This thesis focuses on photovoltaic thermal (PVT) implication in building includes rooftop and building integrated thermal aspects, and their multifunctional uses in distributed way including thermal comfort, space heating, small scale industrial functioning by making sun bath (low temperature application), drying industries. This thesis explores a precise cutting edge technology covering potential utilization of resources by different PVT application in building (thermal and electrical) envelop, methodological applications, some techno-economic software, and operational feasibility survey. Initially, the thesis reports the temperature dependent behavioral analysis of different photovoltaic (PV) technologies, and presents an analytical model to predict the power output depends upon the local weather conditions. The fabricated prototype test cells on which integration of PVT modules reflects a perfect simulation of building integrated photovoltaic-thermal (BiPVT) system that are helpful to interpret the distinct feature of PVT as the integrated roof and façade. This thesis investigates the overall efficacy of different PVT configuration and developed a mathematical model. On the basis of overall energy and exergy, yearly comparative analysis for different weather condition has been investigated. This suggested that semitransparent PVT with duct is more effectiveness as compared to other configuration. Further, the cooling potential of different PV along with thermal comfort by surface water flow was analyzed. This investigation helps in finding the perspective gap in PV usage as a roof. The developed analytical model resolves the fault and failure problem of PV in residential application as a roof and façade for thermal comfort. In this thesis, along with electrical and thermal energy, exergy was evaluated for a BiPVT system used as a roof of rooms for different types of PV arrays. Moreover, analytical and numerical approaches are adopted to achieve thermal comfort by varying roof thickness and air exchange. The techno-economic analysis of photovoltaic (PV) system in residential application with govt. initiatives presents an optimistic approach towards the feasibility of solar power in decentralised sector. The overall purpose of this thesis is to point out all alternative methodologies of PVT system that can be used in grid/off-grid electrification for electrical as well as thermal load demand in building to identify the features of each approach and present their strengths and weaknesses.