To support this formula we use Merten's 3rd theorem:

$$\lim_{n\to\infty}\prod_{2\le p\le n}\frac{p-1}{p}\cdot\log(n)=e^{-\gamma}$$, with the Euler-Mascheroni constant $\gamma = 0.5772156649...$,

from which we deduce the asymptotic equivalences

$$\frac{1}{2}\cdot e^{\gamma}\cdot\prod_{2\le p<\sqrt{n}}\frac{p-1}{p}\sim\frac{1}{\log(n)},\quad\text{and, therefore}\quad\frac{\pi(n)}{n}\sim\frac{1}{2}\cdot e^{\gamma}\cdot\prod_{2\le p<\sqrt{n}}\frac{p-1}{p}\qquad(2.1)$$

Numbers q ($\sqrt{n}<q<n$) which lend themselves to a Goldbach Partition must satisfy the two conditions:

$$q\not\equiv 0(\mathrm{mod}\ p)\quad\text{and}\quad q\not\equiv n(\mathrm{mod}\ p)\ \text{ for all prime numbers } p\ (2\le p<\sqrt{n})\qquad(2.2.1)$$

To estimate their density, we have to modify the formula (2.1) to :

$$\frac{G(n)}{n}\sim\frac{1}{2}\cdot e^{\gamma}\cdot\prod_{\substack{2\le p<\sqrt{n}\\ n\equiv 0(\mathrm{mod}\ p)}}\frac{p-1}{p}\cdot\prod_{\substack{3\le p<\sqrt{n}\\ n\not\equiv 0(\mathrm{mod}\ p)}}\frac{p-2}{p}\qquad(2.2.2)$$

This can be written in the form :

$$G(n)\sim\pi(n)\cdot\prod_{\substack{3\le p<\sqrt{n}\\ n\equiv 0(\mathrm{mod}\ p)}}p-1\cdot\prod_{\substack{3\le p<\sqrt{n}\\ n\not\equiv 0(\mathrm{mod}\ p)}}p-2\Big/\prod_{3\le p<\sqrt{n}}p-1\qquad(2.2.3)$$

Simplifying the quotient, and counting partitions into prime numbers q and $n-q$, with $q\le n/2$, we obtain the formula (2a).

Obviously, the formulas (2a) and

$$g'_{alt}(n)=\frac{1}{2}\cdot\frac{n}{\log(n)}\cdot\prod_{\substack{3\le p<\sqrt{n}\\ n\not\equiv 0(\mathrm{mod}\ p)}}\frac{p-2}{p-1}\ \text{, and}\qquad(2b)$$

$$g''_{alt}=\frac{n}{4}\cdot e^{\gamma}\cdot\prod_{\substack{2\le p<\sqrt{n}\\ n\equiv 0(\mathrm{mod}\ p)}}\frac{p-1}{p}\cdot\prod_{\substack{3\le p<\sqrt{n}\\ n\not\equiv 0(\mathrm{mod}\ p)}}\frac{p-2}{p}\qquad(2c)$$

are equivalent, as are the formulas (1.1, 1.2), and (2) :

$$\frac{g_{alt}}{g_{HL}}=\left[\frac{\pi(n)}{n/\log(n)}\right]\cdot\left[\frac{1}{1/\log(n)}\cdot\frac{e^{\gamma}}{2}\cdot\prod_{2\le p<\sqrt{n}}\frac{(p-1)}{p}\right]\cdot\left[\prod_{\sqrt{n}<p<\infty}\frac{(p-1)^2}{p\cdot(p-2)}\right]\sim 1,$$

each of the three factors in square brackets tending towards unity.