Water: hydrogen bond strength $5-8 \text{ kT}$ ($\theta = 25^\circ C$)

On average, 2 H-bonds per molecule of liquid water could be suggested. Wikipedia gives:

- $3.24$ at $100^\circ C$
- $3.59$ at $25^\circ C$

But also $2.357$ at $25^\circ C$

@ $25^\circ C$, $k_B T = (298 \text{ K}) (1.38 \times 10^{-23} \text{ J K}^{-1}) (6.02 \times 10^{23} \text{ bonds mole}^{-1})$

$= 2.477 \text{ J mole}^{-1} = 2.5 \text{ kJ mole}^{-1}$

@ $100^\circ C$, $k_B T = (373 \text{ K}) (1.38 \times 10^{-23} \text{ J K}^{-1}) (6.02 \times 10^{23} \text{ bonds mole}^{-1})$

$= 3.16 \text{ J mole}^{-1} = 3.1 \text{ kJ mole}^{-1}$

So: H-bond bond strength is $5-8 kT$ (approx)

For a single bond:

If use $2.35$ bonds/mole, it's $31-47 \text{ kJ/mole}$

Using $3.2$ bonds/mole, it's $42-64 \text{ kJ/mole}$

Theoretical heat of vaporization of water is $40.65 \text{ kJ/mole}$, so clearly breaking H-bonds is a large contribution to the heat of vaporization of water.

@ Energy of 2 electrons separated by distance:

$V = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2}$

We want $V = k_B T$

So:

$k_B T = \frac{e^2}{4\pi\epsilon_0 k_F z}$

$z = 80$

$\mu^2 = \frac{(4\pi\epsilon_0)(k_B T/k)}{e^2}$

For $T = 25^\circ C$ $\rightarrow \mu^2 \approx (0.7 \text{ nm})^{-2}$