We at this point have the following expressions:

$$
\begin{align}
y &= f(x) + \epsilon \tag{1}\\
\tilde{y} &= A\beta \tag{2}\\
C(A,\beta) &= \frac{1}{n}\sum_{i=0}^{n-1}(y_i - \tilde{y}_i)^2 = \mathbb{E}[(y-\tilde{y})^2] \tag{3}
\end{align}
$$

With this one can rewrite $\mathbb{E}[(y-\tilde{y})^2]$ as follows:

$$
\begin{align}
\mathbb{E}[(y-\tilde{y})^2] &= \mathbb{E}[(f+\epsilon-\tilde{y})^2] \tag{4}\\
&= \mathbb{E}[(f+\epsilon-\tilde{y}+\mathbb{E}[\tilde{y}]-\mathbb{E}[\tilde{y}])^2] \tag{5}\\
&= \mathbb{E}\Big[(\mathbb{E}[\tilde{y}]-\tilde{y})^2 + (f+\epsilon-\mathbb{E}[\tilde{y}])^2] \tag{6}\\
&\quad + 2\mathbb{E}[-\mathbb{E}[\tilde{y}]^2 + \mathbb{E}[\tilde{y}](f+\epsilon) - (f+\epsilon)\tilde{y} + \mathbb{E}[\tilde{y}]\tilde{y}\Big] \tag{7}\\
&= \mathbb{E}\Big[(\mathbb{E}[\tilde{y}]-\tilde{y})^2 + f^2 + \epsilon^2 + 2f\epsilon + \mathbb{E}[\tilde{y}]^2 - 2(f+\epsilon)\mathbb{E}[\tilde{y}]\Big] \tag{8}\\
&= \mathbb{E}[(\tilde{y}^2-\mathbb{E}[\tilde{y}])^2 + (f^2 - 2f\mathbb{E}[\tilde{y}] + \mathbb{E}[\tilde{y}]^2) + \mathbb{E}[\epsilon^2] \tag{9}\\
&= \mathrm{var}(\tilde{y}) + (f-\mathbb{E}[\tilde{y}])^2 + \sigma^2 \tag{10}\\
&=: \mathrm{var}(\tilde{y}) + \mathrm{BIAS}[\tilde{y}] + \sigma^2 \tag{11}
\end{align}
$$