Title of the Paper: Marketing Aspects for IMACS

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Abstract:

A series of papers was pre-printed explaining the prior published patent application for a first-principals-based sustainability measurement system. In addition to measuring environmental and human condition impacts, the Impact Measurement And Conservation System (IMACS) automatically applies conservation to participating products sold by participating retailers and purchased by participating consumers, such that all damaging impacts are neutralized and the consumer takes home a 100% sustainable product. Under default model conditions, global warming would be reversed in 40 years. Fresh water withdrawals would be limited to sustainable available amounts, restoring the fresh water flows through watersheds, using reverse osmosis systems to provide the balance of fresh water needed. Wildlife areas would be restored to the scientifically required area fractions for each ecoregion in the same 40-year period, but it would likely take 1 – 2 centuries for global biodiversity to stabilize around the new lower biodiversity level. Except for the actual implementation, all technical aspects needed for this global restoration system are already fully developed or sufficiently developed to start their use now (DACCS, remote sensing of impacts). The existing approach to protect biodiversity and reduce global warming relies entirely on government action, varies strongly per country and is largely ineffective; extinction rates are about 100 times higher than background extinction rates, while global warming will not be limited to 1.5 ºC, further increasing extinction rates. Implementation of IMACS would add a bottom-up approach by asking consumers to buy more sustainable products. The critical assumption made is that there is enough consumer demand to drive the growth of consumer participation in IMACS from 0% to 100% in 20 years. In this paper, I review the marketing aspects of selling more sustainable products and services. Under IMACS, the sustainability transition is in part driven by cost savings throughout the supply chain due to the use of roof PV solar, geothermal heat pumps, and electric transportation. These cost savings are much larger than the retailer's cost to provide conservation and the remaining savings can be split between consumers (lower prices) and retailers (higher profit margins). For non-participating retailers and non-participating consumers, the costs of utility provided energy are expected to increase due to the need for intermediate (days – weeks) and seasonal energy storage (H_2 electrolyzers, H_2 storage and H_2 fuel cells). This difference in costs of energy by itself will create an incentive for IMACS participation in addition to motivation based on environmental and human condition aspects. The conclusion is that there is already a large consumer demand for sustainable products globally. Consumers are even willing to pay higher prices for products that are more sustainable or that are made under acceptable or better human conditions. Since under IMACS participating consumers pay the same price as non-participating consumers, the percentage of consumers willing to participate would even be larger than when the more sustainable products were more expensive. The model assumptions of a 5% annual increase in consumer participation appears therefore conservative and a return to pre-industrial atmospheric conditions in 40 years appears feasible.

Keywords: Sustainability, Sustainable economy, biodiversity, protection, restoration, carbon neutrality, carbon negativity, Carbon capture engineering, Sustainability sciences, international protection of human rights

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Marketing Aspects for IMACS

1. Abstract

A series of papers was pre-printed explaining the prior published patent application for a first-principals-based sustainability measurement system. In addition to measuring environmental and human condition impacts, the Impact Measurement And Conservation System (IMACS) automatically applies conservation to participating products sold by participating retailers and purchased by participating consumers, such that all damaging impacts are neutralized and the consumer takes home a 100% sustainable product. Under default model conditions, global warming would be reversed in 40 years. Fresh water withdrawals would be limited to sustainable available amounts, restoring the fresh water flows through watersheds, using reverse osmosis systems to provide the balance of fresh water needed. Wildlife areas would be restored to the scientifically required area fractions for each ecoregion in the same 40-year period, but it would likely take 1 – 2 centuries for global biodiversity to stabilize around the new lower biodiversity level. Except for the actual implementation, all technical aspects needed for this global restoration system are already fully developed or sufficiently developed to start their use now (DACCS, remote sensing of impacts). The existing approach to protect biodiversity and reduce global warming relies entirely on government action, varies strongly per country and is largely ineffective; extinction rates are about 100 times higher than background extinction rates, while global warming will not be limited to 1.5 ºC, further increasing extinction rates. Implementation of IMACS would add a bottom-up approach by asking consumers to buy more sustainable products. The critical assumption made is that there is enough consumer demand to drive the growth of consumer participation in IMACS from 0% to 100% in 20 years. In this paper, I review the marketing aspects of selling more sustainable products and services. Under IMACS, the sustainability transition is in part driven by cost savings throughout the supply chain due to the use of roof PV solar, geothermal heat pumps, and electric transportation. These cost savings are much larger than the retailer's cost to provide conservation and the remaining savings can be split between consumers (lower prices) and retailers (higher profit margins). For non-participating retailers and non-participating consumers, the costs of utility provided energy are expected to increase due to the need for intermediate (days – weeks) and seasonal energy storage (H_2 electrolyzers, H_2 storage and H_2 fuel cells). This difference in costs of energy by itself will create an incentive for IMACS participation in addition to motivation based on environmental and human condition aspects. The conclusion is that there is already a large consumer demand for sustainable products globally. Consumers are even willing to pay higher prices for products that are more sustainable or that are made under acceptable or better human conditions. Since under IMACS participating consumers pay the same price as non-participating consumers, the percentage of consumers willing to participate would even be larger than when the more sustainable products were more expensive. The model assumptions of a 5% annual increase in consumer participation appears therefore conservative and a return to pre-industrial atmospheric conditions in 40 years appears feasible.

2. Introduction

Sustainability relates to all actions humans take, from decisions to purchase groceries and other goods and services, the selection of the place to live in, choice of transportation, where you work and how you do it. Due to the current eight billion and growing global population, wildlife habitats are shrinking resulting in large scale biodiversity losses and extinctions *(1,2).* Global warming causes increasingly larger problems; more extreme weather and storm damage, increased water stress at some and excessive rain and mud slides at other locations, causes sea level rise and permanent loss of land and further aggravates habitat loss and biodiversity losses. Climate change already causes increased migration to developed countries and causes increasing human suffering and deaths in both developing and developed countries and is expected to bring massive economic losses *(2).* These issues cannot be addressed effectively by treating the symptoms, but can only be solved by addressing the root causes. Consumers increasingly state that global warming and biodiversity loss are global crisis and would like to do something to solve these underlying causes. Many consumers want to improve future outcomes by buying more sustainable products and services *(3).* To meet these customer demands, producers and retailers want to offer their customers more

sustainable products and services, but that is more difficult that it seems. In 2023 the Impact Measurement and Conservation System (IMACS) patent application *(4)* was published. Prior to this patent application, spelling out how sustainability can be measured using first-principals-based methods, no systems existed allowing the measurement of sustainability on a scientific basis and in a globally uniform way. Prior to the patent application, sustainability was a vague "feel good" and "look good" concept. Producers have been printing the term "sustainable" on almost anything they sell, without defining what they mean with it and without credible indications that such "sustainable" conditions actually relate to the products and services sold. Even where producers try to source materials, parts and products from supply chain partners who attempt do act "more sustainable", only one or a few environmental impacts are followed, while the degree to which these products and services are "more sustainable" remains unclear to the consumer. The consumer typically has no insight into the damaging environmental impacts products collect along the supply chain. In order to become (more) sustainable, end-user consumers must be able to select (increasingly more) sustainable products and services *(5).* Existing methods that estimate environmental impacts like LCA (Life Cycle Analysis) or IOA (input-output analysis) do so only generically and for a general product ("how sustainable is peanut butter") but cannot determine which jars of peanut butter collect more or less environmental impacts along the supply chain until consumed *(6,7,8).* To address this, when LCA/IOA impact assessments are used, separate LCA/IOA impact assessments should be made for all products going to each different retail outlet for each separate delivery. LCA/IOA impact assessments costs a lot of time (2 – 5 person days) and are expensive. Doing this for all products and retail location combinations for each delivery is both impractical and unaffordable. In addition, LCA and IOA methods exclude all impacts added by employees and investors, together representing the bulk of all environmental impacts products and services collect. Even stronger, of all the moneys paid for products and services sold, nothing goes "into the ground or into the sea", it is all paid to people as income. Under IMACS, environmental impacts in excess of sustainable amounts are transferred with the labor or service provided and in turn to the products made and services delivered *(9,10,11).* Going far enough back into the supply chain, the consumption and work done by people thus represents 100% of all environmental impacts. Leaving environmental impacts collected by humans out of the picture thus grossly distorts the total of environmental impacts collected by products and services.

3. Relevance of Impacts Measurement and Conservation System (IMACS) for supply chain stakeholders

Sustainability: In order for products or services to be sustainable, the following conditions must be met:

- Damaging and conserving environmental and human condition impacts need to be measured or estimated for all events along the supply chain where such impacts are added *(9,10,11)*. Where damaging impact values are uncertain, a value close or equal to the upper value of the impact range for the product/service type must be used *(21).*
- Damaging environmental and human condition, expressed on a per dollar basis need to be below sustainable limits for all impact types/groups *(9,10,11)*. Where damaging impacts are above such limits, adequate conservation needs to be applied to neutralize each impact type *(1).*
- Conservation must be applied to restore historic damage done within the shortest possible timeframe *(17).* This must be applied on a per dollar spending basis for all impact groups.
- Product and service sustainability values need to be calculated based on the damaging and conserving impacts per dollar spending *(22).* A product or service is (100%) sustainable, when the net current impacts per dollar spending are zero and a reasonable fraction of the historic impacts (per dollar spending) are neutralized.

Methods meeting these four requirements would lead to a global sustainable future condition. Declaring a product or service sustainable without meeting these requirements would essentially correspond to "greenwashing".

Misconceptions: There is a general misconception that more sustainable products are (or need to be) more expensive. In case "good human conditions" are included under "sustainable conditions" (as is the case under IMACS), this could be the case to some extent when modern slavery and sweatshop conditions are eliminated and all workers are paid living wages. However, in the typical cases where this is relevant, the work is done in developing countries where labor costs are low anyhow. Even when workers are paid a living wage, the price increase due to the higher pay is typically not much; most of the price paid by the consumer for the product is a combination of shipping costs, labor costs in high wage countries and profits made. Payments by manufacturers to apply effective conservation hardly take place (if at all). If one of more otherwise comparable products is much more expensive, the product is in most cases less sustainable, due to the higher environmental impacts of the

additional income earned (the additional amount paid). In general, not doing environmental damage costs less than doing the damage followed by paying for its restoration. Products and services made sustainable from the start (and moving along the supply chain to the consumer through sustainable process steps), have thus typically lower costs and can be sold for a lower price.

Measuring impacts from all Sources: For products and services the IMAC system includes impacts from all sources, divided over three groups: location-based impacts (LBIs: impacts related to the location), supplier-based impacts and own-employee impacts. Under IMACS it does not matter where damaging impacts originate from; they all count. A manufacturer with zero CO_2 emissions from LBIs, own processes and suppliers, but 14 ton/y CO_2 emissions from each of its own 1000 employees has (in first pass) the same overall emissions as a manufacturer with 14,000 ton/y CO_2 emissions from LBIs, own processes and suppliers but zero CO_2 emissions from own employees.

Low costs of IMACS impact determinations: While LCA/IOM impact determinations are excessively costly at the scale needed, the IMAC system uses a statistical approach when inputs are not accurately known (which is initially in all cases and everywhere). The statistical approach leads to very low cost per impact estimation. Participating supply chain partners can choose to use different levels of accuracy for impact determination, where the cruder levels cost much less but lead to higher estimated impacts. A manufacturer, suppliers or store can decide to select accurate impact determinations for only a few of its most sold products, carry out a crude method for 1 - 5% of the next most sold products each year and determine no impacts for the 95% remaining products offered for sale. The default impact estimation method for this 95% of products would estimate the highest impacts but would costs nothing. Each year more estimates of better accuracy are made for the same estimation method, simply due to the increasingly larger databases of "better" estimates available. Where sellers deem this important, estimation methods of higher accuracy can be used to get the most accurate values. With increasing supply chain partner participation and after selection of participating suppliers, impacts are increasingly estimated with higher accuracy leading to on average lower impacts. With impacts of suppliers and employees now "known", new impact estimates are no longer needed and impacts for product and services produced can be calculated straightforwardly and automatically from existing data at insignificant costs.

Product participation leads to immediate lowering of impacts and calculated sustainability. First participation of products results in a strong reduction of (high) default impacts to mostly (much) lower estimated impacts and higher calculated sustainability. This happens due to the reduction of uncertainty prior to reducing any impacts.

Impact groups included: All currently relevant impact groups are included. 1. Biodiversity conservation, 2. Cultivated area use (all areas not protected for their biodiversity), 3. Climate change, 4. Fresh water use and conservation, 5. Soil and surface water acidification or pH change, 6. Soil & sediment use and conservation, 7. Coastal area use and conservation (protection from sea level rise), 8. Atmospheric ozone layer damage and conservation, 9. Infectious disease prevention and mitigation 10. Human reproduction, 11. Human conditions.

Scientific determination of impacts: Impacts would be determined using scientific based methods for all impact groups. The IMACs organization would create eleven scientific councils staffed with scientists; one council for each impact group. Each scientific council would represent a sampling of global experts in each field. While starting with crude formulas, over time the formulas and models used will become more accurate. The scientific councils would decide on the change of methods, formulas and setting used to calculate impacts and sustainabilities.

Accuracy of impact determination. Compared to IMACS impact determinations, LCAS and IOA impact determination are very flawed, since they attempt to address only "process" impacts and ignore the impact of most of the society (employee and investor impacts). In addition (unless applied at massive scales and very high costs), LCAS and IOA impact determination methods are incapable to determine the differential supply chain costs for each product or service, like the differences in impacts due to shipping to different store locations and the different impacts of the stores themselves and the changes over time. IMACS can do this all for the same low costs.

Measuring impacts of all types using one system: Currently a number of different organizations are used to provide sustainability information or certification of products and services, like Aquatic Stewardship council (ASC), Marine Stewardship Council (MSC), Sustainable Fisheries Partnership, FishChoice, Forst stewardship Council (FSC), Global organic textile standard (GOTS), Bluesign, Green Seal and others. In most cases these organizations do not provide the sustainability data as needed for supply chain calculations *(9,10,11).* However, these organizations each have experience within their fields and the IMACS organization would try to cooperate with them and develop scientific based standards or otherwise create new organizations providing the required data. Over time IMACS would provide all sustainability data needed, replacing all above mentioned and similar organizations.

Everybody is responsible for "self-created" impacts or impacts "added" with purchased made. Impacts can best be reduced or eliminated. Alternatively impacts can be neutralized by application of conservation. Impact prevention is always cheaper than neutralization through conservation. Prevention is also better, since here is no capacity limit to "doing less damage", while there will be a continuous shortage of conservation during most of the

"environmental restoration" period, allowing only a fraction of impacts of all products and services to be neutralized.

IMACS saves money for participating supply chain partners while selling increasingly more sustainable products. Occupants of all buildings would save money by installing roof solar and heat pumps compared to buying electricity and natural gas from utilities. These savings could be as high as 73 - 80% of the cost otherwise paid for utility electric and natural gas. Retailer A who generated all his electricity of the building's own roof, using only heat pumps for heating and cooling and using electric transportation, does not only have no CO_2 emitting from his store but also lower costs of energy and thus saves money, increasing profits. While selling a "jar of peanut butter" from the same production series, A's jar is more sustainable (with respect to GHG emissions) than the jar sold by competitor B (using natural gas, utility electric and using fossil fuel transportation). These savings of A are much larger than the cost of conservation paid for the supply chain impacts collected upstream of the retail store.

Applying conservation. Conservation is only applied to participating products purchased by participating consumers with a remaining positive conservation budget. Comparing all types of conservation, the costs of carbon sequestration are by far the largest. The focus in this paper is therefore on those costs. Under default model conditions, the participating consumer conservation budget rises between model years 2 and 13 from 0.94 – 28 $/y under the conservative C-sequestration cost scenario and from 0.64 – 14 $/y for the base cost scenario. The conservation costs are paid by the seller using an electronic (E)-voucher. For the first 10 years and under default model conditions (reversing global warming in 40 years) the costs of conservations are very low. Only in model year 11, the conservation costs as percentage of sales for the "average" seller rise to 0.1 – 0.24% for respectively the base and the conservative carbon sequestration costs scenario, but remain zero for sellers that are part of a "carbon neutral" supply train. By then, the savings resulting from the much lower cost of energy for carbon neutral sellers are large. Starting in model year 11, conservation costs start to rise due to the required sequestration of historic CO_2 emissions.

The **percentage of participating products** is calculated for each impacts group as the percentage for which all globally available conservation is applied with all participating sellers. This percentage is applied over the total of sales per retailer or seller and daily adjusted. Due to the low conservation capacity (even at more than 100% annual growth rates), this percentage remains very low through the first ten model years

Seller's choice of participating products. Sellers decide which products and services will be part of the participating group. To minimize E-voucher costs, sellers will likely choose products and services with the lowest impacts as participating products.

Forming sustainable supply chain segments. Participating retailers would reduce their impacts by buying from participating suppliers. IMACS participants are therefore likely to seek each other out and from participating supply chains sections. These sections will grow to an entire low impact layer of participating supply chain partners with lower cost and the remaining non-participating layer with high impacts and costs.

Prices paid by consumers. Under the participation agreement, sellers cannot sell products and services at a higher price to participants. Price discounts offered must be the same or larger for participants.

Daily updated impact and sustainability values. Using IMACS, the more sustainable retailer can show this lower environmental impact and higher sustainability value in the store using a hand-held scanner (or smart phone) and provide the customer the trail of environmental impacts throughout the supply chain. This allows producers with more sustainable practices to make the lower impacts of their products and services for sale numerically visible.

4. Consumer Demand for Sustainable Products

When consumers are asked whether sustainability is important to them, the overwhelming answer is *"YES" (15).* Harvard Business Review (HBR) studies have shown that customers are transitioning from considering sustainability as a "nice-to-have" to a baseline requirement for purchase. The study concludes that embracing sustainability drives consumer and employee trust, which in turn increases sales and business outcomes. Trusting employees are more motivated and have lower absenteeism, while consumers are more likely to buy a trusted brand over others. Highly trusted brands outperform other by up to 400% in terms of market value. Relatively small increases in the HBR TrustID score give relatively larger increases in expected stock returns. Effects of trust are increasingly more important among younger generations. Gen Z and Millennial customers believe that when a brand cares about its impacts on people and planet, they are 27% more likely to buy it compared to older generations. When Gen Z and Millennial customers rate a brand highly on humanity and transparency of its policies, they are

respectively 15 – 30% more likely to spend more money on their products over its competitors *(12).* Younger generations will soon have most of the purchasing power in the US.
According to Simon-Kucher & Partners, more than a third of global customers are willing to pay more for sustainability, indicating a growing demand for environmentally friendly alternatives. "*While attitudes vary across generations, countries, and industries, 85% of consumers have become 'greener' in their purchasing in recent years. Companies must act now to avoid obsolescence in the future" (13).* Bain & Company report that the percentage of customers that is willing to pay more for products with a positive environmental or health benefits in Europe, US and Asia Pacific is respectively 74, 71 and 90%, while half the European spending on sustainable insurgent brand is spent by millennials *(16).* Of particular importance is the fact that both for profit companies and consumers see themselves as the primary catalyst for change *(13).* This means that consumer demands for sustainability are likely to induce producers to change faster with respect to sustainability.
Over the past five years 85% of global consumers changed their purchases towards more sustainable alternatives. This is more strongly the case for younger consumers *(13)*. With some EU countries leading the way in the percentage of consumers making significant changes towards a more sustainable lifestyle (34 – 42%), the 22% for the US increases to 55% when including those who made at least some modest changes. Sustainability appears to be a significant purchase criterion (60% globally and 61% US). Attitudes towards sustainability vary per industry group between 44 – 74%. The importance of sustainability for both sellers and buyers is likely to increase. The willingness to pay more for sustainable products and services is high in the US (42%) with an average price premium of 37%. The availability of sustainable products is changing to become the expectation instead of the exception *(13).*
According to Deloitte, at least half of all customers in 23 countries purchased at least one "sustainable" good or service in April 2023. Demand for "green products" is no longer coming from niche segments but from mainstream consumers. Customers are willing to pay innovative brands that deliver on sustainability promises a price premium of 27% on average. Consumers look for distinct attributes they associate with sustainability like natural/renewable, recycled/repurposed, energy and resources used, packaging, production location, durability and environmental impact information, while green products also include aspects of social responsibility *(14).*

5. Retailers' Response to Sustainability Trends

Retailers adapting to sustainability trends
According to a recent McKinsey & NielsenIQ study, products making environmental, social and governance (ESG products) related claims have a 28% cumulative growth over the past 5-year period versus 20% for products not making such claims *(15).* Products with ESG claims represented 56% of all growth over the past 5-year period. Product making ESG claims thus sell better. However, many consumer-packaged-goods (CPG) executives report that it is challenging to create sufficient consumer demand for their ESG initiatives for these products The McKinsey & NielsenIQ study states: *"The potential costs—particularly in an inflationary context—of manufacturing and certifying products that make good on ESG-related claims are high" (15).* This statement is copied here to address its merits or the lack thereof. In general, and when done right, more sustainable products and services have lower costs, due to energy cost savings and environmental damage avoided *(2).* If after creating ESG claims the product costs are higher than for the closest alternative, than in most cases the ESG product is less sustainable. It could be that the certification process used is very expensive. In that case, (since all current labor creates damaging environmental impacts) the added certification steps made the product less sustainable. Alternatively, the ESG related claims embodied in terms such as "cage free," "vegan," "eco-friendly," and "biodegradable" printed on those products' packages may represent some degree of animal welfare, but typically poorly represent environmental and human condition impacts. This is especially the case compared to the globally uniform, all impact types included and more accurately measured impacts under IMACS. Compared to IMACS, ESG claimed products poorly represents sustainability. Using the IMACS systems would provide impact data for all impact types carried and allows traceability. While doing so at low costs, IMACS by itself represents the most comprehensive certification system. In addition, statements on the packaging would need to be simplified, since the same product would have higher or lower impacts (and thus sustainabilities) depending on the route it has taken to the customer (differences in shipping, storage, retailer and delivery).
Over half of executives surveyed in the packed goods industry believe that sustainability is a critical area for product innovation and 70% said their companies would make significant investments in sustainability innovation over the next year. Deloitte states that companies likely need to move quickly to prevent consumers to switch to buying from a growing crop of niche players who already made such changes *(14).*

Challenges and Strategies retailers face on the path to sustainability

Operating at the end of the supply chain, retailers feel limited in what they can do *(16).* Retailers have very little insight into the true environmental and social impacts of the products they sell and have to spend a lot of time (and costs) working with suppliers and consultants to even get a rough indication of such impacts. They often follow a product-by-product approach, which is inefficient leading to high costs. Product attributes that make it hard to reach ESG goals are *(16)*:

1. Products not entirely sustainable
2. Low availability
3. Time consuming to find sustainable products
4. Lack of sustainable alternatives
5. Lack of variety
6. Do not trust what the brand claims
7. Lack of information
8. High price.

All these attributes are improved to more desirable outcomes using IMACS:

1. Initially the global conservation capacity is very small and only a small (but growing) fraction of all products sold can be sold as fully sustainable. Listing a product as (100%) sustainable, while the conservation needed to claim this is not available, would be greenwashing.
2. Availability of "more sustainable" products grows with supply chain reduction of impacts (CO_2 emissions, no wildlife area losses) and the growing availability of conservation (neutralizing damaging impacts).
3. More sustainable products are easily found by both retailers and consumers by simply looking at the IMCS calculated impacts and sustainability. Since all IMACS impacts are listed on the "product data sheet", suppliers, retailers and consumers can select products with lower impacts. While not 100% sustainable, IMACS rated products sold by participating retailers will have lower estimated impacts compared to otherwise the same products sold by non-participating retailers.
4. Retailers can switch product participation between IMACS rated products and offer each day a different product from this selection as participating (100 % sustainable).
5. Due to switching between participating products, the variety of sustainable products will strongly increase.
6. Since all impact data are collected by independent (IMACS trained, licensed and bonded) impact rating organizations (IMOs) and all impact data are collected by the IMACS organization, sustainability related information no longer originates from the brand. However, a brand that does what it promises and shows consistently higher sustainability ratings for its products will gain more trust than it could ever do on its own.
7. All sustainability and human conditions information is immediately accessible by reading the quick reference CQR code on the product using a smart phone or a store scanner.
8. As per seller's participation IMACS agreement, prices of a participating product cannot be higher than for the same product sold earlier as a non-participating product, while participating and non-participating buyers pay the same price. Impacts calculations are highly automated allowing costs to be kept low. Initially there is so little conservation available that the fraction of products participating at any given time is very low, while fully utilizing the conservation industry's capacity (biodiversity protection CO_2 sequestration, fresh water generation and recycling). Retailers can save large amounts of money by installing roof solar and geothermal heating and cooling systems, using buildings with multiple floors, using less water, etc. Continuing the use of utility electric will not provide these savings. These costs savings are much larger than the costs of product rating and conservation *(2).* Products will on average have lower costs, increasing profits.

Note that under IMACS impacts are divided over eleven impact groups and will be introduced one-at-a time, while the remaining impacts will be kept at their "global average" values. The "global warming" and "biodiversity" group impacts will be introduced first.

A recent Brain & Company survey showed that the progress on sustainability goals made by 90% of the retail companies was less or much less than they had anticipated *(16).* Brain & Company state that retailers tend to be at an intermediate stage of ESG maturity. Looking at their ESG maturity stage figure (*(16) figure 1*), one would be made to believe that we are almost there. Nothing is farther from the truth. In order to become sustainable in climate change aspects, all supply chain actors have to become carbon neutral and remove a fraction of historic CO_2 emissions from the atmosphere for every dollar of sales made. This has to start with the retailer who is the customer interface with the overall supply chain. To become sustainable in biodiversity, for every m^2 of cultivated land used (agricultural, building lands, etc.) used, a section of wildlife area of the same size (default) within the same ecoregion needs to be protected for its biodiversity. I can go on listing such requirements for all eleven IMACS

impact groups. Since such IMACS sustainability criteria are not met for any product currently sold anywhere, the product sustainability would be zero for all CPGs. The criteria used to reach ESG maturity (*(16) figure 1*) are apparently too vague and too weak to be meaningful and the use of ESG labeling by itself reflects a form of "greenwashing". Retailers wonder why consumers say they want sustainable products, but do not buy ESG labeled products when offered for sale? The reason is likely two-fold; consumers correctly feel that the ESG labeling (reflecting environmental, social and governance aspects), is not reflecting the actions needed to label a product as sustainable, while consumers correctly doubt whether paying more for a ESG labeled product is worth the increase in sustainability (it almost never is!)

6. Comparing Costs and Savings of Sustainability with Marketing Costs

US retail companies pay about 15% of their revenues on marketing and advertising *(19).* Globally this would correspond to 7 – 11% of revenues *(20).* Due to automation of the data flow along the supply chain, the fully implemented costs of measuring impacts using IMACS are expected to be very low and much lower than the current non-automated product-by-product costs for supporting ESG claims. Cost paid for conservation applied are expected to be the largest for carbon sequestration (DACCS). Focusing on these costs and under the default IMSCS implementation scenario (a gradual transition from 0% to 100% consumer and supply chain participation in 20 years), the cost of DACCS payments along the supply chain are estimated at 0 – 0.2% of sales for model years 0 – 15, while running the global IMACS facilities at capacity. For model years 20 – 40, the costs will rise to 2 – 5% of sales for the base and conservative DACCS cost scenario, excluding the large subsidies currently available in the US *(17)* and much lower in the US including these subsidies. By that time, paying for environmental damage done will be the "*new normal*", and tax measures (tax refunds) are likely in place to eliminate such costs for restoration of historic damage done. For the society as a whole and limited to GHG emissions, the savings from operating carbon neutral (or negative) are estimated at 3.6% of US GDP *(2)* due to savings in the costs of energy alone. For the rest of the world such savings are likely larger due to the in most cases higher current costs of energy. Note that such savings only result from using building mounted PV solar and ground source heat pumps for heating and cooling, since the prices of wind and solar power provided by the utilities are likely to go up. Comparing the economic sectors (residential, commercial and industrial), the commercial sector representing most of the supply chain has the highest costs of energy use. The potential savings in the costs of energy are thus much larger in the economic sector than for the average society. Especially in the earlier year, when retailers and their supply chain partners will jockey for market share, the cost for conservation are low due to their limited supply, while the savings of using roof PV solar and GSHPs are large. Looking over the 40-year period for reaching pre-industrial atmospheric conditions, the total costs paid for DACCS are much smaller than the above-described energy savings made *(17).* Even when all energy savings were ignored, the current costs of marketing and advertising are much larger than the costs of DACCS in the peak year. The marketing benefits of being able to state: *"We will pay the costs of conservation to neutralize all damaging impacts of all participating products you buy from us"*, is probably the lowest cost type of advertising when expressed as dollar additional sales over IMACS and conservation costs paid.

7. Sustainability as a Competitive Advantage

As reviewed in the above sections, sustainability scores high on the list of consumer criteria to buy a product or not. IMACS is a first principals-based system of methods that is globally uniform and allows easy and low costs calculation of impacts and provides means of conservation to neutralize all impacts for an increasing percentage of products over time. At full implementation (100% participation) all impacts can be determined at high levels of accuracy and is highly automated. The calculation is as simple as adding all impacts made along the supply chain (using product and individual data sheets and location-based impacts) and applying two corrections (the individual sustainable absorption and the excess impact deduction) all calculated automatically for all participating products and individuals *(9, 10, 11).* The same calculation can be made for non-participating products and individuals. Initially a small percentage of sellers, products and individuals will participate and impacts will be computer estimated as the average for a product group plus three time the sample standard deviation *(21).* This is extremely low costs and is done as default for all non-rated products for both the participating and non-participating sellers. Consumers can use their phones to compare impacts of (say) a jar of peanut butter with the same label, but sold by participating and non-participating sellers. Due to the reduced uncertainty of impacts of participating sellers, their

products will almost always have much lower impacts and higher sustainability values compared to the otherwise same product sold by non-participating sellers. This is the case, even prior to any impact reducing changes made (carbon neutrality or sourcing of more sustainable products). Participating sellers thus have a strong competitive edge. In addition, once participating, retailers (and other supply chain actors) fully realize that they will have to pay the conservation costs for all impacts accrued. This includes the DACCS costs needed to neutralize their own CO_2 emissions. This in turn creates an incentive to install carbon neutrals systems, move to multi-floor buildings, use water saving and recycling systems and work with other local organizations (town, for-profits, non-profits) to build new or renovate existing buildings into carbon neutral residences for their employees. The latter provides a competitive edge for employee retention compared to retention based on wages increases only.

8. IMACS and Marketing Synergy

IMACS integration into retailers' marketing strategies.
IMACS can be easily integrated into retail marketing strategies. Retailers (and other supply chain partner) need to first apply with the IMACS organization per location for participation. A retail chain can thus start with one participating store. After application, an impact rating organization (IRO) of their choice will visit the location and enter location-based impacts (LBIs) into their account using dedicated software. This will include lot surface area and number of building floors used. Water use and missions from electricity use, and fossil fuel combustion will be set up for automatic data retrieval from the corresponding utilities. Other GH emissions will be determined locally. The corresponding impacts will be divided among all products sold on a per dollar sales basis. In addition, the retailer needs to select products for which the impacts need to be estimated. Since carbon sequestration represents the highest cost of conservation (restoration) it is most beneficial for retailers to selects products that are expected to have the lowest GHG impacts and are sold at the highest volume. Initially there is very little conservation capacity available and only for some of these products enough conservation can be applied to fully neutralized their impacts. The product participation percentage is set globally as a percentage of sales, such that the global conservation capacity is daily sold out *(1).* Initially, the impact reduction resulting from becoming carbon neutral (and other impact reductions) will be much larger and will have larger effects on product sustainability. After the impacts of this group are estimated, the retailer selects a sub-set of "participating products" (for which the neutralizing impacts will be paid by the retailer). Conservation is applied daily to the top listed product and any remaining budget is applied to #2, etc., until the retailer's daily conservation budget for each conservation parameter is exhausted. Since the available conservation is initially so small and the product volume sold is high, the conservation costs as percentage of sales is initially negligible. The retailer can market the participating products as "participating" and state in this daily adds (internet pages) *"We will pay the costs of conservation to neutralize all damaging impacts of all participating products you buy from us"*. If so desired, the retailer can continue the use of ESG claims on products, but by then the general public will be well informed that most ESG claims have little to do with the measurement of damaging impacts and the application of conservation. Alternatively, the retailer may completely drop all ESG claims, saving costs and use a fraction of the prevented spending on estimating impacts for a larger collection of products sold, reducing their estimated impacts. In all cases the retailer should move to turn his store carbon neutral using roof mounted PV solar and GSHPs. For small stores this can be done in a few days, for larger ones in a few weeks, with most inside work done during the night and outside work done during the day. In other stores (no roof PV solar options available) the retailer (chain) may decide to start participation using new multifunction buildings with adequate roof solar options. The retailer can then also claim in his advertisements that *"Our customers shop in a carbon neutral / negative store!".* Rather than designing "new" products with lower impacts, it is faster and more efficient (lower costs) to lower impact of existing product by switching to participating suppliers with a large fraction of IMACS rated products. This process is called "Sustainability by Selection" (SbS). Within the group of rated products available from suppliers, the retailer can select those with the lowest impacts in each product group. SbS will remove high impact products from the supply chain and can create a significant reduction of the retailer's average product impacts before making any process changes (production or transportation). SbS also puts pressure on all supply chain partners to reduce process impacts where they can. The retailer can now state in their adds: *"We select the most sustainable products from participating suppliers".* SbS also creates an initially thin, but growing lower cost supply chain layer of participating supply chain partners. Since this layer as increasingly converting to carbon neutrality using roof solar and GSHPs, this layer has lower costs (73 – 80% potential reduction in of costs of energy) *(2).* However, this layer has a limited supply capacity; late adaptors may not easily find a way in, creating an additional competitive advantage for early adopters.

The potential impact on brand perception and consumer loyalty
We need to consider two types of brands; the product brand and the retailer brand. The retailer brand is likely most important, since that is where the impact reduction will need to start by applying SbS and by installing carbon neutral systems (roof PV solar, GSHPs and electric transportation). Product brand sustainability perception is secondary. *"Only when the tide goes out do you discover who's been swimming naked."* (Warren Buffet). Brands selling supposedly "more sustainable products for higher prices than similar others are likely to find out that their product sustainability measured under the more accurate and inclusive IMACS is much lower than expected and likely lower than average. Brands without participating products are automatically rated at the highest impacts (due to uncertainty in estimated impacts). To prevent such shock effect, brands that currently score high on the ESG scale should be the first ones to start IMACS participation in order to weather the ESG to IMACS transition and minimize damage to consumer trust with respect to sustainability.

9. Discussion

Insights gathered from the studies mentioned

There is a large global consumer interest in buying sustainable products and services, even to the extent that consumers are willing to pay significantly more for sustainable products. However, the assumption that sustainable products need to cost more than their less sustainable comparators is false. Except for immediately neutralizing any damage done, it is almost impossible to "create" (more) sustainable products other than making incremental changes towards sustainability in the production and distribution processes. Once such process changes are in place (roof PV solar, GSHPs and electric transportation, less land use, multi-story building with south facings roofs, less fresh water use, less waste generation, adequate waste treatment, etc.) they apply to most or all products made, stored, shipped and sold in the facilities used. Trying to create a "new more sustainable product" without changing the process for all products made in the same facility is an effort in futility. Any such efforts also create additional damaging impacts. The average US citizen emitted 14.4 ton of CO_2 in 2022. For one employee working for a year on ESG aspects, these 14.4 tons of CO_2 need to be distributed over all existing or new ESG products sold. This applies to each supply chain partner working on SEG products and to the additional revenue stream resulting from more expensive products with "higher ESG sustainability"; each additional revenue dollar adds additional CO_2 emissions and other damaging impacts to the product sold *(9, 10, 11).* Even applying neutralizing amounts of conservation (as under IMACS) to otherwise non-sustainable products is a temporary solution; without changes towards sustainability in the production and distribution processes, application of conservation is alike "carrying water to the sea". The main functions of applying conservation to otherwise non-sustainable products under IMACS are to temporarily offset a fraction of the damage done while building up a sufficiently large conservation capacity to restore Earth in the long run (decades to centuries). This in particular applies to cultivated area use, GHG emissions, wildlife area protection and water use.

The potential for IMACS to influence market dynamics and consumer choices

When implemented, IMACS is expected to have an overwhelming influence on market dynamics and consumer choices. While initially limited to the most important damaging impacts (greenhouse gas emissions and biodiversity loss) and for a small fraction of products services, consumers will for the first time have a measurement system that can accurately calculate damaging impacts, calculate required conservation impacts for 100% sustainability and automatically apply the required conservation. This will initially apply to a small fraction and over time to an increasing fraction of products and services and to an increasing number of impact groups. More sustainable products are lower in costs when the transition to carbon neutrality is carried out in the most cost-efficient way. These cost savings can be split between seller and buyer. More sustainable products can thus be sold at both higher profit margins and at lower prices. This allows a growth in market share for participating sellers (retailer and other supply chain partners). Under IMACS, participant sellers cannot let participant buyers pay the cost of damage done along their own supply chain. They cannot increase prices of products when they become "participating" and cannot charge participant buyers more than non-participant buyers, however they can offer discounts for participant consumers buying participant products. These discounts could be similar to current discounts offered to "loyalty customers". Using IMACS, consumers can more easily (online) check prices, impacts and sustainabilities for otherwise comparable products and services, where typically the more sustainable products also have lower prices.

This in turn allows consumers to order the best combination of lowest price and highest sustainability for products from different stores using automated ordering systems making these optimized selections.
With employees consuming products with average (but currently unsustainably high) impacts, the unsustainable excess with be reflected in their labor output and be transferred to the employer products. Employee participation will lower the impact uncertainty of each employee and lower their labor impacts. Employers should therefore use incentives for employees to participate. Since built to be sustainable, such residences are cheaper to live in. Sustainable housing could be part of those employee incentives. Retailers and other supply chain partners need to cooperate with town boards and other organizations to build sustainable residences for their employees. Employees with lower-than-average impacts per dollar income spent, should be offered financial incentives, since these employees reduce retailer's costs otherwise made to buy conservation. Individual participation also affects individuals' career, since employers rather hire and promote sustainable employees due to their lower excess labor impacts. While the costs of impact and sustainability calculations under IMACS appear to be low due to the high level of automation, pilot studies would be needed to estimate how low they really are. This would require the development of the various software modules used to estimate impacts, to calculate the supply chain step outputs and to calculate the resulting sustainabilities. This cannot be done without significant funding.

10. Conclusion

General
There is a large consumer demand for sustainable products. Currently no sustainable products are offered on markets anywhere. The assumption that sustainable products need to cost more than their less sustainable comparators is false. More sustainable products can only be offered by making incremental changes towards sustainable manufacturing and distribution processes. The most sustainable process choices also result in the lowest costs. Less sustainable process choices result in higher than current costs. Sustainable products can thus be offered to consumers at lower costs while increasing profit margins. More sustainable products and services can best be offered through incremental reduction of damaging impacts. Such improvements reduce impacts for all products made in the same facility. Attempts to produce more sustainable products on a per item bases is in most cases and illusion. Unless all current damaging impacts are measured/estimated and fully neutralized and a reasonable fraction of historic impacts are restored, products are not sustainable. Making ESG statements without meeting these conditions corresponds in most cases to "greenwashing".

Capability
Current systems intended to reflect sustainability of products and services do not have the capability to accurately measure all impacts of products produced and even less to add impacts accrued along the supply chain to the consumer. In addition, current systems cannot calculate the types and amounts of conservation to be applied and apply these automatically as needed to render the products impact free. ESG product labeling is applied on a product-by-product scale, does not allow mathematical manipulation along the supply chain and cannot easily be automated, resulting in reported higher costs for more sustainable ESG labeled products. In contrast, the IMACS calculation is as simple as adding all impacts made along the supply chain and applying two corrections (the individual sustainable absorption and the excess impact deduction) all calculated automatically for all participating products and individuals *(9, 10, 11)* and for all steps along the supply chain. IMACS is thus capable to differentiate the impacts for two jars of the same series of (say) peanut butter sold at different stores at different dates.

Impact Reduction
Prior to participation of any products or services, damaging impacts of any products or services will be estimated as the average + 3 standard deviations for their product or service group. Starting with high average impacts and a large variability per product or service group, this leads to high impacts for non-participating products and services. These impacts can be strongly reduced by participation. Retailer/seller participation in IMACS allows impact determination using various levels of crudeness/accuracy, where the cruder methods result in higher impacts but lower estimation costs and vice versa. Producers and other supply chain partners can further reduce damaging impacts by making incremental changes towards more sustainable manufacturing and distribution processes. Buyers/consumers can select products and services with lower impacts to become more sustainable. This sustainability-by-selection process (SbS), is the primary driver for sustainability improvements.

Applying Conservation
Products and services only become sustainable after all damaging impacts are neutralized by the application of conservation. Every-one "owns" the damaging impacts created. The cost of conservation, while purchased in name of the consumer, therefore is paid by the retailer using an electronic E-voucher. All other participating supply chain partner forward E-voucher to their customers ultimately reaching the consumer. For a fully participating supply chain, all partners thus only pay for the impacts they caused themselves or were assigned (historic damage assigned on a per dollar price basis).

Costs & Capacity
Due to its globally standardized calculation methods used for all impacts types, the automation used, the costs of managing the IMACS system and calculating the impacts and sustainabilities of products and services is very low compared to the actual costs of conservation to be paid. The capacity of supplying conservation is currently limited and will remain so during most of the global restoration period. The current commercial capacity for DACCS is essentially zero. The same applies for the capacity of providing wildlife area protection and restoration and all other types of conservation needed. Wildlife areas need to be managed for their biodiversity and management organizations need to be first certified and bonded before "Title-To-Conservation" (TTC) certificates can be sold. The Environmental Conservation Organizations (ECO) who buy TTC certificates in bulk, distribute the TTC to retailers in all fractional amounts as needed. The limited supply of conservation divided over the global consumer spending leads to initially very small costs for retailers. Cost paid for conservation applied are expected to be the largest for carbon sequestration (DACCS). Focusing on these costs and under the default IMACS implementation scenario (a gradual transition from 0% to 100% consumer and supply chain participation in 20 years), the cost of DACCS payments along the supply chain are estimated at 0 – 0.2% of sales for model years 0 – 15, while annually roughly doubling the global DACCS capacity and running them at capacity. After 15 years, paying for your own environmental damage done will be the "*new normal*", and tax measures (tax refunds) are likely in place to eliminate such costs for restoration of historic damage done. For the society as a whole and limited to GHG emissions, the societal savings from operating carbon neutral (or negative) are estimated at 3.6% of US GDP *(2)* due to savings in the costs of energy alone. For the rest of the world such savings are likely larger due to the in most cases higher current costs of energy. Societal savings from maintaining ecological services are estimated to be much larger (almost 200% of global GDP). The savings made by retailers and the rest of the supply chain are much larger than the cost of conservation paid.

Market Dynamics
When implemented, IMACS is expected to quickly overtake all other systems attempting to express sustainability related information for products and services. In addition to having a better marketing position with respect to sustainability, early IMACS adopters have lower costs at an earlier date and better access to the participating and more sustainable supply chain layer. In addition to forming the organization and developing the required software, the main task would be to market the IMACS system. Based on the globally high consumer interest for sustainable products, even when sold at higher costs, it should not be difficult to attract a large percentage of the global population as IMACS participants, especially when the costs for participating products are the same or lower compared to otherwise comparable non-participating products. A growing consumer participation in IMACS will in turn attract more retailers and later all supply chain stakeholders to participate. Currently 71 - 90% customers in Europe, US and Asia Pacific is willing to pay more for products with positive environmental or health benefits. The percentage of consumers willing to preferentially buy more sustainable products for the same price should be even larger. In that light, the model assumptions of an average annual increase of 5% of participating consumers (100% in 20 years) appears to be conservative. Using an average 5% per year increase in consumer and product participation, (and otherwise default model conditions) Earth would return to pre-industrial atmospheric conditions in 40 years and return to the best approximation of its pre-industrial biodiversity in 1 - 2 centuries *(17).*

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