



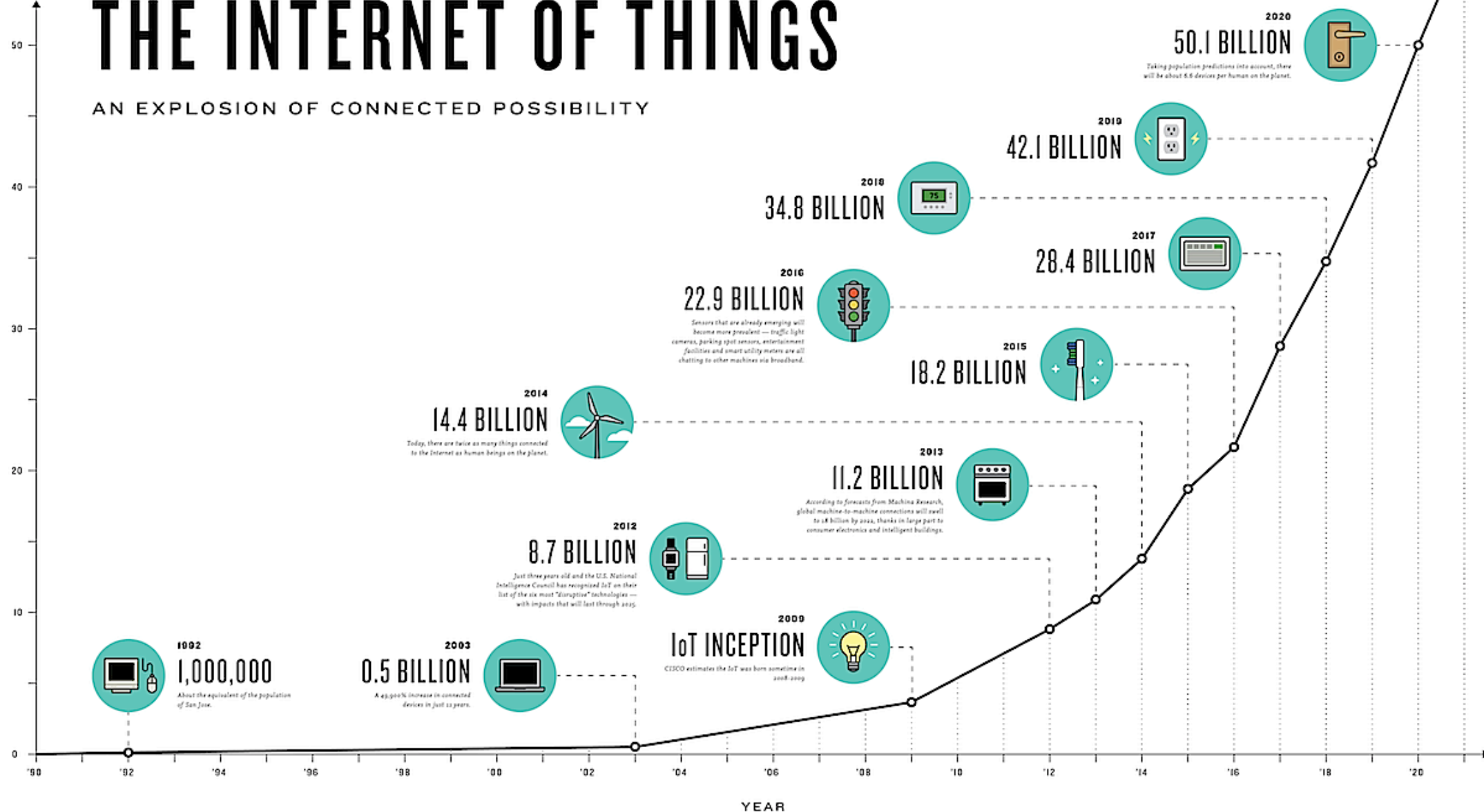
# IoT and Sustainability

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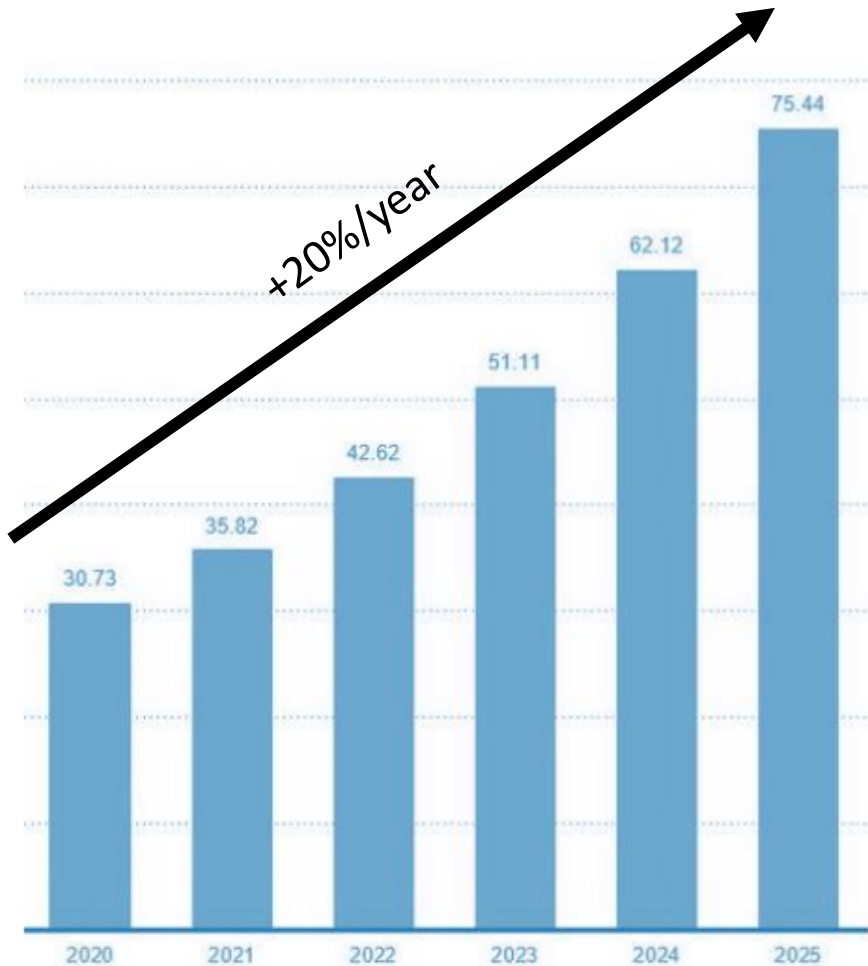
# THE INTERNET OF THINGS

AN EXPLOSION OF CONNECTED POSSIBILITY

BILLIONS OF DEVICES



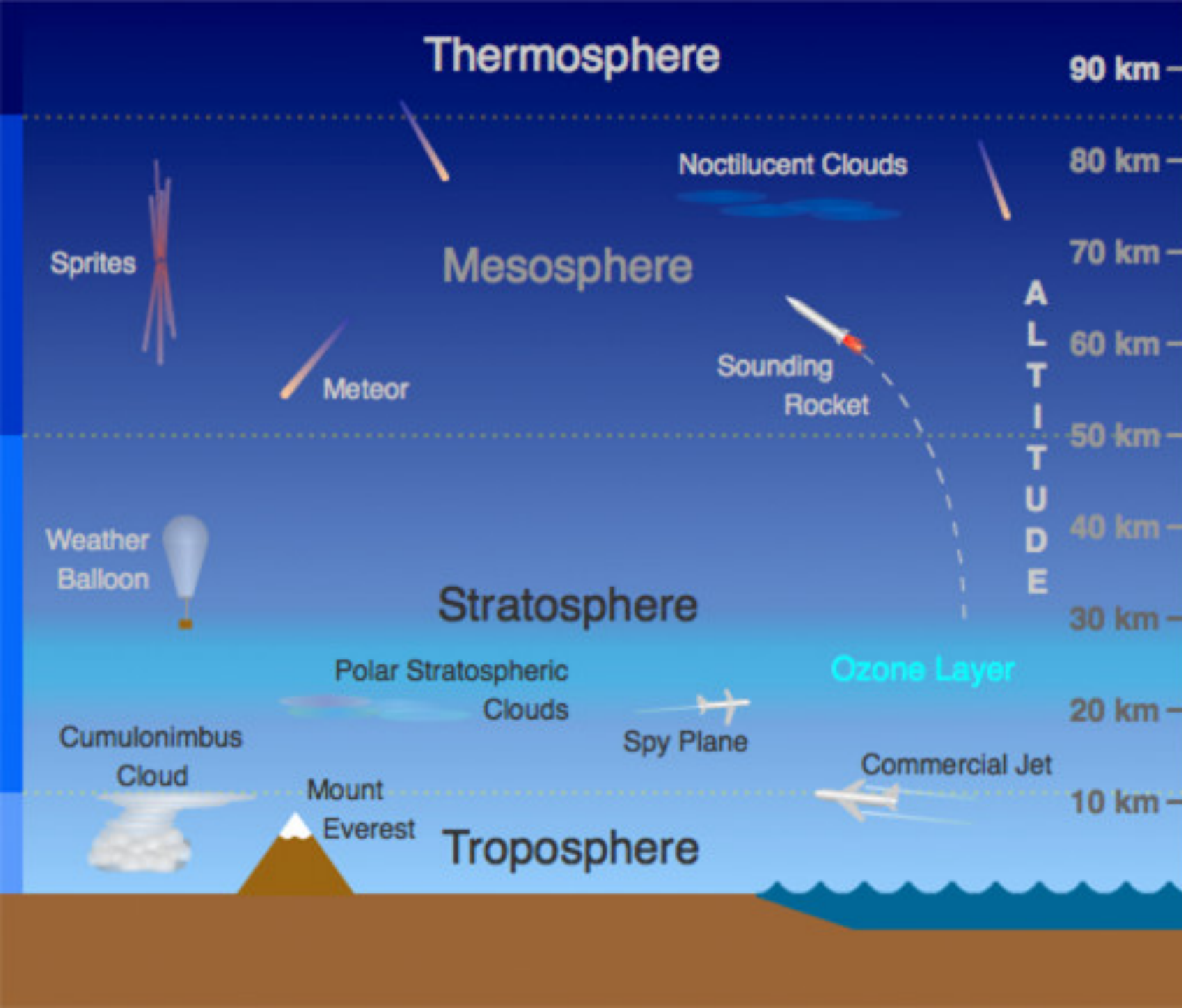
## IoT-devices (in bn):



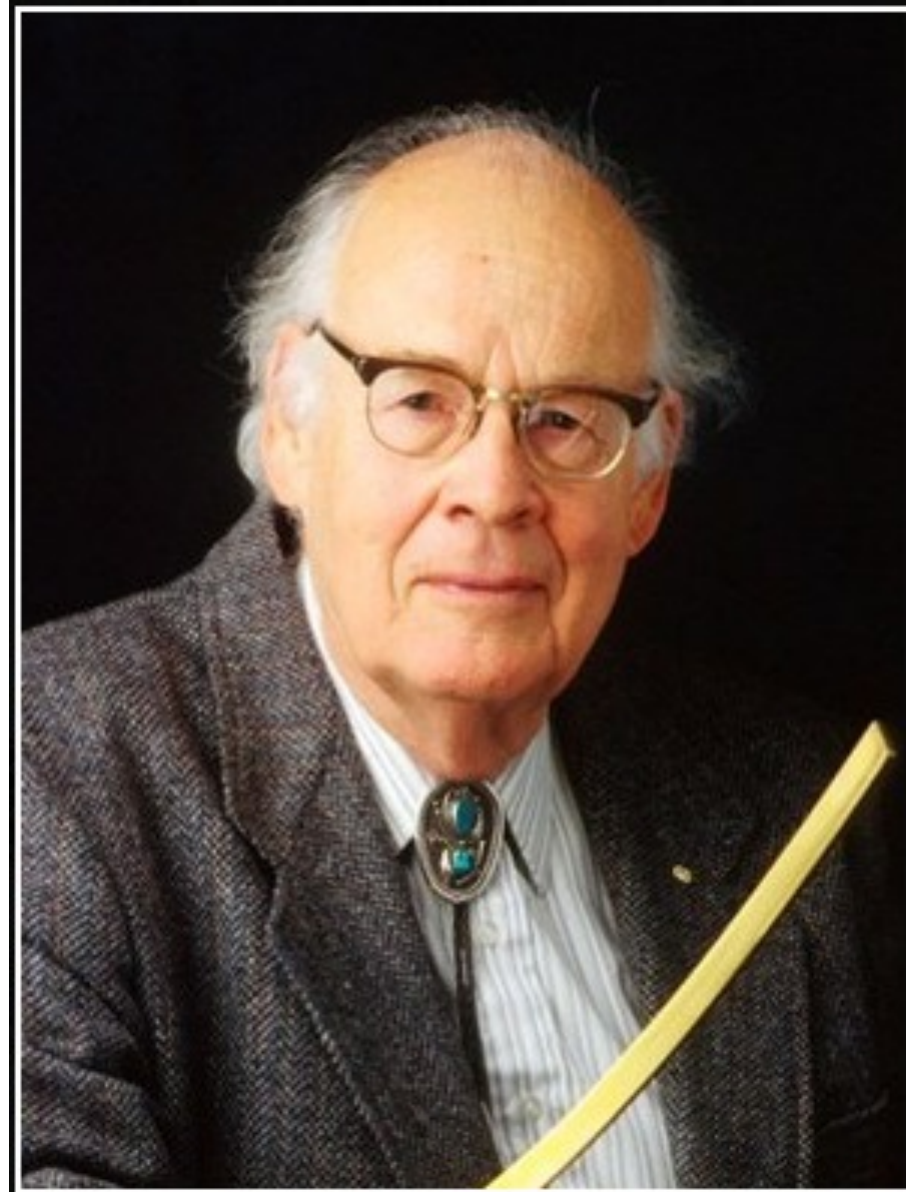
In 2016, Masayoshi Son, the CEO of SoftBank Group Corp., predicted that in the next 20 years there will be a trillion connected devices in the world and orbiting the planet.

125 devices per column x  
4 columns per page x  
2 pages per sheet  
= 1000 devices per sheet

1 trillion devices  
= 1 billion sheets  
= area of Manhattan  
= telephone directory of 100 km thick



Human scale vs terrascale



The greatest shortcoming of the  
human race is our inability to  
understand the exponential  
function.

— *Albert Allen Bartlett* —

**AZ** QUOTES

[Exponential Growth Arithmetic, Population and Energy, Dr. Albert A. Bartlett - YouTube](#)

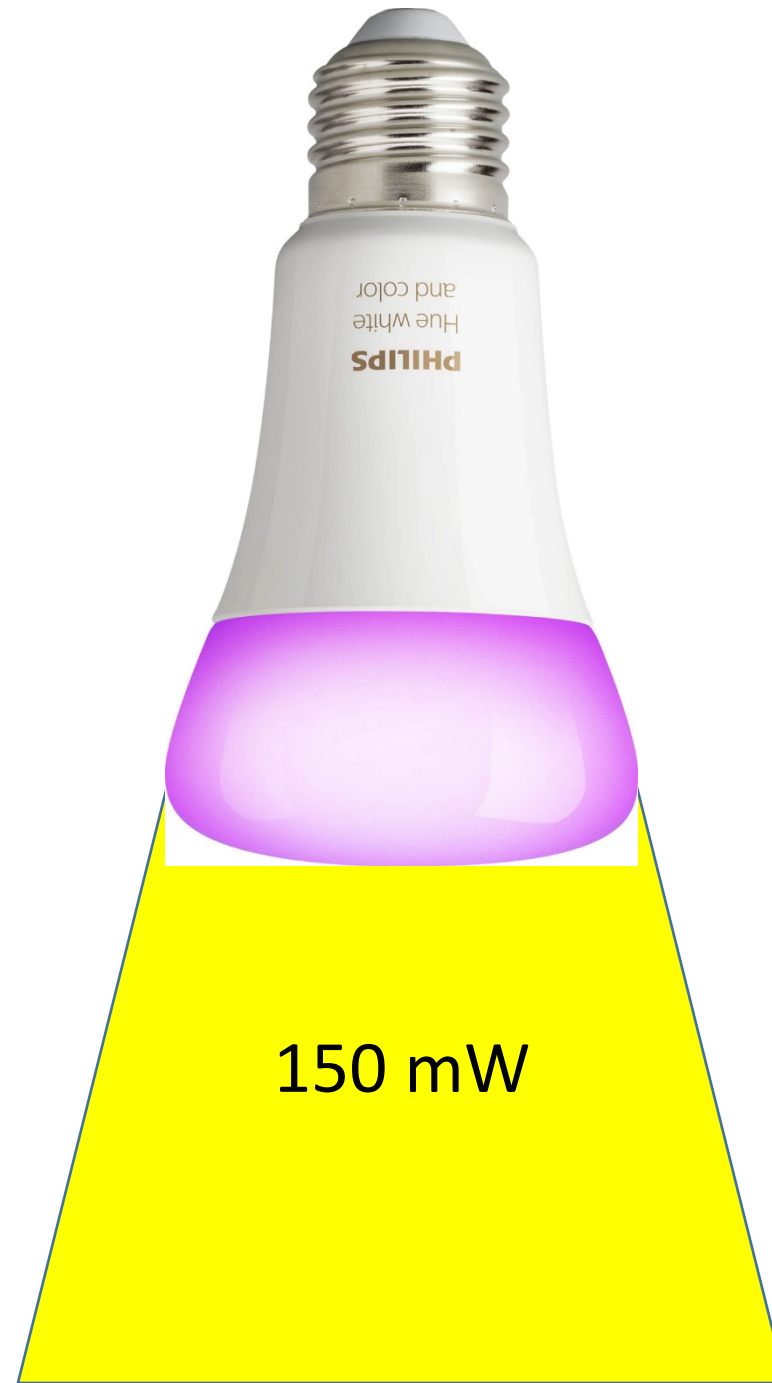
# Standby power

Device	Power
Charger in socket	20 mW
Television off by remote	300 mW
Display sleep mode	370 mW
Notebook off	470 mW
Notebook sleep mode	820 mW
Radio	970 mW
Microwave	1400 mW
Timer	1500 mW
Garage door opener	1800 mW
Set top box, off by remote	13240mW
Cable modem standby	3590 mW

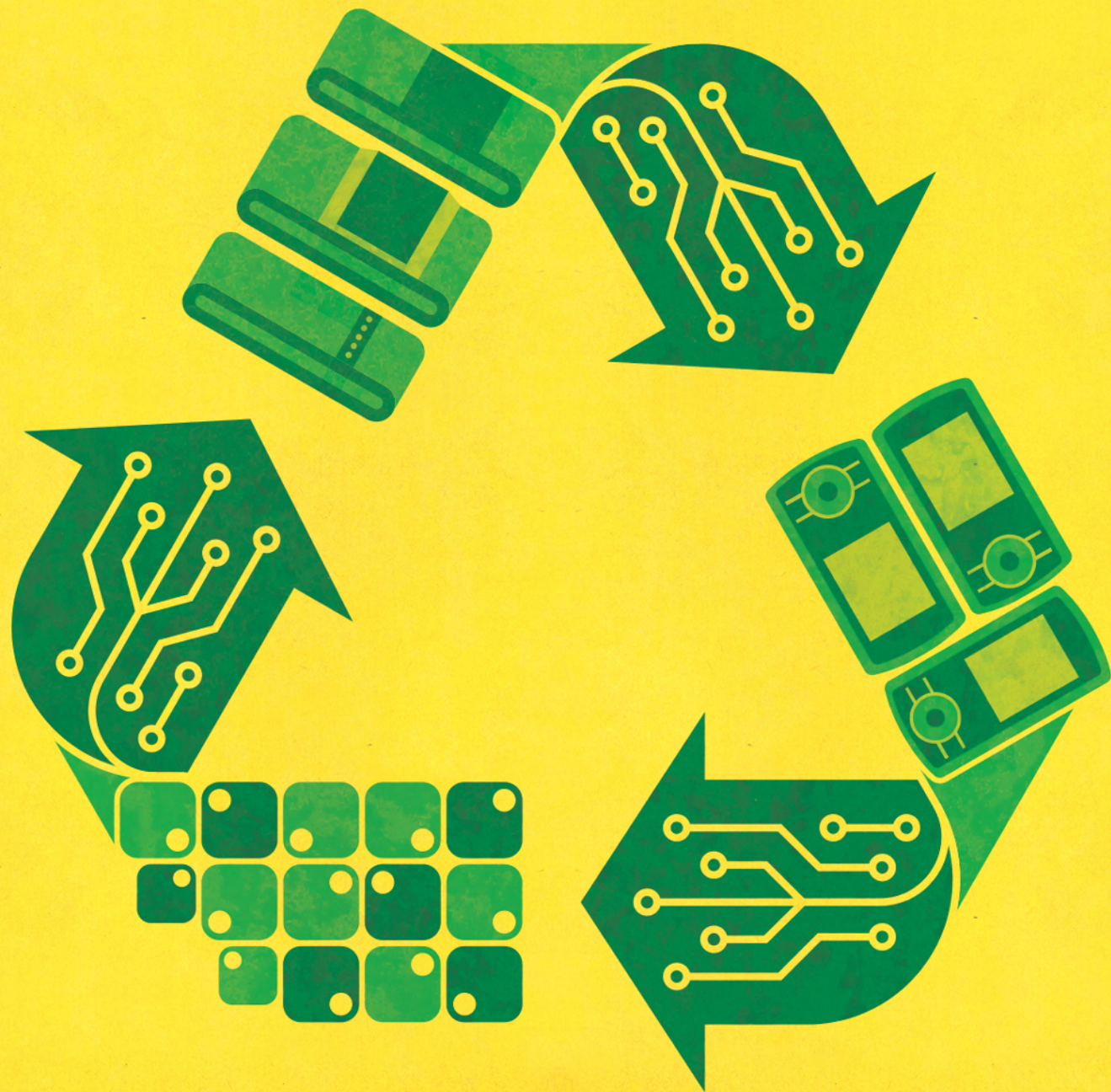
[Standby Power Summary Table » Standby Power \(lbl.gov\)](#)

1 mW x 1 trillion = 1 GW





150 mW



17 May 2018 | 19:00 GMT

# The Internet of Trash: IoT Has a Looming E-Waste Problem

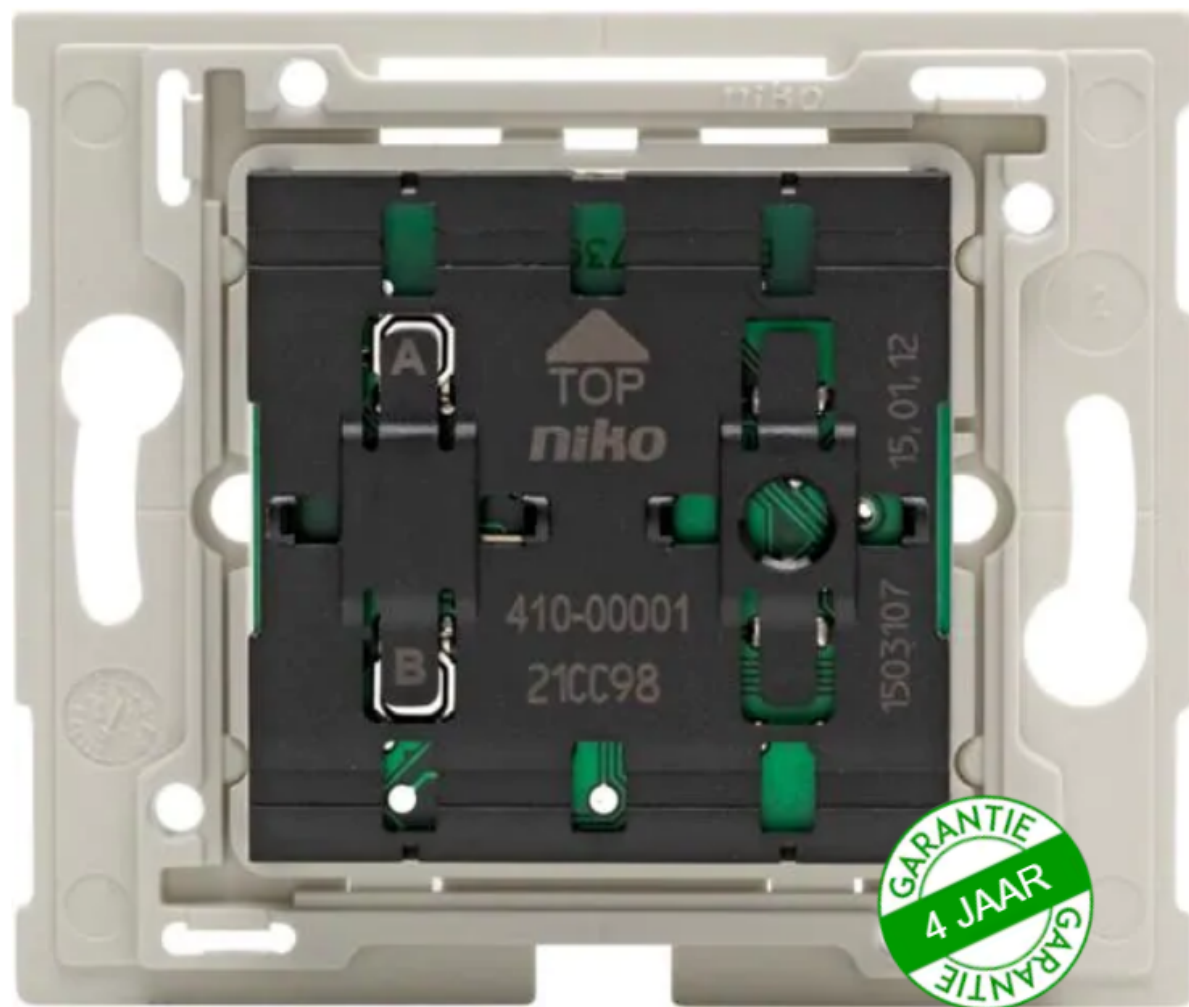
A lack of forethought will leave us with a mountain of obsolete devices and no way to dispose of them

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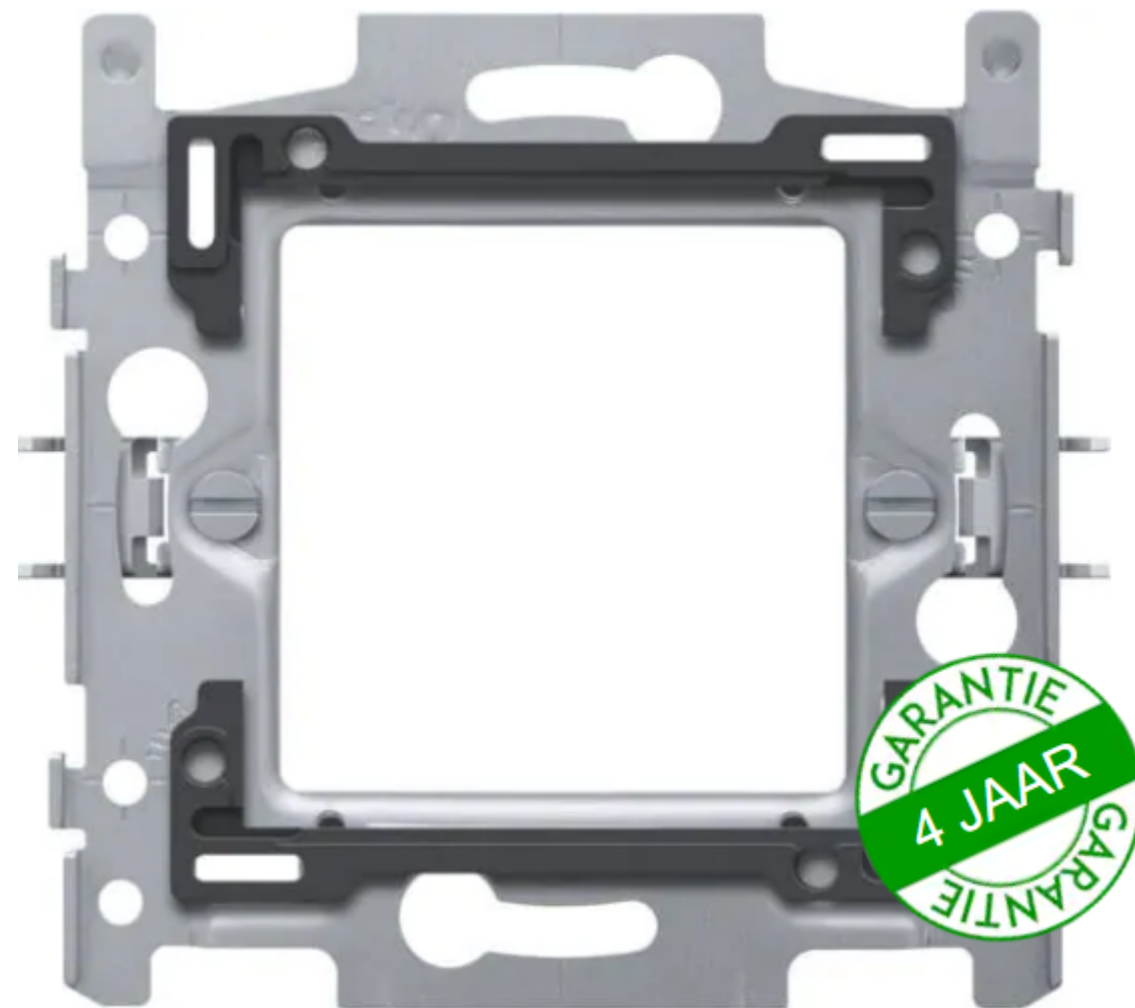
By **Stacey Higginbotham**

The United Nations found that people generated 44.7 million metric tons of e-waste globally in 2016, and expects that to grow to 52.2 million metric tons by 2021.

We're adding semiconductors to products that previously had none, and we're also shortening the life of devices as we add more computing, turning products that might last 15 years into ones that must be replaced every five years.

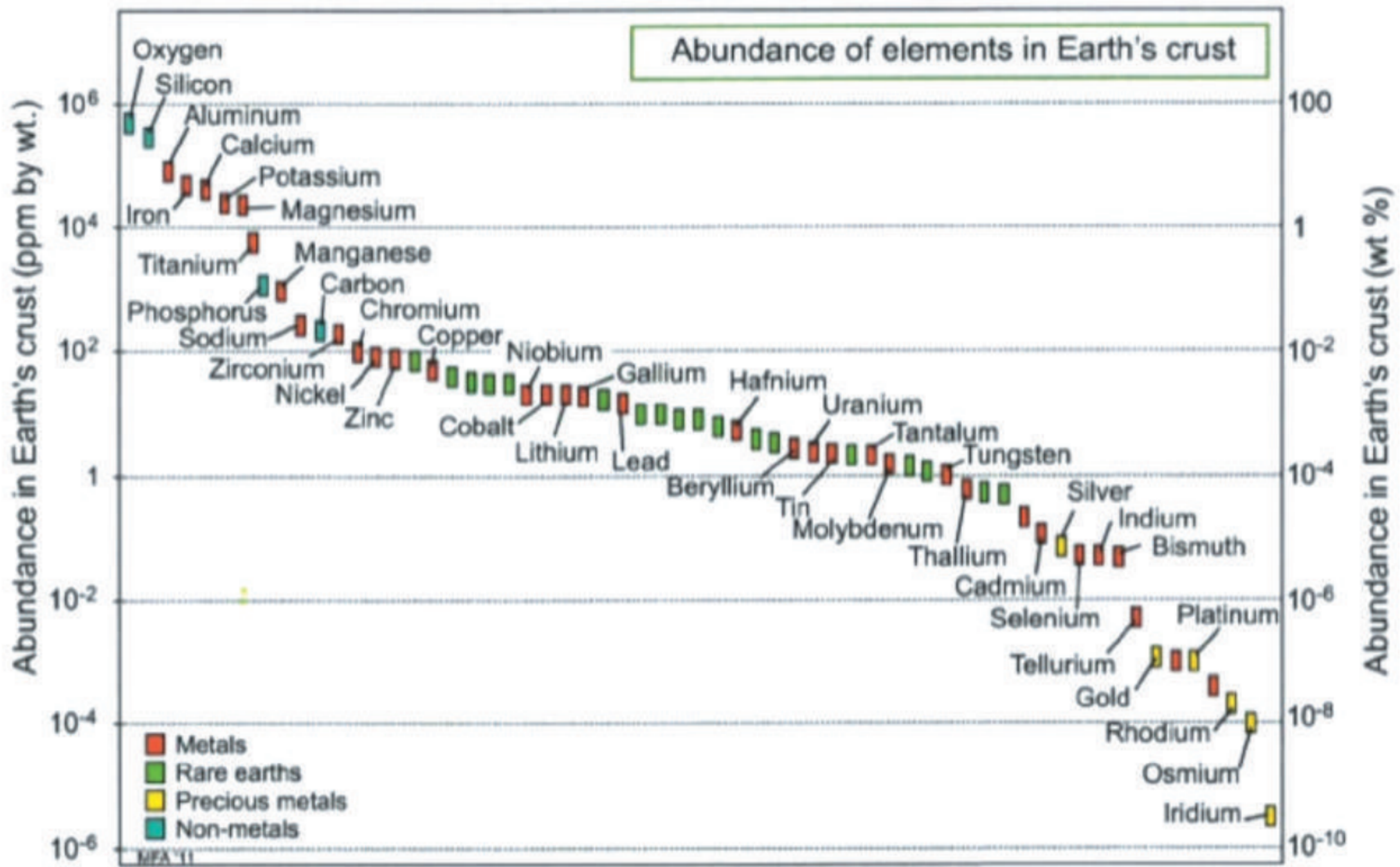


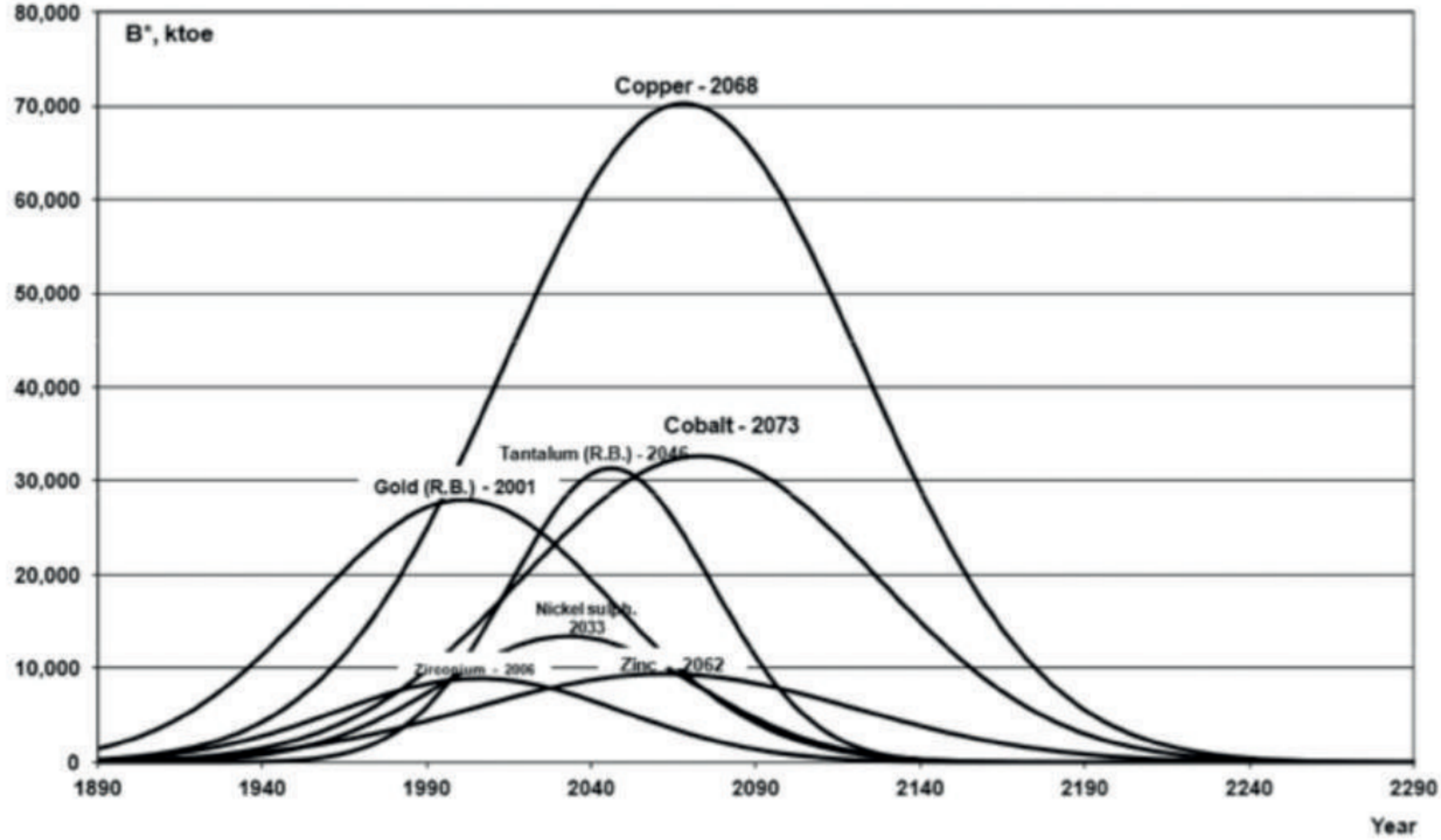
€ 43,04



€ 1,37

	I	II											III	IV	V	VI	VII	O												
1	hydrogen 1 <b>H</b> 1.00794(7)		1980s																helium 2 <b>He</b> 4.002602(2)											
2	lithium 3 <b>Li</b> 6.941(1)	beryllium 4 <b>Be</b> 9.0121831(2)	1990s										boron 5 <b>B</b> 10.811(7)	carbon 6 <b>C</b> 12.0109(8)	nitrogen 7 <b>N</b> 14.00643(4)	oxygen 8 <b>O</b> 15.999(4)	fluorine 9 <b>F</b> 18.9984032(5)	neon 10 <b>Ne</b> 20.1797(6)												
3	sodium 11 <b>Na</b> 22.98976928(2)	magnesium 12 <b>Mg</b> 24.304(6)	2000s										aluminum 13 <b>Al</b> 26.9815385(3)	silicon 14 <b>Si</b> 28.0855(3)	phosphorus 15 <b>P</b> 30.97376199(5)	sulfur 16 <b>S</b> 32.06(5)	chlorine 17 <b>Cl</b> 35.45(3)	argon 18 <b>Ar</b> 39.948(1)												
4	potassium 19 <b>K</b> 39.0983(1)	calcium 20 <b>Ca</b> 40.078(4)	scandium 21 <b>Sc</b> 44.955912(2)	titanium 22 <b>Ti</b> 47.867(1)	vanadium 23 <b>V</b> 50.9415(2)	chromium 24 <b>Cr</b> 51.9961(6)	manganese 25 <b>Mn</b> 54.938044(3)	iron 26 <b>Fe</b> 55.845(2)	cobalt 27 <b>Co</b> 58.933194(5)	nickel 28 <b>Ni</b> 58.6934(4)	copper 29 <b>Cu</b> 63.546(3)	zinc 30 <b>Zn</b> 65.38(2)	gallium 31 <b>Ga</b> 69.723(1)	germanium 32 <b>Ge</b> 72.63(1)	arsenic 33 <b>As</b> 74.921595(6)	selenium 34 <b>Se</b> 78.96(3)	bromine 35 <b>Br</b> 79.904(1)	krypton 36 <b>Kr</b> 83.80(1)												
5	rubidium 37 <b>Rb</b> 85.4678(3)	strontium 38 <b>Sr</b> 87.62(1)	yttrium 39 <b>Y</b> 88.90584(2)	zirconium 40 <b>Zr</b> 91.224(2)	niobium 41 <b>Nb</b> 92.90638(2)	molybdenum 42 <b>Mo</b> 95.94(1)	technetium 43 <b>Tc</b> 98(1)	ruthenium 44 <b>Ru</b> 101.07(2)	rhodium 45 <b>Rh</b> 102.90550(2)	palladium 46 <b>Pd</b> 106.42(1)	silver 47 <b>Ag</b> 107.8682(1)	cadmium 48 <b>Cd</b> 112.411(8)	indium 49 <b>In</b> 114.818(1)	tin 50 <b>Sn</b> 118.710(7)	antimony 51 <b>Sb</b> 121.757(1)	tellurium 52 <b>Te</b> 127.6(3)	iodine 53 <b>I</b> 126.905(5)	xenon 54 <b>Xe</b> 131.29(2)												
6	cesium 55 <b>Cs</b> 132.9054519(2)	barium 56 <b>Ba</b> 137.327(2)	lanthanum 57 <b>La</b> 138.90547(1)	hafnium 72 <b>Hf</b> 178.49(2)	tantalum 73 <b>Ta</b> 180.94788(2)	tungsten 74 <b>W</b> 183.84(1)	rhenium 75 <b>Re</b> 186.207(1)	osmium 76 <b>Os</b> 190.23(2)	iridium 77 <b>Ir</b> 192.222(1)	platinum 78 <b>Pt</b> 195.078(2)	gold 79 <b>Au</b> 196.966569(5)	mercury 80 <b>Hg</b> 200.59(2)	thallium 81 <b>Tl</b> 204.38(3)	lead 82 <b>Pb</b> 207.2(1)	bismuth 83 <b>Bi</b> 208.9804(1)	polonium 84 <b>Po</b> [209]	astatine 85 <b>At</b> [210]	radon 86 <b>Rn</b> [222]												
7	francium 87 <b>Fr</b> [223]	radium 88 <b>Ra</b> [226]	cerium 58 <b>Ce</b> [140.90765]	praseodymium 59 <b>Pr</b> [140.907652]	neodymium 60 <b>Nd</b> [144.242]	promethium 61 <b>Pm</b> [144.9127]	samarium 62 <b>Sm</b> [150.358]	euroium 63 <b>Eu</b> [151.964]	gadolinium 64 <b>Gd</b> [157.254]	terbium 65 <b>Tb</b> [158.92534]	dysprosium 66 <b>Dy</b> [162.50087]	holmium 67 <b>Ho</b> [164.930329]	erbium 68 <b>Er</b> [167.259]	thulium 69 <b>Tm</b> [168.93274]	ytterbium 70 <b>Yb</b> [173.054688]	lutetium 71 <b>Lu</b> [174.967]	thorium 90 <b>Th</b> [232.0377]	protactinium 91 <b>Pa</b> [231.036889]	uranium 92 <b>U</b> [238.02891]	neptunium 93 <b>Np</b> [237.048173]	plutonium 94 <b>Pu</b> [244.06422]	americium 95 <b>Am</b> [243.061381]	curium 96 <b>Cm</b> [247.0654]	berkelium 97 <b>Bk</b> [247.067151]	californium 98 <b>Cf</b> [251.079588]	einsteinium 99 <b>Es</b> [252.0833]	fermium 100 <b>Fm</b> [257.10375]	mendelevium 101 <b>Md</b> [258.103868]	nobelium 102 <b>No</b> [259.108889]	lawrencium 103 <b>Lr</b> [262.10536]







*Figure 162: Rare materials that ICT relies on*

Umicore, one of the most advanced companies in the field of electronic materials recycling, manages to extract 17 elements out of the 60.

At the end of their life, the recycling rate of electronic equipment is very low (less than 15%).





# THE WAY AHEAD – MAIN PRIORITIES



## Economic and Societal Priorities

1	2	3	4	5	6	7	8	9	10	11	12
Support for SMEs and start-ups	Accurate economic parameters estimate	Data and information as critical assets	Increase digital skills and competencies	Build Trust	Identification of the Key Regulatory and Legal Issues	Interoperability and Replicability	Security and Reliability by Design	Innovation procurement	Sustainability	Cohesion	Sovereignty

## Research, Innovation & Deployment Priorities

1	2	3	4	5	6	7	8	9	10
Reliable, low-cost, sustainable and scalable IoT networks	Next Generation IoT data processing architectures	Futureproof security and trust	IoT, processes, and data Interoperability	IoT, Citizens, Privacy-by-design, and Ethics	Real time decision-making for IoT	Autonomous IoT solutions	Human and Sustainable Development in the loop IoT	IoT Data Sharing and Monetization enabling models and technologies	Sustainable and biocompatible devices