Fermionen $\epsilon(\vec{k}) = \frac{\hbar^2 k^2}{2m}$, $\{\alpha\} = \{n_{\vec{k}_1}, n_{\vec{k}_2} \dots\}, \quad n_{\vec{k}_i} \in \{0, 1\}$

Mit Teilchenzahl $N_\alpha = \sum_{\vec{k}} n_{\vec{k}}$ und Energie $E_\alpha = \sum_{\vec{k}} \epsilon(\vec{k}) n_{\vec{k}}$

$$Z_G = \sum_\alpha e^{-\beta(E_\alpha - \mu N_\alpha)} = \prod_{\vec{k}} \sum_{n_{\vec{k}=0}}^{1} e^{-\beta(\epsilon(\vec{k})-\mu) n_{\vec{k}}} = \prod_{\vec{k}} (1 + e^{-\beta(\epsilon(\vec{k})-\mu)})$$

$$U = -\left(\frac{\partial}{\partial\beta} \ln(Z_G)\right)_{\beta\mu} = \sum_{\vec{k}} \epsilon(\vec{k}) \frac{1}{e^{\beta(\epsilon(\vec{k})-\mu)} + 1} = \sum_{\vec{k}} \epsilon(\vec{k}) \underbrace{f(\epsilon(\vec{k}) - \mu)}_{FD-Vert.fn}$$