# Lower the Heat

How one small change can have a positive impact on the road to net zero

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# Contents

# Executive Summary

Human activity, including the burning of fossil fuels for heat and power, is increasing atmospheric concentrations of greenhouse gases, leading to rising surface temperatures, mean sea-level rise, permafrost melt and extreme weather events.

These changes in climate activity are threatening global and regional communities with devastating consequences such as droughts, flash flooding, food and water scarcity and economic uncertainty. In addition, the effects of climate change are impacting the natural world, including an increased rate of animals under threat of extinction and the depletion of natural capital, such as coral reefs and fish stocks.

Far-reaching change is required by individuals and businesses across every industry, sector, and activity. The enormity of the task can feel overwhelming, yet incremental changes can make a big difference.

A good starting point for us all is to assess the climate impact associated with energy consumption from technologies we use everyday. The appliances sector – including refrigerators, washing machines and dryers, dishwashers, televisions, printers and other consumer electronics – accounted for one-quarter of all electricity used in buildings globally in 2019, and 15% of global final electricity demand.

While the energy consumed by the appliance sector is increasing year-on-year, regional differences in energy efficiency and electricity grid carbon emission intensity mean that in some areas, such as Europe and the United States, energy usage in the appliance sector is expected to fall – and efforts are needed to ensure that this trend continues. In other regions, such as Asia and Africa, increasing populations and appliance ownership trends are expected to cause significant increases in energy consumption – making gains in energy efficiency even more important.

In this report, we examine how the operation of appliances in our homes and businesses is contributing to climate change, and we illustrate the impacts on the natural world that are associated with the carbon emissions stemming from our use of appliances. We look at printers as an example of common household appliances, and we assess the 'operational energy efficiency' of different printer technologies and show the potential impact of market-wide adoption of more energy-efficient printers. We then show how the carbon reduction achieved by this adoption could enable the printer sector to align with the decarbonisation pathway described by the International Energy Agency's (IEA) Net Zero Scenario, which calls for appliance energy usage to fall to 60% of 2020 levels by 2050.

Printing seems like a small place to start, but when everyone on the planet makes small changes, it has an enormous impact. Simply put, smarter technology decisions are crucial to turning down the heat.

Tim Forman,
Senior Research Associate at University of Cambridge

# About the research

Epson joined forces with experts at the University of Cambridge to better understand how printing can play its part in reducing the impact of global warming. This is an important part of Epson's 'Turn Down the Heat' campaign with National Geographic to promote the protection of the world's permafrost.

The research project drew on the following sources to reveal the real-world impact of our printing decisions:

- International and regional reporting of energy and greenhouse gas emissions trends
- Peer-reviewed projections of climate change and related impacts
- Market research data reflecting printer sales by global region
- Electricity grid carbon intensity emission factors
- A detailed analysis of global printer energy consumption

# Testing methodology

From the outset, both Epson and University of Cambridge researchers were committed to ensuring the research outcomes were accurate and based on quantifiable and highly credible data sources.

When analysing the impact of a switch from laser to inkjet printers, the researchers went beyond like-for-like energy comparisons between laser and inkjet printers; they considered the indicative lifecycles of modern printers and used Energy Star's most up-to-date testing methodology.

Energy Star's recent revision (3.0) of the Typical Electricity Consumption (TEC) methodology provides the industry's leading standardised method of comparing appliance energy performance. Applied to printers, the methodology uses standard assumptions about operation patterns – including varying use over a specific period of time – to evaluate product energy performance.

Initially the researchers, using market research data which provided global unit sales of laser and inkjet printer by model and the TEC3 energy consumption methodology, calculated the energy consumption and associated carbon emissions linked to printer use in Western Europe, Central & Eastern Europe, Middle East & Africa, Asia Pacific, Latin America, Japan and Canada.

Once a value was determined for 'current' annual energy and carbon rates, the researchers then ran their calculations model again based on a 100% switch to inkjet printers. Noting that, based on the TEC3 method, inkjet printers are up to 90% more efficient than laser printers, depending on printer type and model.

This methodology allowed the researchers to approximate total energy and carbon emission reductions by implementing a shift to a less energy intensive printer, demonstrating the benefits of incremental improvements in the appliances market.

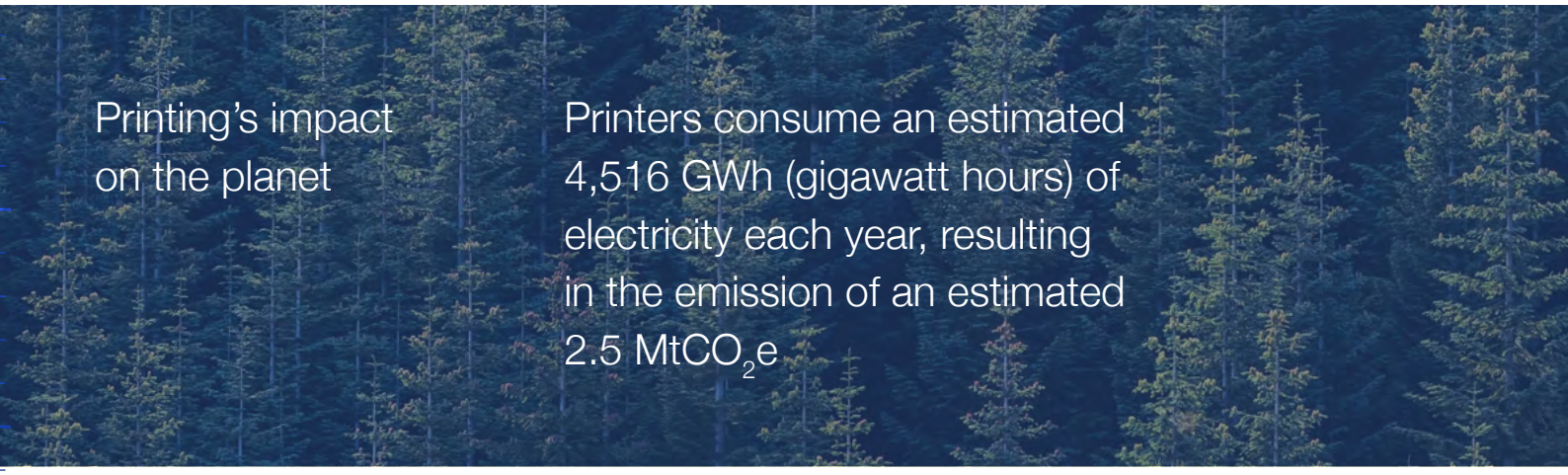
To make smarter decisions, we need to properly understand climate science, and the impact of our technology choices. That's the purpose of this study: to build knowledge and show how just one small change can have a positive impact on the path to net zero. We know that printers are only one part of the puzzle, but if we turned down the heat across every single household and business appliance, our sector could play a big part in protecting the world's permafrost."

Henning Ohlsson,
Director of Sustainability, Epson Europe

# Key findings

## Appliance emissions targets

- Appliance energy usage must fall to 60% of 2020 levels by 2050 to follow the IEA's Net Zero emissions scenario
- To keep the world on track for a net zero carbon future, the energy consumed globally by appliances must fall on average by approximately 25% from 2020 levels by 2030 and 40% by 2050
- According to IEA analysis, failure to meet its Net Zero decarbonisation scenario risks a 100% increase in the frequency of extreme heat waves and a 40% increase in ecological droughts
- Improving the energy efficiency of appliances – and reducing the energy required to produce appliances – is crucial to reaching net zero emissions by 2050 and avoiding the worst climate change scenarios



## Printing's impact on the planet

Printers consume an estimated 4,516 GWh (gigawatt hours) of electricity each year, resulting in the emission of an estimated 2.5 $MtCO_2e$

## Printer switch savings

- A pathway to a net zero future for the printing sector is possible; however, it depends on a global switch to the most energy efficient products such as inkjet printing technology
- Based on the TEC3 method, inkjet printers can be up to 90% more efficient than laser printers, depending on printer type and model
- A worldwide switch from laser to inkjet printers could reduce energy emissions by 52.6%
- A worldwide switch to inkjet could deliver global electricity savings in excess of 2,240 GWh per year equivalent to approximately

### 1,300,000 metric tonnes of carbon dioxide per year, or:

280,175 cars driven for one year

353 wind turbines running for a year

3,052,033 barrels of oil consumed

Calculated based on forecasted energy consumption per region and equivalent carbon dioxide emission savings (adapted from EPA GHG calculator)

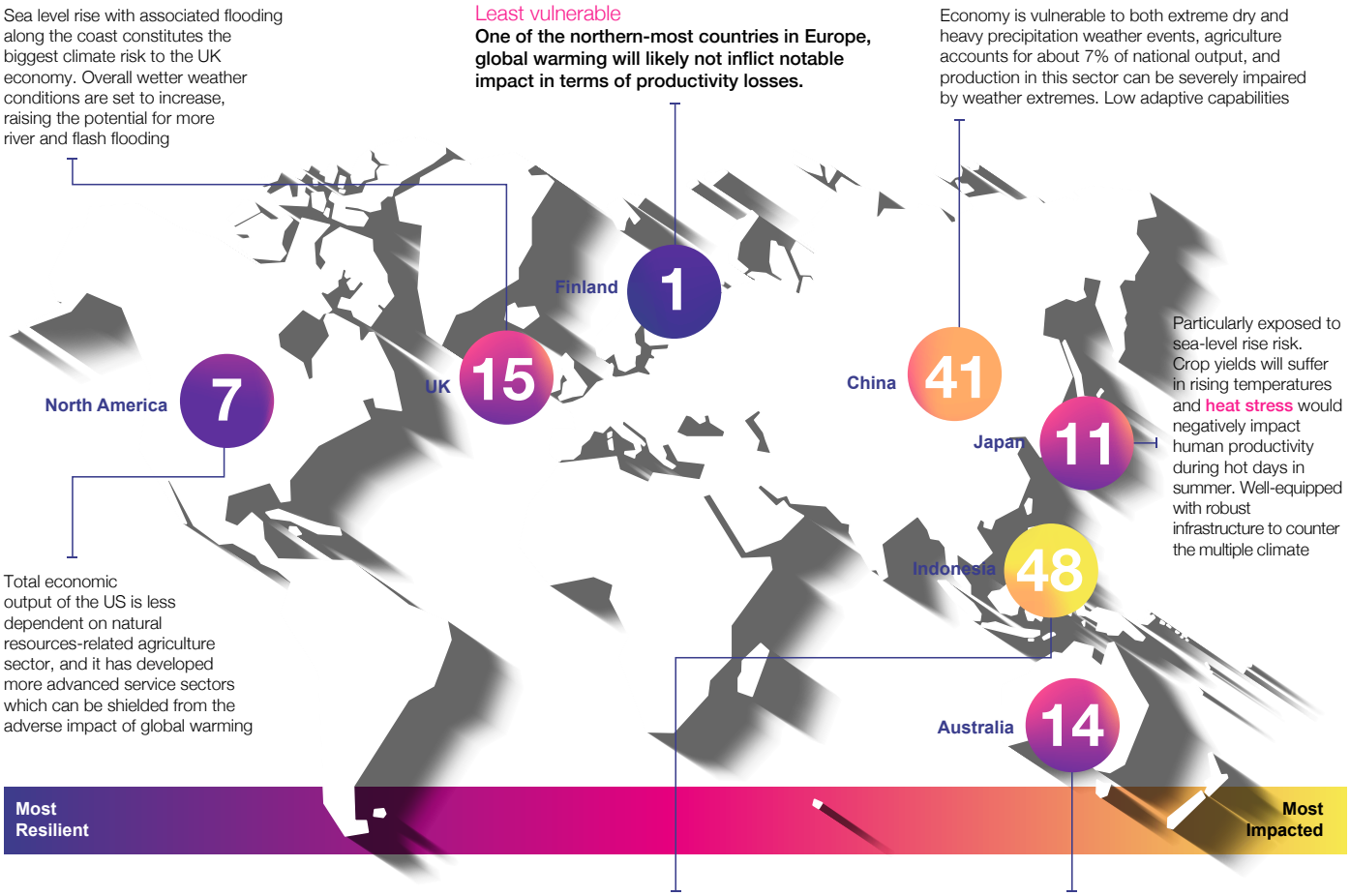
# Climate context

Recent news coverage around climate change has, at times, been noisy and overwhelming – dominated by promises and hyperbole. This section of our report goes back to the facts around the impact of climate change on people and the planet, reminding us why change is necessary.

## Regional climate change impacts

Human activities, specifically the burning of fossil fuels, is increasing atmospheric concentrations of greenhouse gases. This is leading to rising surface temperatures, mean sea-level rise and extreme weather events that are threatening global and regional communities. In a 3.2°C temperature-rise scenario by 2050, there will be an 18.1% loss of global economic value.[2]

The impact of climate change is global; however, the degree of vulnerability varies depending on geographic location and economic resilience. Below is a global heat map showing seven of the least and most vulnerable economies.




Source: The Regional Impacts of Climate Change, An Assessment of Vulnerability IPCC 2018 https://www.ipcc.ch/site/assets/uploads/2020/11/The-Regional-Impact.pdf

[2] The economics of climate change:no action not an option, 2020, Swiss RE Institute https://www.swissre.com/dam/jcr:e73ee7c3-7f83-4c17-a2b8-8ef23a8d3312/swiss-re-institute-expertise-publication-economics-of-climate-change.pdf

## Displacement of human communities

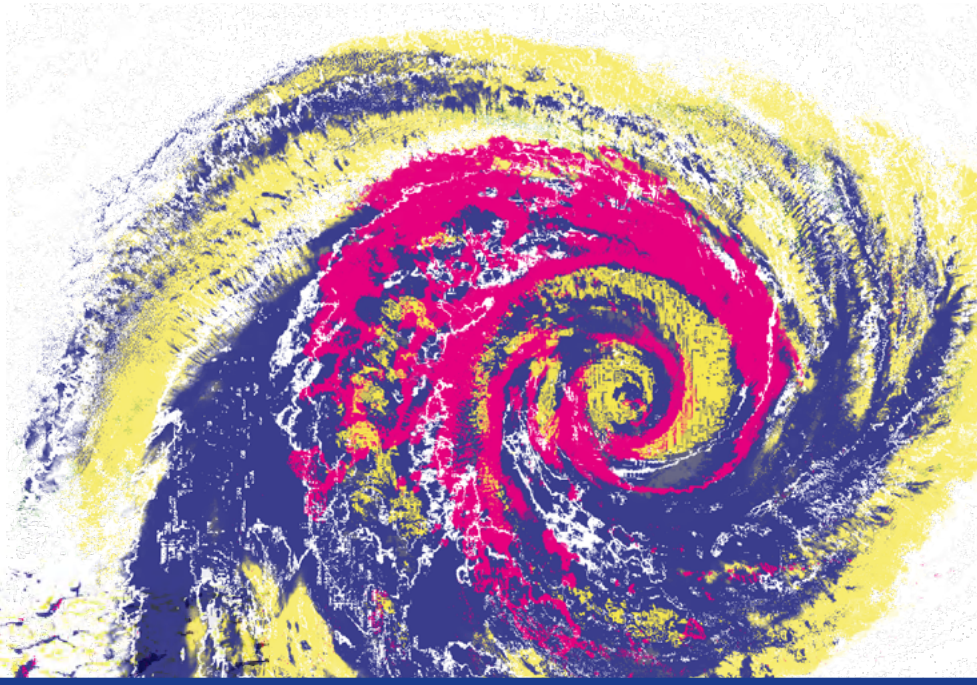
The effects of climate change such as water scarcity, increased frequency of natural disasters, agricultural disruption and shoreline erosion could cause displacement of human communities around the world. This is one of the most devastating social impacts of climate change, with one prediction placing the number of displaced people at 200 million by 2050.

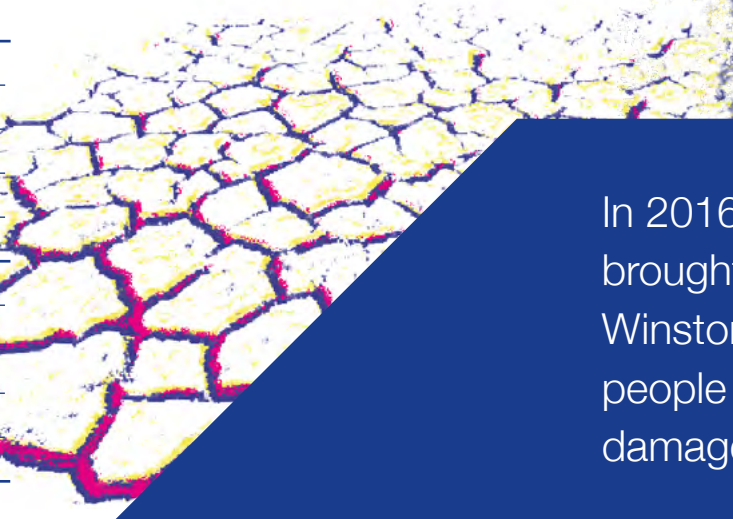
# 1 in 45 by 2050

By 2050 one in every 45 people in the world could be environmental refugees' - people displaced by climate change

# 25/47

Of the 47 nations regarded as being either water stressed or water scarce, 25 are regarded as facing a high risk of armed conflict or political instability because of climate change





In 2016, a year after Cyclone Pam brought destruction to Vanuatu, Cyclone Winston displaced more than 55,000 people in Fiji and caused loss and damage worth 20% GDP

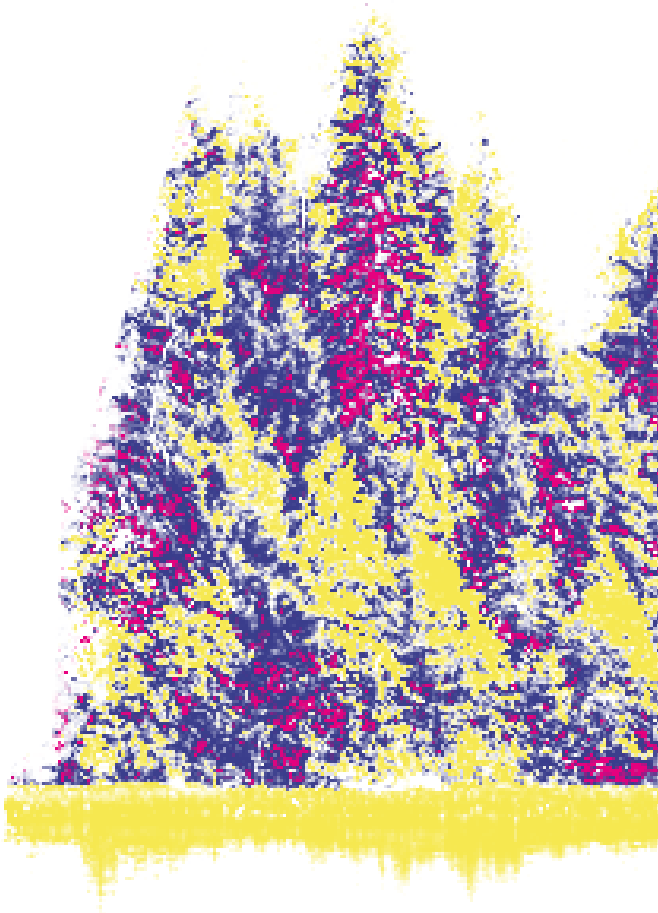
Sources: Myers, N., 1993. Environmental refugees in a globally warmed world. Bioscience, 43(11), pp.752-761.Smith, D, Vivekananda, J (2007) 'A Climate of Change: the links between climate change, peace and war', International Alert Government of Fiji (May 2016). Fiji Post-Disaster Needs Assessment: Tropical Cyclone Winston.

## Animal extinction risk

Human activities, including intensive agricultural processes, are threatening up to one million plant and animal species with extinction. Drastic action is required to reduce this threat and to mitigate biodiversity destruction.

**>55%**

>55% ocean surface area covered by industrial fishing vessels



**>40%**

>40% amphibian species threatened with extinction

**5.6 $GtCO_2/a$**

5.6 GtC02/a $CO_2$ emissions thought to be sequestered in marine and terrestrial ecosystems every year

**75%**
Land

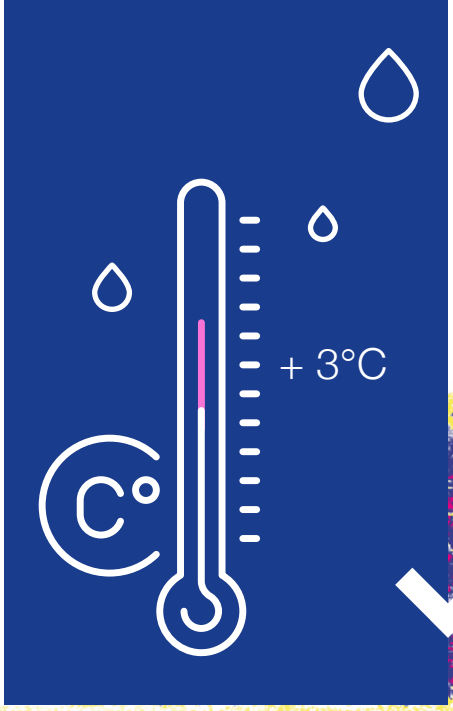
75% land-based and 66% of marine environments have been **significantly altered by human actions**

**66%**
Marine

Source: Nature, humans are driving one million species to extinction, 2009 https://www.nature.com/articles/d41586-019-01448-4

## Impact to natural capital

Climate change is also accelerating the depletion of the world's 'natural capital', or its natural resources that directly or indirectly provide value to people, including ecosystems, fauna and flora, land, minerals, the air and oceans, and natural services processes and functions.







### Permafrost Coverage

A 3°C rise in global temperatures could melt 30 to 60 percent of the top permafrost layers that exist across the Arctic region

### Forests

Forests cover 31% of global land area. Global forests declined by an average rate of 40% from 1990-2020

70%

### Fish Stocks

14% rise in global capture fisheries production from 1990 to 2018. 70% of the fish population is fully used, overused or in crisis.

50%

### Coral Reefs

Global coral reefs have reduced by 50% since 1955, due to global warming, overfishing, pollution and habitat destruction

Sources: Biskaborn, B.K., Smith, S.L., Noetzli, J., Matthes, H., Vieira, G., Streletskiy, D.A., Schoeneich, P., Romanovsky, V.E., Lewkowicz, A.G., Abramov, A. and Allard, M., 2019. Permafrost is warming at a global scale. Nature communications, 10(1), pp.1-11.

UN Food and Agriculture Organisation of the United Nations, The State of the World's Forests 2020

Ritchie, H. and Roser, M., 2019. Seafood production. Our World in Data.

Sully, S., Burkepile, D.E., Donovan, M.K., Hodgson, G. and Van Woesik, R., 2019. A global analysis of coral bleaching over the past two decades. Nature communications, 10(1), pp.1-5.

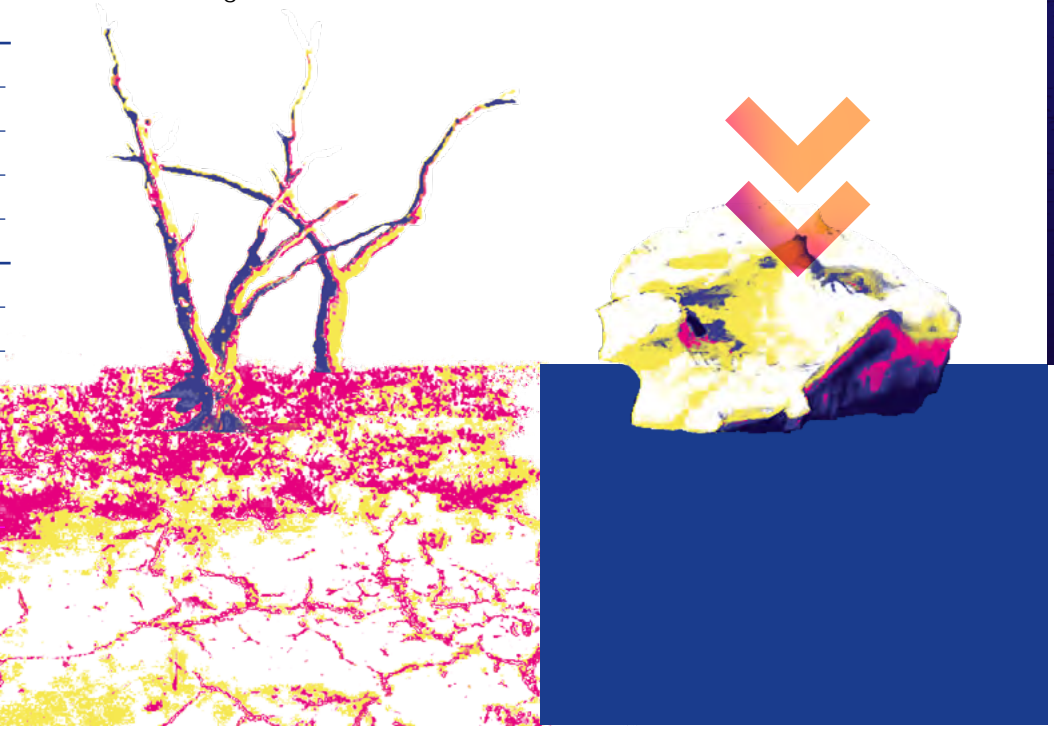
## Rising sea levels

Earth's global sea levels are rising as a direct result of climate change. The primary cause of climate change is greenhouse emissions in the atmosphere which warms the planet, resulting in the melting of polar ice sheets and glaciers globally, as well as the expansion of oceans due to increases in sea temperature.

Sea level rise is one of the most severe global risks from climate change and is threatening coastal ecosystems resulting in permanent submergence of land and more frequent and intense coastal erosion and flooding.

The energy to raise an average temperature increase of the world's oceans by 0.01°C would increase the atmospheric temperature by approximately 10°C.

30% of the world's irrigated areas are facing problems with salt water intrusion.



+10°C

If $CO_2$ emissions continue to increase sea levels may rise by a further 0.4 to 0.8m by 2100

Global mean sea level increased by 0.2m between 1901 and 2018

Sources: Douglas, B.C., 1991. Global sea level rise. Journal of Geophysical Research: Oceans, 96(C4), pp.6981-6992. Kelman, I. and West, J.J., 2009. Climate change and small island developing states: a critical review. Ecological and Environmental Anthropology, 5(1), pp.1-16. Betzold, C., 2015. Adapting to climate change in small island developing states. Climatic Change, 133(3), pp.481-489.

# A look at appliances

Domestic appliances have a role to play in this higher order problem, as the world aims to pursue improved efficiency to prevent every kilogram of greenhouse gas being released to the atmosphere.

Reducing the impacts of climate change requires us to reduce the carbon (or 'greenhouse gas') intensity of our lifestyles, which means we must use less energy and decarbonise that energy.

The world needs to decarbonise electricity, but the fact is that electricity remains relatively carbon-intensive. Even a complete transition to renewable technology will leave some residual carbon-intensity, and so it is critical that we reduce the demand for electricity – as well as do our best to reduce its carbon-intensity.

## Office outputs

The energy used in buildings accounts for approximately 28% of global energy-related $CO_2$ emissions. Furthermore, energy use in buildings accounts for roughly 38% of total global final energy consumption and 45% of consumption in OECD[3] countries[4].

The largest proportion of this energy use – and of the building sector's carbon footprint – is associated with the heating, cooling and ventilating of our buildings. In this regard, the use of appliances accounts for a very significant share of a building's carbon footprint. In fact, the electricity consumed by appliances for uses including cooking, cleaning, lighting, information technology, cold storage, and entertainment is estimated at 3,250 TWh, representing roughly 15% of global final electricity demand[5].

Selecting energy efficient office appliances and consuming less energy are important actions for businesses seeking to reduce carbon emissions that drive climate change.

3 The Organisation for Economic Co-operation and Development (OECD) brings together Member countries and a range of partners that collaborate on key global issues at national, regional and local levels.

4 Cabeza, L.F., Urge-Vorsatz, D., McNeil, M.A., Barreneche, C. and Serrano, S., 2014. Investigating greenhouse challenge from growing trends of electricity consumption through home appliances in buildings. Renewable and Sustainable Energy Reviews, 36, pp.188-193.International Energy Agency, 2020. Tracking Buildings. https://www.iea.org/reports/tracking-buildings-2020

5 International Energy Agency, 2020. Appliances and Equipment https://www.iea.org/reports/appliances-and-equipment

6 International Energy Agency, 2020. Energy Efficiency

7 US Department of Energy, Energy Efficiency and Renewable Energy, 2008

8 International Energy Agency, 2021. Appliances and Equipment (Tracking report). https://www.iea.org/reports/appliances-and-equipment

## Appliance energy consumption on the rise

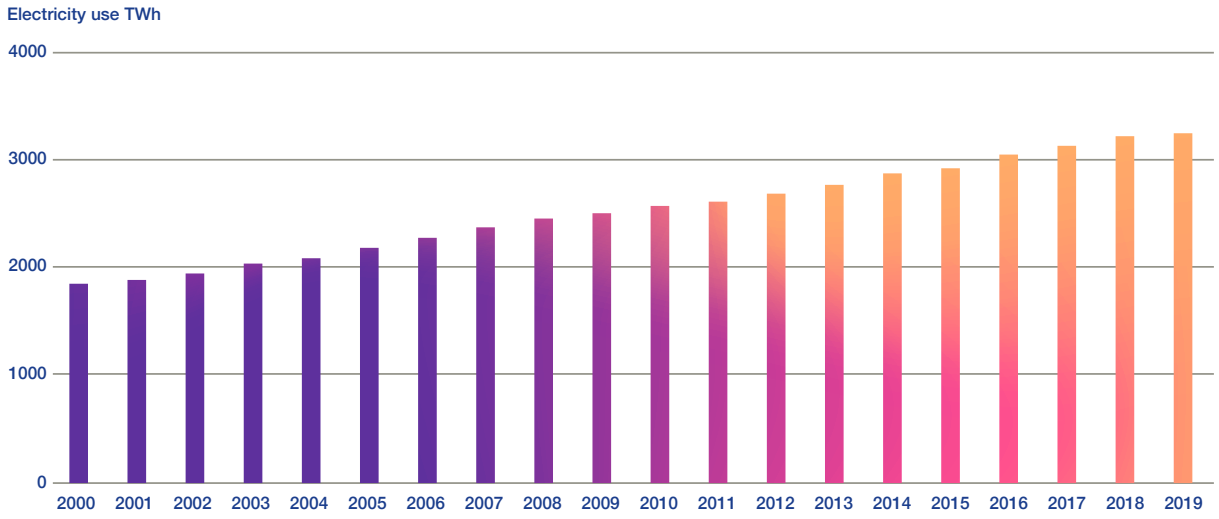
Appliance energy consumption is generally increasing internationally and is predicted to continue to increase; however, there is significant regional variation behind this trend driven predominantly by population growth, rising levels of appliance ownership, and changes in consumption and energy behaviour.

Changes to working patterns linked to the pandemic and the emergence of new information technology mean that many of us are spending more time working from home, which can have significant impacts on household energy consumption. In fact, working from home for a day can increase the energy consumed by a household by an estimated 7% to 23% compared to working at the office[6].

Energy consumed from plug-in appliances globally continued to increase in 2020 despite the pandemic. Appliance energy consumption in advanced economies such as Europe and the United States is expected to fall by at least 15-20% by 2030 even without further policy intervention[7]. Conversely, appliance energy consumption in Asia is expected to rise by over 50% and in Africa by roughly 130% by 2030[8].

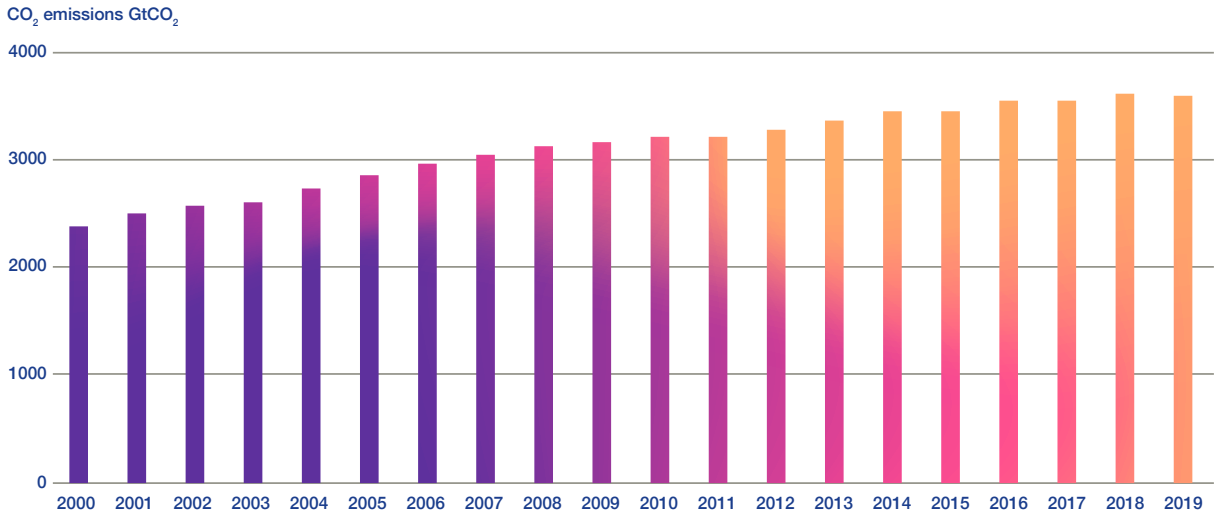
## Appliance energy consumption on the rise

Annual global electrical energy consumption by appliances (2000-2019)




## Carbon-intensive appliances

Annual carbon emissions from appliances electricity consumption (2000-2019)




## Carbon-intensive appliances

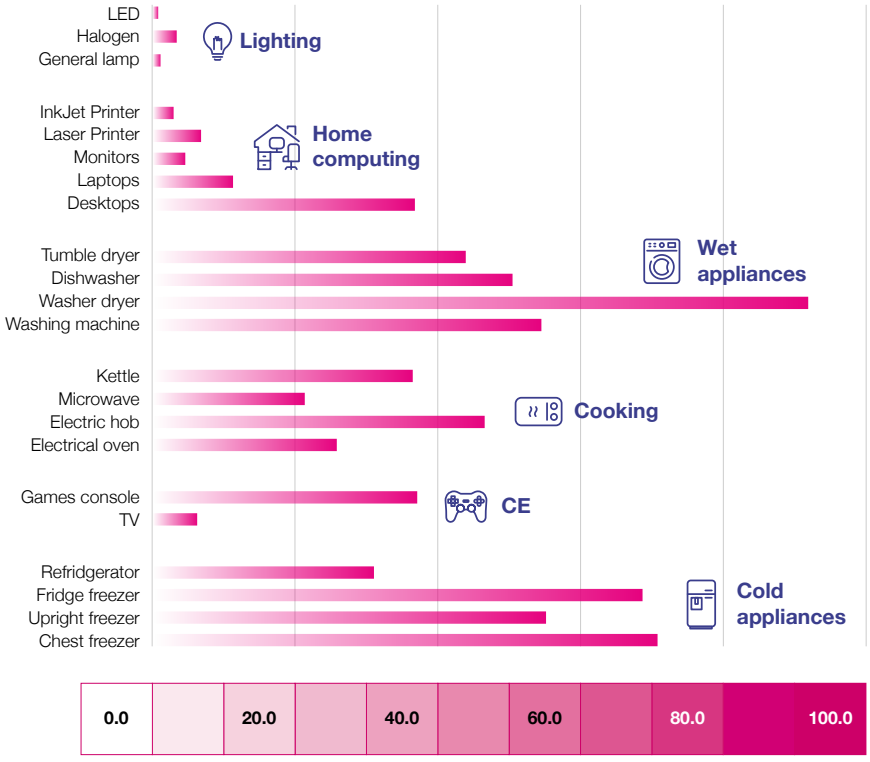
Wet appliances are generally the most energy-intensive and, subsequently, the most carbon-intensive. For example, an average washer/dryer used in the UK consumes 424 kilowatt hours (kWh) of electricity per year[9]; this electricity in the UK has an estimated carbon footprint of over 90 kilograms of $CO_2$ equivalent per year (90.02 $kgCO_2e$)[10].

This highlights how small changes in behaviour, such as re-wearing clothes and only running full loads of washing, could make a big difference.

Technological advancements in artificial lighting, such as improved uptake of LED light fittings, have reduced energy consumption in this subcategory substantially, reinforcing how incremental changes can mitigate total sector carbon emissions. Every single efficiency measure can make a difference.

## Carbon emissions per appliance sub category

United Kingdom 2020




Typical appliance power consumption % for UK dwelling

Other
1.7%

Water heating
7.1%

ICT equipment
8.1%

Handheld appliances
9.7%

Wet appliances
13.6%

Cooking
13.8%

Consumer equipment
14.4%

Lighting
15.4%

Cold appliances
16.2%

[10] Extrapolated from: International Energy Agency (IEA) Appliances and Equipment https://www.iea.org/reports/appliances-and-equipment UK Government Department for Business, Energy & Industrial Strategy National Statistics Database Energy consumption in the UK 2021 https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2021

[9] Extrapolated from UK Department for Business, Energy and Industrial Strategy (BEIS), 2021 Greenhouse gas reporting: conversion factors 2021

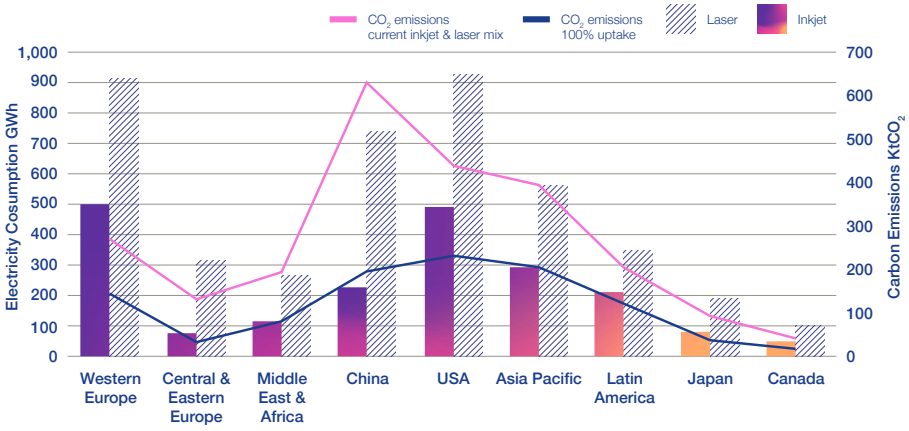
# Printing and the planet

Our research has identified that, globally, printers consume an estimated 4,516 GWh (gigawatt hours) of electricity each year, resulting in the emission of 2.5 $MtCO_2$. This is equivalent to consuming 3,052,033 barrels of oil.

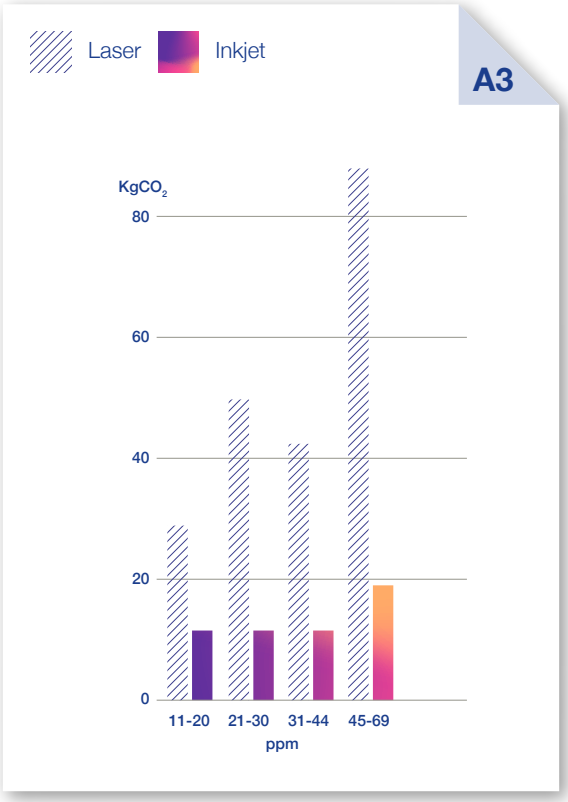
Total energy consumption includes the two principal printer technology categories: inkjet (1,665 GWh) and laser (2,700 GWh). Based on the Energy Star TEC3 product specification for imaging equipment efficiency standards, inkjet printers typically use less energy per printing task, in the order of up to 90% depending on the format, colour tone and speed of the printer model.

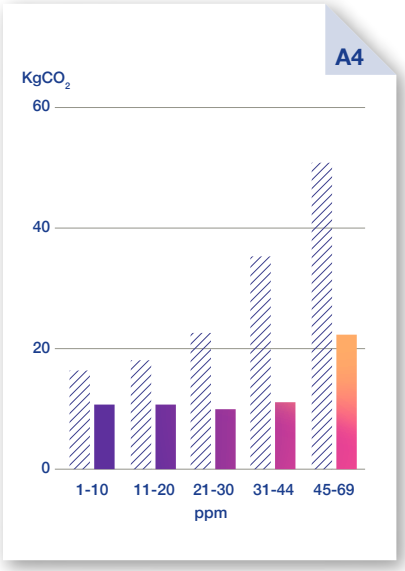
The following graph shows estimated annual energy and carbon from the current market, based on total quantity of printers in operation over a current four-year sales period. However, a worldwide switch to inkjet from laser printing technology could deliver global electricity savings in excess of 2,240 GWh per year - equivalent to approximately 1,300,000 metric tonnes of carbon dioxide per year.

## Annual printer energy consumption by region (TEC 3 methodology)




## Colour inkjet versus laser printer $CO_2$ emissions (Western Europe)



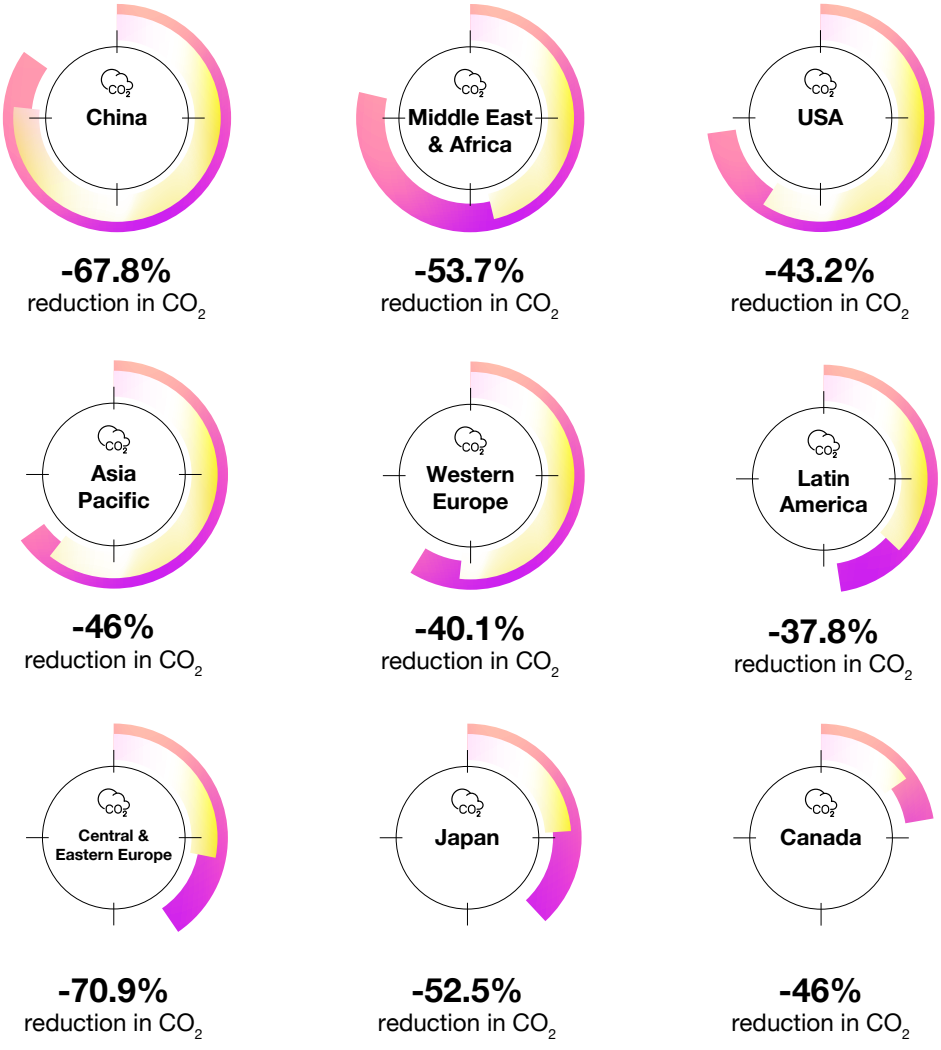




A comparison of inkjet and laser printer operating carbon emissions over a typical four year period shows significantly lower carbon emissions associated with inkjet printers than laser printers.

# Carbon emissions mitigation through enhanced printer efficiency

The research by Dr Tim Forman of the University of Cambridge revealed a worldwide switch from laser to inkjet printers by 2025 could reduce energy emissions by 52.6%.

With 2017-2020 global sales showing inkjets accounting for <50% of total printer sales, there is a significant opportunity to reduce energy consumption associated with printer operation. The graph below shows the operational energy and carbon savings that could be achieved across global regions by a complete market shift to inkjet printers:



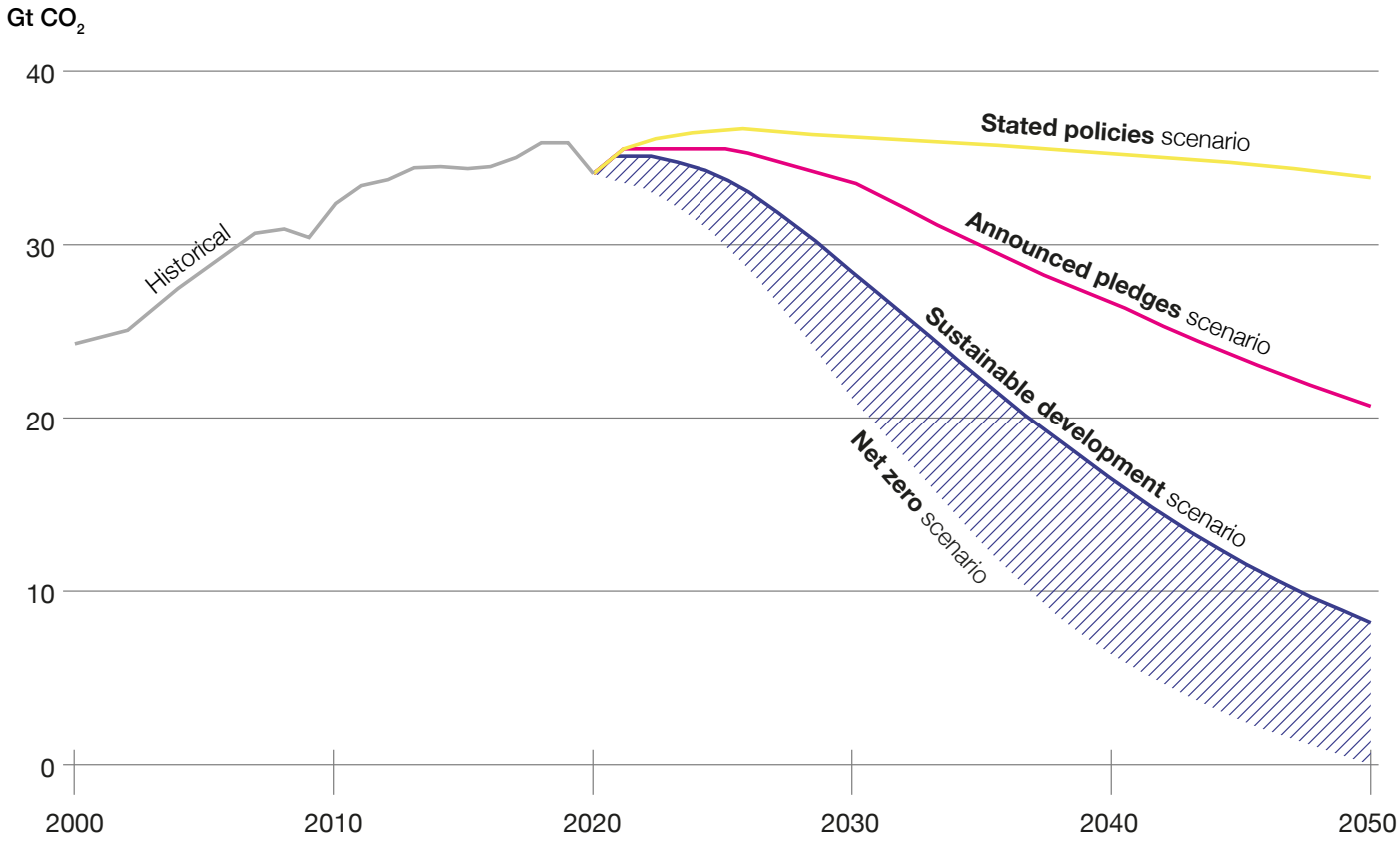

A worldwide switch from laser to inkjet printers by 2025 could reduce energy emissions by 52.6%

# The road to net zero


Improving the energy efficiency of appliances – and reducing the energy required to produce appliances – is crucial to reaching net zero emissions by 2050 and avoiding the worst climate change scenarios.

According to IEA analysis, failure to meet its Net Zero decarbonisation scenario risks a 100% increase in the frequency of extreme heat waves and a 40% increase in ecological droughts.

To keep the world on track for this net zero carbon future, the energy consumed globally by appliances must fall on average by approximately 25% from 2020 levels by 2030 and 40% by 2050.



# A call for action

Reducing the energy required to power our appliances in our homes and workplaces, including printers, is critical to minimising the devastating impacts of climate change.

This research has revealed that a pathway to a net zero future for the printing sector is possible; however, it depends on a global switch to the most energy efficient products such as inkjet printing technology.

We believe there is still more that can be done to reach net zero, and indeed move towards net positive, and have identified three ways we can make a collective change:

1. **Technological innovation:** With appliance ownership continuing to increase, reducing carbon emissions will rely on enhancing technological energy efficiency standards and reducing the energy intensity of manufacturing. One example of industry progress toward more energy efficient appliances is Epson's Heat-Free Technology, which does not require heat in the ink ejection process. Instead, pressure is applied to the Piezo element, which flexes backwards and forwards firing the ink from the printhead.

2. **International co-operation:** Greater international co-operation is needed to align MEPs, encourage the uptake of more efficient appliances, and improve efficiency labelling. As we saw with lighting regulations, this has the potential to accelerate action and drive down the costs of efficient appliances.

3. **Behaviour change:** If everyone on the planet makes one positive change, it can have a huge positive impact. People can choose Heat-Free Technology when replacing an existing printer to help reduce energy consumption and the associated greenhouse gas emissions. It also brings benefits in terms of efficiency, productivity, and financial savings.

There's no getting away from the fact that we're facing a global climate crisis, but the future is in our hands. One thing we have control over is our choice of technology and how we consume energy – and we can make the world a better place one appliance at a time.

https://www.epson.co.uk/heat-free-technology

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