The use of phase-change materials (PCM) to improve the performance of conventional solar walls (SWs) has been recently proposed. A holistic analysis of the thermal and energy performance of a PCM-enhanced SW is performed by employing numerical simulations on two different physical scales. Initially, a computational fluid dynamics tool is used to investigate the thermal behaviour of a SW, by varying a range of operational parameters such as height, width, inlet air temperature, inlet air velocity and incident solar radiation. Predictions of air velocity and temperature distributions in the air cavity are used to determine the impact of each operational parameter. Furthermore, a building energy performance simulation tool is employed to provide a realistic estimation of the energy savings when a PCM-enhanced SW is used. A reference apartment is used to compare the energy demand and energy consumption 'before' and 'after' the installation of a conventional and a PCM-enhanced SW. A range of parameters, such as climatic conditions or *U*-values of external walls and windows, is varied; the selected values correspond to five typical European cities. It is shown that a PCM-enhanced SW results in higher savings in total energy consumption compared to a conventional SW.