, ECEEE 2009 SUMMER STUDY, www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2009/Panel_4/4.118/paper

Tassou S. A., Ge Y., Hadawey A., Marriott D. (2011), Energy consumption and conservation in food retailing, Applied Thermal Engineering 31 (2011), p. 147-156

Unibail-Rodamco (2013), "Environmental Reporting, Quarterly Consolidation Q4 2012", Unibail-Rodamco SE, Paris 2013, www.unibail-rodamco.com/W/.../Unibail-Rodamco_RA_2012_GB.pdf, last accessed 13 May 2014

Woods R. et al. (2014), An analysis of systemic energy inefficiencies, Report 2.2 of CommONEnergy, Trondheim, 2014