Temperature and relative humidity are crucially important for the reliability of electronic devices in outdoor applications. For small enclosures, thermal control by a heat sink that is cooled by natural convection is the most widely used method. In this work, the functionality of a heat sink as a thermal mass for partially storing the heat that is generated by the electronics inside a typical electronics enclosure is studied using transient 3D CFD simulations. The stored energy is released with a time lag for the purpose of enhancing the stability of the local climate inside the enclosure. A typical enclosure is assumed to be exposed to Copenhagen outdoor conditions over a two-day time period. For fast and long-term predictions, a Cauer ladder RC model is developed based on CFD simulation results. A correlation for calculating the Nusselt number representing heat transfer between the trapped air inside the enclosure and the heat sink is derived. Compared with CFD simulations, the RC model is found to predict slightly lower values for temperature, and slightly higher values for RH – given that the value of absolute humidity is quite constant over the timescales here, then the higher values of RH are largely due to the lower values of temperature. The lumped model correctly predicts the trend for temperatures and RH variations, however, suggesting that a properly calibrated RC model can be used for scoping calculations, and more importantly for long-term predictions. The method can be used for any other ambient and working conditions, as long as the temperature difference in the air does not exceed 25 °C.