

S Mary's

... a Church inspired by God's passion for the World

..... God gives the man a job: warden in the Eden Garden. Job spec
- to protect and till it

Genesis 2:15 The Street Bible



Recycling, our use of finite resources, and why it matters

Richard Herrington

1st February 2023

Who am I?



- Lead Scientist for the NHM's research theme 'Resourcing the Green Economy' since April 2022 - developing a 'centre of excellence' focused on using the Earth's natural resources for a sustainable future for our planet and its people.
- Visiting Professor at the University of Exeter and Imperial College, London, the latter where I teach undergraduate courses in mineral deposits geology
- Member of the UK government's Critical Minerals Expert Committee and also advisor to BEIS's Critical Minerals Intelligence Centre

- 80 million specimens in the NHM collections
- Includes >185,000 mineral specimens
- 300 research scientists working at the NHM



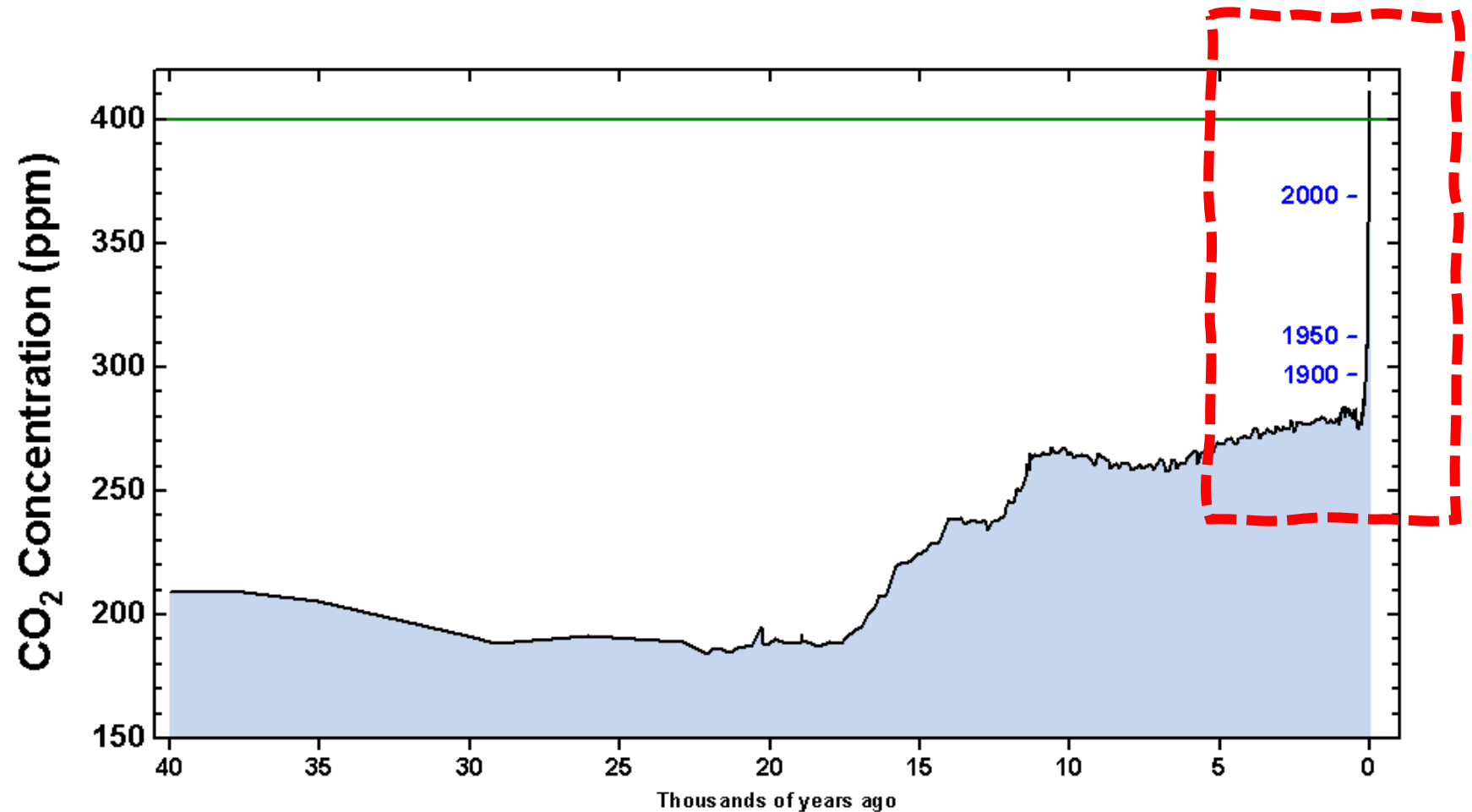
Ga-rich sphalerite ZnS



Kunzite $\text{LiAl}(\text{SiO}_3)_2$
Gem quality spodumene

The
backdrop
to the
problem

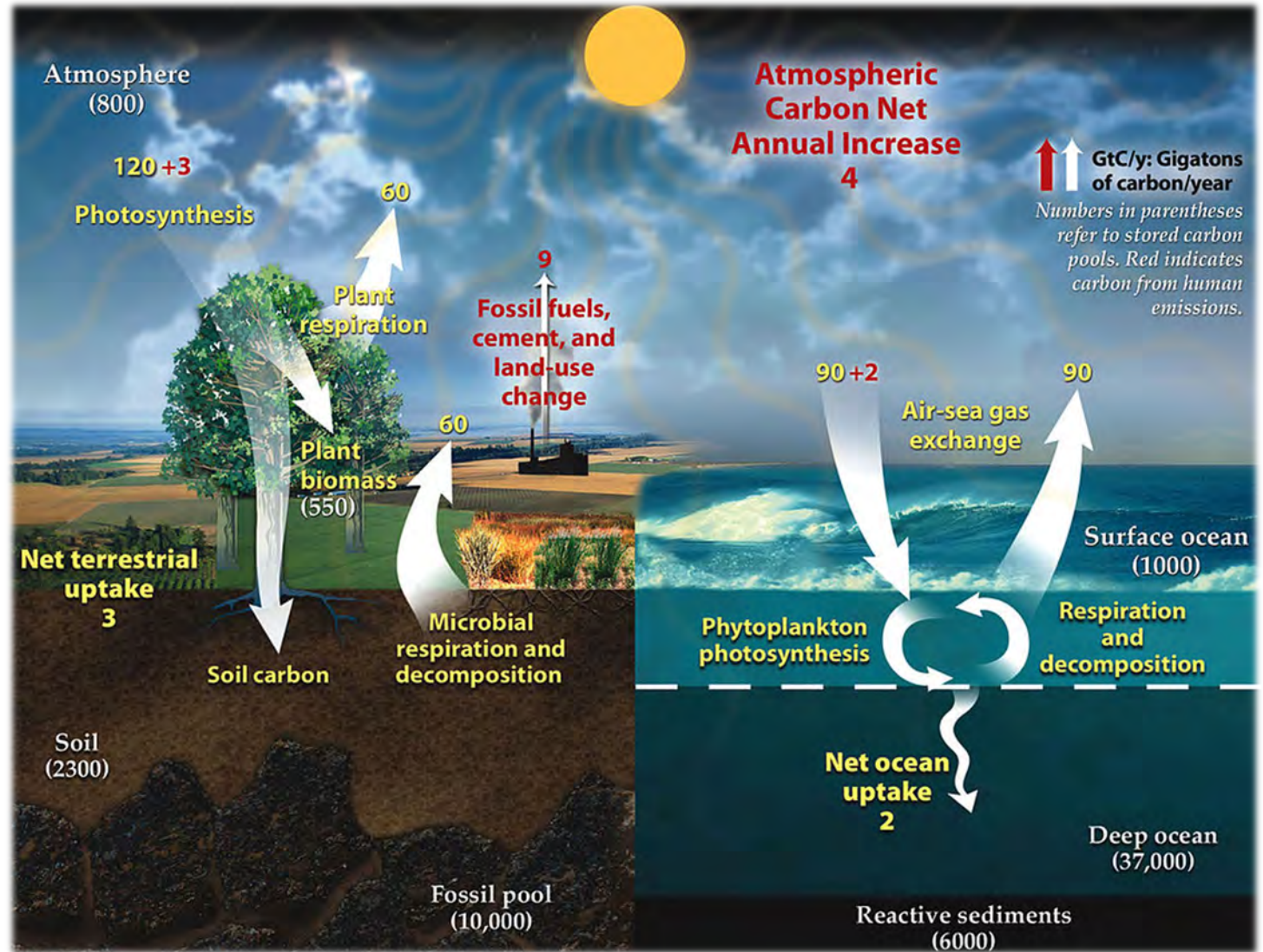
CO₂ is rising,
the planet is
warming up



CO₂ concentration in parts-per-million during the past 40,000 years (post last glacial minimum) Source: Data from <https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases>

Our use of carbon isn't balanced

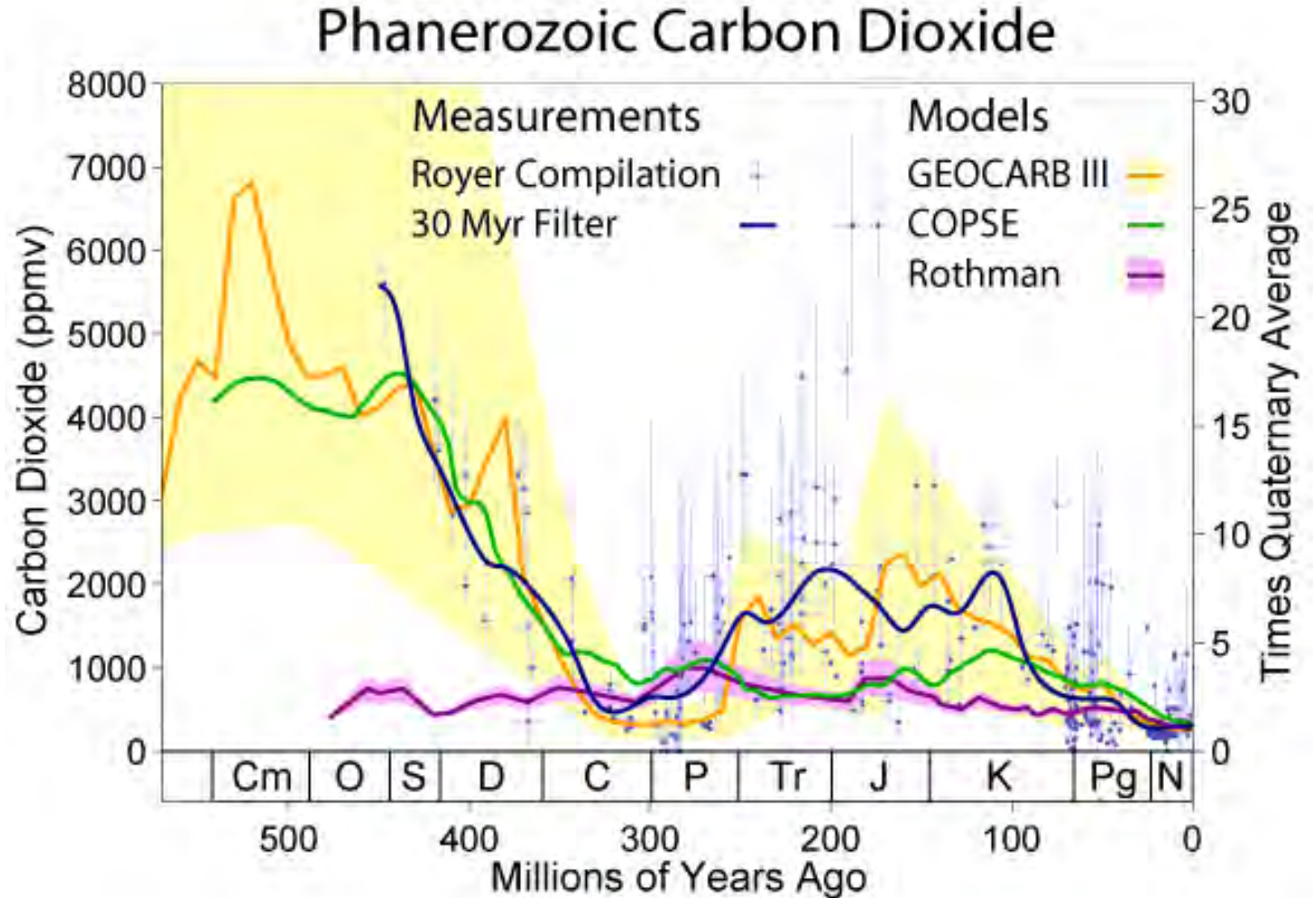
Net increase in the atmosphere of around 4 billions of tonnes of CO₂ per year



Yellow numbers are natural fluxes, red are human contributions, white are stored carbon

Won't the planet heal itself?

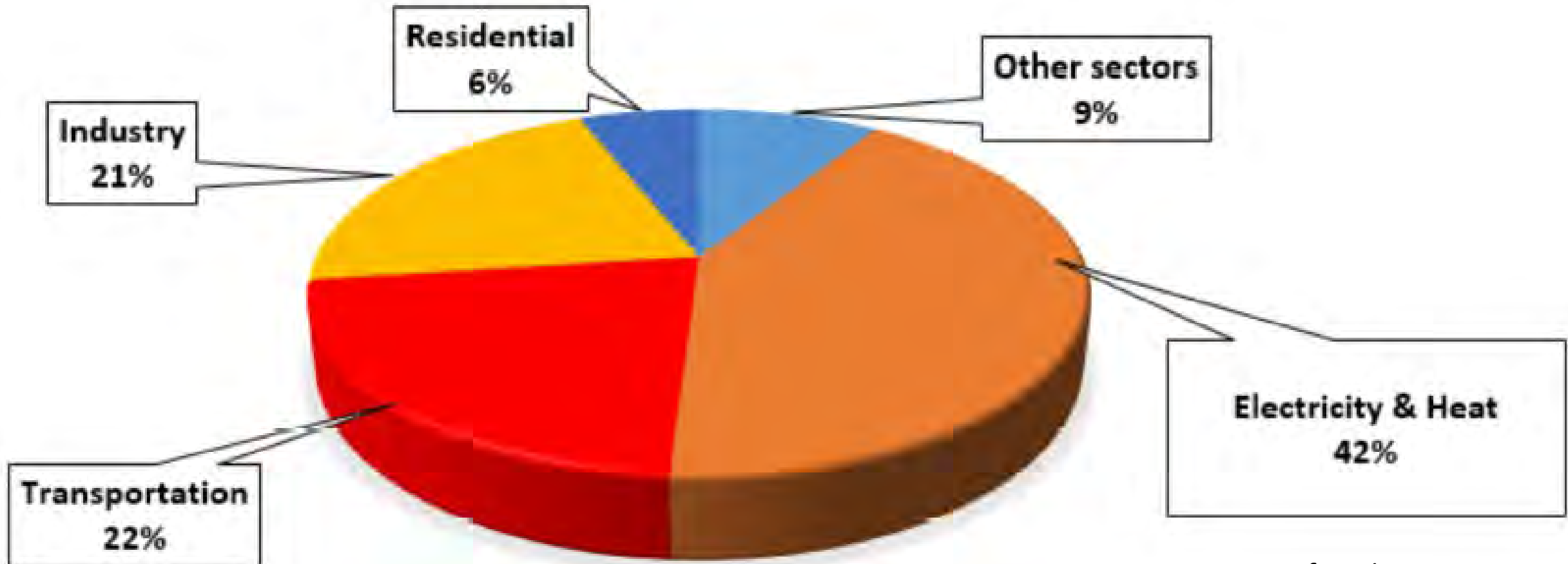
- Yes, but this will take millions of years – humans are already in trouble....
- We need to cut our CO₂ emissions



Who are the culprits?

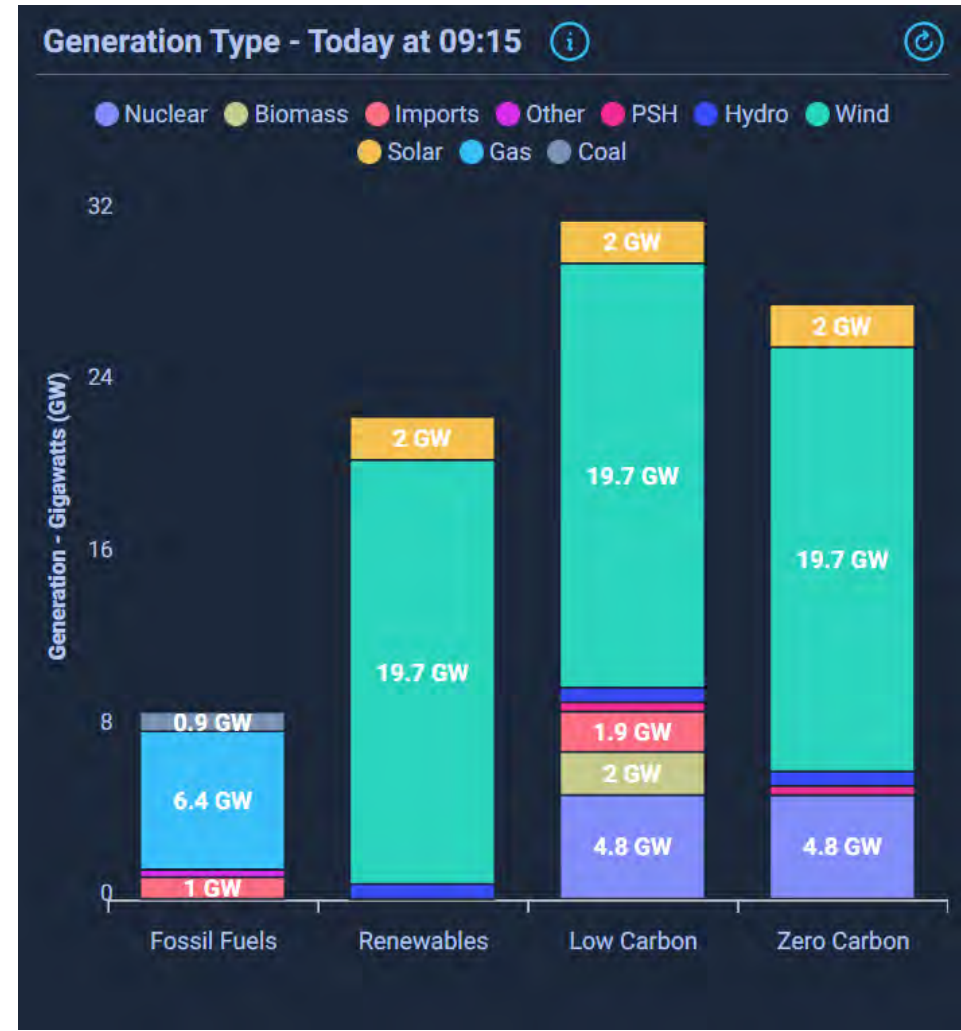
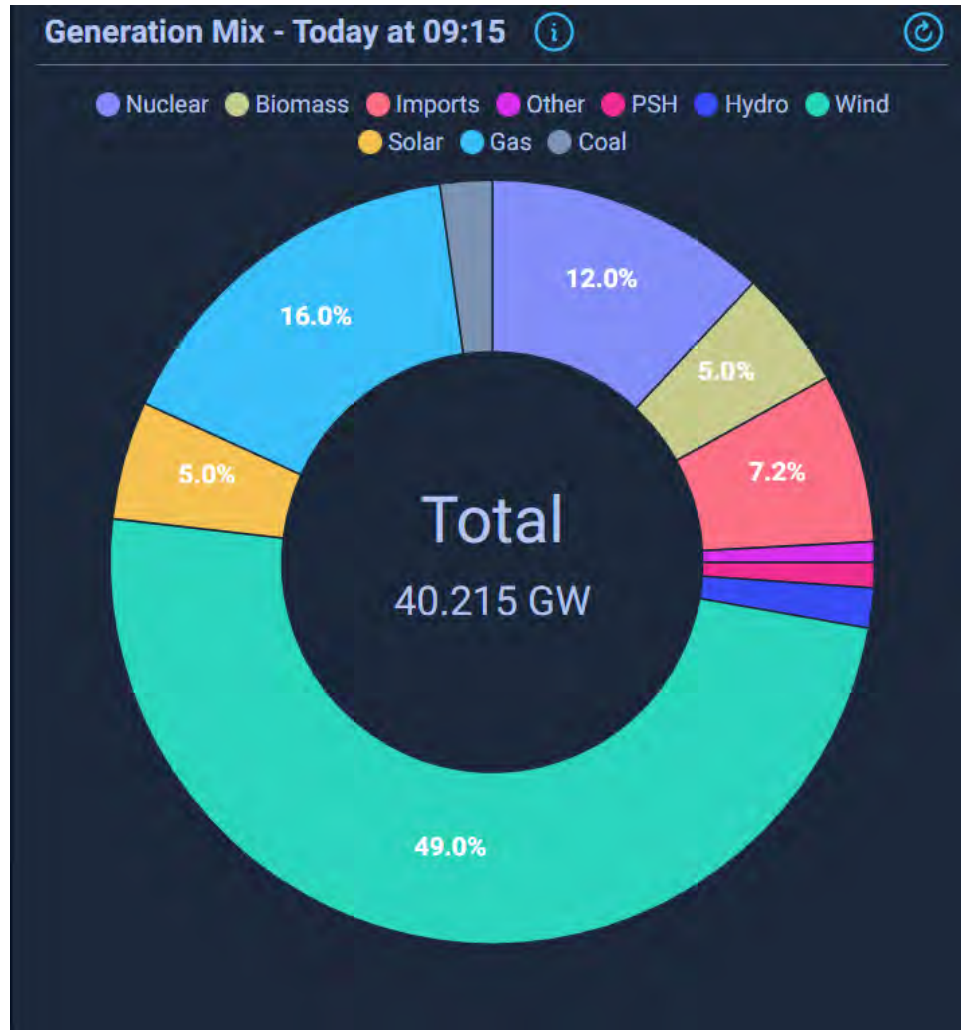
We need to tackle energy generation, transportation and industry

Sources of anthropogenic CO₂

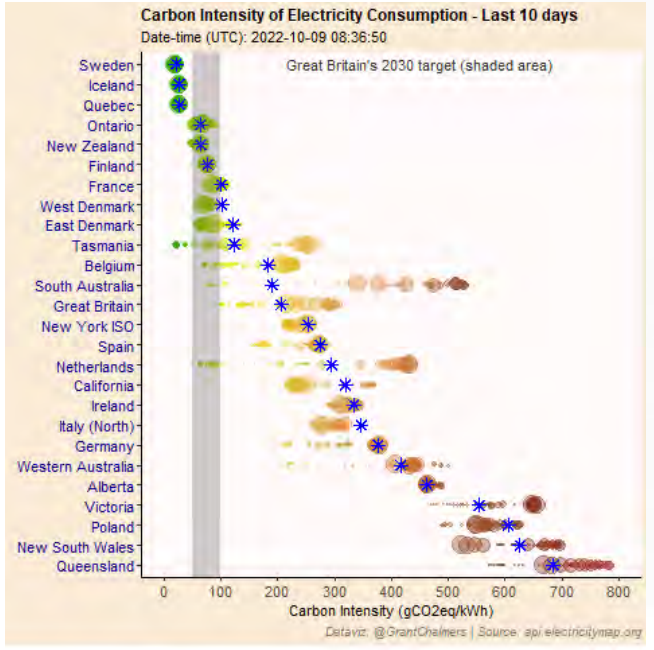
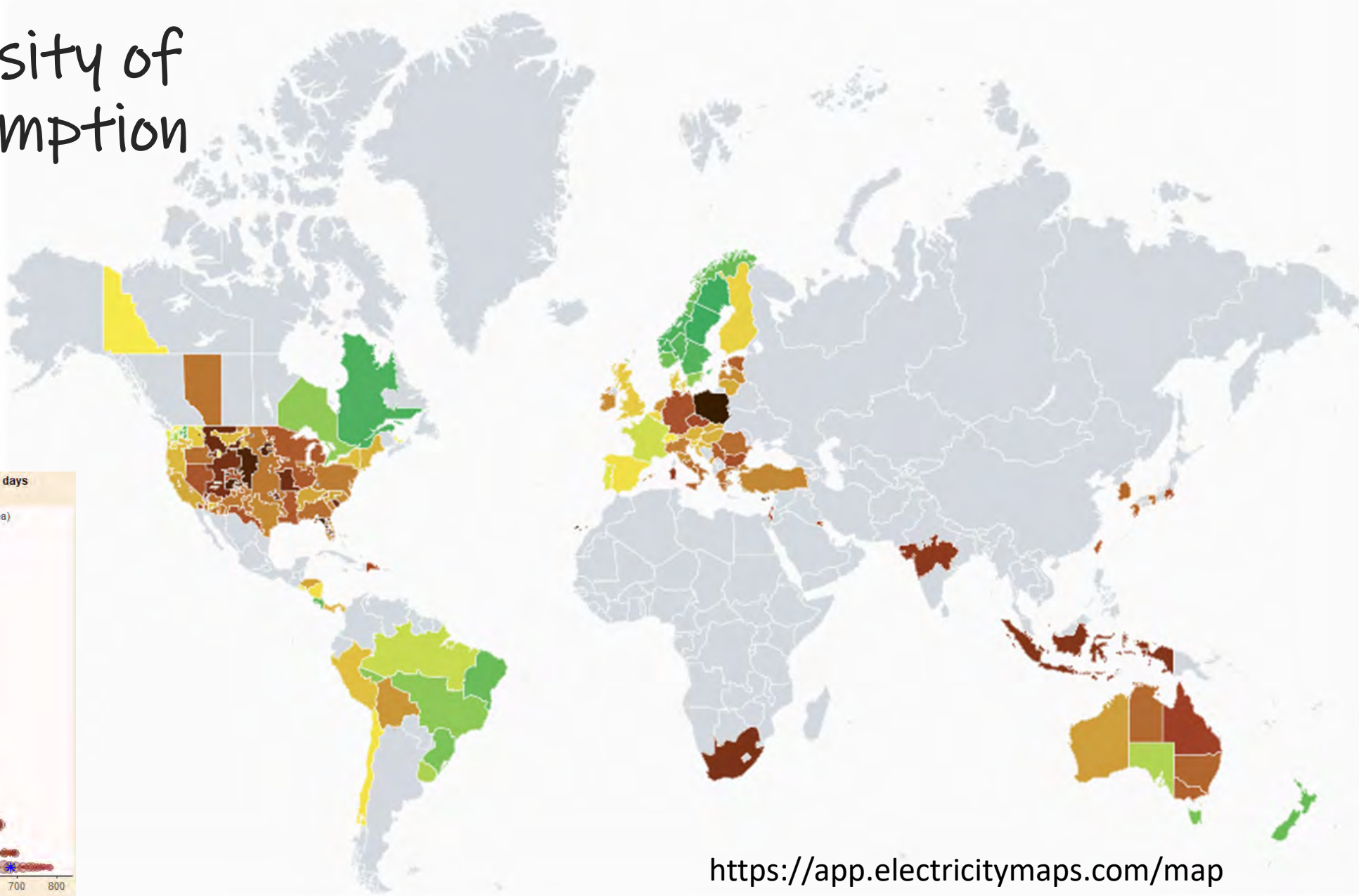


How are we doing with energy?

Actually not bad in Britain but still a work in progress



Carbon intensity of energy consumption for 2022

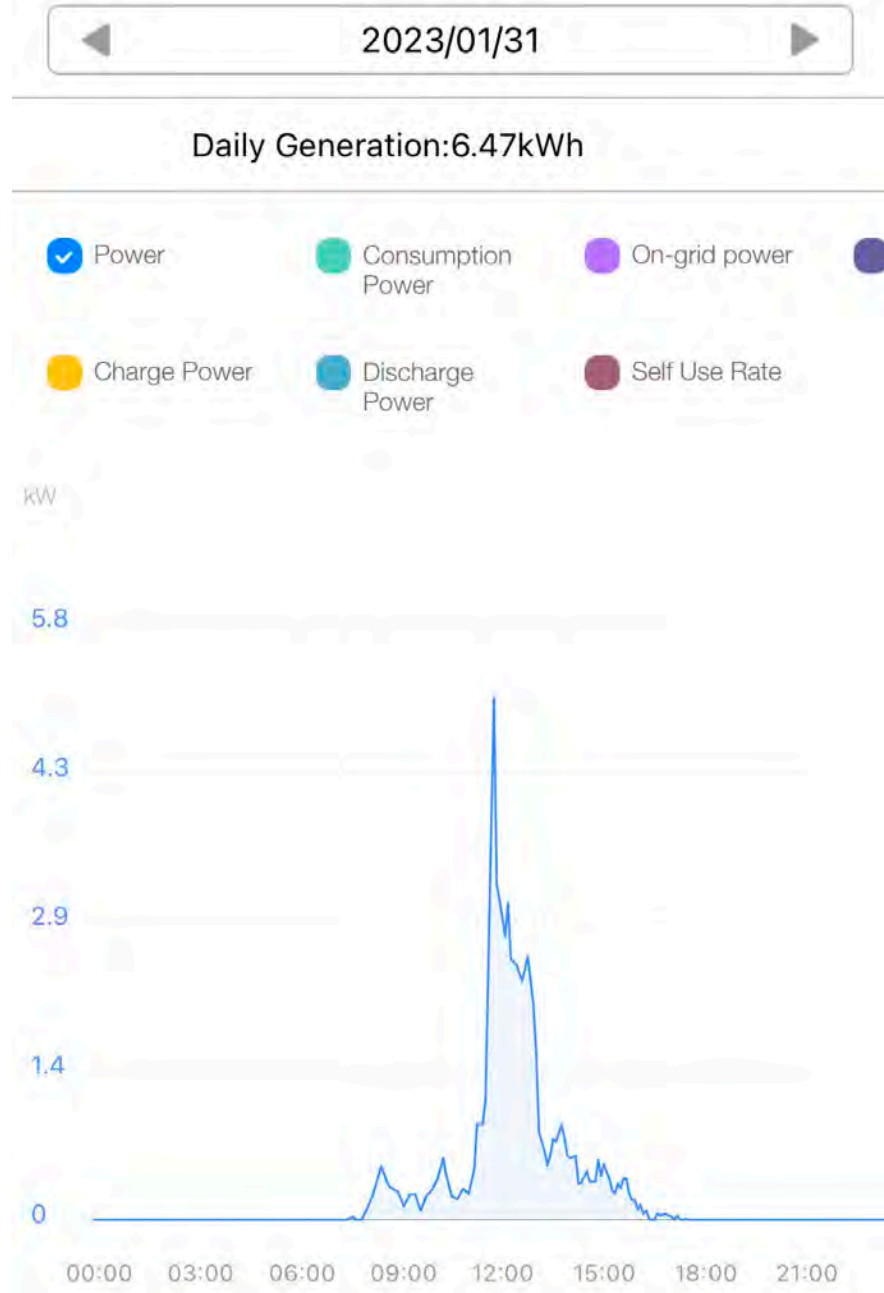


<https://app.electricitymaps.com/map>

'Wildgoose solar farm' helping in its small way



31st January 2023



Committee
on Climate
Change
Report in
2019 was a
really
important
document



Theresa May announces legislation for zero emissions by 2050

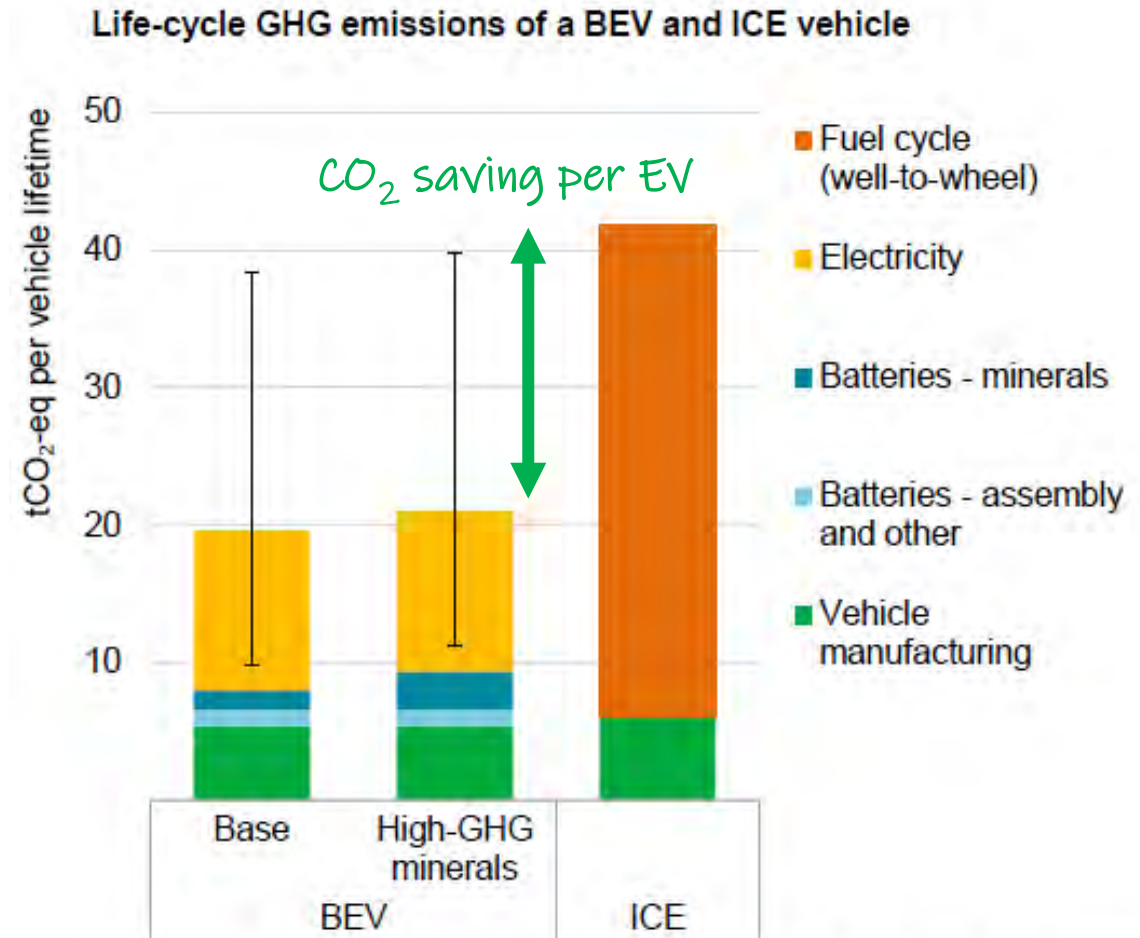
June 12, 2019



© Ojen

Having battery electric vehicles makes carbon sense

ICE = internal combustion engine
BEV = battery electric vehicle



IEA 2022

Government pledge

- **Electric vehicles.** By 2035 at the latest all new cars and vans should be electric (or use a low-carbon alternative such as hydrogen). If possible, an earlier switchover (e.g. 2030) would be desirable, reducing costs for motorists and improving air quality. This could help position the UK to take advantage of shifts in global markets. The Government must continue to support strengthening of the charging infrastructure, including for drivers without access to off-street parking.

Ambition for decarbonising transport ambitious but problematic

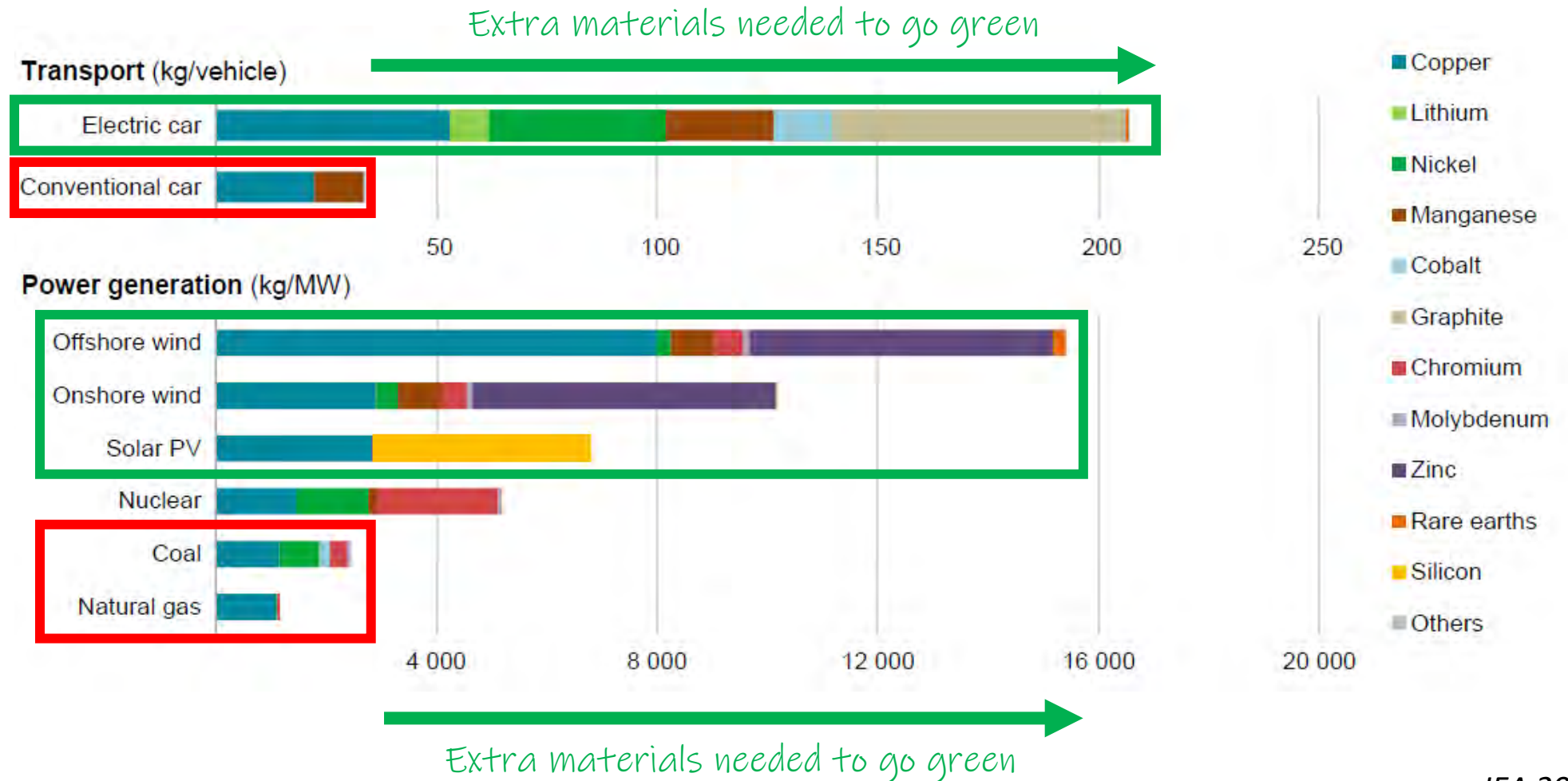
Problem identified



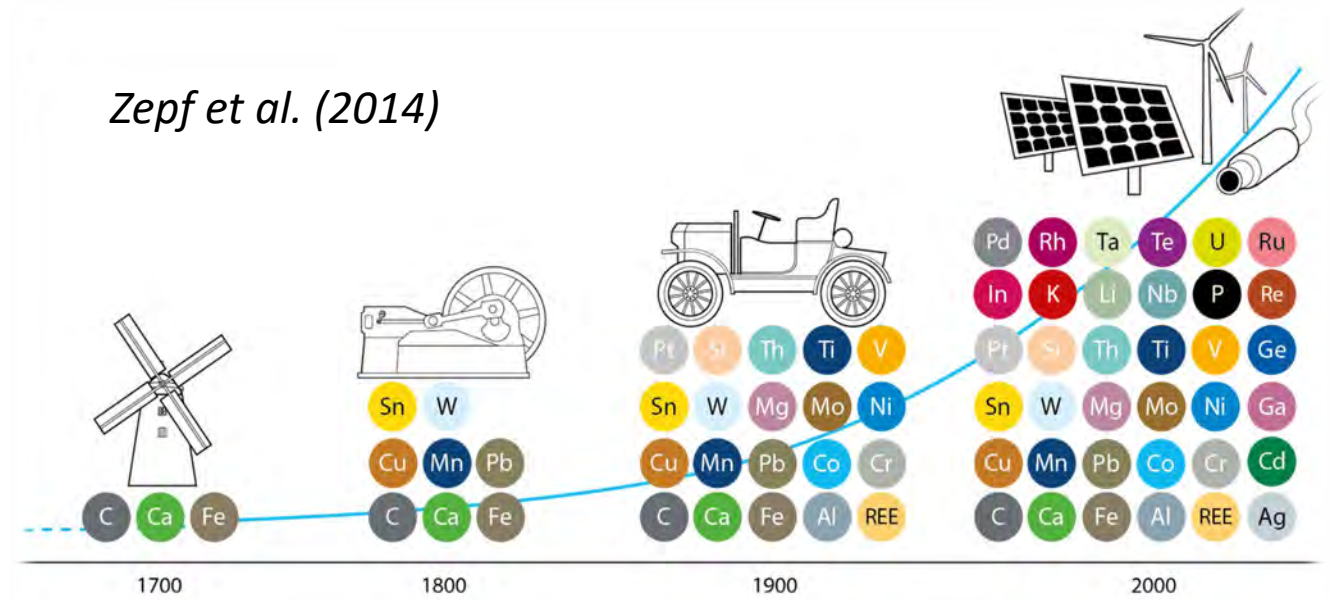
The image shows a screenshot of a press release from the Natural History Museum. The page header includes the museum's logo and navigation links: 'Visit', 'Discover', 'Take part', and 'Join'. Below the header is a photograph of a mineral specimen, identified as 'specimen of the mineral cobaltite - a cobalt iron arsenic sulphide'. The main heading of the press release is 'Leading scientists set out resource challenge of meeting net zero emissions in the UK by 2050', with a sub-heading 'PRESS RELEASE'. It is dated 'First published 5 June 2019' and includes social media icons for Facebook, Twitter, and Email. The text of the press release states: 'A letter authored by Natural History Museum Head of Earth Sciences Prof Richard Herrington and fellow expert members of SoS MinEralS (an interdisciplinary programme of NERC-EP SRC-Newton-FAPESP funded research) has today been delivered to the Committee on Climate Change'.

The metal resource needed to make all cars and vans electric by 2050 and all sales to be purely battery electric by 2035. To replace all UK-based vehicles today with electric vehicles (not including the LGV and HGV fleets), assuming they use the most resource-frugal next-generation NMC 811 batteries, would take 207,900 tonnes cobalt, 264,600 tonnes of lithium carbonate (LCE), at least 7,200 tonnes of neodymium and dysprosium, in addition to 2,362,500 tonnes copper. This represents, just under two times the total annual world cobalt production, nearly the entire world production of neodymium, three quarters the world's lithium production and 12% of the world's copper production during 2018. Even ensuring the annual supply of electric vehicles only, from 2035 as pledged, will require the UK to annually import the equivalent of the entire annual cobalt needs of European industry.

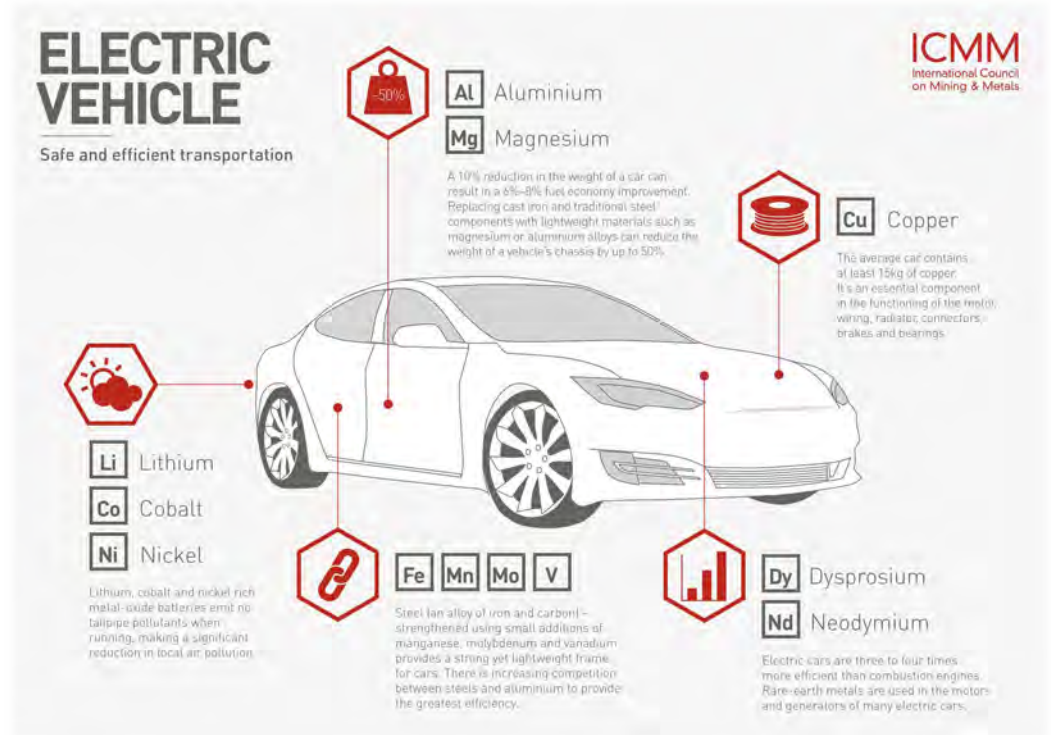
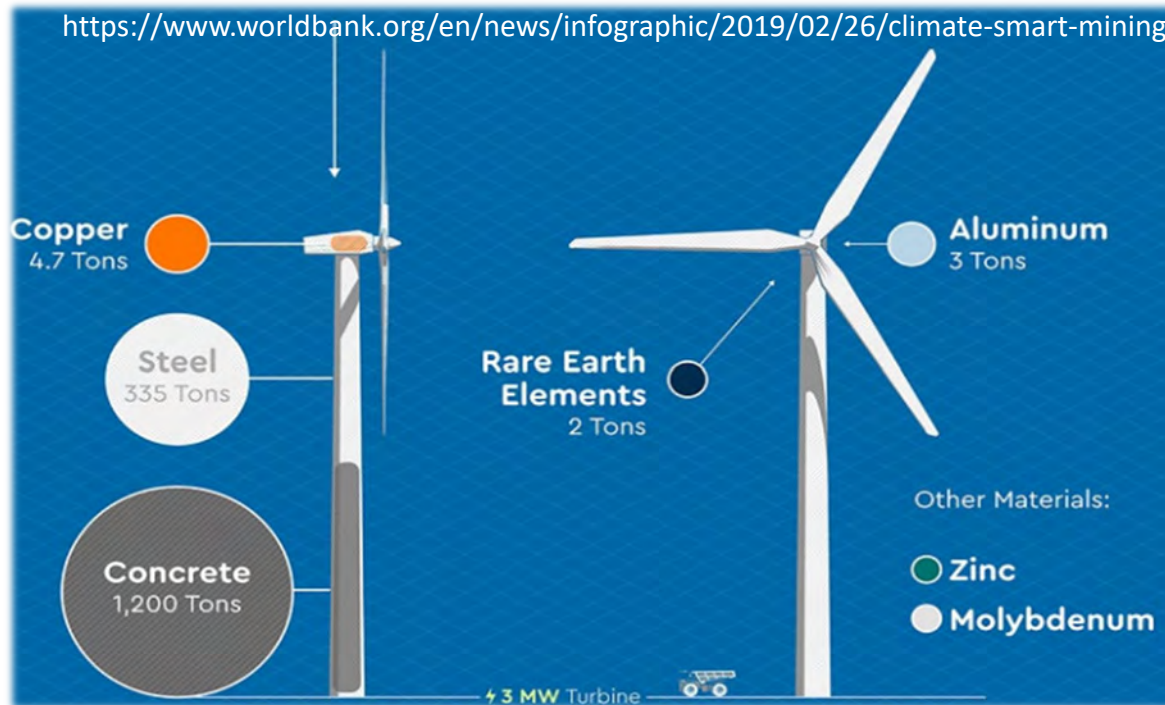
Going low-carbon is a metal and mineral hungry business



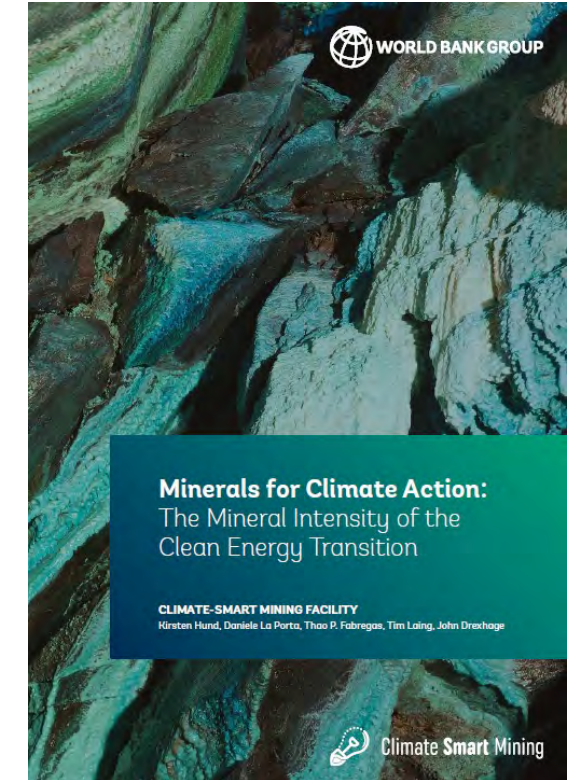
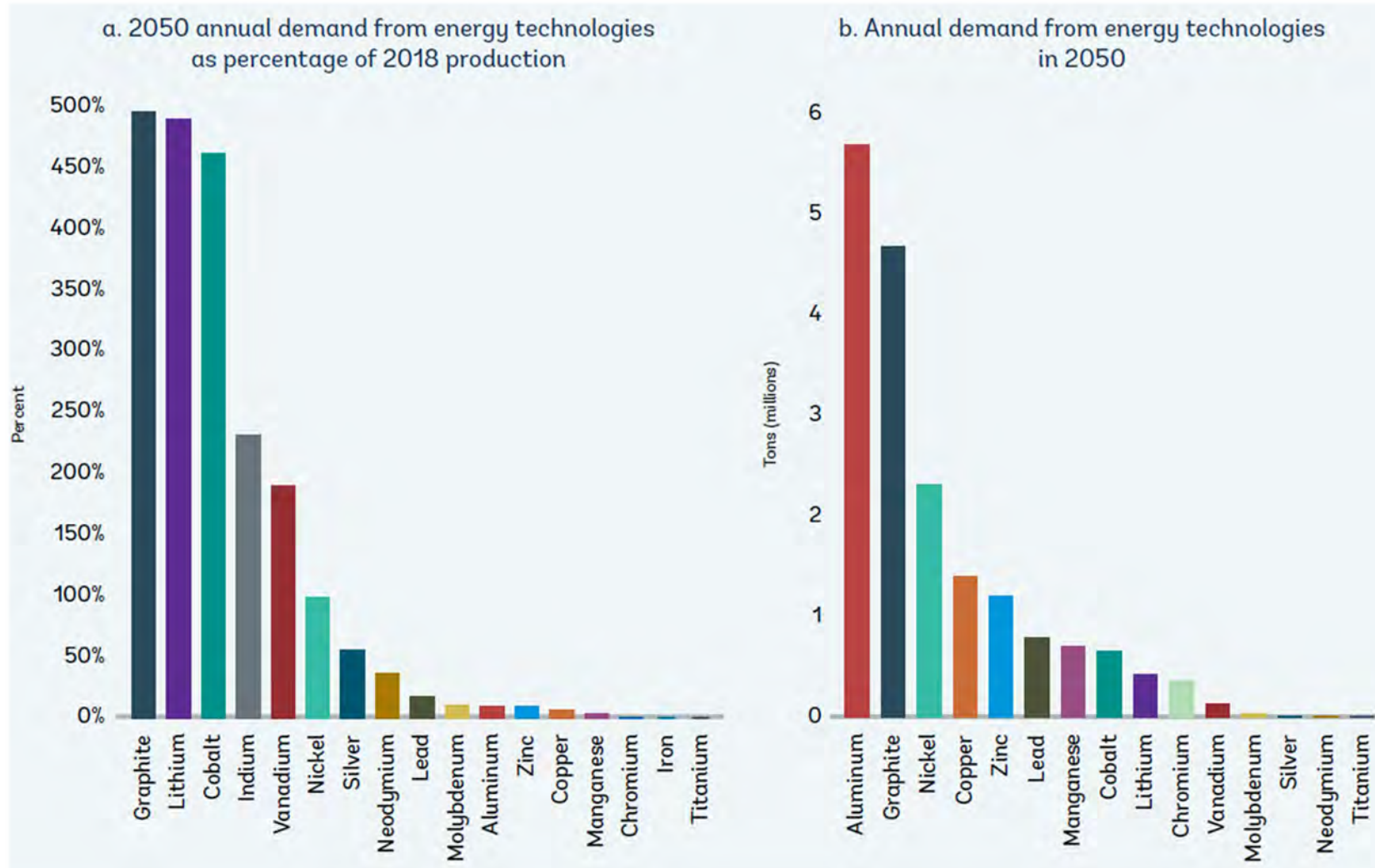
There are lots of different metals in renewable technologies



<https://www.worldbank.org/en/news/infographic/2019/02/26/climate-smart-mining>



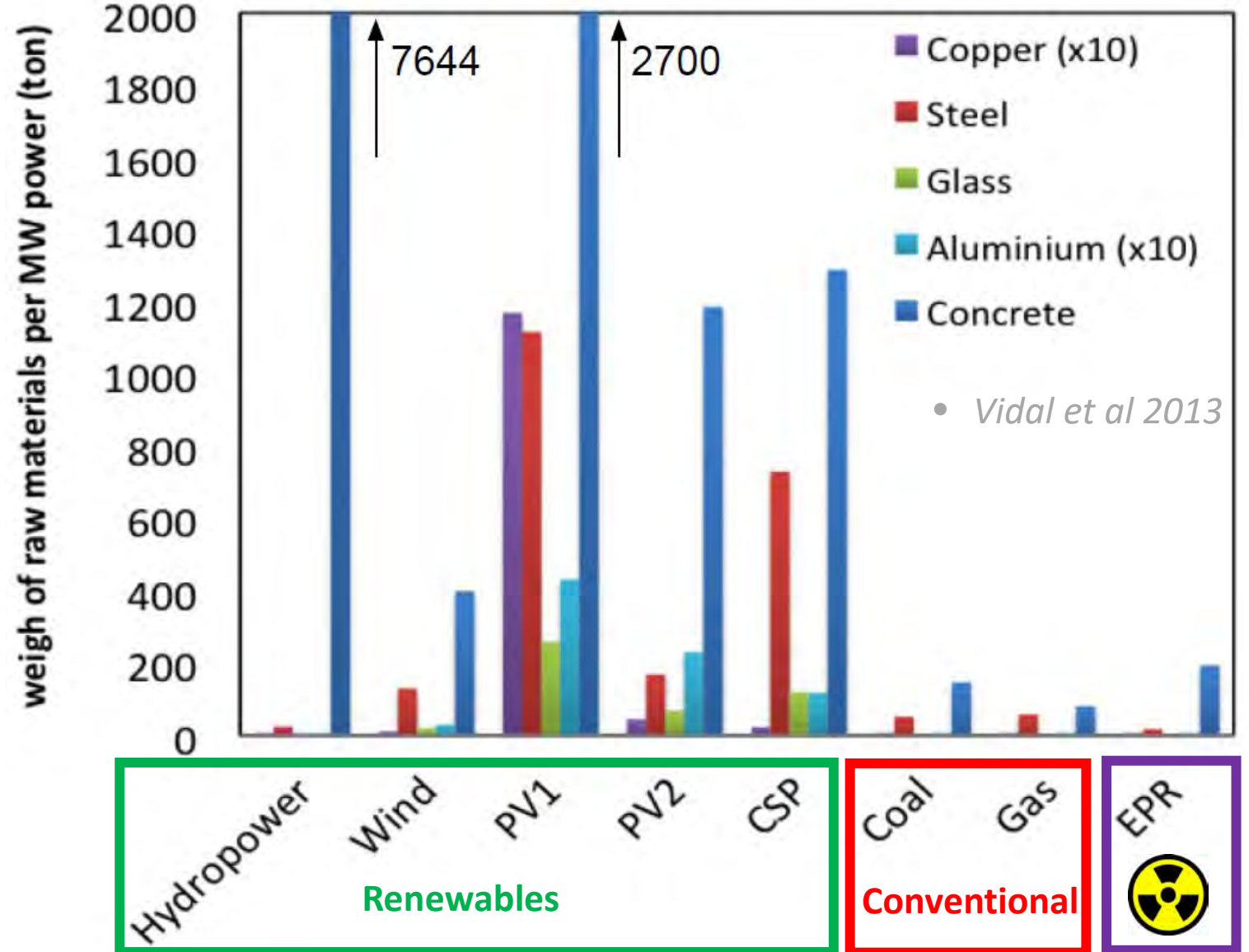
Increased demand is very significant!



<https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf>

Not just for
uncommon
minerals

Renewable
energy uses far
more steel,
copper, glass,
aluminium and
concrete per
megawatt of
capacity



Recycling! it is really important to recycle - for at least 5 reasons

- Recycling reduces landfill!
- Recycling reduces our need for new raw materials
- Recycling conserves energy
- Recycling creates jobs
- Recycling reduces pollution



- *Some metals like lead are up to 80% recycled*
- *Producing one tonne of aluminium from scratch results in an average of 17 tonnes of carbon emissions compared with the 0.6 tonnes emitted from secondary or recycled aluminium*
- *The US recycling industry employs 750,000 jobs and pays more than £30 billion in wages*
- *Recycling keeps plastics and toxic metals etc. out of the environment*

How are we doing on recycling?



- Germany the world leader at 66%
- Wales is a shining star at around 60%
- UK overall stuck at around 44% and has been declining recently (during lockdown)
- US the worst of the major economies - 33% California 44%
- 40% of UK waste incinerated with energy recovery
- 11% of our waste still goes to landfill
- UK still produces more than 200 million tonnes of waste per year
- Average family in the UK throws away 20% of the food we buy with a value of £800 per year per family

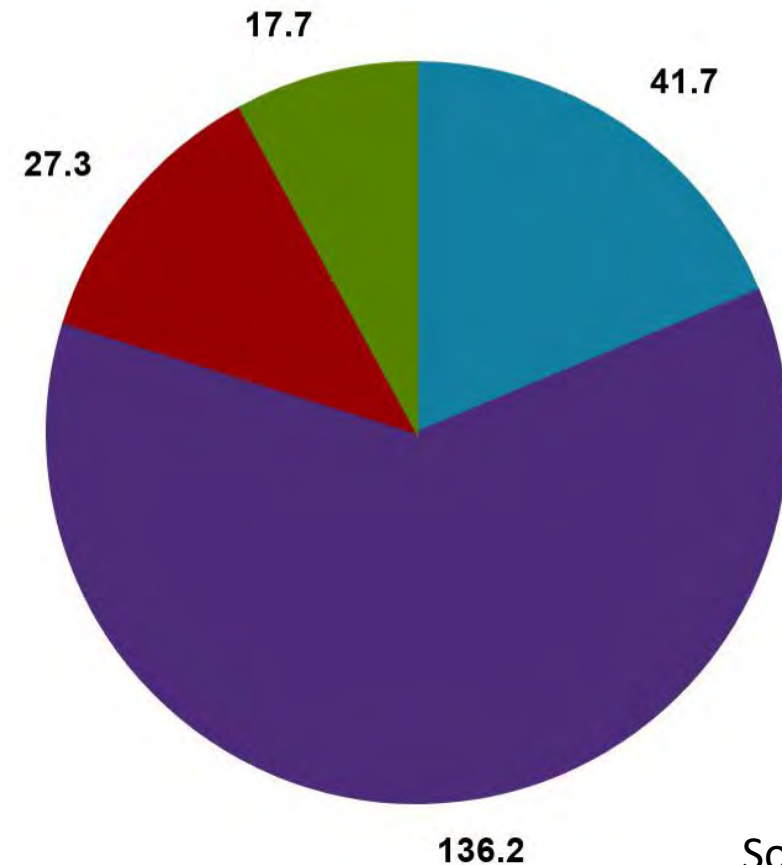
War on waste

- Lots of this waste can be eradicated with a will to re-use materials
- Household waste still needs to come down – its currently around 300kg per person per year

Waste generated in the UK

Million tonnes, 2016

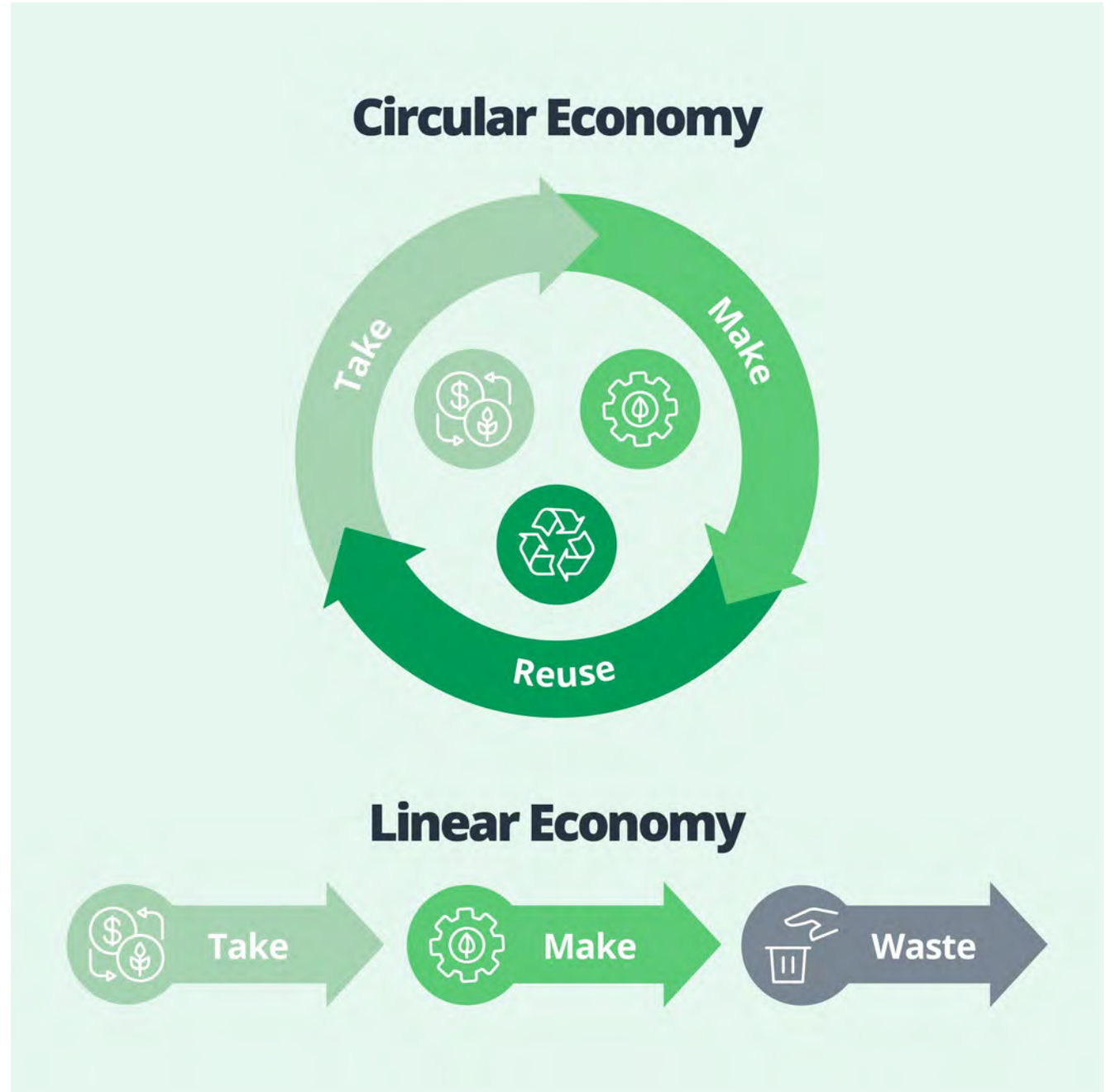
Commercial Construction Household Other



Source: DEFRA

War on waste

- We must turn our outdated ideas of the linear economy and adopt circular economy principles
- We in the developed world could also think about 'reduce' too



What can be done?

- Remember in the phrase 'throw it away' there really should be NO 'away' – some examples:
- Every family uses around 330 glass bottles a year, the majority still go into landfill and never decompose – glass is 100% recyclable and only uses 30% of the energy needed for new glass
- 75% of all waste paper is recycled - recycling reduces energy consumption of paper production by around 35%
- 15 million plastic bottles are used every day in the UK – plastic takes 500 years to decompose in landfill – plastic can be readily recycled
- 80% of the components in a mobile phone or other electrical products can be re-used or recycled if returned to a recycling point/store/Oxfam etc.
- Think before you bin it.....

The rubbish 'jars' of Deb Seymour from Seattle USA who has been recycling and minimising her waste since 1980!

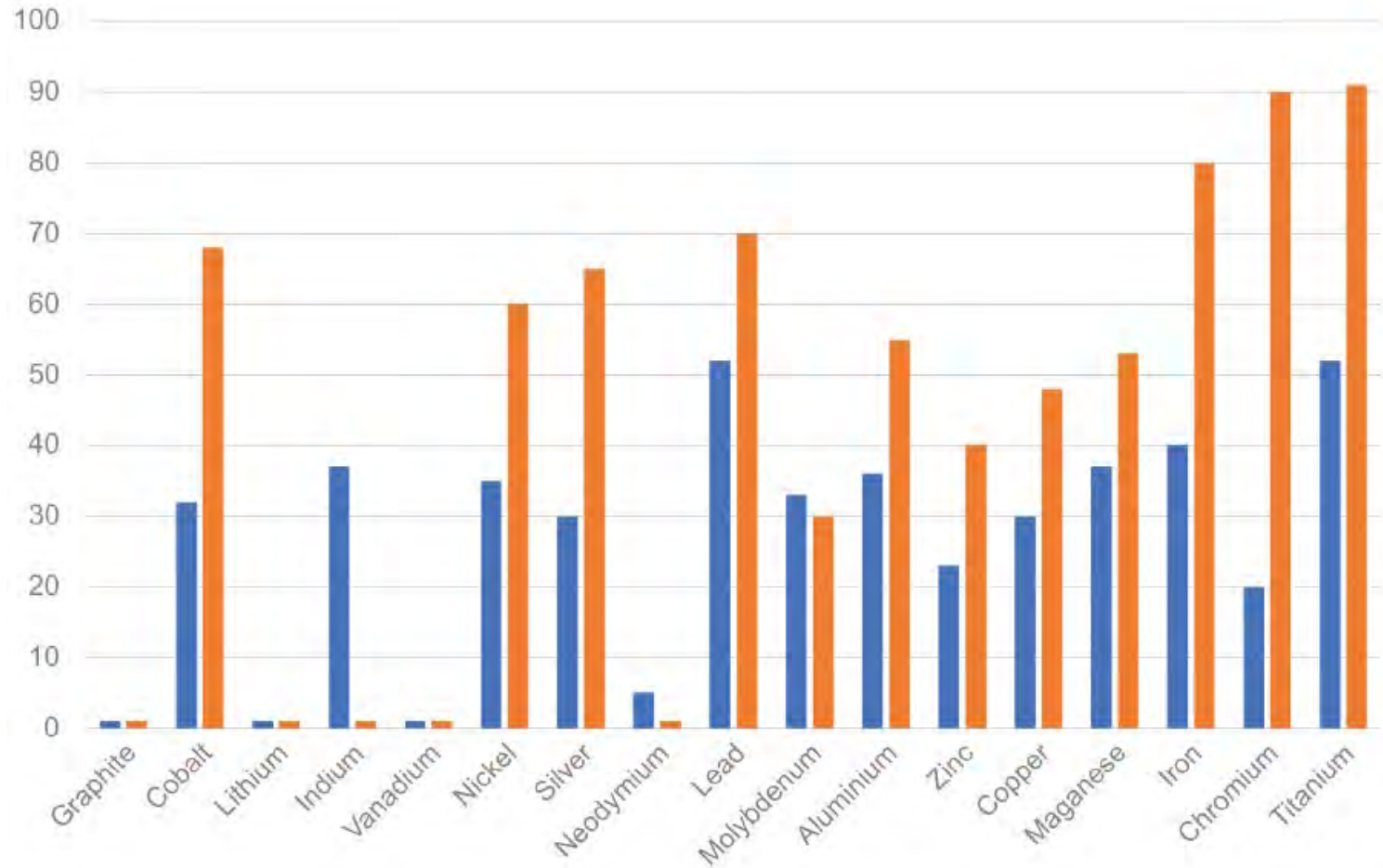


What does your monthly bin look like?

So that's all sorted then - Wait a minute with current recycling rates there is still a challenge....

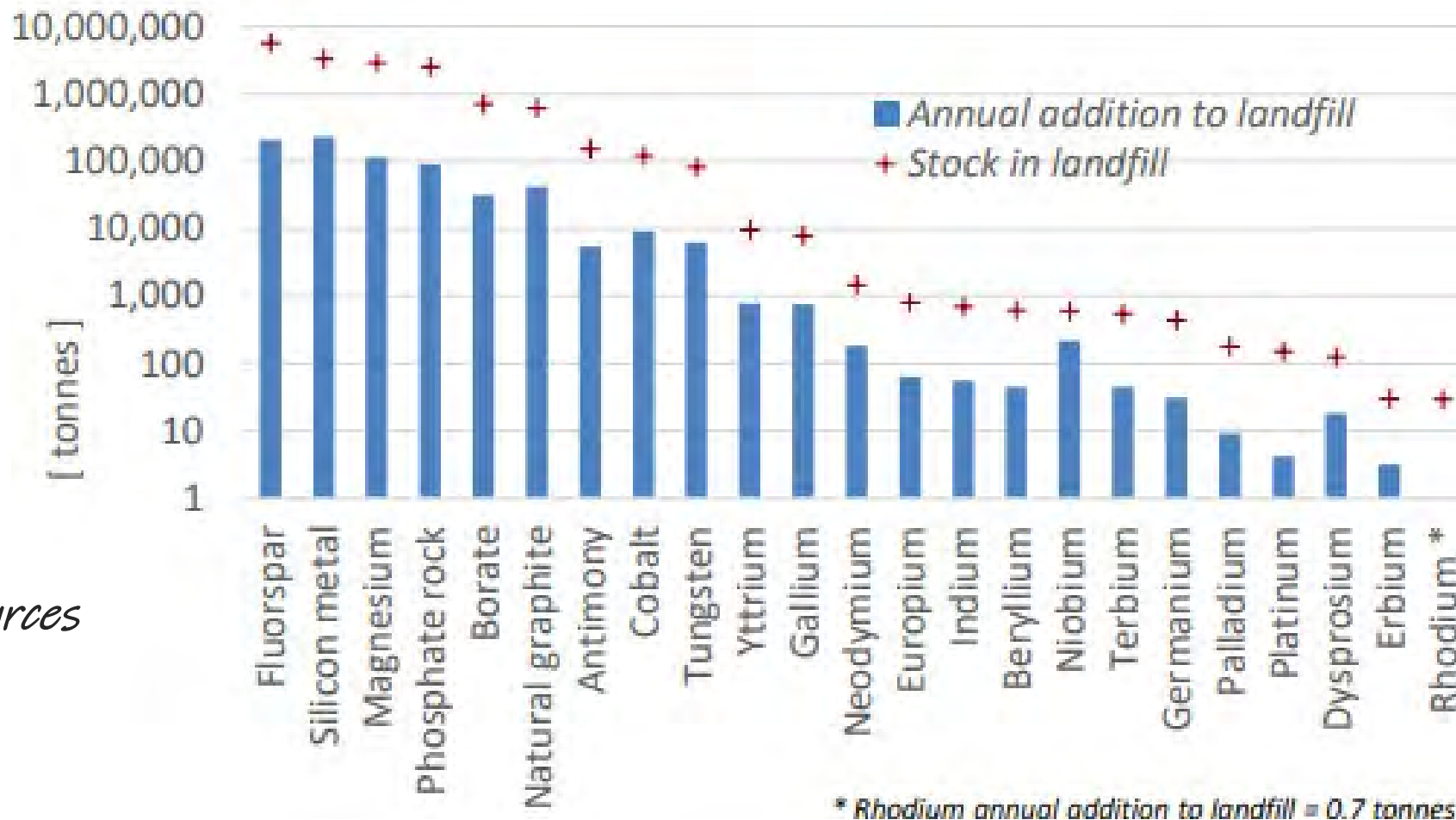
Orange =
percentage of
commodity
recycled at
end-of-life

Blue =
percentage of
current
demand
satisfied by
recycling



Authors figure from published data

Some of the materials we need can come from waste but it still won't be enough in the short term



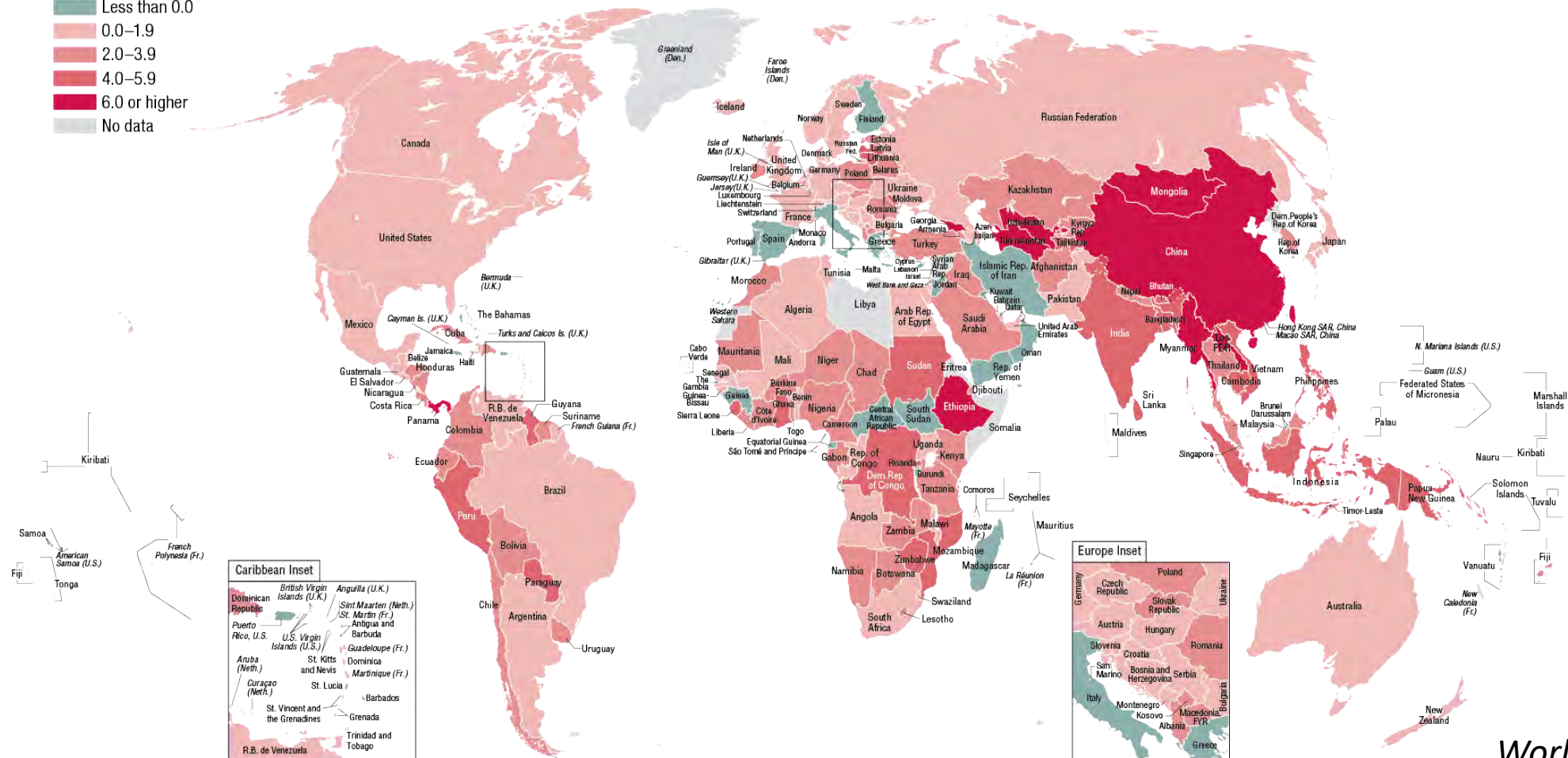
Estimated metal resources in European waste and landfill

Still, even with 100% recycling and using wastes, our economies are still growing so we are demanding more – securing and extracting new resources is inevitable

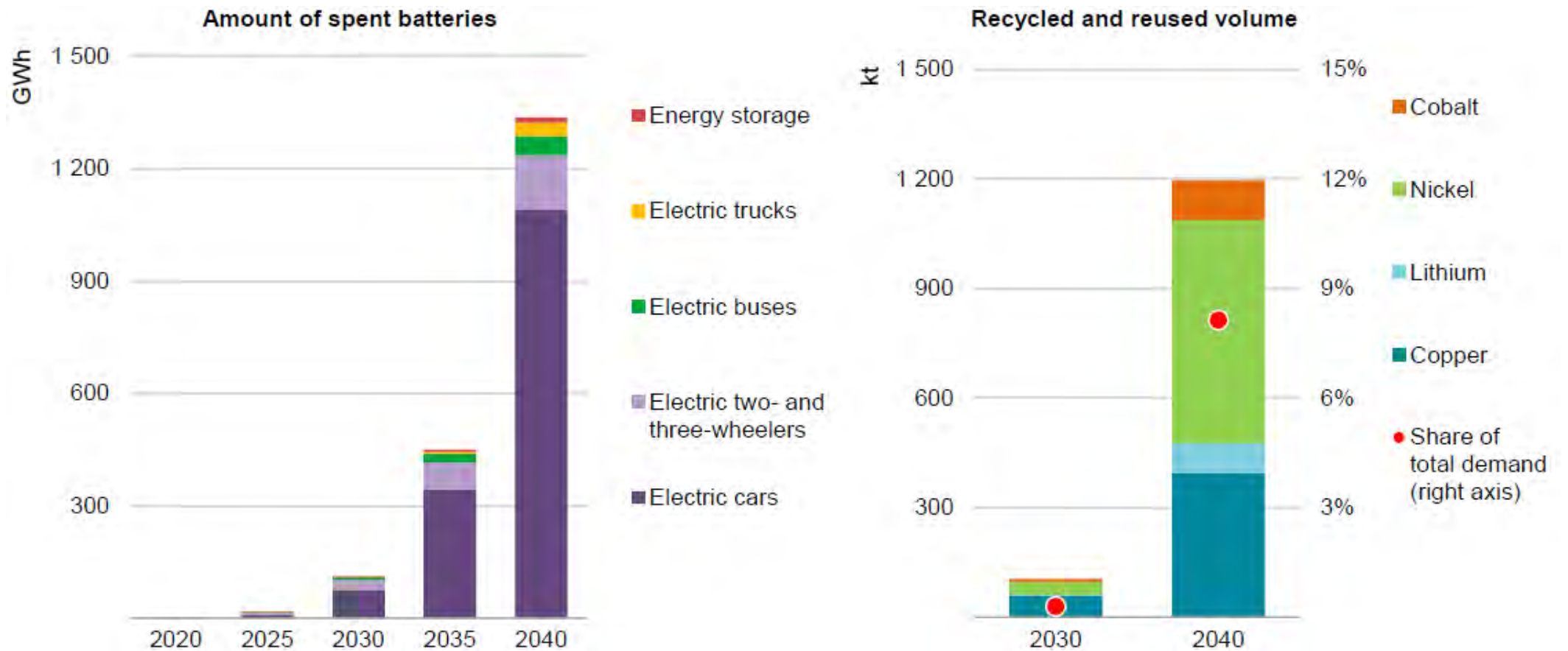
Economic growth

Average annual growth in GDP per capita in local currency units, 2009–15 (%)

- Less than 0.0
- 0.0–1.9
- 2.0–3.9
- 4.0–5.9
- 6.0 or higher
- No data



Only by 2040 at a minimum will we begin to have the new metals available to recycle



Until then at least we will have to find and open new mines

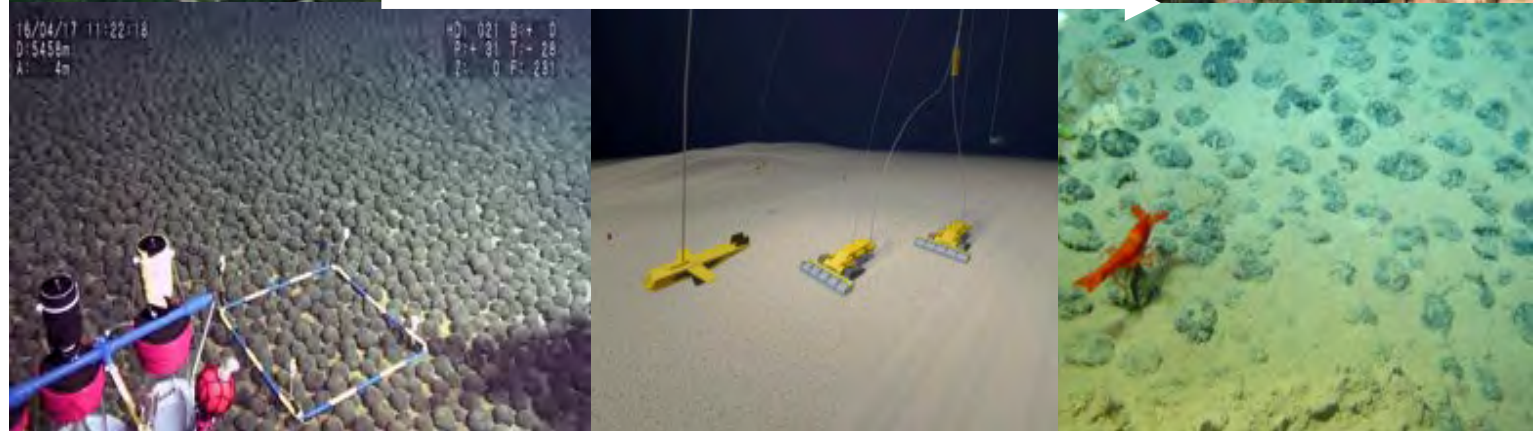
But big decisions for society to make

- On land?



Or

- In the deep ocean?



A debate for society to tackle

Opinion Mining


This article is more than 4 months old

The Observer view on the pros and cons of deep-sea mining

Observer editorial

Sun 29 Aug 2021 06:30 BST

There may be merits to mining the seabed, but investing in alternative green technologies on land should be the priority



164

Marine Policy 82 (2017) 134-137

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Should deep seabed mining be allowed?

Rakhyun E. Kim

Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands

ARTICLE INFO

Keywords:
Deep seabed mining
Deep sea minerals
International Seabed Authority
Benefit of humankind
Common heritage of humankind
Law of the sea

ABSTRACT

Commercial interest in deep sea minerals in the area beyond the limits of national jurisdiction has rapidly increased in recent years. The International Seabed Authority has already given out 26 exploration contracts and it is currently in the process of developing the Mining Code for eventual exploitation of the mineral resources. Priority issues have so far been feasibility and profitability of this emerging industry, while relatively little consideration has been given as to how, and to an even lesser extent, whether deep seabed mining should proceed. This article makes a case that the global community should question and scrutinize the underlying assumption that deep seabed mining is going benefit humankind as a whole before commercializing the common heritage of humankind.

- However society is going to have to choose as there is no alternative if we want to hit the climate change targets!

Our National Parks

JOURNALISM PROGRAM FEATURE WRITING PROJECT



Mining threatens park wildlife, water, air

By MELISSA MALLIN
School of Communication
University of Miami

Posted December 19, 2013

Mining poses serious threats to national parks.

Although no longer permitted inside park borders, existing mines near and around national parks threaten wildlife, damage water quality and induce air pollution.

Journal of Environmental Law

Issues Advance articles Submit Purchase Alerts About

Conservation and Access to Land for Mining in Protected Areas: The Conflict Over Mining in South Australia's Arkaroola Wilderness Sanctuary

Alexandra Wawryk

Journal of Environmental Law, Volume 26, Issue 2, July 2014, Pages 291-317, <https://doi.org/10.1093/jel/equ008>

Published: 19 May 2014

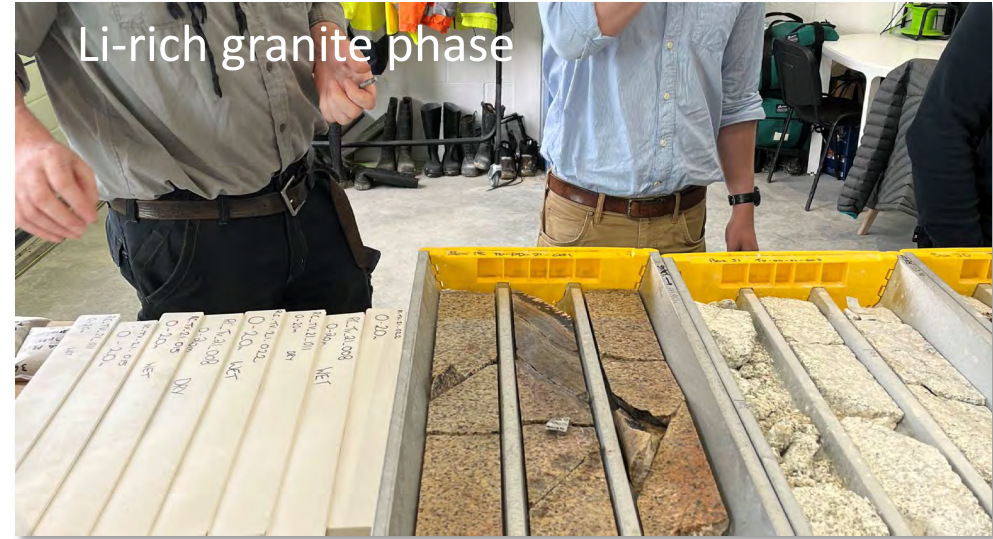
Volume 26, Issue 2
July 2014

< Previous Next >

Maybe bring the mining back close to home?



Former kaolin workings



Li-rich granite phase



Lepidolite in UST



Li from micas?

Some communities welcome new opportunities

BBC

NEWS

Kiruna: How to move a town two miles east

By Tabby Kinder
Kiruna, Sweden

6 March 2014



MIA STALNACKE/FLICKR

MIA STALNACKE/FLICKR

The mine provides jobs and wealth for the town's inhabitants

PlymouthLive NEWS

Plymouth's tungsten mine worth £415m as it prepares to reopen

Feasibility study shows Tungsten West's mine is economically viable and has enough ore for 27 years

By William Telford Business Editor

02:00, 17 Jan 2023

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Comments 7

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In Your Area



Tungsten West's Hemerdon Mine, on the edge of Plymouth

Advertisement

Cornish Lithium raises £6 million in new Crowdfunding Raise

THE TIMES

Investors crowd in to fund Cornish Lithium

Fundraising 'sells out in 15 minutes'



Other regions are less welcoming

POLITICO

Portugal to scrap lithium mining project

Locals spent years fighting to halt the project, a cornerstone of Lisbon's raw materials policy.

BY AITOR HERNÁNDEZ-MORALES AND SOFIA DIOGO MATEUS

April 27, 2021 | 10:11 pm

Serbia

Rio Tinto plans for Serbia lithium mine suspended after protests

Local authorities put \$2.4bn project on hold after scale of opposition shakes country's government

Associated Press
in Belgrade

Thu 16 Dec 2021 18:34
GMT



Le Télégramme

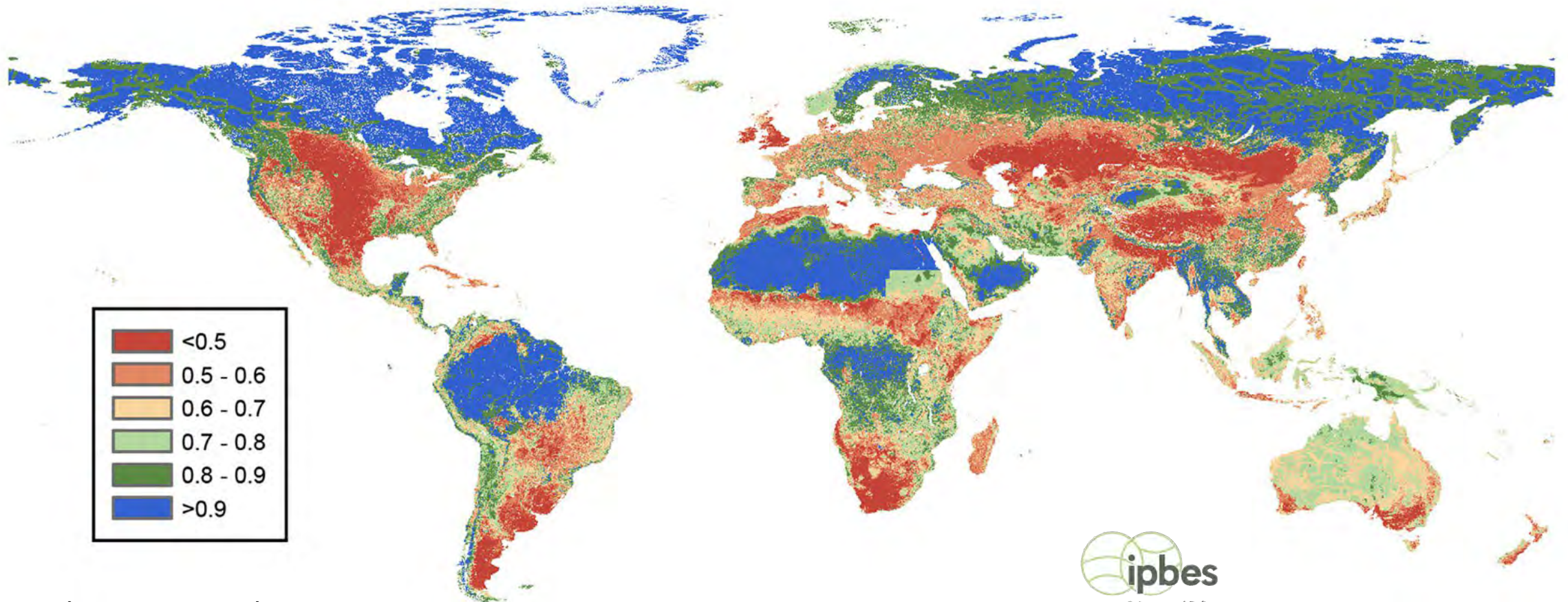
Publié le 23 octobre 2015

Manif anti-mines. L'avis en jeu



Developing mines closer to home could be a more environmentally sound decision

Estimated Biodiversity Intactness Index – blue = intact; red = very degraded



Sanchez-Ortiz et al. in preparation

COP26 and COP27 recognised environment as a major issue

The four main goals:

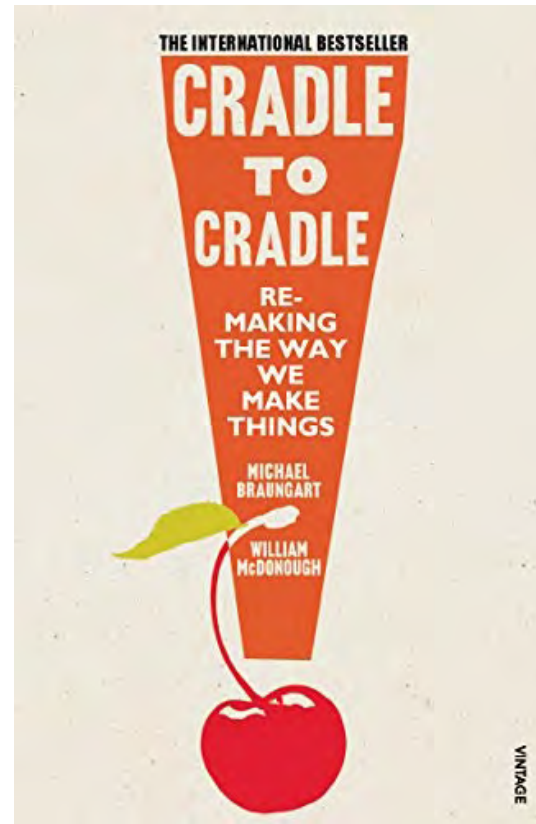
- Secure global net-zero by mid-century and keep limit of 1.5°C temperature increase “within reach”
- Adapt to protect communities and natural habitats
- Mobilise finance
- Collaborate to deliver



Agenda items:

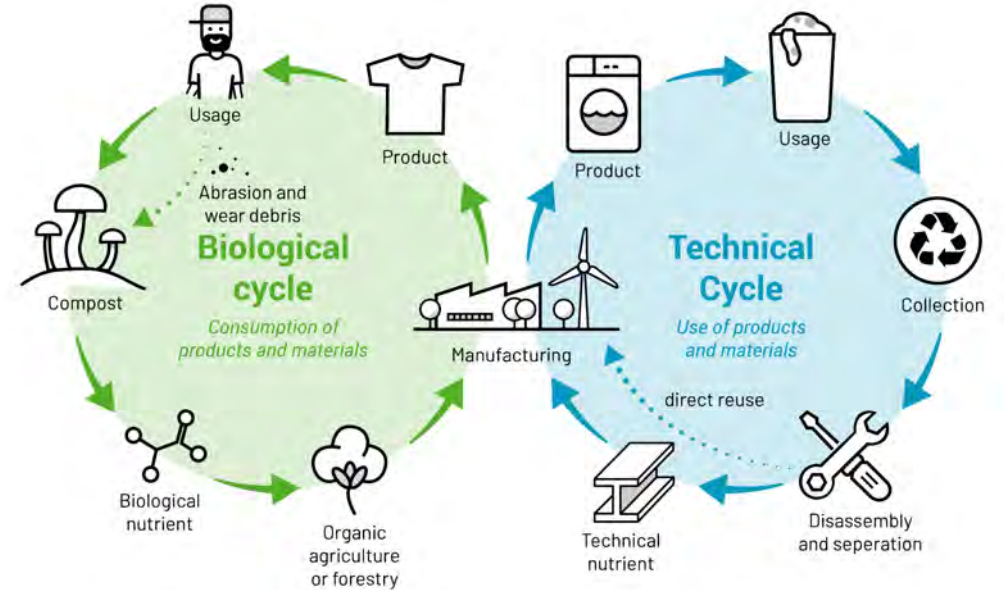
- Mobilising public and private finance
- Accelerating the transition to clean energy
- Elevating the voice of young people and demonstrating the critical role of public empowerment
- Ensuring sustainable land use
- Adapting to climate hits and addressing the loss and damage
- Progressing meaningful participation by women and girls
- Looking at innovative science
- Driving towards zero-emission transport
- Promoting environmental action in cities

A 'new' philosophy is needed



CRADLE TO CRADLE

A concept by Michael Braungart and William McDonough



- Imagine a world in which all the things we make, use and consume all provide 'nutrition' for both nature and human industry
- We should wean ourselves off the concept of waste since one user's residue can be another's raw material – it happens in nature
- Perhaps we can get back to real planetary stewardship.....

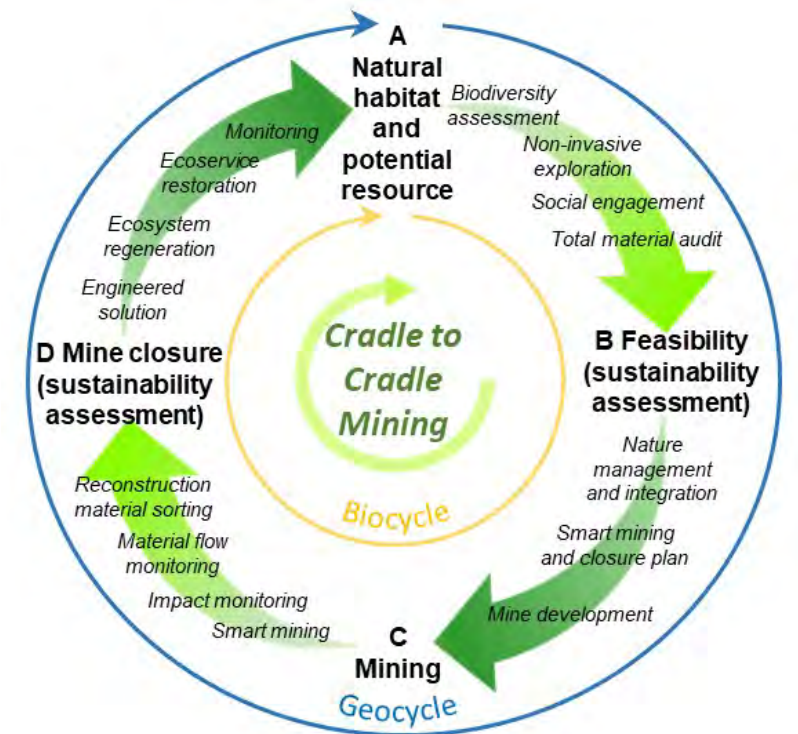
What is it that am I working on?

- With a colleague I have been developing a new concept for mining that is inherently regenerative



Flambeau mine, Wisconsin

- There is a clear need to protect and reconstruct the ecosystem while we recover the minerals we need
- Our model is to develop a 'cradle to cradle' circular approach to mining not the entrenched linear 'cradle to grave' model



Mine Closure 2022 - M Tibbett, AB Fourie & G Boggs (eds)
© 2022 Australian Centre for Geomechanics, Perth, ISBN 978-0-6450938-4-1
doi:10.36487/ACG_repo/2215_0.02

Cradle-to-cradle mining: a future concept for inherently reconstructive mine systems?

R Herrington *Natural History Museum, UK*

M Tibbett *University of Reading, UK*

Mine Closure 2022

Proceedings of the 15th International Conference on Mine Closure

4-6 October 2022 | Brisbane, Australia

Takeaway messages

- Reducing atmospheric CO_2 is the number 1 priority in arresting climate and environmental change we see on Earth today
- Technologies that will reduce our CO_2 production – excluding use of fossil fuels - necessarily demand metals and minerals, many of which we have never used before in large quantities
- We must therefore optimise our reuse and recycling of all materials we currently use – ‘zero waste’
- We should seek to reduce consumption where we can
- We should investigate using waste materials that are currently sitting idle
- Nevertheless, there is still a clear need to mine an increased volume of a range of minerals
- This new sourcing must be done in a way that there is a net positive impact for both people and the planet
- Controversially, developing new mines closer to home may be a good thing for people and planet
- All our activities should follow ‘cradle to cradle’ (Christian Stewardship!) principles

Mining our green future

Richard Herrington ✉

Nature Reviews Materials **6**, 456–458 (2021) | [Cite this article](#)

7849 Accesses | **169** Altmetric | [Metrics](#)

Accepted manuscript

Mineral revolution for the Wellbeing Economy

Published online by Cambridge University Press: 12 August 2022

Richard Gloaguen, Saleem H. Ali , Richard Herrington, Leila Ajjabou, Elizabeth Downey and Iain S. Stewart

Article Metrics



Global Sustainability

Mine Closure 2022 - M Tibbett, AB Fourie & G Boggs (eds)
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Post script



God spoke: "Let us make human beings in our image, make them reflecting our nature

So they can be responsible for the fish in the sea,
the birds in the air, the cattle,

And, yes, Earth itself,
and every animal that moves on the face of Earth."

God created human beings;
he created them godlike,

Reflecting God's nature.

He created them male and female.

God blessed them:

"Prosper! Reproduce! Fill Earth! Take charge!

Be responsible for fish in the sea and birds in the air,
for every living thing that moves on the face of Earth."

Genesis 1:26-28 The Message