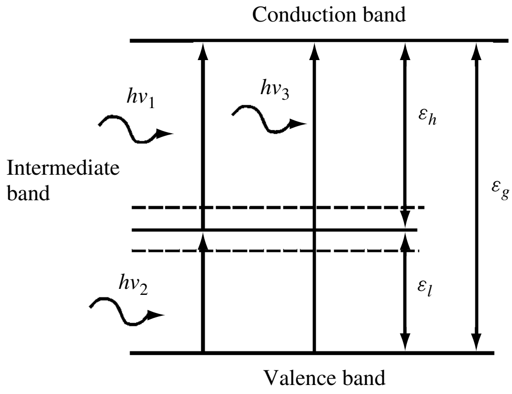

Figure 4.13 The band diagram of an intermediate band solar cell

In this IB material we admit that there are three quasi-Fermi levels, one for each band. The cell voltage is q times the splitting of the CB and VB quasi-Fermi levels.

In general, there is an energy threshold for each one of the absorption mechanisms described earlier. However, the ideal structure is the one in which the upper energy (lintel) of a photon that can be absorbed in certain mechanisms – involving, for example, transitions from the VB to the IB – is the threshold of the next one – for example, transitions from the IB to the CB. More specifically, calling ε_g the energy interval between the conduction and the valence band, ε_l the interval between the Fermi level in the intermediate band and the valence band and $\varepsilon_h = \varepsilon_g - \varepsilon_l$, and assuming that $\varepsilon_l < \varepsilon_h$, we consider that all the photons in the interval $(\varepsilon_l, \varepsilon_h)$ are absorbed by transitions from the VB to the IB, all the photons in the interval $(\varepsilon_h, \varepsilon_g)$ are absorbed by transitions from the IB to the CB and all the photons in the interval (ε_g, ∞) are absorbed by transitions from the VB to the CB.

Under such conditions the equations that rule the current–voltage characteristic of the cell are

$$I/q = \lfloor \dot{N}(T_s, 0, \varepsilon_g, \infty, \pi) - \dot{N}(T, \mu_{CV}, \varepsilon_g, \infty, \pi) \rfloor + [\dot{N}(T_s, 0, \varepsilon_h, \varepsilon_g, \pi) - \dot{N}(T, \mu_{CI}, \varepsilon_h, \varepsilon_g, \pi)] \quad (4.81)$$

$$\dot{N}(T_s, 0, \varepsilon_l, \varepsilon_h, \pi) - \dot{N}(T, \mu_{IV}, \varepsilon_l, \varepsilon_h, \pi) = \dot{N}(T_s, 0, \varepsilon_h, \varepsilon_g, \pi) - \dot{N}(T, \mu_{CI}, \varepsilon_h, \varepsilon_g, \pi) \quad (4.82)$$

with μ_{XY} being the photon chemical potentials equal to the separation of quasi-Fermi levels between band X and band Y. Equation (4.81) states the balance of electrons in the CB (addition of those that are pumped from the IB and the VB by means of the absorption of the corresponding photon less those that radiatively recombine). Equation (4.82) states a similar balance equation for the electrons in the IB and takes into account that no current is extracted from the IB. In addition,

$$qV = \mu_{CV} = \mu_{CI} + \mu_{IV} \quad (4.83)$$