



Behavioral Economics in Companies: Nudging green behavior

Evidence of the effectiveness of green nudges in companies

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Köln, 01.05.2023

IW-Report 26/2023

Wirtschaftliche Untersuchungen,
Berichte und Sachverhalte



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Stand:

April 2023

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JEL-Classification

D22 – Firm Behavior: Empirical Analysis

D91 – Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making

Q51 – Valuation of Environmental Effects

Zusammenfassung

Der Klimaschutz ist eine der größten Herausforderungen, vor denen Gesellschaft und Wirtschaft derzeit stehen. Neben der Politik (Makroebene) und den einzelnen Verbrauchern (Mikroebene) sind auch Unternehmen (Mesoebene) mit zunehmendem Druck konfrontiert, ökologisch nachhaltiger zu handeln. Die unternehmerische Transformation zu mehr ökologischer Nachhaltigkeit erfordert neben der ökologischen Verbesserung in den Produktionsprozessen und Wertschöpfungsketten auch eine Entwicklung hin zum Büromodell der Zukunft, dem „Green office“, das durch den Dreiklang von „Green IT“, „Green building“ und „Green behavior“ realisiert wird. Dies erfordert veränderungsbereite Mitarbeiter und Strukturen, die den Wandel ermöglichen. In Anbetracht der Tatsache, dass Mitarbeiter in Büros noch keine finanziellen Anreize haben, sich im Arbeitskontext ökologisch nachhaltig zu verhalten, stellt sich die Frage, ob verhaltensökonomische Erkenntnisse genutzt werden können, um Mitarbeiter zu ökologischeren Entscheidungen in ihrem Arbeitsleben zu motivieren. Durch einen intelligenten und effektiven Einsatz von Green Nudges können Mitarbeiter dabei unterstützt werden, klimafreundliche Entscheidungen in folgenden Handlungsfeldern zu treffen: Energieeffizienz, nachhaltige Mobilität und Ressourcennutzung. Beispielhafte Nudges sind Gamification-Elemente wie Team-Fahrrad- oder Energiesparwettbewerbe, Feedback-Mechanismen zum Strom- oder Kraftstoffverbrauch, Vereinfachungen von Fahrgemeinschaften, und Default-Änderungen wie zum Beispiel doppelseitiges Drucken. Richtig konzipiert können Green Nudges betrieblichen Klimaschutz, Spaß, Teamgeist und Entscheidungsfreiheit miteinander verbinden und beispielsweise signifikante Einsparungen von 6,5 Prozent beim Stromverbrauch erzielen. Wenn alle Büros der deutschen Top-7 Städte (Köln, Düsseldorf, Stuttgart, Frankfurt, Hamburg, München, Berlin) durch Green Nudges durchschnittlich 6,5 Prozent Strom einsparen würden und man von einem jährlichen Stromverbrauch von 70kWh pro m² Bürofläche ausgeht, könnten in Deutschland jährlich 419.676 MWh, mehr als 176.000 Tonnen CO² und 167,87 Millionen Euro Stromkosteneingespart werden.

1 Introduction: Going green as a team

Climate change, the finite nature of natural resources, a growing world population and the quest for prosperity challenge society and policy to act responsibly and sustainably. The debate on climate change and the upcoming energy transition was recently intensified by the Ukrainian war. The European Green Deal and the German climate package underline the political relevance of ecological sustainability in various fields of application, initiatives, and strategies at the federal and state level. In addition to the government and individual consumers, the public discussion and broad social consensus regarding climate neutrality also induce companies to act more responsibly and to make corporate structures ecologically more sustainable (Bauer, 2014, 4). Sustainability is no longer only a pending economic trend but rather a “must have” to exist and to compete in the market in the long-term. Companies are confronted with increasing pressure to act from different sides: not only political guidelines but also climate-conscious consumers, risk-conscious investors as well as industrial partners demand corporate climate protection (Ricci, 2021). Climate-friendly solutions are not only gaining importance in production, but also play a role in the design of office concepts. How can companies make a relevant contribution to ecological sustainability not only in their own production and manufacturing, but also in their day-to-day business in the headquarters and office buildings? What are the characteristics of the future model of progressive companies, the “Green office”, and how is it to be realized in practice?

To successfully implement greener behavior in corporations, it is not enough to implement ecological sustainability in a top-down approach. "This vision [of a full integration of ecological sustainability] is achieved when what has been documented as [ecologically] sustainable is also noticed in daily working life" (author's own translation, Odgers Berndtson, 2021, 41). Corporate transformation to more ecological sustainability requires people who are willing to change and structures who enable change (Odgers Berndtson, 2021, 27 f., 43). But in contrast to their private lives, in the corporate context employees are not financially incentivized to act greener as they do not bear the company's cost of unecological behavior.

Therefore, the question arises if and to what extent employees can be motivated to adopt greener behavior at work but without financial incentives? How do we manage to raise climate awareness and a change of behavior among employees so that there is a long-term common interest in implementing ecological sustainability strategies in the company? How can business leaders develop measures to motivate their employees towards greener behavior and to ensure that the gap between ecological aspiration and reality (Mind-Behavior-Gap) shrinks? This paper responds to these questions and gives impulses to use behavioral tools for ecological purposes in the corporate context. In addition to “Boosts” via more information, “Nudging”, the systematic promotion of certain behavioral patterns, offers a promising path to a new awareness and behavioral change among office employees. The central aim of this paper is to investigate to what extent green nudges can be used to trigger climate-friendly behavior at the workplace. Based on an analysis of studies and experiments several nudging concepts are analyzed on their effectiveness regarding the three fields of action: energy efficiency, (sustainable) mobility and resource use. On this basis, final behavioral recommendations are derived for companies.

2 Ecological sustainability on a corporate level

2.1 Multi-Stakeholder pressure on companies

Climate change is one of the greatest challenges of our time. At the same time, it offers an opportunity to develop a new more ecological and long-term oriented economic model. To make climate protection as guiding principles of European policies the EU member states, and the European parliament agreed on the European Green Deal (EGD). The agreement is to reduce EU emissions by at least 55 percent by 2030 compared to 1990 levels (European Commission, 2021a). The overall target of this EU Commission's key project is to make the European Union the first association of states that achieves greenhouse gas neutrality by 2050. At the end of 2019, the Commission presented an announcement with its ideas for the Green Deal and a comprehensive work program for further development of EU policies in the sense of sustainable transformation. The measures are multifaceted and range from climate, environmental and bio-diversity protection to mobility and industrial policy to specifications in energy, agricultural and consumer protection policy. By introducing the European Climate Change Act in 2020 the climate neutrality goal was made binding by the EU Commission and since then it provides planning security and serves as a guide for public authorities, companies, and citizens (BMU, 2021).

Individual consumers are forced to adapt their consumption behavior, companies must change their structures and processes towards climate-neutrality. Since the Green Deal is gradually embedded into regulations across Europe, corporations can expect a high need for adaption and should be aware of green economy transition addressed changes in policies and legal requirements. "The Green Deal will award companies operating in Europe that are willing to transition to greener activities with more financing opportunities, though this will come at the cost of higher fiscal and regulatory pressure" (Rane, 2020). Despite incentives and growth opportunities, there will be great regulatory pressure for companies to make corporate operations greener. In the medium to long term, almost every company will be influenced by the effects of the European Green Deal at different levels, for example in the form of efficiency requirements for acquisitions or construction measures, through sustainability requirements for products or packaging, through changed cost structures for energy and raw materials, or through changed requirements in the development of products and production plants (Riether, 2022). And since the European Green Deal (EGD) includes new taxes and tariffs for high-carbon products, companies falling behind the transition will face rising operating costs.

In addition to new political regulations, also increased requirements of consumers and partners (indirectly) force corporations towards ecological change. In recent years, the uncertainty in society led to a change in values towards more transparency, trust, and justice. Against the backdrop of societal developments, trust and responsibility became increasingly important for companies. The results of the Edelman Trust Barometer 2021 show that companies are given a special role in solving societal challenges. The clear consumer's expectation is shown by the various measures that companies need to consider before they are considered for purchase: 79 percent of surveyed Germans expect companies to take one or more measures that go beyond their actual product and business. Such measures include addressing social and political challenges, honestly addressing uncomfortable truths, demonstrating transparency, and thus bringing positive change in society, and standing up against misinformation (Edelmann, 2021). Especially climate protection is an important factor in terms of loyalty and trust in companies: According to a survey which included 24,000 respondents, 91 percent would like companies to generally position themselves more clearly on the topic of environmental protection and sustainability. The majority (60 percent) would even boycott companies that do not act against climate change in the future (Dentsu International/Microsoft Advertising, 2021).

These studies show that if companies want to continue to experience acceptance on the market and remain competitive, it is their task to integrate these values into their everyday actions and to handle resources responsibly. To reduce ecological damage, companies can design their production processes, services, products, and investments in an environmentally compatible manner. This is achieved, for instance, through an efficient use of resources, the use of regenerative energies, the reduction of waste and pollutant inputs on the part of their own production, acting producers and service providers. But besides improving one's own production and value chains, how can corporations make further ecological progress in the sense of Sustainable Development Goal (SDG) 13 (Climate protection)? How can the design and management of office buildings be adapted to the need of climate protection?

2.2 The way to a green office

Despite the pandemic-related economic downturn, the office employment in Germany increased by about 2.0 percent overall from 2020 to 2021 (both as of June 30) which equals an increase of over 240,000 jobs. This puts the level of office employment above the levels seen in 2019 and 2018. The rate of office employment subject to social security contributions also increased from 36.6 to 36.9 percent meaning that office employment has risen at an above-average rate in Germany overall. There was a particularly strong increase in office employment in, among other places, Berlin (+3.6 percent), Cologne (+2.7 percent) and Leipzig (+3.0 percent) (Voigtländer/Oberst, 2022, 9).

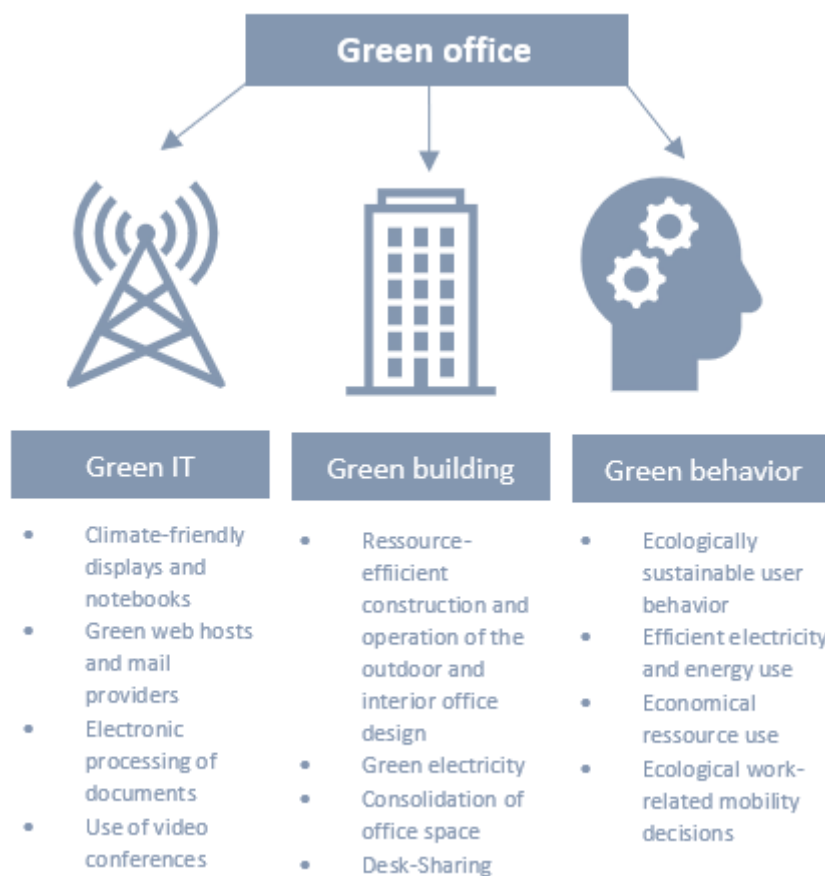
After the pandemic-related short-term shift towards remote working, employees started to return to their office, albeit not working there anymore five days per week. It is not yet certain in which direction the working world will develop but experts predict that a mixture of remote working and presence culture will prevail in the long-term. A still existing relevance of office buildings is confirmed by a survey conducted in the end of 2022: Almost every second (45 percent) of the 600 companies surveyed want to reduce the possibility of working from home after the pandemic, and more than one fourth of companies (27 percent) wants to ban it completely in the future (Bitkom, 2022). The importance of offices stimulates a discussion on the ecological usage of office buildings and ecologically sustainable behavior of employees in the workplace. An office concept oriented towards ecological goals, is referred to as a "green office". It integrates coordinated measures from three main areas: In addition to ecological information and communications technology ("green IT"), "green offices" are characterized by environmentally friendly building and room designs ("green building") and ecologically sustainable user behavior of employees ("green behavior") (Bauer, 2014, 5).

Green IT

The concept "green IT" includes an efficient and environmentally friendly production and use of information and communication technology and devices such as notebooks or displays. On "The Green Web"-website, for instance, companies can check for free how sustainable their website is in terms of the energy used to power it. Examples of green web hosts are "Avalon Networks" and "Biohost". The mail provider "posteo.com", for instance, relies on servers that are powered by green electricity. As part of green IT, companies can consciously pay attention to buy and use environmentally friendly devices, such as devices with the highest energy efficiency class. Moreover, document management systems such as an electronic processing of documents, digital archiving, and management of data for paperless working belong to the Green IT-principle. Besides the ecological aspect that less trees are cut and that less water and energy is consumed,

paperless offices have more advantages: They can lead to a reduction of costs because those who save space for file archiving and require less floor space for file folders will save on rent, including ancillary costs. Moreover, the daily search for work-related documents poses a threat to performance. Productivity can be increased through an effective digital system (Flüter-Hoffmann, 2023). A further possibility to act in the sense of “green IT” is the expansion of video and telephone conferences. With open-source platforms such as Microsoft Teams, Zoom and Skype online conferences can be easily conducted from home and unnecessary, far, emission-intensive work trips can be reduced (Bauer et al., 2014, 6).

Figure 1: Green office



Source: Author’s own figure

Green building

Office buildings referred to the principle “green building” are buildings which are built and operated in an economically efficient and resource-efficient way and allow ideal energy management and a minimal use of utility resources. One approach is to purchase 100 percent green electricity which can be realized by switching to providers such as “Greenpeace energy”, “Lichtblick” or “enyway”. In addition to an efficient use of energy, green office buildings focus on an environmentally and climate friendly interior design of the office landscape. Another possible measure for “green building” is the consolidation of office space to save energy and resources. Even if office buildings with their advantages in communication and teamwork do not become

superfluous, the number of desks and thus the total office space can, in many cases, be reduced due to the pandemic-related expansion of remote working in Germany. As indicated above, the hybrid office approach, the combination of concentrated work in the home office and teamwork in the office, will probably prevail. From an ecological point of view, the concept "Desk-Sharing" can reduce the needed area of office buildings which, in turn, would reduce energy use and therefore presents an opportunity in the sense of "green building".

A green office, however, involves more than green power, green building materials or office equipment. It is mainly supported by the people who spend a large part of their day inside the office, who develop ideas and make contacts there. If a company fails to engage its employees in corporate climate protection, every - no matter how well-intentioned investment in "green IT" or "green building"- will not lead to change in the long-term. For example, if a company invests in hardware that is produced in an environmentally-friendly manner and can save energy, but the employees are not informed about the sustainability-promoting functions of the equipment, then no changes in usage behavior will be seen and thus no ecological development will take place. The ideal of a green office can only be realized by the interaction of "green building", "green IT" and "green behavior".

Green behavior

In addition to green information and communications technology (green IT) and environmentally friendly building and office designs (green building) it is particularly important that the employees themselves change their behavior. The green office's third pillar "green behavior" is defined as ecological user behavior. Climate-friendly behavior on the part of office users holds great potential for reducing energy and resource consumption. Sustainable behavior on the part of the employees also includes an ecological kind of mobility which refers to the travel to work and business-related trips. The prerequisite for achieving a shift towards greener behavior is that the individual employee accepts climate-friendly concepts in the office. How is this assured? How can the measures and ideas presented above be realized in the daily office life? By incorporating insights from behavioral sciences ecological programs can achieve greater effectiveness. A promising method is "Nudging", the technique to predict the behavior of people and to guide them into a certain desired direction. "Green nudges", a special type of nudges, are behavioral tools that can be used to sensitize individual consumers to greener decisions (Enste/Potthoff, 2021). In how far can the potential of green nudges be further exploited in the corporate context?

3 The power of green nudges in offices

Behavior-based tools, so-called "nudges", can be used to steer human behavior in a specific, desired direction through small interventions. The basic idea of nudging is to facilitate (complex) decisions and to reduce self-control problems through a careful, minimally invasive re-design of decision-making situations. Unlike classical climate policy instruments, nudging is not about commandments, prohibitions, penalties, or taxes. Instead, decision architects use empirically proven characteristics of real human decision-making behavior (e.g. herd behavior, persistence in the status quo) to understand behavioral barriers and to close the "mind-behavior gap," the gap between the will to and the actual execution of an action (in this case: climate-friendly decisions). The use of nudges is motivated by the behavioral economic insight that people do not always act rationally and according to their own (long-term) goals but are often subject to a certain inertia as well as ignorance of their actions and its consequences. This is evident in sustainable consumption at the individual

private consumption level (Enste/Potthoff, 2021, 26 ff.) and it becomes even more complex to motivate employees to make sustainable decisions as they do not bear the costs of their unsustainable behavior. As a result, there is only a limited awareness of one's own everyday (green) decisions in the office and the consequences for the climate and environment. Even if an employee is motivated to act environmentally friendly, he or she might not act according to his/her preference because other employees are not acting that way. The nudging concept offers valuable starting points for influencing the behavior of employees in a targeted manner and thus driving change. Green nudges present a behavior change tool to facilitate more ecological employee behavior which is insufficiently addressed with traditional organizational intervention policies such as educational workshops. Based on selected field experiments we analyze to what extent green nudges can change behavior to greener choices regarding the following fields of action: energy efficiency, (sustainable) mobility, and resource use.




3.1 Energy efficiency by defaults, feedback, and competition

People make various decisions that affect energy use not only in their private lives at home but also at work. Energy consumption in the office does not always take place consciously and in a controlled manner but rather by the use of equipment whose consumption values only very few users are aware of. The fact that energy is "invisible" does not facilitate consumption awareness. Overall, everyday energy use is perceived only to a very limited extent by employees. This problem has become even more urgent and relevant through the energy crisis in Europe. Table 3-1 shows a selection of possible behavioral measures to counteract this problem, the tool's mode of action and the respective savings effects for corporate energy efficiency.

To test the effectiveness of defaults for energy saving purposes Brown et al. (2013) conducted the following randomized controlled experiment: The default settings on office thermostats in an OECD building were manipulated during the winter heating season. The employees' chosen thermostat settings were observed for six weeks, and the employees were not informed about the changes in the default settings. The people working in the 93 offices in the first floor of the OECD's Marshall Building were randomly allocated to one of three treatments: (1) a control group in which the thermostat default was left at its original setting of 20 Celsius, (2) a group in which the default was decreased by 1 Celsius per week until a default setting of 17 Celsius was achieved, (3) a group in which the default was increased to 21 Celsius in the first week before being decreased by 1 Celsius per week until a setting of 18 Celsius was reached. The employees were permitted to adjust the thermostat upwards to a maximum of 3 Celsius above the default. This default nudge takes advantage of people's insensitivity of small changes in temperature and their aversion to expending cognitive effort worrying about their office's temperature. The results of the experiment prove that small decreases in the default (1 °C) lead to a greater reduction in chosen settings than large decreases (2 °C) as people started to opt out of the default when the difference in temperature was too strong. Decreasing the default setting in treatment 1 (Group 2) caused a significant reduction of 1-2 degrees in the chosen thermostat setting for weeks 2-4 of the experiment. The authors of the study forecast that there would be an average 0.98 °C reduction in actual thermostat settings if the 20 °C default was reduced to 19 °C across all offices in the building during working hours and if they assume that the +/- 3 °C constraint on thermostat settings was still maintained. "If the estimate of 7% energy savings per 1 °C reduction in settings is valid, and we assume that around 40% of electricity consumption in the OECD Marshall Building is due to heating offices (...), then this change in thermostat settings translates into possible savings of 12,350 kWh per month (...)" (Brown et al., 2013, 134). The experiment thus empirically proves the effectiveness of small reductions in the default of office thermostats.

However, it must be stated that the effect dissipated in the fifth and sixth week of the experiment. The study also found that the default effect was less strong for employees who were more inclined to adjust their thermostats before the intervention (Brown et al., 2013, 133).

Table 3-1: Nudges to reduce the energy use by up to 7 percent

Nudge	Thermostat default 	Public energy feedback 	Team energy-saving competition 
Explanation	Changing the default setting for thermostats in office buildings (e.g. reduction by 1 °C)	Energy consumption of all employees' computers is measured through an electricity meter and feedback per mail	Employees in different buildings compete against each other in an energy-saving competition
Mode of action	<ul style="list-style-type: none"> Changing the default setting 	<ul style="list-style-type: none"> Making information visible (Feedback) Setting a social reference point 	<ul style="list-style-type: none"> Making information visible (Feedback) Setting a social reference point
Target	To reduce energy use by heat consumption	To reduce energy use by saving electricity	To reduce energy use by saving electricity
Empirical evidence	Brown et al., 2013	Handgraaf et al., 2013	Dixon et al., 2015
Effect	7 percent reduction in energy use	6,4 percent reduction in electricity consumption	6,5 percent reduction in electricity consumption

Source: Author's own table

Another potential nudge for energy saving purposes is to give employees a public energy feedback. Handgraaf et al. (2013) researched on the effectiveness of this social norm-based behavioral tool in the corporate context. Employees from five departments of a Dutch environmental consultancy firm participated in the study. In the social norm treatment group, the computer energy consumption of employees was measured via an electricity meter and was recorded in kWh units for a period of 8 weeks. The employees received weekly feedback by mail which included a grade from 5.0 to 10.0 and formulated praise or criticism according to the grade such as "Unfortunate" for a grade of 5 and "Great!" for a grade of 9 or 10. The mail also contained a ranking in the form of a table with actual full names and scores of the co-workers (Handgraaf et al., 2013, 88). This nudge works by providing information in the form of weekly feedback on energy consumption and the public comparison with other employees which sets a social reference point. The employees who received the social norm-nudge conserved on average 6.4 percent electricity. The effects were quite strong

for eight weeks and even after the study's authors stopped to provide employees with feedback and social rewards, participants in this condition still conserved energy. However, it must be borne in mind that all participants were informed that they would receive weekly "Personal Energy Saving Reports" which detail their energy consumption. Accordingly, the Hawthorne-Effect which means that behavioral effects are based solely on the subjects' knowledge that they are participants in a study, cannot be excluded. But providing social rewards for employees' energy conservation does not cost much money and if employees save energy in this way, this behavior change is not only beneficial from a climate perspective but also from a financial one as a company's energy bill reduces. The described behavioral tool can therefore be seen as an effective and relatively cheap energy-saving strategy. Further studies also find that social norm-nudges are a promising approach to reduce energy consumption. Carrico/Riemer (2011), for instance, found that monthly group-level feedback by mail results into a 7 percent reduction in energy use.

A further potential behavioral tool in the context of energy efficiency are team energy saving competitions. In a study of Dixon et al. (2015) employees in six different buildings at a university competed against each other in an energy conservation competition for an entire year. The subjects had access to an online platform where electricity consumption feedback between buildings was presented in the form of graphs and a ranking. This gamification nudge works through social comparison, feedback, and the element of competition. The nudge resulted into average electrical energy savings (kWh/ft²) of 6.5 percent per participated building. These findings show that by introducing team saving competitions people can be motivated to save energy. Alternatively to different office buildings of large corporations or universities as tested in the study such a competition can also be realized on a smaller level such as between two different floors or office rooms, with the winner being the team that has implemented the most energy-saving measures and has reduced its consumption relatively seen the most. In this way, companies that have only one office building can apply the same nudge: measuring the competition between different departments or teams and choosing a "winning department" that saved the highest percentage share of energy. The prerequisite for a functioning of this, however, is that the electrical energy consumption of individual floors or parts of floors is measured separately, and that separate accounts exist or that the kWh amount is measured via individual electricity meters. After companies completed such a behavioral measure, it should be taken care to ensure that the savings do not disappear or are followed by higher consumption (Rebound effect). A longer duration or regular repetition of the behavioral measure can be useful to anchor the nudge's effect in the long-term. To increase motivation and to include the fun factor, such team energy-saving competitions can be combined with social rewards such as a social event in the form of a dinner, a team-building outdoor activity or a party within the winner team.

Such a team energy-saving competition is just one exemplary measure to save electricity in offices. Companies should implement an energy-saving tool which suits them most and they can also combine different green nudges to achieve the highest energy savings potential. If a typical German urban office of 230 m² area would implement an electricity-saving nudge or a combination of green nudges and would achieve average annual electricity savings of 6.5 percent this results into the following potential annual savings in electricity consumption, cost and carbon emissions (Table 3-2):

Table 3-2: Electricity savings potential for a typical German urban office

Annual savings in kilowatt hours (kWh), euros and kg CO² for a typical urban office in a German Top-7 office property location based on an average annual electricity consumption of 40 (lower savings potential) and 70 (upper savings potential) kWh/m² and an electricity price of 40ct/kWh

	Area		Lower savings potential per year	Upper savings potential per year
Typical urban office	230 m ²	kWh	598	1,046.50
		€	239.20	418.60
		kg CO ²	251.16	439.53

Source: Own calculations based on BDEW, 2023; Bundesnetzagentur, 2022; Dixon et al., 2015; JLL, 2023; Rheinreal, 2022; Stadtwerke Gießen AG, n.d.; UBA, 2022, Value AG, 2023

The average electricity consumption of offices and administrations is 40 to 70 kWh/m² of office space per year (Stadtwerke Gießen AG, n.d.). The median office size in a German Top-7 office property location was 230 m² in quarter 4 of 2022 (Own calculations based on Value AG, 2023). Table 3-2 provides an overview of the theoretical savings potential when assuming an initial consumption of 40 kWh/m² per year (lower savings potential) and 70 kWh/m² per year (upper savings potential). Depending on its annual baseline electricity consumption a typical German urban office can save 598 - 1,047 kilowatt hours of electricity and 239 - 419 euros in electricity costs per year. Based on the average CO² emissions required to generate 1 kilowatt-hour of electricity in Germany in 2021 (UBA, 2022), a typical urban office of 230 m² can save 251 - 440 kilos of CO² per year. This is only an estimated value as the annual CO² footprint of companies can vary greatly due to different electricity consumption and different electricity providers which source electricity from different resources such as water, gas, wind, solar, atom energy, lignite and hard coal. Nevertheless, the calculation shows a positive tendency regarding the extent to which even a single office can save electricity costs and can improve its carbon footprint through behavioral economic measures.

If electricity-saving behavioral economic measures were extensively implemented in major German office cities and brought average electricity savings of 6.5 percent, the savings potential would be much greater: If the entire Cologne office area used in quarter 4 of 2022 would participate and achieve the respective savings in electricity consumption and if one assumes a low average baseline electricity consumption of 40 kWh/m² per year and an electricity price of 40ct/kWh then 19,848.14 MWh, 8,336.22 tons of CO² and almost 8 million euros in electricity cost could be saved per year. As table 3-3 shows, the highest savings potential in this scenario is to be found in Berlin and Munich with respective potential savings of 21.67 and 21.54 million euros of electricity cost per year. If all offices used in the German Top-7 office property cities (Cologne, Stuttgart, Düsseldorf, Frankfurt, Hamburg, Munich, Berlin) would save an average of 6.5 percent electricity per year, almost 240,000 MWh, almost 96 million euros in electricity cost and more than 100,000 tons of CO² could be saved per year (Table 3-3).

Since a typical German urban office of 230 m² consumes 6,900 - 16,100 kWh per year which is below the upper limit of 50,000 kWh as an annual electricity consumption for commercial customers, an average price of 40ct/kWh was used for this extrapolation (BDEW, 2023).

Table 3-3: Low baseline consumption scenario:

Annual potential savings in megawatt hours (MWh), tons of CO² and euros for offices in the Top-7 office property locations based on an average yearly consumption of 40 kWh/m² and an electricity price of 40 ct/kWh

Office area of Top-7	Used office area in million m ²	Savings potential		
		MWh	CO ² in t	Mio. €
Cologne	7.63	19,848.14	8,336.22	7.94
Düsseldorf	8.59	22,341.62	9,383.48	8.94
Stuttgart	8.91	23,171.46	9,732.01	9.27
Frankfurt	10.76	27,977.04	11,750.36	11.19
Hamburg	14.78	38,433.04	16,141.88	15.37
Munich	20.71	53,857.44	22,620.12	21.54
Berlin	20.84	54,186.08	22,758.15	21.67
Total	92.24	239,914.82	100,722.23	95.93

Source: Own calculations based on BDEW, 2023; Bundesnetzagentur, 2022; Dixon et al., 2015; JLL, 2023; Rheinreal, 2022; Stadtwerke Gießen AG, n.d.; UBA, 2022, Value AG, 2023

If one assumes a higher annual electricity consumption of 70 kWh/m² (high baseline consumption scenario) the potential annual savings in MWh, CO² and electricity cost would be as followed (Table 3-4): If all offices used in Cologne in quarter 4 of 2022 would save on average 6.5 percent electricity per year Cologne would save more than 34.7 thousand megawatt hours (MWh), 13.89 million euros in electricity cost and almost 14.6 thousand tons of CO² per year. In this scenario, the biggest office space city Berlin would save more than 94.8 thousand MWh, 39.8 thousand tons of CO² and more than 37.9 million euros per year.

If all offices used in the Top-7 cities would save an average of 6.5 percent electricity per year and the average basis consumption would be 70 kWh/m², almost 419.7 thousand MWh and 167.87 million euros in electricity cost could be saved per year. The savings potential is also great from a climate perspective: Through a widespread deployment of behavioral economic electricity saving measures and respective average savings of 6.5 percent, in the high baseline consumption scenario more than 176 thousand tons of CO² could be saved per year. Based on an average annual CO² consumption of 8.09 tons per capita in Germany in 2021 the potential total annual CO² savings of 176,263.89 tons achieved by German offices equal the yearly CO² consumption of 21,787 Germans (Own calculations based on Global Carbon Atlas, 2022).

Table 3-4: High baseline consumption scenario:

Annual potential savings in kilowatt hours (MWh), tons of CO² and euros for offices in the Top-7 office property locations based on an average yearly consumption of 70 kWh/m² and an electricity price of 40 ct/kWh

Office area of Top-7	Used office area in million m ²	Savings potential		
		MWh	CO ² in t	Mio. €
Cologne	7.63	34,734.25	14,588.38	13.89
Düsseldorf	8.59	39,097.83	16,421.09	15.64
Stuttgart	8.91	40,550.06	17,031.02	16.22
Frankfurt	10.76	48,959.82	20,563.12	19.58
Hamburg	14.78	67,257.83	28,248.29	26.90
Munich	20.71	94,250.52	39,585.22	37.70
Berlin	20.84	94,825.64	39,826.77	37.93
Total	92.24	419,675.94	176,263.89	167.87

Source: Own calculations based on BDEW, 2023; Bundesnetzagentur, 2022; Dixon et al., 2015; JLL, 2023; Rheinreal, 2022; Stadtwerke Gießen AG, n.d.; UBA, 2022, Value AG, 2023

It is important to know that the figures presented in tables 3-2 to 3-4 represent only theoretical savings potentials, as there is no reliable figure for the actual office space currently used in Germany. Based on data of the total existing office space in the Top-7 cities in quarter 4 of 2022 and their respective vacancy rate in quarter 4 of 2022, the Top 7 cities' actual office space used in quarter 4 of 2022 was estimated and used for the extrapolation of the annual savings potentials. Through different company sizes and respective office space used, office buildings can have different yearly electricity consumptions and therefore might also have different electricity saving potentials if they implement green nudges. It must also be taken into account that the savings of 6.5 percent kWh per m² occurred only in a field experiment. It cannot be assured that all Cologne offices neither all offices in the German Top-7 cities would participate in such green nudge interventions, or that every office would achieve electricity savings of 6.5 percent. Green nudges such as team energy saving competitions are just an example of many more measures which can lead to great reductions in electricity consumption. If companies combine different electricity saving measures such as team-energy savings competitions, feedback on electricity consumption via mail or default changes of elevators and refrigerators in operation the savings potential can be even higher than 6.5 percent. The extrapolation based on average electricity savings of 6.5 percent serves as an exemplary scenario to show the potential effect strength and savings potential in electricity amount, cost and CO² if green nudges would be implemented across the board in Cologne and other major office cities (BDEW, 2023; Bundesnetzagentur, 2022; Dixon et al., 2015; JLL, 2023; Rheinreal, 2022; Stadtwerke Gießen AG, n.d.; UBA, 2022, Value AG, 2023).

3.2 Sustainable mobility by simplification, salience, and social norms




Another central field of action is an ecologically sustainable mode of transport. Potential behavioral economic measures to promote a more ecological way of mobility in the corporate context are shown in table 3-5. Companies who want to limit their employees' carbon footprint can, for instance, encourage carpooling by setting up an internet platform to put their workforce in touch with colleagues who live nearby. Such a website can be included in the company's intranet and includes, for instance, a calendar where employees can organize daily trips to work but also business trips to customers, suppliers, or other business-related trips together with their colleagues. This "Carpool"-nudge can decrease solo-car-trips and has a potential networking effect which can also be beneficial for companies. Abrahamse/Keall (2012) provide empirical evidence of the effectiveness of such a web-based behavioral intervention. Through implementing a webpage as described above the share of commuters enrolled in the scheme who carpool as their main mode of transportation increased from 12 to 27 percent while the percentage of those driving alone diminished significantly. The psychological barriers which are addressed here are the lack of awareness of the carpooling scheme, of potential carpool matches and of the cost savings of carpooling (versus driving alone). In addition to that, the convenience of carpooling can be enhanced by making driving and parking less convenient for lone motorists, for instance, by halving the size of parking lots (Kristal/Whillans, 2019).

Another exemplary nudge in this context is a smartphone application which provides feedback on the cost and consumption of transportation fuels. This nudge's mode of action is to reveal previously unknown information and to provide feedback in real time what makes consumption more salient and, in turn, can steer behavioral change. The effectiveness of feedback mechanisms to change driving behavior is empirically supported by Thommes and Hoffmann (2019) who conducted a field experiment with truck drivers working for a German logistics company. The experiment's control group remained unmonitored, and the treatment group received feedback on the fuel-efficiency of their driving style. The duration of the observation was seven months. Informing drivers about their driving performance significantly increased their level of fuel efficiency by 4.23 percent. As CO² emissions fall in direct proportion to the drop in fuel consumption, the percentage of the latter gives precise information on the resulting CO² emission reduction. The average CO² emissions were cut significantly by 5.33 percent (from 837.54 to 792.83 grams of carbon dioxide per kilometer). However, this nudge's effectiveness depends on previous driving performance: Initially bad drivers improved their performance more than initially good drivers. The driving performance of those drivers who were already intrinsically motivated to drive fuel-efficiently before the treatment were not affected by the nudge: Such people's driving efficiency level remained high during the intervention (Thommes/Hoffmann, 2019). The implementation of this nudge is recommendable especially for employees doing many business-related car drives.

A further possible behavioral intervention is to introduce a kilometer race-bicycle competition which is supposed to encourage individual employees, teams, and different organizations to cycle as much as possible during the work week. The competition leads to personal health benefits, reduces the carbon footprint, and can build up team spirit. This behavioral intervention can be built through a website or an application where participants register for the competition as individuals or as a team. In different sized groups the registered teams then compete against each other. A German pilot project (BITS), for instance, uses a gamification approach that involves using an application to collect cycling data on kilometers traveled, average speed, and CO²-reduction compared to car use. By organizing competitions and corresponding rewards, participants are motivated to increase their bicycle use and to make an active contribution to climate protection. Another real-life example of such a nudge is the German community project "Who cycles the most?" in which from

August 1 to September 31 in 2022, 24 Berlin companies competed against each other, and employees documented their bicycle kilometers in an application. During this period of two months the 1,925 participating employees cycled 1,117,395 kilometers to work which has saved a total of 212,305 kg of CO² (Mehrwert Berlin, 2022).

Table 3-5: Nudges to promote sustainable mobility

Nudge	Carpool-Nudge	Feedback to fuel consumption	Team bicycle competition
			
Explanation	Platform to promote carpooling between colleagues	Employees are provided with an application to promote fuel-efficient driving	Employees compete against each other in who cycles the most
Mode of action	<ul style="list-style-type: none"> Simplification 	<ul style="list-style-type: none"> Making information visible 	<ul style="list-style-type: none"> Promoting self-commitment Using social norms
Target	Reduce work-related CO ² -emissions	Reduce work-related CO ² -emissions	Reduce work-related CO ² -emissions
Empirical evidence	Abrahamse/Keall, 2012	Tulusan/Staake/Fleisch, 2012	Mehrwert Berlin, 2022
Effect	Increase of carpool participation rate from 12 to 27 percent	Improvement of fuel efficiency by 4.23 percent	212,305 kg CO ² saved in 2022 (24 companies)

Source: Author's own table

A further possibility to use team challenges in the context of sustainable mobility is to install a glass pillar at a central location in the company: For each trip to work by bicycle or foot, employees receive a ball which they can throw into this container. As soon as a certain number of balls is in the public glass pillar, an appreciative team event such as a hike or a joint dinner will be organized to reward the team's sustainable mobility behavior. This nudge works through self-commitment as part of a group task, and the glass column with the balls serves as feedback on the team's behavior. The connection to a social event can enhance motivation and team spirit. Further methods to promote more ecological work-related transport choices is to provide employees with discounted job tickets and to provide offices with (enough) bicycle racks so that employees can easily switch from car to bicycle (Simplification). The convenience of choosing the bicycle to travel to work can be further increased by positioning bicycle racks near the entrance while positioning the parking space for cars further away from the office.

3.3 Less use of resources by new defaults and social norms




Resource use in the form of paper or food consumption is another relevant field of action when it comes to ecological sustainability in the work context (Table 3-6). A possible behavioral tool to motivate paper savings is to change the default from one-sided to double-sided printing. A Swedish field experiment which included 18 departments of a major Swedish university set double-sided printing as a standard. This default decreased the average paper consumption by 15 percent and the conservation effect endured until the end of the observation (six months after) (Egebark/Ekström, 2013, 1).

Another tool to conserve resources such as paper is to provide employees with overviews of the number of pages printed per day, week, month, or year. Based on this, an average benchmark of all departments can be shown. Employees with below-average consumption receive a happy smiley on their feedback sheet while a sad smiley is shown to employees with above-average consumption (Bockstahler, 2020). A further behavioral tool which can encourage employees to save paper is to include a text reminder to save paper below the signature when sending mails. Lines such as "Save about 250 ml of water, 5 grams of CO², 0,06 kWh energy and 15 grams of wood per page." remind recipients to think about the need to print before printing the mail or attachment.

Besides paper conservation, corporate green nudges can be implemented for other purposes such as to decrease food waste by decreasing the plate size in corporate canteens or buffet tables at corporate events. The effectiveness of this nudge is empirically proven by a field experiment of Hansen/Jespersen/Skov (2015): The experimental setup consisted of two buffet tables which were set up on two different floors. One buffet table was equipped with normal sized plates (27 cm) that served as a control group (n= 75) and another buffet table was equipped with smaller sized plates (24 cm) serving as the intervention group (n = 145). The participants were allocated to one of the two floors and got the information that this was due to logistical aspects. After the intervention the food waste was collected in designated trash bags and weighted in bulk. This study shows that dishware size has a big influence on the amount of food wasted among people in self-service eating settings: Smaller plates (Intervention group) decreased food waste by 26 percent compared to the usual sizes provided by the caterer (Control group) (Hansen/Jespersen/Skov, 2015). If such a nudge is implemented in a company's canteen, food waste of employees can significantly be reduced.

Green nudges can also be used to decrease the number of disposable mugs in a company's café or canteen. Loschelder et al. (2019), for instance, nudged café customers (students, employees) to resist using disposable to-go-cups in a local café at the Leuphana University of Lüneburg. For a period of four weeks a sign with the lines "more and more customers are switching from to-go-cups to a sustainable alternative. Be part of this movement and choose a reusable mug" was put next to the café's coffee machine. During the intervention period data with a total of 23,946 hot beverages sold was collected, 18,019 in disposable cups and 5,927 in reusable cups. The results show that the social norm-nudge helped employees and students to avoid disposable cups: the use of reusable ceramic mugs was increased by 17.3 percent relative to the baseline which equals 4.1 percentage points (from 23.7 percent during the baseline to 27.8 percent) (Loschelder et al., 2019, 4 ff.). If companies would implement this nudge in their corporate cafés or local coffee points the number of disposable mugs can be reduced which is a development that saves cost and helps the climate and environment at the same time. Social norm-nudges work as people orient their own behavior and decisions strongly on what others do (Bandwagon effect). Accordingly, notices such as the latter or "60% of your colleagues already work paperless" can be effective nudges to encourage environmentally friendly behavior in the office.

Table 3-6: Nudges to reduce resource use by up to 26 percent

Nudge	Double-sided printing 	Smaller plates in canteens 	Social norm sign to promote re-usable mugs 
Explanation	The default setting for printing is changed from single-sided to double-sided printing on the employees' notebooks	Decreasing the place size in the canteens of companies	A sign "More and more customers are switching from to-go cups to a sustainable alternative" is put next to the coffee machine in corporate cafés
Mode of action	<ul style="list-style-type: none"> Changing the default 	<ul style="list-style-type: none"> Changing the default 	<ul style="list-style-type: none"> Social norm
Target	Reducing paper consumption	Reducing food waste	Decreasing the number of disposable mugs
Empirical evidence	Egebark/Ekström, 2013	Hasen/Jespersen/Skov, 2015	Loschelder et al., 2019
Effect	15 percent less paper consumption	26 percent less food waste	17.3 percent switch from disposable to reusable ceramic mugs

Source: Author's own table

4 Behavioral economic recommendations

Companies have a direct impact on ecological problems such as the scarcity of resources, environmental pollution, global warming, or the decline in biodiversity. Therefore, corporations have a duty to become aware of their responsibility towards the environment and climate and must carry responsibility for the needs of today's society as well as those of the future. While the efforts to date for corporate ecological change are mainly against the background of legal regulations or economic considerations in the form of a business case ("It pays off") what rather concerns the production process and value chains, this analysis addresses (green) behavior of those employees who work in offices. Besides ecologically improving their own production and value chains, corporations should think further and integrate climate protection measures into their day-to-day business in their headquarters and office buildings (especially those companies working in the service sector). The prospective, ecologically sustainable version of corporations, the green office, requires the triad of "green IT", "green building" and "green behavior".

It is essential for companies to think about long-term solutions to save energy and resources because of climate change but also in view of the recent increase in gas and electricity prices due to the energy crisis. Climate protection from down to the top, through active 'green' employees, can set new, green impulses in companies. Nudges are a promising tool to support employees in adopting more ecologically sustainable behavior. Especially regarding energy efficiency, the potential effectiveness of corporate nudging is relatively

high (see chapter 3.1). Addressing people's behavior is a key aspect in achieving energy savings and improving energy efficiency, but also when it comes to the promotion of more ecological work-related mobility choices and a more sustainable resource use in terms of paper consumption and food (waste) handling. Based on the analysis of field experiments in chapter 3 the following final recommendations for companies and its business leaders can be derived:

To promote corporate energy efficiency:

- Change the default setting for thermostats in office buildings to reduce energy use by heat consumption
- Change the default of elevators in operation and switch off those which are not needed
- Change the default of refrigerators in operation and switch off those which are not needed
- Give your employees feedback about their electricity consumption via mail to sensitize and motivate them to save electricity
- Introduce team energy saving competitions to reduce corporate energy use

To promote sustainable transport choices

- Implement a platform to promote carpooling between colleagues to reduce solo car use to work
- Provide employees with an application which gives feedback on fuel efficiency to reduce work trip-related CO² emissions
- Introduce team bicycle competitions against different companies or between different departments in your company to motivate employees to get to work by bicycle
- Provide employees with discounted job tickets to simplify the use of public transport to get to work
- Reduce the number of parking lots and increase the number of bicycle racks in front of the office to promote work trips by bicycle for employees who live nearby

To promote an economical resource use

- Change the default in your employees' notebook from one-sided to double-sided printing to reduce paper consumption
- Add the "Think before you print"-reminder in corporate mails
- Decrease the plate size in the corporate canteen to reduce food waste
- Place a sign with the lines "more and more of your colleagues are switching from to-go-cups to a sustainable alternative" next to the coffee machine to decrease the number of disposable mugs in your corporate café or canteen

5 How to implement green nudges in companies

The exemplary measures are intended to encourage business leaders to develop their own ideas to support their employees in adopting more ecological behavior in the workplace. Companies should start to question the extent to which routine processes still make sense or are merely habits. Nudges are a good tool to overcome habits and to break the mind-behavior-gap, the inconsistency between attitudes towards sustainable consumption and actual behavior. Besides improving the company's level of ecological sustainability and reducing office maintenance costs, corporate green nudges have more advantages: For the employees themselves nudges such as reminders appealing to social norms or defaults such as changes of the thermostat

setting, or double-sided printing do not require much effort or time. Green Nudging is therefore considered a low-threshold tool for reducing greenhouse gas emissions in everyday office life. Gamification elements in the form of bicycle challenges or team energy saving competitions do not only promote more ecological decisions in the corporate context but can also strengthen team spirit and be fun for employees. According to a nudge pilot project sponsored by the Federal Ministry for Economic Affairs and Climate Action, the participating companies who implemented several nudges into their employee's working life reported that the involvement of the workforce and the higher visibility of climate protection measures resulted not only into more ecological behavior but also let to a stronger identification with the company (Bremer Energie-Konsens GmbH, 2023). Green nudges can effectively promote climate-friendly behavior among employees while combining fun with climate protection. Another value of corporate green nudging lies in encouraging greener behavior while still guaranteeing the employee's freedom of choice as they are not forced to implement the targeted behavior change. A further advantage of implementing corporate green nudges is that sustainable behavior in the workplace can positively influence ecological behavior in the private life. Through potential spillover effects in another context, the effects achieved can be reinforced.

For the conception and selection of suitable green nudges, the design thinking approach offers methodological inspiration. Design thinking is a form of brainstorming in which ideas for effective nudges can be generated. First, all ideas are only collected and not yet evaluated. Then follows a check as to whether freedom of decision is given to the employees and whether the idea is realistically implementable or practical. In case of complex change goals, it is advisable to break down the goal into simple steps, which can then be more easily "translated" into effective nudges. The next step is to prioritize the nudge ideas and to select suitable nudges. This is followed by an iterative process of implementation, evaluation, and rework. After a nudge is implemented, target behavior is measured. It is recommended (although not always feasible) to try out the corporate green nudge in a small test or pilot group or if possible, to study two comparison groups. The behavior of the treatment group exposed to the newly introduced green nudge is then compared to the behavior of a control group which continues to work as before. The effectiveness of the nudge can then be analyzed in a "Lessons learned"-workshop. Based on the results, the nudge concept and implementation can be improved. As previously indicated, a crucial success factor is to maintain transparency throughout the entire process because employees can quickly get the impression that they are manipulated rather than supported in choices which would be more harmful than beneficial. Transparency should therefore be a key concept during the implementation of corporate green nudges (Behringer, 2018).

Green nudges, however, cannot be seen as the one and only solution of companies to protect the climate. It is important to be aware of the limitations of nudges. Not every nudge might be appropriate for every employee. Just as individual citizens (Potthoff/Enste, 2021, 55 ff.), employees can have different environmental attitudes and expectations and might therefore differ regarding their receptivity to certain nudges. Organizational practices which concern environmentally friendly behavior are particularly effective among employees having weak individual environmental concerns (Dumont et al., 2017; Raineri/Paillé, 2016). The effectiveness of a nudge depends not only on the target group but also on the design of the nudge. According to research of Kotsopoulos et al. (2018) a gamified application for energy conservation at the workplace, for instance, can be appealing to employees and become a daily habit if it implements at least three game elements such as progression, levels and points. Gamification such as team energy saving competitions or team bicycle competitions, however, can contradict with personality traits or cultural norms (Seaborn/Fels, 2014) and extrinsic incentives through competitions, rewards and badges used in gamification can crowd out intrinsic motivation (Crowding out effect) to green behavior (Shahri et al., 2014).

Due to their limited effectiveness especially regarding long-term effects behavioral interventions cannot be seen as substitutes for direct forms of regulations (tariffs, taxes) for ecological change in companies but they

can be considered a useful tool to implement greener user behavior in offices without restricting the employees' freedom of choice or needing financial incentives. In addition to following the rules of the European Green Deal (EDG) and ecologically improving their own production and value chains companies should strive to develop their headquarters and office buildings into a "green office". Besides the climate aspect this future-oriented office concept also helps companies to work more economically and to save costs in the long term. During the development towards a green office, business leaders should implement green nudges such as defaults, feedback systems, gamification elements and social norms to motivate their employees towards more ecological decisions in a relatively cost-effective way. We recommend companies to choose green nudges which are to be implemented in the easiest and cheapest way and promise to achieve significant saving effects. To maximize the potential of ecological employee behavior, suitable and feasible nudge concepts presented from the list above can also be combined. As shown by the calculation in chapter 3.1, in case of a widespread introduction of certain green nudges such as electricity-saving measures, notable saving effects can be realized. The measures presented in chapter 3 and 4 serve as an inspiration for companies to implement and combine green nudges that are easiest for them to implement and most promising regarding the desired effect. In the interest of corporate climate protection, it should be borne in mind that the ultimate decision to act still lies with the employees themselves. To achieve a broad acceptability of the behavioral measures and to strengthen the trust of those affected, the attempt to motivate green behavior through nudges should be as transparent as possible. In this way, corporate ecological sustainability can be improved on a shared and ethically qualitative basis.

Abstract

Climate protection is one of the greatest challenges society and economy are currently facing. In addition to policy (Macro level) and individual consumers (Micro level) also companies (Meso level) are confronted with increasing pressure to act more ecologically sustainable. Besides ecological improvement in the production processes and value chains, corporate transformation to more ecological sustainability also demands a development towards the office model of the future, the “Green Office” which is realized by the triade of “green IT”, “green building” and “green behavior”. This requires employees who are willing to change and structures who enable change. In view of the fact that employees in offices are not yet financially incentivized to act ecologically sustainable in the work context the question arises as to whether behavioral-economic insights can be used to motivate employees towards more ecological choices in their work life. By an intelligent and effective use of green nudges employees can be supported by adopting climate-friendly choices with regard to the following fields of action: energy efficiency, sustainable mobility and resource use. Exemplary nudges are gamification elements such as team bicycle or energy-saving competitions, feedback on electricity or fuel consumption, carpool simplifications and default changes such as double-sided printing. If properly designed, green nudges can combine corporate climate protection, fun, team spirit and freedom of choice and can, for instance, achieve significant savings of 6.5 percent in electricity consumption. If all offices used in the top 7 cities (Cologne, Düsseldorf, Stuttgart, Frankfurt, Hamburg, Munich, Berlin) would save an average of 6.5 percent electricity through green nudges, assuming an annual electricity consumption of 70kWh per m² office area, 419,676 MWh, more than 176,000 tons of CO² and 167.87 million euros in electricity costs could be yearly saved in Germany.

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