SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING
LRESE-Laboratory of Renewable Energy Sciences and Engineering

EPFL

Renewable Energy: PV Example

Band gap of Silicon 1.1 eV → $\lambda_{\mathrm{bg}} = \frac{hc}{E_{\mathrm{bg}}} = 1.1\ \mu\mathrm{m}$

We divide the spectrum from 0 to λ_{bg} into 10 intervals ($N = 10$) so that we can calculate the efficiency:

$$\eta = \frac{\int_0^{\lambda_g} \frac{E_g}{E} e_{\lambda b}\, d\lambda}{\int_0^{\infty} e_{\lambda b}\, d\lambda} = \frac{1}{\sigma T^4} \int_0^{\lambda_g} \frac{E_g}{E} e_{\lambda b}\, d\lambda \approx \frac{1}{\sigma T^4} \sum_{i=1}^{N} \int_{\lambda_i}^{\lambda_{i+1}} \frac{E_g}{E_{\lambda_{m,i}}} e_{\lambda b}\, d\lambda = \sum_{i=1}^{N} \frac{E_g}{E_{\lambda_{m,i}}} F_{\lambda_i - \lambda_{i+1}}$$

Interval, i	λ_i [μm]	λ_{i+1} [μm]	$\lambda_{\mathrm{m},i}$ [μm]	$E_{\lambda_{\mathrm{m},i}}$ [eV]	$F_{\lambda_i - \lambda_{i+1}}$	Useful: $\frac{E_{\mathrm{bg}}}{E_{\lambda_{\mathrm{m},i}}} F_{\lambda_i - \lambda_{i+1}}$
1	0	0.11	0.057	22	0	0
2	0.11	0.23	0.17	7.33	0.004	0.001
3	0.23	0.34	0.283	4.4	0.056	0.014
4	0.34	0.45	0.396	3.14	0.125	0.044
5	0.45	0.57	0.509	2.44	0.147	0.066
6	0.57	0.68	0.622	2.00	0.133	0.073
7	0.68	0.78	0.735	1.69	0.109	0.071
8	0.78	0.9	0.848	1.47	0.086	0.064
9	0.9	1.02	0.961	1.29	0.066	0.056
10	1.02	1.1	1.074	1.16	0.051	0.049
11	1.1	∞			0.221	
					$\sum_{i=1}^{N} F_{\lambda_i - \lambda_{i+1}} \approx 1$	$\sum_{i=1}^{N} \frac{E_g}{E_{\lambda_{m,i}}} F_{\lambda_i - \lambda_{i+1}} = \underline{0.438}$