Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

OCDO
OFFICE OF CHIEF DENTAL OFFICER ENGLAND

NHS England London

Faculty of Dental Surgery
ROYAL COLLEGE OF SURGEONS OF ENGLAND

Clinical guidelines for environmental sustainability in dentistry

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Foreword

The aims of dental services are to provide safe, high-quality patient care and preventative advice. It is recognised that in doing so, services will have an impact on the environment. Delivering high quality dental healthcare services using effective environmentally sustainable management of dental practices will, through educational programmes, guidelines, and dedicated action, support the reduction of greenhouse gas emissions into the atmosphere, leading to an improved environment and human health.

The *Clinical guidelines for environmental sustainability in dentistry* is an initial step in creating a more environmentally sustainable dental healthcare system. These clinical guidelines align with the Irish 2021 Climate Action plan, to create a climate action roadmap, and to the UK's Climate Change Act 2008 NHS target, set in its report on 'Delivery a Net Zero National Health Service', which aims to tackle climate change by reducing the amount of greenhouse gases being released.

Our approach to formulating environmentally sustainable clinical guidelines for dentistry has sought advice from the breadth of stakeholders relevant to dental healthcare services. We aim to provide a better understanding and raise awareness on how to make dental healthcare services more environmentally sustainable through all our combined actions within or for dental practices.

Developed by Trinity College Dublin (Republic of Ireland), NHS England (London), and the Office of the Chief Dental Officer England, these guidelines aim to give all staff working in dentistry a better understanding of how to make services more environmentally sustainable.

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Clinical guidelines for environmental sustainability in dentistry

1. Background

Climate change through increased greenhouse gas emissions[1] to the atmosphere is a challenging global issue as it poses a major threat to human health and even more so to the health of future generations. Over 28,000 premature deaths per year due to air pollution are estimated in the UK [1]. If no rapid action is taken, there will be more extreme weather events, such as frequent air pollution, flooding and heatwaves, leading to increased risks of respiratory diseases, water-borne diseases, heat stroke, injuries and premature death [2].

After the Climate Change Act was adopted in 2008, the NHS has taken significant steps to reduce its environmental and human health impacts by reducing its carbon footprint[2] by 100% under the *NHS Carbon Footprint*[3] and *NHS Carbon Footprint Plus*[4] by 2040 and 2045 respectively [3].

Within dentistry, staff travel for work purposes and commuting to work was found to be the most carbon-intensive activity (33.4%) in dental services across England in 2013 to 2014, followed by patient travel to dental practices (31.1%), procurement (19.0%), electricity and gas (15.3%), nitrous oxide release (0.9%), waste (0.2%) and water (0.1%) (Figure 1) [4].

When assessing the carbon footprint of 17 various dental procedures (Figure 2), dental examinations were considered the highest contributor to the dental carbon footprint (27.1%) due to a high proportion of examination-only encounters within NHS dental services in 2013 to 2014. This was followed by scale and polish (13.4%), amalgam fillings (9.7%), composite fillings (9.7%) and other procedures.

A proportion of the dental carbon footprint associated with 33 million courses of dental examinations was attributed to patient travel (43.9%) and staff travel (30.5%). Although, when compared with courses of treatment interventions, an individual examination-only procedure was found to be the lowest contributor to the carbon footprint [4].

Different levels of organisations have taken actions to improve carbon footprint within the NHS dental services. For instance, the National Institute of Clinical Excellence (NICE) recommends relevant organisations to develop policies encouraging their staff to walk and cycle as part of their travel to and from work [5]. With regard to sustainable waste management, Plymouth University demonstrated proper nitrile gloves and paper waste management as environmentally sustainable and cost-effective [6].

Accelerated actions and system transformation are required both to create a sustainable healthcare system and to achieve the targets set by the Irish government and British National Health Services. Appropriate service delivery approaches, workforce, health information systems, funding, preventive care and leadership for environmental sustainability in dentistry is crucial in order to sustain long-term benefits of environmental and human health [7].

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[1] The term ‘greenhouse gas emission’ refers to the emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3).

[2] The term ‘carbon footprint’ refers to the total amount of greenhouse gas emitted by an organisation, individual, service or product.

[3] The NHS Carbon Footprint includes both direct and indirect emissions, which are those that we cause ourselves or that are caused by products or services we buy.

[4] The NHS Carbon Footprint Plus includes all indirect emissions, which are more difficult to estimate and outside of our control.

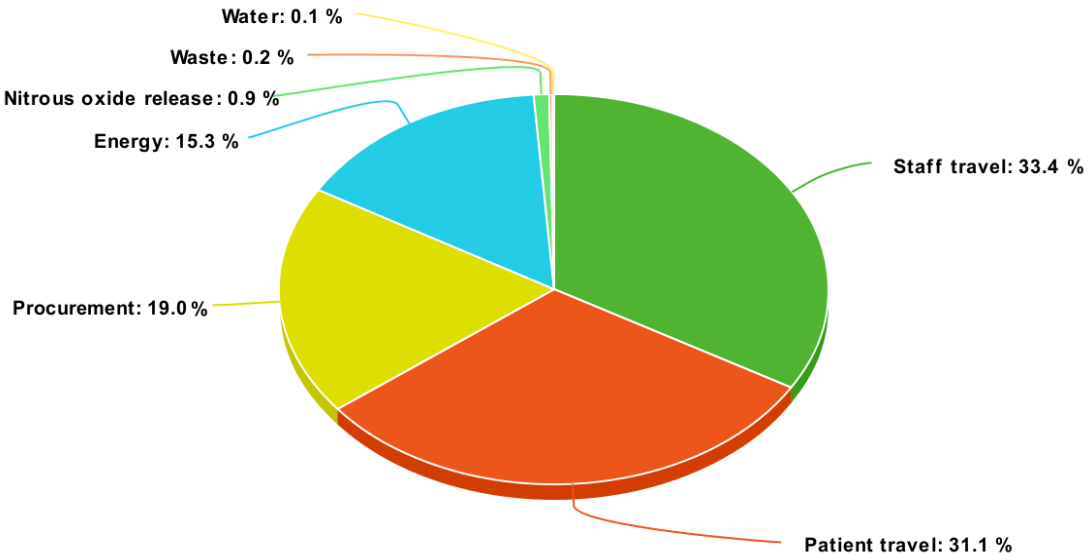

Figure 1. *The carbon footprint of dentistry in England 2013-2014. Reproduction [4].*

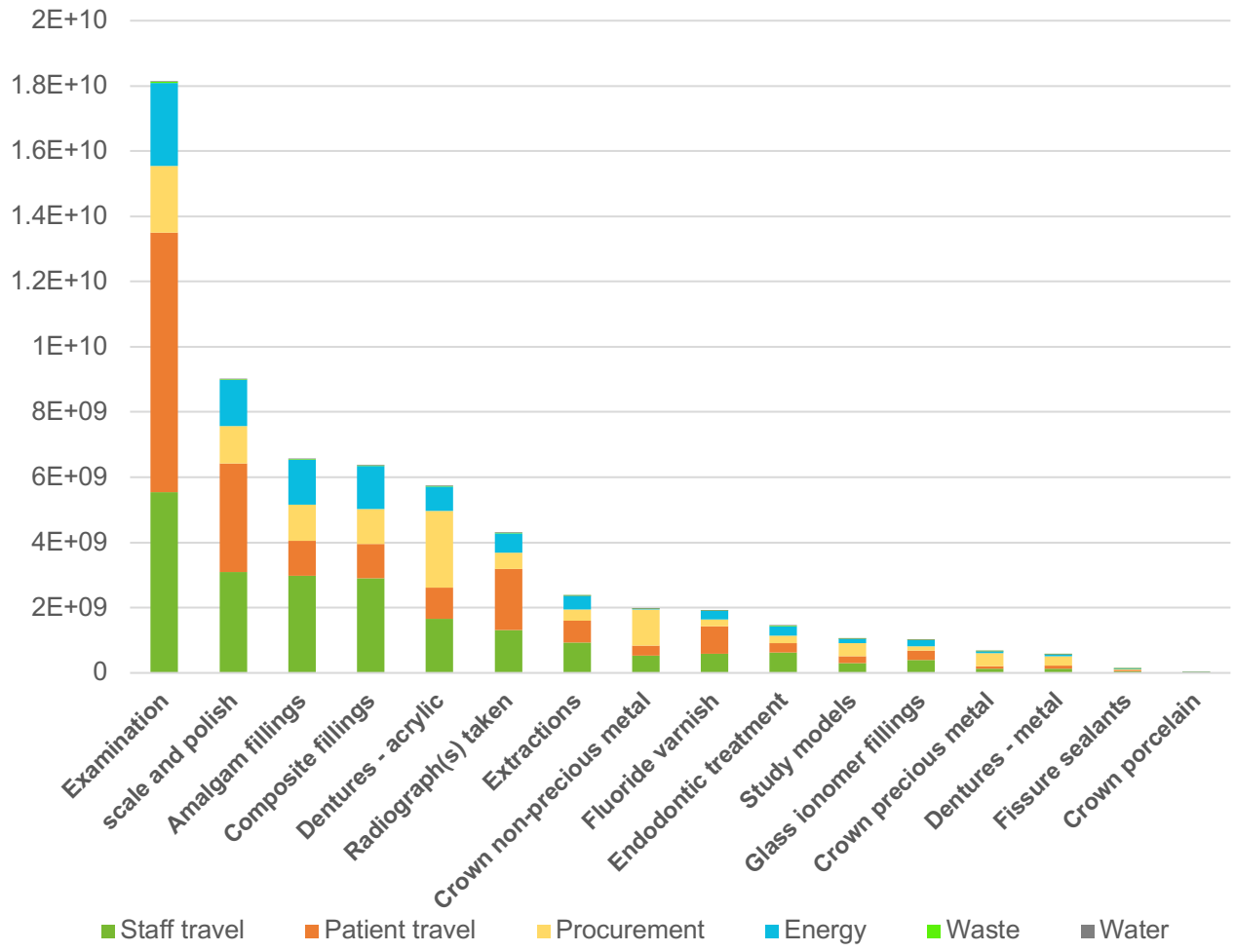

Figure 2. *Carbon emission (CO_2 equivalent) for every dental procedure (excluding other procedures) Reproduction [4].*

2. Vision

Our vision is to provide a pragmatic public health-focused approach to the development of clinical guidelines for the delivery of environmentally sustainable dental care aligned to wider sustainability goals.

The vision is to:

- Raise awareness and understanding of the environmental effects of oral health care across the dental profession and the public
- Provide direction to the profession on how they might manage changes to their practice to provide environmentally sustainable dental health care
- Reduce levels of carbon emissions, especially emissions resulting from patient and staff transportation. Travelling to and from the dental clinical settings accounted for 64.5% of the carbon footprint of dentistry in 2013 to 2014.

3. For whom have these clinical guidelines be written?

Users of these clinical guidelines	Examples
Dental teams	• Dentists • Dental care professionals • Dental practice managers • Dental leads, e.g., Specialists in dental public health, Offices of the Chief Dental Officer • Non-clinical staff within dental practices
Education organisations	• Universities, e.g., University College London, Trinity College Dublin • Royal Colleges, e.g., Royal College Surgeons England, Royal College of Surgeons in Ireland, Royal College of Physicians and Surgeons of Glasgow, Royal College of Surgeons of Edinburgh • Health Education Authorities, e.g., Health Education England, NHS Education for Scotland, Health Education and Improvement Wales • Professional bodies, e.g., College of General Dentistry, British Dental Association
Government establishments (National, regional and local)	• National Health Services, e.g., National Health Service England, Health Service Executive Ireland • Public health agencies
National regulatory organisations	• Dental Council, e.g., General Dental Council, Dental Council of Ireland • Independent regulators, e.g., Care Quality Commission
Public health professionals	• Dental public health practitioners/specialists

4. Alignment of clinical guidelines to international frameworks

Sustainable Development Goals and Ottawa Charter

These clinical guidelines are intended to support implementation of the 2030 United Nations (UN) Sustainable Development Goals (SDGs) [8]. This UN Agenda sets out a framework for achieving a more, sustainable, prosperous and peaceful society by 2030. Climate action is emphasised in the SDGs, i.e. 'Take urgent action to combat climate change and its impacts' [9].

The SDG declaration emphasises that in order to achieve the climate change goal, the following targets must be covered: 'Integrating climate change measures into national policies, strategies and planning' and 'Improving education, awareness and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning'. This places national strategies, including the development of clinical guidelines at the centre of the SDG 13 climate change goal and SDG 13 as a contributor to sustainable development, with linkages to all other relevant SDG targets. Progress towards SDG 13 will be dependent on other SDGs, including quality education (SDG 4), clean water and sanitation (SDG 6); affordable and clean energy (SDG 7); industry, innovation and infrastructure (SDG 9); reduced inequalities (SDG 10); and responsible consumption and production (SDG 12).

The foundation for subsequent efforts of SDG 13 in tackling climate change and its impact, and other linked SDGs, was laid within the Ottawa Charter. According to the Ottawa Charter, "Peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice, and equity are all main resources for health" [10] and the SDGs also target these themes. The 1986 Ottawa Charter on health promotion is "the process of enabling people to increase control over, and to improve, their health". The following five main actions towards the prevention of illness and promotion of health were incorporated within this charter: "building healthy public policy, creating supportive environments for health, strengthening community action for health, developing personal skills and reorienting health services" [10].

5. Summary of domains and clinical guidelines

Table 1 summarises all domains within the clinical guidelines for environmental sustainability in dental practice. Each listed statement was based on the principles of the Ottawa Charter, in order to achieve its relevant SDG goal.

In clinical guideline 7(a), creating supportive environments within the caries-risk community to improve access for fluoride via fluoridation water supplies is central to the success of the Ottawa Charter. However, its proposal and implementation to the non-fluoridated areas require support from many stakeholders, including the government establishments, public health professionals, dental teams and members of the public. With this community oral health prevention approach, improvement in oral health and the SGD 10 (that is, reduction in inequalities within and among nations) can be achieved, which in turn will combat climate change (SDG 13) due to its lower emission of carbon into the air.

Domain		Clinical guideline		Aligned Ottawa Charter principle	Aligned Sustainable Development Goal	
1	**Travel**	1(a)	Encouraging efficient dental appointments to reduce travel for staff and patients	Strengthening community action	9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
		1(b)	Encouraging active travel for staff and patients		3	Ensure healthy lives and promote well-being for all at all ages
		1(c)	Installing electric vehicle charging points	Creating supportive environments	9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
2	**Procurement**[5]	2(a)	Purchasing more sustainable choice of products or services	Creating supportive environments	12	Ensure sustainable consumption and production patterns
		2(b)	Encouraging the reduction of anaesthetic gases for dental procedures			
		2(c)	Improving appropriate access to dental care			

[5] Sustainable procurement is a process 'whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, while minimising damage to the environment.' 'It should consider the environmental, social and economic consequences of: Design; non-renewable material use; manufacture and production methods; logistics; service delivery; use; operation; maintenance; reuse; recycling options; disposal; and suppliers' capabilities to address these consequences throughout the supply chain [17].

3	**Waste**	3(a)	Managing proper segregation of clinical and non-clinical waste	Developing personal skills	12	Ensure sustainable consumption and production patterns
		3(b)	Introducing recycling			
		3(c)	Reducing paper waste			
		3(d)	Reducing single-use plastics			
		3(e)	Managing food waste			
		3(f)	Managing amalgam waste			
		3(g)	Reducing water waste			
		3(h)	Managing safe disposal of medication			
4	**Energy efficiency**	4(a)	Retrofitting existing dental practices	Creating supportive environments	9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
		4(b)	Generating own power within dental practices		7	Ensure access to affordable, reliable, sustainable and modern energy for all
5	**Education**	5(a)	Training in good practice of green dentistry	Developing personal skills	4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
6	**Biodiversity**	6(a)	Creating a biodiverse garden	Creating supportive environments	9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
		6(b)	Designing the built environment with features that support flora and fauna			
7	**Effective prevention**	7(a)	Recommending community water fluoridation scheme in non-fluoridated areas	Creating supportive environments	10	Reduce inequality within and among countries
		7(b)	Recommending supervised tooth brushing programmes for nurseries and early years settings in targeted areas where oral health and/or the risk factors for poor oral health are greatest			
		7(c)	Incorporating preventive care in every patient pathway	Re-orienting dental services into preventive care services		

Table 1. *Summary of the seven domains supporting environmental sustainability in dentistry*

6. Clinical guidelines per domain

Key

The following symbols will be used:

Cost of action:

 = Low/ No cost (practice funded)

= Medium cost (national-part funding/ practice-part funded)

= High cost (national funding)

Action can be achieved within:

 = 1 month

= 1 year

= 5 years

Domain 1: Travel

Clinical guideline 1 (a):
Encouraging efficient dental appointments to reduce travel for staff and patients

Actions:

Dental teams should consider:

- combining multiple dental procedures, e.g. combining restorations with other preventive measures, within a single visit [7, 11]

- using low environmental footprint technology for virtual appointments, where possible [12]

- using a digital intraoral scanner to reduce travel (patient, laboratory and where appropriate) [7]

- scheduling appropriate dental examination according to caries risk (i.e. 3 to 24 months) [13]

Education organisations should consider:

- highlighting the environmental and human health benefits of reduced travel for staff and patients by encouraging efficient dental appointments [7]

National regulatory organisations should:

- ensure that education organisations incorporate the environmentally sustainable benefits of reduced staff and patient travel into the training curricula [7]

- work with primary care teams to develop integrated, robust data sharing for remote working and overcome cross organisational barriers with firewalls, etc.

Clinical guideline 1 (b):
Encouraging active travel for staff and patients

Actions:

Dental teams should consider:

- starting a step challenge for the entire workplace by collecting pedometer counts every week [14] 
- raising awareness and encouraging employees to walk and/ or cycle as part of their daily commute [4] 
- advising and supporting to help people plan how they are going to increase their levels of active travel [14] 
- disseminating information on how to be more physically active and on the health benefits of such activity [4] 
- using active travel to get to and from practices [4] 
- choosing a less busy road as an alternative route to travel to work [4] 

Education organisations should consider:

- highlighting the importance of active travel for staff and patients to promote planetary and human health [14] 

Government establishments should consider:

- encouraging walking among staff and patients by:
  - producing maps showing recommended safe walking routes as direct as possible and along routes that keep walkers separate from traffic [15] 
  - ensuring routes are well signed - particularly routes from bus stops, local rail, and underground stations [15] 
  - having a discussion with local outdoor clothing suppliers to provide discounts on footwear and clothing for staff [15] 
- encouraging cycling among staff to and from dental practice by:
  - discussing with local authorities to improve cycle infrastructure and facilities, e.g. safe bike storage, to deliver a better, quality and safer cycling environment [15] 
  - having promotional activities that can provide people with information, skills and positives examples of role models [15] 

Public health professionals and government establishments should consider:

- developing policies to encourage staff to walk, cycle or use other modes of transport involving physical activity (to travel to and from work and as part of their working day) [14]

National regulatory organisations should:

- ensure that education organisations incorporate the environmentally sustainable benefits of active staff and patient travel into the training curricula [14]

Clinical guideline 1 (c):
Installing electric vehicle (EV) charging points

Actions:

Dental teams should consider:

- supporting the installation of EV charging at dental practices [14] 
- displaying information about the advantages of using an electric vehicle in the practice, as well as the locations of the nearest charging stations [14] 
- encouraging themselves to use EVs [14] 

Education organisations should consider:

- highlighting the planetary and human health benefits of installing charging points for EVs [16] 

Government establishments should consider:

- supporting the installation of EV charging infrastructure on the sites within or near dental practices [16] 
- regulating EV charging energy rates to improve affordability 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of charging points installation for EVs [16] 

Domain 2: Procurement

Clinical guideline 2 (a):
Purchasing more sustainable choice of products or services

Actions:

Dental teams should consider:

- purchasing groceries items and stationery with social or environmental accreditation [17]

- buying wood products or furniture that are from forestry certification programmes [17]

- utilising less toxic and more eco-friendly chemicals for cleaning and disinfection [17]

- using digital radiography equipment to prevent the use of hazardous processing chemicals [14]

- asking each supplier whether they have a statement on sustainability and request a copy through email [14]

- auditing stock every month to determine whether items are closer to the expiry dates and to re-order stock [14]

- reducing order frequency whenever stock requirements can be predicted more accurately [14]

Education organisations should consider:

- highlighting the planetary and human health benefits of purchasing more sustainable products for dental practices

Government establishments should consider:

- developing environmentally sustainable policies in sustainable procurement for dental practices [18]

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of purchasing dental products and services

Public health professionals should consider:

- supporting government establishments to develop sustainable procurement policies

Clinical guideline 2 (b):
Encouraging the reduction of anaesthetic gases for dental procedures

Actions:

Dental teams should consider:

- educating patients about the environmental impacts of general anaesthesia compared with local anaesthesia and conscious sedation techniques [19]

- assessing the efficacy of and addressing waste from inhalation sedation systems delivering nitrous oxide to dental patients [20, 21]

- using alternatives to general anaesthesia, such as conscious sedation, for dental procedures where possible and clinically appropriate [19]

- reducing the use of nitrous oxide for anaesthetic and analgesic agents for dental procedures where possible and clinically appropriate [22]

Education organisations should consider:

- highlighting the planetary and human health benefits of reducing anaesthetic gases used during dental procedures [22]

Government establishments should consider:

- developing environmentally sustainable policies for dental general anaesthesia and its alternatives [23, 24]

National regulatory organisations should:

- ensure that education organisations incorporate the environmentally sustainable benefits of clinically appropriate use of conscious sedation and anaesthetic gases for dental procedures into the training curricula

Public health professionals should consider:

- supporting government establishments to develop policies on conscious sedation and general anaesthesia and alternatives in dentistry

Clinical guideline 2 (c):
Improving appropriate access to dental care in order to reduce travel and resources used

Actions:

Dental teams should consider:

- enhancing primary dental care by providing:
  - effective triage systems [25, 26]
  - intermediate-level (tier-2) locally-based services [27]
  - comprehensive electronic referral systems [25, 26]
  - teledentistry[6] services where possibly appropriate [11]

- services that prioritise behavioural management techniques over the use of anaesthetic gases, including nitrous oxide [28]

[6] Teledentistry makes use of communication tools, including audio and visual communication to deliver dental services remotely, including consultation and oral health education.

Domain 3: Waste management

Clinical guideline 3 (a):
Managing proper segregation of clinical and non-clinical waste

Actions:

Dental teams should consider:

- supporting their staff by raising awareness and implementing behavioural change programmes on waste segregation [29] 
- developing a guide on waste segregation for staff [6] 
- providing bins with clear labels [6] 
- segregating the following healthcare waste into appropriate bins [6]: 
  - waste for recycling, including cardboard, paper and plastic into recycling bin
  - domestic waste, including packaging into black bin
  - clinical waste, including gloves, aprons contaminated with infectious bodily fluids into yellow bin

Education organisations should consider:

- highlighting the planetary and human health benefits of proper segregation of clinical and non-clinical waste [29] 

Government establishments should consider:

- developing policies in the management of proper segregation of clinical and non-clinical waste [30] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of proper segregation of clinical and non-clinical waste [29] 

Public health professionals should consider:

- supporting government establishments to develop policies in management of segregating clinical and non-clinical waste [30] 

Clinical guideline 3 (b):
Introducing recycling within dental practices

Actions:

Dental teams should consider:

- developing a recycling policy and distributing to staff [6]

- a contract for waste disposal includes recycling [6]

- placing recycling bins in strategic locations and label them clearly [6]

- conducting waste audits on a regular basis [6]

Education organisations should consider:

- highlighting the planetary and human health benefits of introducing recycling within dental practices [16]

Government establishments should consider:

- developing environmentally sustainable policies in recycling [30]

- cross organisational discussions/ regulation involving manufacturers of healthcare supplies, and public/ commercial waste organisations

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of recycling waste [16]

Public health professionals should consider:

- supporting government establishments to develop recycling policies [30]

Clinical guideline 3 (c):
Encouraging the reduction of paper waste in dental practices

Actions:

Dental teams should consider alternatives to printing documents, for example:

- slideshows presentation or video conference for staff meetings [31]
- electronic patient records and scanning for record keeping [6]
- email and voicemail instead of memos or letters [31]
- telephone calls or text messaging for appointments and remainders [31]

Dental teams, if printing a hard copy is necessary, should consider:

- using recycled paper [31]
- reducing the font size or spacing within documents [6]
- proofreading documents carefully on screen before printing out [31]
- setting double-sided printing and photocopying as default [31]

Dental teams should consider:

- monitoring and auditing paper consumption and using a calculator to determine the amount of carbon emissions [15]
- reviewing the use of paper for record keeping [31]

Education organisation should consider:

- highlighting the importance of paper waste reduction within dental practices to promote planetary and human health [32]

Government establishments should consider:

- developing environmentally sustainable policies in paper waste management [30]

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of managing paper waste reduction [32]

Public health professionals should consider:

- supporting government establishments to develop paper waste management policies [30]

Clinical guideline 3 (d):
Encouraging the reduction of single-use plastics in dental practices

Actions:

Dental teams should consider:

- using autoclavable plastic or metal as an alternative for single-use disposables (e.g. suction tips, cups, examination kits and impression trays) [33] 
- limiting multiple use of gloves while providing patient care [33] 
- raising awareness and encouraging public and patients to use plastic free toothbrushes and toothpaste dispensers [33] 
- monitoring and auditing on single-use plastics consumption on a regular basis [33] 

Education organisation should consider:

- highlighting the importance of waste reduction in single-use plastics within dental practices to promote planetary and human health [32] 

Government establishments should consider:

- developing environmentally sustainable policies in single-use plastics waste management [30] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable benefits of managing single-use plastics waste reduction [32] 

Public health professionals should consider:

- supporting government establishments to develop single-use plastics waste management policies [30] 

Clinical guideline 3 (e):
Managing the disposal of food waste in dental practices

Actions:

Dental teams should consider:

- arranging waste collectors to collect food waste [34] 
- composting food waste in the garden to improve soil quality [35] 
- installing worm farms to manage food waste [6] 

Education organisations should consider:

- highlighting the benefits of managing food waste disposal to promote planetary and human health [36] 

Government establishments should consider:

- developing environmentally sustainable policies in disposal of food waste management [30] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable and human health benefits of proper disposal of food waste [36] 

Public health professionals should consider:

- supporting government establishments to develop policies in food waste disposal management [30] 

Clinical guideline 3 (f):
Managing amalgam waste within dental practices[7]

Actions:

Dental teams should consider:

- reducing or eliminating amalgam waste [37] by using: 
  - amalgam as minimal as possible [38]
  - pre-capsulated amalgam [29]
  - alternative restorative materials, including composites [29]
- checking chair-side amalgam traps, vacuum filters and amalgam separators regularly to ensure their efficiency [39] 
- using non-hypochlorite cleaners to minimise dissolution of amalgam [39] 
- utilising an amalgam waste container for collecting the waste [29] 

Education organisations should consider:

- highlighting the importance of managing amalgam waste to promote planetary and human health [40] 

Government establishments should consider:

- their role in environmental policies related to amalgam waste management [41] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable importance of proper management of amalgam waste [40] 

Public health professionals should consider:

- supporting government establishments to understand their role related to environmental policies covering amalgam waste management [41] 

[7] This supports the strategy of phasing down the use of dental amalgam across all age groups by 2030 as described in the Minamata Convention on Mercury [27]

Clinical guideline 3 (g):
Reducing water waste within dental practices

Actions:

Dental teams should consider:

- liaising the property owners and water management consultants to improve water efficiency within the dental practice [16] 
- installing taps with motion-sensor or/ and low pressure taps in dental surgeries [14] 
- purchasing water efficient dental equipment, e.g. dental autoclaves [14] 
- using dry vacuum pump for dental suctions [14] 
- utilising water efficient toilet facilities, e.g. low flow and motion sensor taps, dual flush toilets [16] 
- installing a practice water meter for monitoring [16] 
- reminding themselves and patients to turn off taps when tooth brushing [14] 
- switching off any water-using equipment, e.g. dishwashers, when not in use [14] 
- inspecting for water leaks regularly [16] 
- reporting water leaks and dripping taps immediately to the water company [16] 

Education organisations should consider:

- highlighting the benefits of reducing water waste within dental practices from an environmentally sustainable perspective [42] 

Government establishments should consider:

- developing environmentally sustainable policies in water use and water efficiency [30] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the environmentally sustainable importance of conserving water within the healthcare practices [42] 

Public health professionals should consider:

- supporting government establishments in developing water use and water efficiency policies [30] 

Clinical guideline 3 (h):
Managing the safe disposal of medications

Actions:

Dental teams should consider:

- carrying out a monthly audit on stock to ensure medications are used before they expire [14] 
- contacting local pharmacies to enquire about medication disposal and find out whether they provide this service to patients [14] 
- advising patients on how to dispose of prescribed medication [14] 
- providing a box used for returning unused medications by staff and patients [14] 

Education organisations should consider:

- highlighting the importance of managing the safe disposal of medications to promote planetary and human health [43] 

Government establishments should consider:

- developing policies in the management of safe disposal of medications [30] 

National regulatory organisations should:

- ensure that the training curricula provided by education organisations includes the environmentally sustainable benefits of safe disposal of medications [43] 

Public health professionals should consider:

- supporting government establishments to develop policies in the management of safe disposal of medications [30] 

Domain 4: Energy efficiency

Clinical guideline 4 (a):
Retrofitting existing dental practices

Actions:

Dental teams should consider:

- installing simple ventilation systems and natural ventilation, including opening windows [14] 
- installing heating ventilation and air conditioning [44] 
- using more efficient equipment [14] 
- liaising with energy management consultants to decide if it is desirable to spend environmental resources on retrofitting existing structures than constructing a new building [34] 

Education organisations should consider:

- highlighting the planetary and human health benefits of well-insulated practices [14] 

Government establishments should consider:

- providing financial incentive to facilitate the retrofitting of healthcare practices [14] 

National regulatory organisations should:

- ensure that training curricula provided by education organisations include environmentally sustainable and human health importance of retrofitting existing dental practice [14] 

Public health professionals should consider:

- engaging with relevant key stakeholders (e.g. construction, engineering and environment specialists) dental teams to address the planetary and health problems caused by low quality dental practices [45] 

Clinical guideline 4 (b):
Generating own power within dental practices

Actions:

Dental teams should consider:

- obtaining a site evaluation for renewable power options [14] 
- looking for a certified installer and discussing the available options with the dental teams [14] 
- checking with the local planning department if permission is required [14] 
- installing solar water heating unit within the practice or solar panel system on the roof [6] 

Education organisations should consider:

- highlighting the importance of self-generation[8] power to promote planetary and human health benefits [46] 

Government establishments should consider:

- providing financial incentive to facilitate own power generation within dental settings [47] 
- developing environmentally sustainable policy in energy use and efficiency [30] 

National regulatory organisations should:

- ensure that the training curricula provided by the education organisations include the planetary and human health benefits of renewable power alternatives [46] 

Public health professionals should consider:

- supporting government establishments to develop energy use and efficiency policy [30] 

[8] *self-generation power is the use of power generated on-site by an energy consumer in order to reduce, at least in part, the purchase of electricity from the grid [37]

Domain 5: Education

Clinical guideline 5 (a):
Education and training in good practice of green dentistry

Actions:

Dental teams should consider:

- posting any advertisements on educational programmes related to environmental sustainability in dentistry and encouraging their staff to attend [29] 
- attending any educational programmes related to environmental sustainability in dentistry [29] 

Education organisations should consider:

- embedding environmental sustainability in dentistry into curricula across the breadth of subject matters, spanning all years of undergraduate and postgraduate training [48] 
- integrating research on environmental sustainability in dentistry into teaching [48] 
- encouraging undergraduate and postgraduate students to investigate environmental sustainability in dentistry as primary research topics, and as a standard consideration for all future studies [48] 
- supporting the national regulatory organisations in the implementation of environmental sustainability in dentistry within the dental curricula [16] 
- reviewing of current infection prevention and control practices to reduce unnecessary resource use 
- recommending a mandatory part of the entry process to undergraduate, postgraduate and international dental examinations 
- recommending environmental sustainability in dentistry included in application literature and processes to dental schools at both undergraduate and postgraduate levels 

Government establishments and public health professionals should consider:

- supporting education and training on environmentally sustainability in every aspect of dentistry for all levels of profession [29] 

National regulatory organisations should consider:

- recommending all undergraduate and postgraduate dental curricula to support effective and efficient oral health services that are environmentally sustainable [29] 

Domain 6: Biodiversity

Clinical guideline 6 (a):
Creating a biodiverse garden

Actions:

Dental teams should consider:

- creating pollinator-friendly green plant borders [14] 
- choosing native, shrubs and perennial plants [14] 
- placing bird food outside during winter [14] 
- mowing lawns less frequently [14] 

Education organisations should consider:

- highlighting the planetary and human health benefits of creating a biodiverse garden [14] 

Government establishments should consider:

- supporting dental practice about promoting biodiversity within the dental practice [14] 

National regulatory organisations should:

- ensure that education organisations incorporate the environmentally sustainable benefits of constructing a biodiverse garden into the training curricula [14] 

Clinical guideline 6 (b):
Designing the built environment with features that support flora and fauna

Actions:

Dental teams should consider:

- liaising with green infrastructure company to install low water use living walls and roofs [14] 
- growing plants on a balcony [14] 
- placing artificial nests in the roof eaves [14] 

Education organisations should consider:

- highlighting the importance of incorporating flora and fauna friendly features into the built environment to promote planetary and human health [14] 

Government establishments should consider:

- providing financial incentives to facilitate the creation of green environments within the dental healthcare settings [14] 

National regulatory organisations should:

- ensure that education organisations incorporate the environmentally sustainable importance of green infrastructure into the training curricula [14] 

Domain 7: Effective prevention

Clinical guideline 7 (a):
Recommending community water fluoridation scheme[9] in non-fluoridated areas

Actions:

Dental teams should consider:

- supporting community water fluoridation as an effective practice [49, 50] 
- educating patients about the benefits of community water fluoridation [51] 
- encouraging patients to support this scheme [51] 

Education organisations should consider:

- highlighting the benefits of water fluoridation from both a prevention and environmental sustainability perspective [50, 52] 

Government establishments should consider:

- proposing and establishing a water fluoridation scheme for the area [49] 
- conducting public consultations regarding the scheme following the guidelines as laid out in the national statutory framework with regard to water fluoridation [51] 
- working with local water companies and public health professionals to consider the feasibility of establishing a local water fluoridation scheme [51] 

National regulatory organisations should:

- ensure that education organisations incorporate into their training curricula the benefits of water fluoridation scheme from both a prevention and environmental sustainability perspective [50, 52] 

Public health professionals should consider:

- supporting government establishments to understand their roles in relation to water fluoridation [51] 

[9] Water fluoridation had the lowest environmental impact of all the caries prevention programmes at the community levels. The carbon emission of processing fluoridating water for one person was equivalent of 0.443kg carbon (kg CO2 eq) per year, as compared to 1.95kg CO2 eq for supervised toothbrushing in schools and 3.31kg CO2 eq fluoride varnish application in schools) [36]

Clinical guideline 7 (b):
Recommending supervised tooth brushing (TB) programmes for nurseries and early years settings in targeted areas where oral health and/or the risk factors for poor oral health are greatest

Actions:

Dental teams should consider:

- educating patients about the benefits of TB programmes for preschool children [53, 54]

Education organisations should consider:

- highlighting the benefits of TB programmes from both a prevention and environmental sustainability perspective [53, 54]

Government establishments should consider:

- commissioning TB programmes for all preschool sites in areas of deprivation [14]

- providing funds for TB programmes as part of the evidence-based oral health preventative programme [55]

National regulatory organisations should:

- ensure that education organisations incorporate into their training curricula the benefits of TB programmes from both a prevention and environmental sustainability perspective [53, 54]

Public health professionals should consider:

- supporting government establishments for commissioning TB programmes [56]

- encouraging dental teams to deliver high quality TB programmes [56]

Clinical guideline 7 (c):
Incorporating preventive care in every patient pathway

Actions:

Dental teams should consider:

- applying fluoride varnish (FV) to the teeth whenever the patient is already attended the dental practice (i.e. no additional travel)[10] [57]

- applying FV and/or fissure sealants on the patient only based on the caries risk of the individual [57]

Education organisations should consider:

- highlighting the benefits of a FV programme from both a prevention and environmental sustainability perspective [57, 58]

Government establishments should consider:

- commissioning preventive care services within dental practices and social care [14]

National regulatory organisations should:

- ensure education organisations incorporate into their training programmes the importance of a FV programme from both a prevention and environmental sustainability perspective [57, 58]

Public health professionals should consider:

- encouraging dental teams to provide high quality preventive care within dental practices and social care [14]

[10] The least impact in all measures of environmental sustainability, including carbon emission, comes from using FV when a patient is already at a dental appointment. This is due to the patient already having an appointment and being in the dental chair (e.g., routine recall appointment), patients and staff have already travelled to the dental practice, the practice and much of the required equipment are already being used and staff are already wearing personal protective equipment.

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8. Authorship

Membership of the steering group

No.	Member	Authorship	Position	Office
1.	Majidi Bakar	First author	Postgraduate Student, Clinical Doctorate in Dental Surgery (D.Ch.Dent.) in Dental Public Health	Trinity College Dublin
2.	Brett Duane	Co-author	Associate Professor in Dental Public Health	Trinity College Dublin
3.	Amarantha Fennell-Wells	Co-author	Senior Clinical Policy Manager	Office of Chief Dental Officer England
4.	Charlotte Klass	Co-author	Consultant in Dental Public Health	NHS England London

9. References

1. England, P.H. *Review of interventions to improve outdoor air quality and public health.* 2019 [cited May 2022; Available from: https://www.gov.uk/government/publications/improving-outdoor-air-quality-and-health-review-of-interventions.
2. Organisation, W.H. *Climate and health country profile 2015: United Kingdom* 2015 [cited May 2022; Available from: https://apps.who.int/iris/rest/bitstreams/1031209/retrieve.
3. Services, N.H. *Delivering a 'Net Zero' National Health Service*. 2020 [cited May 2022; Available from: https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf.
4. England, P.H. *Carbon modelling within dentistry: towards a sustainable future*. 2018 [cited March 2022; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/724777/Carbon_modelling_within_dentistry.pdf
5. Excellence, N.I.f.H.a.C. *Physical activity in the workplace: Public health guideline [PH 13]*. 2008 [cited May 2022; Available from: https://www.nice.org.uk/guidance/ph13/chapter/1-Recommendations.
6. Duane, B., Ramasubbu, D., Harford, S., Steinbach, I., Swan, J., Croasdale, K., & Stancliffe, R. , *Environmental sustainability and waste within the dental practice.* British Dental Journal, 2019. **226**(8): p. 611-618.
7. Duane, B., *Sustainable Dentistry: Making a Difference (BDJ Clinician's Guides)*. 2023: Springer.
8. Affairs, D.o.E.a.S. *The 17 United Nations Sustainable Development Goals*. 2015 [cited March 2022; Available from: https://sdgs.un.org/goals.
9. Rights, T.D.I.f.H. *The Human Rights Guide to the Sustainable Development Goals*. 2016 [cited March 2022; Available from: https://sdg.humanrights.dk/en/goals-and-targets.
10. Organisation, W.H. *The 1st International Conference on Health Promotion, Ottawa, 1986*. 1986 [cited March 2022; Available from: https://www.who.int/teams/health-promotion/enhanced-wellbeing/first-global-conference.
11. Duane, B., et al., *Environmental sustainability and travel within the dental practice.* British Dental Journal, 2019. **226**(7): p. 525-530.
12. Purohit, A., J. Smith, and A. Hibble, *Does telemedicine reduce the carbon footprint of healthcare? A systematic review.* Future Healthcare Journal, 2021. **8**(1): p. e85.
13. Excellence, N.I.f.H.a.C. *Dental checks intervals between oral health reviews: Clinical guideline [CG19]*. 2004 [cited December 2022; Available from: https://www.nice.org.uk/guidance/cg19.
14. Harford, S., Ramasubbu, S., Duane, B. & Mortimer, F. . *Sustainable Dentistry: How-to guide for dental practices*. 2018 [cited March 2022; Available from: https://sustainablehealthcare.org.uk/dental-guide.
15. Services, N.H. *Developing and implementing travel plans A good practice guide for the NHS in London*. 2006 [cited March 2022; Available from: https://www.eltis.org/sites/default/files/tool/nhs-travel-plan-guide-part-1.pdf.
16. Services, N.P. *To reduce our carbon emissions*. 2020 [cited April 2022; Available from: https://www.property.nhs.uk/media/2683/our-2020-pledges.pdfc.
17. Duane, B., Ramasubbu, D., Harford, S., Steinbach, I., Stancliffe, R., Croasdale, K., & Pasdeki-Clewer, E. Harford, S., Ramasubbu, S., Duane, B. & Mortimer, F. , *Environmental sustainability and procurement: purchasing products for the dental setting.* British dental journal, 2019. **226(6)**: p. 453-458.
18. Department for Environmental, F.a.R.A. *Procuring the Future: Sustainable Procurement National Action Plan: Recommendations from the Sustainable Procurement Task Force*. 2006 [cited December 2022; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69417/pb11710-procuring-the-future-060607.pdf.

19. Herr, M.M., R.E. Outterson, and S. Aggarwal, *Lost in the Ether: The Environmental Impact of Anesthesia.* Operative Techniques in Orthopaedics, 2022: p. 100997.
20. Fennell-Wells, A. and A. Chakera, *14 Delivering the nitrous oxide project: a case for collaborative leadership*. 2021, BMJ Specialist Journals.
21. Anaeshetists, A.o. *Nitrous oxide project*. 2022 [cited December 2022; Available from: https://anaesthetists.org/Home/Resources-publications/Environment/Nitrous-oxide-project.
22. Sherman, J., Le, C., Lamers, V., & Eckelman, M. , *Life cycle greenhouse gas emissions of anesthetic drugs.* Anesthesia & Analgesia, 2012. **114(5)**: p. 1086-1090.
23. Programme, U.N.E. *The Kigali Amendment to the Montreal protocol: another global commitment to stop climate change*. 2016 [cited December 2022; Available from: https://www.unep.org/news-and-stories/news/kigali-amendment-montreal-protocol-another-global-commitment-stop-climate.
24. Key, A. *Drugs and Fluids Used During Anaesthesia*. 2016 [cited December 2016; Available from: https://aneskey.com/drugs-and-fluids-used-during-anaesthesia/.
25. Goldthorpe, J., et al., *An evaluation of a referral management and triage system for oral surgery referrals from primary care dentists: a mixed-methods study.* 2018.
26. Hill, H., et al., *An eReferral Management & Triage System for minor Oral surgery referrals from primary care dentists: a cost-effectiveness evaluation.* BMC health services research, 2021. **21**(1): p. 1-8.
27. Marland, O. and R. Keat, *A service evaluation of oral medicine, maxillofacial and oral surgery e-referrals to Royal Preston Hospital.* British Journal of Oral and Maxillofacial Surgery, 2020. **58**(10): p. e145.
28. McGain, F., et al., *Environmental sustainability in anaesthesia and critical care.* British Journal of Anaesthesia, 2020. **125**(5): p. 680-692.
29. Martin, N., Sheppard, M., Gorasia, G., Arora, P., Cooper, M., & Mulligan, S. , *Drivers, opportunities and best practice for sustainability in dentistry: A scoping review.* Journal of Dentistry, 2021. **112, 103737**.
30. Croner-i. *NHS sustainability: tackling the issues*. 2014 [cited May 2022; Available from: https://app.croneri.co.uk/feature-articles/nhs-sustainability-tackling-issues.
31. Trust, W.K.P.C. *Paper Policy*. 2009 [cited March 2022; Available from: http://map.sustainablehealthcare.org.uk/west-kent-primary-care-trust/paper-policy.
32. Atherton, A. and D. Giurco, *Campus sustainability: climate change, transport and paper reduction.* International Journal of Sustainability in Higher Education, 2011.
33. Sitterson, K. *Helping the environment: reduce the plastic footprint in your dental office*. 2017 September 2022]; Available from: https://www.dentistryiq.com/dental-hygiene/practice-management/article/16365970/helping-the-environment-reduce-the-plastic-footprint-in-your-dental-office.
34. House of Commons Environment, F.a.R.A.C. *Food waste in England: Eighth Report of Session 2016–2017*. 2017 [cited March 2022; Available from: https://publications.parliament.uk/pa/cm201617/cmselect/cmenvfru/429/429.pdf.
35. Environment, H.f.a.H. *H2E 10-Step Guide to Composting in Healthcare Facilities*. 2020 [cited April 2022; Available from: https://archive.epa.gov/region1/healthcare/web/pdf/composting.pdf.
36. Salemdeeb, R., et al., *Environmental and health impacts of using food waste as animal feed: a comparative analysis of food waste management options.* Journal of cleaner production, 2017. **140**: p. 871-880.
37. Kessler, R., *The Minamata Convention on Mercury: a first step toward protecting future generations*. 2013, National Institute of Environmental Health Sciences.
38. Muhamedagic, B., Muhamedagic, L., & Masic, I. , *Dental office waste - public health and ecological risk.* Materia Socio-medica, 2009. **21**(1): p. 35-38.

39. Association, A.D. *Best management practices for amalgam waste*. 2007 [cited March 2022; Available from: https://www.lus.org/wp-content/uploads/2020/01/2018_Industrial_Pretreatment_DENTAL_PKT.pdf.
40. Environment, U.N. *Minamata Convention on Mercury*. 2019 [cited May 2022; Available from: https://www.mercuryconvention.org/sites/default/files/2021-06/Minamata-Convention-booklet-Sep2019-EN.pdf.
41. Mulligan, S., et al., *The environmental impact of dental amalgam and resin-based composite materials.* British Dental Journal, 2018. **224**(7): p. 542-548.
42. Anderson, J., *The environmental benefits of water recycling and reuse.* Water Science and Technology: Water Supply, 2003. **3**(4): p. 1-10.
43. Kinrys, G., et al., *Medication disposal practices: Increasing patient and clinician education on safe methods.* Journal of International Medical Research, 2018. **46**(3): p. 927-939.
44. Moran, F., Natarajan, S., & Nikolopoulou, M. , *Developing a database of energy use for historic dwellings in Bath, UK.* Energy and Buildings, 2012(55): p. 218-226.
45. Council, I.G.B. *Leaders in Ireland's housing industry established forum to advance greener, healthier homes*. 2021 [cited May 2022; Available from: https://www.igbc.ie/healthy-homes-ireland-launched/.
46. Energy, D.o. *The environmental and public health benefits of achieving high penetrations of solar snergy in the United States*. 2016 [cited May 2016; Available from: https://www.nrel.gov/docs/fy16osti/65628.pdf.
47. Scheme, E.U.E.T. *Self-Generation*. 2016 [cited May 2022; Available from: https://www.emissions-euets.com/internal-electricity-market-glossary/1333-self-generation.
48. London, K.s.C. *Embedding sustainability into education and the student experience* [cited December 2022; Available from: https://www.kcl.ac.uk/climate-sustainability/education.
49. England, P.H. *Improving oral health: A community water fluoridation toolkit for local authorities*. 2020 [cited March 2022; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/953333/Fluoridation_Toolkit_V1.7.pdf.
50. Duane, B., et al., *The environmental impact of community caries prevention-part 3: water fluoridation.* British Dental Journal, 2022. **233**(4): p. 303-307.
51. England, P.H. *Local authorities improving oral health: commissioning better oral health for children and young people - An evidence-informed toolkit for local authorities*. 2014 [cited March 2022; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/321503/CBOHMaindocumentJUNE2014.pdf.
52. Iheozor-Ejiofor, Z., et al., *Water fluoridation for the prevention of dental caries.* Cochrane Database Syst Rev, 2015. **2015**(6): p. Cd010856.
53. Ashley, P., et al., *The environmental impact of community caries prevention-part 2: toothbrushing programmes.* British dental journal, 2022. **233**(4): p. 295-302.
54. Macpherson, L.M., et al., *National supervised toothbrushing program and dental decay in Scotland.* J Dent Res, 2013. **92**(2): p. 109-13.
55. Anopa, Y., et al., *Improving Child Oral Health: Cost Analysis of a National Nursery Toothbrushing Programme.* PLoS One, 2015. **10**(8): p. e0136211.
56. England, P.H. *Improving oral health: A toolkit to support commissioning of supervised toothbrushing programmes in early years and school settings*. 2016 [cited March 2022; Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/574835/PHE_supervised_toothbrushing_toolkit.pdf.
57. Lyne, A., et al., *The environmental impact of community caries prevention-part 1: fluoride varnish application.* British dental journal, 2022. **233**(4): p. 287-294.

58. Marinho, V.C., et al., *Fluoride varnishes for preventing dental caries in children and adolescents.* Cochrane Database of Systematic Reviews, 2013(7).