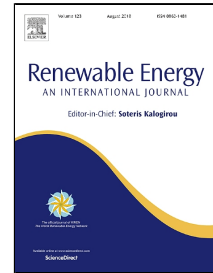


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An analysis of harmonic heating in smart buildings and distribution network implications with increasing non-linear (domestic) load and embedded generation

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1 An analysis of harmonic heating in smart buildings and distribution network  
2 implications with increasing non-linear (domestic) load and embedded generation

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9 **Abstract:** Harmonic distortion is generally not taken into account within domestic installations  
10 and the associated wiring systems, as its potential is considered sufficiently small to be neglected.  
11 Standards to limit harmonic manifestations in the low voltage (LV) network are available, but  
12 these can be breached as a consequence of advancements in power electronics in some modern  
13 household devices contributing higher levels of harmonic distortion than permitted. While these  
14 devices *individually* might not be considered serious in terms of system level harmonic distortion  
15 manifestations, electrical equipment failures and insulation failures - increasingly being derived  
16 from harmonic cable heating - suggest a different story. A 10% increase in THD in a circuit will  
17 result in an increase of 10% in cable heat. Recently, attempts have been made to offer harmonic  
18 derating factors for building electrical circuit design in BS7671, but this approach currently  
19 prioritizes large power devices. This article explores the need for harmonic considerations during  
20 the design stage of electrical services engineering projects. Best practice suggestions, in the context  
21 of the dissemination of heat caused by harmonics related to household load  
22 deployments/configurations, are also provided based on the analysis conducted with real  
23 household data. This is further extended to a practical distribution network where the effect of  
24 harmonic heating at the network level is explored. The results suggest that the harmonics in the  
25 distribution network can amass to cause a cumulative effect on the network. Furthermore, it can  
26 be observed from the results that in a distribution network containing (domestic) solar photo  
27 voltaic (PV) systems, the harmonic heating issue can be reduced. This benefit is not without  
28 consequence however, as increasing PV penetration does not reduce the harmonic content of the  
29 overall system and therefore presents a further concern that may need to be addressed in due time.

30 **Keywords:**

31 Harmonic Distortion (THD), Distribution network analysis; Photovoltaic systems; Non-linear  
32 load; Harmonic load flow; Cable heating;  
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