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Sustainable dermatology—A practical guide for the Australian dermatologist

Eugene Tan MBChB, FACD

Skintel, Auckland, New Zealand

Correspondence
Eugene Tan, Skintel, Auckland, New Zealand.
Email: eugenederm@gmail.com

Abstract

Globally, healthcare systems can account for up to 10% of national CO_2 emissions. There is increasing awareness of the need to act to reduce the impact on our planet by living sustainably in our personal and professional lives. Literature on sustainability can be complex, and with so many demands on our attention and time, it is challenging for the practising dermatologist to grasp where to begin. This manuscript provides a practical guide with quantifiable impacts for each action. With mindful use of resources, both profitability and the well-being of patients and doctors can align with environmental protection.

KEYWORDS

Australia, carbon footprint, climate change, dermatology, ecosystem, environment, environment and public health, global warming, greenhouse gases

INTRODUCTION

Sustainability is about meeting today's needs without compromising the ability of future generations to meet their needs.[1] Current projections for greenhouse gas emissions (GHG) will fail to meet the Paris Agreement goal of limiting temperature rise to 1.5°C by the end of this century.[2] The healthcare sector is responsible for 7% of Australia's GHG emissions with hospitals and pharmaceuticals being major contributors.[3] Whilst dermatology may not seem to be a large contributor, 4.5% of all Australians have a chronic skin condition[4] and most dermatologists treat skin cancer due to its high incidence in Australia.[5] Climate change and extreme weather events have already impacted skin health, and this problem will worsen and disproportionately affect Aboriginal and Torres Strait Islander Australians.[6]

In a recent survey from 2022, the top environmental issues that Australians would like to see action on are renewable energy (48%), climate change (47%) and sustainability (42%).[7] However, heuristic biases are common barriers to action particularly in the field of sustainability and climate change. The problem has been described as being too abstract with perceived high short-term costs and intangible future gains.[8] This is compounded by the fact that manuscripts discussing sustainability can be complex. Whilst emphasis on governments and organisations is very important,[9] equally important are practical guides for the individual physician.

METHODS

Information sources for footprint calculations

A literature search was conducted in MEDLINE via PubMed on April 27th 2023 using the search terms

"Telemedicine"[Mesh] or "outreach" [tiab] or "Surgical Instruments"[Mesh] or "Surgical Equipment"[Mesh] or "Asepsis/methods"[Mesh] or "Anti-Bacterial Agents"[Mesh] or "Plastics"[Mesh] or "Anaesthetics, Local"[Mesh] or "Anaesthesia, Local"[Mesh] or "regional anaesthesia" [keyword] with the Boolean operator "AND" "Carbon Footprint"[Mesh] "OR" "Greenhouse Gases"[Mesh] "OR" "Greenhouse Effect"[Mesh]. No time duration was set due to the limited number of results in initial searches. The titles

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and abstracts were screened for relevancy and reviewed to further identify relevant literature.

For non-medical items, Google Scholar was used with the following keywords "electric vehicle" or "standby appliances" or "LED bulb" or "Halogen bulb" or "combustion engine vehicle" or "electric vehicle" or "solar panel" or "polystyrene" or "Styrofoam" or "plastic" or "flexible plastic packaging" or "recycling" or "surgical scrubbing" or "hand washing" and "lifecycle analysis" or "carbon footprint" or "greenhouse gas" or "usage". Google was used with the keywords "Australian Energy Market Operator" or "water consumption" or "solar hot water" or "water efficient faucets" or "surgical faucets" or "bicycle maintenance" or "Shimano manual" or "recycling" or "public transportation" and "carbon footprint" or "greenhouse gas".

This manuscript was written in consultation with the Environmental Sustainability Group (ESG) of the Australasian College of Dermatologists.

Demographic and usage scenarios

As of April 2023, correspondence with the Australasian College of Dermatologists confirmed there are 739 registered members of which 643 are in active practice in Australia, 16 are in active practice overseas, eight are non-practising and 72 are retired. There are 230 fellows in New South Wales and Australian Capital Territory, 183 fellows in Victoria and Tasmania, 124 in Queensland, 51 in South Australia and Northern Territory and 56 in Western Australia. Almost all practising dermatologists (92%) were exclusively located in metropolitan areas.[10] Location of practice was important for determining commuting distances.

The carbon dioxide equivalent emissions for all electricity generation bought and sold were obtained from the Australian Energy Market Operator.[11] In Australia, the supply and treatment of potable water is predominantly powered by electricity.[12,13] The energy required varies with location and is the highest for Perth due to the demand and use of desalinated water and lowest for Melbourne and Southeast Queensland.

Renewable energy costs 4–8 cents on top of standard grid electricity,[14] and thus, 6 cents was used as the average additional cost.

Data about motor vehicle usage, fuel efficiency, travel distances and patterns of travel were obtained from the Australian Bureau of Statistics, Australian Government Department of Infrastructure and Regional Development and the Federal Chamber of Automotive Industries.[15–18] Estimation of petrol use was based on the average commuting distance per year of 12,000 km.[15] Calculation of emissions from motor vehicles was based on data from the Green Vehicle Guide—an Australian Government Initiative.[19]

Energy and water consumption was based on a model private clinical practice defined in Supporting Information.

Solar panels and solar hot water systems were sized by calculations in Supporting Information.

Calculations of cost

For the detailed methods of cost calculation, see Supporting Information. Values are listed in Australian dollar (AUD). ($1 AUD = $0.59 Euros, $0.63 US Dollars, 0.50 British Pounds, $1.08 New Zealand dollar as of 06/09/2023 via www.xe.com using mid-market rates).

Greenhouse gas abatement curve

A greenhouse gas abatement or marginal abatement cost curve (MACC) is a graph that is commonly used in environmental economics to represent the relationship between the cost-effectiveness of different interventions and the total amount of GHG abated. Its main application is to assist individuals or companies in identifying the most impactful intervention in terms of GHG abatement whilst maximising savings/reducing costs. Detailed calculations are available in Supporting Information. It is customary to calculate this over a period of 10 years. The abatement curve was calculated for utilities (energy consumption) and transportation (motor vehicle, bicycle, public transportation and provision of an out-reach clinic) only. Detailed interventions in surgery are excluded from the scope of the general dermatology abatement curve but precise numbers are listed in the Table 1. Chemicals and waste interventions either have insufficient data or have too much heterogeneity between practices for a MACC to be modelled accurately. Where available, data are listed in Table 1.

RECOMMENDATIONS

A practical guide for the Australian dermatologist is listed in Table 1. The list is not meant to be an ideal or a complete list as different circumstances of each practice will permit different interventions. The purpose of these recommendations is to list actions in terms of their tangible benefits. Where cost savings are listed, this value is specific to the Australian dermatologist. Furthermore, reductions in energy consumption and emissions are based on averages and assumptions. A more detailed calculation would include sensitivity analysis to identify how uncertainties in input parameters affect outcome, but this is beyond the scope of this study.

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TABLE 1 Impact of interventions.

Utilities	CO_2e saved per year	Cost savings per year	Comment
Turning off machines at night	481 kg	$258	Based on the estimate of a 3% reduction in total electricity use
Retrofitting LED bulbs from halogen light bulb	2,179 kg	$1,170	LED lasts 5–10 times longer and consumes one-fifth of the energy
Adjusting thermostat to values closer to that of the outdoor temperature	1,146 kg	$615	Calculations based on a 1°C increase (in summer) or decrease (in winter)
Purchasing renewable energy	16,023 kg	No cost savings—it costs $1500 to purchase renewable power	Renewable energy costs on average 6 cents more than standard electricity rates. (Range 4–8 cents.)
Installing solar panels	11,180 kg	$85,109 net present value	Cost savings are expressed in net present value due to the number of variables required to project return on investment over a 25-year period
Converting to a solar hot water system (electric-boosted) from an electric hot water system	513 kg	$275	Calculations were performed assuming no PV panels were installed and electricity is supplied from the standard grid
Installing double-glazed windows	3,437 kg	$1,845	10% of floor area is recommended for glazing as per National Construction Code
Draught proofing the clinic	881 kg	$473	Up to 10% of the cost of heating and cooling could be saved
Installing water-efficient faucets	18 kg	$347	Based on installation of eight water-efficient faucets
Stopping water running whilst scrubbing and not rinsing one's hands	5 kg	$108	Based on handwashing 35 times a week for 48 weeks worked in one year
Transportation	**CO_2e saved per year**	**Cost savings per year**	**Comment**
Using an EV instead of an ICE vehicle	760 kg	$1,468	Assumes no renewable energy was used to power the EV
Using a conventional bicycle instead of an ICE vehicle	2,180 kg	$2,860	Based on an aluminium 10-speed commuter bicycle with manual gear shifting
Using an e-bike instead of an ICE vehicle	2,148 kg	$2,850	Based on an e-bike with battery voltage of 36 V, 14.4 Ah and 100 km per charge
Using public transport instead of an ICE vehicle	981 kg	$1,288	Cost of public transport was compared to running costs of an ICE vehicle. Cost savings would be greater if purchase costs of the vehicle were included
Carpooling instead of driving a private ICE vehicle	1,094 kg	$1,036	Assumes half the fuel and maintenance costs and CO_2e of an ICE vehicle. Includes the purchase cost of a vehicle
Provide out-reach dermatology clinics	Up to 46,998 kg	Not applicable	Assumes use of ICE vehicle. Value depends on distance travelled with higher savings the further the distance travelled to outreach clinic
Surgery	**CO_2e saved**	**Cost savings**	**Comment**
Avoiding single-use surgical instruments	50%–97%	A reusable stainless steel instrument costs 36% less after 4500 cycles	Precise CO_2e varies depending on number of instruments, quality of instruments and number of sterilisation cycles
Purchasing durable tungsten carbide surgical instruments	1.93 kg per instrument	$31–$150 per instrument saved	The environmental impact of a tungsten carbide-tipped surgical instrument is unable to be assessed due to paucity of data within the life cycle inventory databases. It is assumed to have minimal contribution to the production of surgical instruments as the weight of tungsten carbide is <1 g per set of instruments

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TABLE 1 (Continued)

Surgery	CO_2e saved	Cost savings	Comment
Using only instruments that are necessary	1.93 kg per instrument	$31–$150 per instrument saved	Prices vary depending on which instrument was purchased
Using only what is useful in terms of field sterility and surgical garb	5,520 kg per year	$23,549	Based on eliminating two disposable sterile surgical gowns and two disposable full body drapes (both are plastic). Consumption rate used was 10 surgical cases a day, two days a week for a 48-week work-year
Buffering local anaesthetic	29 kg per kg of lignocaine	Half the cost of local anaesthetic. Current prices are $198.85 per 20 mL bottle, box of 5. 20 mL vial or $78.01 for 5 mL vial, box of 10	Based on ratio 3:1 of 1% lignocaine with 1:1,000,000 adrenaline plus sodium chloride: sodium bicarbonate
Avoiding unnecessary use of antibiotics	Unable to be calculated	Not applicable	Widespread environmental impact from phototoxicity, development, aqua toxicity and antibiotic resistance
Recycling of soft plastics	Up to 1.24 kg per kg of flexible plastic	Not applicable	95% of flexible plastic packaging ends up in landfills, roadside litter and eventually the ocean. Plastic packaging debris is a major threat to marine life with wide-reaching effects ranging from entanglement, ingestion, a transport vector for chemical pollutants and loss of biodiversity/habitat by overlaying the seafloor
Sterilising	**CO_2e saved per year**	**Cost savings per year**	**Comment**
Minimising unnecessary surgical instruments	643 kg	$279	Compared to the wasteful scenario of a tertiary public hospital, four times less sterilisation was required if only the necessary instruments were used
Chemicals and waste	**CO_2e saved**	**Cost savings**	**Comment**
Avoiding anti-bacterial soaps for routine handwashing	Unable to be calculated	$0	Triclosan is especially toxic to algae and microalgae. It is very teratogenic to fish in their developmental stages. Triclosan is an endocrine disruptor—pregnant women and their foetuses are uniquely vulnerable
Recycling as much as possible	1,728 kg per year	Not applicable	Data estimated from lifecycle analyses of hospital waste
Buying recycled paper	0.76 kg per 500 sheets	$0	Each 500-sheet pack of virgin paper produces 2.37 kg of CO_2e
Implementing a paperless system	209 kg per year	$8,640	Based on transitioning from mailing correspondence letters to electronic digital correspondence
Avoiding Styrofoam (Expanded Polystyrene)	4 kg per kg of styrofoam	Varies. Costs is $0.09–0.10 per Styrofoam cup	Rapidly fragments into microplastics which has the ability to be eaten by almost all marine species and acts as a vector for carrying high amounts of toxic chemicals
Eliminating bottled water and drinking tap water instead	4.70 kg per 1 L bottled water	$1.20 per 1 L bottle	Bottled water has a carbon footprint that is 27 times higher than tap water which is 0.173 kg per L

Abbreviations: EV, Electric vehicle; ICE, Internal combustion engine; LED, light-emitting diode.

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1. Reduce electricity waste

Machines on standby can still consume electricity. Turning off machines has been estimated to reduce total electricity use by 3%–12% per year.[20,21] Retrofitting LED bulbs from halogen bulbs has been estimated to reduce running costs for lighting by 80% per year and last up to ten times longer.[22]

Up to 55% of the energy used in homes and businesses are for heating and cooling.[23] Maintaining the thermostat to values closer to the outdoor temperature reduces energy consumption. Every degree Celsius increase (in summer) or decrease (in winter) has been estimated to reduce energy consumption by 13%.[24]

Behavioural habits such as the above have no cost but save money immediately and reduce GHG emissions.

2. Install photovoltaic (PV) panels or purchase renewable energy

Installing PV panels is very cost-effective and has a huge impact on reducing GHG emissions. The payback period can be as short as 1.7 years with a net present value of $85,109. Net present value is the value of all future cash flows over the entire life of an investment discounted to the present. A positive value means a worthy investment.

The installation of solar panels is subject to the availability of adequate roof space and access/permission for such installations. If solar PV is not an option, purchasing renewable energy provides a similar reduction without the initial upfront costs but has an ongoing marginal cost.

3. Install a solar hot water heating system

Installation of a solar hot water system assumes no concomitant use of solar PV panels as it would be counterintuitive to have both. Hot water accounts for around 16% of the average Victorian household's energy costs.[25] A solar hot water system is a passive system which harnesses the sun's energy to heat water. It requires either a gas or an electric backup to provide hot water when the sun is not shining or when the water in the cylinder is used up. Converting to an electric-boosted solar water heating system from an electric storage water heating system saves a modest amount of only $275 per annum with a financial payback period of 20 years.

4. Install double glazing

Double glazing is most effective as part of a newly built premise as the costs of retro-fitting double-glazed windows are high. The payback period for retro-fitting is 20 years.

5. Draught-proof to prevent loss of heat in winter and cooled air in summer

The cost of draught proofing is low and has an excellent payback period of under a year. Air leakage accounts for 15%–25% of winter heat loss and summer heat gain amounting to 5.5% of total electricity consumption saved by weather-sealing doors and windows.[26]

6. Install water efficiency faucets and modify hand scrubbing behaviour

Water efficiency faucets with a 6-star Water Efficiency Labelling Scheme (WELS) of 5 L/min can be expensive with a payback period of 6.9 years, but a behaviour modification such as turning off the faucet whilst scrubbing can be more impactful, reducing water use by up to 63% resulting in savings of $108 per year and 5 kg CO_2e. There is also increasing evidence for the elimination of water altogether from surgical hand antisepsis and replacement with an alcohol-based waterless scrub.[27–29]

7. Choose sustainable modes of transportation

Converting from an internal combustion engine (ICE) vehicle to an electric vehicle (EV) saves $1,468 and 760 kg of CO_2e annually assuming no renewable energy was used to power the EV. This reduction in CO_2e could be increased if renewable sources of electricity were used (saving $1,833 and 2,180 kg CO_2e per annum).

Public transportation produces about 90% less volatile organic compounds, carbon monoxide and almost 50% less nitrogen oxides and carbon dioxide when compared with the scenario of every individual using a private ICE vehicle.[30] The costs and CO_2e of carpooling are estimated to be half of an internal combustible engine light personal vehicle.

Carpooling and purchasing an electric vehicle save GHG emissions but are not as cost-effective nor as impactful as using a bicycle (electric or manual bicycles).

Offering telehealth services is an effective way of bypassing emissions and cost of transportation altogether. In addition, incentives could be offered to staff or patients to choose more environmentally sustainable means of travel such as offering e-vehicle charging stations and the ability to work from home for administration duties.

8. Provide outreach clinics

Outreach clinics (where dermatologists travel to a group of people who may not otherwise have access to those services) have a high impact as around 7 million people—or

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28% of the Australian population—live in rural and remote areas.[31] Patients residing outside metropolitan areas could travel 180 km from large rural areas (population > 25,000–99,999) to more than 360 km for those in remote areas (population < 5000) in order to see a dermatologist. No data exists for the carbon footprint reduction of an Australian dermatology outreach clinic, but data from Ireland[32] estimated a saving of 26,180 kg of CO_2e (based on a 142 km average round trip for the medical team) and data from Canada estimated a saving of 47,000 kg of CO_2e per clinic per annum (based on median distance of 327 km of travel).[33]

9. Avoid single-use surgical instruments and purchase durable tungsten carbide instruments

GHG emissions can be reduced by 50%–97% if reusable products are used.[34,35] A high-quality tungsten carbide-tipped instrument is expected to last up to five times longer compared to a full stainless steel instrument making it both cost-effective and environmentally sustainable in the long term.

10. Use only instruments and consumables that are necessary

An example of a wasteful use of surgical instruments was illustrated in an earlier manuscript where thirty-three surgical instruments were within a surgical tray to excise a skin cancer at a tertiary public hospital compared to only eight instruments at a private clinical room.[36] Seventy-four per cent of the public hospital's instruments were unnecessary and should not have been purchased, sterilised or packaged in the first place (Table 1).

A recent meta-analysis found no substantial evidence exists to support the use of head covers, gowns, full patient draping, laminar airflow and footwear to reduce surgical site infection on skin and minor hand surgery.[37] The need for sterile surgical gowns and excessive full patient sterile draping should be questioned.

11. Buffer local anaesthetic

Previous studies have demonstrated the efficacy and safety profile of buffering local anaesthetic in terms of reducing pain during infiltration.[38] Using the formula described by the authors (see Table 1) would halve both the cost and GHG emissions of local anaesthetic as one vial would last twice as long.

12. Avoid unnecessary medications and demand that pharmaceutical industries and medical suppliers disclose their carbon footprint

Avoid the unnecessary use of antibiotics. Whilst no data exist with regard to the carbon footprint of antibiotics, pharmaceuticals as a whole have a large carbon footprint. A recent analysis of the carbon footprint of the National Health Service in England has revealed that supply chain emissions were dominated by the manufacturing of pharmaceuticals and chemicals.[39] Dermatologists play an important role in demanding that pharmaceutical industries and medical suppliers disclose to us the carbon footprint of their products and supply chain so that we can make informed, environmentally sound purchasing decisions.

13. Recycle

At the time of writing, soft plastic recycling is not a possibility in Australia due to the collapsed REDcycle scheme.[40] Whilst the impact of recycling soft plastics is listed in Table 1, collaborating with pharmaceutical industries and manufacturers of consumables to reduce the use of plastics is even more important. Recycling is not limited to soft plastics and by recycling as much as possible one could save up to 1,728 kg of CO_2e per year.[41]

14. Avoid antibacterial soap for non-surgical handwashing

Triclosan is widely used in antibacterial/antimicrobial products including soaps, toothpaste and cleaning products. Triclosan commonly enters the environment though wastewater as conventional wastewater treatment does not remove it completely. No literature exists in regards to the carbon footprint of triclosan but triclosan has widespread environmental and biological effects (see Table 1).[42] There is no evidence that antibacterial soaps are required in routine handwashing.[43]

15. Implement a paperless system

The carbon footprint of one A4 sheet of office paper ranges from 0.0043 to 0.0047 kg CO_2e and paper production accounts for 1.3% of global GHG emissions.[44] The cost-saving of a paperless system extends beyond the cost of purchasing paper. A simple intervention such as transitioning from mailing correspondence letters to electronic digital correspondence can save $8,640 and 209 kg of CO_2e per annum. There are also the intangible benefits of patient and doctor satisfaction along with improved delivery of health care if extended to areas such as electronic consent.[45]

16. Avoid Styrofoam

Expanded polystyrene (commonly known as Styrofoam) produces up to 4 kg CO_2e per 1 kg of material.

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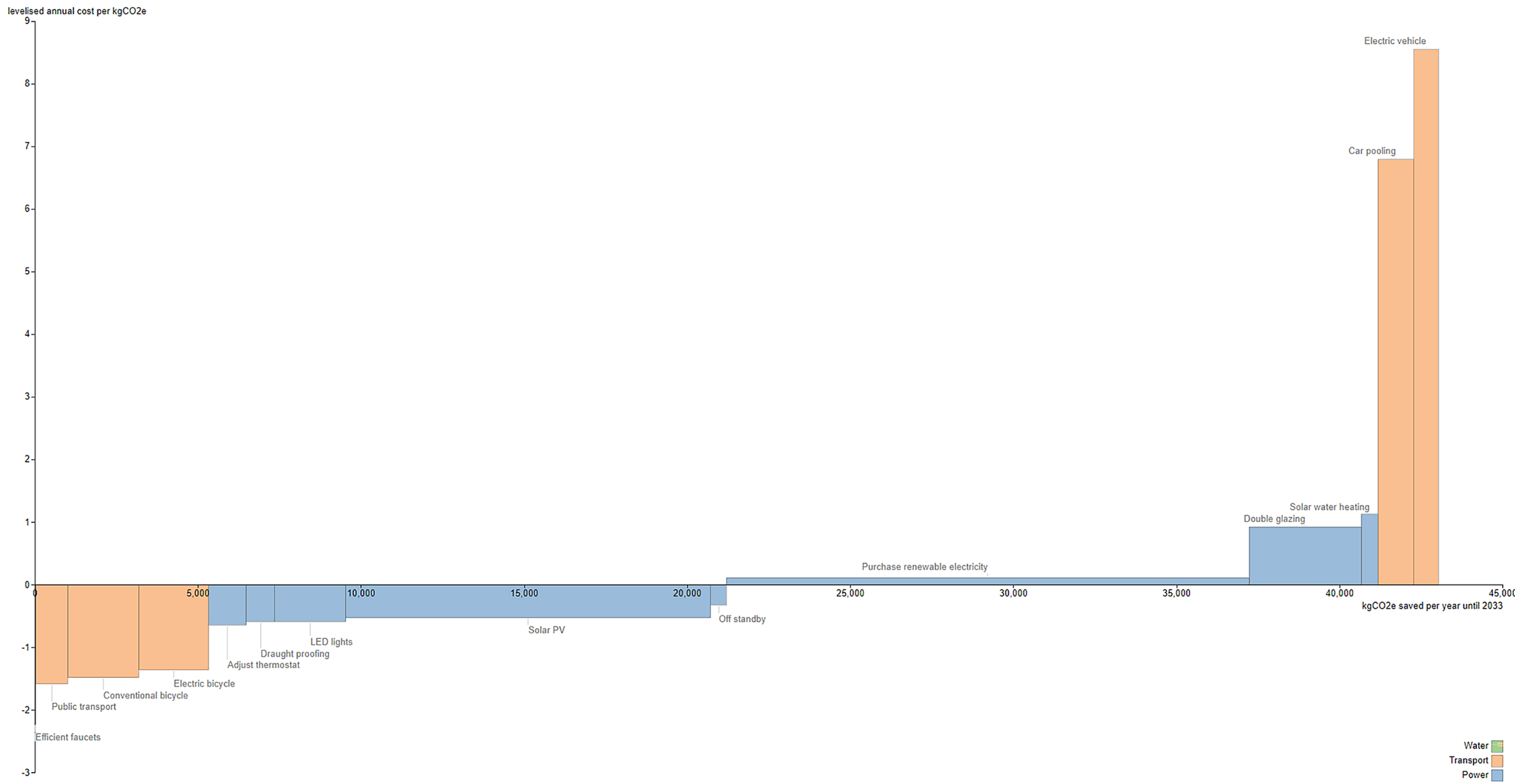

FIGURE 1 Greenhouse gas abatement curve for the average private dermatology clinic. Boxes above the *x*-axis indicate there is a cost to that action – the higher the box, the higher the cost. Boxes seen below the *x*-axis line indicate a saving from that action – the lower the box, the greater the saving. The width of the box indicates the action's potential volume of reduction per year, expressed as $kgCO_2e$. The curve shape is created by ordering the actions from lowest cost on the left, to highest cost on the right. A negative cost refers to a cost saving whereas a positive cost refers to an ongoing cost incurred. *Note*: The impact of turning off faucets is not displayed due to magnitude of scale and resulting under-representation of other variables but is shown in Supporting Information.

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Expanded polystyrene is commonly used in the form of disposable cups in a clinic. The cost of expanded polystyrene is negligible, and because it is light, the carbon emissions are small per item. However, <1% is recycled worldwide due to its chemical properties, and it takes hundreds of years to decompose along with consuming vast spaces in landfills.[46]

17. Eliminate bottled water

The total carbon footprint of one 1 litre plastic water bottle is about 4.70 kg of CO_2e which is twenty-seven times higher than tap water in Australia.[47]

ABATEMENT CURVE

The GHG and financial savings of the above actions are presented in the GHG abatement curve (see Figure 1). On the *x*-axis, interventions are ranked from left (least cost) to right (highest cost). On the *y*-axis, values below zero indicate a saving, whereas values above zero indicate a cost. Sixty-seven per cent (10 out of 15) of the abatement measures analysed could be achieved at positive net present value meaning that adopting these ten options would generate positive economic returns over a short period of 10 years.

CONCLUSION

Sustainability and cost savings are often tightly coupled and this is particularly important in our competitive environment and cost of living crisis.[48] These economically attractive sustainable options are time perishable—for every year of delayed implementation, there is a missed opportunity for a potential saving.

The importance of sustainability is being recognised by many medical specialties including our own.[49–51] In addition to policy changes, by initiating the steps above, each dermatologist can begin making an impact and lead the way in reducing the carbon footprint of our profession.

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ORCID
Eugene Tan https://orcid.org/0000-0001-7935-9179

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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