(c) some measure of the resource consumption or environmental degradation caused by the technology.

Translating this hypothesis into useful formulas for comparing sustainability impacts is more challenging. One algorithm assumes that population (*P*) is a good surrogate for (a), but that the metrics implied by (b) and (c) should be expressed mathematically, not as absolute quantities, but rather as relative impacts on the population and economic activity respectively. Thus, useful simulants for (b) and (c) are per capita gross domestic product (*GDP/P*), and energy consumption per GDP (*E/GDP*), giving the following equation for the sustainability impact, S_I:

$$S_I = (P) \times (GDP/P) \times (E/GDP) \tag{1-22}$$

Some analysts interpret (*GDP/P*) and (*E/GDP*) as aggregate measures of standard of living and energy intensity (i.e., reciprocal energy efficiency). Multiplication of the three factors on the right hand side (RHS) of Equation (1-22) suggests the seemingly trivial result that $S_I = E$ or that total world energy consumption is a measure of sustainability, suggesting that energy use only benefits sustainability. This result alone might satisfy some sustainability "metricators," but Equation (1-22) offers much more. It can reveal the potency of specific adverse impacts simply by appending its RHS with one further multiplicative factor depicting the intensity of that impact per unit of energy used, e.g., the amount of carbon dioxide CO_2 emitted per Btu (CO_2/E):

$$S_I = (P) \times (GDP/P) \times (E/GDP) \times (CO_2/E) \tag{1-23}$$

Multiplying the RHS terms of Equation (1-23) equates S_I with total CO_2 emissions.[9]

Equation (1-23) can be modified in several ways (e.g., to allow for human actions that mitigate undesired impacts of energy). For example, CO_2 emissions can be combated by intentionally removing CO_2 from the atmosphere (e.g., by planting more trees; Chapter 10) or by capture and sequestration of anthropogenic CO_2 emissions (Chapter 7). Then, Equation (1-23) would become:

$$S_I = (P) \times (GDP/P) \times (E/GDP) \times (CO_2/E) - (CO_2)_{sq} \tag{1-24}$$

where $(CO_2)_{sq}$ is the amount of CO_2 sequestered. Another CO_2 mitigation approach would be to use some form of solar energy (e.g., tides, wind, photovoltaic electricity) to displace energy that was previously supplied from fossil fuels. This would reduce the

9 When used to quantify release rates of CO_2 to the atmosphere, Equation (1-23) is commonly referred to as the Kaya Equation, in recognition of Professor Yoichi Kaya.