British Computer Society
The Chartered Institute for IT
Consultancy Specialist Group

Webinar

Consultancy and Green IT

John Booth
BSc (Hons) Tech (Open), MBCS, CDCAP

22nd April 2021

Consultancy & ICT Sustainability (Green IT)

John Booth BSc (Hons) Tech (Open), CDCAP, MBCS

V Chair BCS Green IT SG

BCS Consultancy/Green IT SGs

Virtual

22th April 2021

John Booth

- MD - Carbon3IT Ltd
- Technical Director – National **Data Centre** Academy

- Vice Chair BCS Green IT SG
- BSI TCT7/3 Committee – EN 50600 **Data Centre** Standards
- EU Code of Conduct for **Data Centres (Energy Efficiency) Joint Author/Reviewer/Committee Member**
- Data Centre Alliance – Chair SIG **Data Centre Energy Efficiency & Committee Member Sustainability**
- DCD CEEDA (Certified **Energy Efficient Data Centre** Award) Global Lead Assessor
- ISO 50001 **Energy Management** Systems Lead Auditor
- ISO 22301 Business Continuity Management Systems Lead Auditor
- **Energy Saving Opportunities Scheme** (ESOS) Lead Assessor – Energy Management Association
- Certified **Data Centre Audit** Professional (CDCAP™)
- Certified **Data Centre Sustainability** Professional (CDCSP™)
- Advisory Board - Sustainable Digital Infrastructure Alliance

- EU H2020 Projects
  - PEDCA - Pan European **Data Centre** Academy
  - EURECA – Green Procurement for Public Sector **Data Centre**
  - CATALYST – **Data Centres** as Flexible Energy Hubs (Renewables, Grid & Heat Services)

Firstly, what is a “Consultancy”?

- A consultant (from Latin: consultare "to deliberate") is a professional who provides expert advice in a particular area such as business, education, law, regulatory compliance, human resources, marketing (and public relations), finance, health care, architecture and planning, engineering, science, security (electronic or physical), or any of many other specialized fields.

- A consultant is usually an expert or an experienced professional in a specific field and has a wide knowledge of the subject matter The role of consultant outside the medical sphere (where the term is used specifically for a grade of doctor) can fall under one of two general categories:

- Internal consultant: someone who operates within an organization but is available to be consulted on areas of their specialization by other departments or individuals (acting as clients); or

Firstly, what is a "Consultancy"?

- External consultant: someone who is employed externally to the client (either by a consulting firm or some other agency) whose expertise is provided on a temporary basis, usually for a fee. Consulting firms range in size from sole proprietorships consisting of a single consultant, small businesses consisting of a small number of consultants, to mid- to large consulting firms, which in some cases are multinational corporations. This type of consultant generally engages with multiple and changing clients, which are typically companies, non-profit organizations, or governments.

- By hiring a consultant, clients have access to deeper levels of expertise than would be financially feasible for them to retain in-house on a long-term basis. Moreover, clients can control their expenditures on consulting services by only purchasing as much services from the outside consultant as desired.

- Consultants provide their advice to their clients in a variety of forms. Reports and presentations are often used. However, in some specialized fields, the consultant may develop customized software or other products for the client. Depending on the nature of the consulting services and the wishes of the client, the advice from the consultant may be made public, by placing the report or presentation online, or the advice may be kept confidential, and only given to the senior executives of the organization paying for the consulting services

What is “Sustainability”?

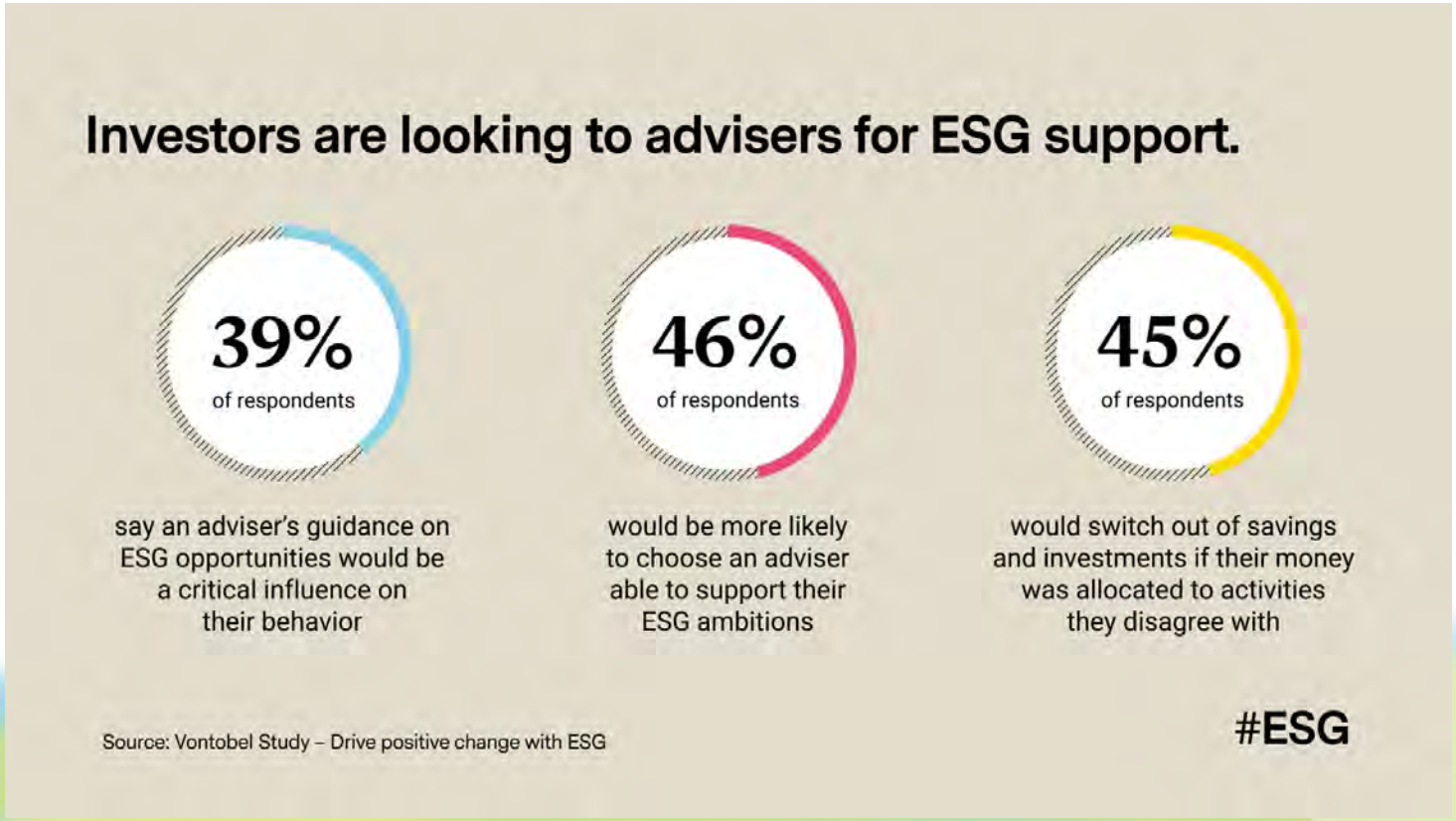
- Sustainability is defined as “"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.“

- The United Nations have published a document that extends this definition into 17 specific goals

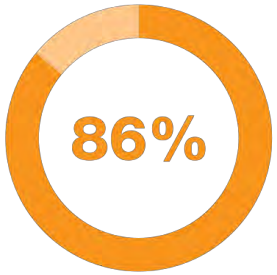
- [1]https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf,

UN Sustainable Development Goals

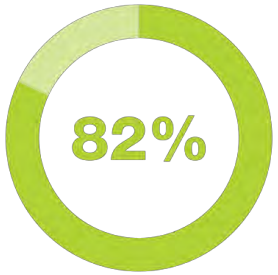
Why ICT Sustainability?



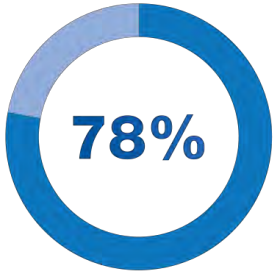
Why ICT Sustainability?



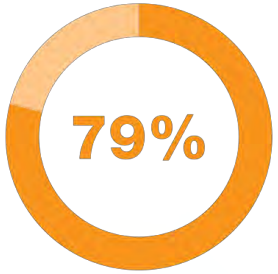
say they care about sustainability in general



say they care about sustainability aspects of packaging



say they support/buy from businesses with sustainability initiatives

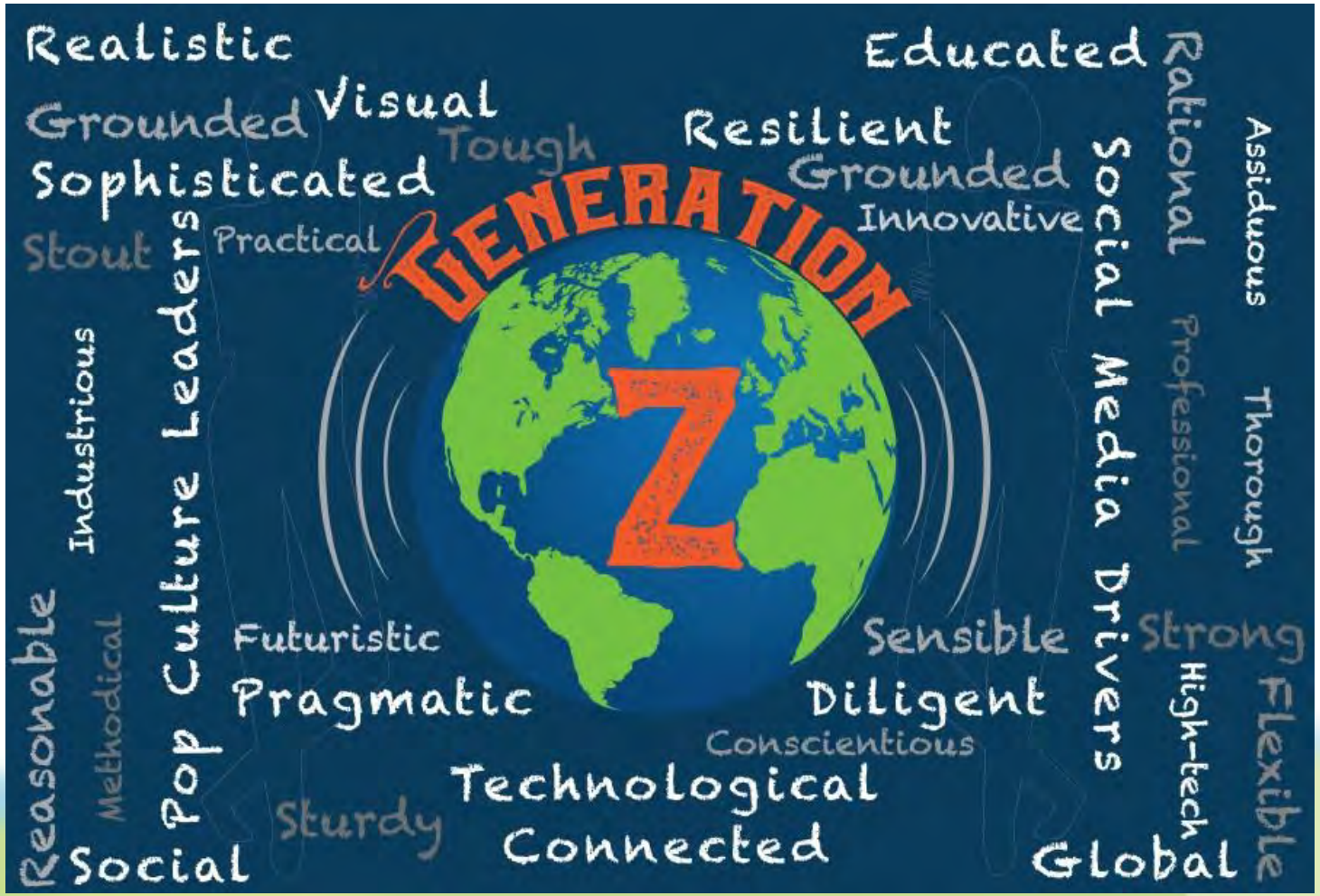


say they prefer products that are in sustainable packaging over ones that are not

Percentages based on summary of those who strongly agree or somewhat agree with statements.

FPA survey conducted by The Harris Poll[2]

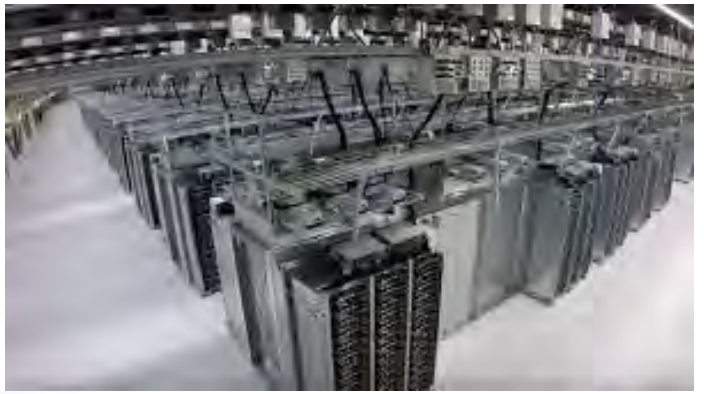
Why ICT Sustainability?



Doggerland!


Continental Europe above sea level
16,000 B.C.
8000 B.C.
7000 B.C.
Land area today
Ice sheet 16,000 B.C.
Ice sheet 16,000 B.C.
NORWAY
NORWEGIAN TRENCH
BRITISH ISLES
ATLANTIC OCEAN
DOGGERLAND
North Sea (today)
DENMARK
Tybrind Vig
Tweed
Howick
UNITED KINGDOM
DOGGER BANK (today)
IRELAND
Outer Silver Pit Lake
Wismar Bay
ENGLAND
WALES
Ouse
Goldcliff
Severn
London
Thames
NETHERLANDS
Rhine
BELGIUM
GERMANY
BRITTANY
Téviec Island
FRANCE
NORTH AMERICA
EUROPE
AREA ENLARGED

The 3 Parts of ICT Infrastructure(s)



Conclusion, is IoTr truly sustainable?

With thanks to materials innovation!

Elements Employed in Silicon Tech'

Before 90's

90's through 2005

Beyond 2006

hydrogen 1 H 1.0079																	helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]				

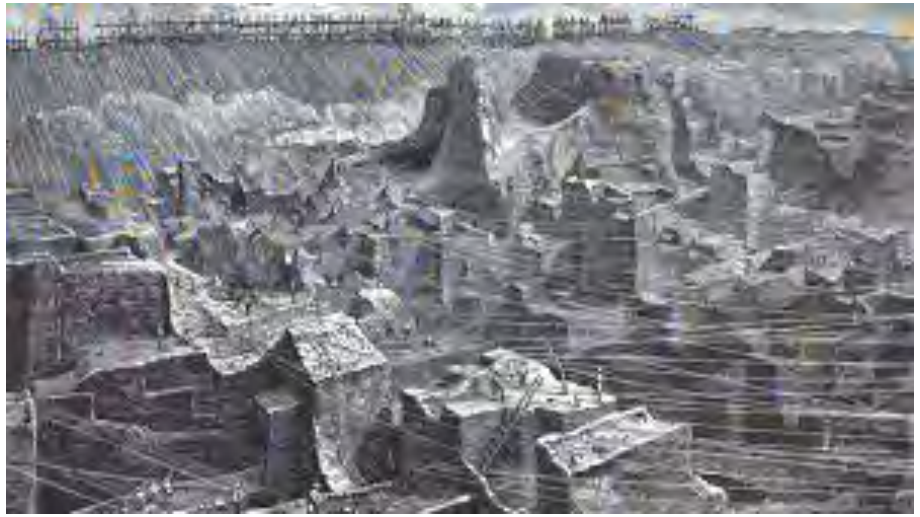
*lanthanoids	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**actinoids	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Key:
element name
atomic number
symbol
atomic weight (mean relative mass)

With thanks to: Prof R Lanyon-Hogg & the National Geological Society

Rare Earths

South African Gold/Diamond Mining 1900s



ICT Materials

- For PC's
- 240kgs of fossil fuels
- 21lbs of chemicals
- 1500 Litres of Water
- 1000 Different materials
- FOR ONE PC.

- In 2009, 367.8 million PC's were manufactured.
- And that in 2008, the number of PC's on the planet exceeded…
- 1 billion units.
- Totals
- Fossil Fuel 240 Billion Kgs
- Chemicals 22 Billion Kgs
- Water 1500 Billion Litres

ICT Materials

- For Servers (x3)
- 27,282,000 in use 2009
- Fossil Fuels 625.5 x 27,282,000 = 17,064,891,000 Kgs
- Chemicals 64.53 x 27,282,000 = 1,760,507,460 Kgs
- Water 3,150 x 27,282,000 = 85,938,300,000 Kgs/Litres

- Total Fossil Fuels used in Computing to date = 241,323,304,572.50Kgs or
- 24.1 Billion Tonnes (estimated)

- Total amount of fossil fuels to produce the 1Billion Desktops and 27 Million Servers to date would run Drax for...
- 2400 Years.
- NB Drax used to provide 7% of UK Generation Capacity

eWaste

eWaste

- Studies conducted at Chinese, Indian, Nigerian and Ghanaian e-waste sites found large concentrations of heavy metals and organic contaminants such as PBDEs, PCBs and polycyclic aromatic hydrocarbons (PAHs)in the air, in dust, soil, vegetation and in the blood of workers and residents on and in the vicinity of the sites

- https://www.sciencedirect.com/science/article/pii/S0160412019340012

eWaste

1. Temperature exchange equipment:
more commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers, air conditioners, and heat pumps.

2. Screens and monitors:
typical equipment includes televisions, monitors, laptops, notebooks, and tablets.

3. Lamps:
typical equipment includes fluorescent lamps, high intensity discharge lamps, and LED lamps.

4. Large equipment:
typical equipment includes washing machines, clothes dryers, dishwashing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels.

5. Small equipment:
typical equipment includes vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring, and control instruments.

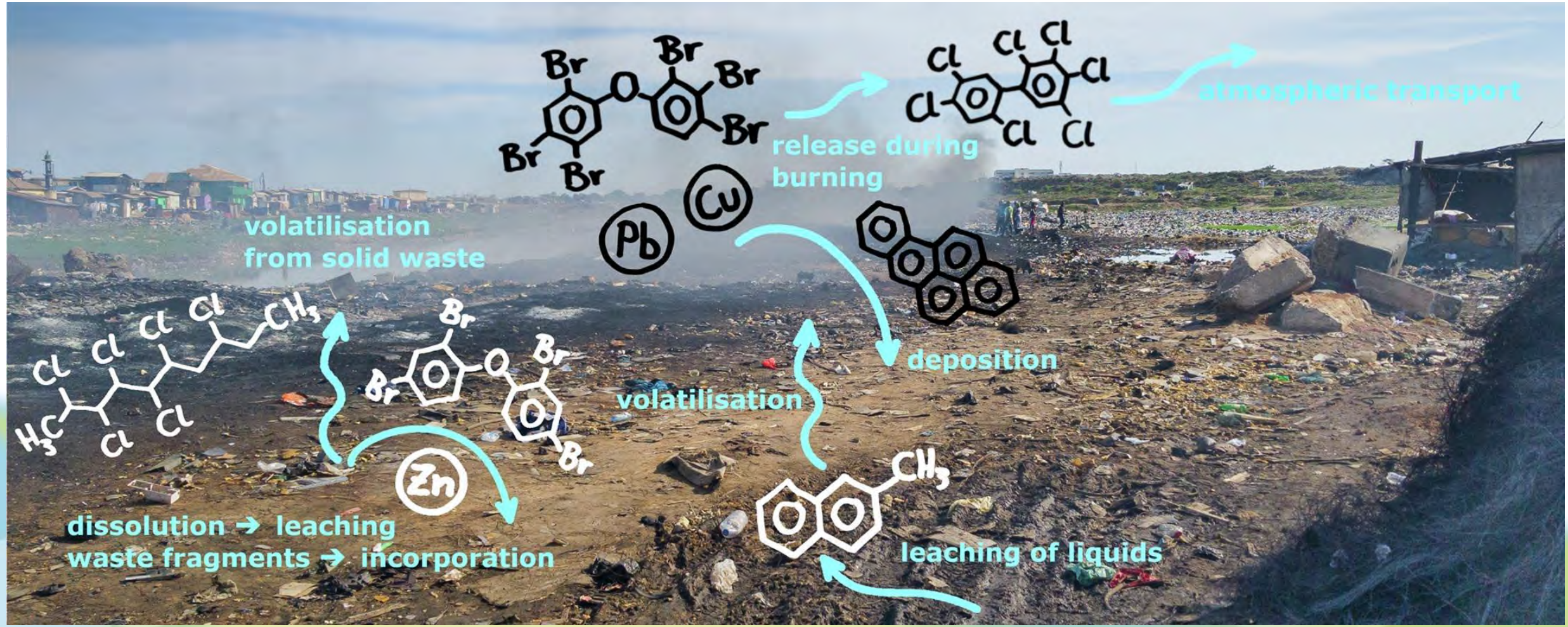
6. Small IT and Telecommunication equipment:
typical equipment includes mobile phones, Global Positioning System (GPS) devices, pocket calculators, routers, personal computers, printers, and telephones.

eWaste

- The Global E-Waste Monitor 2020 reports a record 59 ~~tons~~ MTonnes of e-waste, and predicts a rise to 81 ~~tons~~ Mtonnes by 2030.

- https://www.techrepublic.com/article/global-e-waste-is-up-21-in-5-years-causing-serious-environmental-harm/

eWaste


release during burning
atmospheric transport
volatilisation from solid waste
deposition
volatilisation
dissolution → leaching
waste fragments → incorporation
leaching of liquids

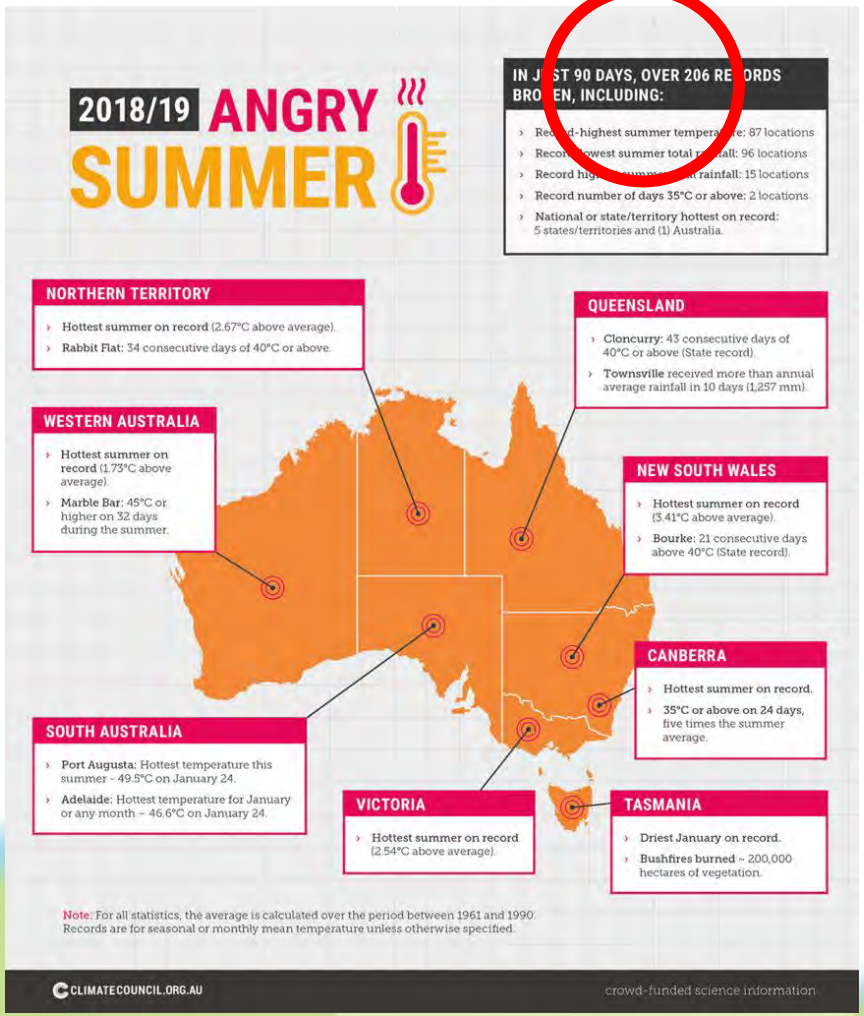
Background


90 DAYS:
123
RECORDS
BROKEN
AUSTRALIA
HOTTEST JANUARY
HOTTEST SUMMER
HOTTEST DAY
7 DAYS
35°C


HIGHLIGHTS
Summer 2019
PERIODICALLY WET
EDINBURGH
MILD
BELFAST
MANCHESTER
DROUGHT CONCERNS
CARDIFF
LONDON
AccuWeather


CHALLENGES AHEAD

Background



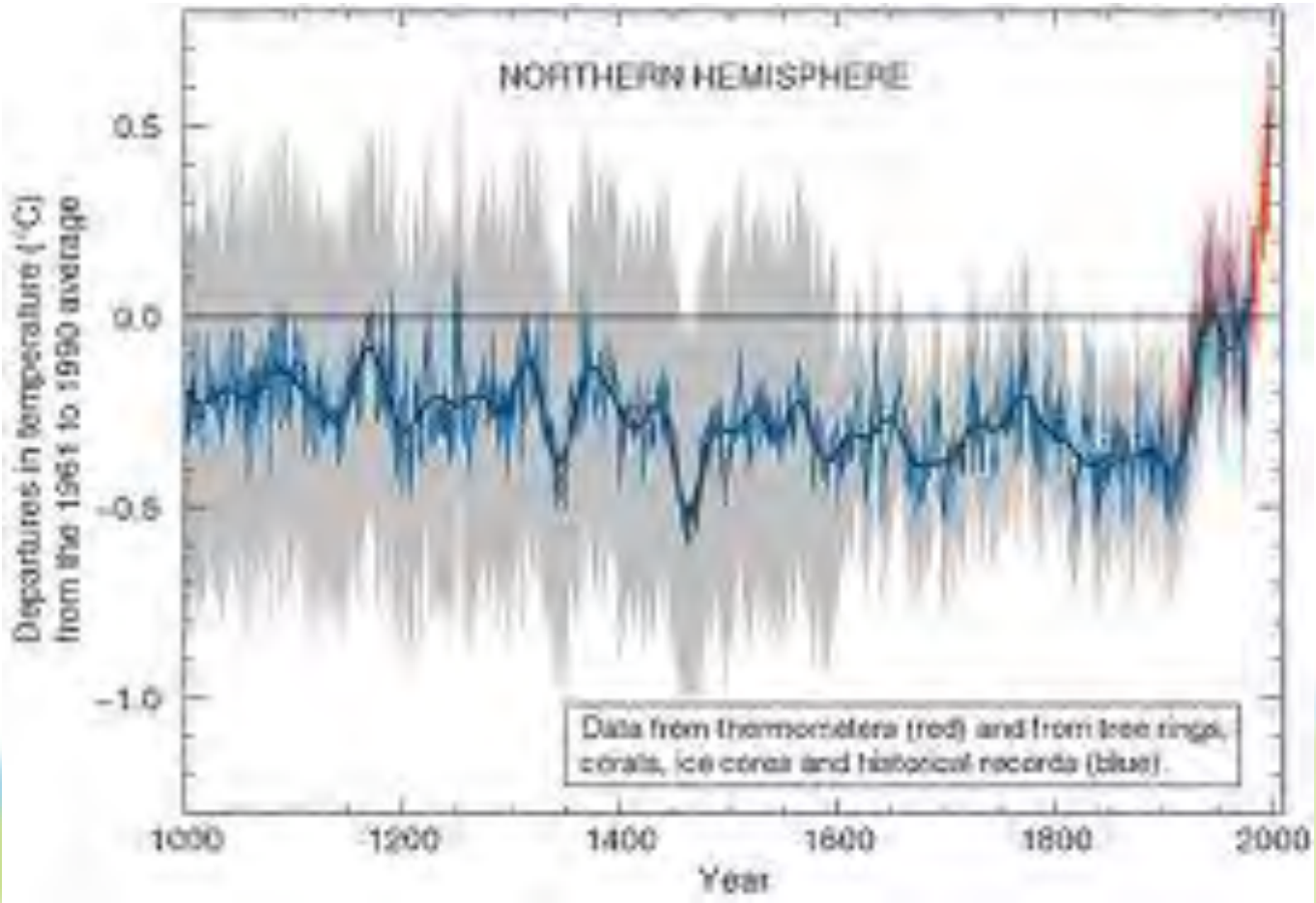
Source: Climate Council Australia
https://www.climatecouncil.org.au/resources/2018-19-angry-summer-infographic/
Accessed 04/02/2020

The Greenhouse Gases

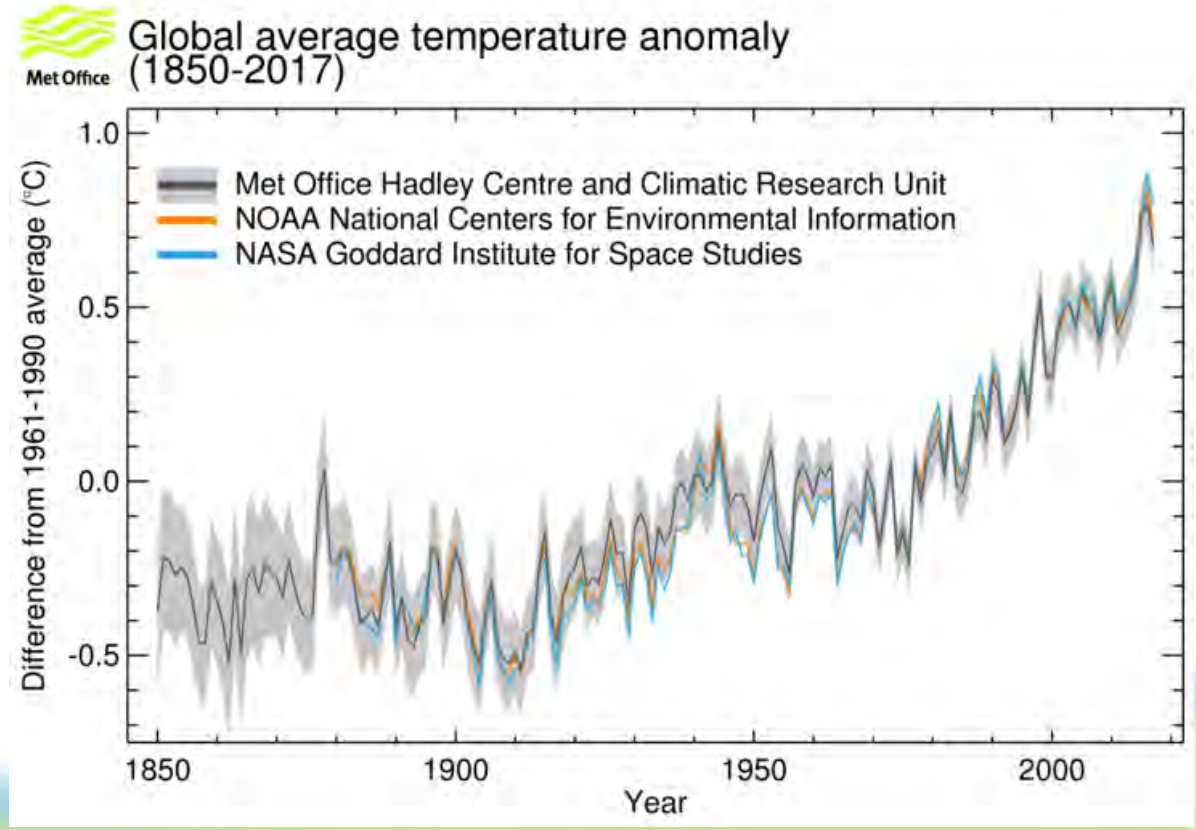
The Gases	DGWP* for 100 year horizon
Carbon Dioxide (CO2)	1
Methane (CH4)	25
Nitrous Oxide (N2O)	298
Hydrofluorocarbons (HFC's)	100-14,800 depending on gas
Perfluorocarbons (PFC's) gas	7390-12,200 depending on
Sulfur hexafluoride (SF6)	22,800

- Ref: P27, "Climate Change, From science to sustainability". Peake & Smith 2003
- Oxford University Press/Open University
- *Direct Global Warming Potential

The “Hockey Stick” Graph



Latest Aggregated Data Sets

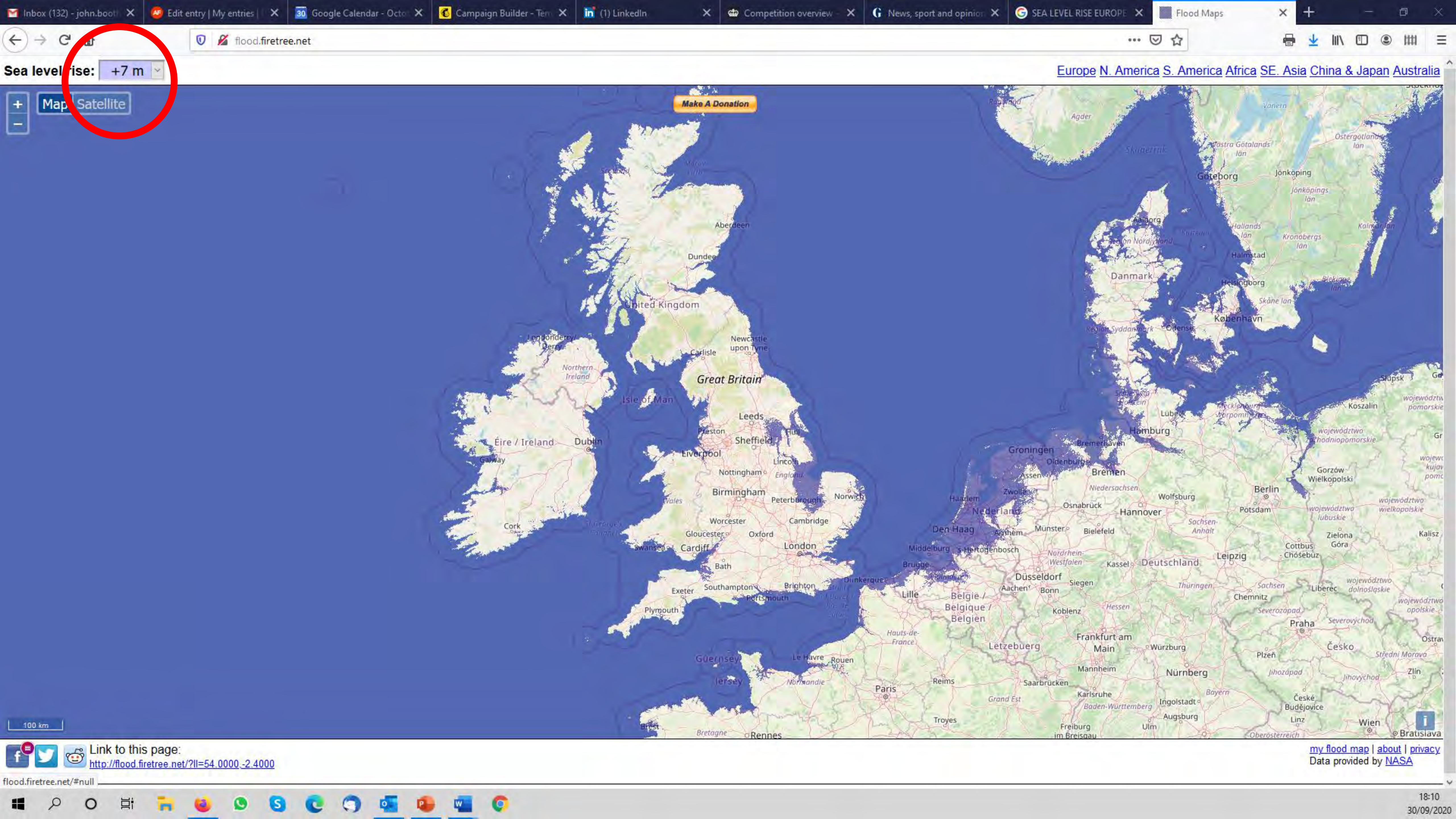


Climate Change Quotes

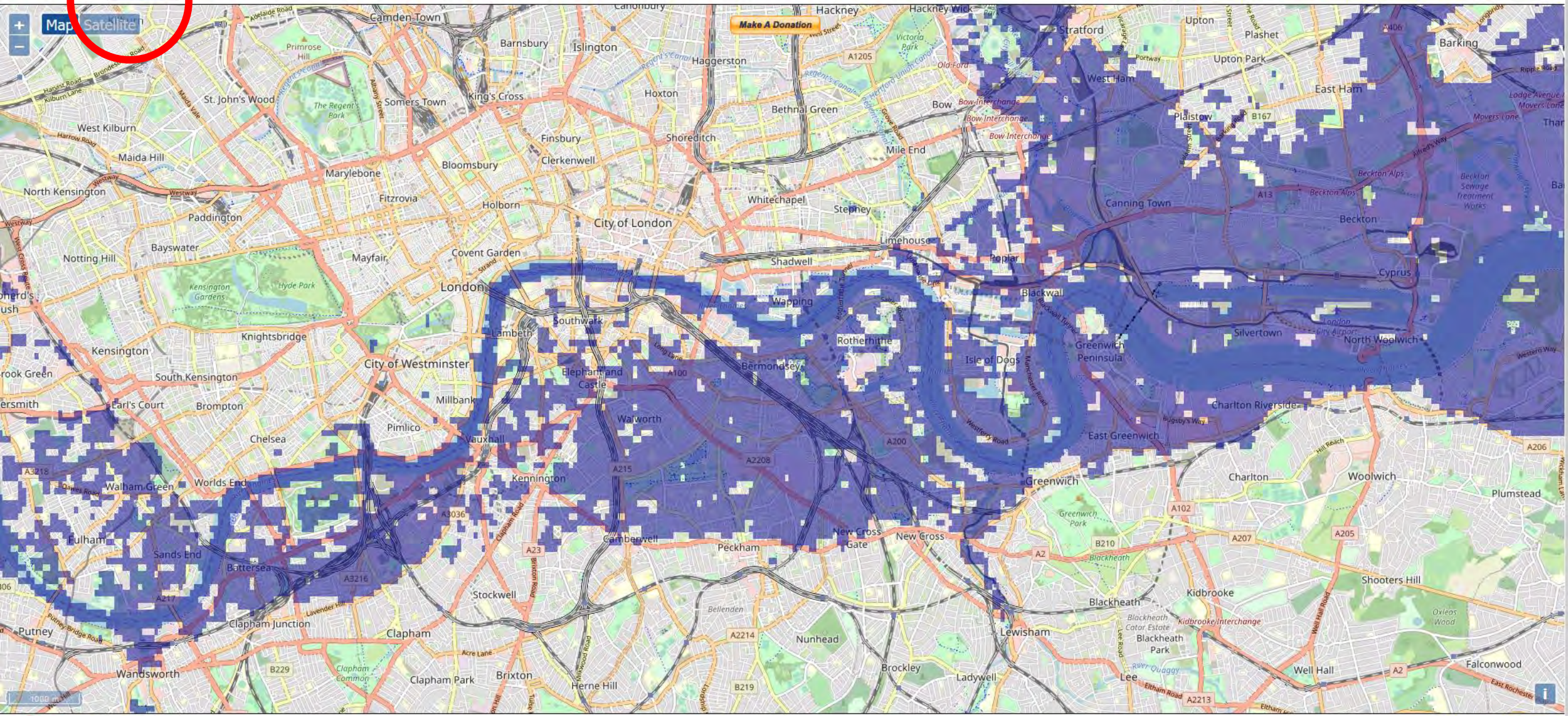
- *"On the island where I live, it is possible to throw a stone from one side to the other. Our fears about sea-level rise are very real. Our Cabinet has been exploring the possibility of buying land in a nearby country in case we become refugees of climate change".*
- **Teleke Lauti, Minister for the Environment, Tuvalu.**
- *"Climate change is the most severe problem we are facing today, more serious even than the threat of terrorism"*
- **David King, UK Government Chief Scientific Advisor, Jan 2004**.
- *"How could I look my grandchildren in the eye and say I knew about this and did nothing?*
- **David Attenborough, 2006.**

Doggerland!


Continental Europe above sea level
16,000 B.C.
8000 B.C.
7000 B.C.
Land area today
Ice sheet 16,000 B.C.
Ice sheet 16,000 B.C.
NORWAY
NORWEGIAN TRENCH
BRITISH ISLES
ATLANTIC OCEAN
DOGGERLAND
North Sea (today)
DENMARK
Tybrind Vig
Tweed
Howick
UNITED KINGDOM
DOGGER BANK (today)
IRELAND
Outer Silver Pit Lake
Wismar Bay
ENGLAND
WALES
Ouse
Goldcliff
Severn
London
Thames
NETHERLANDS
Rhine
BELGIUM
GERMANY
BRITTANY
Téviec Island
FRANCE
NORTH AMERICA
EUROPE
AREA ENLARGED



flood.firetree.net
Sea level rise: +7 m
Europe N. America S. America Africa SE. Asia China & Japan Australia
Map Satellite
Make A Donation
United Kingdom
Great Britain
Aberdeen
Dundee
Newcastle upon Tyne
Carlisle
Isle of Man
Leeds
Preston
Sheffield
Liverpool
Hull
Lincoln
Nottingham
Birmingham
Peterborough
Norwich
Cambridge
Worcester
Gloucester
Oxford
London
Cardiff
Swansea
Bath
Exeter
Southampton
Portsmouth
Brighton
Plymouth
Guernsey
Jersey
Northern Ireland
Londonderry/Derry
Éire / Ireland
Dublin
Galway
Cork
Danmark
København
Odense
Aalborg
Göteborg
Jönköping
Halmstad
Helsingborg
Hamburg
Lübeck
Bremerhaven
Bremen
Groningen
Oldenburg
Assen
Zwolle
Haarlem
Nederland
Den Haag
Arnhem
Middelburg
's-Hertogenbosch
Brugge
Dunkerque
Lille
Belgie / Belgique / Belgien
Düsseldorf
Aachen
Bonn
Osnabrück
Münster
Bielefeld
Hannover
Wolfsburg
Berlin
Potsdam
Deutschland
Leipzig
Kassel
Siegen
Koblenz
Chemnitz
Praha
Česko
Frankfurt am Main
Würzburg
Nürnberg
Mannheim
Letzebuerg
Saarbrücken
Karlsruhe
Ingolstadt
Augsburg
Plzeň
Paris
Reims
Rouen
Le Havre
Troyes
Rennes
Wien
Bratislava
Linz
Koszalin
Słupsk
Gorzów Wielkopolski
Zielona Góra
100 km
Link to this page:
http://flood.firetree.net/?ll=54.0000,-2.4000
my flood map | about | privacy
Data provided by NASA
18:10
30/09/2020

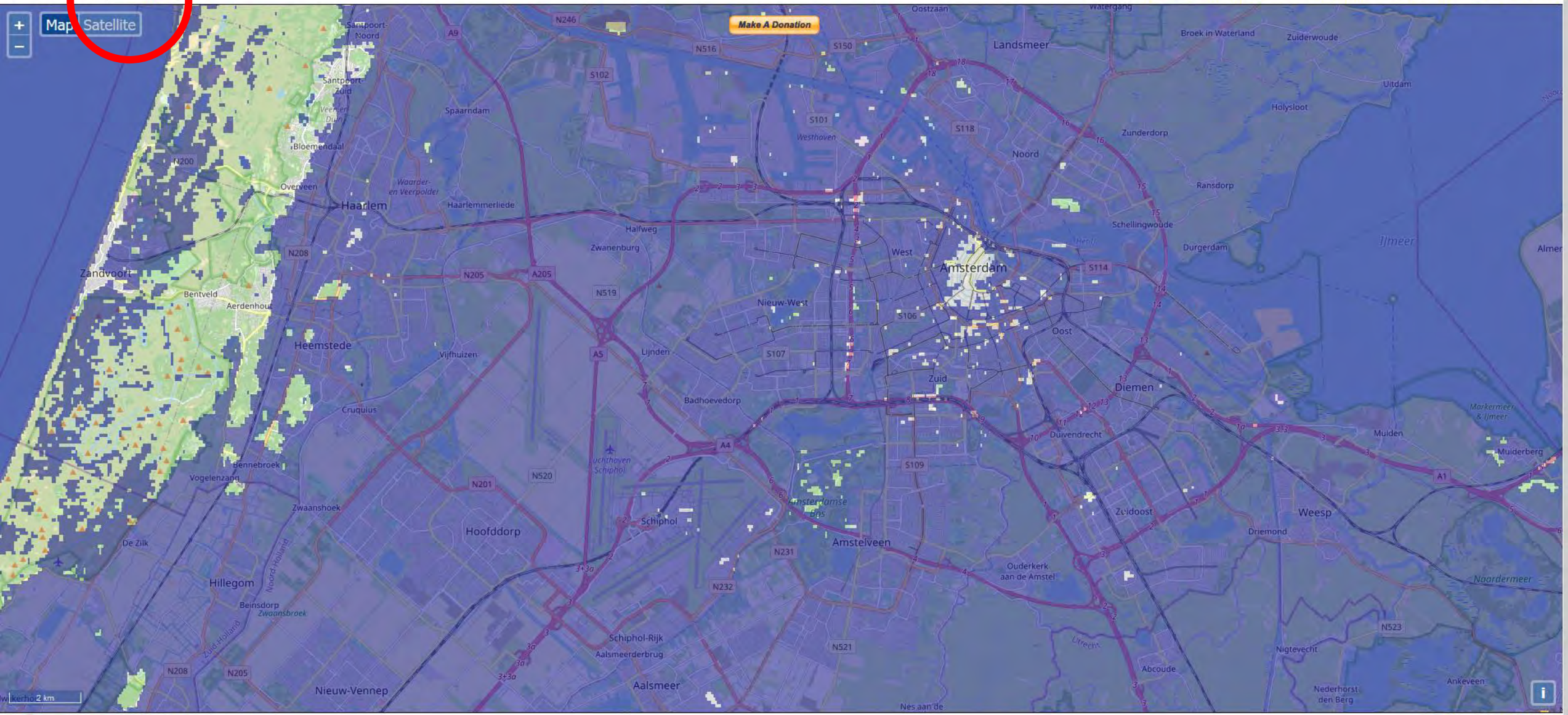


Link to this page:
http://flood.firetree.net/?ll=51.4980,-0.0608&zoom=13

my flood map | about | privacy
Data provided by NASA

18:32
30/09/2020

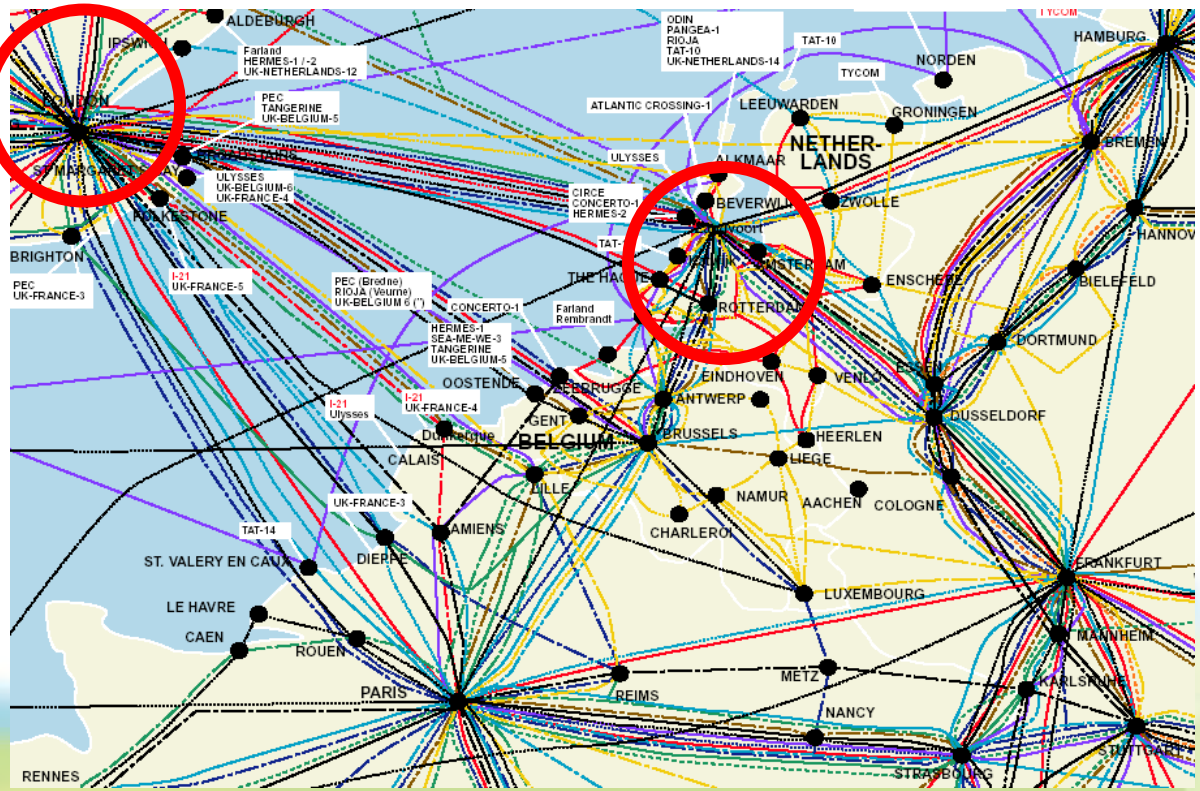
Sea level rise: +7 m



Link to this page:
http://flood.firetree.net/?ll=52.3494,4.8132&zoom=12

Sea level rise: +60 m

Network Connections – European Core



Energy!

Jaenschwalde (DE) (Lignite)

Grand Maison Dam (FR) (Pumped Storage)

Drax (UK) (Co-Fire Biomass/Coal)

Lubmin (DE) (Nuclear)

Borssele (NL) (Nuclear)

Centralised Generation

Local Generation

UK Grid Mix (Live)

- https://www.gridwatch.templar.co.uk/

templar.co.uk

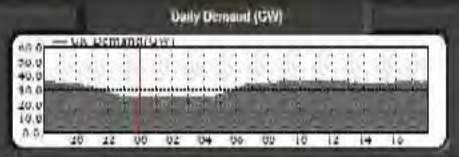
Amazon.co.uk eBay Facebook YouTube Google

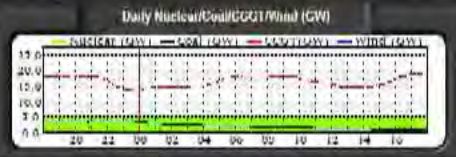
Donate Download Links Info Stats

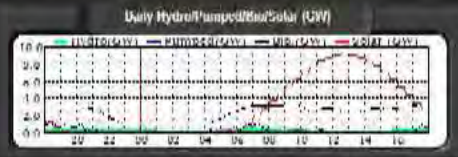
G.B. National Grid Status

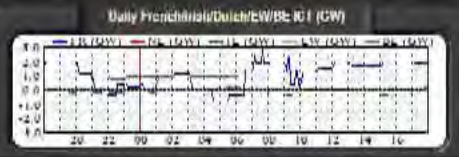
Data courtesy of Elexon portal and Sheffield University

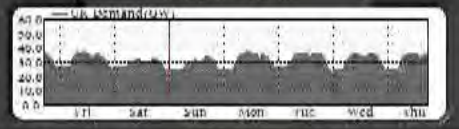
Demand 35.78GW | Frequency 50.064Hz | CCGT 19.65GW (54.91%) | Nuclear 4.61GW (12.88%) | Biomass 2.95GW (8.24%) | Wind 0.76GW (2.12%)

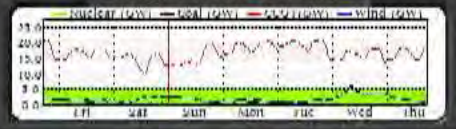


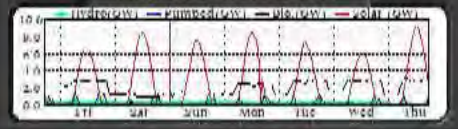


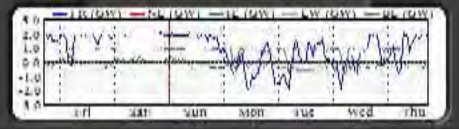


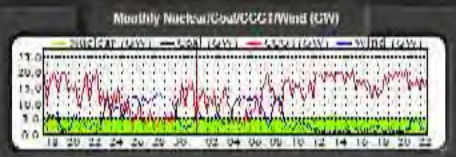


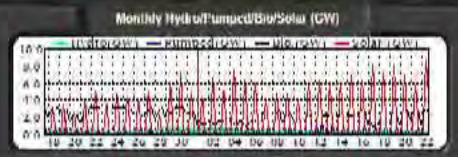


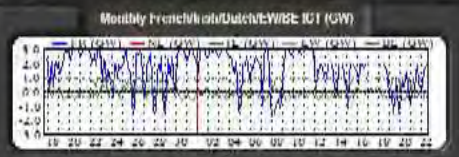


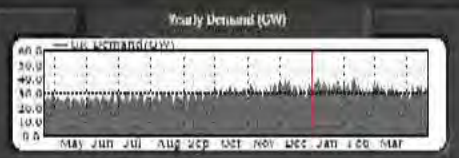


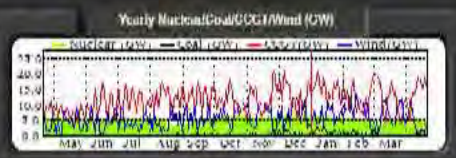


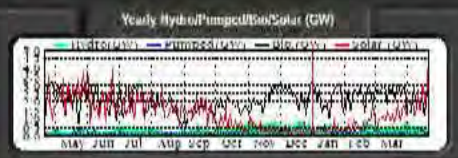


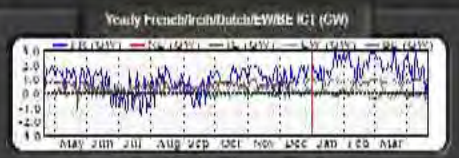








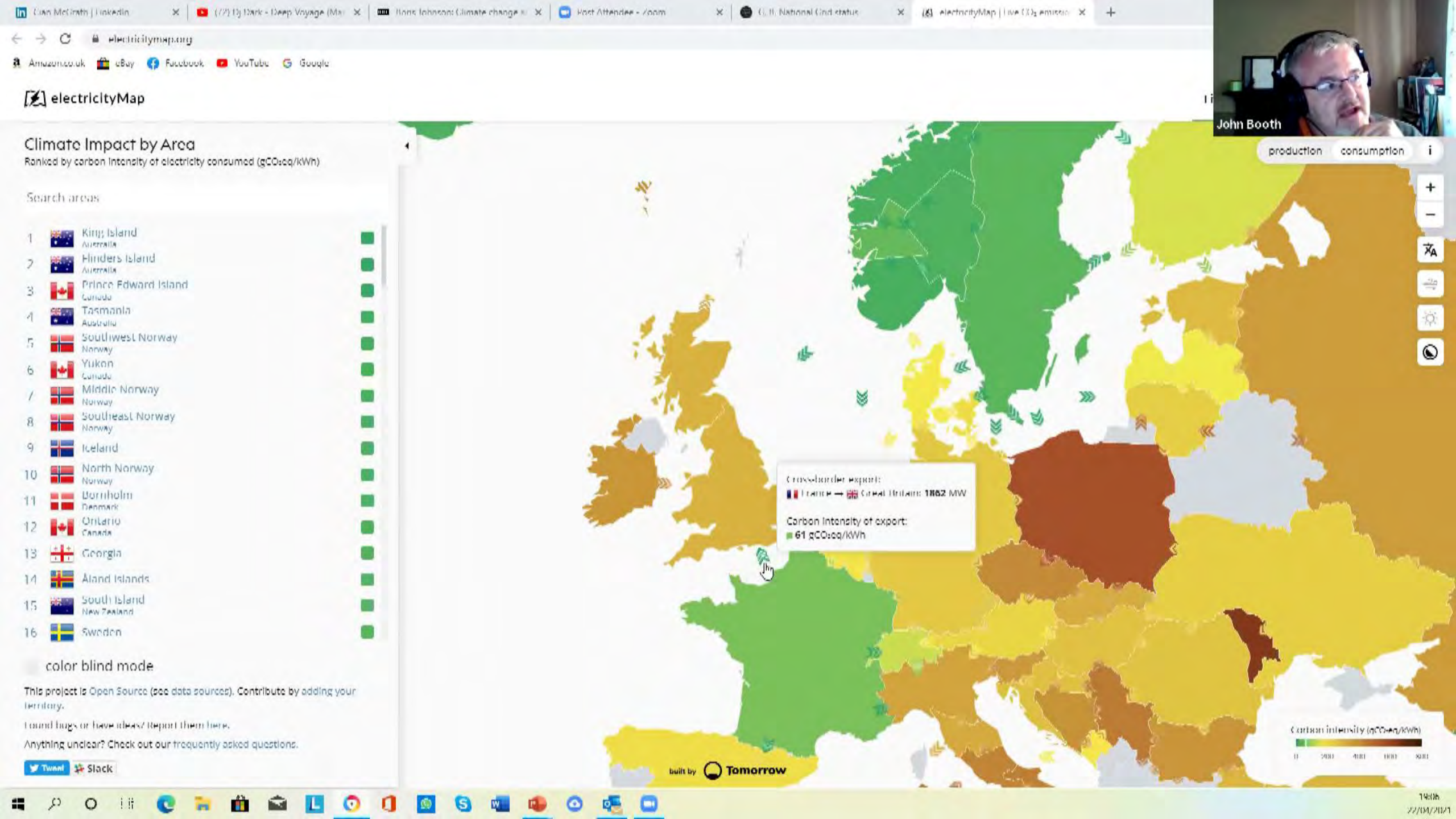




Data last recorded on Thursday the 22nd. of April, 2021 at 19:00 BST

Europe Cross Borders Energy Flows (Live)

- https://www.electricitymap.org/?page=map&solar=false&remote=true&wind=false


electricitymap.org
electricityMap
John Booth
Climate Impact by Area
Ranked by carbon intensity of electricity consumed (gCO2eq/kWh)
Search areas
1 King Island Australia
2 Flinders Island Australia
3 Prince Edward Island Canada
4 Tasmania Australia
5 Southwest Norway Norway
6 Yukon Canada
7 Middle Norway Norway
8 Southeast Norway Norway
9 Iceland
10 North Norway Norway
11 Bornholm Denmark
12 Ontario Canada
13 Georgia
14 Aland Islands
15 South Island New Zealand
16 Sweden
color blind mode
This project is Open Source (see data sources). Contribute by adding your territory.
Found bugs or have ideas? Report them here.
Anything unclear? Check out our frequently asked questions.
Twant
Slack
production
consumption
Cross-border export:
France → Great Britain: 1862 MW
Carbon intensity of export:
61 gCO2eq/kWh
Carbon intensity (gCO2eq/kWh)
built by Tomorrow

But…

- 7GW Coal Decommissioned by 2024
- 7GW Nuclear Decommissioned by 2023

- There is a looming “Energy Gap”

Net Zero!

- The UK's 2050 net zero target — one of the most ambitious in the world — was recommended by the Committee on Climate Change, the UK's independent climate advisory body. Net zero means any emissions would be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture and storage

CCC Progress Report
July 2019

- Climate change adaptation is a defining challenge for every government, yet there is only *limited evidence* of the *present UK Government*# taking it *sufficiently seriously.*

- # Previous “hung” parliament

- Ref: https://www.theccc.org.uk/wp-content/uploads/2019/07/2019-Progress-Report-Summary.pdf

CCC Progress Report
July 2019

- It is time to act. Next year may see the UK host the most important global climate summit since Paris in 2015. Our credibility in the COP26 Presidency rests on real action at home.
- The Adaptation and Mitigation Committees have reviewed the UK Government's approach to climate change adaptation and emissions reduction. Our reports are published in parallel, as required under the Climate Change Act.

- We find a substantial gap between current plans and future requirements and an even greater shortfall in action.

Data Centres

- Climate Issues
- Energy Issues
- Net Zero!

Data Centre Energy Demands – Global

- Assessing implications of growing demand for data centers requires robust understanding of the scale and drivers of global data center energy use that has eluded many policy-makers and energy analysts.
- The reason for this blind spot is a historical lack of “bottom-up” information on data center types and locations, their information technology (IT) equipment, and their energy efficiency trends.
- This has led to a sporadic and often contradictory literature on global data center energy use.

- Ref: https://science.sciencemag.org/content/367/6481/984.full

Data Centre Energy Demands – Global

- 1% of Total Global Energy
- 2% of Total Global Energy
- 3% of Total Global Energy

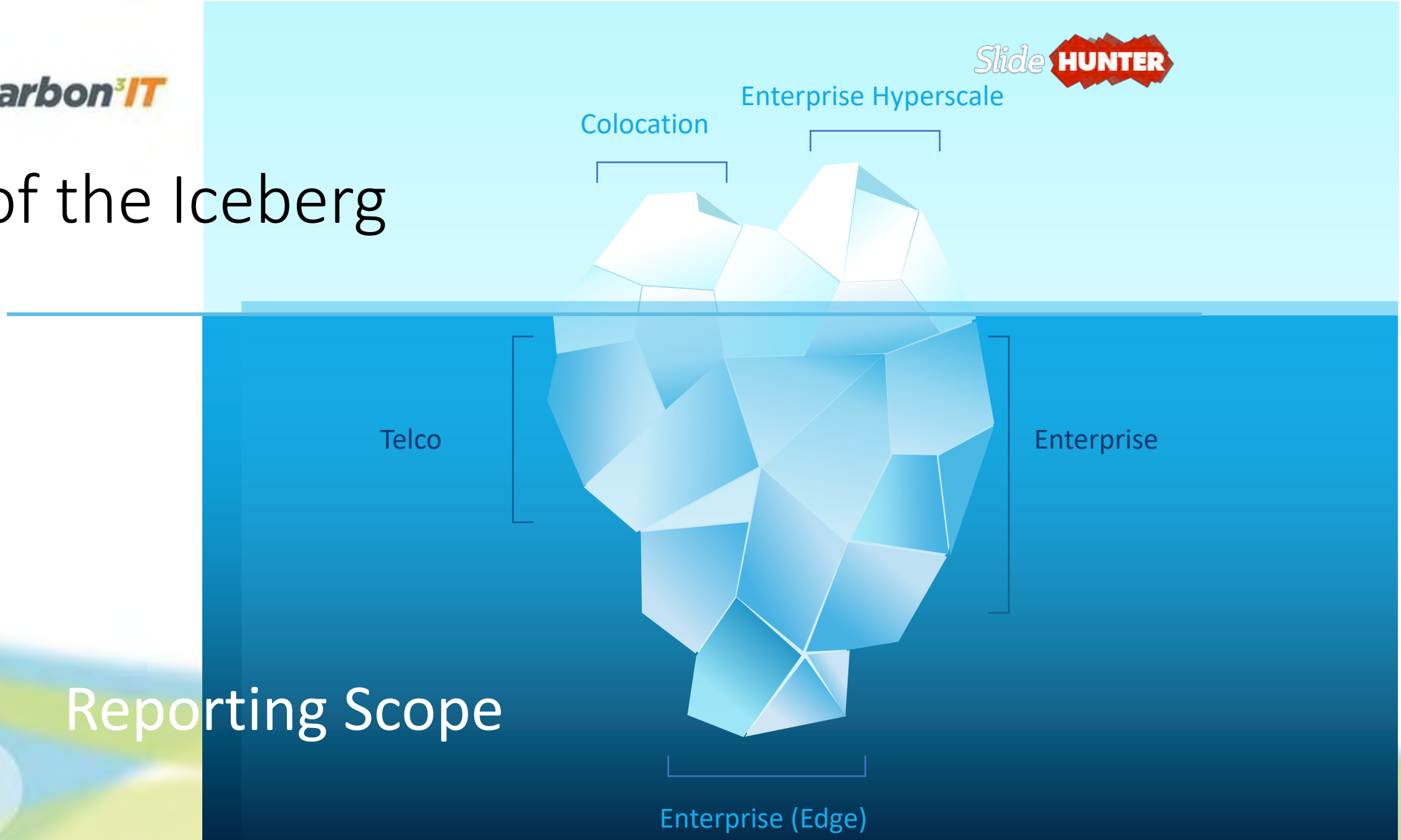
Data Centre Energy Demands – Global Estimates & Forecasts

- 2010
- 153TWh 2005 (Estimated)
- 203-273TWh 2010 1.1-1.5% Global Energy Use (Estimated)

- 2018
- 205TWh 1% Global Energy Use (2010-194TWh)

- Ref: https://science.sciencemag.org/content/367/6481/984.full

Tip of the Iceberg



Reporting Scope

Data Centre Energy Demands - UK

- We don't really know!

- What we do know is that the commercial data centre sector, i.e. Colocation in the CCA 2nd Period (3rd is due!) Published in September 2017

- 2.579TWh

Data Centre Energy Demands - UK

- Or..
- 0.76% of Total UK Generation
- 339TWh
- Which is
- 0.285% of Primary Energy
- 2339TWh

- Ref: http://www.techuk.org/images/CCA_Second_Target_Report_04.pdf

Data Centre Energy Demands - UK

- Excludes BT (3rd in CRC tables)
- Excludes All Private Data Centres/Server Rooms!

Data Centre Energy Demands – UK
Carbon3IT Research 2017

- Based upon 80,000 DCs, Server Rooms, etc
- Average Energy Cost £57K
- Total 38.54TWh
- Add CCA – 2.579TWh
- = 41.11TWh
- 12.13% of UK Generation

Data Centre Energy Demands – EU

2007 •56TWh

2020

•104TWh

A problem for environmental policy makers
A problem for the energy bill payer
A compelling motive to optimise energy efficiency

Data Centre Energy Demands – Recommendations

- Policy Support – Energy Efficiency Standards IT Equipment
- Investment in New Technologies
- Public Data and Modelling

- Global data center energy use is entering a critical transition phase; to ensure a low-carbon and energy-efficient future, we cannot wait another decade for the next reliable bottom-up estimates.

- Ref: https://science.sciencemag.org/content/367/6481/984.full

Whilst…

- The EU has ambitious plans and has begun preparing policy and other instruments to create the….

- EU Green Deal

EU Green Deal – Data Centres

- On the 11th December 2019…

- "At the same time, Europe needs a digital sector that puts sustainability at its heart. The Commission will also consider measures to improve the energy efficiency and circular economy performance of the sector itself, from broadband networks to data centres and ICT devices"

EU Green Deal – Data Centres

- On the 19th February 2020…
- "Data centres and telecommunications will need to become more energy efficient, reuse waste energy, and use more renewable energy sources."
- "They can and should become climate neutral by 2030."

EU Data Centres Energy

- Lack of credible data

- EUCOC Data (2017) INDICATES 289 DC's consumed 3.7 TWh
- UK (CCA) 2.579 TWh

- Hmmmm, that's means that EU data centres = 1.21 TWh ?

EU
Climate Neutral Data Centre Pact

EU
Code of Conduct for Data Centres (Energy Efficiency)

Things to Consider - Devices

- Thin Clients
  - Desktop Energy Reduction
  - Increased Data Centre/Server Energy Use
- Laptops
- Personal Printers – MFD Printers
- Printer Software
- ECO-Fonts
- Use GPOs to put devices in standby (Automatically)
- TCO Documents for Procurement

Things to Consider - Networks

- Use Switch Energy Management features
- Auto

Things to Consider – Data Centre

- Become EUCOC Participant or Endorser
- CEEDA Assessment
- Calculate DC KPIs (ISO 30134 Series)

Things to Consider – Cloud

- Use EUCOC Participants
- Use Climate Neutral Data Centre Pact Signatories
- Ask for Environmental Data
- Ask them to undertake CEEDA

Things to Consider – General

- Green IT Policy/Strategy
- Green IT Champions
- Procurement
- Renewable Energy

- External Assessment
- Expert Guidance
- Carbon 3IT Green IT Course

Things to Consider – BCS

- Join BCS Green IT SG
- Actions Pending…

Questions & Answers

Thank You

JOHN.BOOTH@CARBON3IT.COM

WWW.CARBON3IT.COM

@CARBON3IT Twitter/Skype