

The Western Lifestyle and Its Long Way to Sustainability

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S Supporting Information

ABSTRACT: Since Fukushima, few people still consider nuclear power as a safe technology. The explosion of Deepwater Horizon was yet another incident revealing the dangers involved in the hunt for fossil fuels. Despite the public attention and outrage at these events, neither the concept of environmental citizenship, nor the United Nations Framework Convention on Climate Change has prevailed in the struggle against environmental degradation. Economic growth offsets efficiency gains, while strategies for energy sufficiency are usually not seriously considered. Action toward a more sustainable society, for example, a 2000 W- and 1 ton CO₂-society, must be taken by individuals but further incentives must be set. In order to provide individuals with detailed information about their mitigation options, we took the results from a survey of environmental behavior of 3369 Swiss Citizens, and combined them with life cycle assessment. Our results from this bottom-up approach show a huge bandwidth of the ecological footprints among the individuals interviewed. We conclude that a continuous consumption of not more than 2000 W per person seems possible for the major part of the population in this society. However, it will be far more difficult not to exceed 1 ton CO₂ per capita.



INTRODUCTION

The 2000 W Society. The global average primary energy consumption is 17 500 kWh primary energy per person per year.¹ This corresponds to a continuous requirement of 2000 W. A typical person in the Western World continuously uses 5000–12 000 W. On average, people in some Asian and African countries only need fractions of that. In the 1990s, collaborators at ETH described the vision of a 2000 W society, in which each person in the developed world would cut the overall power demand to an average of no more than 2000 W and emit no more than 1 ton of CO₂ per year without lowering the living standard. This would permit a redistribution of resources in favor of less developed countries without accepting an overall increase of the total world resource consumption. As a consequence, a balance between industrialized and developing countries would be achieved and thus all people could enjoy a good standard of living.¹ The idea of a 2000 W society is very close to a widely accepted description of sustainability:^{2a} “...meet the needs of a much larger but stabilizing human population, ... sustain the life support systems of the planet, and ... substantially reduce hunger and poverty”.

There may be as many definitions and theoretical concepts of sustainability as there are groups trying to define it. However, according to the United States Environmental Protection Agency sustainability is based on a simple principle: “Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that

permit fulfilling the social, economic and other requirements of present and future generations.”^{3a}

Adaptation to a 2000 W society might not be in perfect accordance with many definitions of sustainability, but it could serve as an important and pragmatic step toward a sustainable lifestyle. The city of Basel has accepted this idea and serves as a pilot region.⁴ The citizens of Zürich decided in a popular vote 2008 to aim at realizing the 2000 W society.⁵ Other regions in Switzerland⁶ and Germany^{7,8} have also started to follow suit.

However, even though books like “The limits to growth”⁹ have sold millions of copies, and awareness of the potential environmental damage of our lifestyle in the developed countries is at an all-time high, we have not seen a lessening of environmental burdens per capita. Hope for an economic solution to environmental problems grew when Grossman & Krueger¹⁰ empirically investigated a relationship between environmental pressure and per capita income. The idea discloses that with increasing economic development, environmental conditions deteriorate at first but then improve. The curve is an adaptation of S. Kuznets’s hypothesis¹¹ that income inequality increases, but then falls, with development, resembling an inverted U on a graph. Many Kuznets curves have been found for environmental concerns,^{12–15} but there are as many skeptics of this concept as there are supporters. In one

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review, Gallagher¹⁶ provides turning points for CO₂ emissions. Turning points describe points where CO₂ emissions start to decrease with increasing gross domestic product or income per capita. The range provides values at the lower end of 10 000 \$¹⁷ (GHG: 6.5 t CO₂ per capita) and 75 000 \$ per year at the upper end¹⁸ (GHG not provided). However, there are serious doubts whether all environmental problems will be resolved automatically with economic growth.^{19–24} Another notion is that people have to be educated and governed in order to develop a more sustainable lifestyle based on sufficiency.²⁵

Snapshot of the Current Resource Consumption. How should it be possible to reduce energy consumption by two-thirds without suffering a loss in living standards? Are there single individuals complying with the goals of a 2000 W society whose standard of living could serve as a model? The first step to answer this question is to take a snapshot of the current resource consumption. Many studies have modeled the energy consumption of a society from the top-down, for example, determining carbon footprints by breaking down national energy statistics and splitting them into energy consuming sectors such as household, industry, traffic, or services.^{26–29} Such studies provide interesting insight on the potential to reduce the environmental impact on a global or national scale. However, the concept of a sustainable society is based on the needs of individuals and therefore, environmental burdens of industrial sectors have to be assessed with regard to the contribution of the products of this sector to fulfill important needs of individuals.

Other researchers^{30,31} profiled different lifestyles to characterize the range of environmental burdens related to them. But these studies fail to link the lifestyle to the number of individuals living it and so it is not possible to estimate the improvement potential of the society.

The third type of study models from the bottom-up with the help of a comprehensive survey of environmental behavior.^{32–34} These studies provide insight into the behavior of individuals with regard to all kinds of activities, for example, mobility behavior, housing conditions, etc., but they do not assess the life cycle related environmental burdens associated with the behavior. Kenny and Gray³³ used a survey in order to determine household carbon dioxide emissions in Ireland. The survey technique was not controlled and the sample comprises 109 households. The low sample number and the uncontrolled survey conditions do not allow generalizing of the results. Weber and Matthews³⁴ used a consumer expenditure survey to assess the carbon footprint of American households. The results refer to household, not to individuals. In addition, with reference to Hertwich²⁶ the U.S. are at the upper end of the per capita carbon dioxide production and consequently do not well represent a typical Western lifestyle.

The third IPCC report denotes lifestyle as a “set of basic attitudes, values, and patterns of behavior that are common to a social group, including patterns of consumption or anti-consumption”.³⁵ Thus, an analysis of the results from Hertwich²⁶ showing that the Western countries emit 16.6 t CO₂-equivalents per capita and year while Switzerland emits 18.4 t CO₂-equivalents per capita and year concludes that Switzerland quite well represents a Western lifestyle. The Western countries are defined as countries of Western Europe³⁶ and the U.S., Canada, and Australia (details in the Supporting Information (SI) Table S2). With the present study we combine the answers of a survey about environmental behavior among 3369 Swiss inhabitants³⁷ with a life cycle

assessment (LCA) to provide important information about resource consumption and the environmental impact of existing Western lifestyles. The information helps individuals interested in following a more sustainable lifestyle to find the crucial fields of activity. Further, we provide information about the mean values for consumption per activity field that can be tolerated being still in accordance with a 2000 W society. The environmental impacts are expressed as green house gas (GHG) emissions and cumulative energy demand (CED) in order to benchmark the current society at the demands of the 2000 W society. In addition, we assessed the environmental impact with Ecoindicator 99 (EI99) in order to provide a broader view for sustainable development (e.g., mineral consumption, air pollution, water, and soil quality).

■ MATERIALS AND METHODS

Environmental Survey. The empirical analyses are based on data referring to 2007 gathered in a nationwide, general population study, the Swiss Environment Survey 2007.³⁷ Data collection is based on a two-stage random sample taken from members of the adult population of Switzerland with a telephone registered in the telephone directory. The chosen households were written to before the survey was carried out and asked for their cooperation. The study was described as an investigation into “living conditions in Switzerland” and not as an “environmental study” in order to avoid a disproportionate number of people with an above-average interest in the environment taking part. The chosen households were then contacted by telephone. The individual surveyed in each household was chosen at random from all members of the household over 18 and interviewed in German, French, or Italian. Foreigners who belonged to the resident population were included as long as they could answer questions in one of the three languages. The response rate was 52% (RR2 according to standards laid down by the American Association for Public Opinion Research, AAPOR). The telephone interview, with an average length of 37 min, was followed by a written follow-up questionnaire. A total of 83% (2798 individuals) of those interviewed by telephone (3369 individuals) also took part in the written, postal questionnaire. The questions from the environmental survey covered the following topics: housing situation, mobility behavior, eating habits, and recycling of nondurable consumer goods.

Life Cycle Assessment (LCA). The LCA is an established method designed for assessing the potential environmental impacts caused by products, processes, or activities. It is used to quantify and evaluate the energy and material flows caused throughout a product's life cycle from raw material acquisition through production, use, end of life treatment, recycling and final disposal (cradle-to-grave) and the associated wastes and emissions released to the environment.³⁸

Life Cycle Inventory (LCI) Modeling. The foreground system of our LCI is derived by 26 models (see SI Figures S1–S26) which translate the answers from the environmental survey into units applicable for LCA. The models cover the most important topics in order to characterize the Western lifestyle: housing, mobility, food, and consumption of nondurable consumer goods including recycling.

The answers from the written questionnaire were assumed to be more precise than the answers from the telephone interview as the people could take as much time as necessary to fill in the written questionnaire. Hence, the answers from the written

questionnaire were taken precedence over the questions from the telephone interview.

LCI data for materials and processes in the background system are taken from the ecoinvent database version 2.2.³⁹

The mobility related questions from the survey were translated in transport distances which were used in LCI. For public transportation (train, bus, tramway) the questionnaire provided information to the time spent in a specific means of transport from which the distance was calculated using average speed. For personal mobility (own and hired car, motorbike) the survey provided data about the distance driven, mean fuel consumption, and the type of fuel. In addition we accounted for the number of passengers in a car and for infrastructure and maintenance of the car and the road. We assumed a mean flight distance of 1000 km (one way) for short haul flights, while the distance of long haul flights was calculated using spherical trigonometry to calculate the length of the orthodrome and adding 10% for ascent, descent, and deviation to the orthodrome.

We calculated heat energy consumption for housing using the following parameters: standard heat energy consumption per m² for low energy buildings (Minergie), living area, number of people per flat, heat energy carrier, cost of heat energy carrier or (owner-occupied) additional property expense or rental price (rented flat), kind of house (detached, semidetached, etc.), year of construction, renovation (new insulated and windows replaced after construction). Beside the use of the house we accounted for building infrastructure and electricity consumption (washer, dryer, cooking, electronics, etc.).

The surveyed individual indicated the number of meals with meat per week. Their calorie uptake is calculated depending on age and gender and used to calculate the consumption of 12 different food products (bread, meat, fish, fruits and vegetables, etc.). The standard food product consumption was modified for a vegetarian meal and meal with meat and linked to LCI data for the food production.

The benefit of recycling is accounted for using an “avoided burden” model. This approach calculates the difference between the environmental burdens of the recycling process and those of the disposal and standard production of the corresponding good. Thus, a negative value means that recycling makes sense from an environmental point of view.

Life Cycle Impact Assessment. The GHG emissions are assessed by the characterization of different gaseous emissions according to their global warming potential and the aggregation of those emissions in the impact category climate change. Characterization values for greenhouse gas emissions are based on global warming potentials published by the IPCC⁴⁰ and a time horizon of 100 year is used in this study. The CED⁴¹ is widely used as a screening indicator for environmental impacts. CED aims to investigate the primary energy use and includes the direct as well as the indirect or gray consumption of energy due to the use of, for example, construction materials or raw materials. In this work the CED includes all renewable and all nonrenewable resources. CED measures energy expressed as Joule. Energy per time can be expressed as continuous power and the corresponding unit is Watt. The EI99⁴² offers a way to measure various environmental impacts, and weights the final result to a single score. Damage to human health includes models to assess climate change, ozone layer depletion, ionizing radiation, respiratory, and carcinogenic effects. Ecosystem quality accounts for land use change, eutrophication, acid-

ification, and ecotoxicity. Damages to resources account for the depletion of minerals and fossil fuels.

Evaluation. For the testing of the environmental impact versus net income (the environmental Kuznets curve) we summarized the results from the individuals in 8 income categories at intervals of 25 000 CHF. Income categories over 200 000 CHF were not analyzed due to the small sample size ($n < 4$ for income categories at intervals of 25 000 CHF). Thus, the 18 highest incomes between 210 000 CHF and 1 400 000 CHF are excluded in the discussion of the relation between environmental impacts and income.

For the purpose of characterizing an energy sufficient lifestyle we compiled a subpopulation ($n = 107$) containing those individuals that consume between 1800 and 2200 W. For this subpopulation we summarized the most influencing parameters and their environmental impacts. Out of this subpopulation we created a subgroup ($n = 69$) with an annual income equal to the annual income of the total study population.

RESULTS AND DISCUSSION

Energy Demand and Carbon Intensity. We found a huge bandwidth of the annual CED per capita, ranging from about 1400 W to about 20 000 W with a mean of 4200 W within the surveyed sample (Figure 1). The same picture

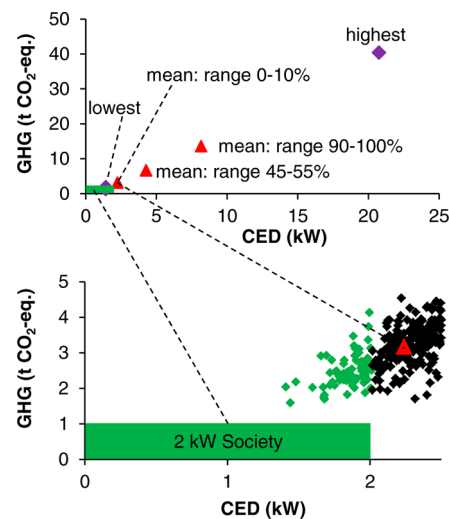


Figure 1. Energy consumption (CED) versus greenhouse gas emissions (GHG). The green box refers to the limitations of a 2000 W society. The means indicated for the three ranges (red) are calculated from 337 values representing a 10% quantile of the CED. Purple: highest and lowest individual value; black: individual values exceeding 2000 W; green: individual values meeting 2000 W ($n = 64$).

emerges for the GHG emissions. Not even the mean value for the 10% of the individuals with the lowest CED lies within the limit of 2000 W and the mean CED values of the range from the 45–55% and the 90–100% quantile are far above the values defined by the 2000 W society.

According to the model calculation no single individual in the survey fulfills the requirements of a 2000 W society. There are indeed 64 (2%) individuals with yearly energy consumption lower than 2000 W, but none of them reaches the 1 ton CO₂ per year goal. Switzerland is still far away from the idealized 2000 W society.

An energy supply of 2000 W completely based on fossil fuel emits roughly 4.7 tons CO₂ per year. To reduce this to 1 ton

CO₂ per year, low carbon energy sources need to provide about 80% of the total energy consumed. Since several nations recently decided to shut down their nuclear power plants, this means that 80% would have to come from renewable sources. Thus, regardless of the energy consumption, the share of renewables has to be tremendously increased in order to keep the GHG levels low. This is already challenging for electricity which amounts to about 25%⁴³ of the total energy demand in Switzerland but even more so for the rest of the energy, mainly used as heat and in transportation.

Environmental Burden of Main Activities. A closer look at the contributions of different activities (Figure 2) reveal that mobility behavior and the housing situation play the dominant roles regarding the environmental impact of individuals.

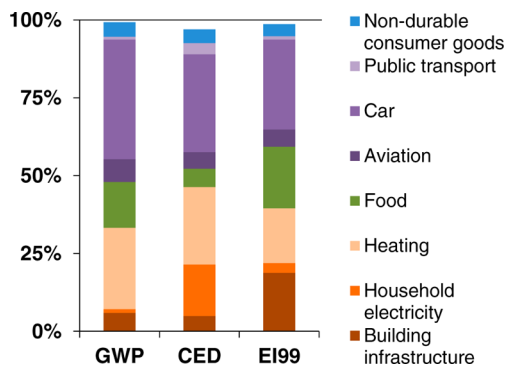


Figure 2. Environmental burdens broken down into the activities housing (represented by Building infrastructure, Household electricity, Heating), food, mobility (represented by Aviation, Car, Public transport) and consumption of nondurable consumer goods (CG) including recycling for all three impact assessment methods (GHG: greenhouse gas emissions; CED: cumulative energy demand; EI99: Ecoindicator 99). The gap to 100% represents benefits from recycling.

The housing situation is dominated by heating. Electricity consumption in the household (washer, dryer, oven, etc.) has a remarkable share of CED, but not of GHG emissions and EI99. This is due to the fact that the electricity supply mix in Switzerland consists predominantly of hydro power (34%) and nuclear power (57%).⁴⁴ Both technologies do not significantly contribute either to the GHG or to the EI99.

Construction materials (concrete, bricks, insulation, glass, steel, wood, etc.) contribute 20% to the EI99 results of the housing situation but are negligible for its CED and GHG. The main contribution to the high EI99 impact of infrastructure stems from sulfidic tailings from copper used for cables etc.

We found no difference throughout the impact assessment methods in the pattern for mobility behavior. Passenger car transport made up the biggest part of this category. A minor share accounted for aviation while public transportation almost disappeared.

The share of food is not insignificant, at least when looking at GHG and EI99. This would still be the case if the energy use for cooking would be accounted for in the food category instead of in household electricity use. Food accounts for a significantly higher score with regard to the GHG and the EI99 compared to CED. The reasons for the higher GHG are dinitrogen monoxide and methane emissions in agriculture, which highly contribute to climate change without demanding primary energy. Land use in agriculture processes is one of the

main contributing factors to EI99 and explains the difference to the CED.

Consumption of the most common nondurable consumer goods in a household (PET, paper, glass, biological waste, aluminum, tin plate) contributes between 5% (GHG and EI99) and 7% (CED) of the total environmental impacts. The average recycling rate of these products is almost 90%. The benefits achieved with recycling sums up to almost 1% (GHG) to 3% (CED). This is indicated in Figure 2 with the small gaps between the bars for nondurable consumer goods (CG) and the 100% line. If the recycling rate were increased to 100%, this gap (environmental benefits) would increase no more than 0.2% (CED). Otherwise, if 0% of waste were recycled, the gap would close. Therefore, with regard to the selected impact assessment methods the potential for a reduction of the environmental burden by increasing recycling rates is very limited even though recycling decreases the environmental burden by 14% (GHG) to 40% (CED) within the category of nondurable consumer goods.

Uncertainties. The comparison of studies investigating ecological footprint of nations households/individuals require careful attention on many different influencing issues. The selection of data (national statistics or individual data), the modeling approach (bottom up versus top down), the selection of the impact assessment, the unit assessed (nation, household, individual), the reference in terms of energy use (end energy or primary energy), the sample size of analyzed data and many more variables bias the outcome of a study.

We identified two major issues to be crucial for the interpretation of our results: the modeling approach and the system boundaries. Our bottom up modeling approach leads to quite reliable results on the level of individuals since all data refer to real values derived from the environmental survey. Studies that break down national statistic values to the level of individuals are much less reliable at the individual level and do not represent the bandwidth of possible results (e.g., 1400 W up to 20 000 W) but only present a mean value.

The second type of uncertainty accrues through the system boundary. We reported an energy demand (4200 W) considerably lower than the 4700 W per citizen reported by the Swiss federal offices of energy⁴⁵ and statistics.⁴³ Deducting the energy demand used in industry and services (36% of total energy consumption according to Swiss Federal Office of Energy⁴⁵) from the top down approach (4700 W) results in approximately 3000 W or 70% of the bottom up value. The difference of 1200 W (30%) can be explained by the fact that the LCA approach considers gray energy imports, which are not accounted for in the official data. For example, both approaches include the fuel consumption in the use phase of a car. But the energy use for the production of the car is not accounted for in the top-down approach applied in the official statistics since no cars are produced in Switzerland, while it is considered in the bottom-up approach, which has no geographical system boundary.

The Environmental Kuznets Curve. We analyzed whether our data suggested the existence of an environmental Kuznets curve for the sample of individuals surveyed and where the turning point could be found. In Figure 3 mean net income in intervals of 25 000 CHF is plotted versus the yearly GHG emissions, CED and EI99 score.

We found a strong linear relationship between net income class and GHG emissions, CED and EI99 up to an annual net income of 200 000 CHF and a corresponding annual GHG of

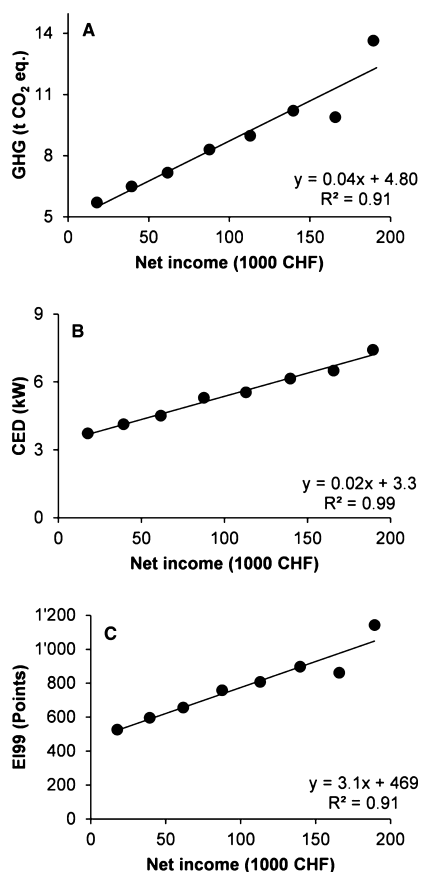


Figure 3. Average net income over intervals of 25 000 CHF versus (A) Greenhouse gas emissions (GHG, in ton CO₂ eq/year), (B) Cumulative energy demand (CED, in kW), (C) Ecoindicator 99 (EI99, in points).

almost 14 t CO₂ per year and capita. If there were indeed a turning point based on the relationship between CO₂ emissions and income, the point would be on such a high level (annual net income >200 000 CHF and CO₂ emissions >14 t) that the climate change impacts could not be accepted anymore. With

regard to global warming we do not believe that “...the strong correlation between incomes and the extent to which environmental protection measures are adopted demonstrates that, in the longer run, the surest way to improve your environment is to become rich” as Beckerman suggested.⁴⁶ Facing the actual environmental problems with such an attitude is dangerous as it justifies laissez-faire attitudes toward pollution and resource consumption. Our results, at least, do not support that economic growth will solve global warming problems. Other ways to mitigate climate change must be found. A viable and broadly supported strategy could be the way to adapt to an energy sufficient society.

An Energy Sufficient Society. We summarized the most influencing parameters and their environmental impacts for a subpopulation (*n* = 107) characterized by an energy sufficient lifestyle.

The subpopulation stands out due to very low requirements on mobility, in particular aviation and driving a car. Moreover, the low heated area and the low heat energy demand per m², even though far above the threshold of a certified low energy house, lead to rather small energy consumption for space heating and warm water. Interestingly enough, 8% (16 out of 213) of the persons living in a low energy building achieve energy intensity smaller than 2000 W. This is a 4 times higher fraction of people compared to the fraction from the entire sample (2% or 64 out of 3,369).

The question arising now is whether the subgroup belongs to the low-income part of the surveyed people and the reduced demand of energy consumption is rather a result of a weaker spending capacity than an altered — intended or unmeant — environmental behavior. The mean income of all surveyed persons amounts up to 45 400 CHF. The income of the subpopulation is indeed lower (34 600 CHF, see Table 1). Figure 4 shows the net income of the subgroup (*n* = 69, income = 45 400 CHF) versus the GHG-emissions, energy consumption and EI99. This result is in a strong contrast to the results achieved for all surveyed people. The subgroup encompasses incomes from 20 000 CHF to 80 000 CHF at rather constant environmental burdens. At least the number of individuals at the upper end of the range implies that the low

Table 1. Key Parameters for a Lifestyle in Compliance with a 2000 W Society^a

	mean	%	CED		GHG		EI99	
			kW	%	tCO ₂ -eq	%	points	%
meals/week with meat (number)	2.79	85.3	0.246	96.1	0.904	91.3	111	90.3
driving the car (km/year)	1690	17.6	0.235	17.1	0.444	17.2	30.7	17.1
flights/year (number)	0.178	19.2	0.020	8.32	0.042	8.36	2.88	8.36
public transportation (minutes/week)	172	47.1	0.083	52.3	0.039	61.7	3.84	57.3
household electricity (kWh/year)	6000	94.4	0.685	94.4	0.074	94.4	18.4	94.4
heat energy (kWh/year)	2880	41.6	0.430	39.3	0.743	42.1	46.1	42.0
heated area (m ²)	34.7	57.5						
heat energy demand per m ² (kWh/(m ² *year))	83	69.7						
Subpopulation Sample Characteristics								
male	31 (of 1472)	2.17						
female	76 (of 1897)	2.90						
age	49.4	95.5						
net income	34 600	76.3						

^aMean values of key parameters for a lifestyle in compliance with a 2000 W society. Percentage values refer to the ratio “mean of the subpopulation (*n* = 107) / “mean of the entire population (*n* = 3369)”. The subpopulation (*n* = 107) is characterized with a constant energy demand of 1800–2200 W. Environmental impacts are expressed as cumulative energy demand (CED), greenhouse gas emissions (GHG) and Ecoindicator (EI99).

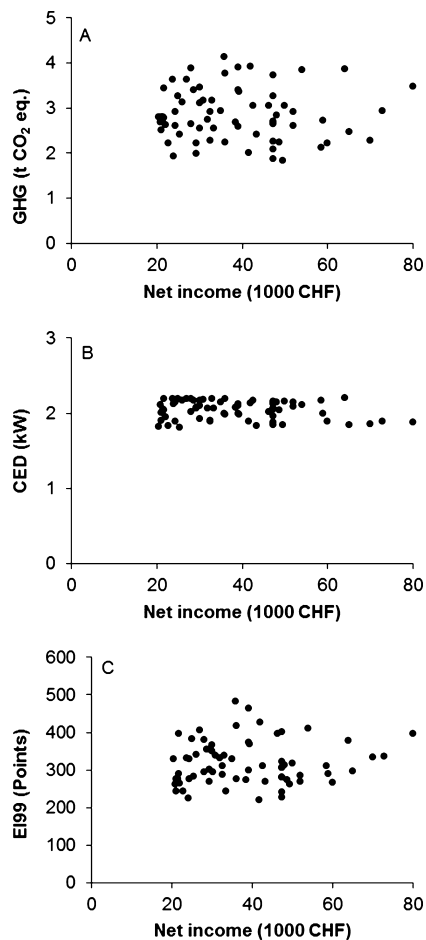


Figure 4. Net income of the subgroup ($n = 69$) versus (A) greenhouse gas emissions (GHG, in ton CO₂ eq/year), (B) cumulative energy demand (CED, in kW), (C) Ecoindicator 99 (EI99, in points).

environmental burdens are not caused by restricted consumption due to economic limitations. From this it follows that these people live a much more sufficient lifestyle than most other people do and the altered behavior regarding the lifestyle is not forced by economical limitations. 3071 individuals have an income below 80 000 CHF. Out of this group, not even 4% consume 2000 W or less. The clear implication of this result is that our current consumption and standard of living must be reduced. A much more sufficient lifestyle must be adopted by a bigger part of the society.

A short glance at the EI99 (Table 1, Figure 2) reveals that the major activities in daily life lead to similar results as CED and GHG irrespective of the choice of the environmental impact assessment method. A sufficient lifestyle not only decreases energy consumption and consequently helps to protect from global warming, it also prevents from other environmental hazards such as air pollution, degradation of ecosystems due to acidification/eutrophication or depletion of scarce resources.

For the political acceptance of a measure, it is fundamental that, first, the measure shows a clear potential for an improvement and second, that the living standard is not affected. Merging the data of the environmental survey with the LCA provides both. With the help of an environmental impact assessment it is possible to quantify the potential of a measure. Furthermore, the environmental survey provides data for the impacts of such a measure on the population. For example,

mobility is obviously an important issue for the population surveyed, thus, actions could be that urban planners design cities in a way that commuting distance are minimized, that infrastructure is close to the place of residence and that public transportation becomes highly attractive. Marketing strategies could be developed with the aim of making people drive less (federal prevention campaign), to buy smaller cars or ones with alternative drive trains,⁴⁷ or to switch to public transportation.

The ambitious aim to convert the current society into a sustainable 2000 W society can only be achieved with the greatest possible efforts. The consumption of no more than 2000 W seems possible. This is underlined by Figure 4b showing that people with high incomes up to 80 000 CHF consume less than 2000 W. However, an average consumption of less than 2000 W for the whole society is unlikely to be achieved by raising efficiency of technical solutions only. This becomes obvious looking at the individuals living in a low energy building. Within all surveyed individuals ($n = 3369$) 216 live in a low energy building, but 16 only meet the 2000 W limit. The saved energy seems to be compensated, possibly by rebound effects, such as more heated area per individual, higher temperature within the building during the cold season, more equipment, or by higher consumption of transport services, etc. Energy consumption in the near future of less than 2000 W is realistic only when assuming a pronounced technological increase in efficiency combined with a smart sufficiency strategy. An example for such a combination would be living in a low energy building with little heated floor area per person in a place that allows restricting transportation demand to a minimum. The necessary mobility would need to be provided predominantly by efficient public transport and or by small, efficient individual vehicles. It means that the citizens don't live too extravagantly, but rather follow a frugal, more sustainable lifestyle keeping in mind Mahatma Gandhi's words "Earth provides enough to satisfy every man's need, but not every man's greed."

The goal of not producing more than 1 ton CO₂ per person per year will be far more difficult than restraining the energy demand. The GHG emissions of those 107 persons with a yearly CED of 2000 W amount to 2.8 tons CO₂ per year, although electricity consumption in Switzerland is low in carbon emissions. Consequently, the residual energy consumption needs to become far less CO₂-intensive. Our subgroup would have to cover more than 60% with renewables in order to reach the 1 ton CO₂ goal.

A sustainable lifestyle requires abstinence from excessive consumption of any kind of goods and services as demonstrated by the subgroup in Table 1. Sufficiency does not only provide a good measure combatting climate change, it also helps to protect from damage to human health and ecosystems and it conserves precious resources as shown with EI99 (Table 1).

The required fields of action are well-known and demonstrated not only by this study.^{26,30,33,34} Likewise, the list of possible measures is known: subsidies for alternative technologies, carbon taxes, individual carbon quota, environmental education, and so on. Anyway, all that knowledge can't stop further environmental degradation. Why? And how can we stop excessive consumption? Many political measures are unpopular, especially when they might harm economic success. How could the current lifestyle be altered? One forward-looking solution could be the 2000 W society. What started 15 years ago as a theoretical concept is being strived for step by

step by a few societies. This leads to recognition, the idea spreads out and is borrowed by many other societies (cities, villages, companies). Meanwhile, there are a variety of flagship projects being realized and a real competition between societies started. The omnipresent topic educates and prepares the people for what might change basic attitudes, values, and patterns of behavior – defined as lifestyle.³⁵ Probably a slow change in lifestyle made it possible for three-quarters of the Zürich population voted in favor of achieving the 2000 W society by 2050,⁵ or that an old dissatisfactory topic like road pricing revives (changing values). The share of individuals aged between 18 and 24 years which acquired a driving license in Switzerland dropped from 71 to 59% (changing behavior) between 1994 and 2010.⁴⁸ A similar trend exists for Zürich.⁴⁹ Hopefully this reflects a good starting point toward a lifestyle based on sufficiency.

■ ASSOCIATED CONTENT

📄 Supporting Information

Twenty-six models of how data from environmental survey are linked to life cycle assessment; Four figures showing environmental indicators/key parameters versus age/gender; One table for assumptions of target destinations; One table with countries assigned to Western Europe. This material is available free of charge via the Internet at <http://pubs.acs.org>.

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Author Contributions

R.M. provided all data from the Swiss Environmental Survey. H.J.A. supervised the project and created the design of the study together with R.M. D.N. led the project, created all models for combining the data from the environmental survey with life cycle assessment, calculated the environmental impacts, analyzed and interpreted the results and wrote the manuscript with feedback from R.M. and H.J.A. All authors have given approval to the final version of the manuscript.

Notes

The authors declare no competing financial interest.

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