

# THE EUCHEMS PERIODIC TABLE

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EuChemS Task Group on the Periodic Table

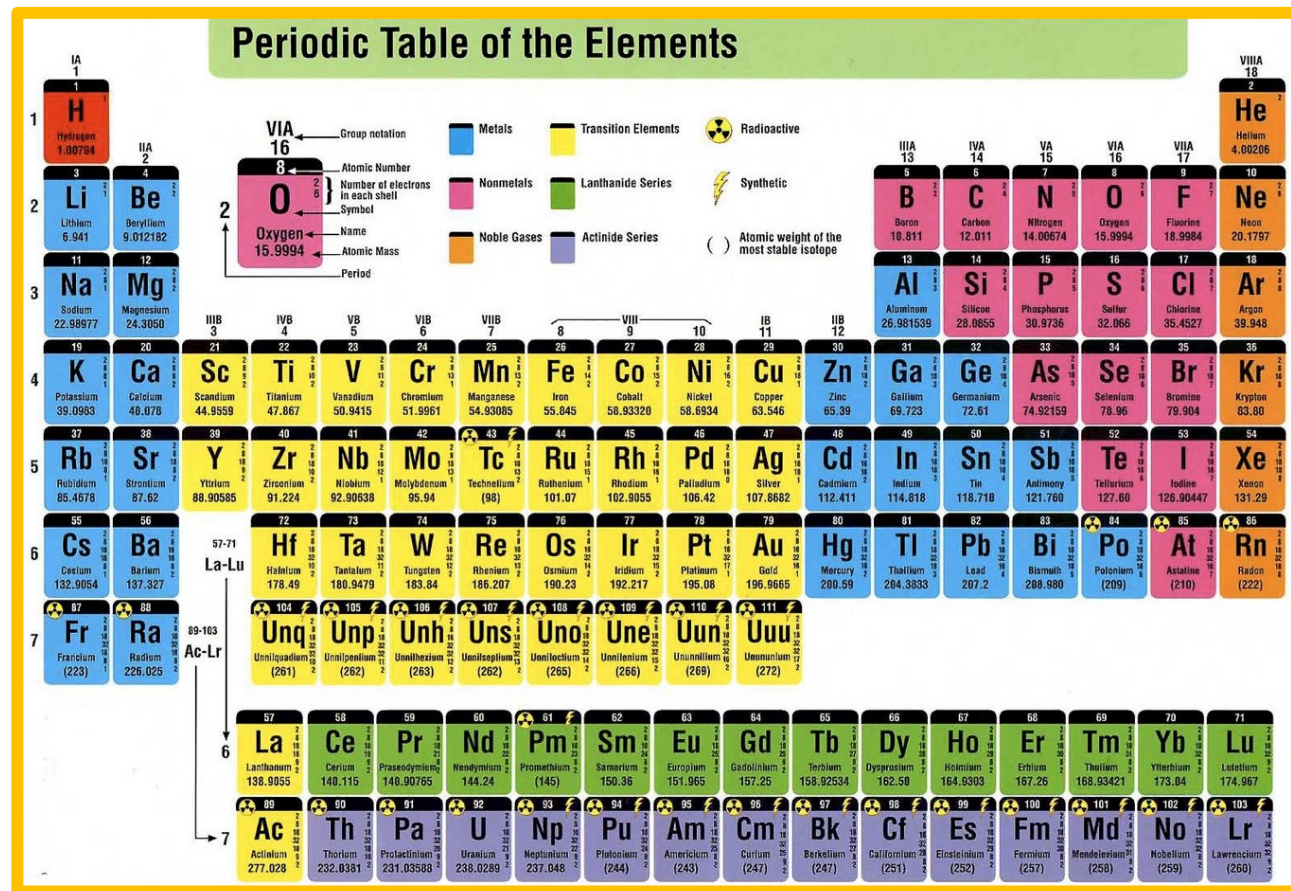
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*The role of Chemicals in our daily life:  
The Phosphorus element – feeding the world and beyond*

The European Parliament, Brussels, May 25<sup>th</sup>, 2023

# THE PERIODIC TABLE OF THE ELEMENTS

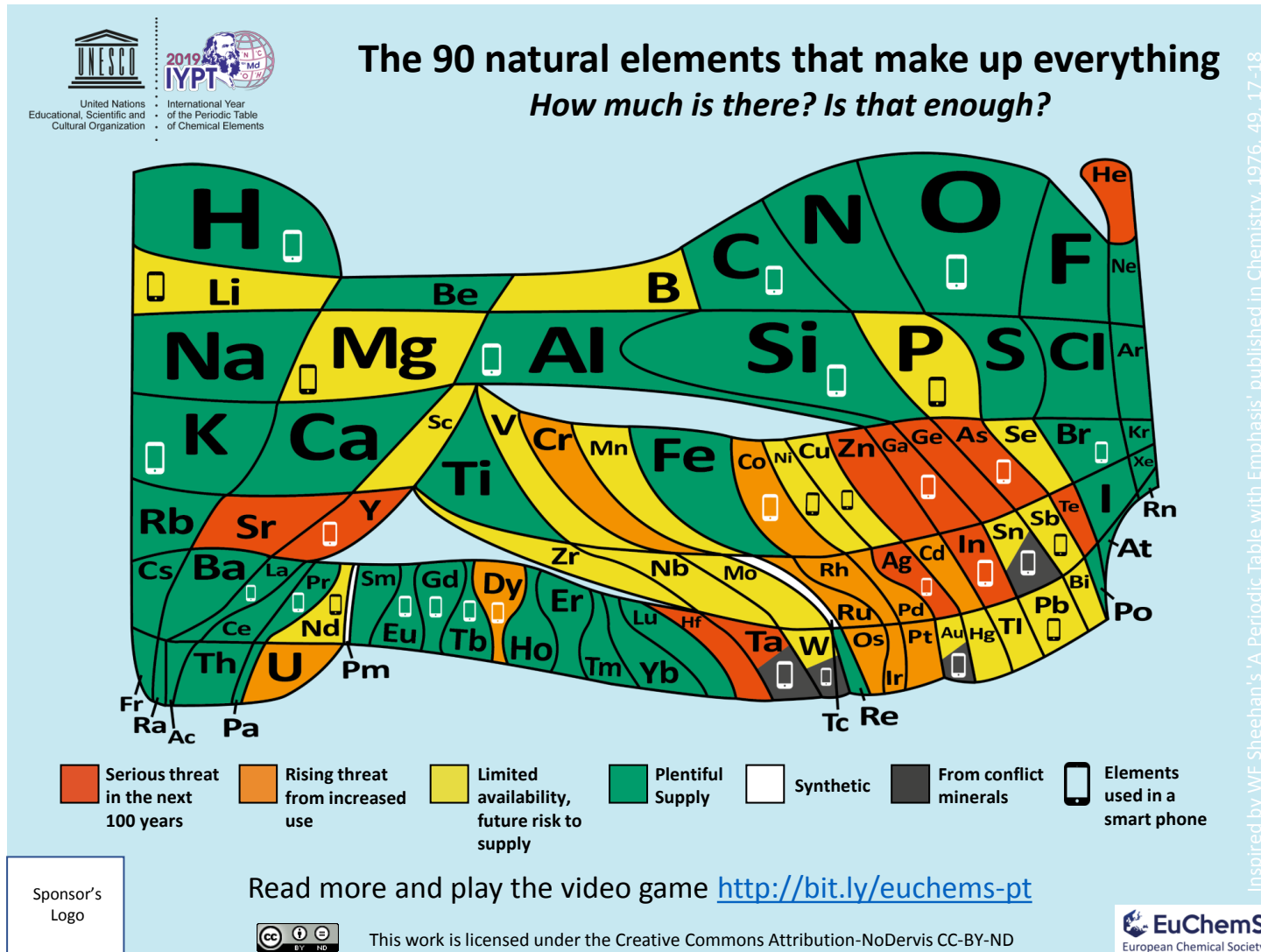


Why do we need a  
"new" periodic table?  
We already have one!

2019

# International Year of the Periodic Table

# THE EUCHEMS TABLE (2019 VERSION)



Each element characterized by

**SIZE**

The larger the more relatively abundant

**COLOR(S)**

They denote current human use

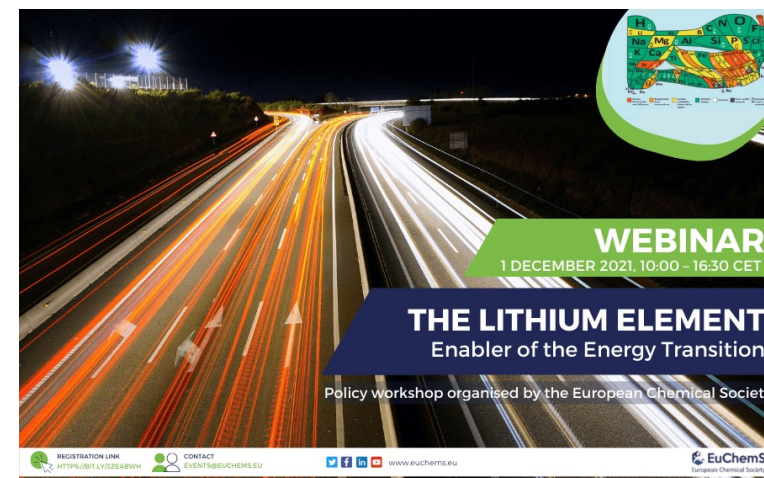
The Table is a  
**LIVING DOCUMENT**



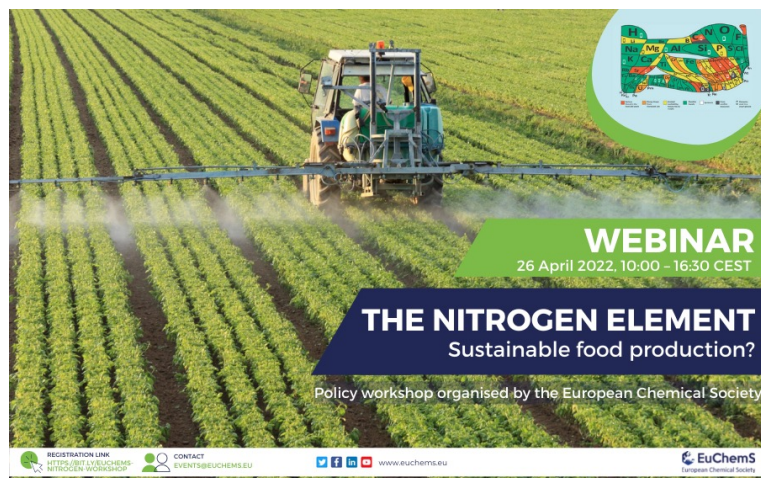
# UPDATING THE TABLE VIA SCIENTIFIC DISCUSSION



April 22, 2021



December 1, 2021



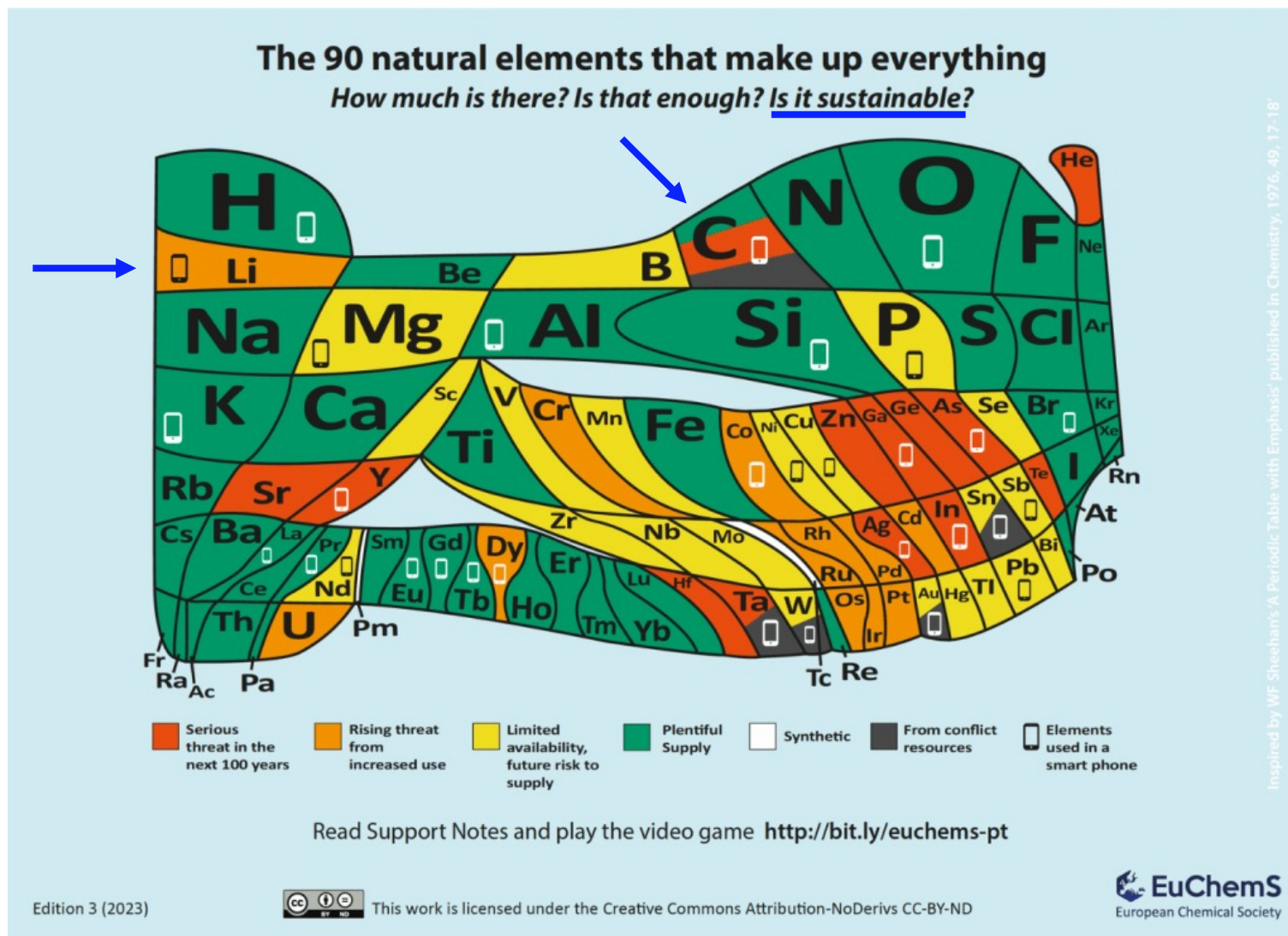
April 26, 2022



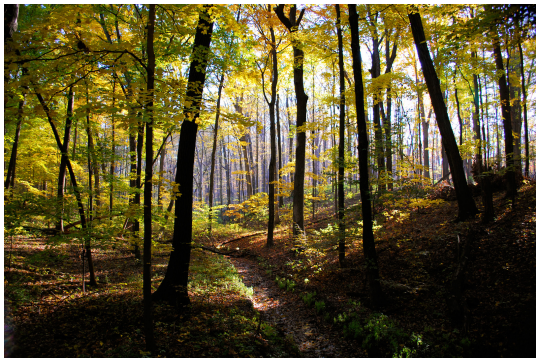
May 25, 2023



# THE LATEST VERSION, 2022



# THE THREE COLORS OF CARBON



Plentiful supply  
**GREEN**



Serious (double) threat  
in the next 100 years  
**RED**



From conflict resources  
**GREY**







# THE RISING RELEVANCE OF LITHIUM

*"For their contributions to the development of the lithium-ion battery (LIBs)"*

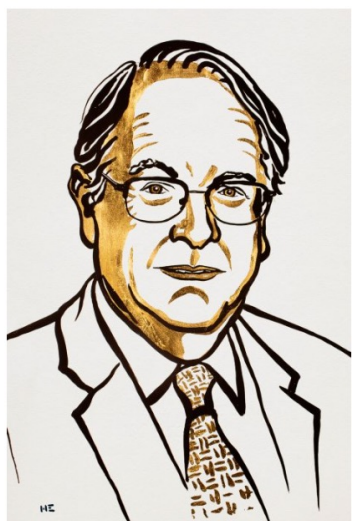
## The Nobel Prize in Chemistry 2019



Ill. Niklas Elmehed. © Nobel Media.

John B. Goodenough

Prize share: 1/3



Ill. Niklas Elmehed. © Nobel Media.

M. Stanley Whittingham

Prize share: 1/3



Ill. Niklas Elmehed. © Nobel Media.

Akira Yoshino

Prize share: 1/3

Among the most disruptive enabling technologies ever



SMARTPHONES  
ELECTRIC VEHICLES  
PORTABLE DEVICES  
HOME APPLIANCES

...

# LITHIUM AND DECARBONIZATION



Electric vehicles

**VIRTUALLY  
NO ALTERNATIVES  
TO LIBs SO FAR**



Storage of intermittent renewables

**VIABLE ALTERNATIVES  
CLOSE TO COMMERCIALIZATION  
(sodium and flow batteries)**

# LITHIUM: RESOURCES AND RESERVES



From rocks  
(Australia)

Estimated RESOURCES 2013: 23 Mton

Estimated RESOURCES 2023: 98 Mton

Current RESERVES: 26 Mton



8 kg/car

BEVs that can be made  
3.2 billions (today 1.4)

DOABLE? HOW?  
It depends from several factors...

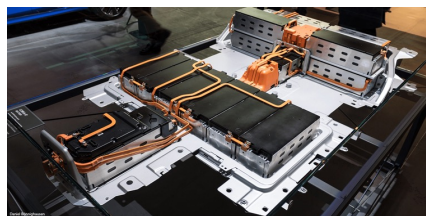


From brines  
(South America)

Data from US Geological Survey



# BATTERIES: THINGS EVOLVE



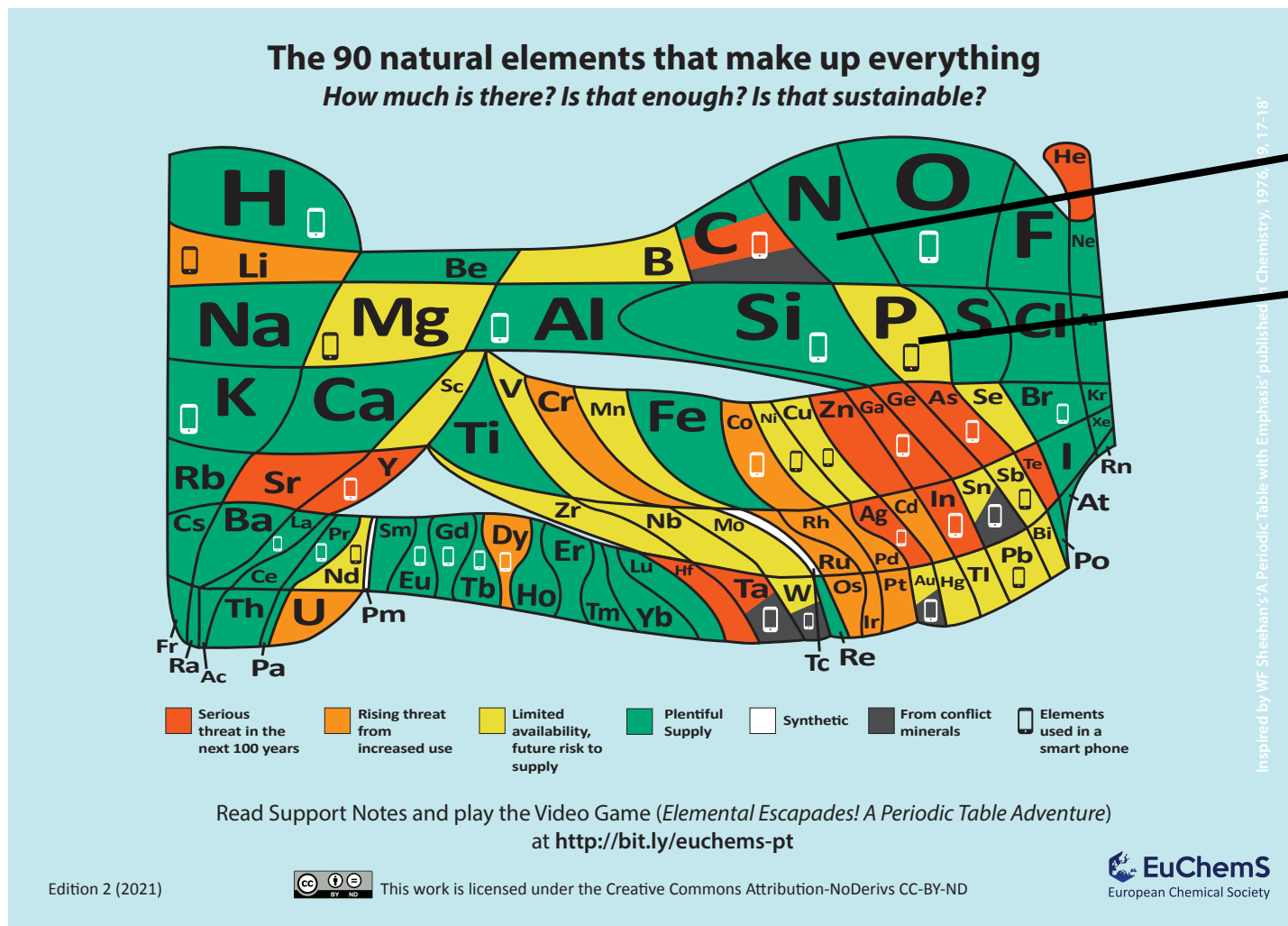
50 kWh (NMC 523)



50 kWh (LFP)

	50 kWh Ni-Mn-Co 523	50 kWh Lithium Iron Phosphate
Lithium	5,5	4,9
Cobalt	9,5	/
Nickel	23,5	/
Graphite	44,0	59,4
Manganese	13,5	/
Copper	17,0	23,2
Aluminum	29,0	39,4
Iron	/	37,3
Phosphorus	/	20,7
TOTALE	142,0	208,1

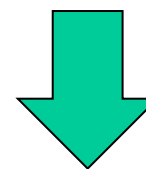
# THE ONGOING STEP: NITROGEN AND PHOSPHORUS



**NITROGEN**

**PHOSPHORUS**

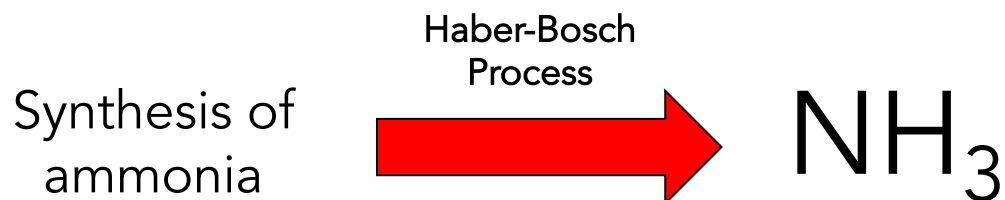
Key elements  
for fertilizers



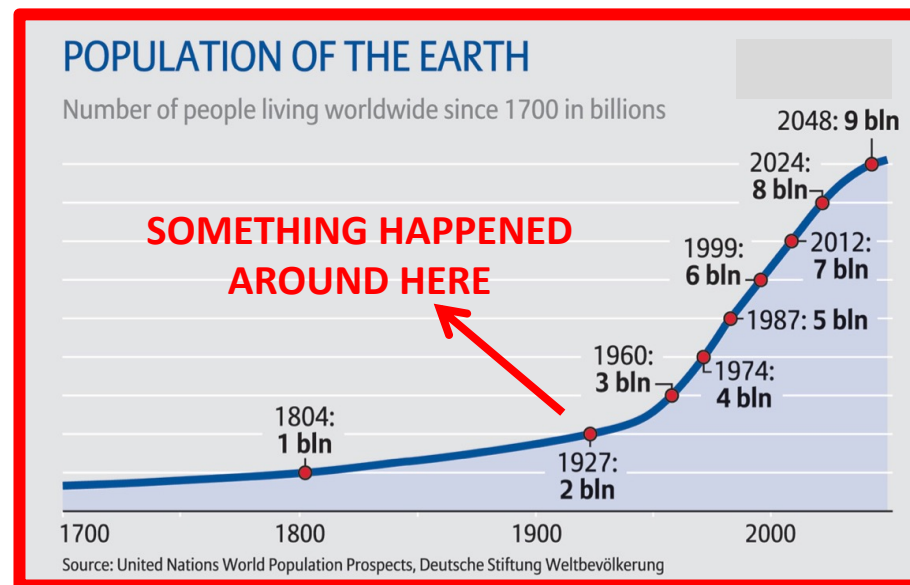
**FOOD  
PRODUCTION**

# NITROGEN: PLENTIFUL AND ... IMPACTFUL

The Earth atmosphere contains  
about 4000 trillion tons of N.  
Virtually unlimited supply  
**To do what?**



1.5 % of annual global  
greenhouse gas emission

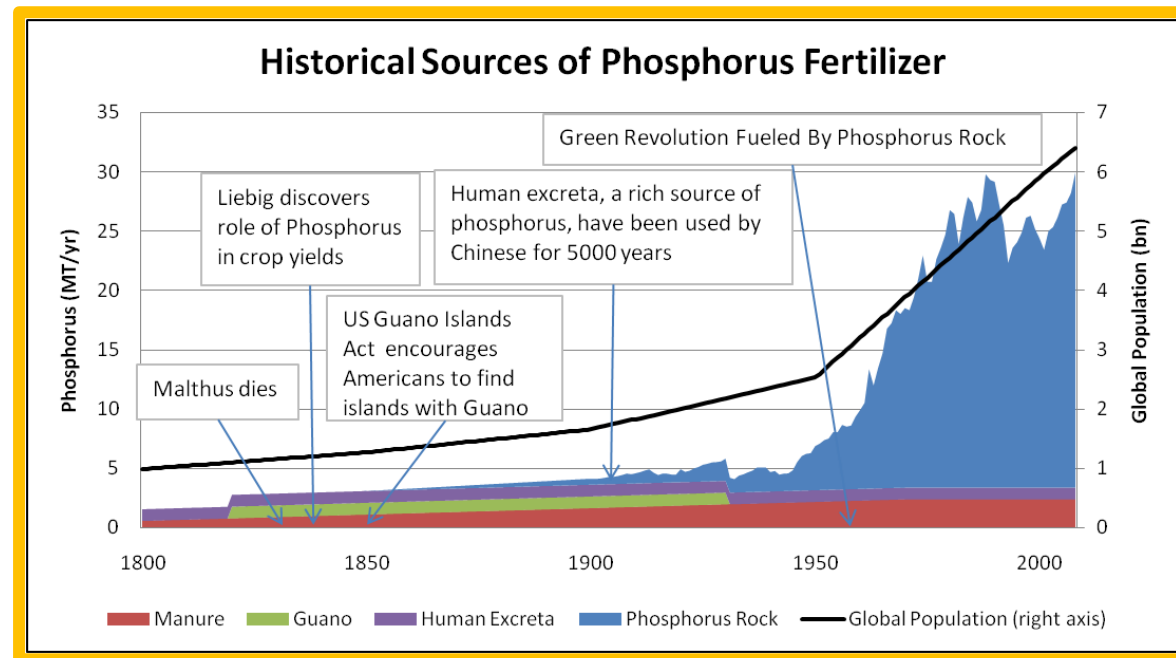




# PHOSPHORUS: AN INCREASINGLY EXPLOITED ELEMENT



Guano islands

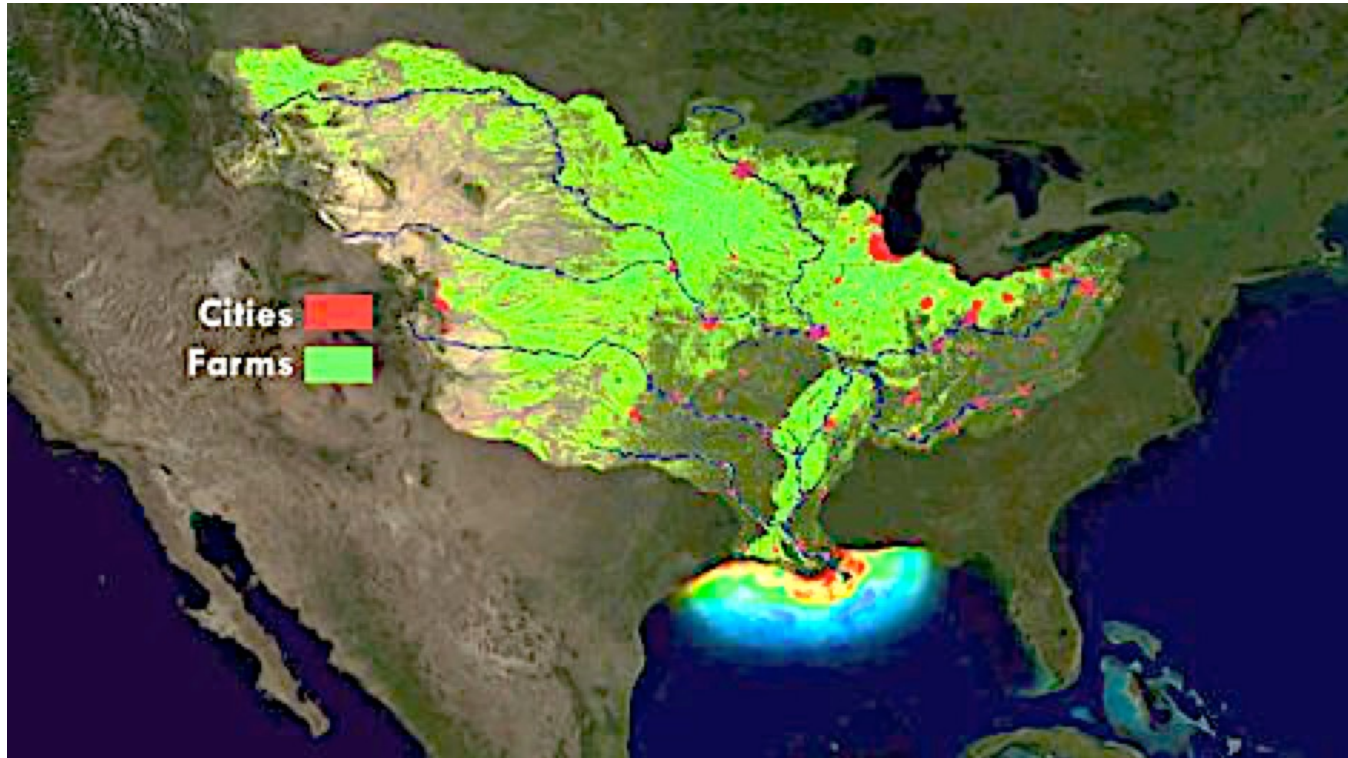


## NOT ONLY FERTILIZERS

Steel, water treatments, batteries, food additives, pesticides, flame retardants, ...

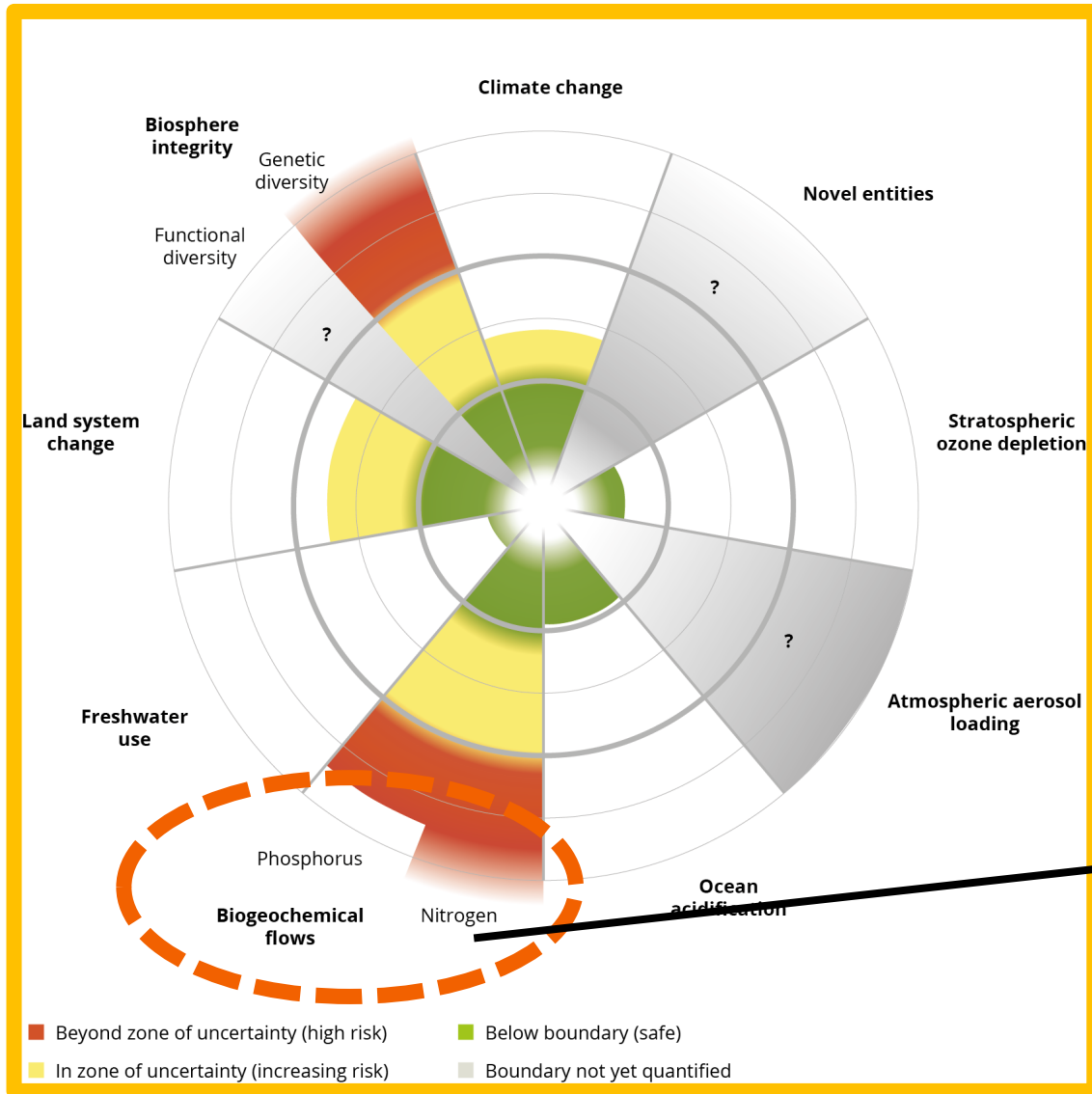
# N AND P: ENVIRONMENTAL IMPACT

N and P runoff in the Gulf of Mexico  
from agriculture, industry, urbanization



Dead Zones

# N,P OVERUSE IS RELEVANT FOR THE BIOSPHERE



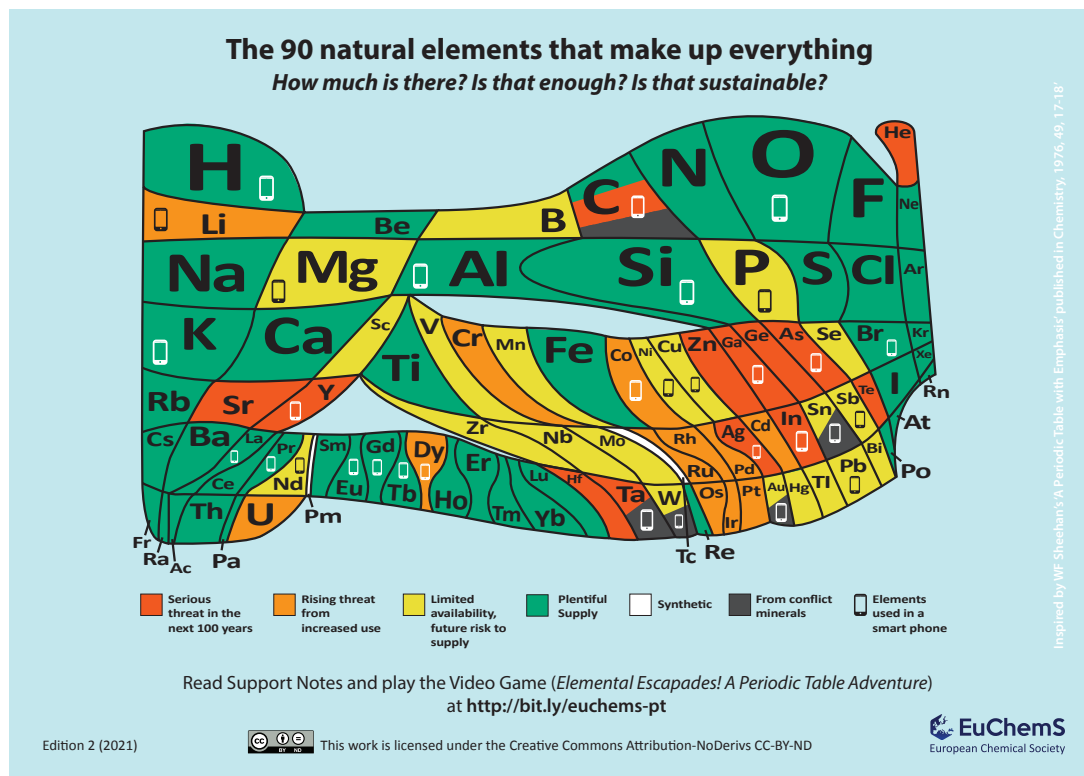
# Status of the 9 planetary boundaries (European Environment Agency)

<https://www.eea.europa.eu/soer/2020/soer-2020-visuals/status-of-the-nine-planetary-boundaries/view>

# LINEAR APPROACH TO RESOURCE USE

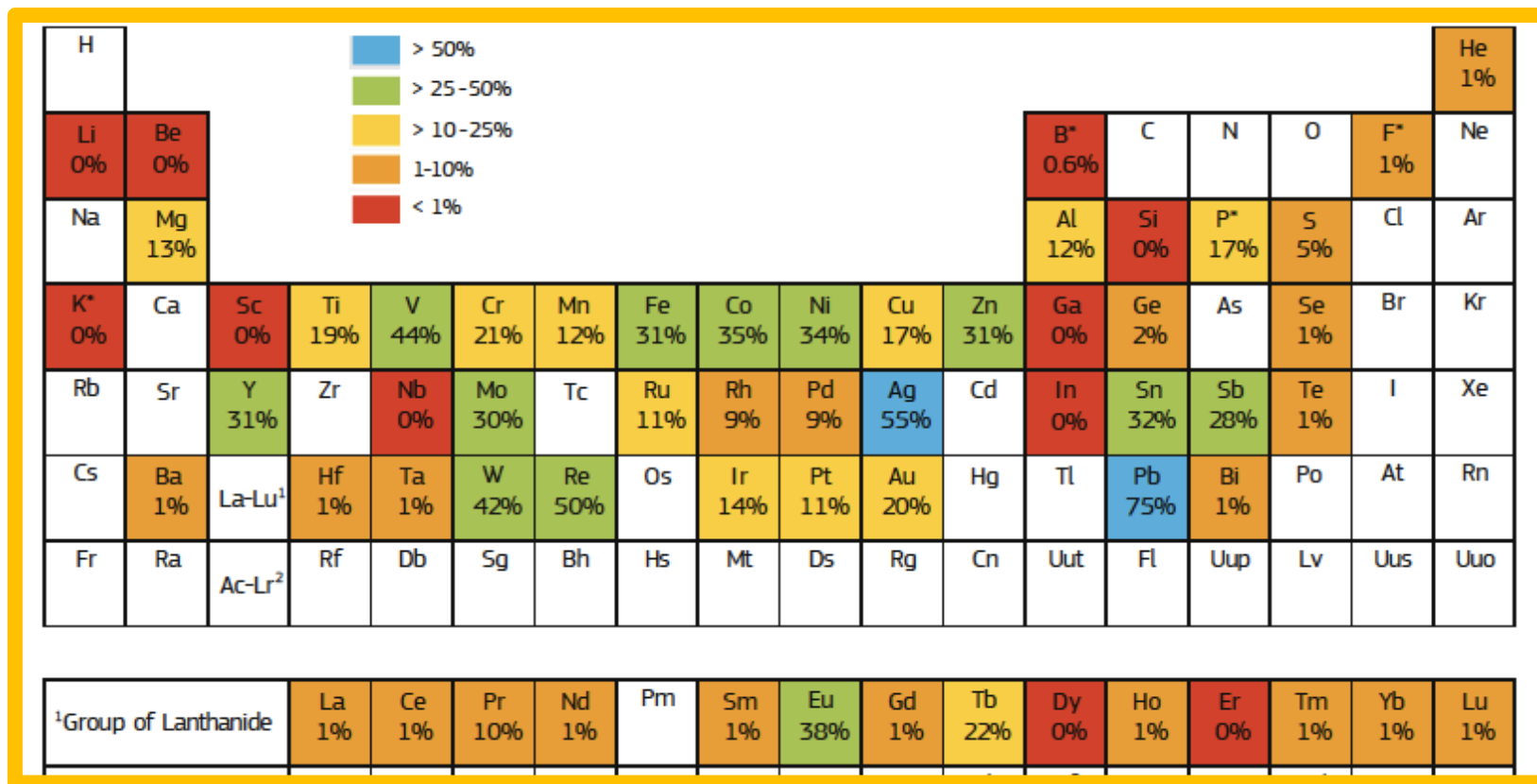


# PROMOTING A CIRCULAR PERSPECTIVE



# EU RECYCLING RATES (METALS)

We need to perform better!

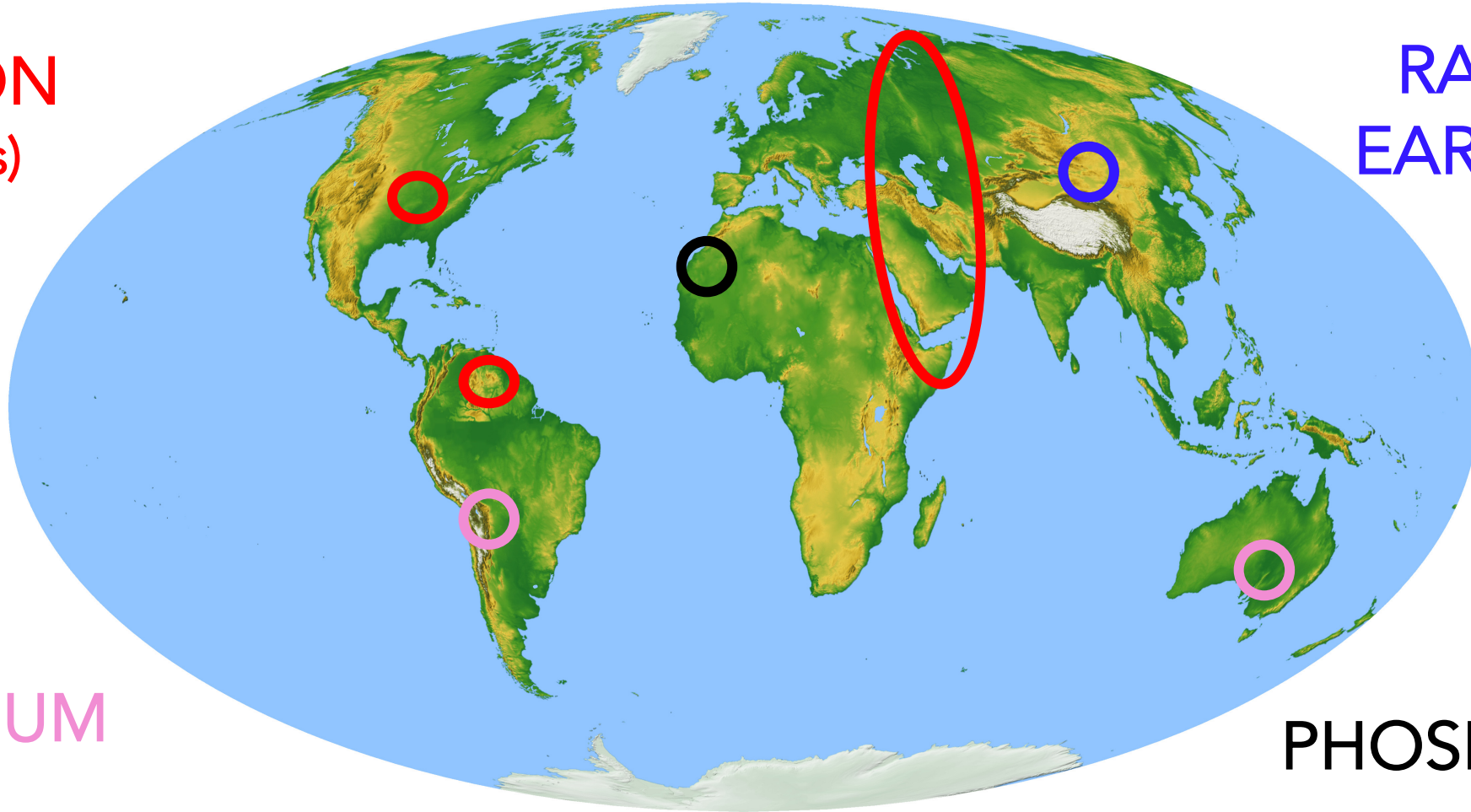


Raw Materials Scoreboard,  
*The European Commission,*  
2018

# MINERAL RESOURCES ARE CONCENTRATED

CARBON  
(oil&gas)

RARE  
EARTHS



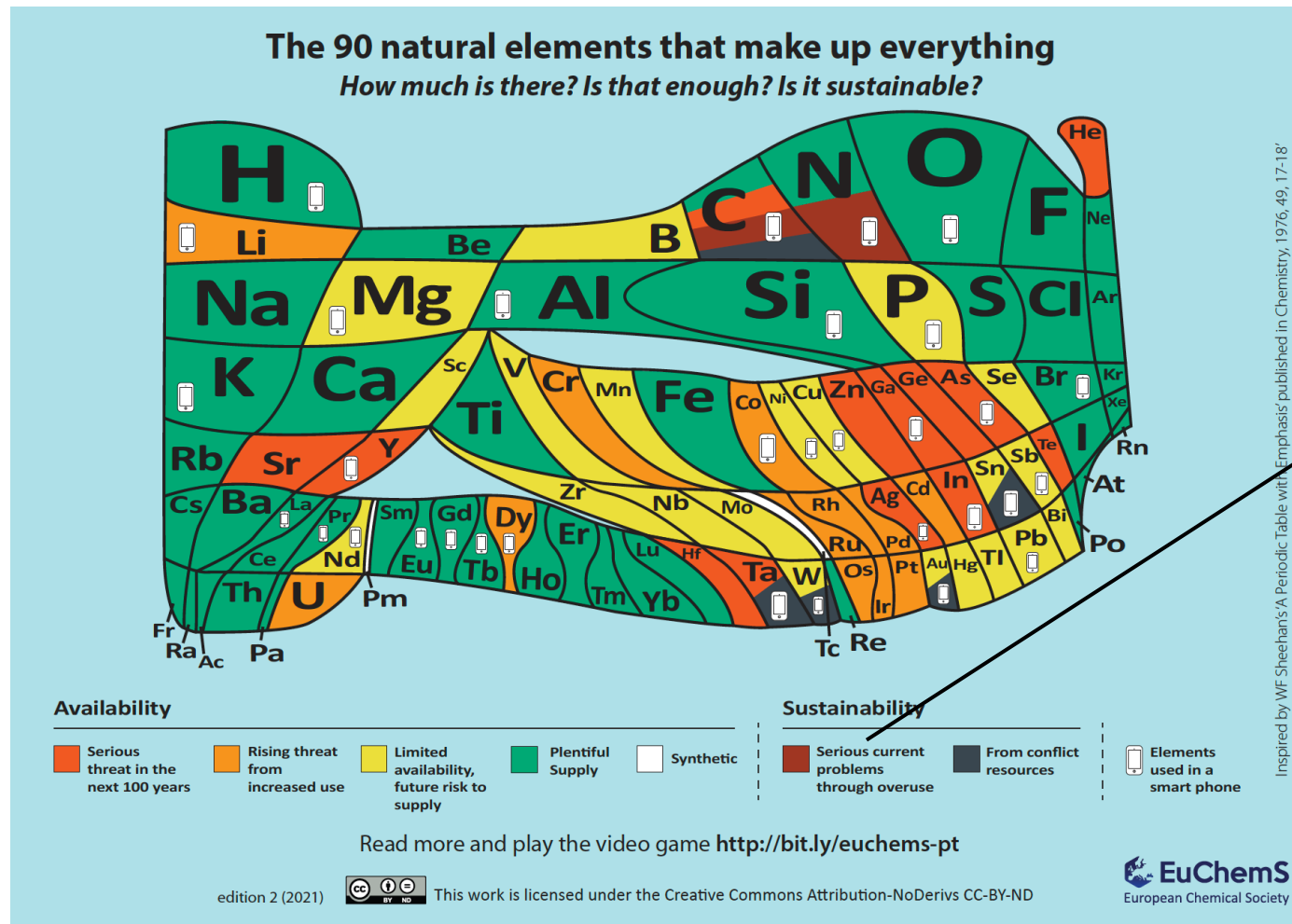
LITHIUM

PHOSPHORUS

## NO ALTERNATIVE TO INTERNATIONAL COOPERATION



# DISCUSSION ONGOING IN EUCHEMS: SHOULD WE ADD A COLOR TO N (AND C AND P)?



P is also a candidate  
The today discussion  
will be key to our  
future decision

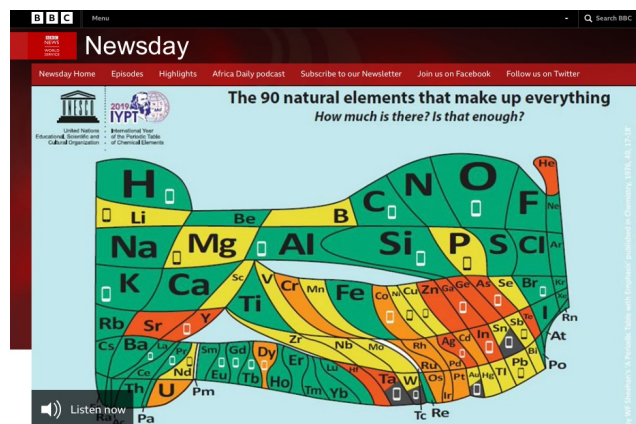
# THE EUCHEMS PT HAS AN IMPACT



## The New York Times

### Is It Time to Upend the Periodic Table?

The iconic chart of elements has served chemistry well for 150 years. But it's not the only option out there, and scientists are pushing its limits.



# OUR SCIENTIFIC DISCUSSION WILL CONTINUE

Rare Earths

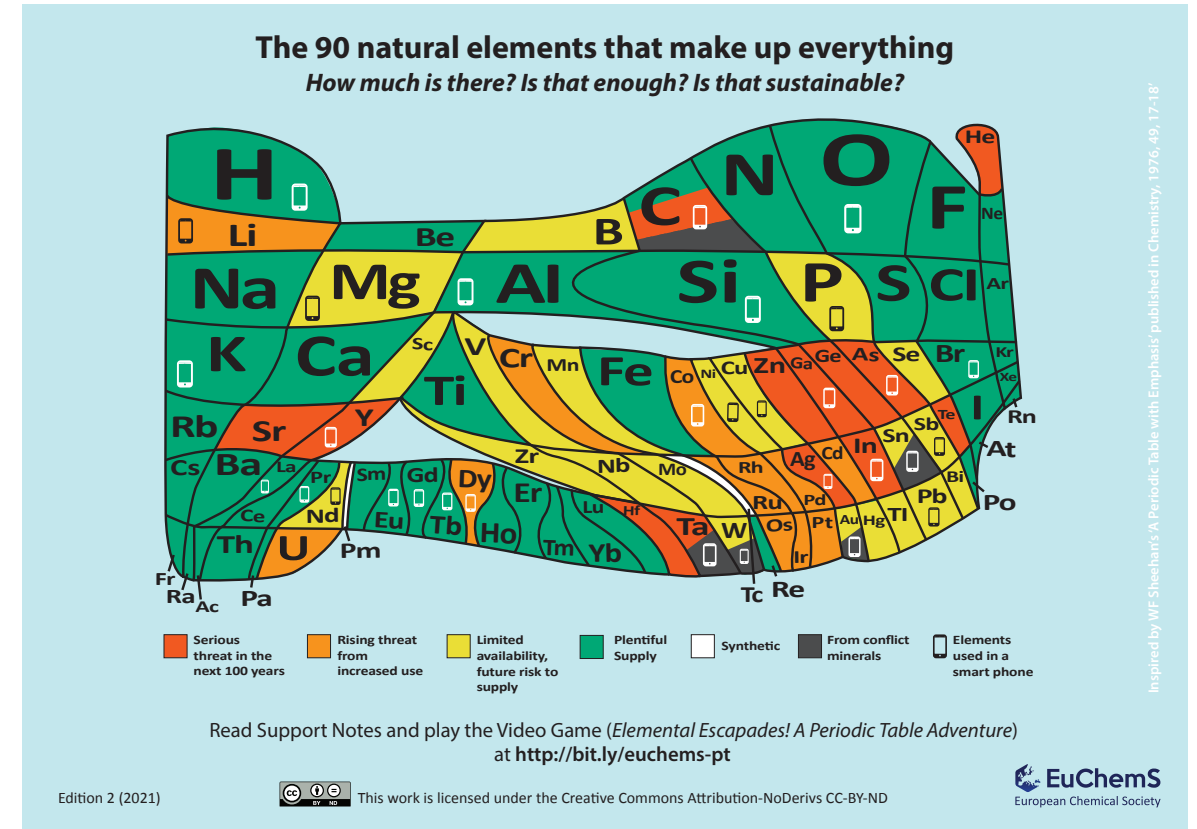
Hydrogen

Helium

Cobalt

Platinum Group  
Elements

Indium





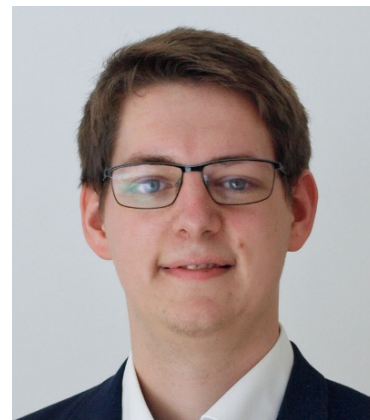
# THE EUCHEMS TASK GROUP ON THE PT



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E. Hey-Hawkins, DE



R. Poli, FR



F. Rutjes, NL



N. Hrastelj (Sec. General)

Thank  
you!