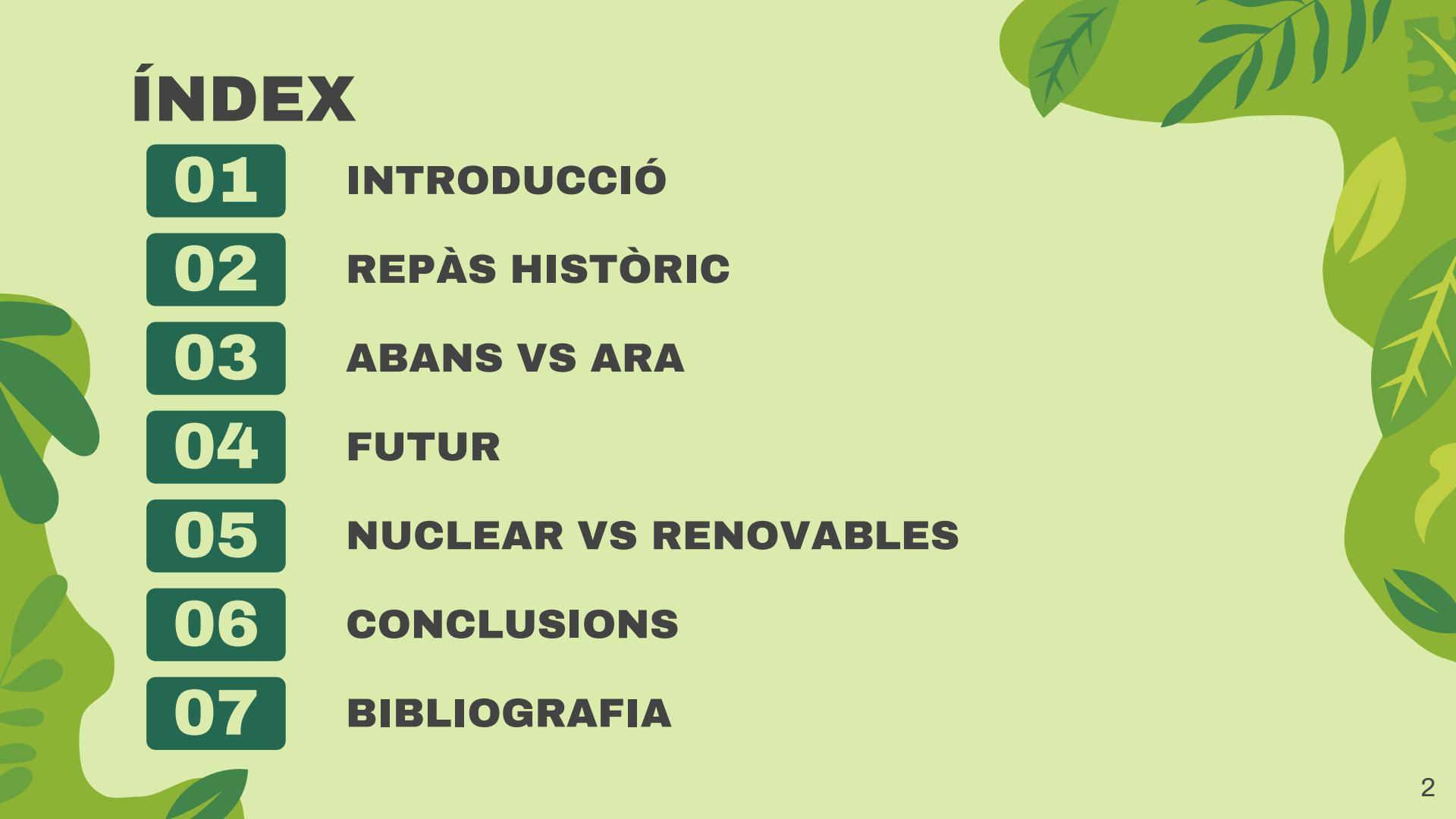


# **Fins a quin punt és viable l'energia nuclear?**

Albert Bausili, Àlex Mitjans i Noa Yu Ventura

# ÍNDEX

- 
- 01 INTRODUCCIÓ**
  - 02 REPÀS HISTÒRIC**
  - 03 ABANS VS ARA**
  - 04 FUTUR**
  - 05 NUCLEAR VS RENOVABLES**
  - 06 CONCLUSIONS**
  - 07 BIBLIOGRAFIA**



01

# INTRODUCCIÓ

- 1.1 Forces gravitacional i electromagnètica
- 1.2 Forces nuclears forta i dèbil
- 1.3 Fissió i fusió
- 1.4 Com es genera energia elèctrica a partir de la nuclear?

# 1.1 Forces gravitacional i electromagnètica

## Gravitacional

Escala molt gran, de cossos astrals

Força molt dèbil

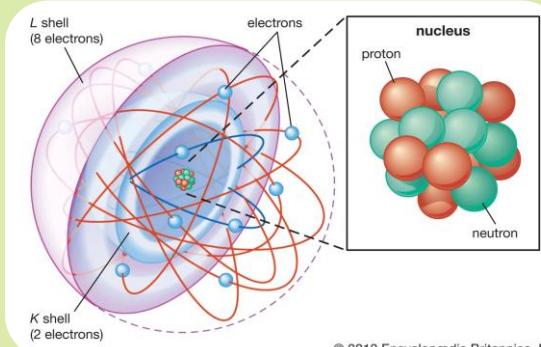
Atrau altres objectes sempre que tinguin massa

## Electromagnètica

Escala molt petita, d'àtoms

Protons del nucli atrauen electrons

No canvien els nuclis dels àtoms. Sí que canvien les seves connexions (molècules)



imatge 1. Representació d'un àtom



imatge 2. Representació gràfica d'una reacció química on hi participa la força electromagnètica.

# 1.2 Forces nuclears forta i dèbil

## Nuclear forta

Escala del nucli d'un àtom

Força molt molt forta en relació a la massa

Manté els protons i neutrons units en un sol nucli

És molt susceptible a les distàncies  
-> nuclis molt grans inestables

El nucli de l'àtom canvia

## Nuclear dèbil

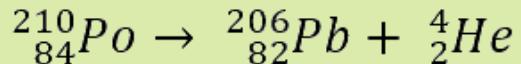
Escala dels components d'un àtom

Força menys forta

Permet als protons convertir-se en neutrons i viceversa

Diferents tipus d'emissió: alfa, beta, gamma, de positró i d'electró

Canvien els protons, neutrons i electrons



# 1.3 Fissió i fusió

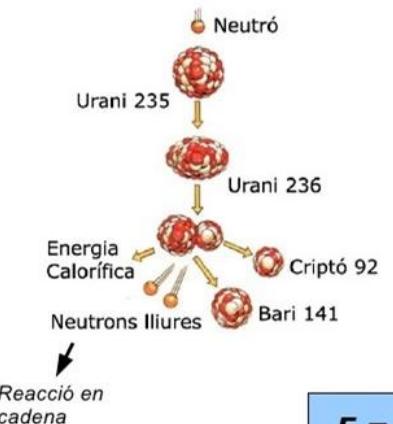
## Fissió

Reacció en cadena

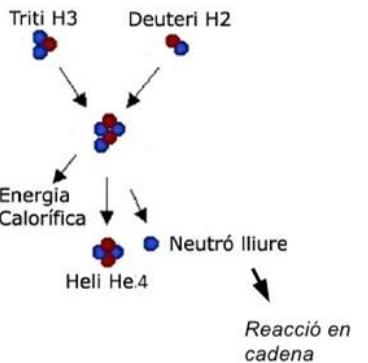
## Fusió

Necessita energia constantment

### ***Fissió***



### ***Fusió***



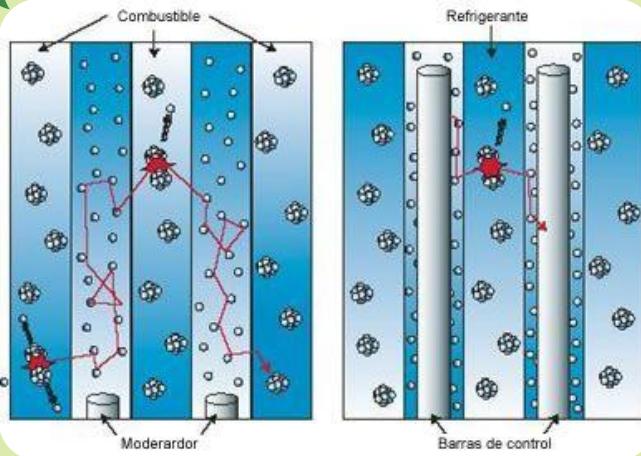
$$E = m \cdot c^2$$

# Teoria de la relativitat espacial d'Einstein

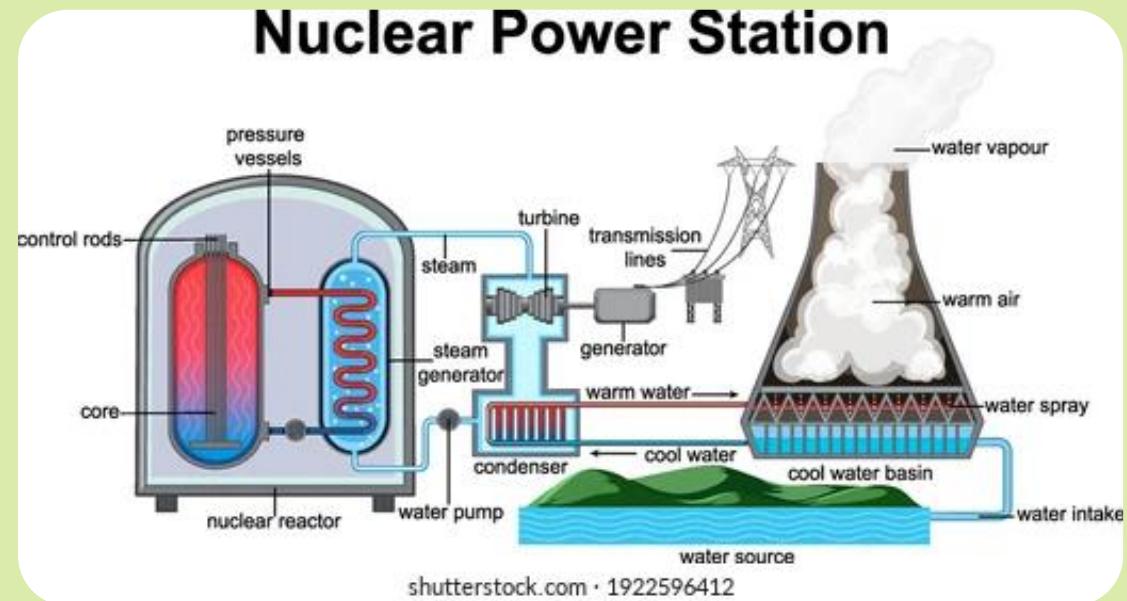
Imatge 3. Diferència entre les dues reaccions nuclears.



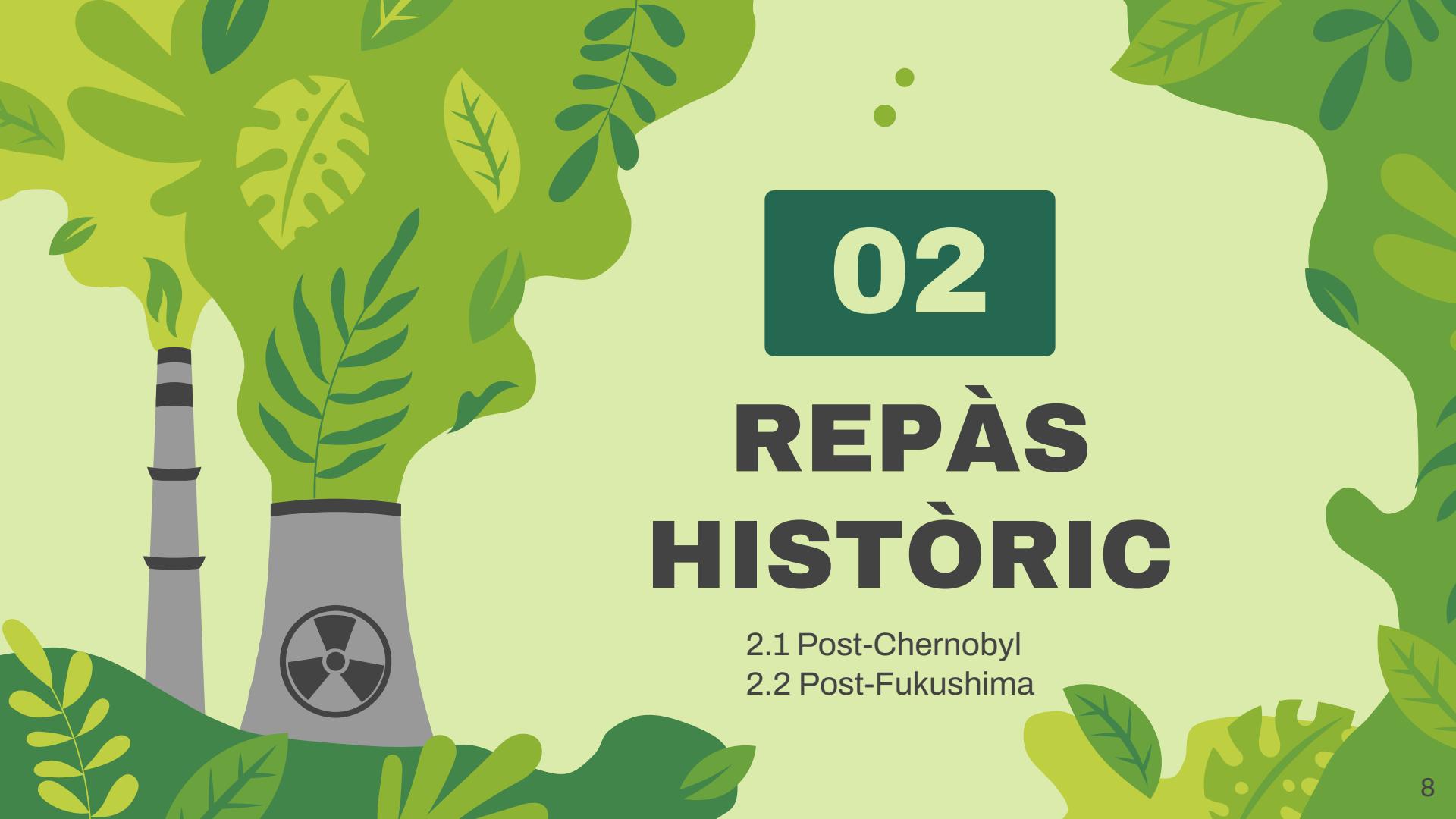
# 1.4 Com es genera energia elèctrica a partir de la nuclear?



Imatge 4. Representació de l'interior d'un reactor nuclear de fissió.



Imatge 5. Representació del funcionament d'una central nuclear.



02

# REPÀS HISTÒRIC

- 2.1 Post-Chernobyl
- 2.2 Post-Fukushima

## 2.1 Post-Chernobyl

### Accident Chernobyl

Mesures de seguretat molt bàsiques

**1986**

**1989**

Representa un avanç històric en l'estudi de la radiació

### Radiació Ionitzant

**1994**

Repositoris geològics de gran profunditat

### DGRs

**2000**

**2000**

### MURA

Sistema innovador de control

### Elpasolites

Nova classe de escintil·ladors

## 2.1 Post-Chernobyl

### Augment de costos

Els nous reactors passen a costar uns 1000\$/kW

### Mes costos

Els nous reactors passen a costar uns 2000€/kW

### 444 Centrals

Pic màxim de centrals nuclears

2002

2003

2004

2006

2008

### Crisi social

Grans preocupacions per la seguretat dels reactors

### Containidors de Carboni

Nous containidors pels residus altament radioactius

## 2.2 Post-Fukushima

### Accident Fukushima

Accident en la central nuclear de Fukushima

2011

2015

### Neutrins

Planxes d'absorció de Neutrins milloren detecció de materials nuclears

2019

2021

2022

### Materials Nous

Es desenvolupen materials més resistentes a la radiació

### Nou Ciment

L'ús de ciment reforçat per fibres d'ultra alt resistència es comença a implementar

### Big Data

L'ús de big data per a millorar la seguretat i la presa de decisions



03

# ABANS VS ARA

- 3.1 Sostenibilitat Económica
- 3.2 Sostenibilitat Social
- 3.3 Sostenibilitat Mediambiental

# 3.1 Sostenibilitat Econòmica



## Post-Chernobyl

- Pocs problemes de finançació
- Grans subsidis gubernamentals
- \$500/kW cost total



## Post-Fukushima

- Problemes de finançació més grans
- Reducció en els subsidis
- \$1000-2000/kw cost total

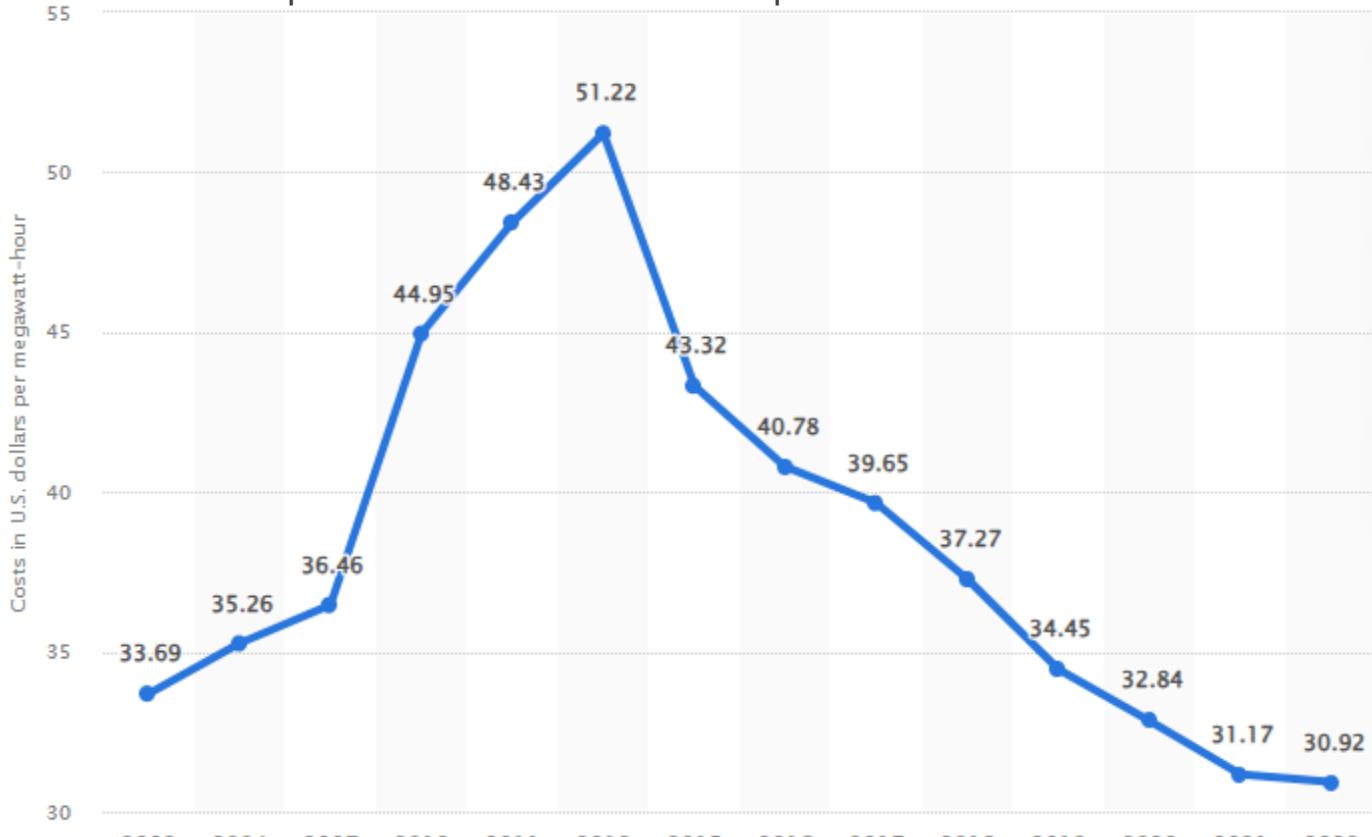


## Avui

- Grans problemes de finançació
- Subsidis encara existents però ridículs
- \$3000/kw cost total

3.

## Cost producció d'electricitat de les plantes nuclears a US



Imatge 1. Grafica cost producció d'energia en \$/MWh

## 3.2 Sostenibilitat Social



### Post-Chernobyl

- Acceptació social alta: És el futur
- Cultura de seguretat inexistent
- Pocs moviments socials



### Post-Fukushima

- Caiguda d'acceptació social: Va ser un error
- Cultura de seguretat en millora
- Bastants moviments socials en contra

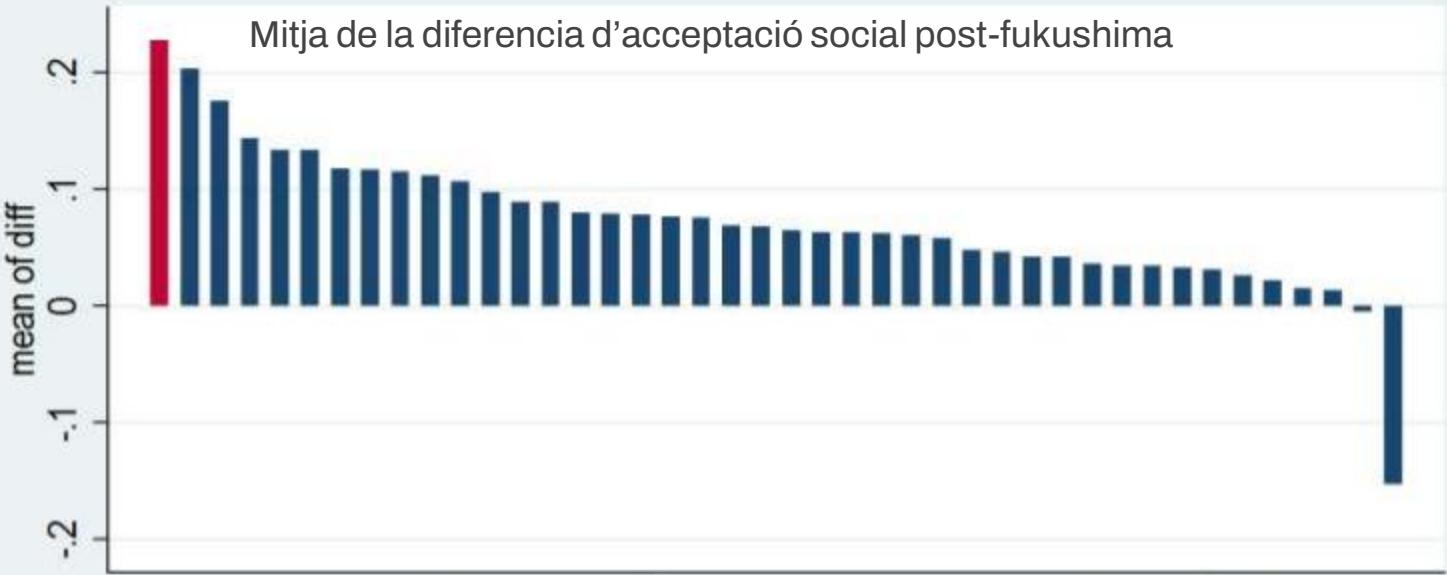


### Avui

- Acceptació social en augment
- Molt alt nivell de seguretat i en constant millora
- Moviments (principalment) acadèmics a favor



3



Imatge 2. Grafica acceptació social post-fukushima

### 3.3 Sostenibilitat Mediambiental



#### Post-Chernobyl

- Emissions CO<sub>2</sub> molt baixes
- Gestió de residus penosa



#### Post-Fukushima

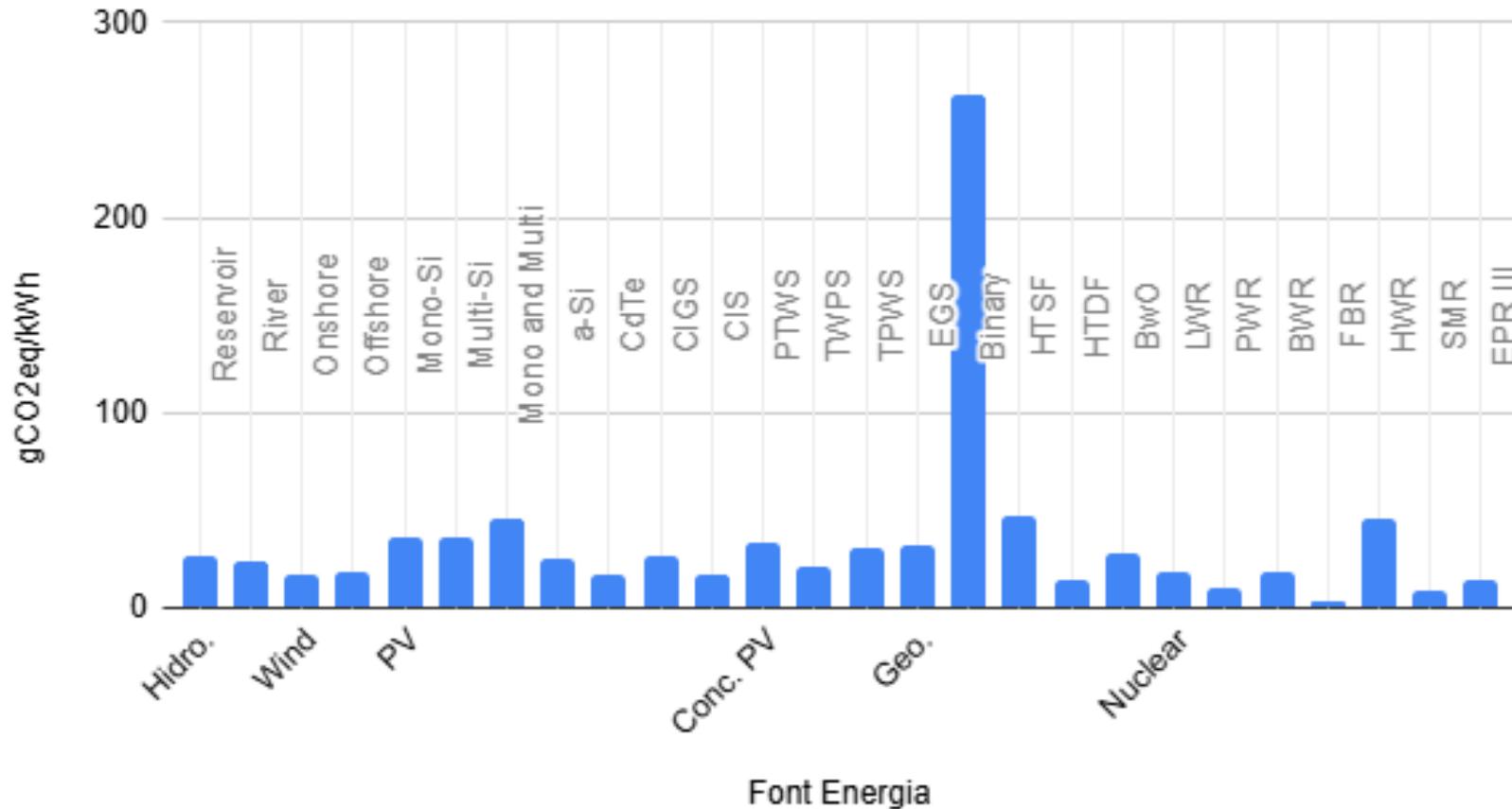
- Emissions de CO<sub>2</sub> baixes comparades amb alternatives
- Centrats en la gestió de residus temporals



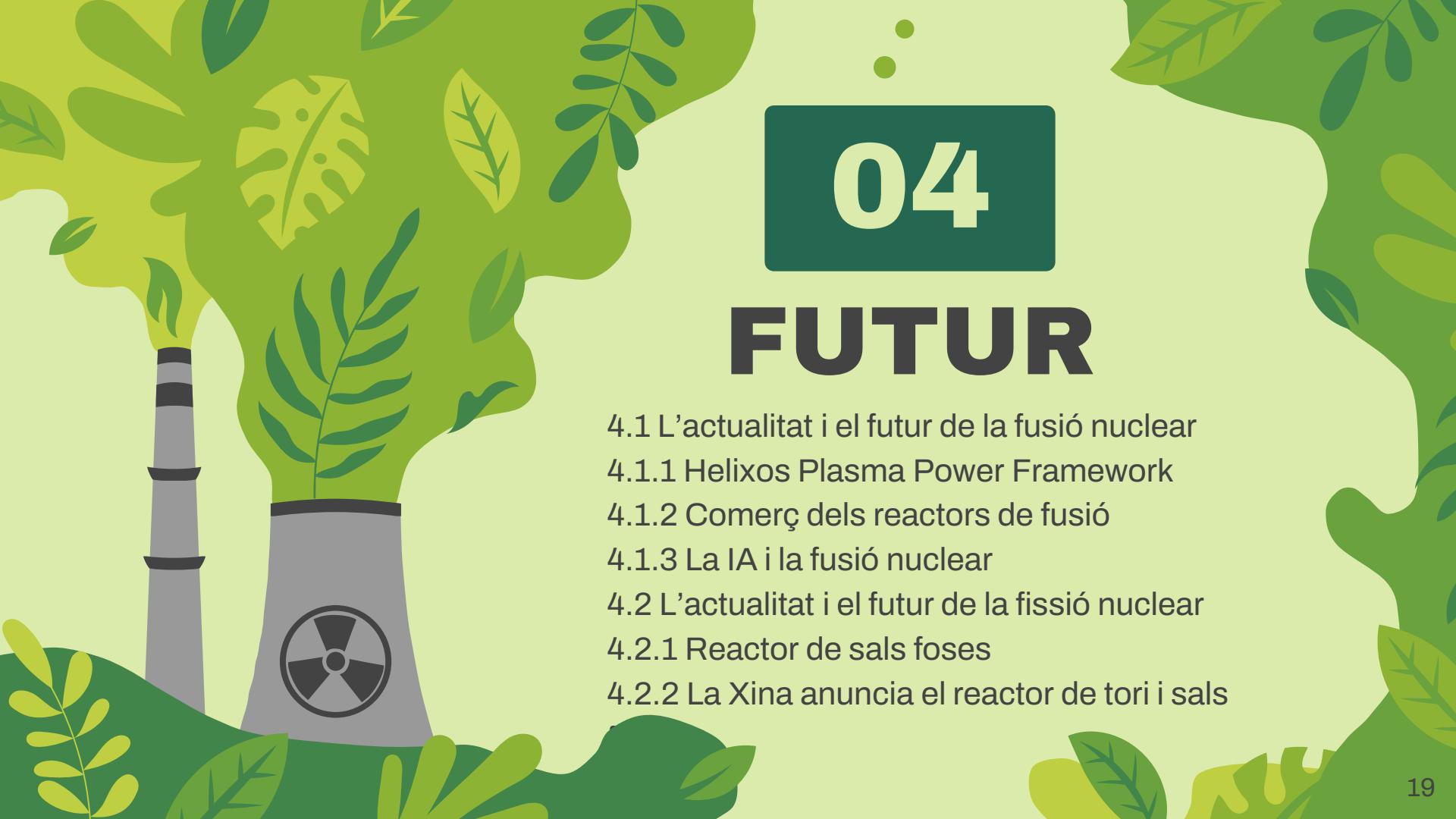
#### Avui

- Emissions de CO<sub>2</sub> incrementant degut a la dificultat de la extracció d'urani
- Principalment DGRs, altament segures

# CO<sub>2</sub> en funció de energia



Imatge 3. Grafica gCO<sub>2</sub>/kWh per cada font d'energia

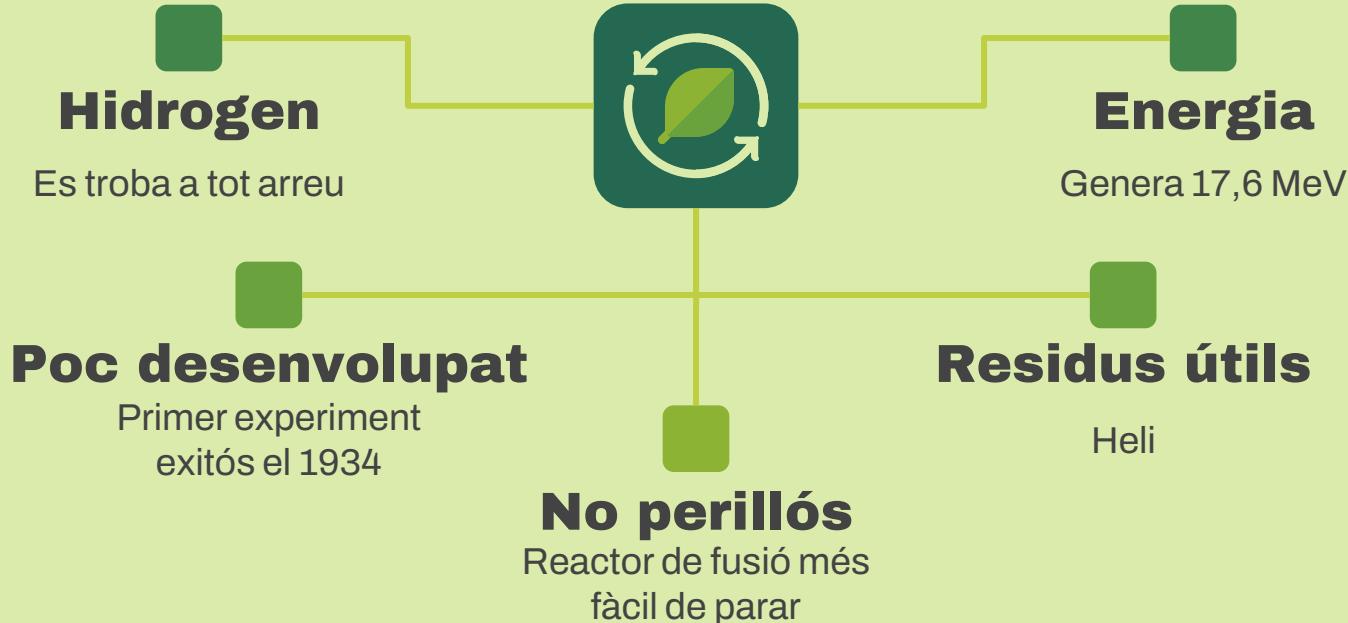


# 04

## FUTUR

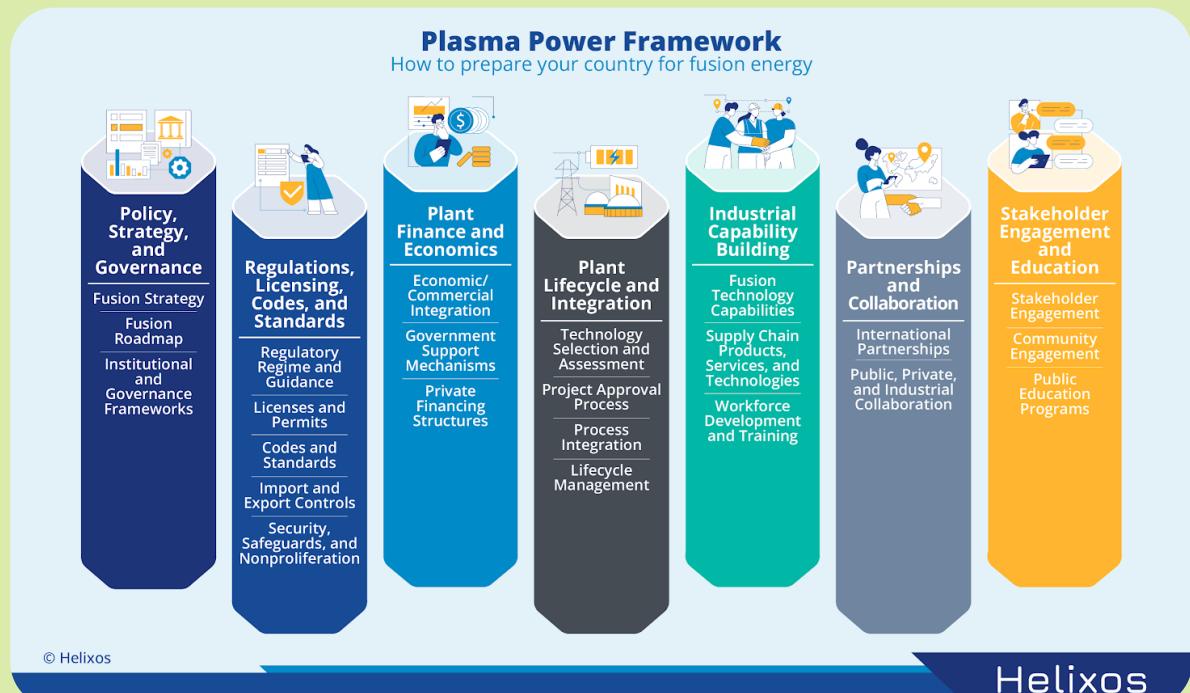
- 4.1 L'actualitat i el futur de la fusió nuclear
  - 4.1.1 Helixos Plasma Power Framework
  - 4.1.2 Comerç dels reactors de fusió
  - 4.1.3 La IA i la fusió nuclear
- 4.2 L'actualitat i el futur de la fissió nuclear
  - 4.2.1 Reactor de sals foses
  - 4.2.2 La Xina anuncia el reactor de tori i sals

# 4.1 L'actualitat i el futur de la fusió nuclear



## 4.1.1 Helixos Plasma Power Framework

Imatge 1. Esquema dels temes que concreta el framework sobre com s'haurien de gestionar els recursos dedicats a energia nuclear de fusió.



## 4.1.2 Comerç dels reactors de fusió

### International Thermonuclear Experimental Reactor (ITER)

Pacte entre molts països (Europa, Estats Units, Xina, etc) per investigar la fusió nuclear. El seu objectiu és poder col·laborar països amb països per a fer la fusió nuclear viable energèticament.



### Kyoto Fusioneerig

Organització japonesa que investiga l'energia nuclear com una solució energètica a llarg temps.

**PRIVAT-PÚBLIC!**

### Korea Superconducting Tokamak Advanced Research (KSTAR)

Organització coreana que investiga la fusió i gràcies a la IA ha aconseguit per primer cop obtenir més energia que la invertida en la reacció nuclear.

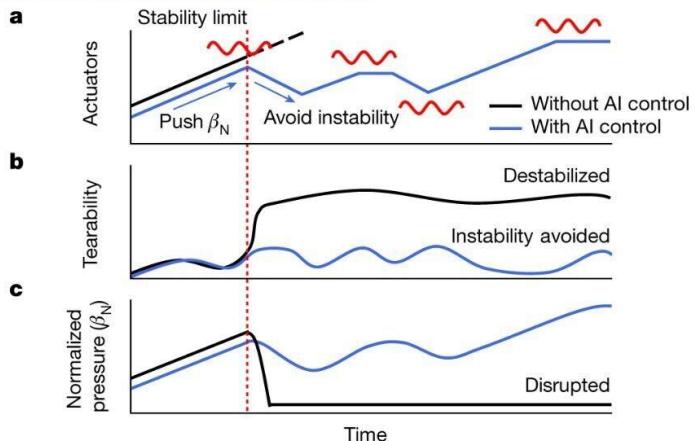


## 4.1.3 La IA i la fusió nuclear

Experiment en què s'ha obtingut un rècord mundial d'energia nuclear generada. Es van obtenir 69 MJ ~ escalfar 4 banyeres.

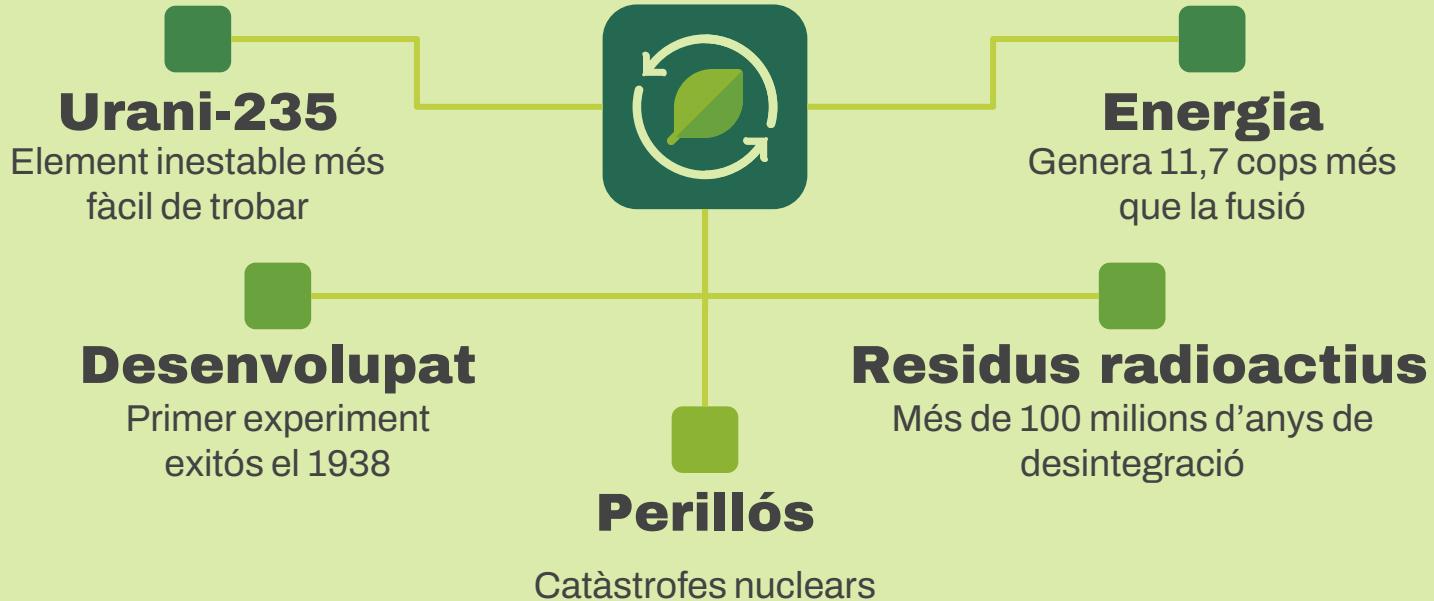
Fig. 2: Illustration of the tokamak control by the AI tearing-avoidance system and the plasma responses.

From: [Avoiding fusion plasma tearing instability with deep reinforcement learning](#)



Imatge 3. Explicació de com la IA ajuda en la fusió nuclear en l'experiment.

## 4.2 L'actualitat i el futur de la fissió nuclear



## 4.2.1 Reactor de sals foses



### Més eficient

Opera a temperatures més altes - 700° comparat amb 300°



### Autoregulatori

La temperatura de la reacció no pot superar la del refrigerant



### Més segur

L'aigua de refrigeració opera a pressions més baixes



### Reutilització de residus

Combustible fissionable, pot ser tori, urani o plutoni



### Més petit

Els reactors ocupen menys espai

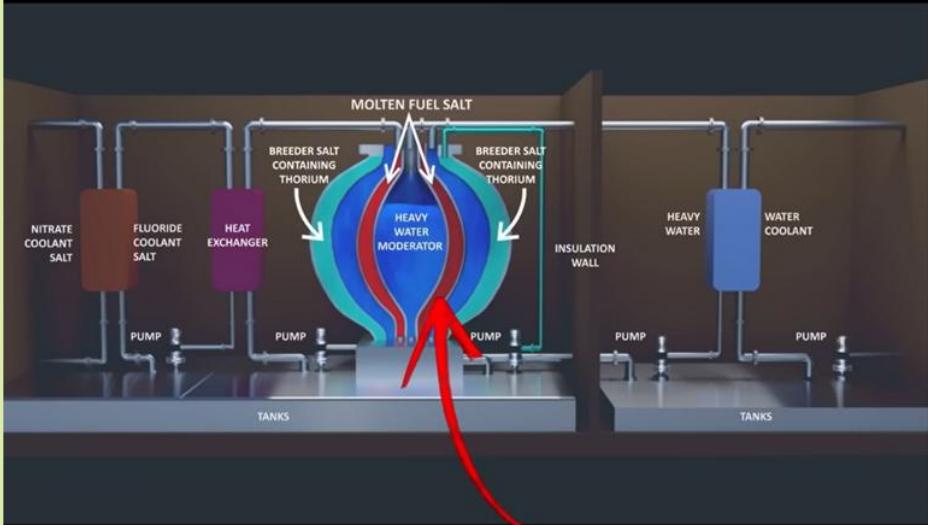


### Corrosiu

Materials no corrosius o evitar el contacte amb l'oxigen

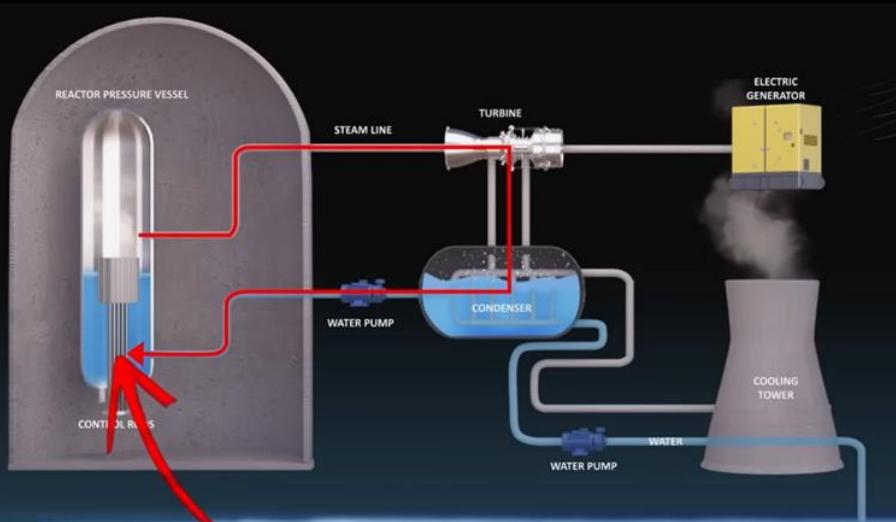
## 4.2.1 Reactor de sals foses

### Molten Salt Reactors



Fuel is in molten liquid form

### Conventional nuclear power plant



Fuel is solid inside the fuel rods

imatge 4. Comparativa de dos tipus de reactors nuclears de fissió.

## 4.2.2 La Xina anuncia el reactor de tori i sals foses

2011	Inverteixen 8M en energia nuclear
2018	Construcció i disseny del projecte TMSR-LF1 en el desert de Gobi
2021	Acaba la construcció
2023	Reben permís d'ús del projecte per fer una prova pilot
2024	Anunci d'un projecte que serà com el projecte pilot a gran escala.
2025-6	Permís construcció del projecte
2029	Projecte completament operacional

### Tori

- Menys fissionable → reacció més estable i controlada
- Deriva en menys residus actinoides (actini fins a lawrenci)
- Vida mitja més alta que l'urani
- 3 cops més abundant en la natura que l'urani

lanthanoid series	6	58 Ce 140.118	59 Pr 140.90706	60 Nd 144.242	61 Pm 145	62 Sm 150.96	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.5	67 Ho 164.93028	68 Er 167.259	69 Tm 168.93428	70 Yb 172.043	71 Lu 173.958
actinoid series	7	90 Th 232.0377	91 Pa 231.05688	92 U 238.02881	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (241)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (268)	102 No (268)	103 Lr (267)

\*Numbering system adopted by the International Union of Pure and Applied Chemistry (IUPAC). © Encyclopædia Britannica, Inc.

Imatge 5. Taula periòdica dels elements retallada.

## 4.2.3 Extra

Terra Power	Estats Units	Reactor de sals foses, en comptes de fer servir urani fer servir sodi (Na).
Naarea	Europa	Reactors nuclears de sals foses amb tori minis (40 Watts).
Thorizon		Reactors nuclears de sals foses amb tori (100 Watts).



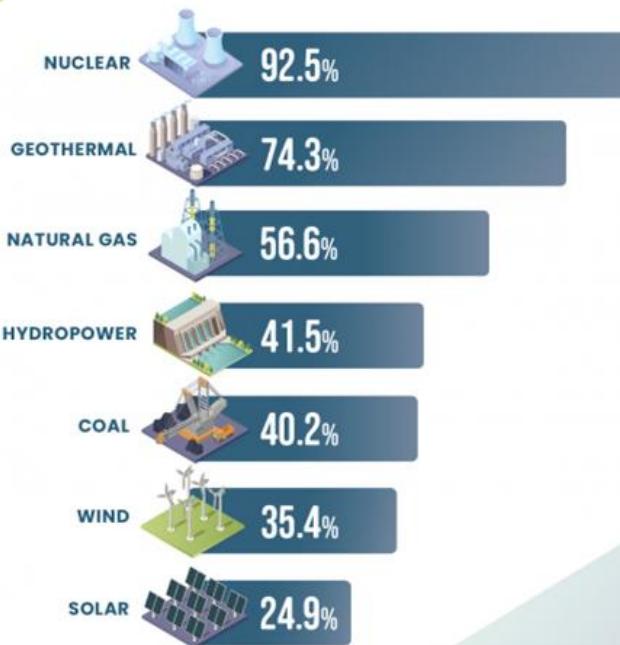
# 05

# NUCLEAR VS RENOVABLES

- 5.1. Producció d'energia
- 5.2. Impacte ambiental
- 5.3. Eficiència energètica
- 5.4. Emissions de CO<sub>2</sub>
- 5.5. Disponibilitat de recursos

# 5.1 Producció d'energia

## Factor de capacitat



## NUCLEAR

Produeixen energia de forma constant, independentment del clima.

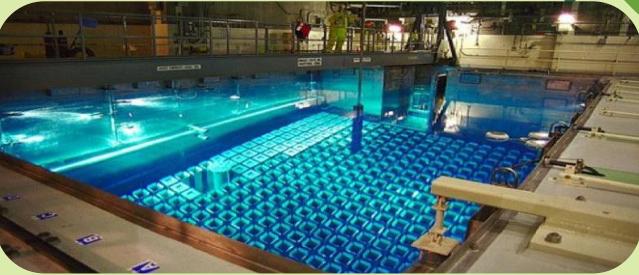


## RENOVABLES

Depenen de factors climàtics (sol, vent, cabal d'aigua, ...)

## 5.2 Impacte ambiental

- **Almacenamiento inicial.** El combustible gastado se almacena por unos pocos años para reducir la carga calorífica en las piscinas de combustible gastado de las centrales nucleares.
- **Almacenamiento intermedio.** Se almacena a medio o largo plazo (entre 20 y 60 años) en las piscinas de combustible gastado o en contenedores en seco, en los Almacenes Temporales Individualizados (ATI) del emplazamiento de las centrales que disponen del mismo.
  - También puede almacenarse en un Almacén Temporal Centralizado (ATC), independientemente al emplazamiento de las centrales nucleares, por un periodo de 60 o 100 años.
- **Almacenamiento definitivo.** Dado el largo periodo de actividad de estos residuos, el Almacenamiento Geológico Profundo (AGP) es la opción internacionalmente aceptada para la gestión final de los residuos radiactivos de alta actividad. En el concepto de diseño multibarrera, es clave la barrera geológica.



## 5.3 Eficiència energètica

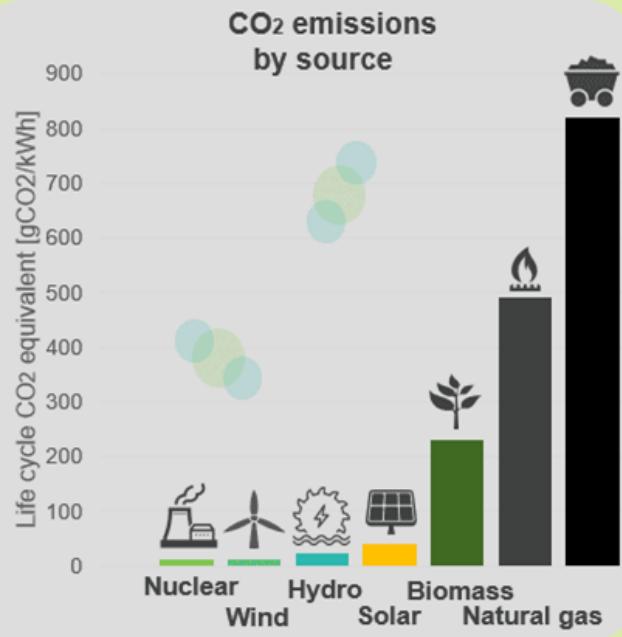
Central nuclear  
d'Ascó  
 $1,12 \text{ km}^2$   
16.232 GWh a l'any

Generación Eólica  
de Castilla-La  
Mancha  
 $80 \text{ km}^2$   
1.000 GWh a l'any

Planta solar Nuñez  
de Balboa  
 $10 \text{ km}^2$   
832 GWh a l'any

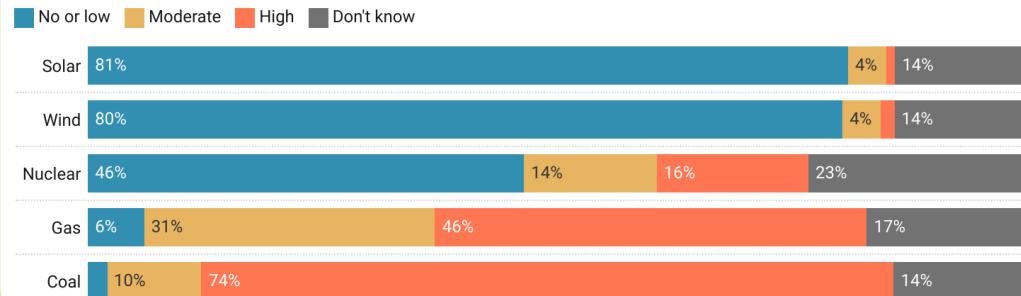


## 5.4 Emissions de CO<sub>2</sub>



### Public opinion in the UK on which energy sources are low-carbon

Over 3000 adults in the UK were asked: "For each of the following forms of energy, please say what level of carbon emissions you think each produces."

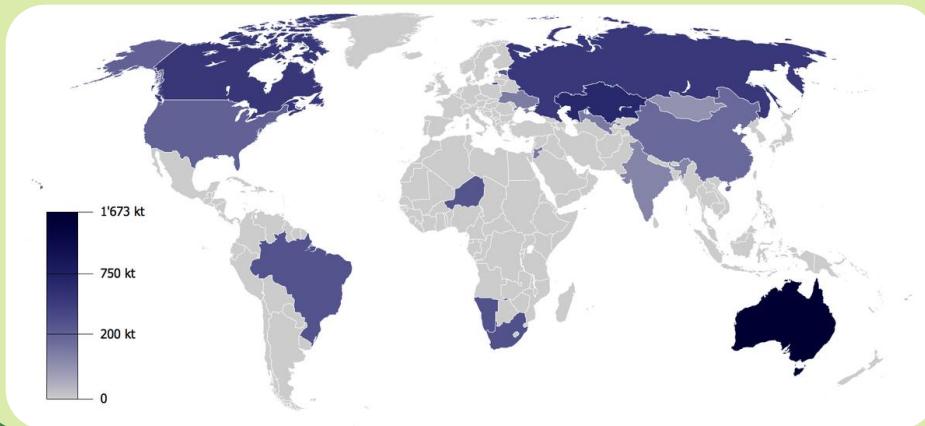


## 5.5 Disponibilitat de recursos



### RENOVABLES

Energia inesgotable (sol, vent)



1. Kazakhstan
2. Namibia
3. Canada
4. Australia
5. Rússia

Torio como combustible nuclear



06

# CONCLUSIONS

# 6. Conclusions

## Nuclear:

- Molt eficient
- Molt poques emissions CO<sub>2</sub>
- Gestió de residus!!

## Renovables:

- Inesgotable
- Poques emissions de CO<sub>2</sub>
- No genera residus perillosos
- Dependents del clima



## Futur:

- A. Fusió nuclear
- B. Energia nuclear + renovables



07

# BIBLIOGRAFIA

# 7. Bibliografia

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- Imatge 2: <https://www.vecteezy.com/free-png/men-holding-hands>
- Imatge 3:<https://www.weforum.org/agenda/2024/02/nuclear-fusion-science-explained/>
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<https://doi.org/10.1016/j.rser.2013.01.035>



# GRÀCIES!

# A PARTIR D'AQUI TOT ES TEMPLATEEEEEE

Albert Bausili, Alex Mitjans i Noa Yu Ventura



## ABOUT THE CAMPAIGN

Do you know what helps you make your point clear? Lists like this one:

- They're simple
- You can organize your ideas clearly
- You'll never forget to buy milk!

And the most important thing: the audience won't miss the point of your presentation



01

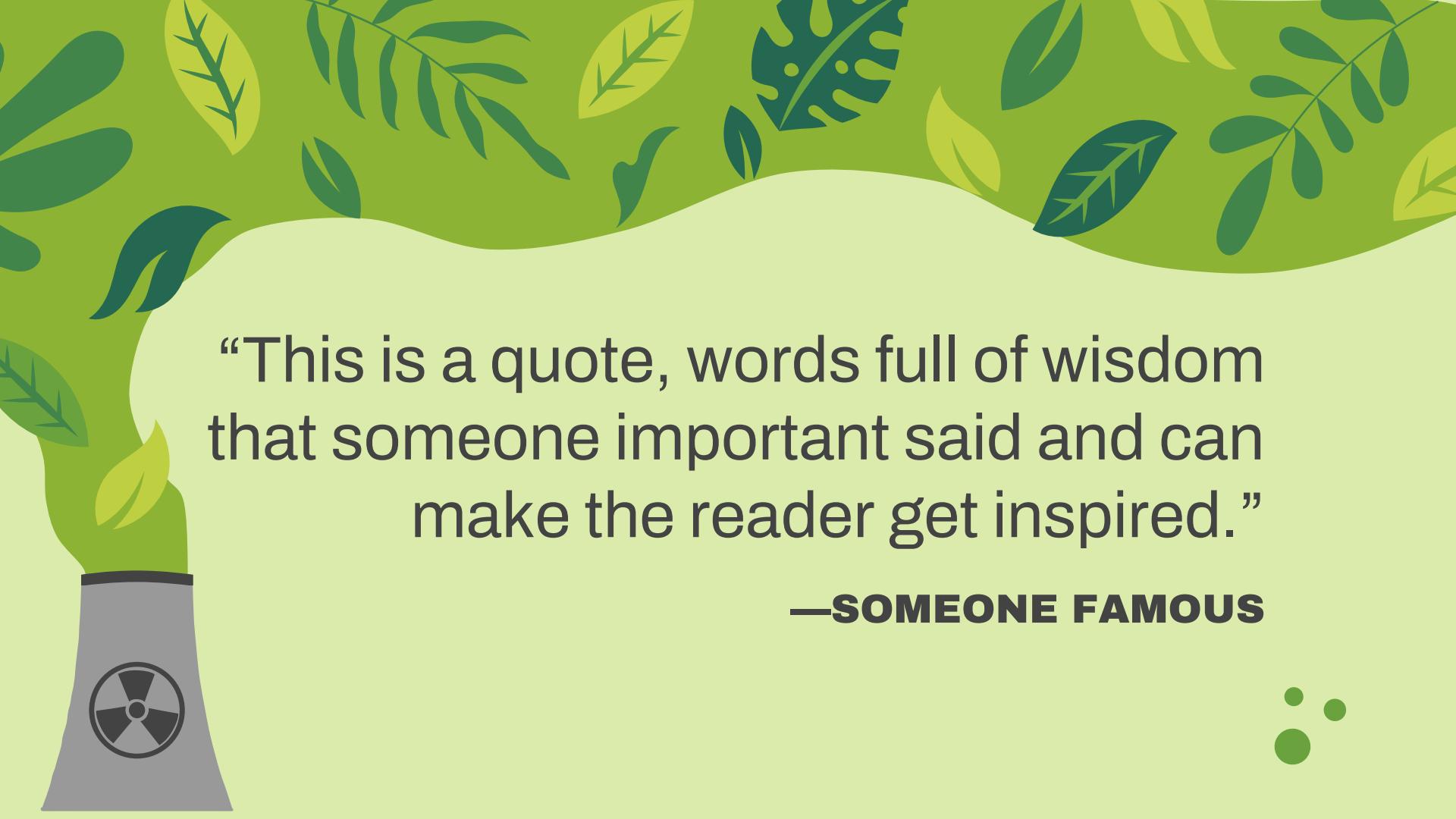
# ABOUT US

You can enter a subtitle here if you need it

# OUR COMPANY

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon. This planet's name has nothing to do with the liquid metal, since Mercury was named after a Roman god





“This is a quote, words full of wisdom that someone important said and can make the reader get inspired.”

—**SOMEONE FAMOUS**





A PICTURE IS WORTH A  
THOUSAND WORDS



**367,000**

Big numbers catch your audience's attention

# OUR GOALS



## MARS

Despite being red, Mars is actually a cold place. It's full of iron oxide dust



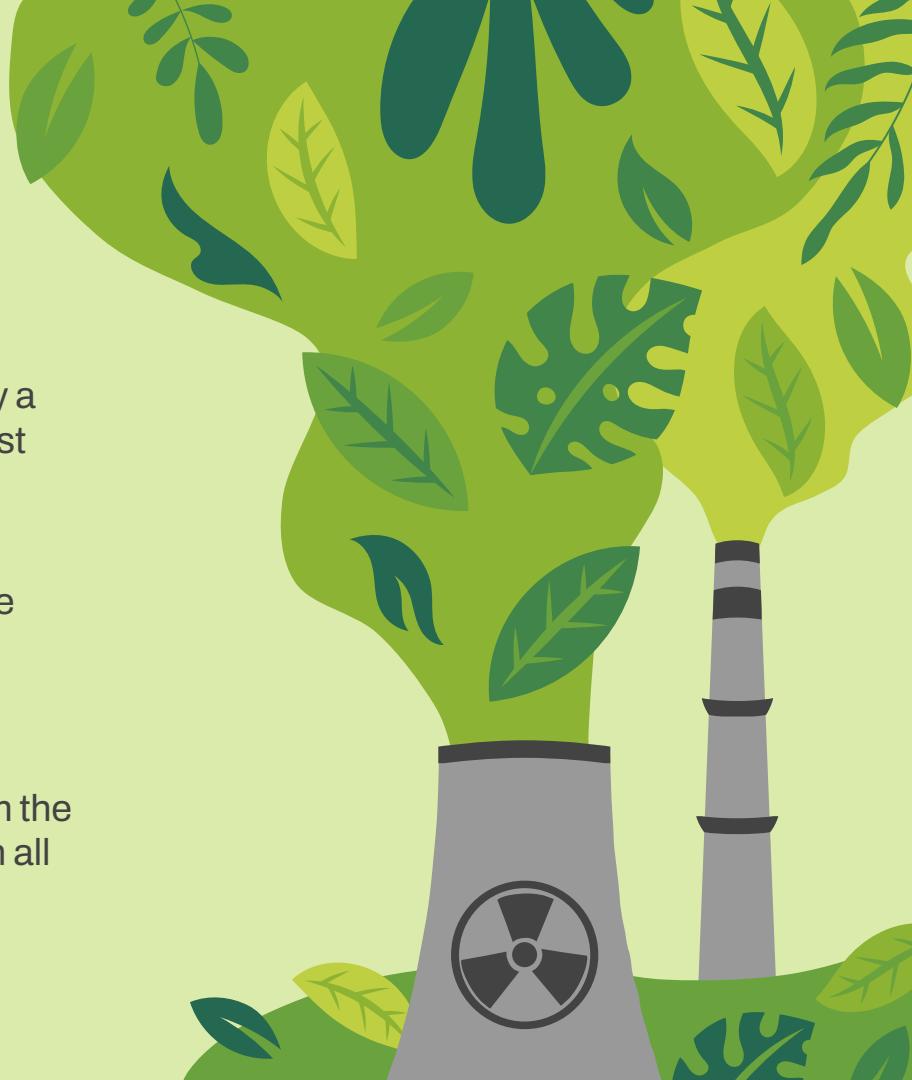
## MERCURY

Mercury is the closest planet to the Sun and the smallest of them all



## NEPTUNE

Neptune is the farthest planet from the Sun and the fourth-largest of them all



# WHAT SETS US APART?



## MARS

Despite being red, Mars is actually a cold place



## JUPITER

Jupiter is the biggest planet in the Solar System



## VENUS

Venus is the second planet from the Sun



## SATURN

Saturn is a gas giant and has several rings



# **AWESOME WORDS**



# CORE VALUES



## MERCURY

Mercury is the closest planet to the Sun



## SATURN

Saturn is a gas giant and has rings



## NEPTUNE

Neptune is very far away from us



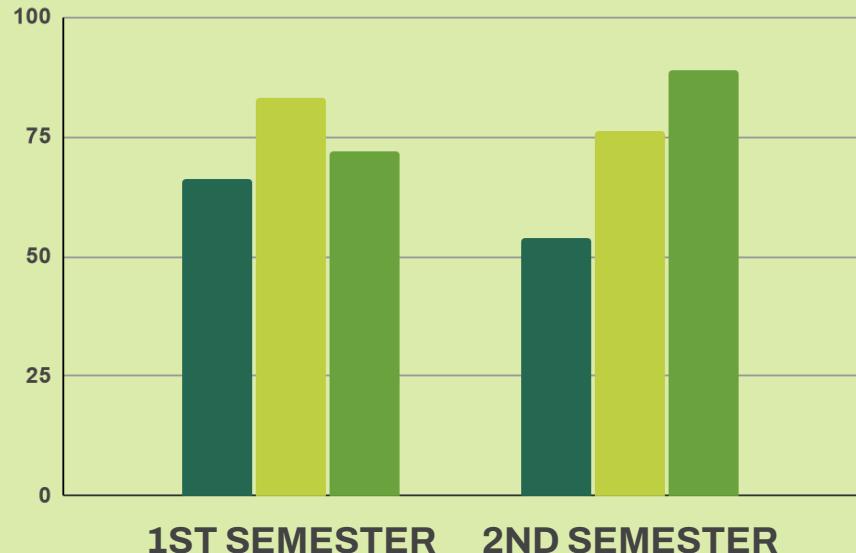
## VENUS

Venus is the second planet from the Sun

## MARS

Mars is actually a very cold place

# MARKET SHARE



## 1ST SEMESTER

Neptune is the fourth-largest planet in the Solar System

## 2ND SEMESTER

Mercury is the closest planet to the Sun and the smallest of them all



MARS



SATURN

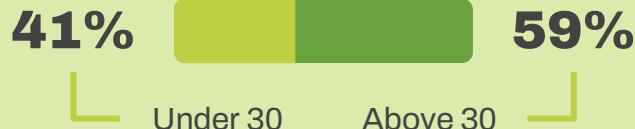


VENUS

Follow the link in the graph to modify its data and then paste the new one here. [For more info, click here](#)

# CORE CUSTOMER AUDIENCE

## AGE



## INTERESTS



- Mars is very cold
- The Earth has life
- Neptune is far away

## AVERAGE INCOME

\$72,000

Yearly income

## LOCATION

### VENUS

Venus has a beautiful name

### MERCURY

Mercury is quite a small planet



# COMPETITOR ANALYSIS

## STRENGTHS



- You can list your competitor's strengths here

## WEAKNESSES



- You can list your competitor's weaknesses here

# MARKET SEGMENTATION



**40%**

## MERCURY

Mercury is quite a small planet

**27%**

## MARS

Despite being red, Mars is cold

**23%**

## VENUS

Venus has a beautiful name

**10%**

## EARTH

Earth is a planet that has life

Follow the link in the graph to modify its data and then paste the new one here. [For more info, click here](#)

# STRATEGY

Venus is the second planet from the Sun

## VENUS

STEP 1



## SATURN

Saturn is a gas giant and has several rings



STEP 2

STEP 3



## NEPTUNE

Neptune is the farthest planet from the Sun

## MARS



STEP 4

STEP 5



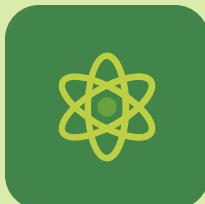
## JUPITER

Jupiter is the biggest planet of them all

# WHAT OUR PROPOSAL IS

## MARS

Despite being red, Mars is actually a very cold place



## NEPTUNE

Neptune is the fourth-largest planet in the Solar System



## SATURN

Saturn is composed mostly of hydrogen and helium

## JUPITER

Jupiter is a gas giant and the biggest planet in the Solar System

# PRICING



**\$20**

## BASIC

Mercury is the closest planet to the Sun and also the smallest one in the Solar System

**\$22**

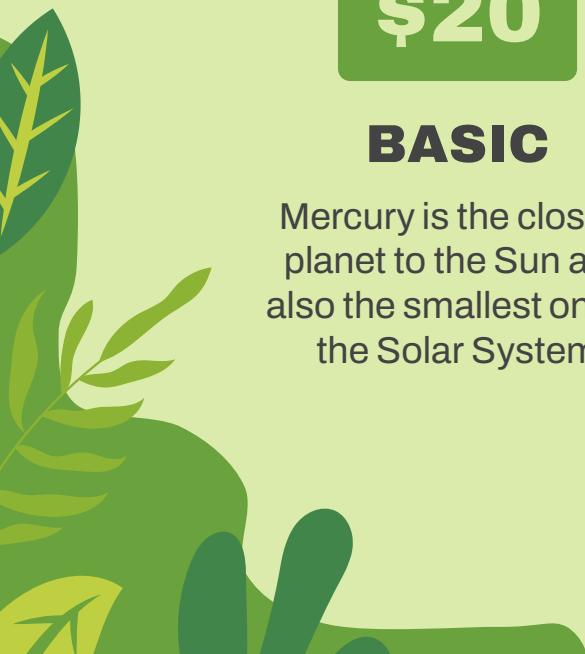
## PRO

Venus has a beautiful name and is the second planet from the Sun. It's terribly hot

**\$28**

## PREMIUM

Neptune is the farthest planet from the Sun and the fourth-largest in the Solar System



# DISTRIBUTION CHANNELS



# PROMOTION



## MULTIMEDIA

Venus is the second planet from the Sun



## DIGITAL

Mercury is the closest planet to the Sun



## PRESS

Mars is actually a very cold place



## PODCAST

Jupiter is the biggest planet of them all



## MOBILE APP

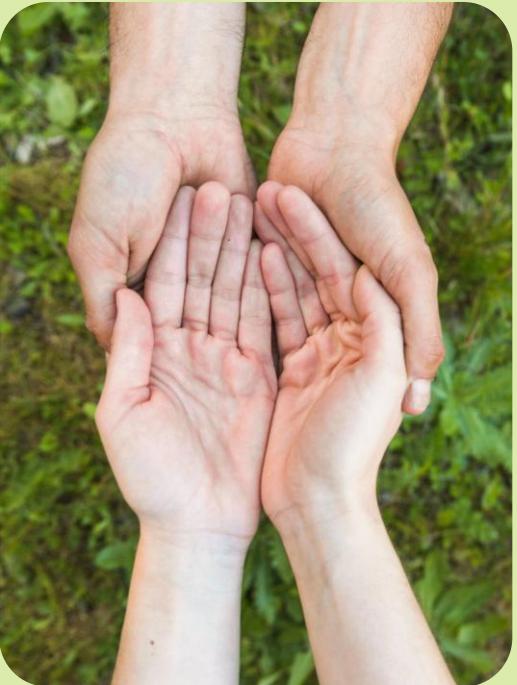
Saturn is composed of hydrogen and helium



## TV

Neptune is the farthest planet from the Sun

# ADVERTISING CAMPAIGN 1



## DESCRIPTION

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon

## CHANNEL

Social media

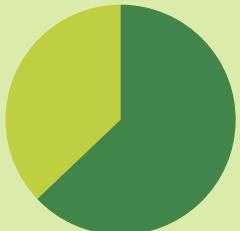
## BUDGET

**\$25,000**

# ADVERTISING CAMPAIGN 2

## GOALS

- Venus has a poisonous atmosphere
- Despite being red, Mars is very cold
- Jupiter is the biggest planet of them all
- Earth is the planet with life



Profit

## MAIN POINTS



Neptune



Mars

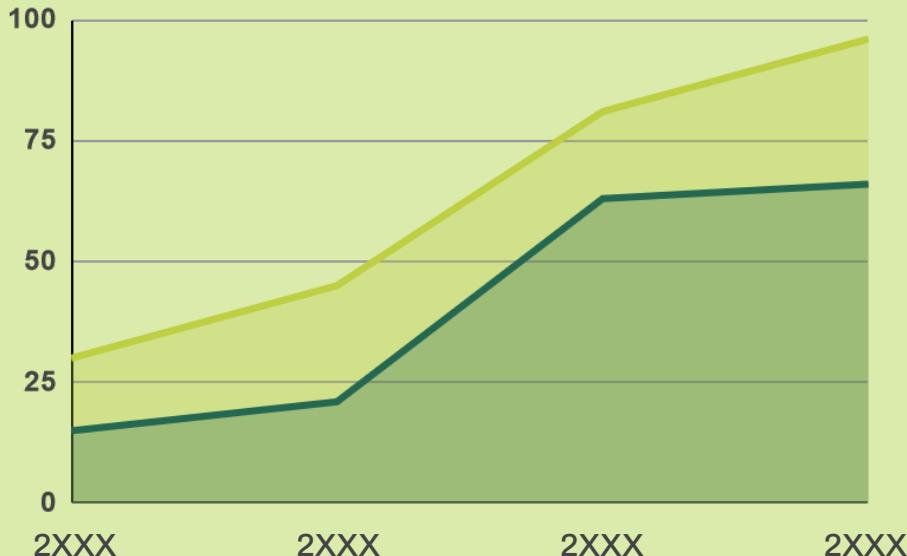


Jupiter

## DESCRIPTION

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon

# PREDICTED REACH



**95%**

**MARS**

Despite being red, Mars  
is a cold place

**67%**

**MERCURY**

Mercury is the closest  
planet to the Sun

Follow the link in the graph to modify its data and then paste the new one here. [For more info, click here](#)

# PR OUTREACH



**80%**

Despite being red,  
Mars is very cold



**65%**

Neptune is very far  
away from us



**45%**

Earth is also known  
as the Blue Planet

## CHANNELS



## KEY MESSAGES

Earth is the third planet from the Sun and the only one that harbors life in the Solar System

# BUDGET ALLOCATION

	AREA I	AREA II	AREA III	TOTAL
JUPITER	\$1,300	\$3,200	\$1,700	\$6,200
MERCURY	\$2,400	\$2,700	\$2,800	\$7,900
SATURN	\$800	\$600	\$1,300	\$2,700
VENUS	\$4,500	\$4,200	\$3,700	\$12,400
NEPTUNE	\$1,800	\$2,000	\$1,200	\$5,000

# OUR TEAM



**SARAH COLE**

You can replace the image  
on the screen with your own



**TOM EVANS**

You can replace the image  
on the screen with your own



**LISA SMITH**

You can replace the image  
on the screen with your own

# TIMELINE

## VENUS

Venus is the second planet from the Sun



## MARS

Despite being red, Mars is a cold place



## NEPTUNE

Neptune is very far away from the Sun



## MERCURY

Mercury is the closest planet to the Sun



## SATURN

Saturn is a gas giant and has several rings





# MULTIMEDIA

You can replace the image on the screen with your own work. Just right-click on it and select “Replace image”

# THANKS!

Do you have any questions?

[youremail@freepik.com](mailto:youremail@freepik.com)

+91 620 421 838

[yourwebsite.com](http://yourwebsite.com)



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# ICON PACK



# ALTERNATIVE RESOURCES

Here's an assortment of alternative resources whose style fits that of this template:

## VECTORS

- Flat design different green leaves
- Hand drawn ecology concept twitch background
- Hand drawn ecology concept twitter header



# RESOURCES

Did you like the resources on this template?

Get them for free at our other websites:

## ICONS

- Flat green house icon pack

## VECTORS

- Hand drawn ecology concept facebook post
- Hand drawn ecology concept twitch background
- Hand drawn ecology concept twitter header
- Hand drawn ecology concept youtube thumbnail
- Realistic power plant illustration

## PHOTOS

- Concept plant in glass bulb
- Crop hand with eco leaves symbol
- Female hands in protection above grass
- Front view of smiley man posing outdoors
- Middle age woman smiling and having a good time
- Side view hands keeping in field
- Young and beautiful woman having online meeting



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(<https://fonts.google.com/specimen/Archivo>)

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#becf41

#8cb333

#6aa23d

#41854a

#256851

# Storyset

Create your Story with our illustrated concepts. Choose the style you like the most, edit its colors, pick the background and layers you want to show and bring them to life with the animator panel! It will boost your presentation. Check out [how it works](#).



Pana



Amico



Bro



Rafiki



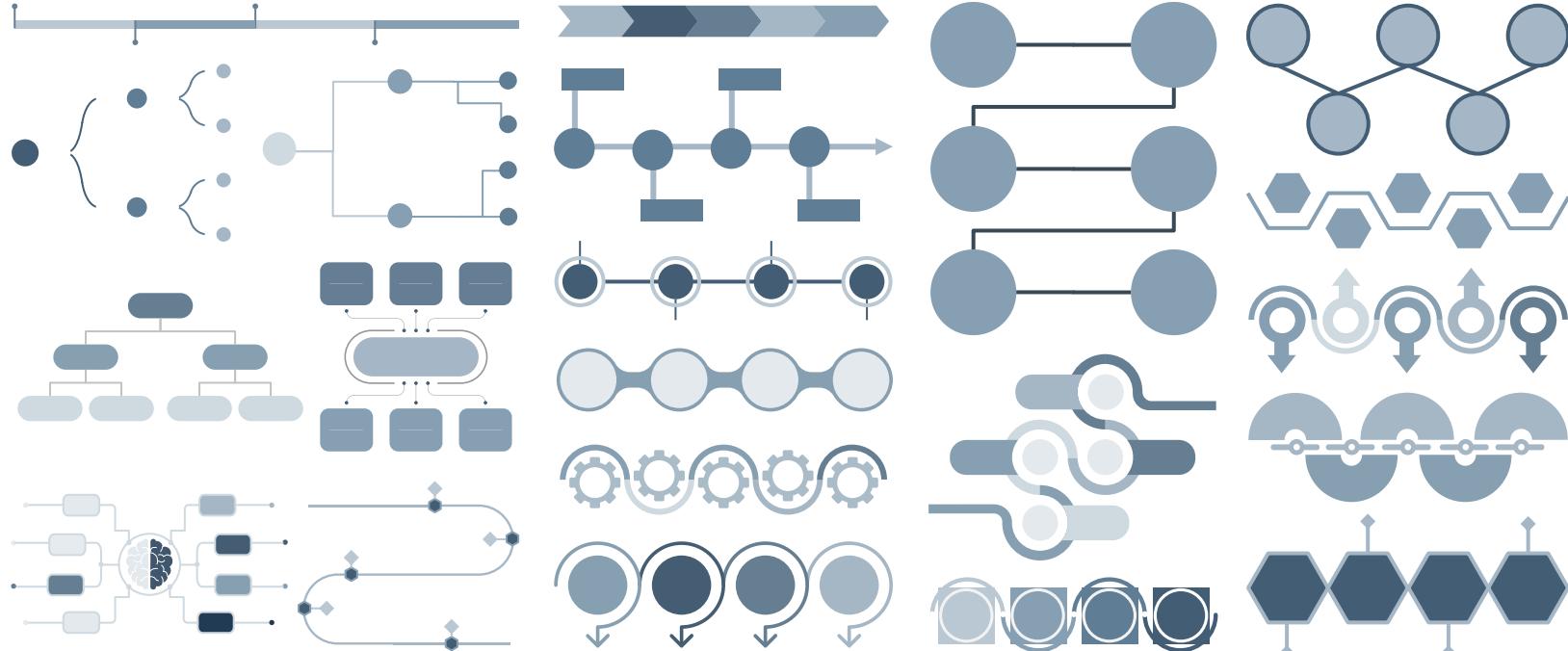
Cuate

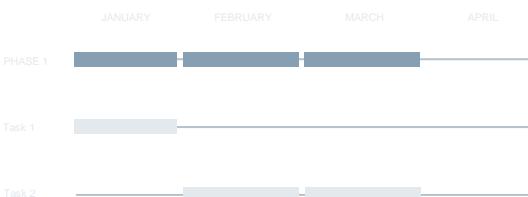
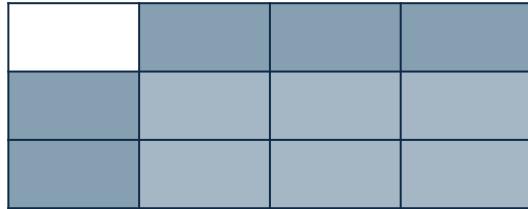
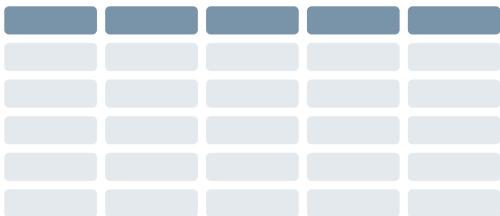
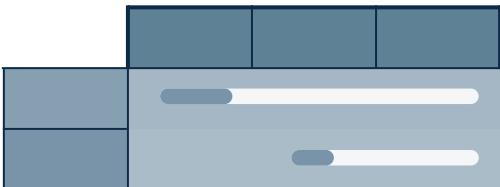
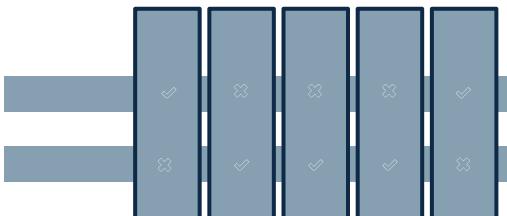
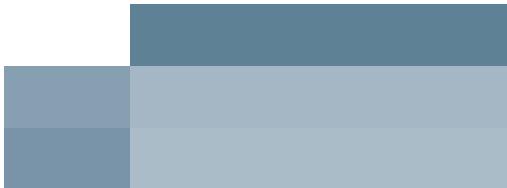
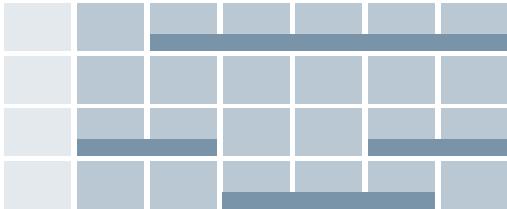
# Use our editable graphic resources...

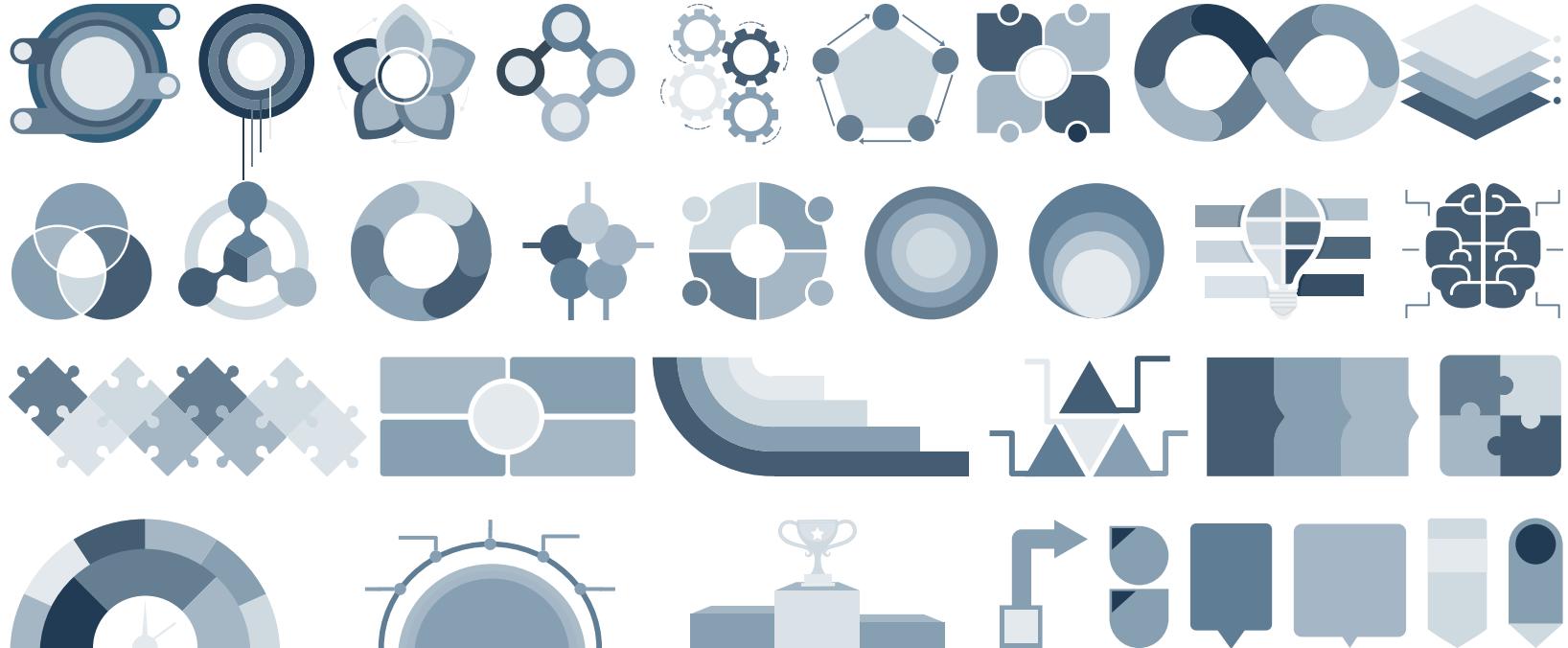
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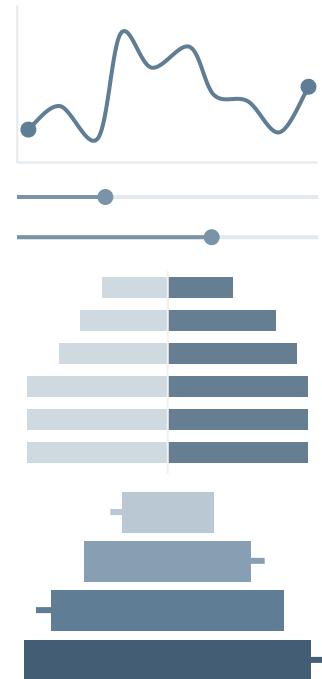
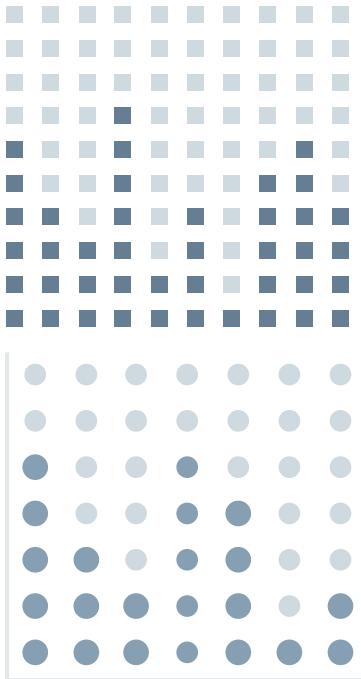












# ...and our sets of editable icons

You can **resize** these icons without losing quality.

You can **change the stroke and fill color**; just select the icon and click on the **paint bucket/pen**.

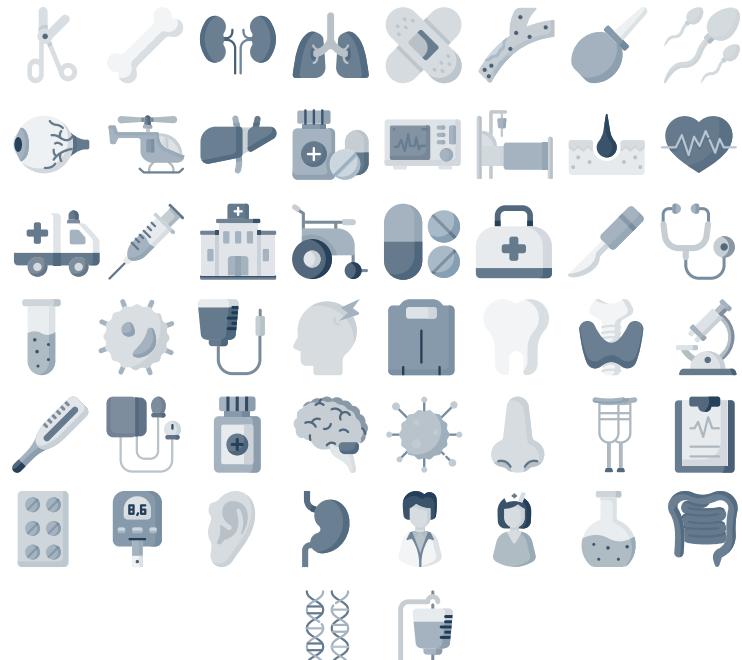
In Google Slides, you can also use **Flaticon's extension**, allowing you to customize and add even more icons.



## Educational Icons



## Medical Icons



# Business Icons



# Teamwork Icons



# Help & Support Icons



# Avatar Icons



## Creative Process Icons



## Performing Arts Icons

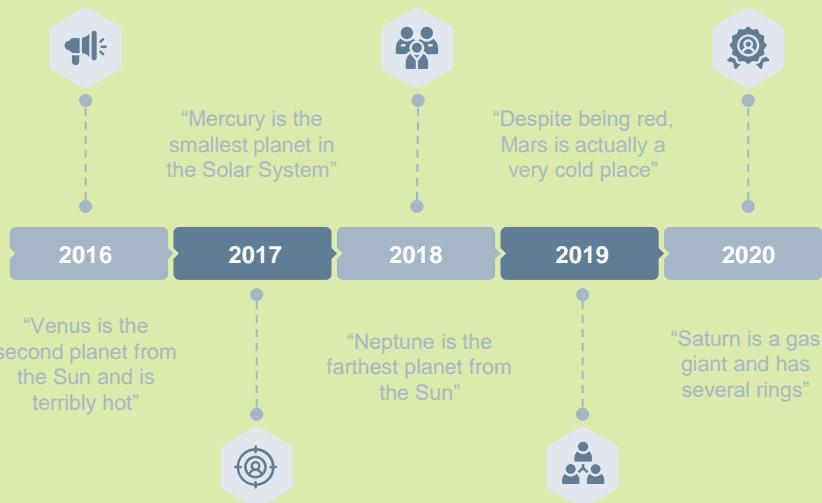


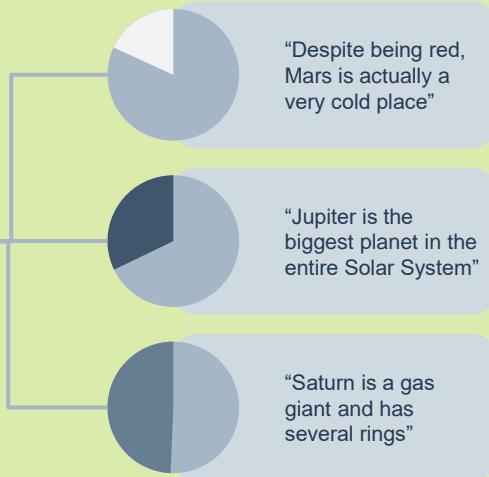
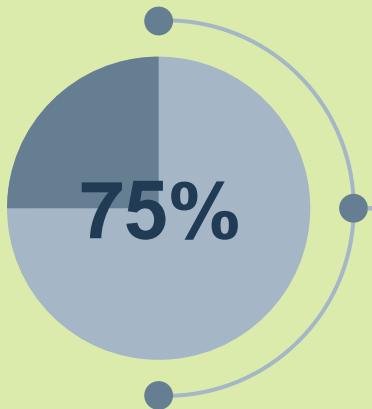
# Nature Icons

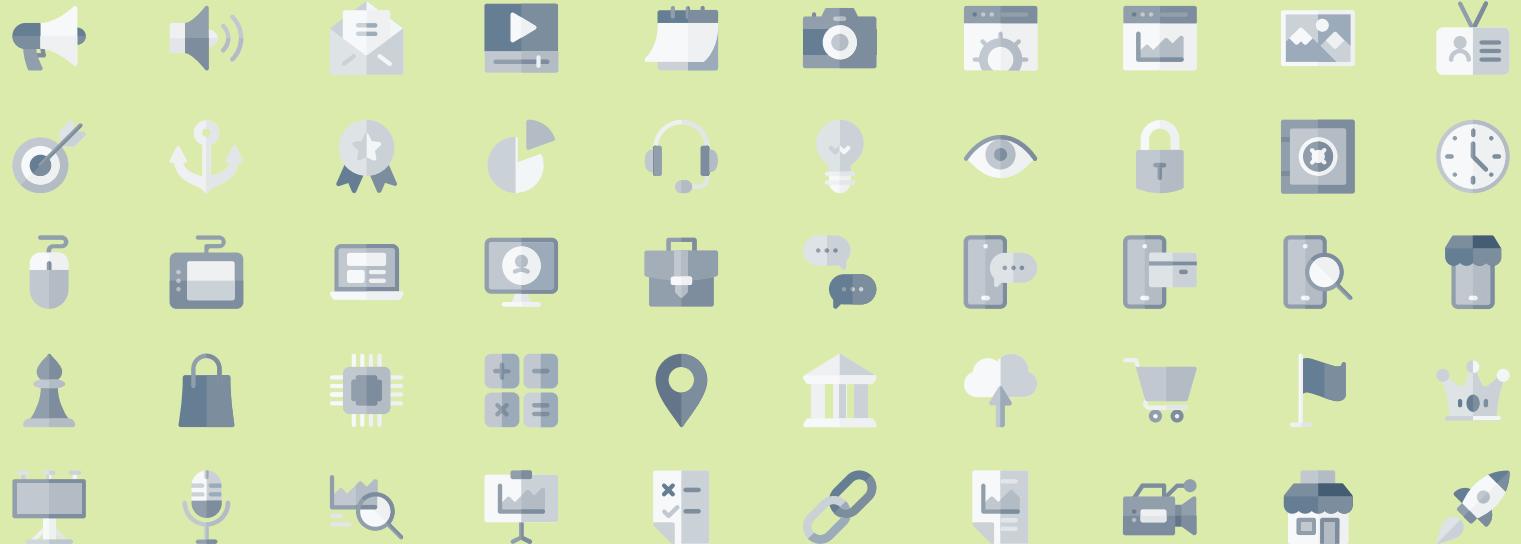


# SEO & Marketing Icons













## Goals & Results



