Crise climatique, CHUM carboneutre et réduction des émissions directes de GES en anesthésie

Stephan Williams
MD, PhD, Anesthésiologiste
Co-gestionnaire médical carboneutralité/dev. durable
Centre hospitalier de l'Université de Montréal

Dans les 15 prochaines minutes:

1 - Crise climatique: genèse, impact santé

2 - Carboneutralité: solution à la crise climatique

3 – Réduction des émissions directes de GES au département d'anesthésie du CHUM

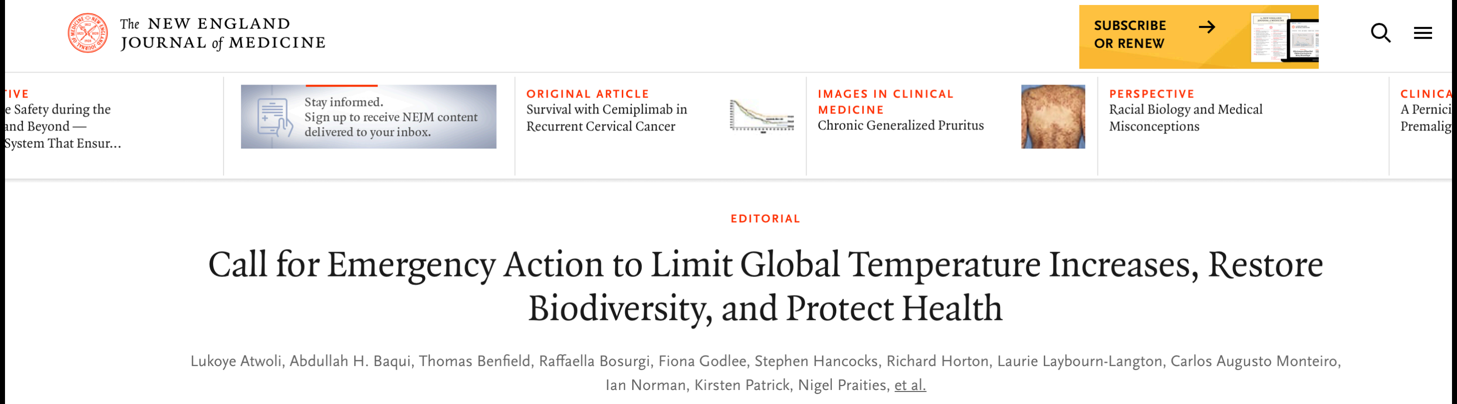
CARBONEUTRALITÉ

DÉC 2021:Conseil d'administration du CHUM a ajouté à la mission/vision/valeurs institutionnelles:

> la carboneutralité avant 2040 sans compromis pour la qualité des soins

Sept 2021: éditorial publié simultanément dans 230 revues médicales

Crise climatique:
«La plus grande menace à la santé… » du XXIème siècle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EDITORIAL

Call for Emergency Action to Limit Global Temperature Increases, Restore Biodiversity, and Protect Health

Lukoye Atwoli, Abdullah H. Baqui, Thomas Benfield, Raffaella Bosurgi, Fiona Godlee, Stephen Hancocks, Richard Horton, Laurie Laybourn-Langton, Carlos Augusto Monteiro, Ian Norman, Kirsten Patrick, Nigel Praities, et al.

Metrics

September 16, 2021
N Engl J Med 2021; 385:1134-1137
DOI: 10.1056/NEJMe2113200

ATIONS GENERAL ASSEMBLY IN SEPTEMBER 2021 WILL BRING

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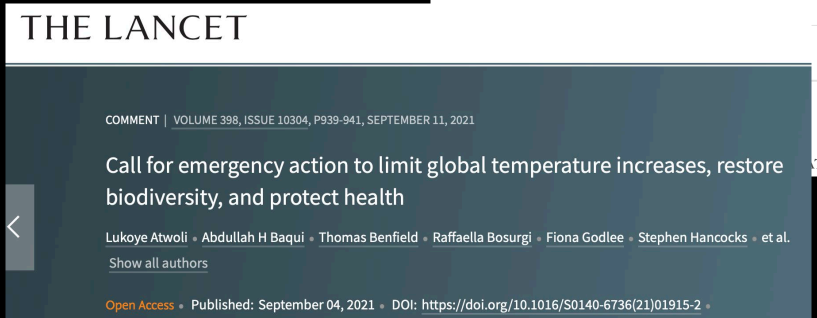
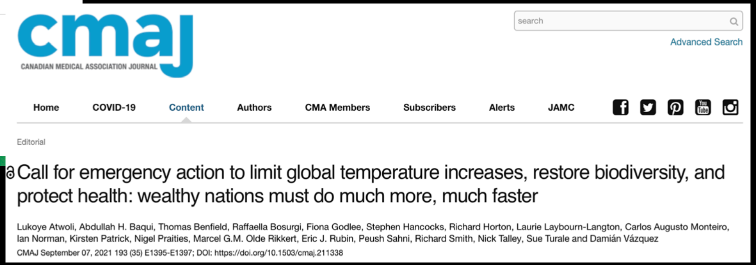


COMMENT | VOLUME 398, ISSUE 10304, P939-941, SEPTEMBER 11, 2021

Call for emergency action to limit global temperature increases, restore biodiversity, and protect health

Lukoye Atwoli • Abdullah H Baqui • Thomas Benfield • Raffaella Bosurgi • Fiona Godlee • Stephen Hancocks • et al.
Show all authors

Open Access • Published: September 04, 2021 • DOI: https://doi.org/10.1016/S0140-6736(21)01915-2 •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Editorial

Call for emergency action to limit global temperature increases, restore biodiversity, and protect health: wealthy nations must do much more, much faster

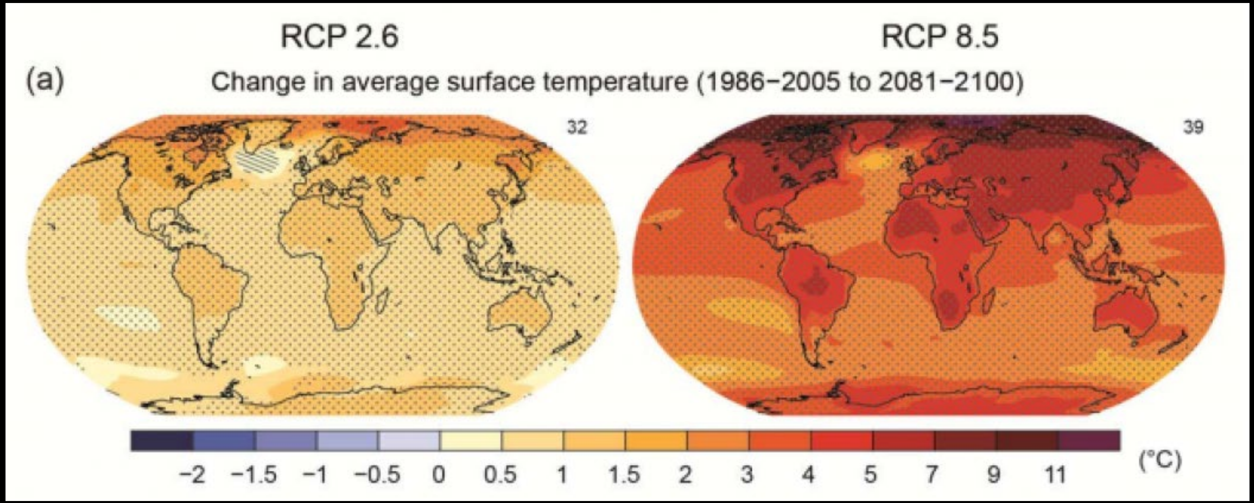
Lukoye Atwoli, Abdullah H. Baqui, Thomas Benfield, Raffaella Bosurgi, Fiona Godlee, Stephen Hancocks, Richard Horton, Laurie Laybourn-Langton, Carlos Augusto Monteiro, Ian Norman, Kirsten Patrick, Nigel Praities, Marcel G.M. Olde Rikkert, Eric J. Rubin, Peush Sahni, Richard Smith, Nick Talley, Sue Turale and Damián Vázquez
CMAJ September 07, 2021 193 (35) E1395-E1397; DOI: https://doi.org/10.1503/cmaj.211338

https://www.who.int/globalchange/mediacentre/news/global-programme/en/

CRISE CLIMATIQUE

« Réchauffement extrême et destructeur du climat de la Terre par l’humain via l’accumulation de gaz à effet de serre (GES) dans l’atmosphère. »

BioScience 70(1), January 2020, 8–12

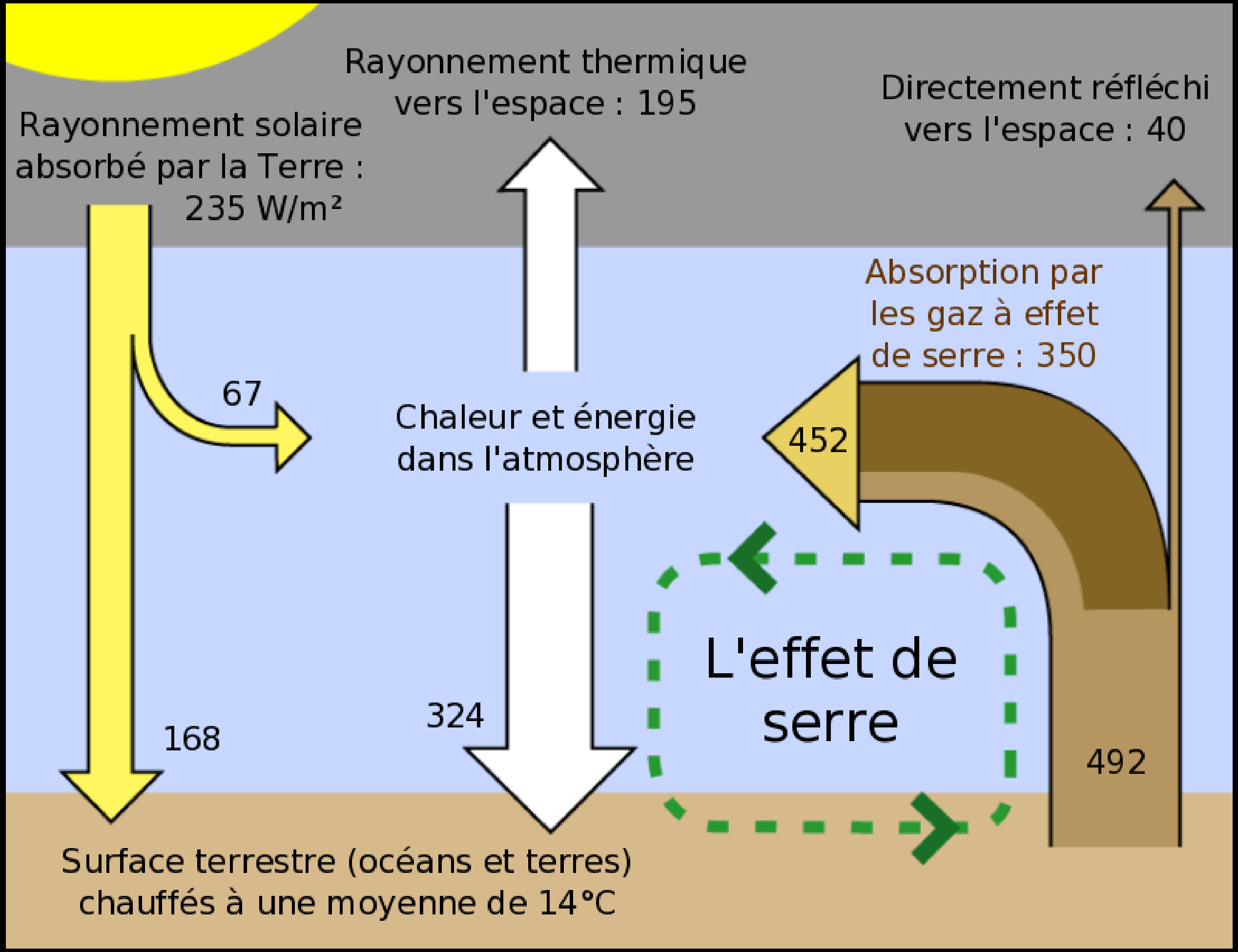

RCP 2.6
RCP 8.5
(a)
Change in average surface temperature (1986−2005 to 2081−2100)
32
39
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
3
4
5
7
9
11
(°C)

GAZ À EFFET DE SERRE (GES):

COMPOSANTS GAZEUX DE L'ATMOSPHÈRE

ABSORBENT ET REDIRIGENT LA CHALEUR VERS LA SURFACE

RÉCHAUFFENT +++ TEMPÉRATURE DE LA TERRE


Rayonnement thermique vers l'espace : 195
Directement réfléchi vers l'espace : 40
Rayonnement solaire absorbé par la Terre : 235 W/m²
Absorption par les gaz à effet de serre : 350
67
Chaleur et énergie dans l'atmosphère
452
L'effet de serre
168
324
492
Surface terrestre (océans et terres) chauffés à une moyenne de 14°C

TERRE: EQUILIBRE THERMIQUE DÉLICAT

ENTRÉES:

99.97% soleil
00.02% noyau chaud
00.01% production humaine

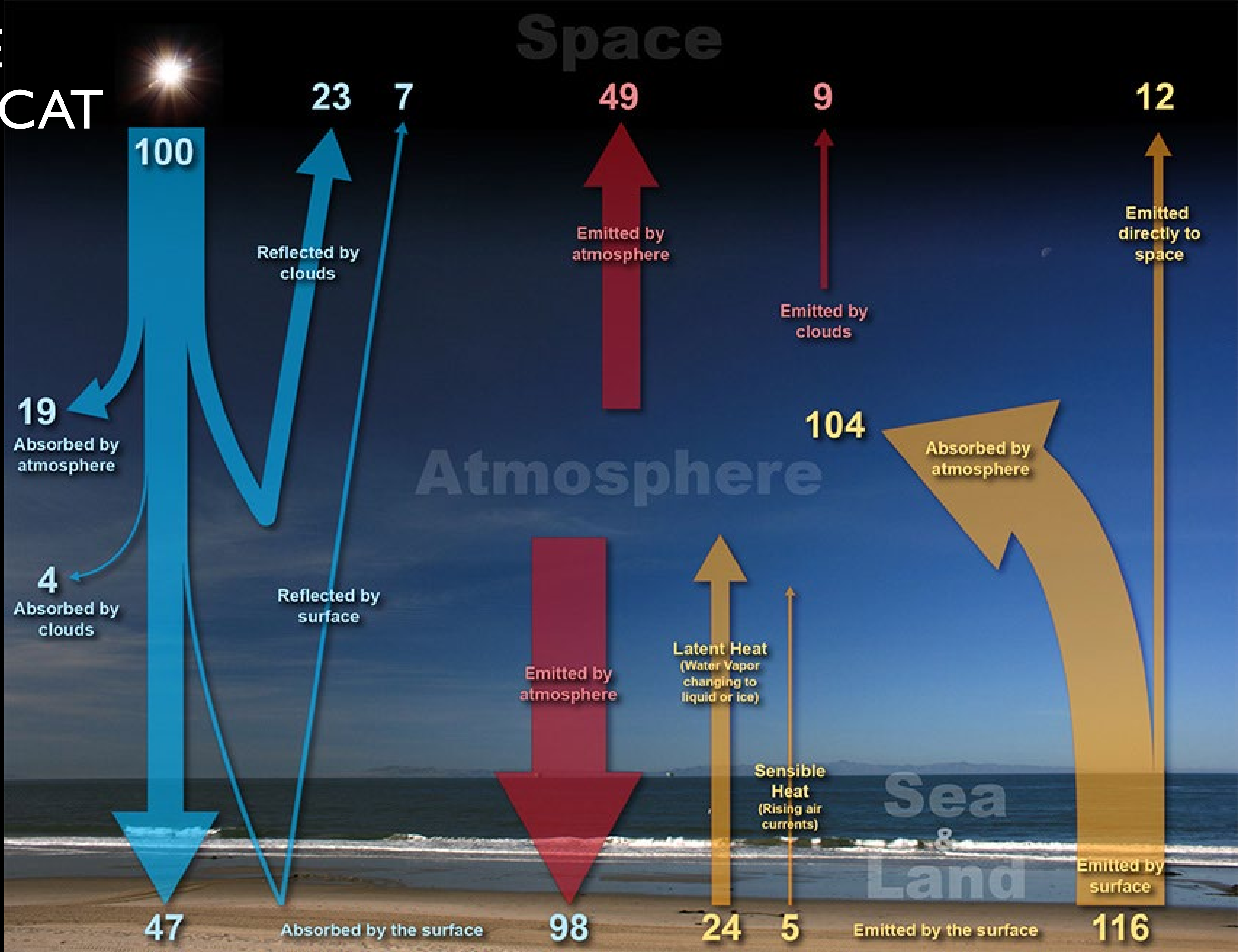
SORTIES:

100%: radiation dans le vide de l’espace

National Oceanic and Atmospheric Administration

Lawrence Livermore Word Energy Flow 2011

Treat Geophys 6 (2007): 217-252


Space
23
7
49
9
12
100
Reflected by clouds
Emitted by atmosphere
Emitted directly to space
Emitted by clouds
19
Absorbed by atmosphere
104
Absorbed by atmosphere
Atmosphere
4
Absorbed by clouds
Reflected by surface
Emitted by atmosphere
Latent Heat
(Water Vapor changing to liquid or ice)
Sensible Heat
(Rising air currents)
Sea & Land
Emitted by surface
47
Absorbed by the surface
98
24
5
Emitted by the surface
116

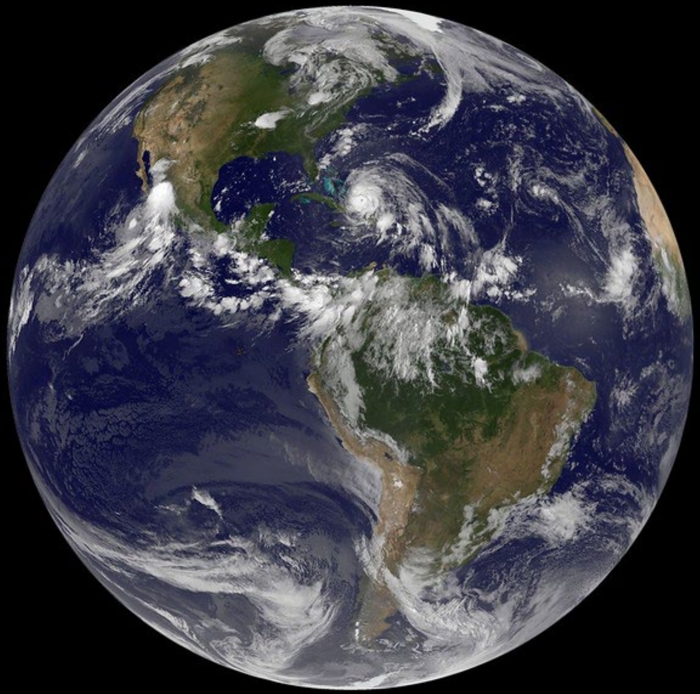
GES: PUISSANTS RÉGULATEURS DE LA TEMPÉRATURE

Lune (pas de GES)

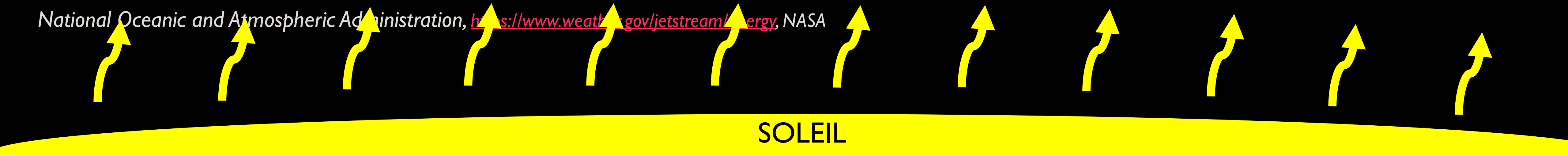
-18°C

Terre (atmosphère avec GES):

+14…15°…?



National Oceanic and Atmospheric Administration, https://www.weather.gov/jetstream/energy, NASA



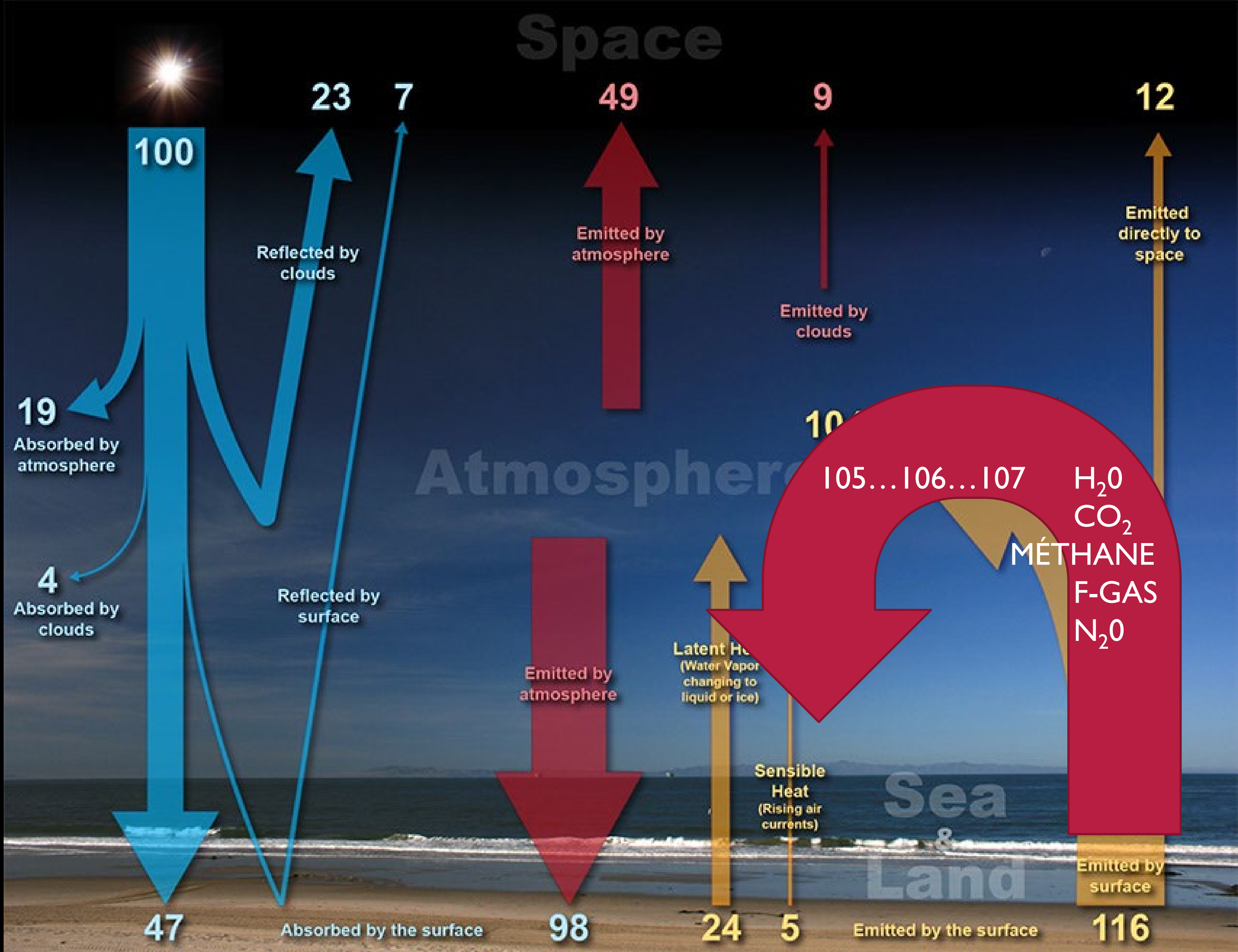
GES

AUGMENTATION
DES GES DANS
L'ATMOSPHÈRE

=

AUGMENTATION
DE LA TEMPÉRATURE
DE LA TERRE

National Oceanic and Atmospheric Administration


Space
100
23
7
Reflected by clouds
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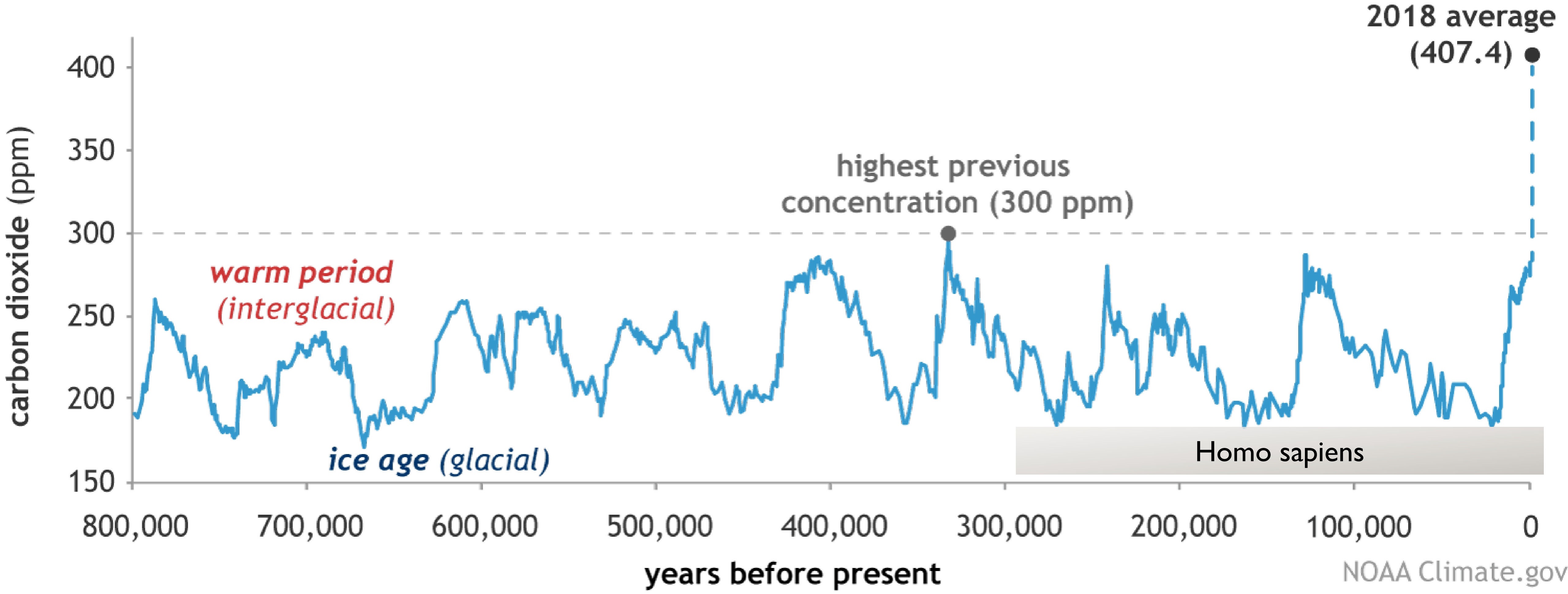
Absorbed by atmosphere
4
Absorbed by clouds
Reflected by surface
47
Absorbed by the surface
49
Emitted by atmosphere
9
Emitted by clouds
12
Emitted directly to space
10
Atmosphere
105…106…107
H_20
CO_2
MÉTHANE
F-GAS
N_20
Emitted by atmosphere
98
Latent He
(Water Vapor changing to liquid or ice)
24
Sensible Heat
(Rising air currents)
5
Sea & Land
Emitted by surface
Emitted by the surface
116

LES GES SONT À DES NIVEAUX IMPRUDENTS

CO_2 during ice ages and warm periods for the past 800,000 years



NOAA Climate.gov
Data: NCEI

↗ GES ⟶ Crise climatique: reconnu depuis plus de 60 ans

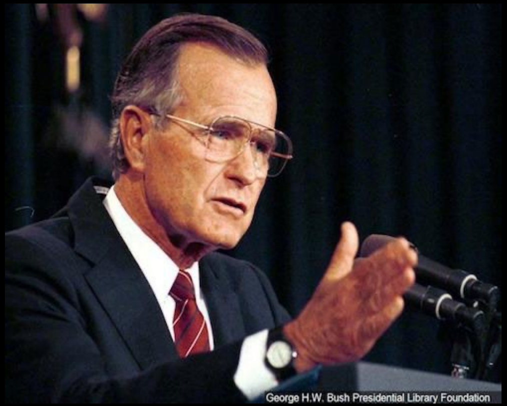
1965

Frank Ikard, président American Petroleum Institute

“CO2 is being added to the earth’s atmosphere by the burning of coal, oil and natural gas…by the year 2000 the heat balance will…cause marked changes in climate

Nature Climate Change **volume 8**, pages1024–1025(2018)

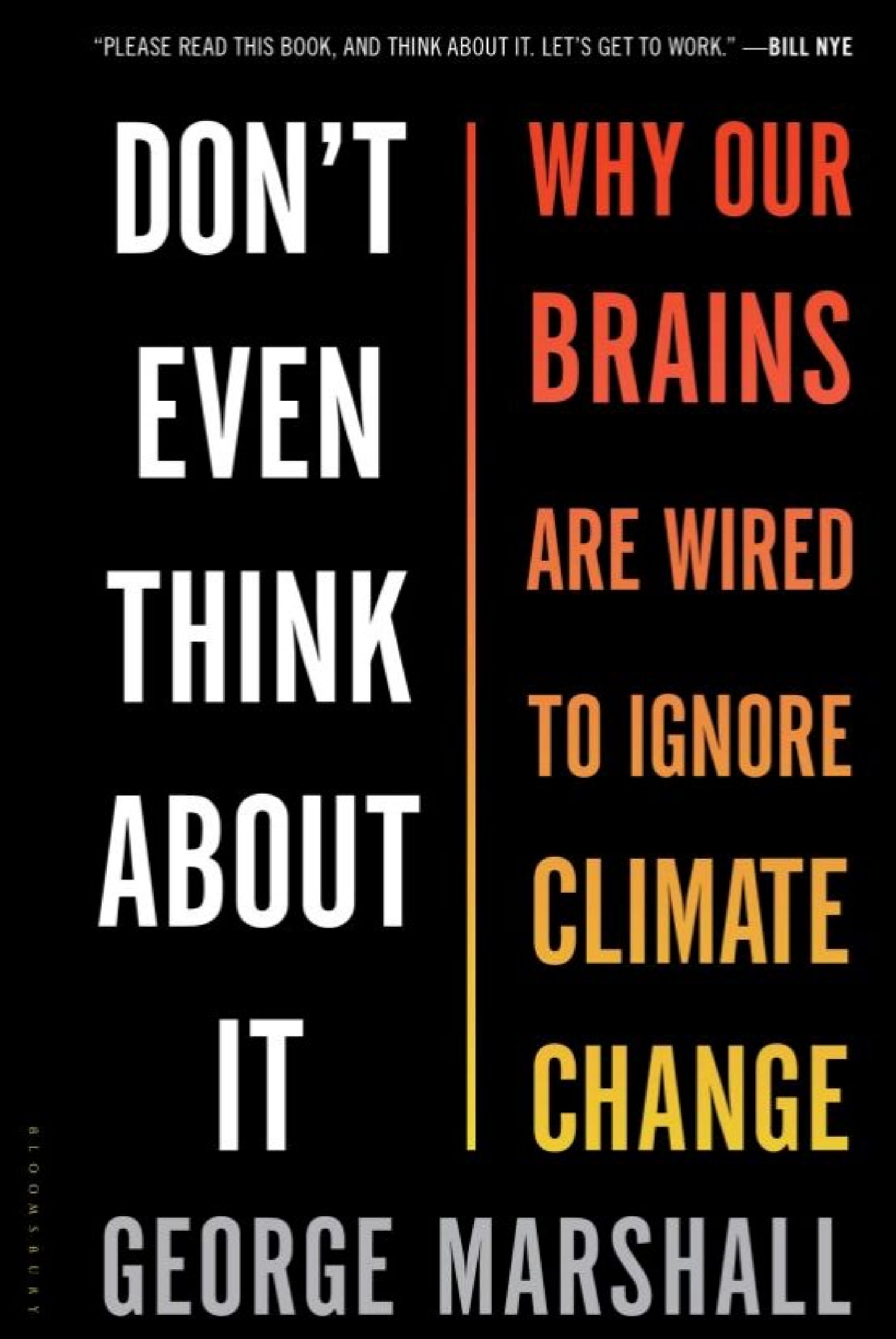
1988/08/31



George H.W. Bush Presidential Library Foundation

George Bush, président EU

"Those who think we are powerless to do anything about the greenhouse effect forget about the 'White House effect'; as President, I intend to do something about it. We will talk about global warming and we will act”


"PLEASE READ THIS BOOK, AND THINK ABOUT IT. LET'S GET TO WORK." —BILL NYE
DON'T EVEN THINK ABOUT IT
WHY OUR BRAINS ARE WIRED TO IGNORE CLIMATE CHANGE
GEORGE MARSHALL
BLOOMSBURY

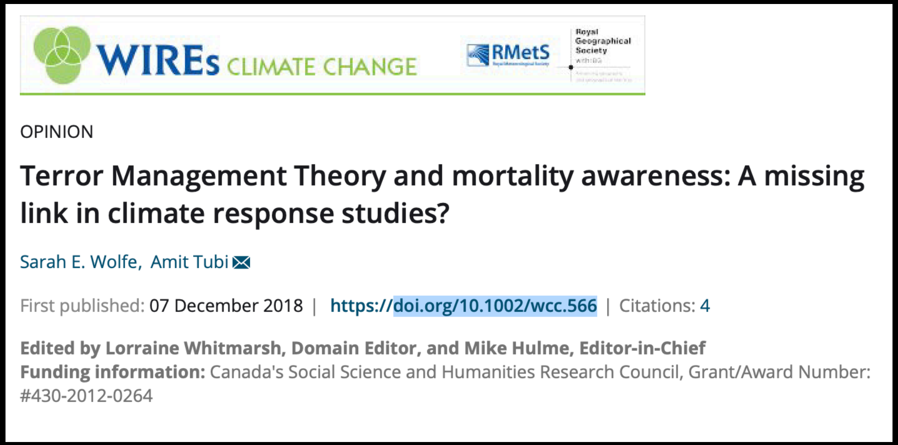
Crise climatique:

Menace impersonnelle

Changements « lents » à l'échelle humaine

Moralité de groupe mal adaptée à ce type de menace

Échelle de temps qui dépasse notre propre mort


WIREs CLIMATE CHANGE
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OPINION

Terror Management Theory and mortality awareness: A missing link in climate response studies?

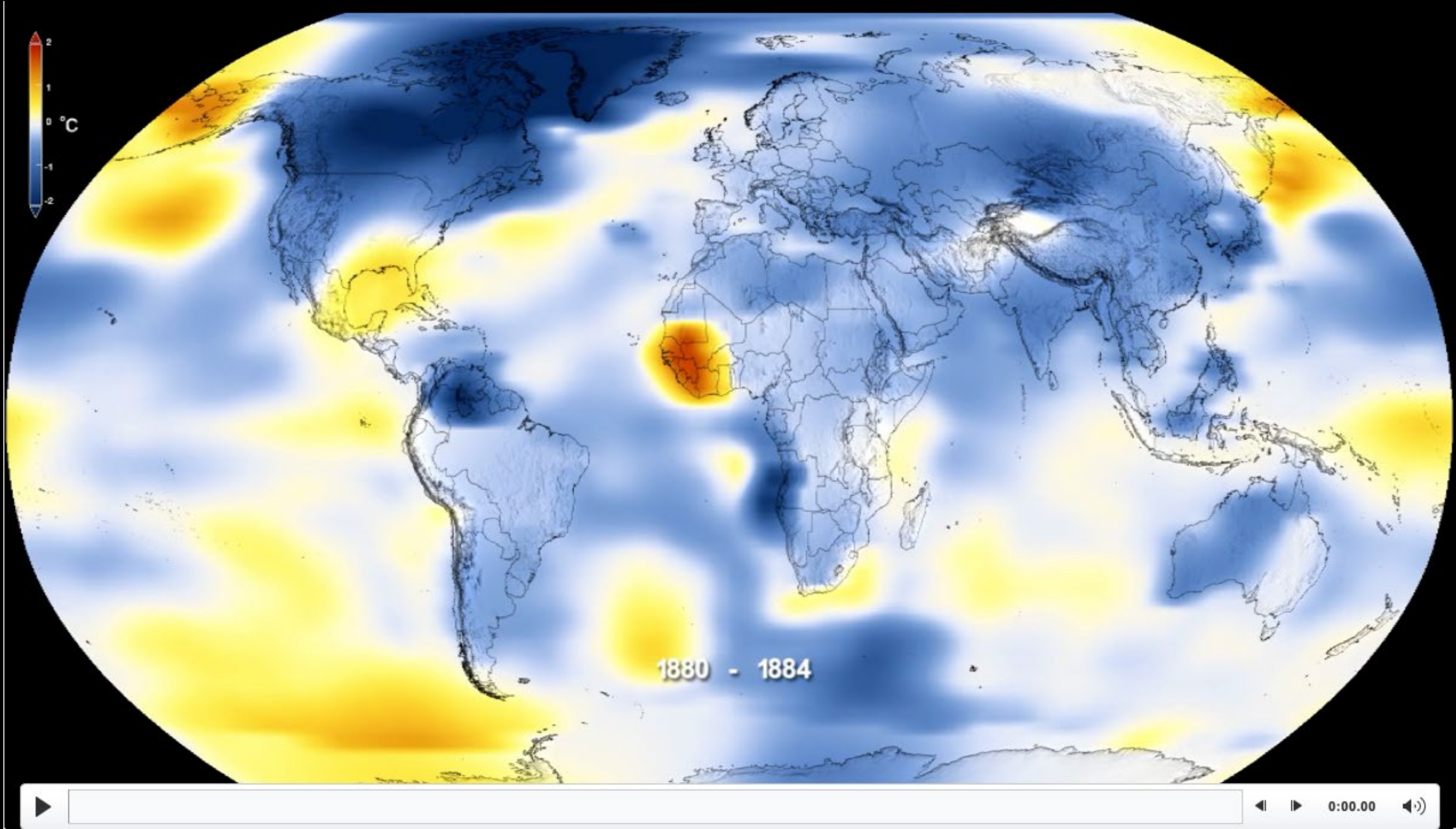
Sarah E. Wolfe, Amit Tubi

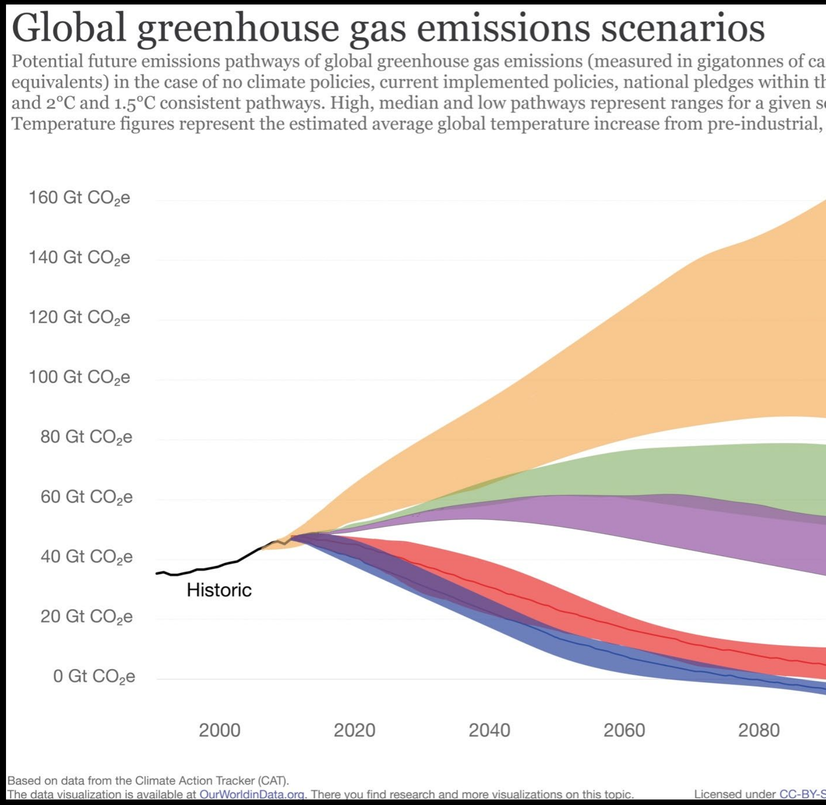
First published: 07 December 2018 | https://doi.org/10.1002/wcc.566 | Citations: 4

Edited by Lorraine Whitmarsh, Domain Editor, and Mike Hulme, Editor-in-Chief
Funding information: Canada's Social Science and Humanities Research Council, Grant/Award Number: #430-2012-0264

GES ↗ : RÉSULTATS

RÉCHAUFFEMENT
PLANÉTAIRE


2
1
0
°C
-1
-2
1880 - 1884
0:00.00



Global greenhouse gas emissions scenarios

Potential future emissions pathways of global greenhouse gas emissions (measured in gigatonnes of ca
equivalents) in the case of no climate policies, current implemented policies, national pledges within th
and 2°C and 1.5°C consistent pathways. High, median and low pathways represent ranges for a given s
Temperature figures represent the estimated average global temperature increase from pre-industrial,

160 Gt CO_2e
140 Gt CO_2e
120 Gt CO_2e
100 Gt CO_2e
80 Gt CO_2e
60 Gt CO_2e
40 Gt CO_2e
20 Gt CO_2e
0 Gt CO_2e
Historic
2000
2020
2040
2060
2080

Based on data from the Climate Action Tracker (CAT).
The data visualization is available at OurWorldinData.org. There you find research and more visualizations on this topic.

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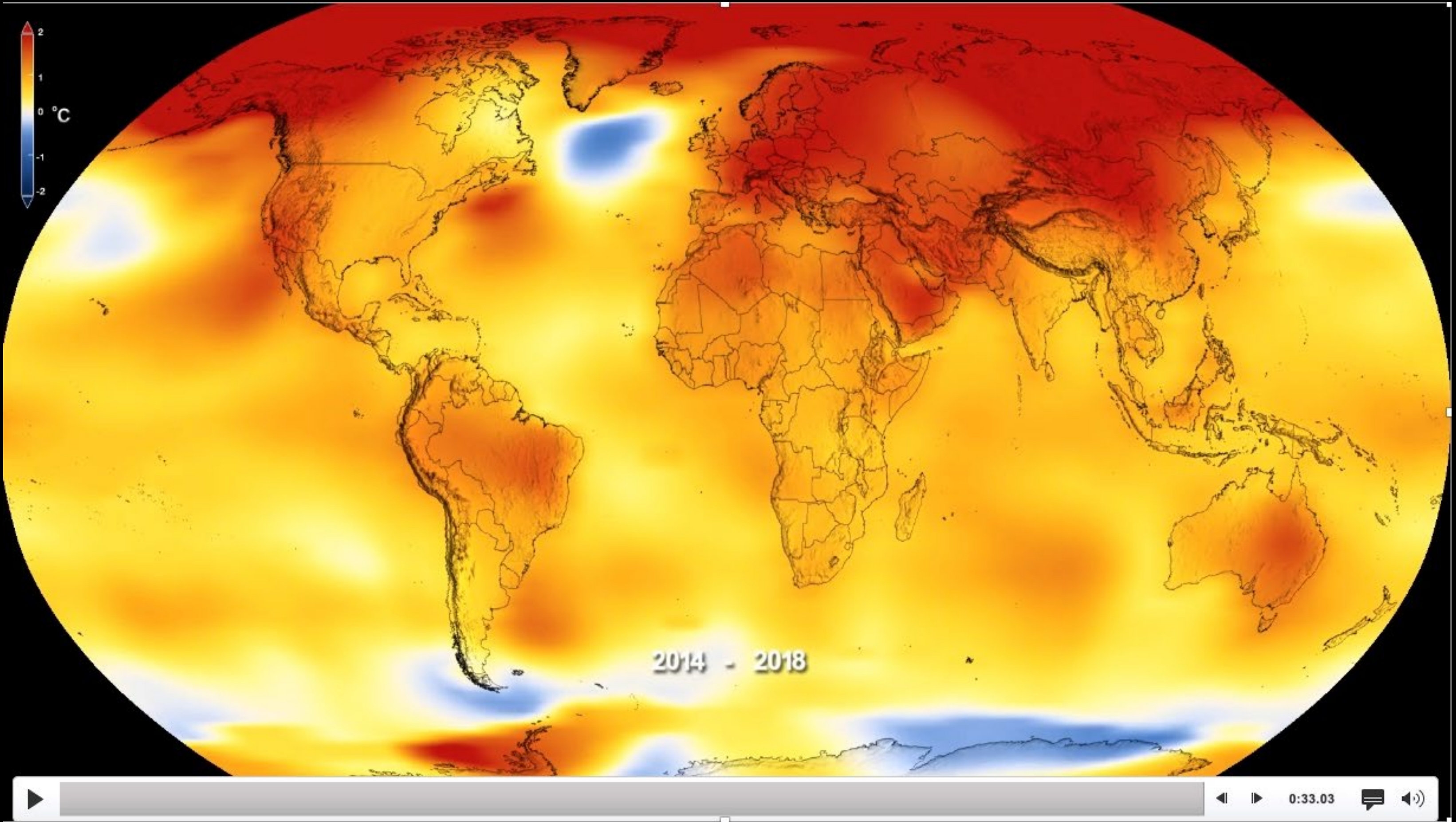
GES ↗: RÉSULTATS

RÉCHAUFFEMENT
PLANÉTAIRE



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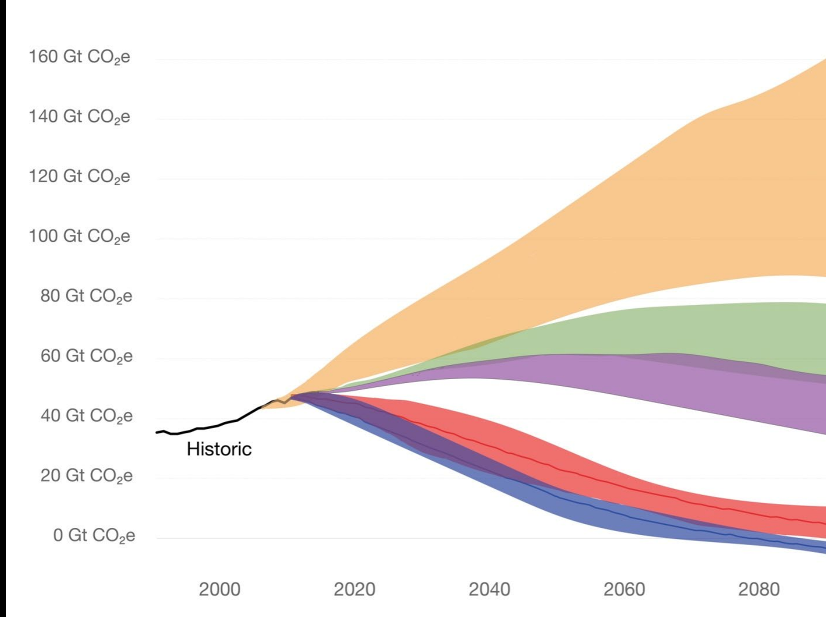

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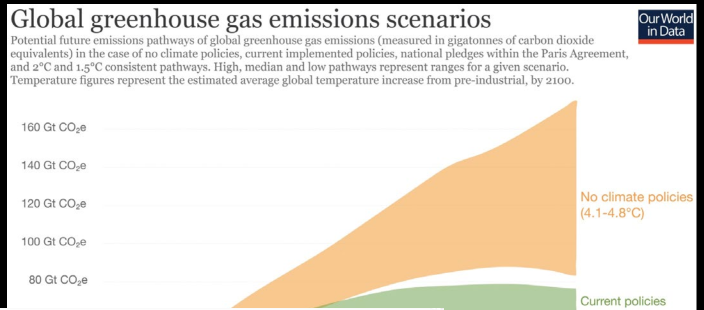

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Our World in Data
160 Gt CO₂e
140 Gt CO₂e
120 Gt CO₂e
100 Gt CO₂e
80 Gt CO₂e
No climate policies (4.1-4.8°C)
Current policies (3.1-3.7°C)
Pledges (2.6-3.2°C)
2°C pathways
1.5°C pathways
2080
2100

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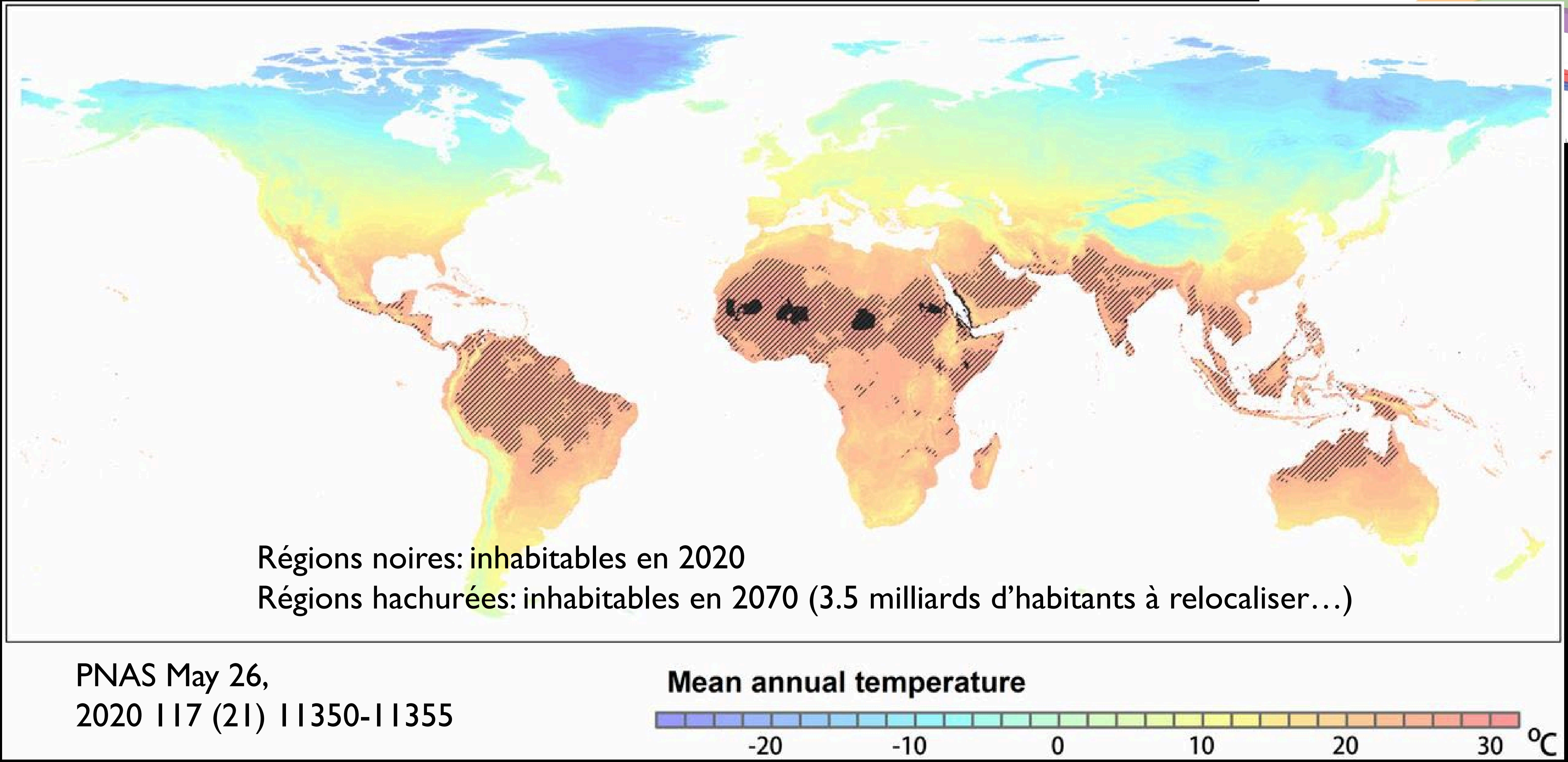


Régions noires: inhabitables en 2020
Régions hachurées: inhabitables en 2070 (3.5 milliards d’habitants à relocaliser…)

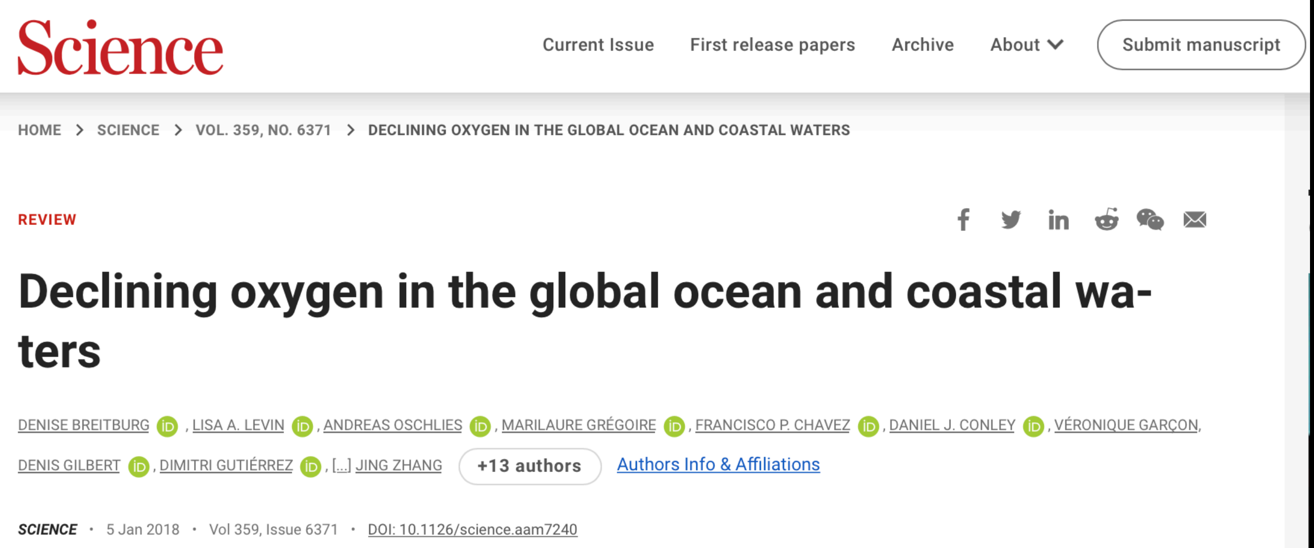
Mean annual temperature
-20
-10
0
10
20
30
°C

PNAS May 26,
2020 117 (21) 11350-11355

GES ↗: RÉSULTATS

ACIDIFICATION ET HYPOXIE DES OCÉANS

(CO2 + H_2O= H^+ + HCO_3^-)



HOME > SCIENCE > VOL. 359, NO. 6371 > DECLINING OXYGEN IN THE GLOBAL OCEAN AND COASTAL WATERS

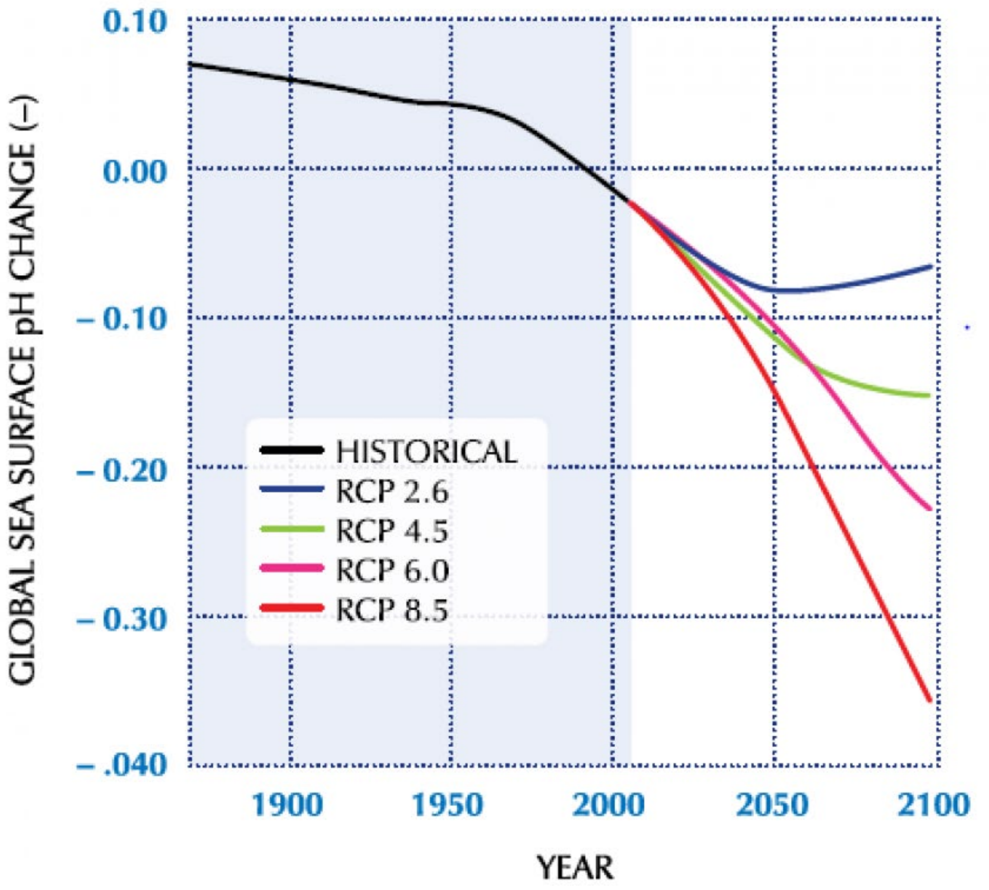
REVIEW

Declining oxygen in the global ocean and coastal waters

DENISE BREITBURG, LISA A. LEVIN, ANDREAS OSCHLIES, MARILAURE GRÉGOIRE, FRANCISCO P. CHAVEZ, DANIEL J. CONLEY, VÉRONIQUE GARÇON, DENIS GILBERT, DIMITRI GUTIÉRREZ, [...] JING ZHANG +13 authors Authors Info & Affiliations

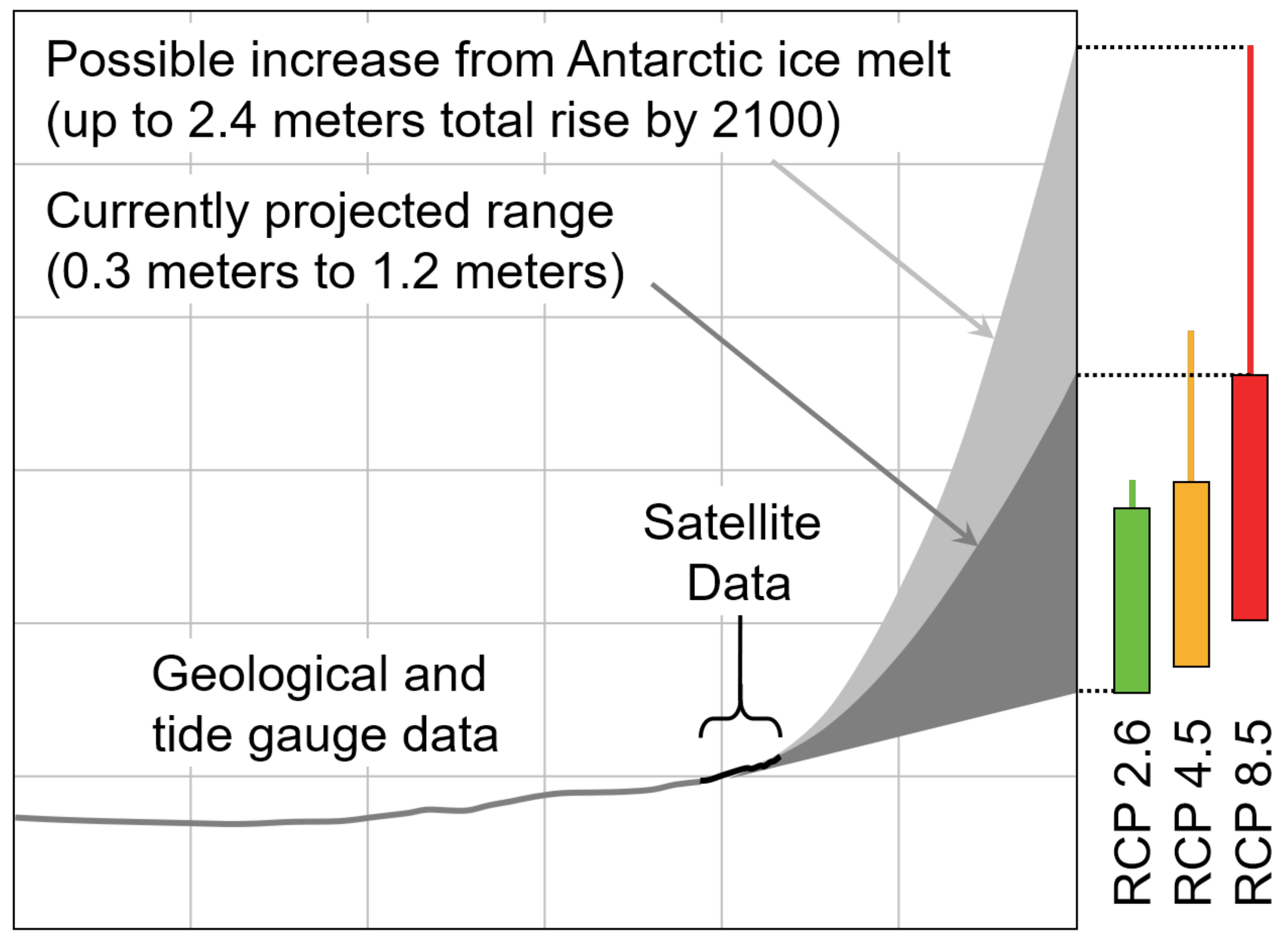
SCIENCE • 5 Jan 2018 • Vol 359, Issue 6371 • DOI: 10.1126/science.aam7240

The severity of future ocean acidification depends on the scale of future CO_2 emissions, shown here for the four IPCC pathways: RCP 2.6, lowest emissions (atmospheric CO_2 at ~421ppm in 2100); RCP 6.0, low emissions (~538ppm); moderate emissions (~670ppm); and RCP 8.5, high emissions (~936ppm). After Bopp et *al*. 2013.



GES ↗: RÉSULTATS

AUGMENTATION DU NIVEAU DE LA MER

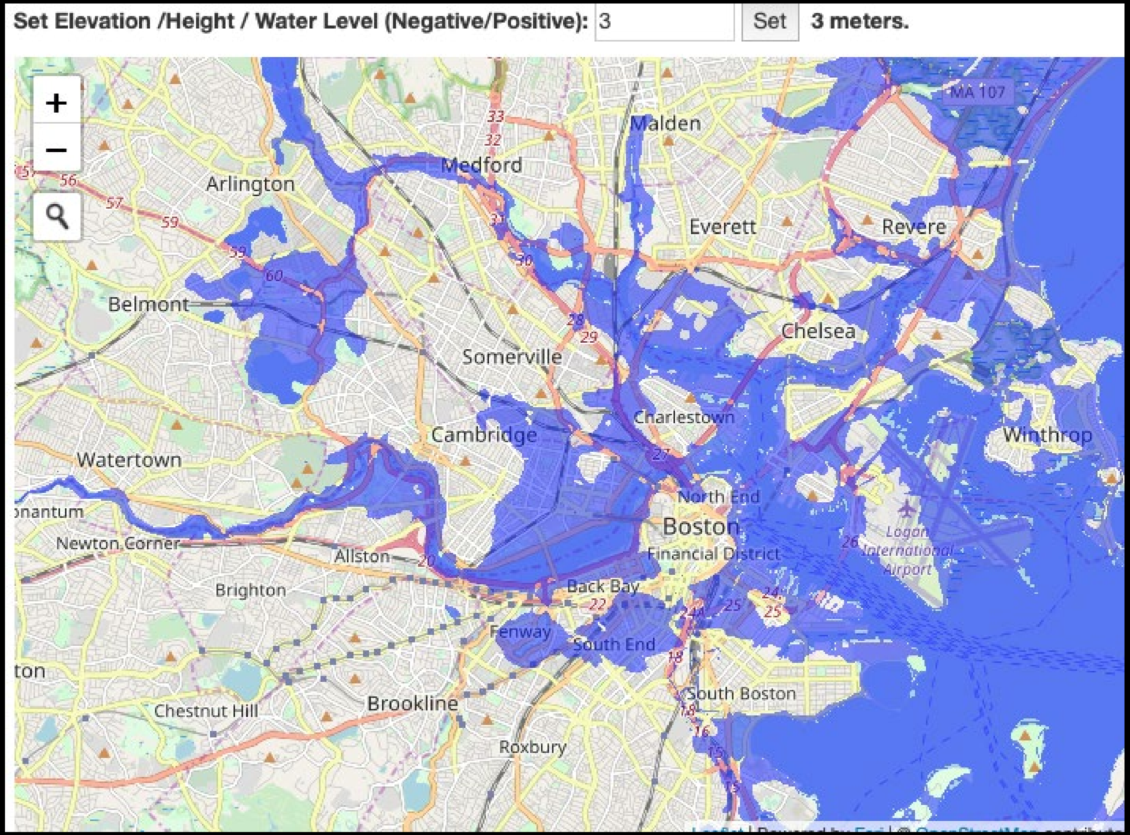


NOAA, 2017

GES ↗: RÉSULTATS

AUGMENTATION DU NIVEAU DE LA MER

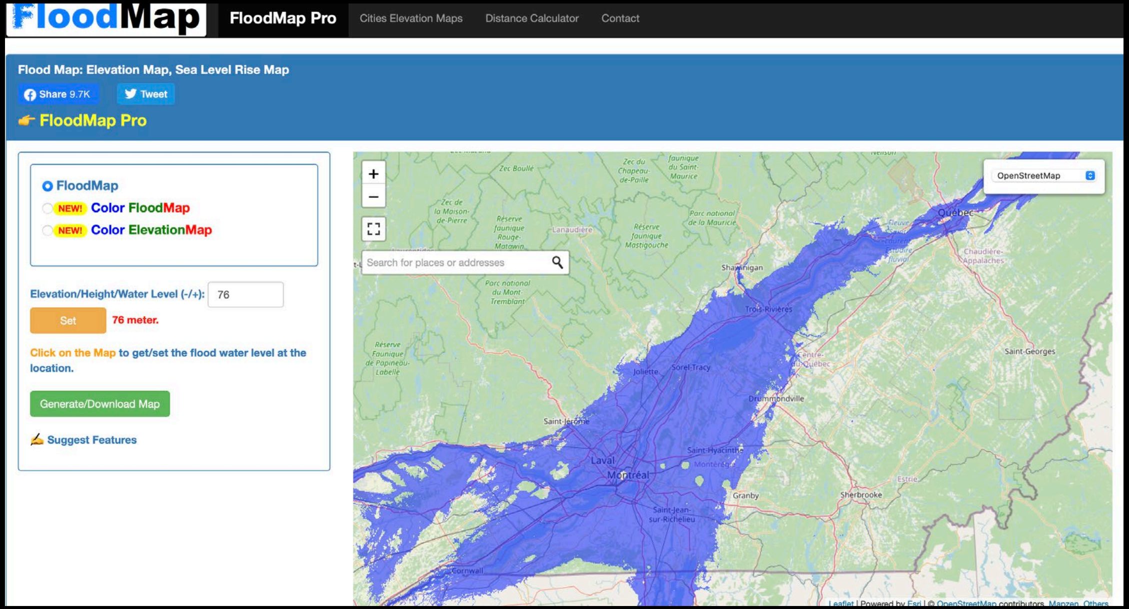
2100 « no change scenario»



Set Elevation /Height / Water Level (Negative/Positive): 3 Set 3 meters.

Malden
Medford
Arlington
Everett
Revere
Belmont
Chelsea
Somerville
Charlestown
Cambridge
Winthrop
Watertown
North End
Boston
Financial District
Newton Corner
Allston
Logan International Airport
Brighton
Back Bay
Fenway
South End
South Boston
Chestnut Hill
Brookline
Roxbury
MA 107

Scénario Fonte complète



Flood Map: Elevation Map, Sea Level Rise Map

Elevation/Height/Water Level (-/+): 76

76 meter.

Click on the Map to get/set the flood water level at the location.

FloodMap
FloodMap Pro
Cities Elevation Maps
Distance Calculator
Contact
Share 9.7K
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FloodMap Pro
FloodMap
NEW! Color FloodMap
NEW! Color ElevationMap
Set
Generate/Download Map
Suggest Features
Search for places or addresses
OpenStreetMap
Québec
Shawinigan
Trois-Rivières
Sorel-Tracy
Joliette
Drummondville
Saint-Jérôme
Saint-Hyacinthe
Laval
Montréal
Saint-Jean-sur-Richelieu
Granby
Sherbrooke
Saint-Georges

GES ↗ : RÉSULTATS

↗ MALADIES INFECTIEUSES

58% des maladies infectieuses connues sont aggravées par la crise climatique

…vs 3% diminuées

Fig. 4: Diseases affected by climatic hazards.

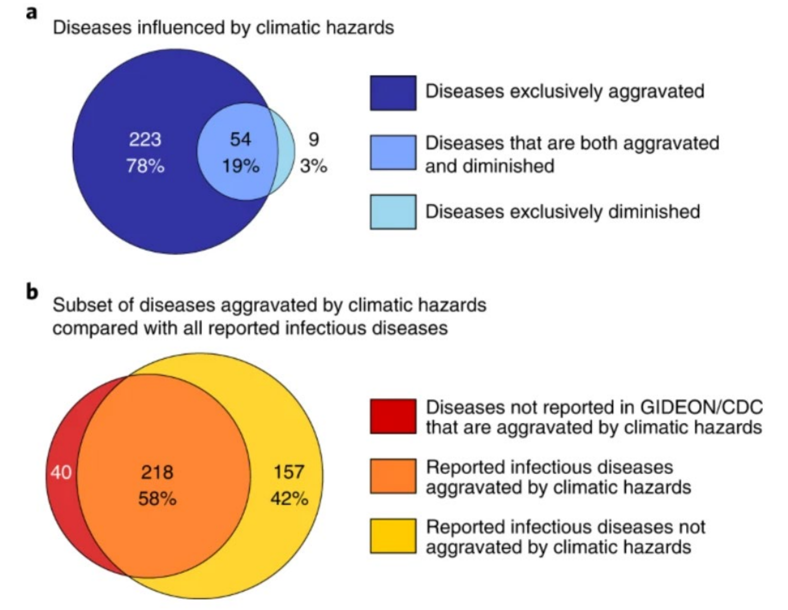
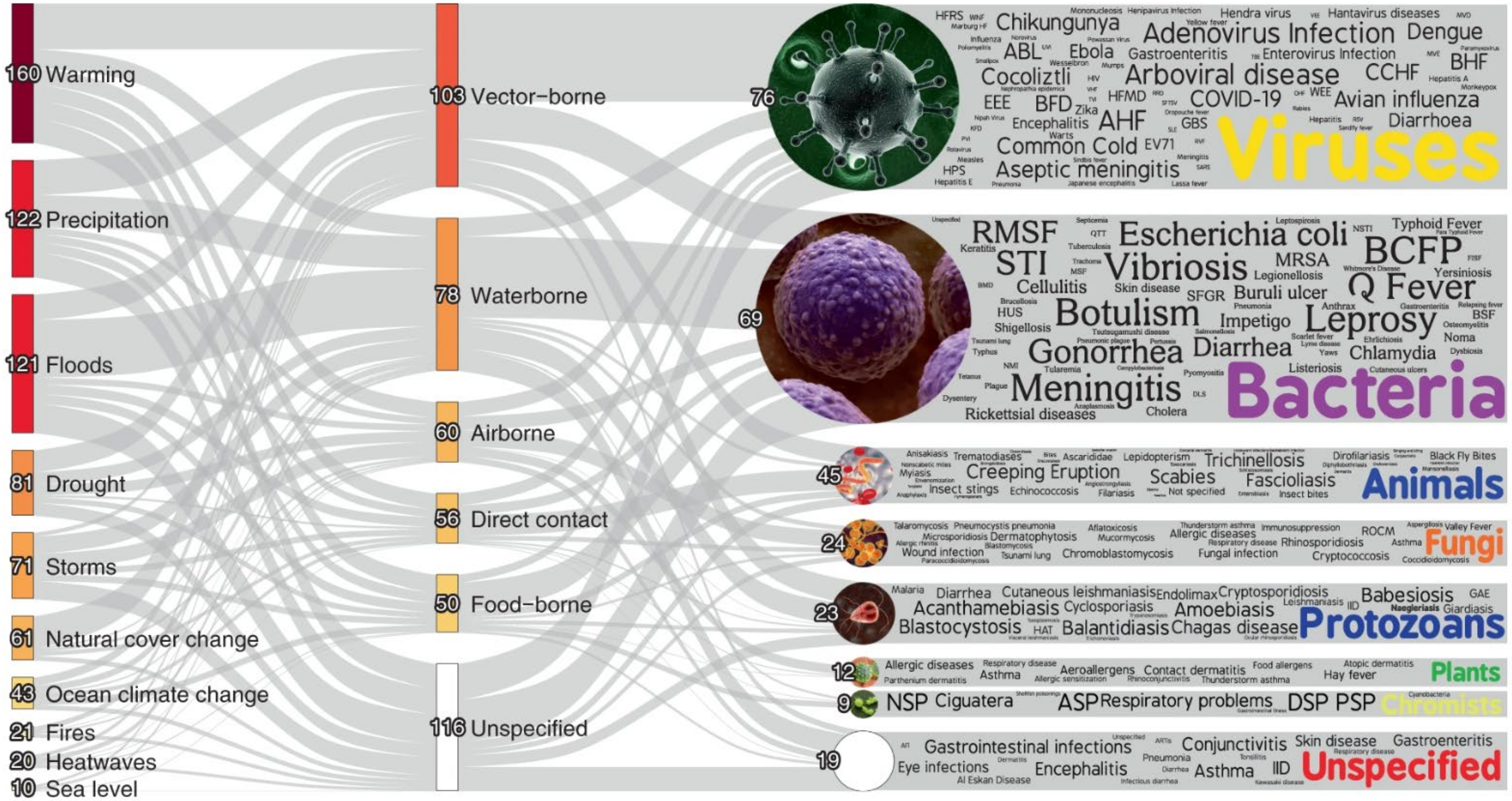


Fig. 3: Pathogenic diseases aggravated by climatic hazards.

From: Over half of known human pathogenic diseases can be aggravated by climate change



Nature Climate Change 12 869-75 (2022)

GES ↗: RÉSULTATS

OMS

« La crise climatique est la plus grande menace à la santé du 21ième siècle…menant à:

Mortalité directe

↗ maladies infectieuses

Dégradation des déterminants les plus fondamentaux de la santé:

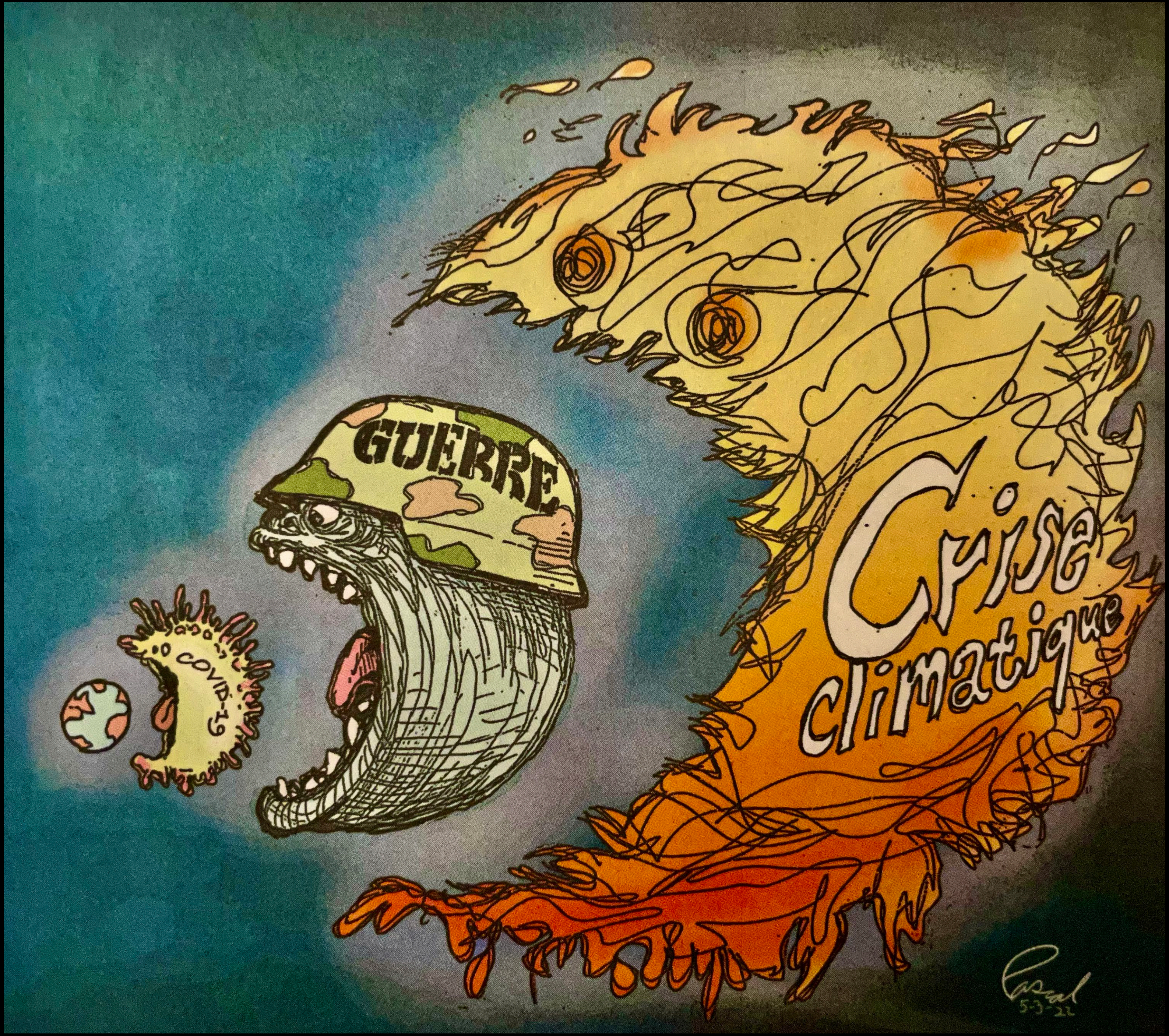
air propre

eau douce potable

nourriture »

Sans parler des conflits qui en découlereont…

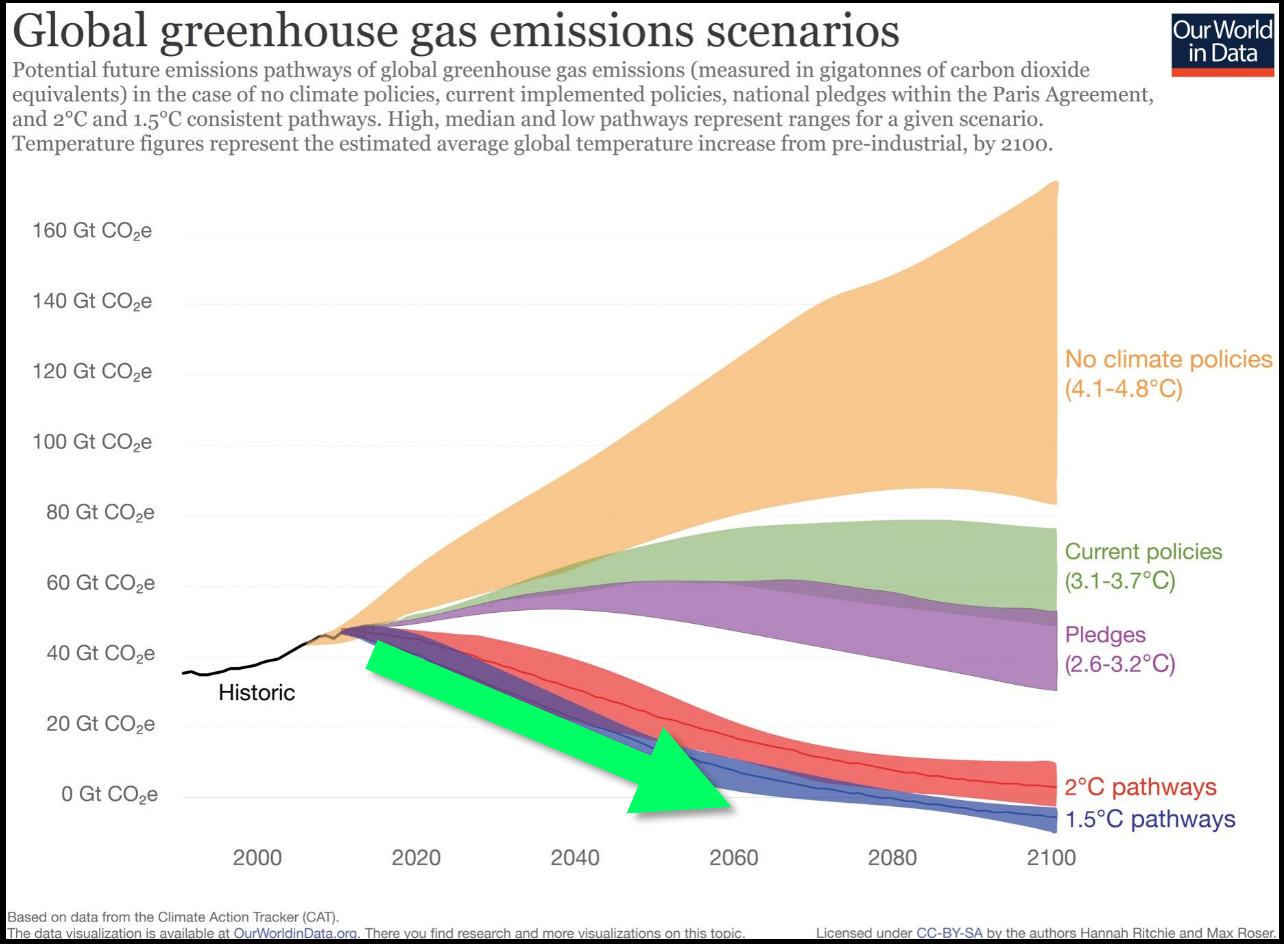
https://www.who.int/globalchange/mediacentre/news/global-programme/en/


GUERRE
COVID-19
Crise climatique
Pascal
5-3-22

CRISE CLIMATIQUE

SÉVÉRITÉ $\propto$ ÉMISSIONS DE GES

SOLUTION: CARBONEUTRALITÉ



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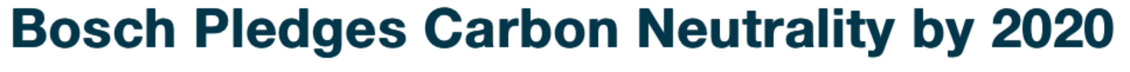
No climate policies (4.1-4.8°C)
Current policies (3.1-3.7°C)
Pledges (2.6-3.2°C)
2°C pathways
1.5°C pathways
2000
2020
2040
2060
2080
2100

Based on data from the Climate Action Tracker (CAT).
The data visualization is available at OurWorldinData.org. There you find research and more visualizations on this topic.

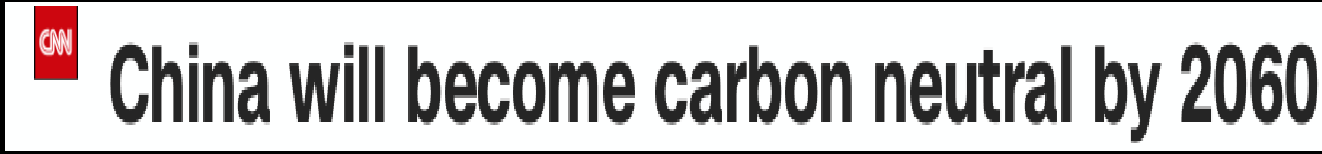
Licensed under CC-BY-SA by the authors Hannah Ritchie and Max Roser.

RÉDUIRE ÉMISSIONS GES JUSQU'À = RÉSOBPTION

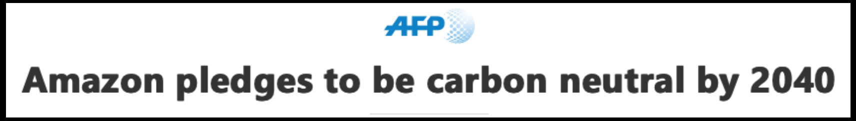
CARBONEUTRALITÉ



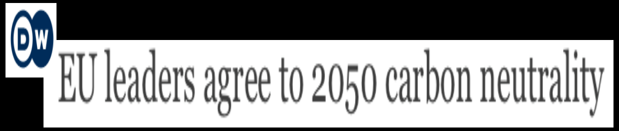
Bosch Pledges Carbon Neutrality by 2020



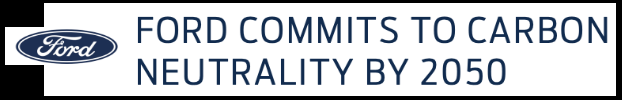
China will become carbon neutral by 2060



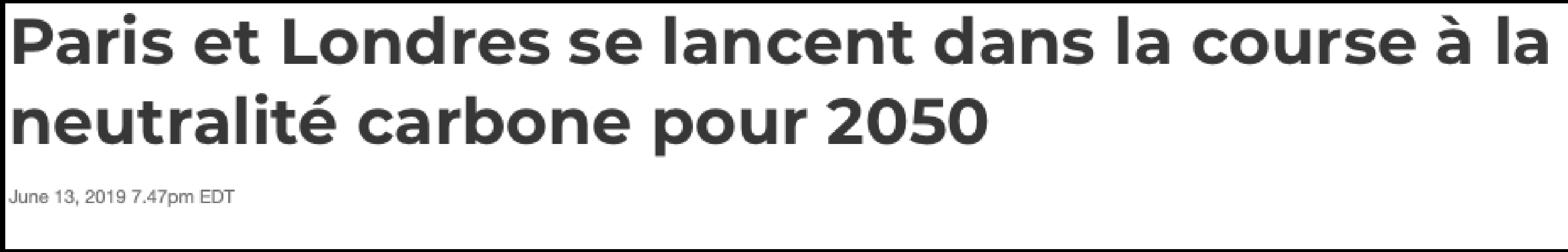
Amazon pledges to be carbon neutral by 2040



EU leaders agree to 2050 carbon neutrality

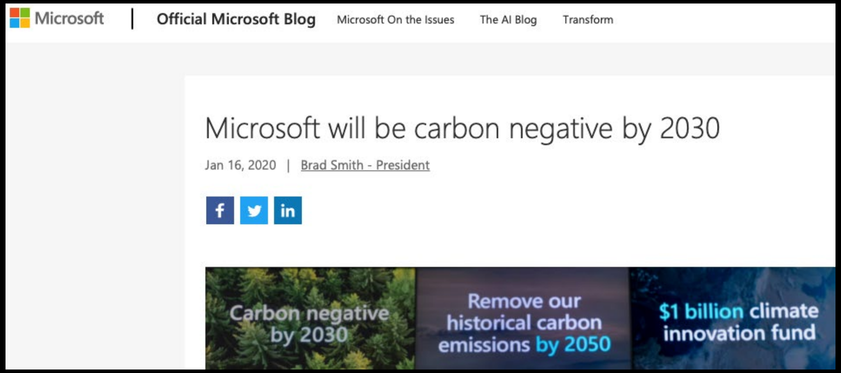


FORD COMMITS TO CARBON NEUTRALITY BY 2050



Paris et Londres se lancent dans la course à la neutralité carbone pour 2050

June 13, 2019 7.47pm EDT

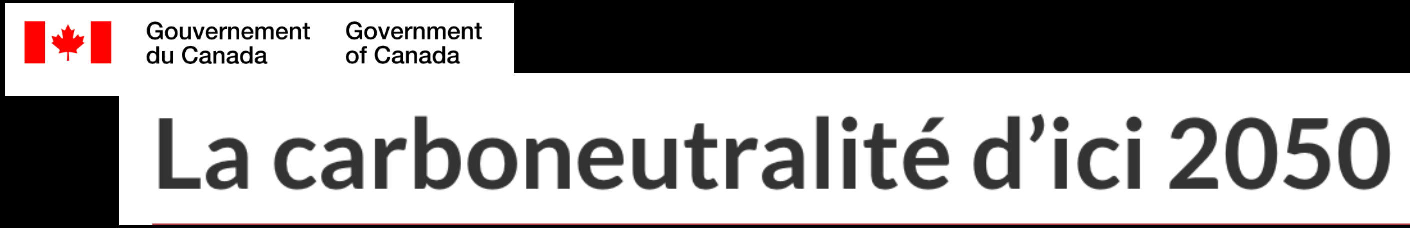


Microsoft
Official Microsoft Blog
Microsoft On the Issues
The AI Blog
Transform

Microsoft will be carbon negative by 2030

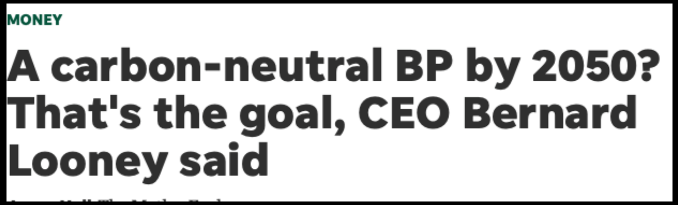
Jan 16, 2020 | Brad Smith - President

Carbon negative by 2030
Remove our historical carbon emissions by 2050
$1 billion climate innovation fund



Gouvernement du Canada
Government of Canada

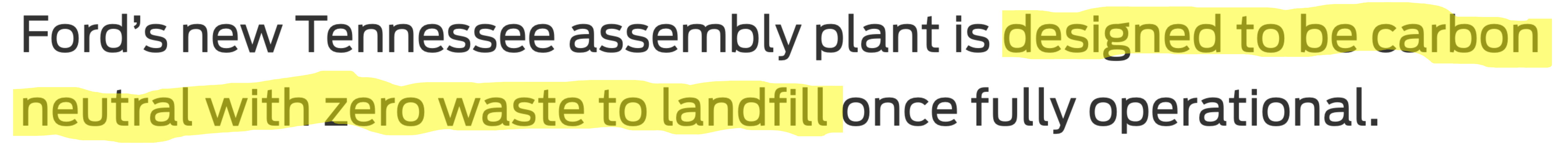
La carboneutralité d'ici 2050



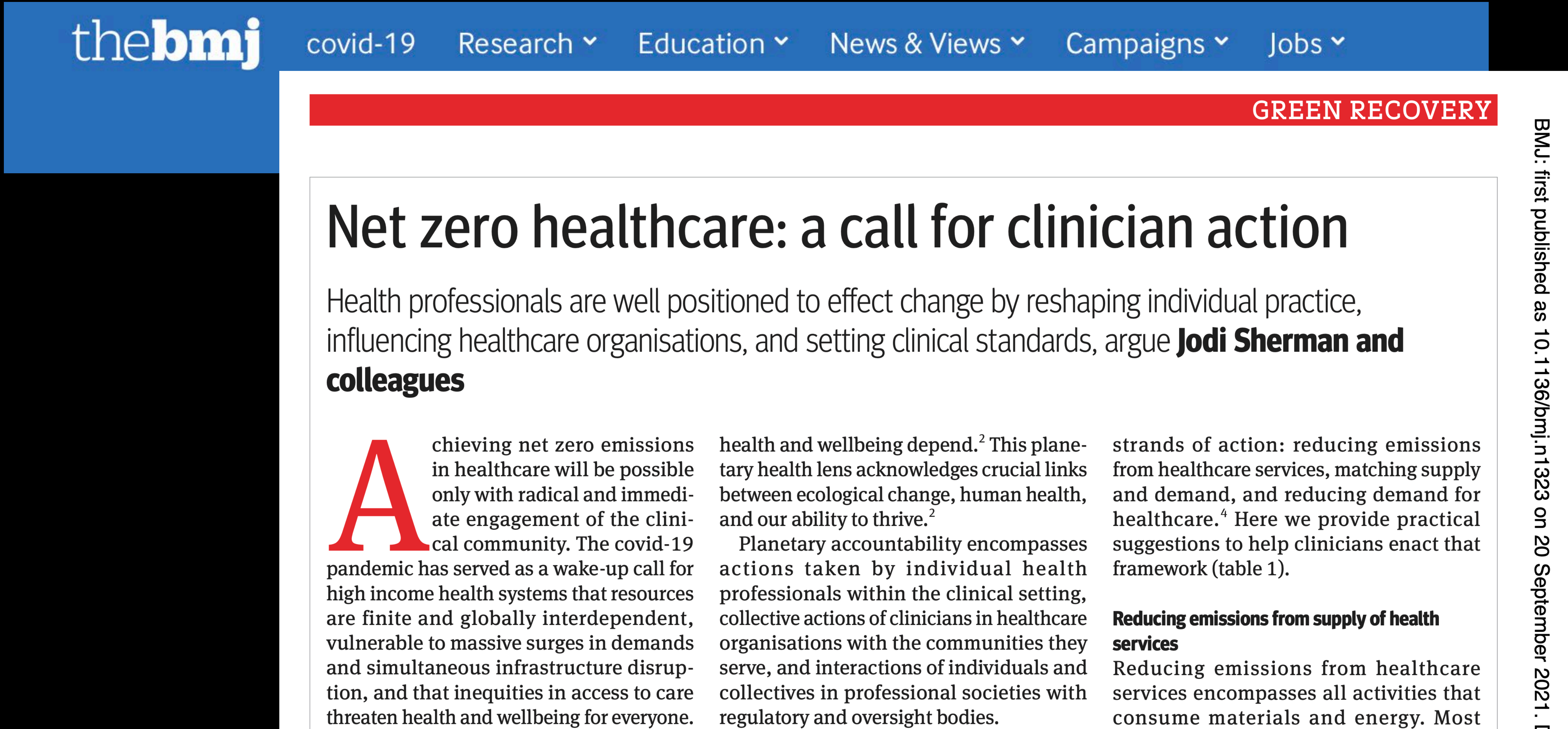
A carbon-neutral BP by 2050? That's the goal, CEO Bernard Looney said

CARBONEUTRALITÉ

Blue Oval City
Ford


Ford’s new Tennessee assembly plant is designed to be carbon neutral with zero waste to landfill once fully operational.

CARBONEUTRALITÉ



GREEN RECOVERY

Net zero healthcare: a call for clinician action

Health professionals are well positioned to effect change by reshaping individual practice, influencing healthcare organisations, and setting clinical standards, argue **Jodi Sherman and colleagues**

Achieving net zero emissions in healthcare will be possible only with radical and immediate engagement of the clinical community. The covid-19 pandemic has served as a wake-up call for high income health systems that resources are finite and globally interdependent, vulnerable to massive surges in demands and simultaneous infrastructure disruption, and that inequities in access to care threaten health and wellbeing for everyone.

health and wellbeing depend.[2] This planetary health lens acknowledges crucial links between ecological change, human health, and our ability to thrive.[2]

Planetary accountability encompasses actions taken by individual health professionals within the clinical setting, collective actions of clinicians in healthcare organisations with the communities they serve, and interactions of individuals and collectives in professional societies with regulatory and oversight bodies.

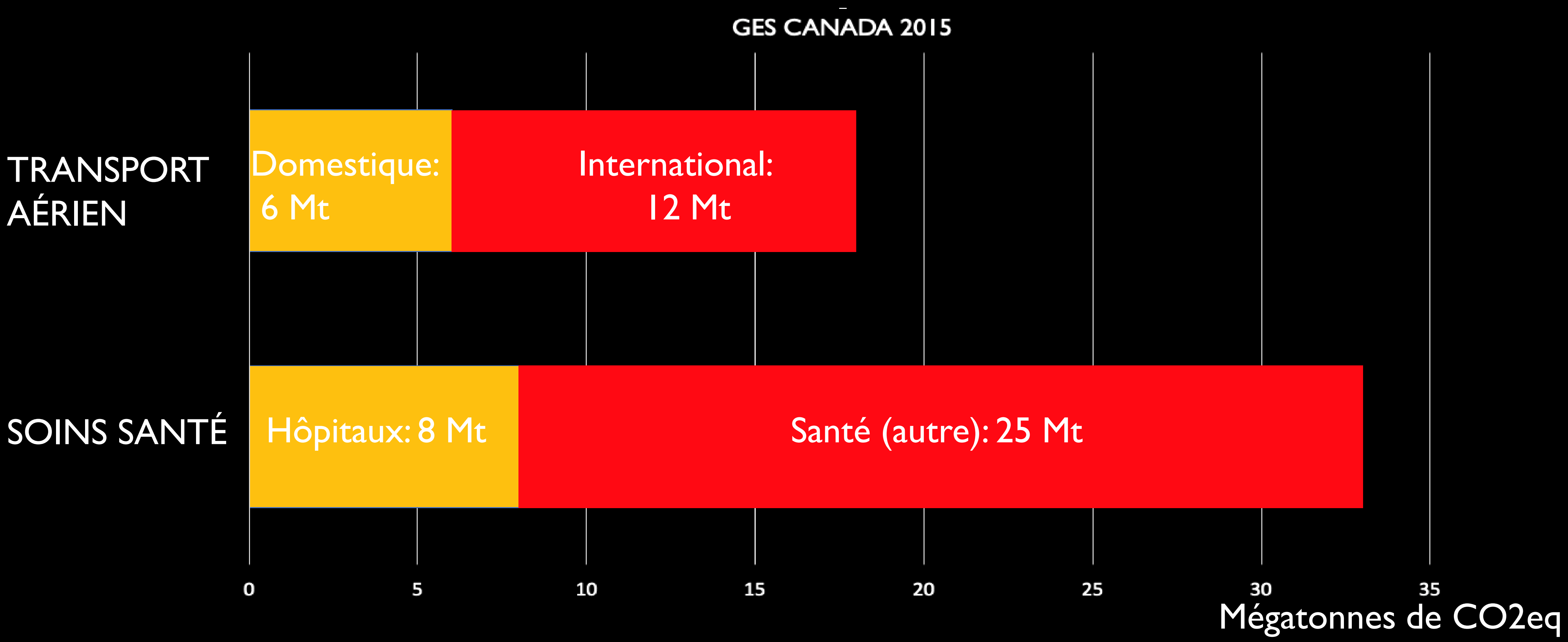
strands of action: reducing emissions from healthcare services, matching supply and demand, and reducing demand for healthcare.[4] Here we provide practical suggestions to help clinicians enact that framework (table 1).

Reducing emissions from supply of health services

Reducing emissions from healthcare services encompasses all activities that consume materials and energy. Most

BMJ: first published as 10.1136/bmj.n1323 on 20 September 2021.

SOINS DE SANTÉ = 5% DES GES ÉMIS AU CANADA



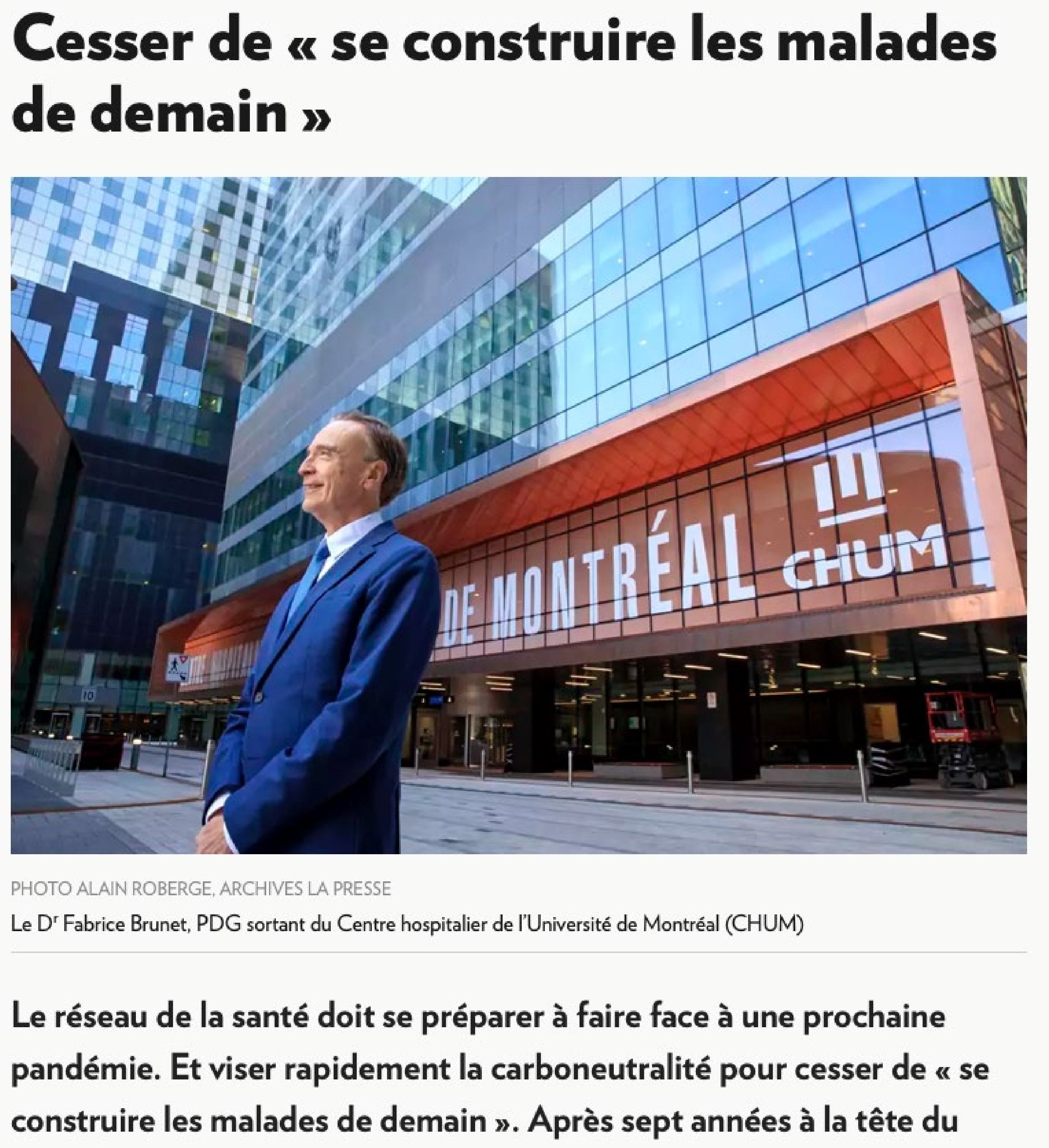
PLoS Med 15(7): e1002623. https://doi.org/10.1371/journal. pmed.1002623
https://tc.canada.ca/fr/services-generaux/politiques/plan-action-canada-reduire-emissions-gaz-effet-serre-provenant-aviation-rapport-annuel-2016

« Soigner en polluant »

Pétrin-Desrosiers C., La Presse, 2021

CARBONEUTRALITÉ =

Brunet F., La Presse, 2022



Cesser de « se construire les malades de demain »

PHOTO ALAIN ROBERGE, ARCHIVES LA PRESSE

Le D^{r} Fabrice Brunet, PDG sortant du Centre hospitalier de l'Université de Montréal (CHUM)

Le réseau de la santé doit se préparer à faire face à une prochaine pandémie. Et viser rapidement la carboneutralité pour cesser de « se construire les malades de demain ». Après sept années à la tête du

CARBONEUTRALITÉ:

- ATTEIGNABLE AVEC TECHNOLOGIES EXISTANTES
- IMPACTS POSITIFS SUR LA QUALITÉ DE VIE
- RÉSULTE EN ÉCONOMIES IMPORTANTES $ VS STATUT QUO

Hawken P (ed). *Drawdown* (2017), ISBN 9780143130444

NHS

Delivering a 'Net Zero' National Health Service

2020: Vrai plan avec mesure GES et jalons annuels

Cibles: -80% de GES en 2030
NHS Carboneutre en 2040

Budget: 3-500 millions £/an (car économies +++)

Staff permanent 200 personnes

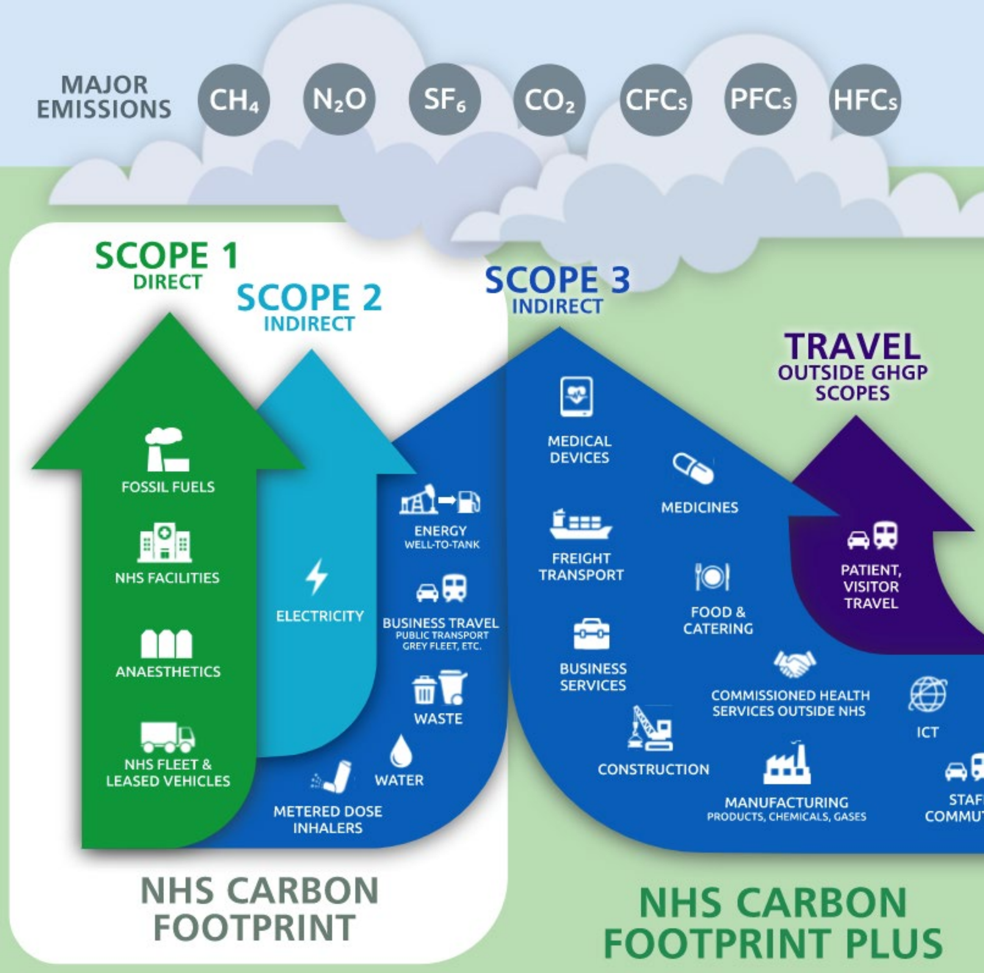
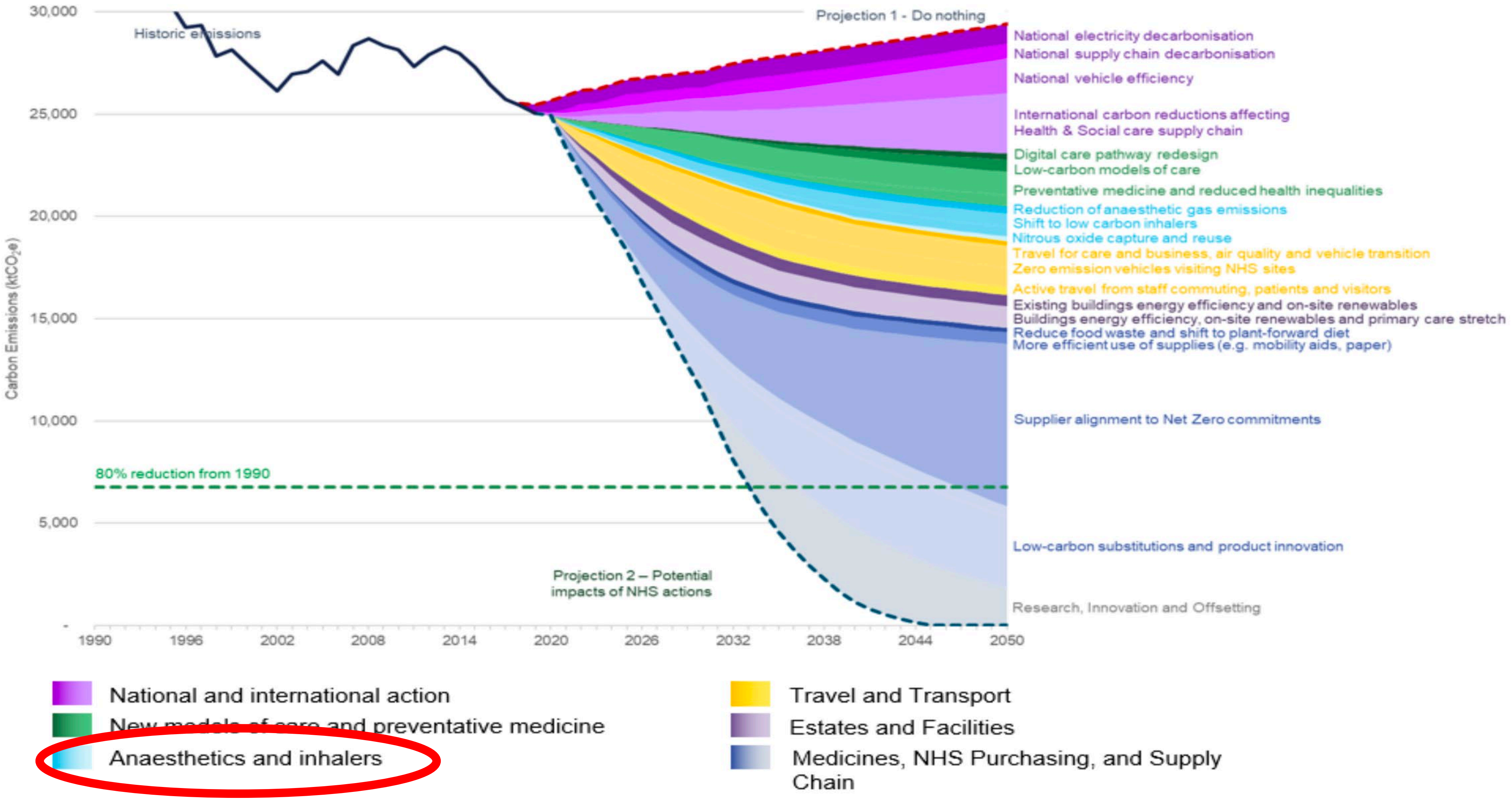

MAJOR EMISSIONS
CH_4
N_2O
SF_6
CO_2
CFCs
PFCs
HFCs
SCOPE 1 DIRECT
SCOPE 2 INDIRECT
SCOPE 3 INDIRECT
TRAVEL OUTSIDE GHGP SCOPES
FOSSIL FUELS
NHS FACILITIES
ANAESTHETICS
NHS FLEET & LEASED VEHICLES
ELECTRICITY
ENERGY WELL-TO-TANK
BUSINESS TRAVEL PUBLIC TRANSPORT GREY FLEET, ETC.
WASTE
WATER
METERED DOSE INHALERS
MEDICAL DEVICES
MEDICINES
FREIGHT TRANSPORT
FOOD & CATERING
BUSINESS SERVICES
COMMISSIONED HEALTH SERVICES OUTSIDE NHS
ICT
CONSTRUCTION
MANUFACTURING PRODUCTS, CHEMICALS, GASES
PATIENT, VISITOR TRAVEL
STAF COMMU
NHS CARBON FOOTPRINT
NHS CARBON FOOTPRINT PLUS

Figure 5: Pathway to net zero for the NHS Carbon Footprint Plus Scope



ANESTHÉSIE, GES ET CARBONEUTRALITÉ

ANESTHÉSIE CARBONEUTRE

1. Trouver/mesurer émissions GES (eqCO2)
2. Réduire au maximum émissions GES
3. Compenser GES résiduels

GES ET GAZ ANESTHÉSIQUES

Émissions SOP = 3-6X GES moyenne générale hôpital

Gaz anesthésiques peuvent facilement générer + GES que toutes autres sources d'une SOP(!)

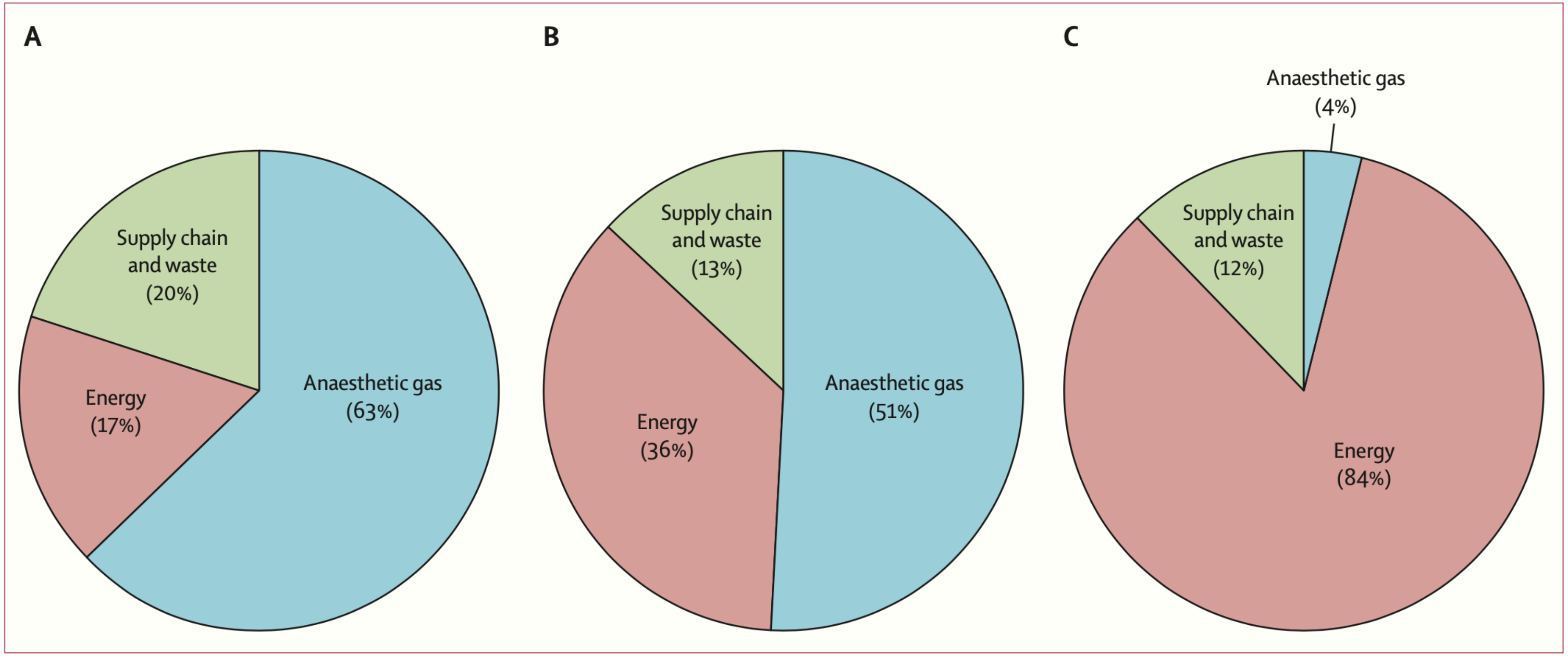
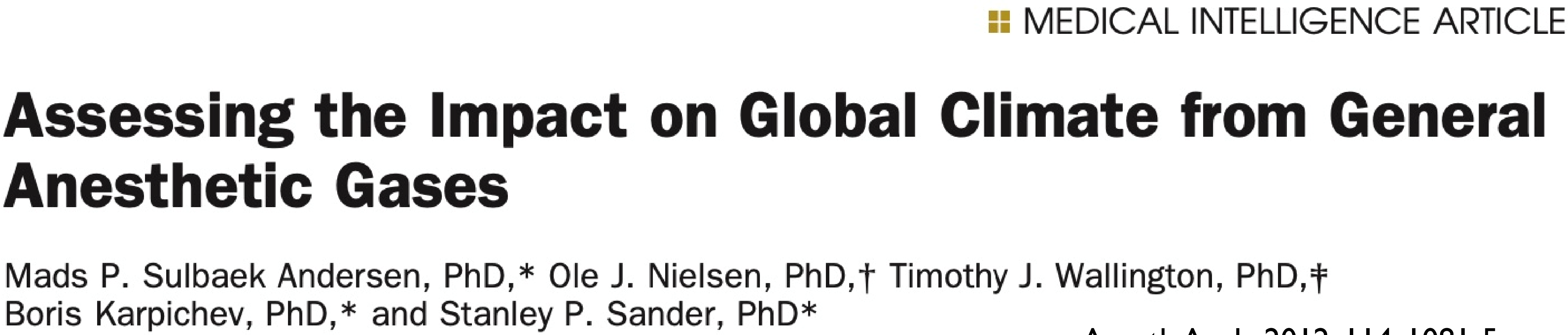


Figure 2: **Relative contribution of scopes 1, 2, and 3 to the carbon footprint of operating theatres at (A) Vancouver General Hospital, (B) University of Minnesota Medical Center, and (C) John Radcliffe Hospital**
Anaesthetic gas=scope 1. Energy=scope 2. Supply chain and waste=scope 3.

Lancet Planet Health **2017; 1: e381–88**



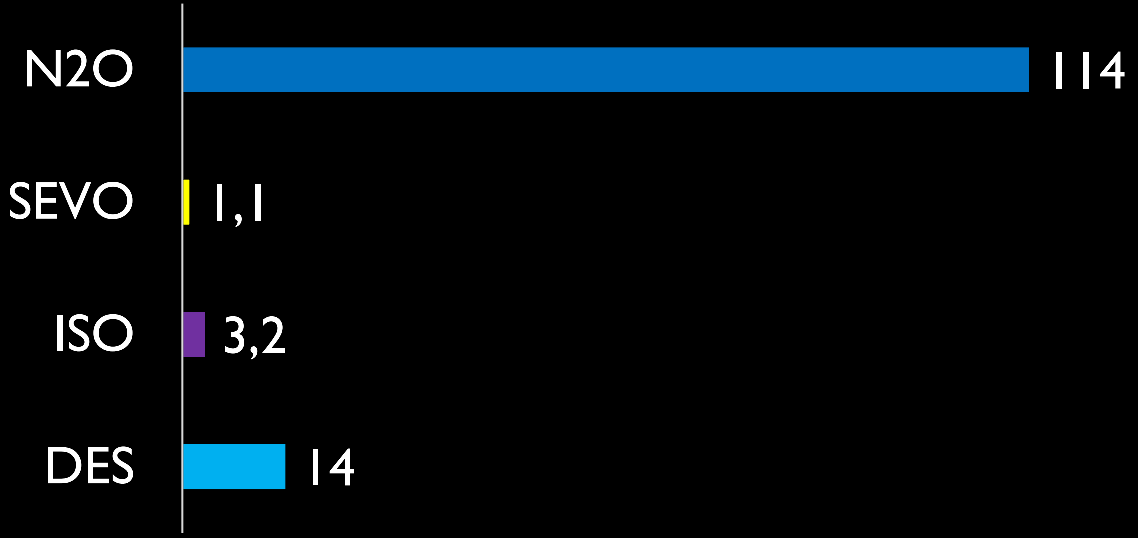
MEDICAL INTELLIGENCE ARTICLE

Assessing the Impact on Global Climate from General Anesthetic Gases

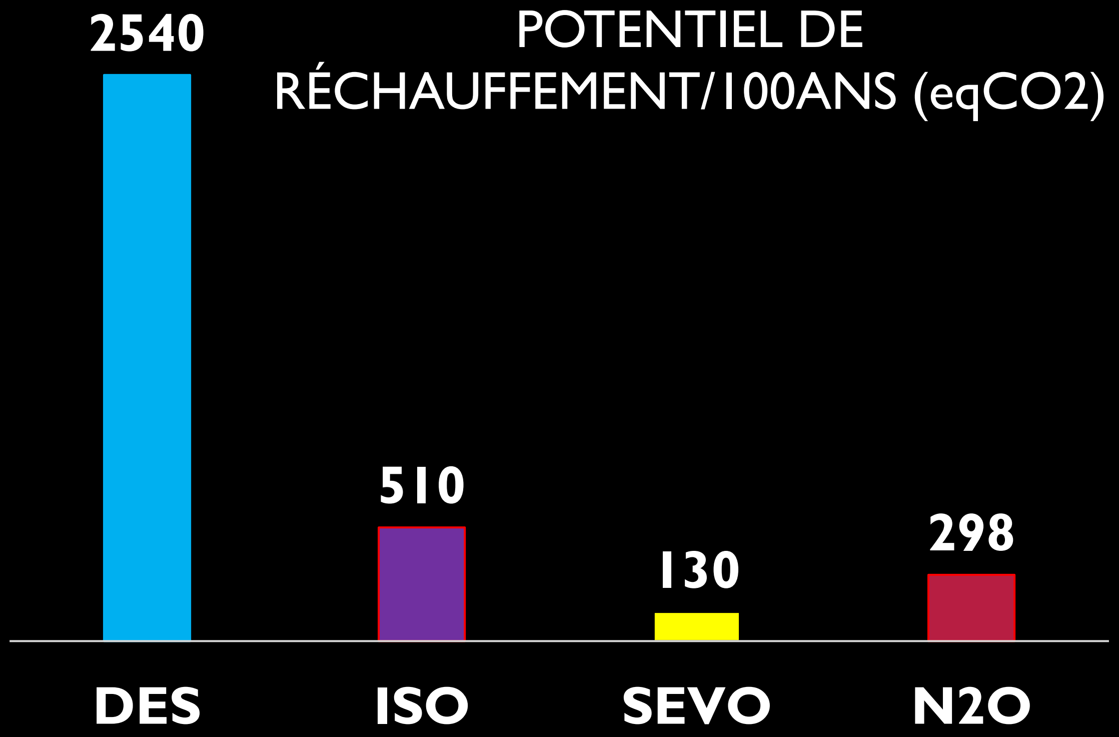
Mads P. Sulbaek Andersen, PhD,* Ole J. Nielsen, PhD,† Timothy J. Wallington, PhD,‡
Boris Karpichev, PhD,* and Stanley P. Sander, PhD*

Anesth Analg 2012; 114: 1081-5

Demi-vie atmosphérique (années)

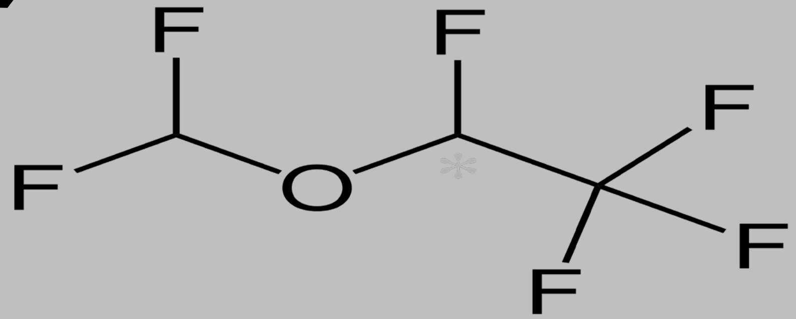


POTENTIEL DE RÉCHAUFFEMENT/100ANS (eqCO2)

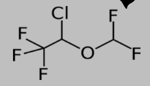


Gaz anesthésiques libérés directement dans l’atmosphère via systèmes « antipollution »

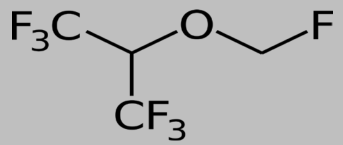
(scavenging)



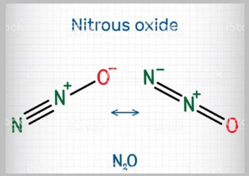
DESFLURANE



ISOFLURANE



SEVOFLURANE



Anesth. Analg. 2012: 144(5): 1086-90

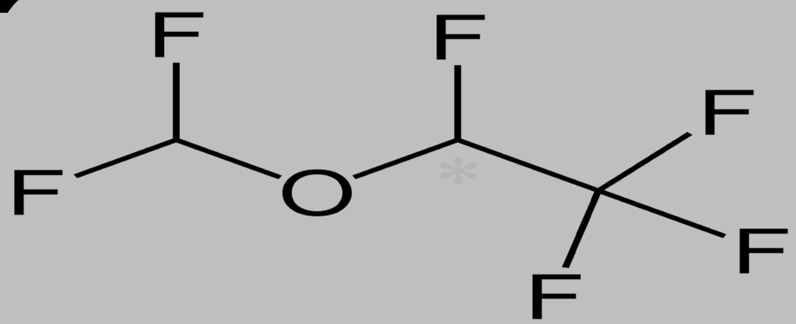
Gaz anesthésiques libérés dans atmosphère par patients en exhalant dans les heures qui suivent l’anesthésie

(Excrétion mesurable halogénés dans l’urine du personnel en fin de quart…)

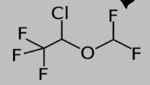
Anesth. Analg. 2012: 144(5): 1086-90

Int Arch Occup Environ Health 2018;91:349-359

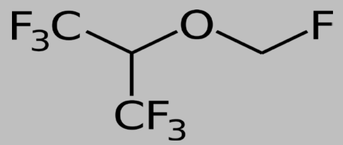
AORN J 2010: doi: 10.1016/j.aorn.2009.10.022



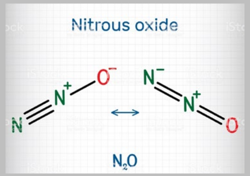
DESFLURANE



ISOFLURANE



SEVOFLURANE



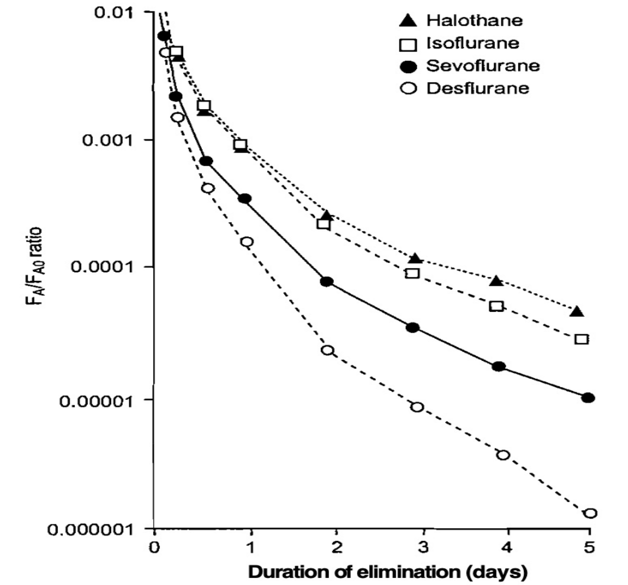


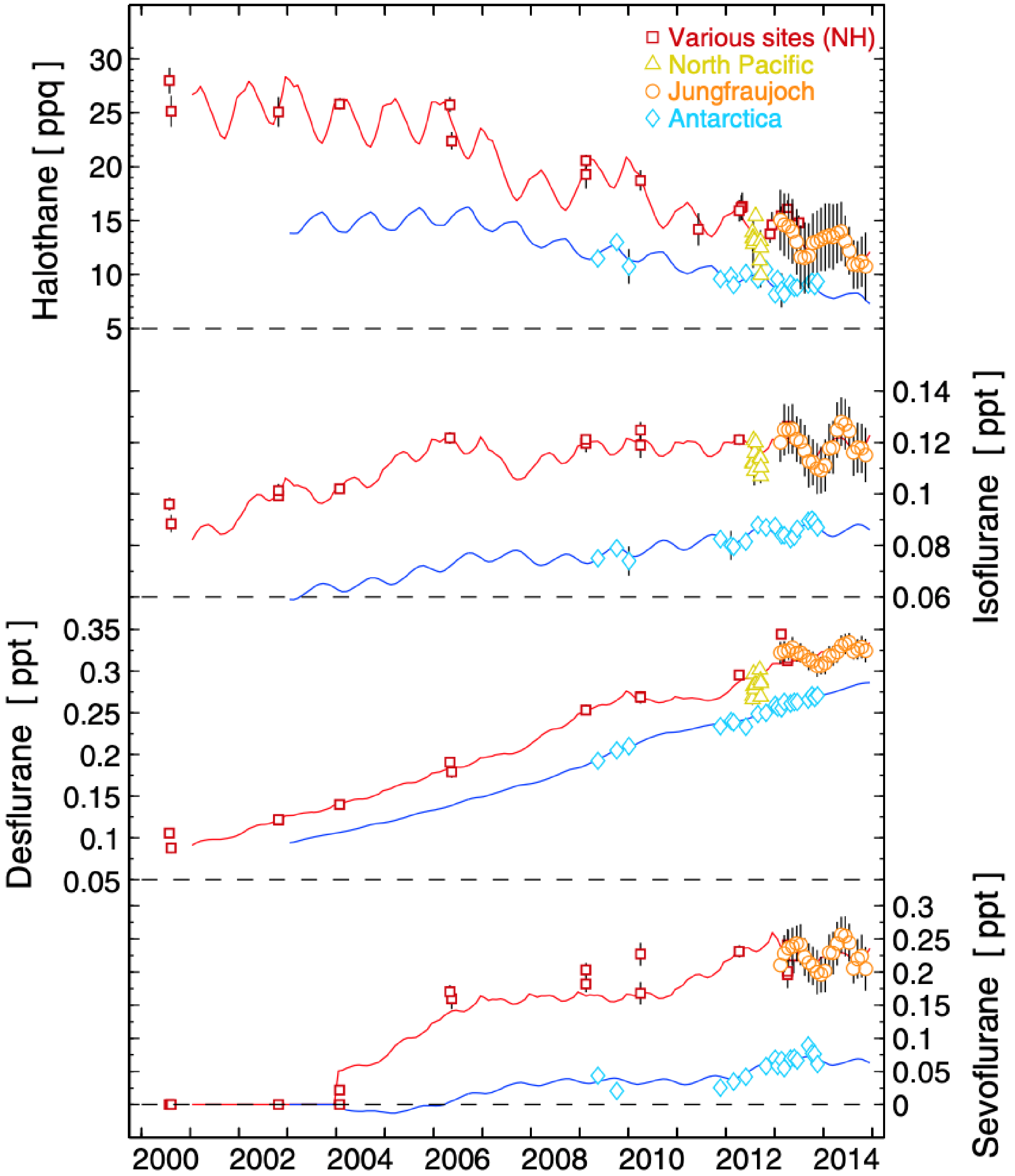
Fig. 6. Elimination of sevoflurane and other inhalational anaesthetics over 5 days. F_A/F_{A0} **is the ratio of end-tidal concentration (**F_A**) to the** F_A **immediately before the beginning of elimination (**F_{A0}**) [from Yasuda et al.,[55] with permission].**

ATMOSPHÈRE: POUBELLE DE L'ANESTHÉSIE

Gaz halogénés anesthésiques mesurés directement dans l'atmosphère:

Dans l'hémisphere nord
Dans le Pacifique Nord
Sur un glacier dans les Alpes
En Antartique…

Geophys. Res. Lett., *42*, 1606–1611



Anesthésie carboneutre passe nécessairement par diminution +++ des émissions reliées aux gaz anesthésiques

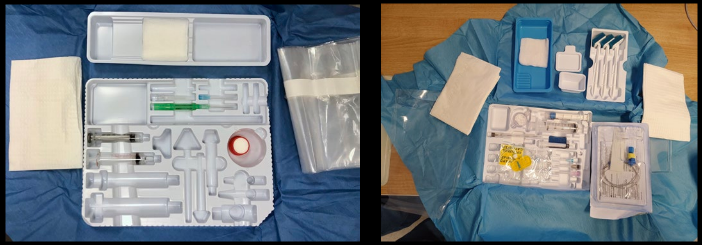
EXEMPLE CHUM

CHUM:

32 SOP, toutes spécialités chx adultes
+ brulés
+ obstétrique
+ radiologie d’intervention
+ radio-oncologie

45 ANESTHÉSIOLOGISTES

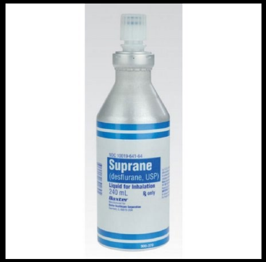
AUDIT CONSOMMABLES CHUM



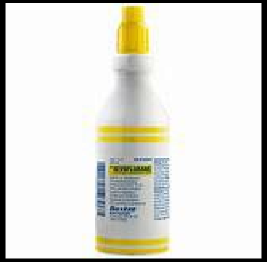
Période	Des (b)	Sevo (b)	N2O (cyl E)	Plateaux rachi	 épidurale
2016-2017	3666	618	40	env 4000	env 3000
…					
2018-2019	1668	675	-	3616	3177
2019-2020	1458	954	-	3969	3231

AUDIT CONSOMMABLES CHUM

OU


Suprane
(desflurane, USP)
240 mL
Baxter

= 900 kg CO2eq

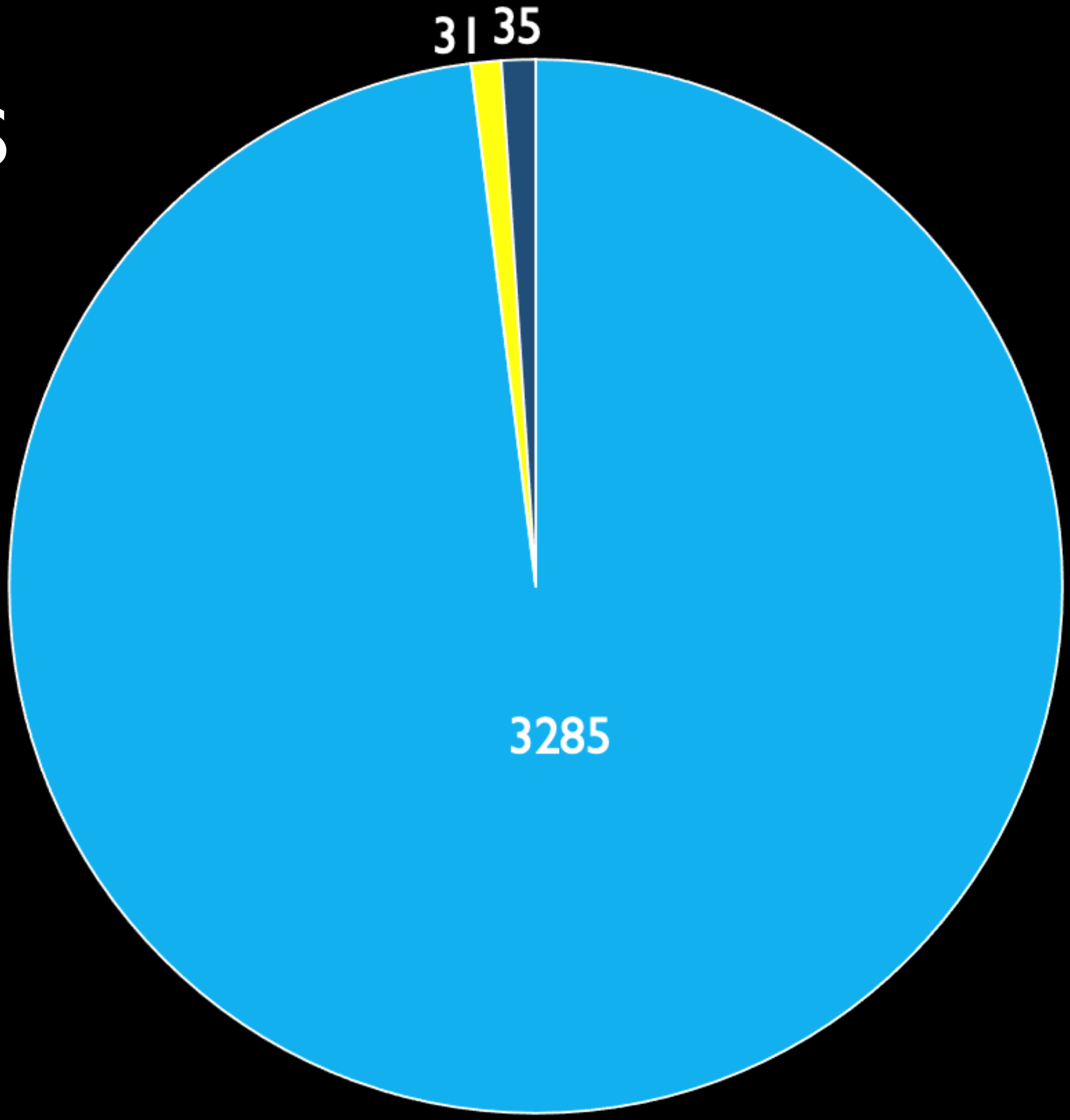

SEVOFLURANE
Baxter

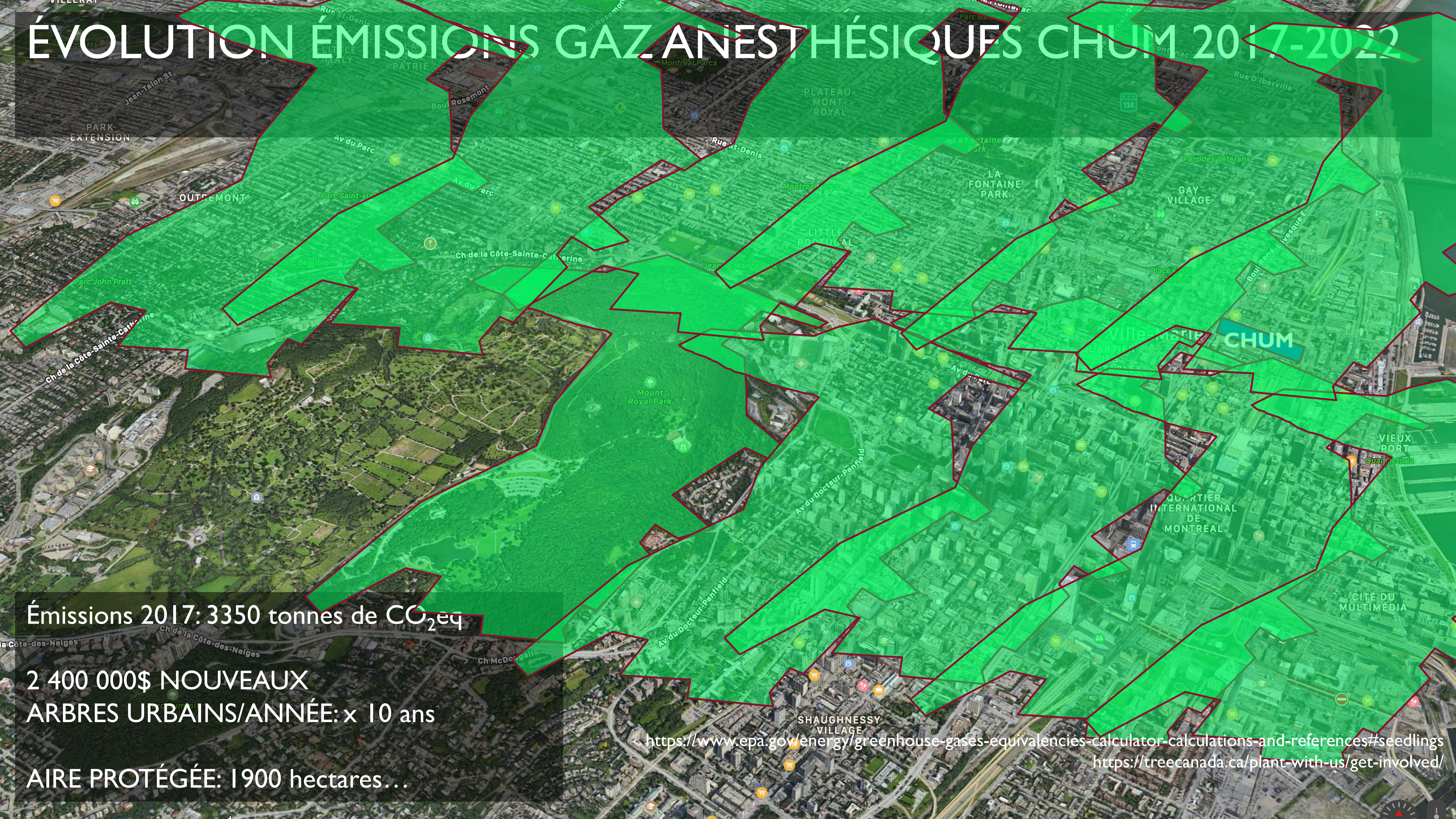
= 50 kg CO2eq

EMISSIONS GES SCOPE 1 ANESTHÉSIOLOGIE CHUM

2016-2017: 3350 Tonnes GES

98% Desflurane




PARK EXTENSION
Jean-Talon St
Boul Rosemont
PLATEAU-MONT-ROYAL
Rue St-Denis
Rue D'Iberville
Av du Parc
OUTREMONT
Parc Saint-Viateur
LA FONTAINE PARK
Parc des Vétérans
GAY VILLAGE
LITTLE PORTUGAL
Ch de la Côte-Sainte-Catherine
Parc John Pratt
Parc Beaubien
Place Émilie-Gamelin
Boul René-Lévesque E
Ville-Marie
CHUM
Mount Royal Park
Av du Docteur-Penfield
VIEUX PORT
Quai Victoria
QUARTIER INTERNATIONAL DE MONTREAL
CITÉ DU MULTIMÉDIA
Ch de la Côte-des-Neiges
Ch McDougall
SHAUGHNESSY VILLAGE

ÉVOLUTION ÉMISSIONS GAZ ANESTHÉSIQUES CHUM 2017-2022

Émissions 2017: 3350 tonnes de CO_2eq

2 400 000$ NOUVEAUX
ARBRES URBAINS/ANNÉE: x 10 ans

AIRE PROTÉGÉE: 1900 hectares…

https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references#seedlings
https://treecanada.ca/plant-with-us/get-involved/

ANESTHÉSIE CARBONEUTRE

1. Trouver/mesurer émissions GES (eqCO2)
2. Réduire au maximum émissions GES
3. Compenser GES résiduels

2. RÉDUIRE EMISSIONS GES DES GAZ ANESTHÉSIQUES

2.1 CHOIX D'AGENT INHALÉ, ANESTHÉSIE IV, RÉGIONALE

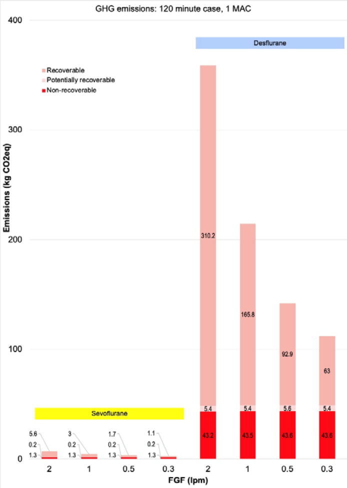
2.2 RÉDUCTION DÉBITS GAZ FRAIS

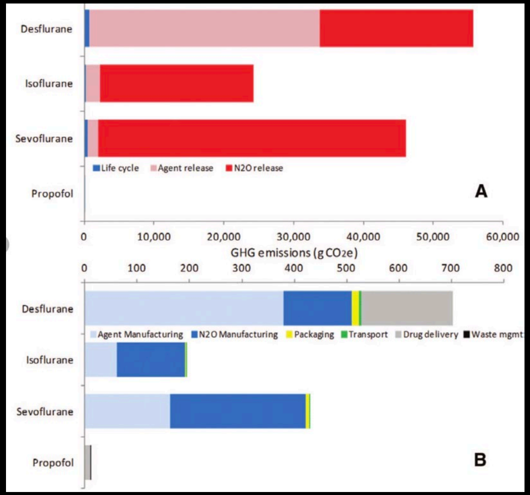
2.3 CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

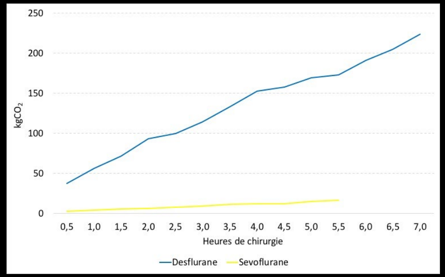
CHOIX D’AGENT INHALÉ

À effet anesthésique idem (et 1/3 coût desfl.):

Sevoflurane 50X moins effet serre que desflurane/N_2O^1







1. Anesth Analg 2012;114:1086 –90
2. Couture et al, abstract SFAR, 2020
3. Paquin et Williams, en préparation

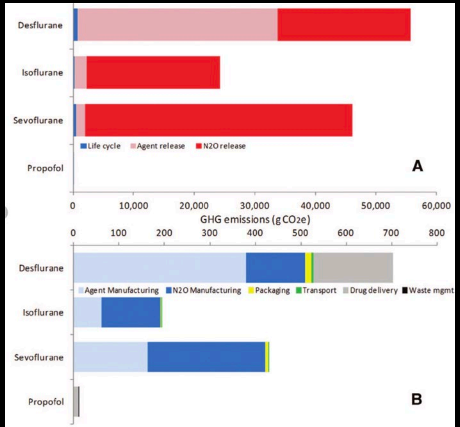
ANESTHÉSIE INTRAVEINEUSE TOTALE / RÉGIONALE

Élimination des agents inhalés de nos anesthésies

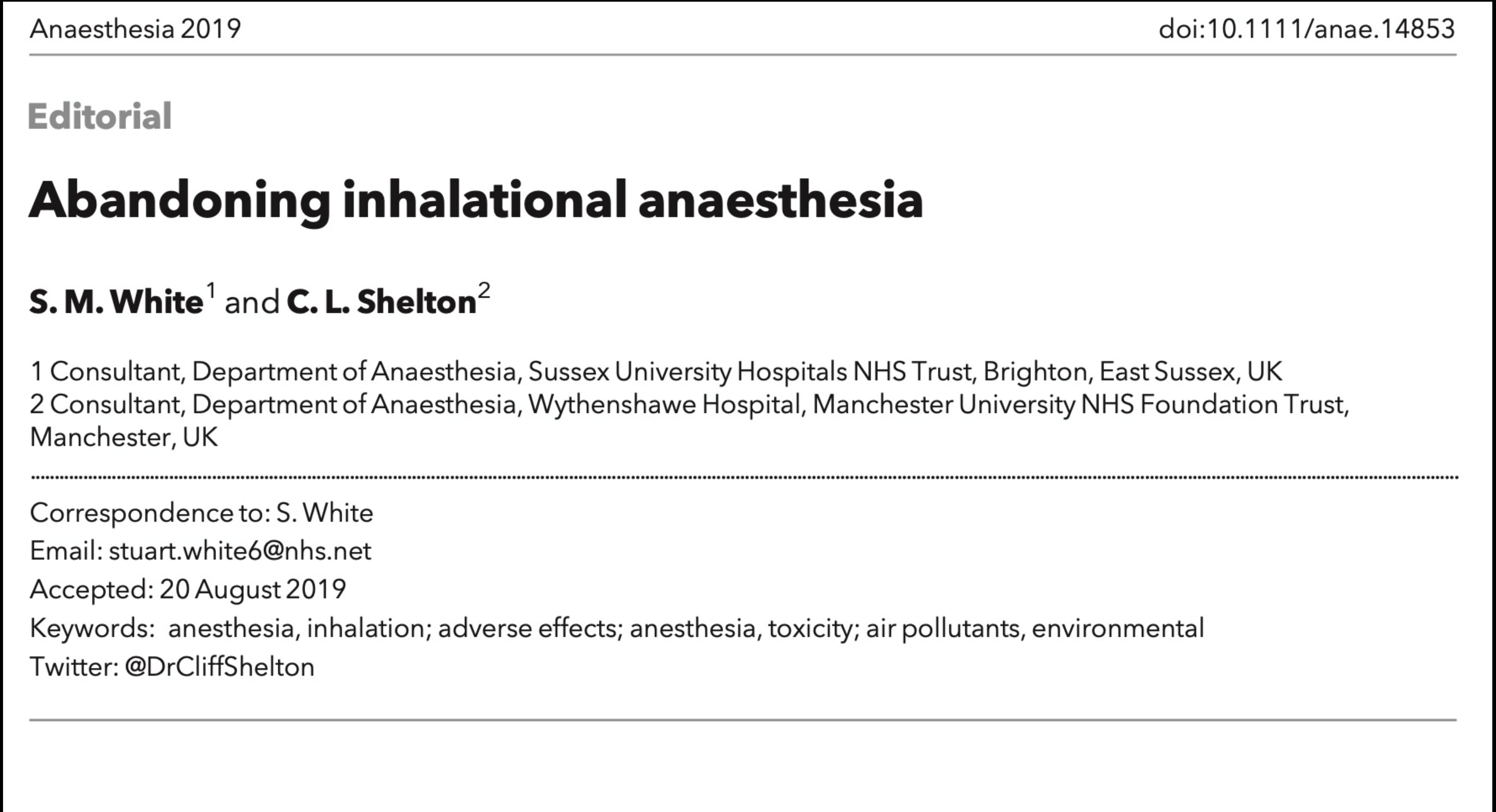
=

Zéro émissions directes GES

ACV: 99-99.9% moins de GES vs desflurane/N_2O[1,2]



1. Anesth Analg 2012;114:1086 –90
2. ACS Sustainable Chem. Eng. 2019, 7, 6580−6591



Anaesthesia 2019 doi:10.1111/anae.14853

Editorial

Abandoning inhalational anaesthesia

S. M. White[1] and **C. L. Shelton**[2]

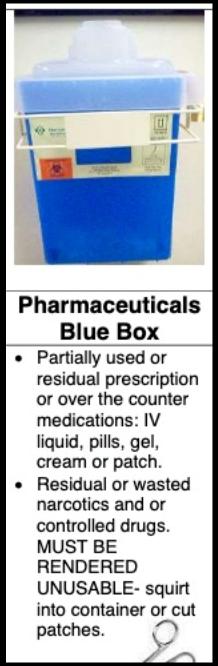
1 Consultant, Department of Anaesthesia, Sussex University Hospitals NHS Trust, Brighton, East Sussex, UK
2 Consultant, Department of Anaesthesia, Wythenshawe Hospital, Manchester University NHS Foundation Trust, Manchester, UK

Correspondence to: S. White
Email: stuart.white6@nhs.net

Accepted: 20 August 2019
Keywords: anesthesia, inhalation; adverse effects; anesthesia, toxicity; air pollutants, environmental

Twitter: @DrCliffShelton

2.4 ANESTHÉSIE INTRAVEINEUSE/RÉGIONALE



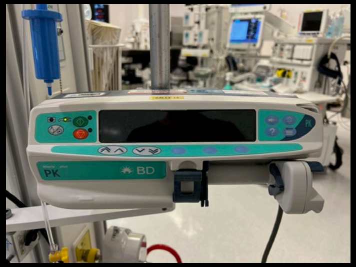
Pharmaceuticals Blue Box

- Partially used or residual prescription or over the counter medications: IV liquid, pills, gel, cream or patch.
- Residual or wasted narcotics and or controlled drugs. MUST BE RENDERED UNUSABLE- squirt into container or cut patches.

Désavantages stratégie tout IV ou régionale:

Régionale:

- applicabilité/acceptabilité pas universelle
- AG en plan B doit toujours être disponible



Anesthésie IV:

- Différences pharmacocinétiques/pharmacodynamiques entre les patients + absence de mesure directe de la concentration au site effecteur…fait que analyse EEG (13$/patient + 0.05 kg GES) utile +++ pour émergences fiables et rapides

CHOIX D’AGENT INHALÉ

Etats-Unis, ROC, Québec:

Approche centre par centre…

N2O beaucoup vs presque pas utilisé…

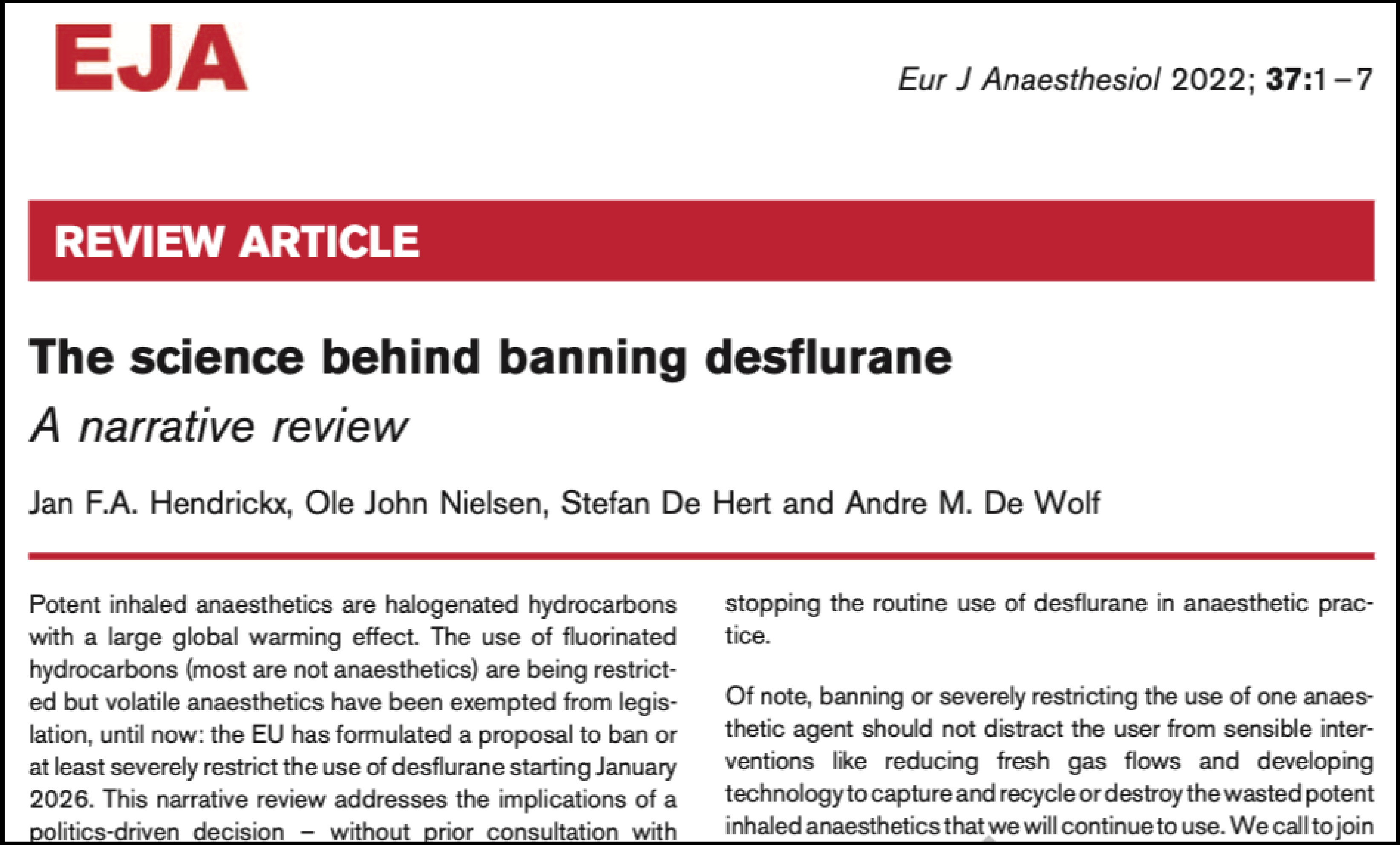
UCSF, Cleveland Clinic, Yale, Toronto, Winnipeg, CIUSSS Centre-Sud, Montérégie-Centre, etc etc : desflurane retiré du formulaire de plusieurs hôpitaux sans affecter roulement ou devenir patients [3,4]

D’autres centres pas de limitation

1. Anesth Analg 2012;114:1086 –90
2. Anaesthesia 2020 https://doi.org/10.1111/anae.15203
3. Anesthesiology 2013 Jul;119(1):61-70
4. Practice Greenhealth Report, sept. 2018

CHOIX D’ANESTHÉSIE

Mais en prenant compte $ et GES…



EJA

Eur J Anaesthesiol 2022; **37:**1 – 7

REVIEW ARTICLE

The science behind banning desflurane

A narrative review

Jan F.A. Hendrickx, Ole John Nielsen, Stefan De Hert and Andre M. De Wolf

Potent inhaled anaesthetics are halogenated hydrocarbons with a large global warming effect. The use of fluorinated hydrocarbons (most are not anaesthetics) are being restricted but volatile anaesthetics have been exempted from legislation, until now: the EU has formulated a proposal to ban or at least severely restrict the use of desflurane starting January 2026. This narrative review addresses the implications of a politics-driven decision – without prior consultation with

stopping the routine use of desflurane in anaesthetic practice.

Of note, banning or severely restricting the use of one anaesthetic agent should not distract the user from sensible interventions like reducing fresh gas flows and developing technology to capture and recycle or destroy the wasted potent inhaled anaesthetics that we will continue to use. We call to join

2. RÉDUIRE EMISSIONS GES DES GAZ ANESTHÉSIQUES

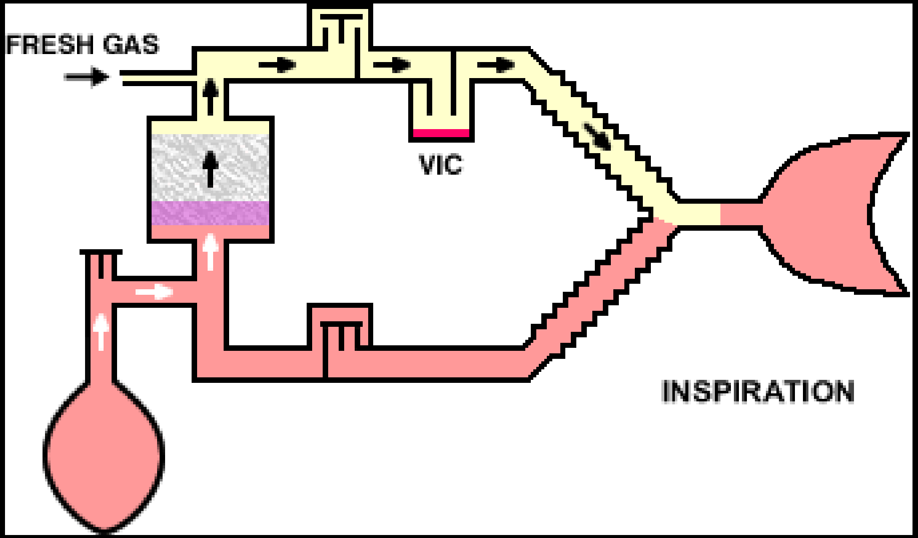
- 2.1 CHOIX D’AGENT INHALÉ, ANESTHÉSIE IV, RÉGIONALE
- 2.2 RÉDUCTION DÉBITS GAZ FRAIS
- 2.3 CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

RÉDUCTION DÉBITS GAZ FRAIS

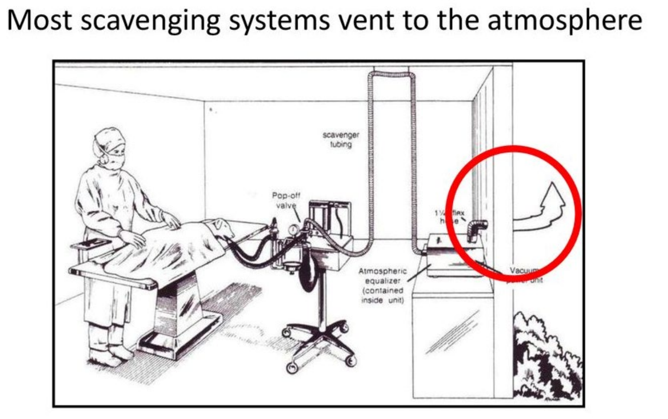
ANESTHÉSIE: CIRCUIT CERCLE

DÉBITS DE GAZ FRAIS (DGF) INJECTÉ DANS LE CIRCUIT POUR:

- Besoins O_2 patient (adulte100-500 ml/min)
- Compenser fuites
- Fournir gaz anesthésique
- Sortir contaminants


FRESH GAS
VIC
INSPIRATION

Excédent de gaz frais + gaz anesthésique sort du circuit via « antipollution» (SCAVENGING)…

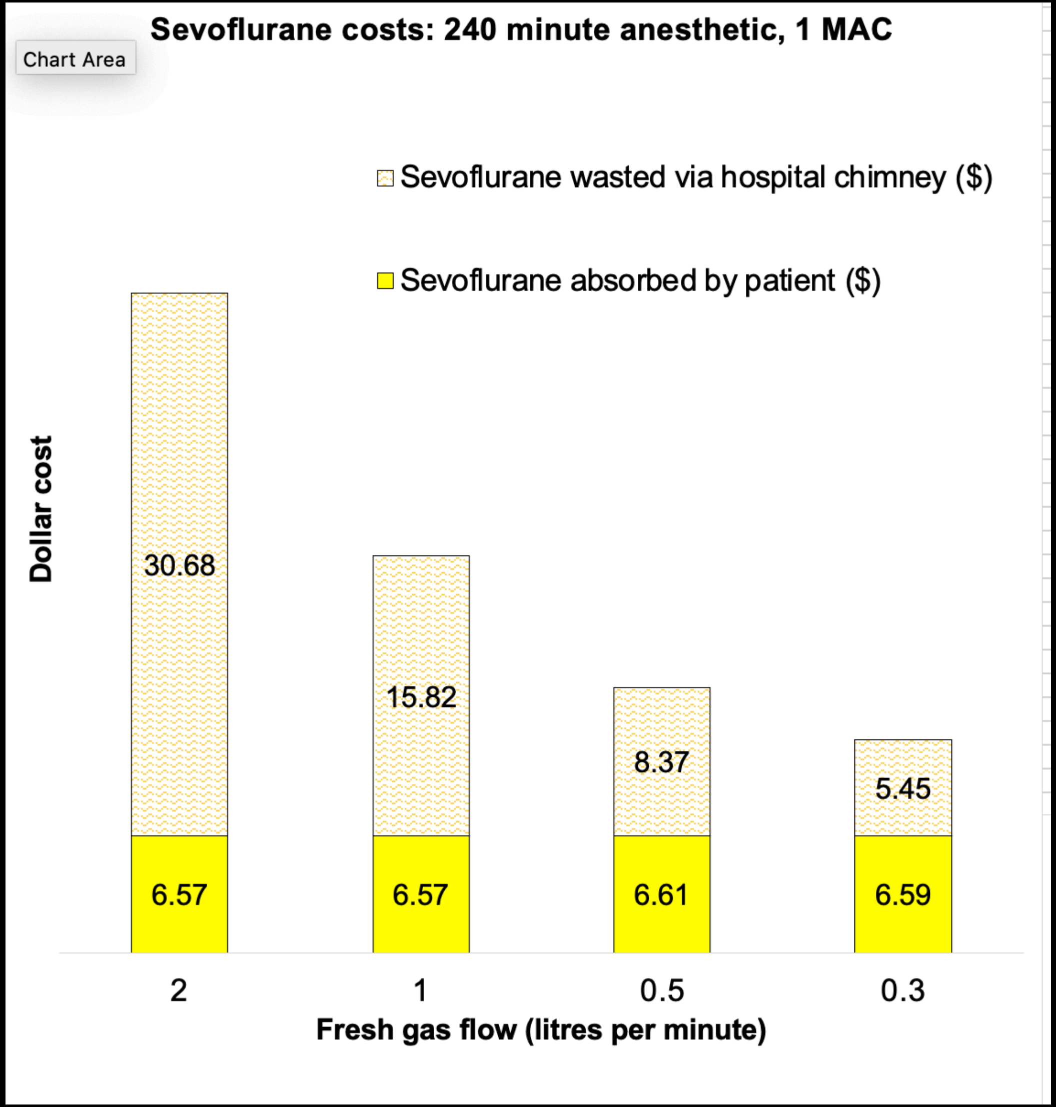

Most scavenging systems vent to the atmosphere
scavenger tubing
Pop-off valve
1½ flex hose
Atmospheric equalizer (contained inside unit)
Vacuum power unit

RÉDUCTION DGF: SIMULATIONS

Agent reçu par patient *ne dépend pas du DGF*

C'est le gaz *perdu dans l'atmosphère* qui varie avec le DGF

Sauf à très faible DGF, *gaz anesthésique perdu dans antipollution excède gaz absorbé par patient(!)*



RÉDUCTION DGF

NOUVELLES STATIONS D'ANESTHÉSIE AVEC
CONTRÔLE AUTOMATISÉ DÉBITS/FEO2/AGENTS INHALÉS:

Simplifient gestion O2/gaz anesthésiques à bas DGF[1]

Programmation permet standardiser bas DGF

DGF typique au CHUM passé de 1-2 lpm à 0.3-0.5 lpm

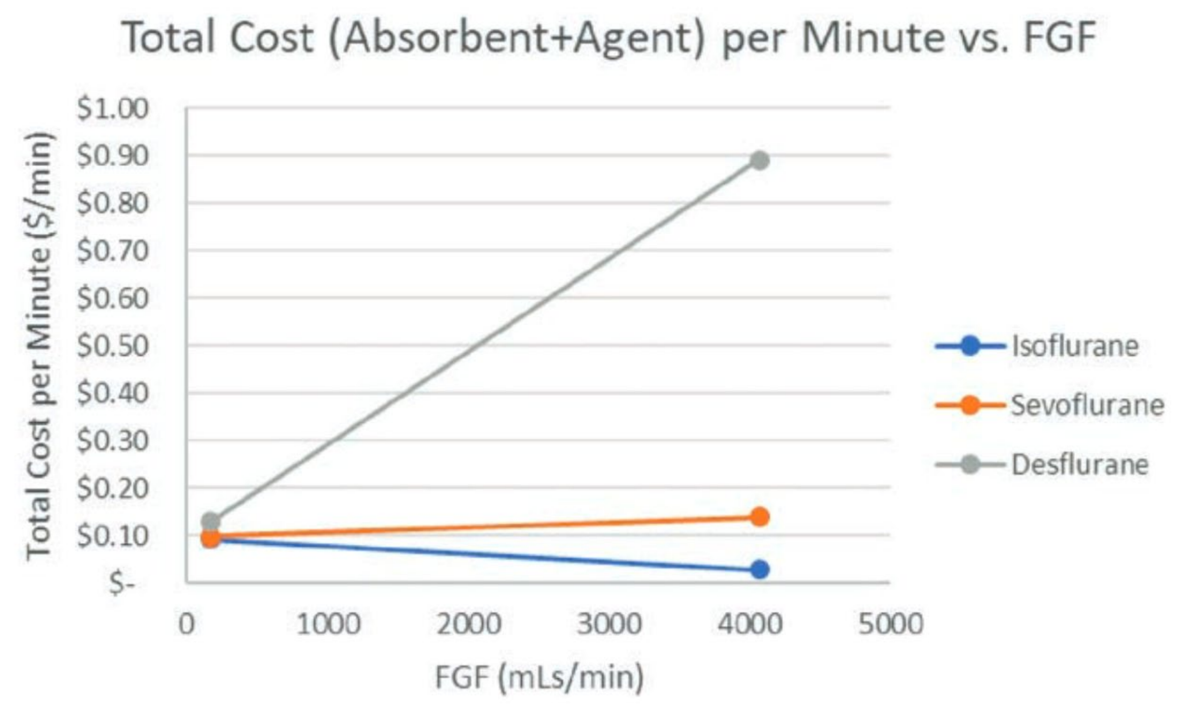
1. *Acta Anaesth. Scand.* 2017:doi: 10.1111/aas.12961

RÉDUCTION DGF

Minimise +++ coûts [1]

Littérature supporte son utilisation avec desflurane et sevoflurane[2,3]

Avec absorbeur CO2 approprié, peu/pas de composé A avec sevo[4] et CO avec des[5]



1. *Anesth. Analg.* 2020; DOI: 10.1213/ANE.0000000000000405
2. https://www.apsf.org/article/concern-about-the-use-of-very-low-flow-sevoflurane-anesthesia/
3. There are no dragons: Low-flow anaesthesia with sevoflurane is safe. *Anesthesia and Intensive Care 2019*
4. *Acta Anaesth Scand* 2007;51:31–7
5. *Acta Anesth. Scan.* 2005; https://doi.org/10.1111/j.1399-6576.2005.00690.x

RÉDUCTION DGF

LIMITATIONS:

1. ne change pas la quantité de gaz absorbé/expiré par le patient
2. DGF < 0.5 lpm pas encore par défaut…et pas toujours "circuit fermé"
3. Même à DGF minimal, émissions GES N2O/desflurane restent trop élevées…

2. RÉDUIRE EMISSIONS GES DES GAZ ANESTHÉSIQUES

- 2.1 CHOIX D'AGENT INHALÉ, ANESTHÉSIE IV, RÉGIONALE
- 2.2 RÉDUCTION DÉBITS GAZ FRAIS
- 2.3 CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

Systèmes de destruction N_2O[1] existent (en investigation pour halogénés)[2]

Systèmes de recapture halogénés disponibles:

> Réduisent de 99% gaz émis via cheminée en capturant, recyclant 99%+ gaz anesthésiques dans l'antipollution[3]

F
F
F
ISOFLURAN
E
SEVOFLURA
Nitrous oxide
N₂O
CHUM

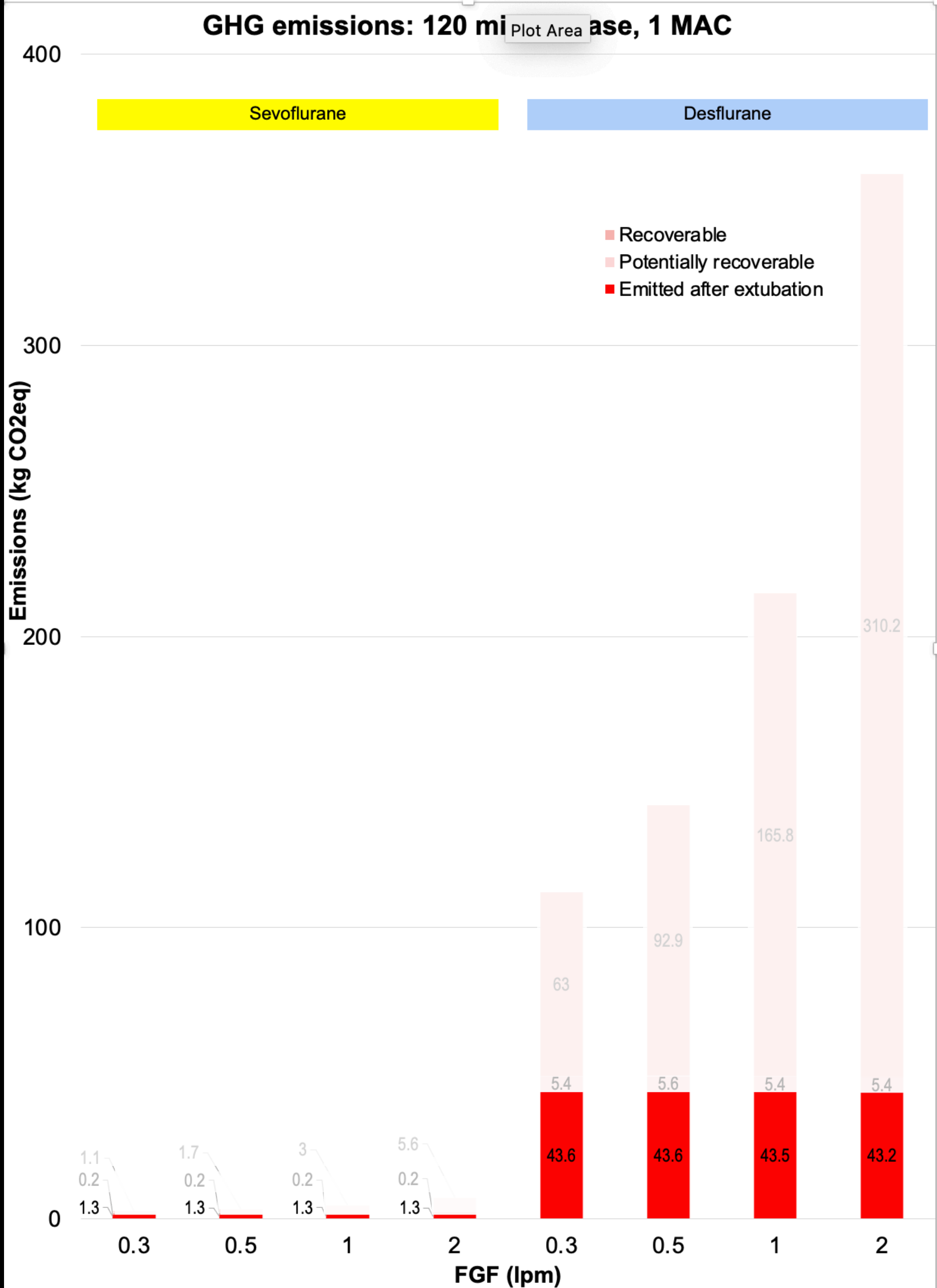
[1] Destruction of medical N_2O in Sweden. 2012 DOI: 10.5772/32169
[2] Anesth. Analg. 2020: DOI: 10.1213/ANE.0000000000004119
[3] Jack Kim, Blue-Zone technologies

CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

SIMULATION:

Élimine le DGF de l’équation des émissions de GES

Paquin-Lanthier et Williams, 2021



CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

Avantages:

Réduction GES 50-80%

Élimine « facteur humain » présent avec réduction DGF

Coût recapture < coût compensation émissions GES desflurane

CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

Désavantages:

Ne régle pas coût/gaspillage agent inhalés associés aux DGF plus élevés

Coût 10$/SOP.jour

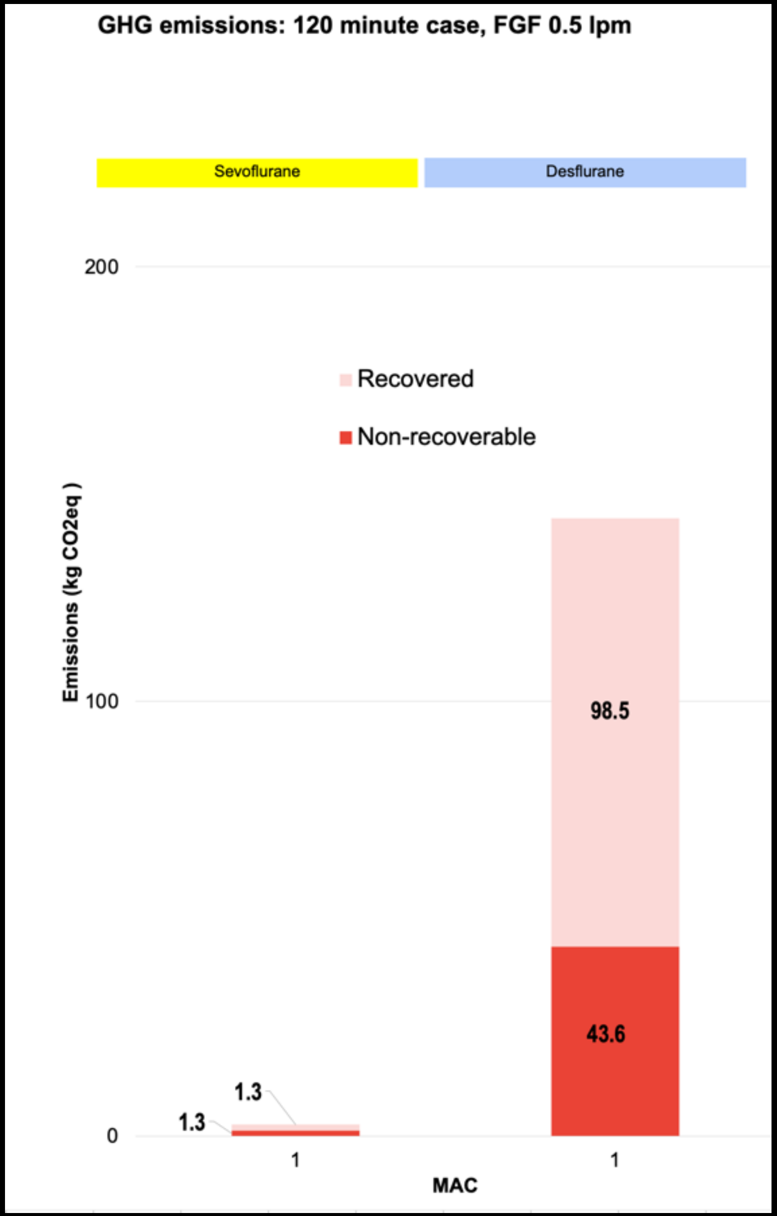
Systèmes différents nécessaires pour halogénés vs N2O….

CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

Ne peut pas récupérer gaz anesthésiques expirés après déconnection de l'antipollution.

N'élimine pas grande différence d'émissions entre desflurane et sevoflurane:

GES 1 SOP desfl./Deltasorb =17 SOP sevo



CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

Coût/tonne GES récupéré prohibitif pour sevoflurane

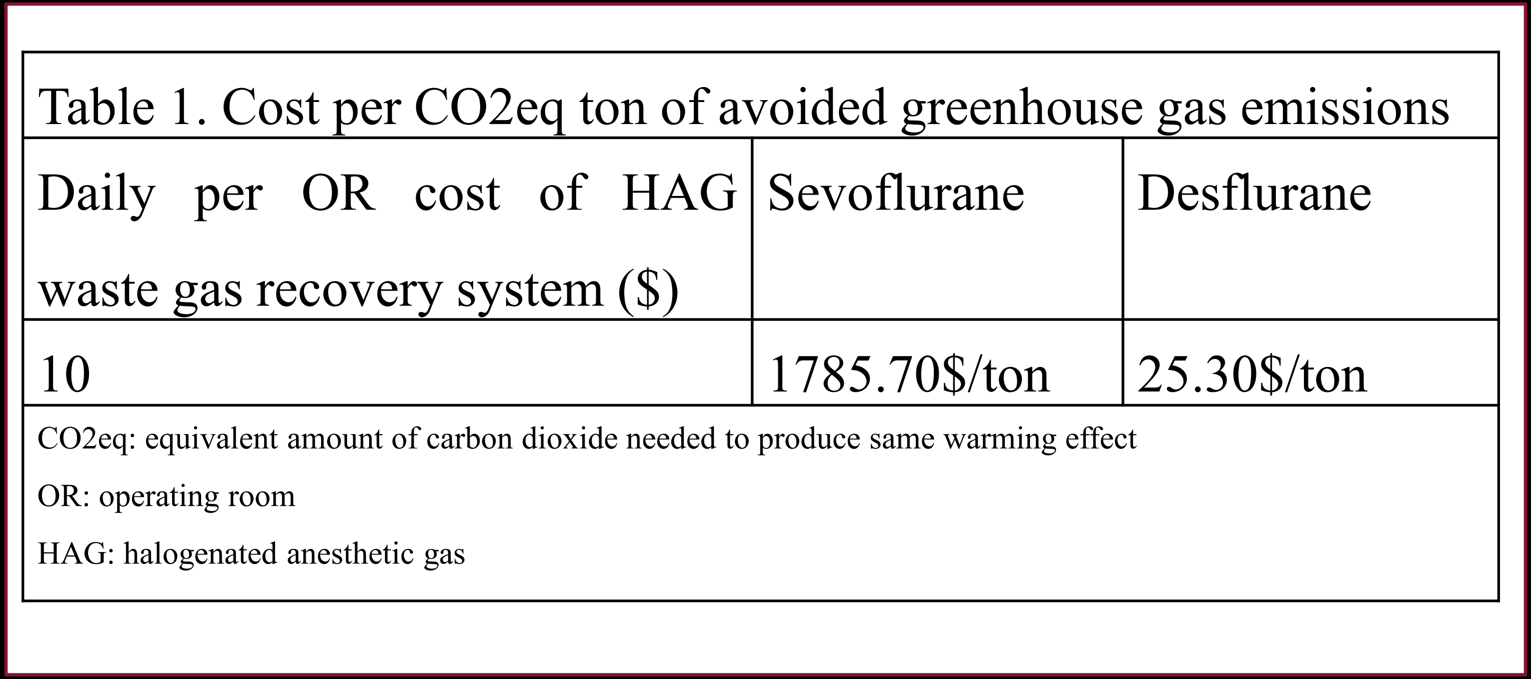


Table 1. Cost per CO2eq ton of avoided greenhouse gas emissions

Daily per OR cost of HAG waste gas recovery system ($)	Sevoflurane	Desflurane
10	1785.70$/ton	25.30$/ton

CO2eq: equivalent amount of carbon dioxide needed to produce same warming effect

OR: operating room

HAG: halogenated anesthetic gas

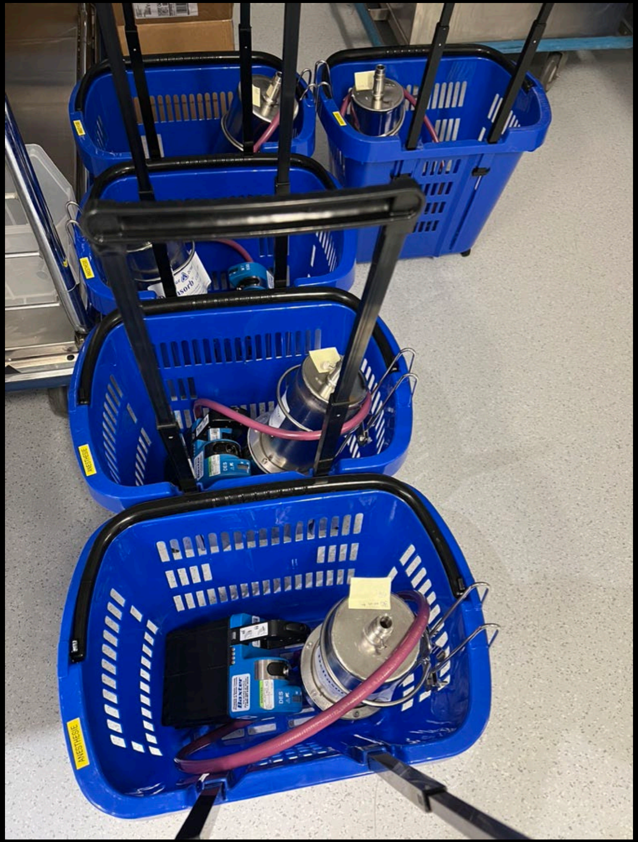
Prix carbone au Canada…170$ en 2030

Dommages/tonne CO2eq: 250$[1]

[1] Nature: sept 2022

CAPTURE/DESTRUCTION GAZ A/N ANTIPOLLUTION

CHUM: choix de déployer recapture uniquement avec 8 vapos desflurane en circulation

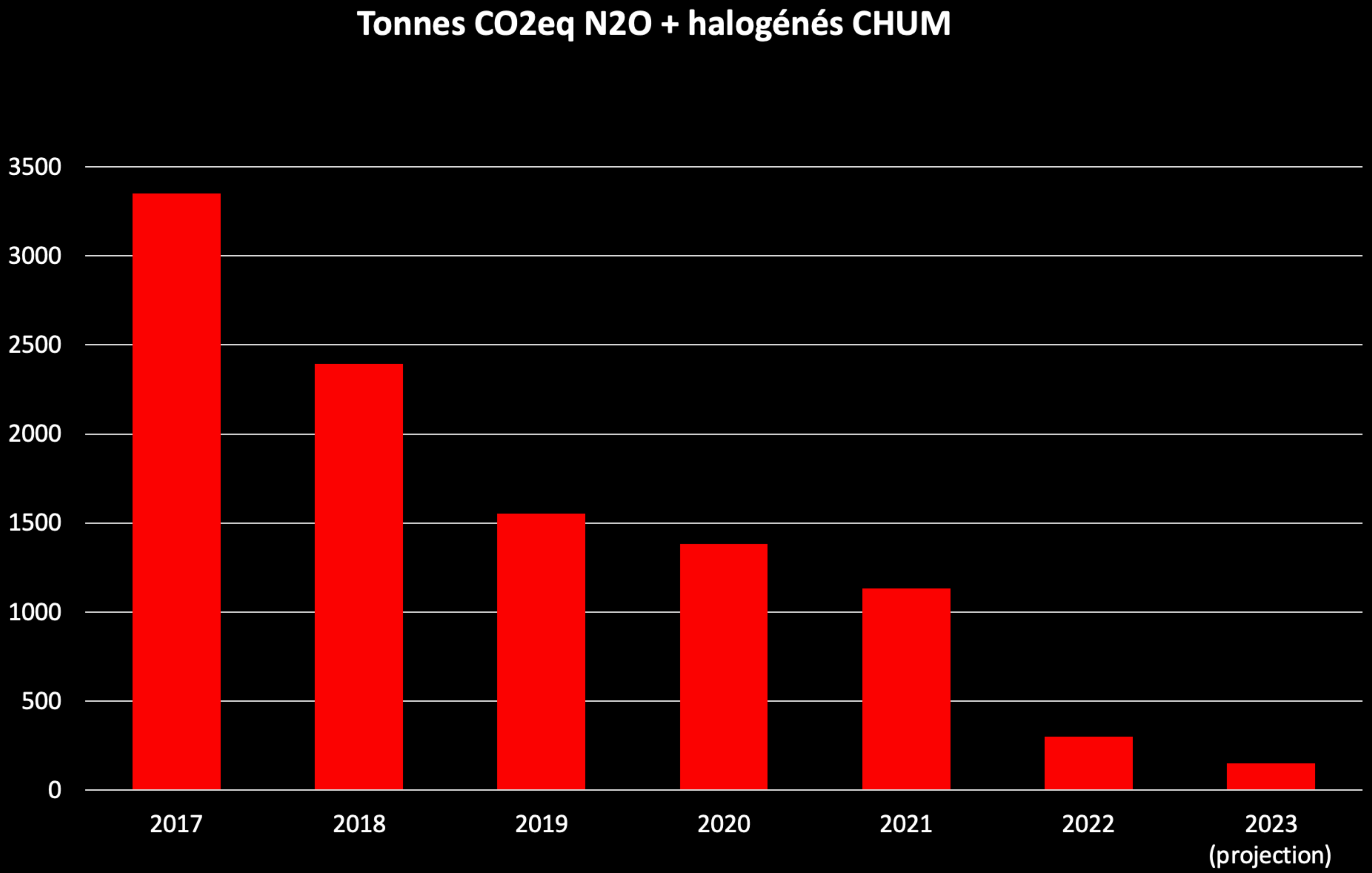


Diminution émissions gas anesthésiques CHUM

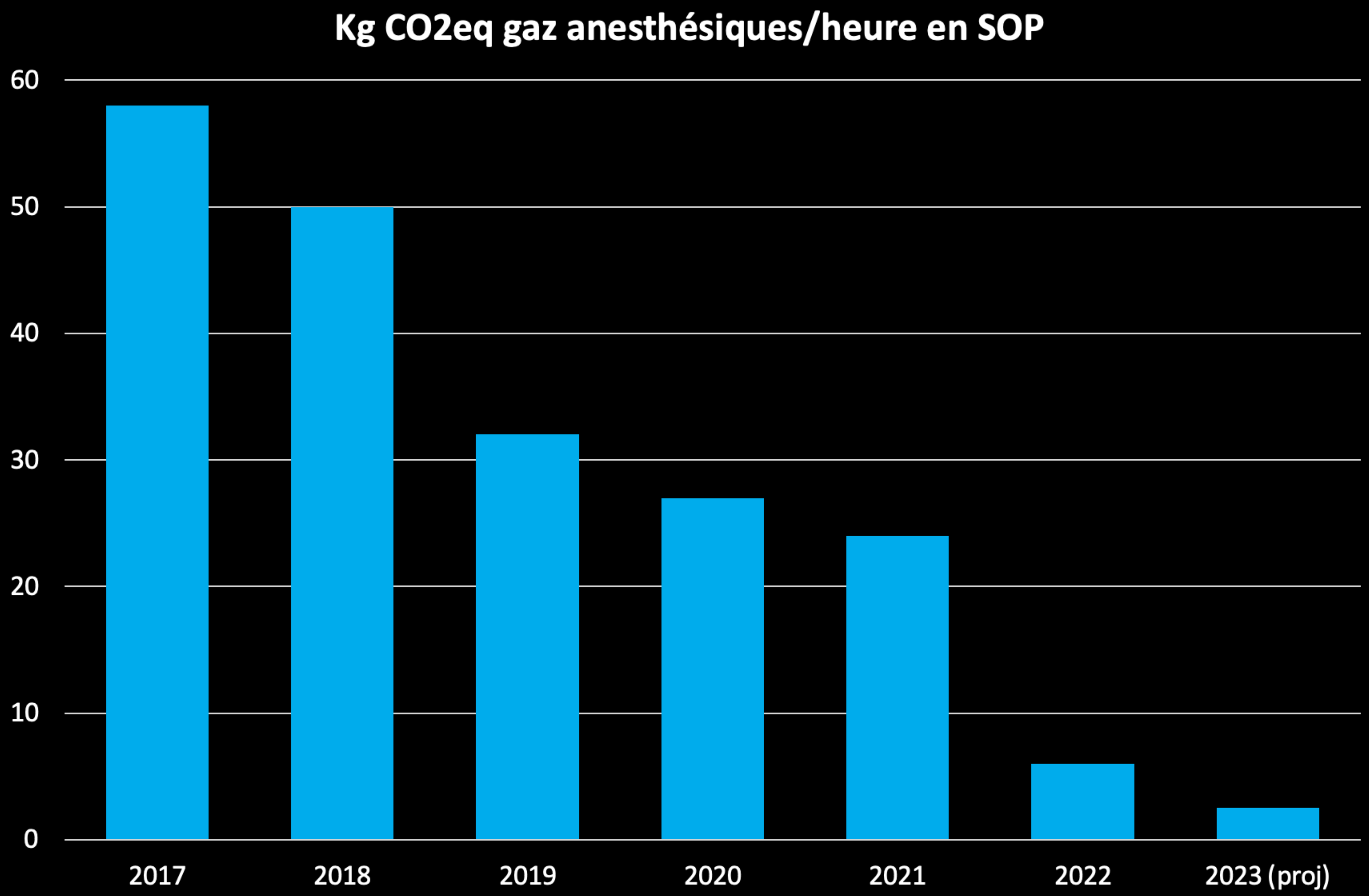
2017-2022… série de présentations scientifiques au dept
2017-2022… évolution choix d'agents pour AG
2017: NCHUM avec nouvelles stations qui dim. +++ consommation gaz halogénés
2020: comité résilience qui mesure GES émis par dept
2021: mise à jour stations pour améliorer ++ performance à bas débit
2021: premières pompes pour AIVOC
2022: recapture gaz anesthésiques
2022: fermeture rampe N2O
2022: pompe AIVOC dans chaque SOP

Diminution émissions gas anesthésiques CHUM

RÉSULTATS:

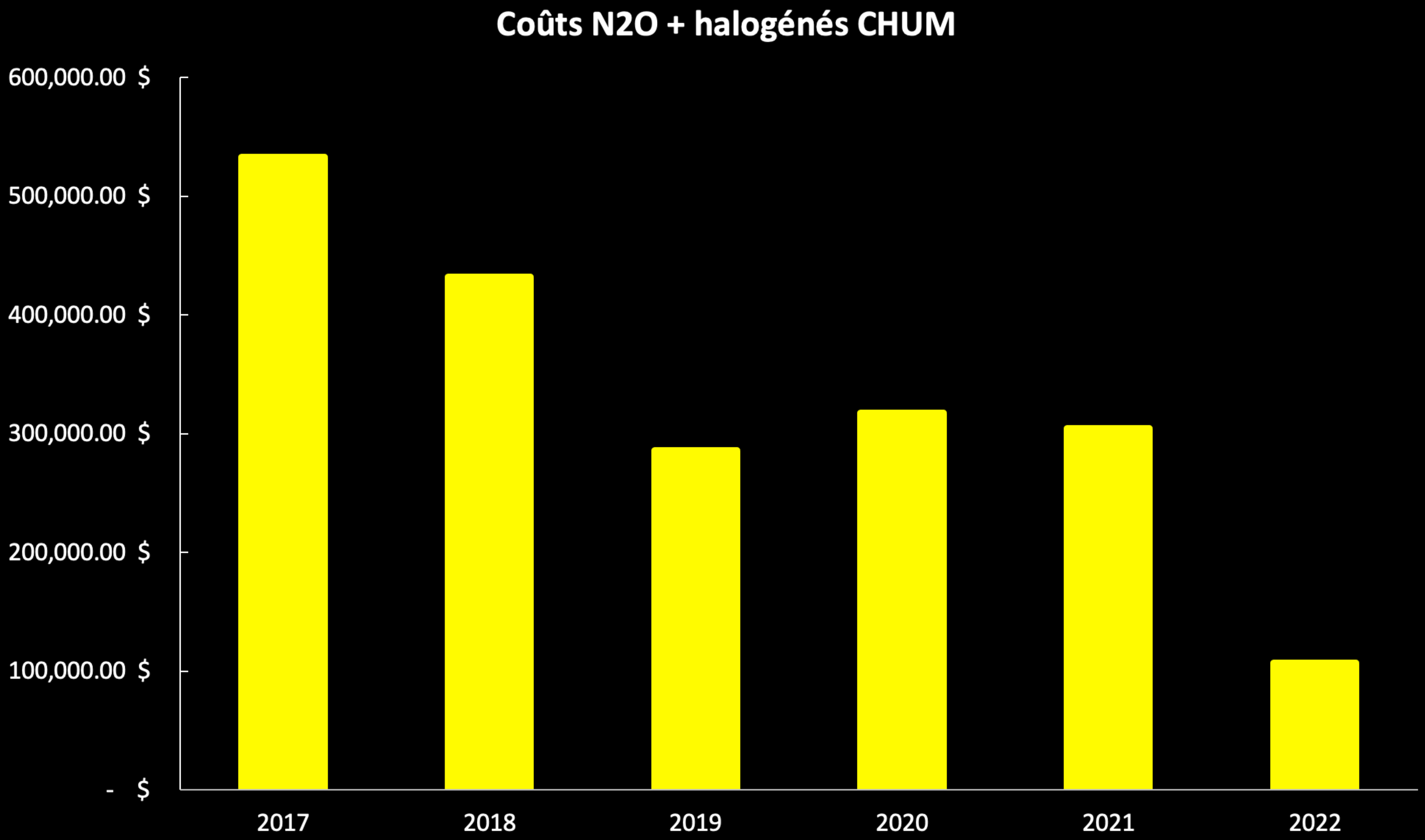


Diminution émissions gas anesthésiques CHUM

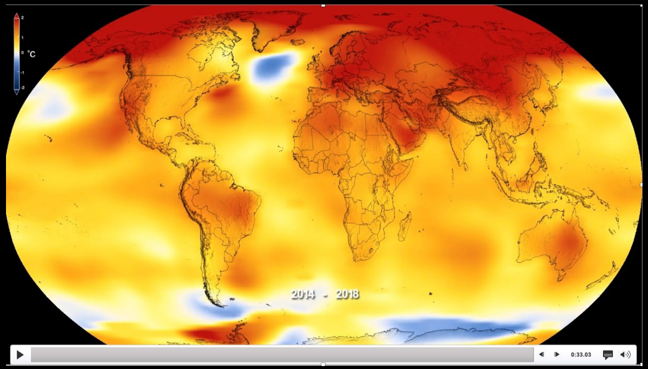


CHUM

Diminution émissions gas anesthésiques CHUM

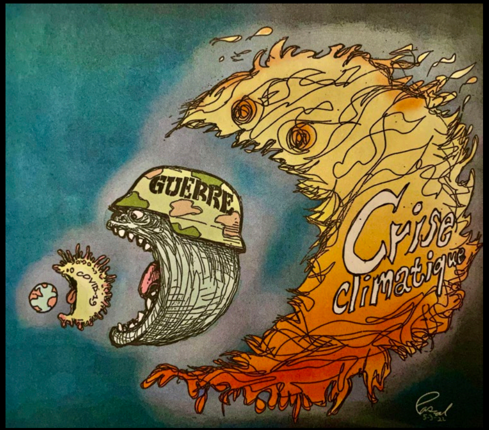


RÉSUMÉ

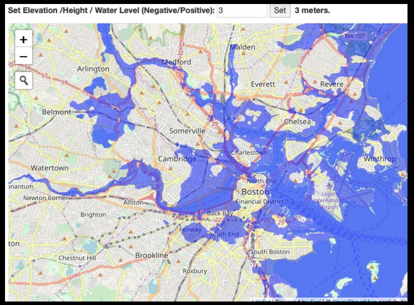

°C
2014 - 2018
0:33.03

Crise climatique:

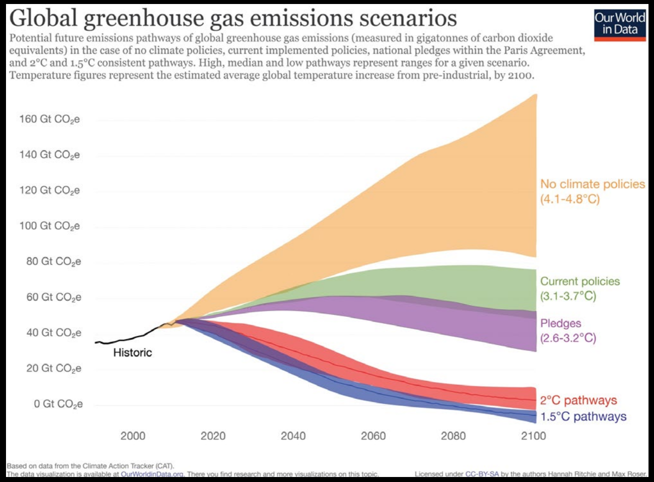
Réchauffement extrême/destructeur de la Terre par l'humain
via l'accumulation de GES dans l'atmosphère


COVID-19
GUERRE
Crise climatique
Pascal
5-3-22

Menace à la santé #1 du XXIième siècle


Set Elevation /Height / Water Level (Negative/Positive): 3 Set 3 meters.
+
−
Malden
Medford
Arlington
Everett
Revere
Belmont
Chelsea
Somerville
Charlestown
Cambridge
Winthrop
Watertown
North End
Boston
Newton Corner
Allston
Financial District
Logan International Airport
Brighton
Back Bay
Fenway
South End
Chestnut Hill
Brookline
South Boston
Roxbury
MA 107

La sévérité de la crise climatique sera proportionnelle à nos émissions de GES


Global greenhouse gas emissions scenarios

Potential future emissions pathways of global greenhouse gas emissions (measured in gigatonnes of carbon dioxide equivalents) in the case of no climate policies, current implemented policies, national pledges within the Paris Agreement, and 2°C and 1.5°C consistent pathways. High, median and low pathways represent ranges for a given scenario. Temperature figures represent the estimated average global temperature increase from pre-industrial, by 2100.

Our World in Data
160 Gt CO_2e
140 Gt CO_2e
120 Gt CO_2e
100 Gt CO_2e
80 Gt CO_2e
60 Gt CO_2e
40 Gt CO_2e
20 Gt CO_2e
0 Gt CO_2e
Historic
No climate policies (4.1-4.8°C)
Current policies (3.1-3.7°C)
Pledges (2.6-3.2°C)
2°C pathways
1.5°C pathways
2000
2020
2040
2060
2080
2100

Based on data from the Climate Action Tracker (CAT).
The data visualization is available at OurWorldinData.org. There you find research and more visualizations on this topic.

Licensed under CC-BY-SA by the authors Hannah Ritchie and Max Roser.

Solution à la crise climatique:

CARBONEUTRALITÉ

Mesurer, diminuer et compenser nos émissions de GES ad équilibre avec la résorption

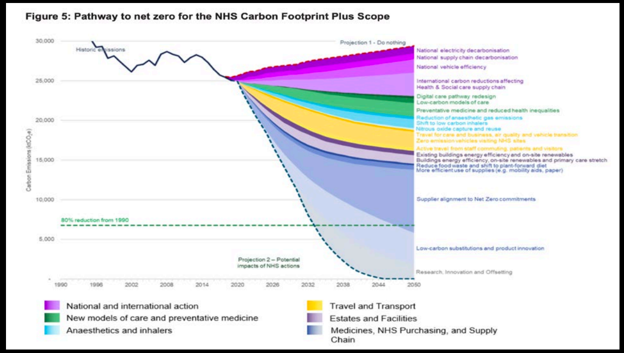
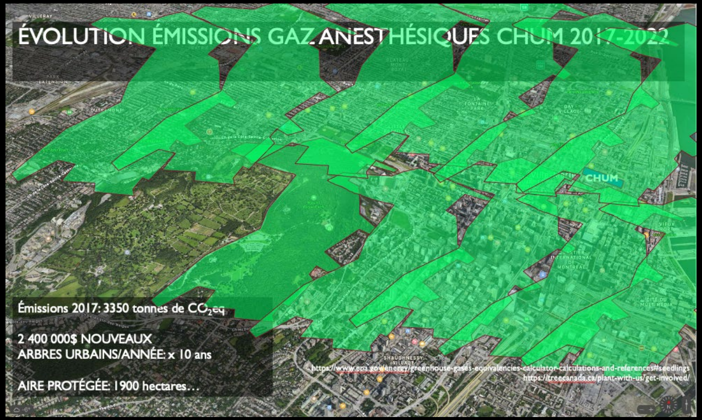


Figure 5: Pathway to net zero for the NHS Carbon Footprint Plus Scope

1. En anesthésie, la carboneutralité passe nécessairement par la réduction (ou arrêt) d'utilisation de desflurane/N_2O



ÉVOLUTION ÉMISSIONS GAZ ANESTHÉSIQUES CHUM 2017-2022

Émissions 2017: 3350 tonnes de CO_2eq

2 400 000$ NOUVEAUX
ARBRES URBAINS/ANNÉE: x 10 ans

AIRE PROTÉGÉE: 1900 hectares…

https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references#seedlings
https://treecanada.ca/plant-with-us/get-involved/

CARBONEUTRALITÉ EN ANESTHÉSIE

2. Diminution DGF: excellente mesure d’économie GES et $

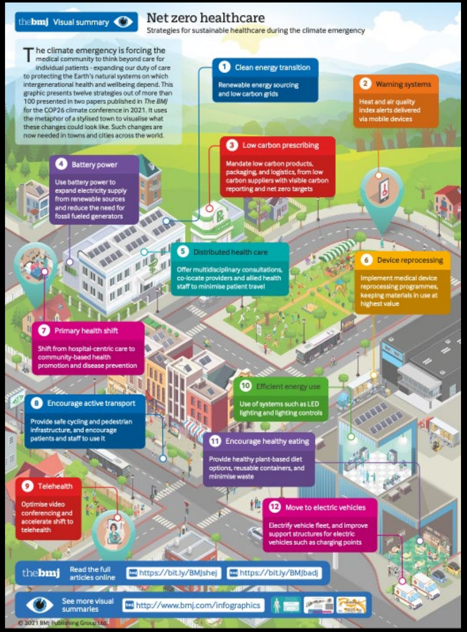
3. Recapture/destruction gaz anesthésiques a/n antipollution:

- Nécessaire mais pas encore disponible au Canada pour N_2O
- Coût/tonne GES épargné favorable pour desflurane mais élevé pour sevoflurane
- Anesthésie desflurane+recapture = 17X + de GES qu’anesthésie sévoflurane sans recapture

Carboneutralité en santé

transformation nécessaire pour tout.s système.s santé
LE PLUS RAPIDEMENT POSSIBLE

Opportunité +++ d’innover/rayonner/améliorer soins…



thebmj Visual summary

Net zero healthcare

Strategies for sustainable healthcare during the climate emergency

The climate emergency is forcing the medical community to think beyond care for individual patients - expanding our duty of care to protecting the Earth’s natural systems on which intergenerational health and wellbeing depend. This graphic presents twelve strategies out of more than 100 presented in two papers published in *The BMJ* for the COP26 climate conference in 2021. It uses the metaphor of a stylised town to visualise what these changes could look like. Such changes are now needed in towns and cities across the world.

1 **Clean energy transition**
Renewable energy sourcing and low carbon grids

2 **Warning systems**
Heat and air quality index alerts delivered via mobile devices

3 **Low carbon prescribing**
Mandate low carbon products, packaging, and logistics, from low carbon suppliers with visible carbon reporting and net zero targets

4 **Battery power**
Use battery power to expand electricity supply from renewable sources and reduce the need for fossil fueled generators

5 **Distributed health care**
Offer multidisciplinary consultations, co-locate providers and allied health staff to minimise patient travel

6 **Device reprocessing**
Implement medical device reprocessing programmes, keeping materials in use at highest value

7 **Primary health shift**
Shift from hospital-centric care to community-based health promotion and disease prevention

8 **Encourage active transport**
Provide safe cycling and pedestrian infrastructure, and encourage patients and staff to use it

9 **Telehealth**
Optimise video conferencing and accelerate shift to telehealth

10 **Efficient energy use**
Use of systems such as LED lighting and lighting controls

11 **Encourage healthy eating**
Provide healthy plant-based diet options, reusable containers, and minimise waste

12 **Move to electric vehicles**
Electrify vehicle fleet, and improve support structures for electric vehicles such as charging points

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