UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA

HEXAGENERATION ENERGY PLANT FROM SEAWATER AND AIR

CEANI-SIANI ULPGC (Spain)

LAS PALMAS DE GRAN CANARIA UNIVERSITY (SPAIN)

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Lourdes Trujillo Castellano

Date: 18/05/2022

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1.- Design Evolution

2.- Description of the final proposal

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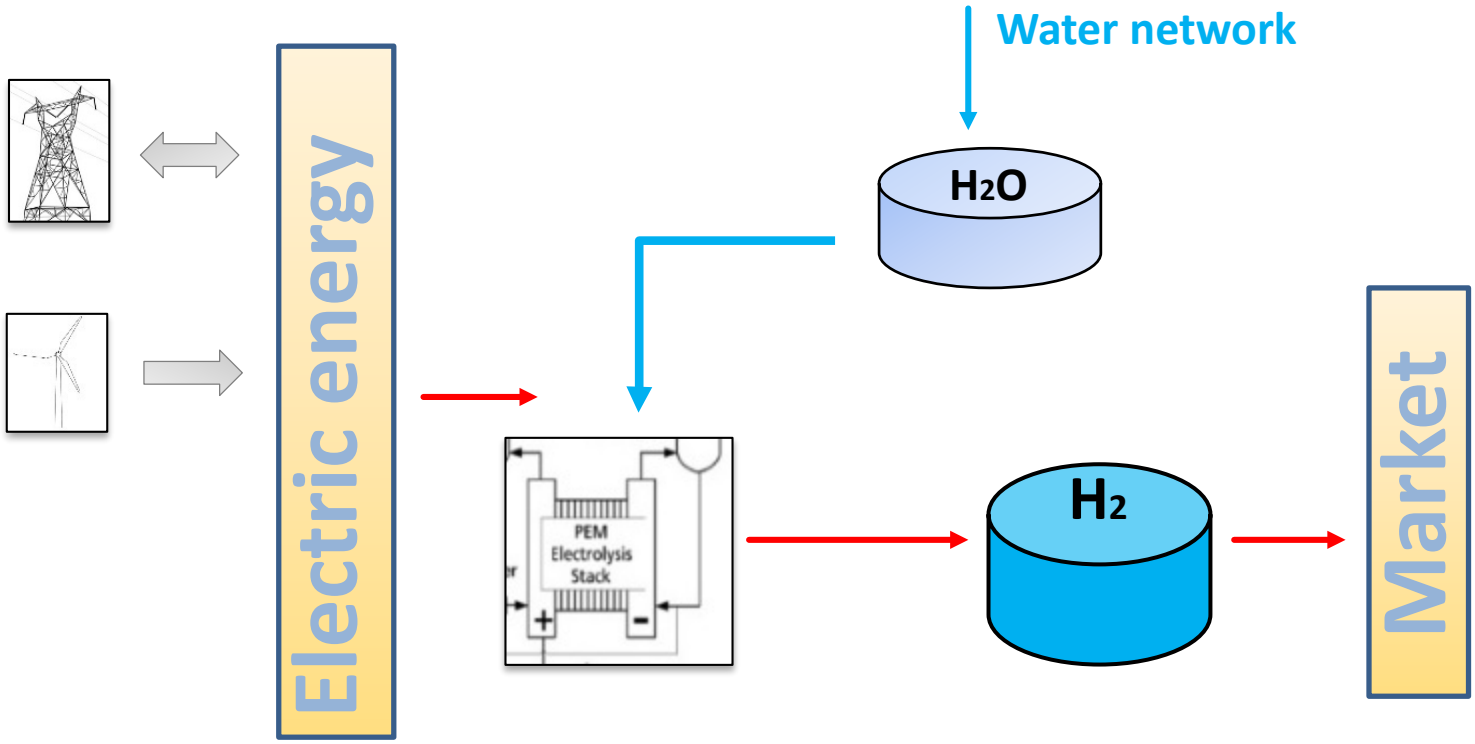
- **Features of offshore wind**

- Decrease environmental impact
- No land occupation
- Higher wind speed and stability, more kWh/kW
- Less turbulence can increase service life

- **Features of green hydrogen**

- Does not cause GHG emissions
- Low bulk density
- Use where produced
- Difficult to transport and store
- Requires water for its production

- **Green hydrogen production**



1º design

Hydrogen station

1ºDesign

The implementation of the first hydrogen station in the island will serve as a catalyst for other companies to add them to existing, or new service stations, and for the appearance of vehicles equipped with fuel cells.

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Fresh water in Canary islands

The water cycle in Canary Islands accounts for more than 20% of the total electrical energy consumed.

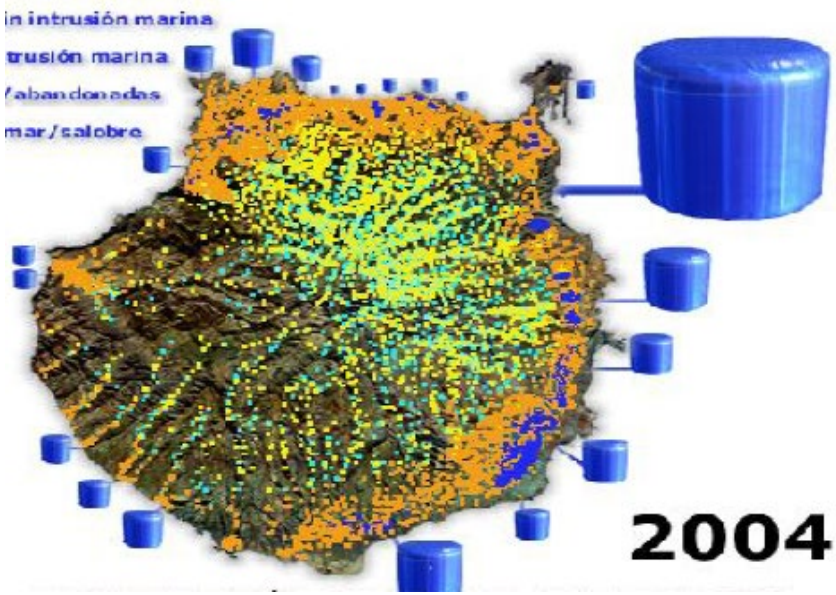
Percentage of desalinated water, with respect to consumption on each island:

Lanzarote	100%
Fuerteventura	100%
El Hierro	90%
Gran Canaria	86%
Tenerife	47%

1.- Need for water

• Fresh water in Canary islands

1904



2004

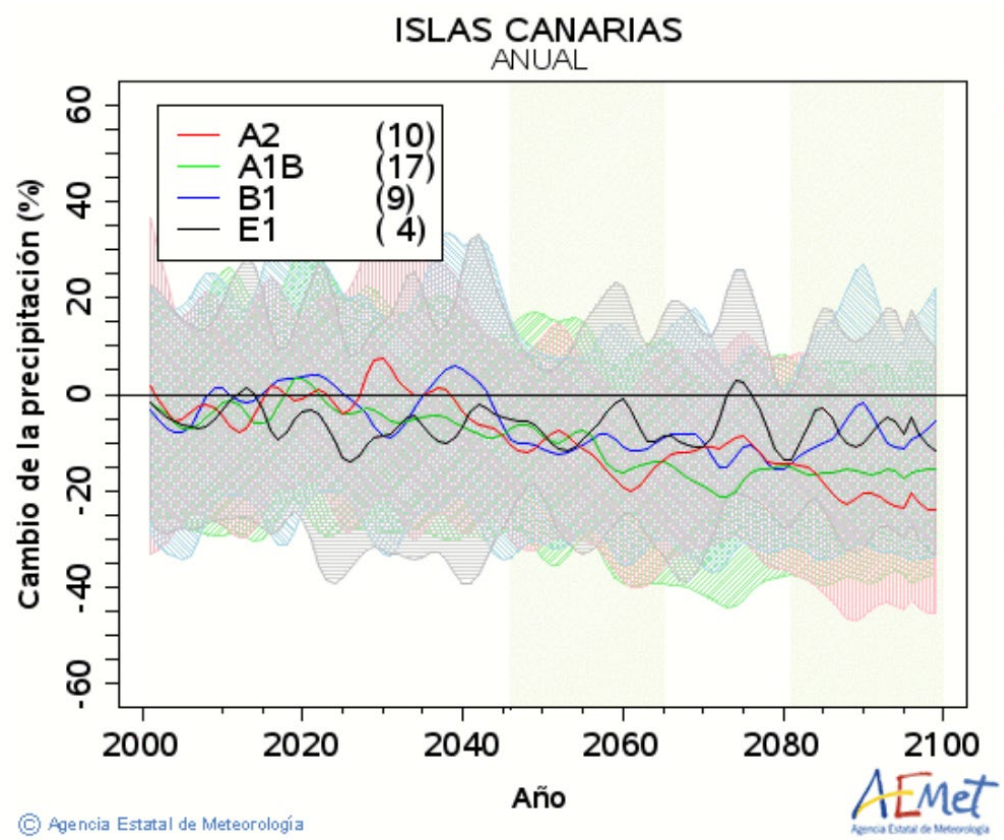
- Dry well
- Brackish well

https://www.eldia.es/la-gomera/2020/06/11/san-sebastian-gomera-limita-usos/1085927.html

https://www.eldia.es/canarias/2020/02/16/amenaza-emergencia-hidrica-planea-canarias/1051885.html

http://www.rtvc.es/noticias/situacion-alarmante-de-las-presas-de-la-gomera-217572.aspx#.X1aO1ot7nZY

• Fresh water in Canary islands



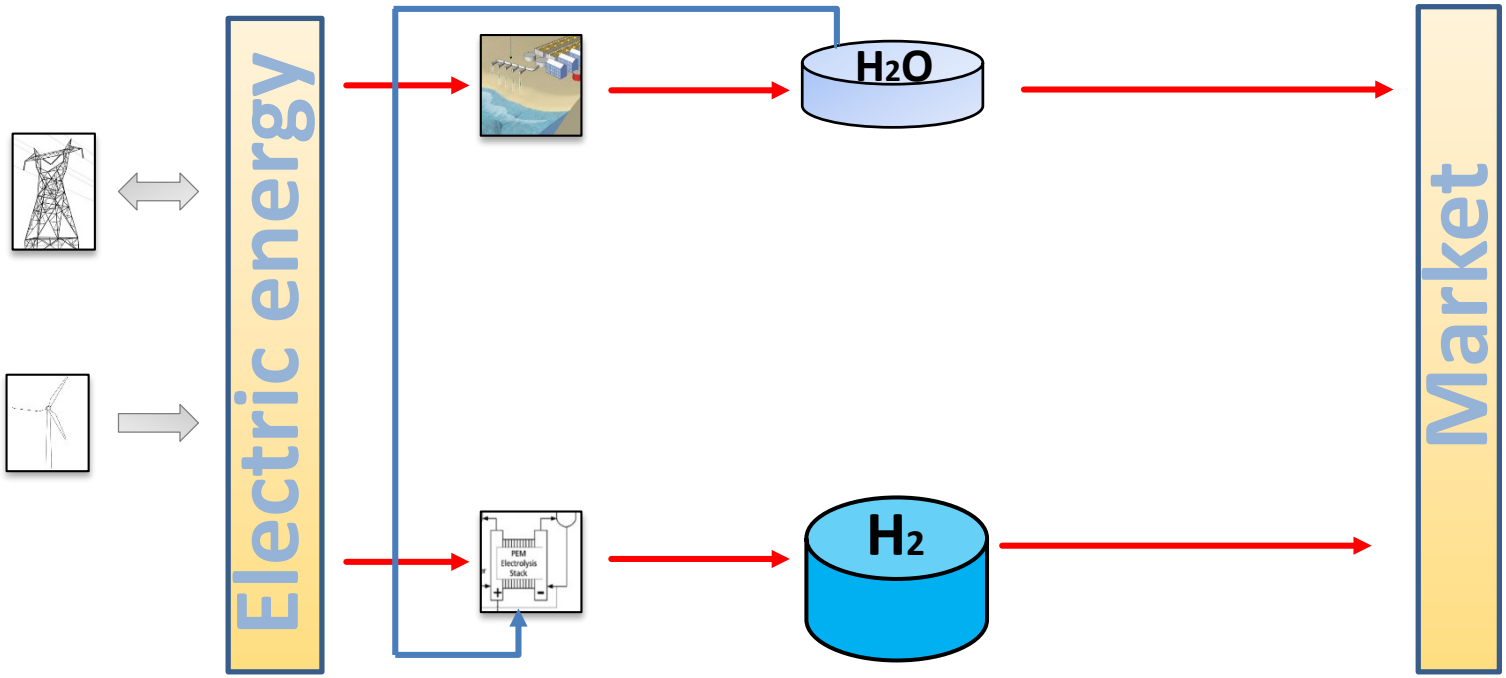
Evolution of rainfall in Canary Islands due to Climate Change
With different models used by AEMET, a reduction of between 10-20% for the year 2,100

• Fresh water in Canary islands

- Gran Canaria is the island in the world with the largest water storage capacity per surface. It has 69 large dams.
- There are many reservoirs on the islands. The islands have considerable heights, with the idea of pumped storage.

- **Green hydrogen and water production**

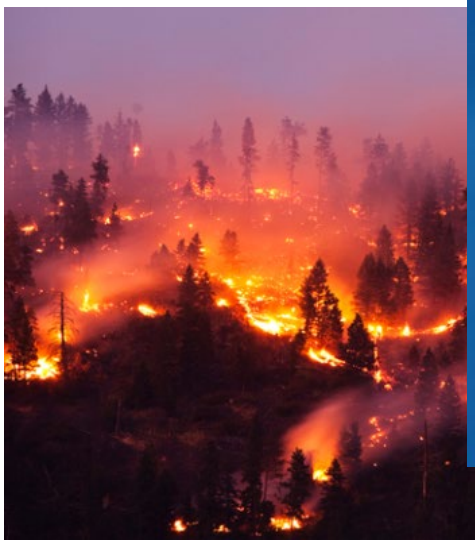
2ºDesign

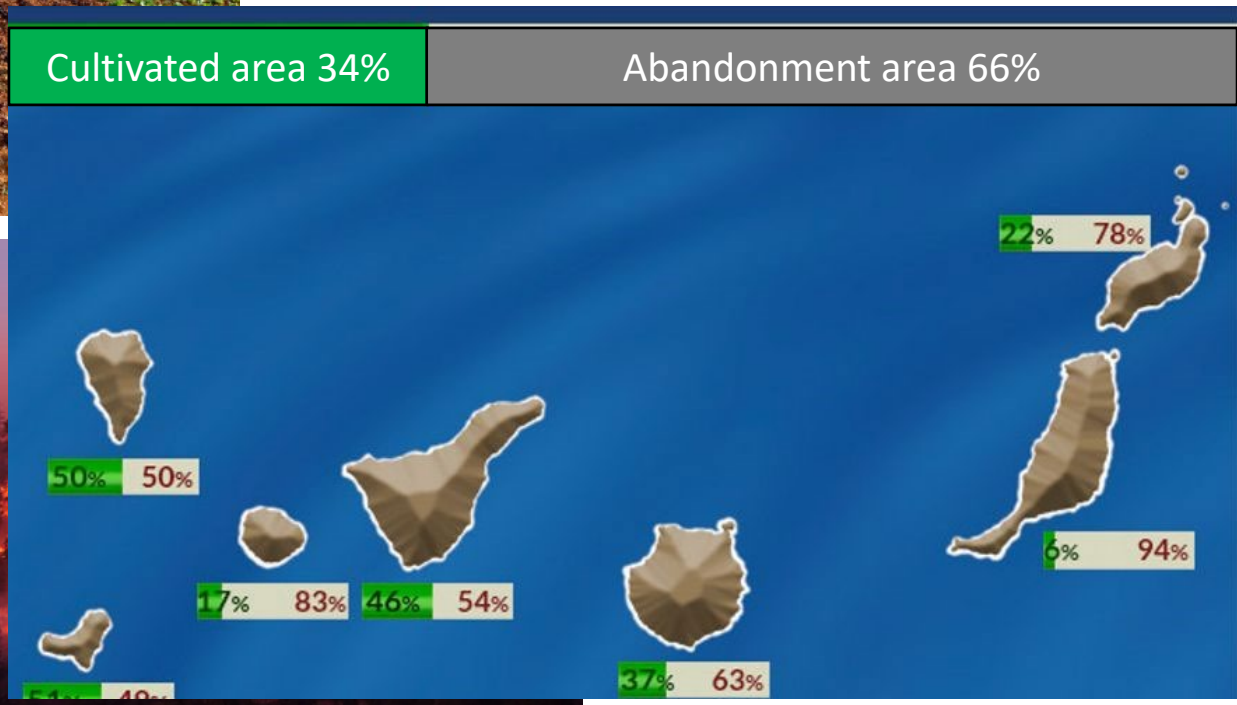


2º design

• Food dependency and agriculture

2.- Farmland abandonment





https://www.canarias7.es/canarias/gran-canaria/superficie-agricola-cultivada-20201026003307-nt.html
https://www.eldiario.es/canariasahora/agricola/agricultura/agricultura-canarias-sector-primario_1_1891434.html

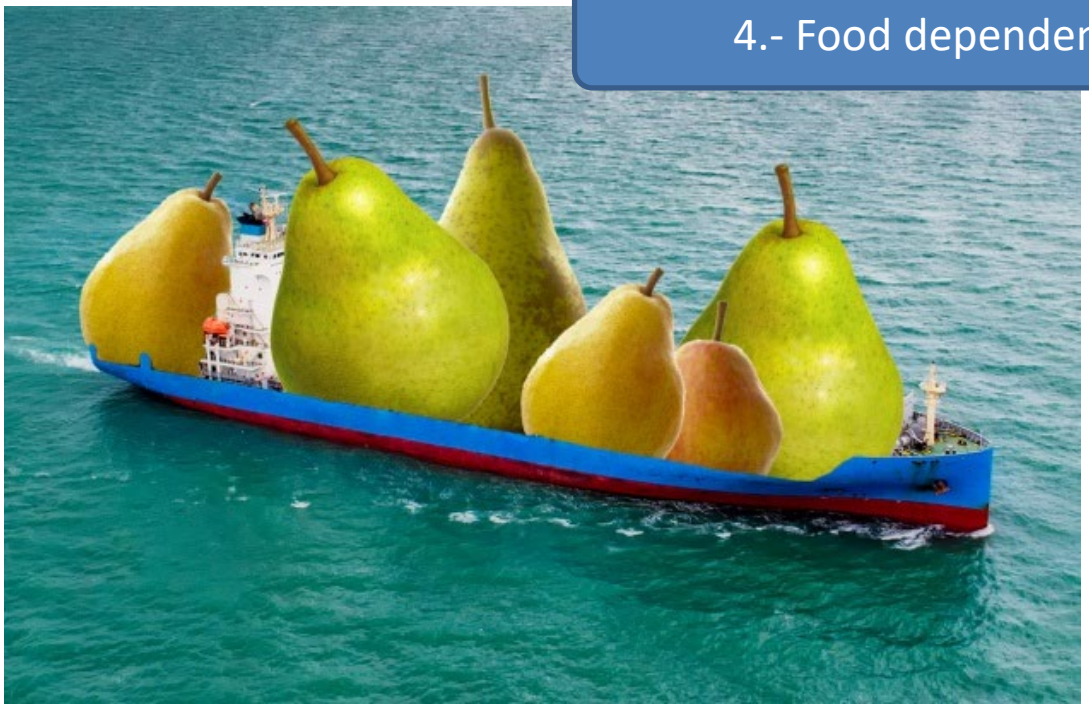
• Food dependency and agriculture

3.- Lack of fertilizers

- Canary Islands in 2019 **imported 4,785 Tons** of nitrogen fertilizers

• Food dependency and agriculture

4.- Food dependency

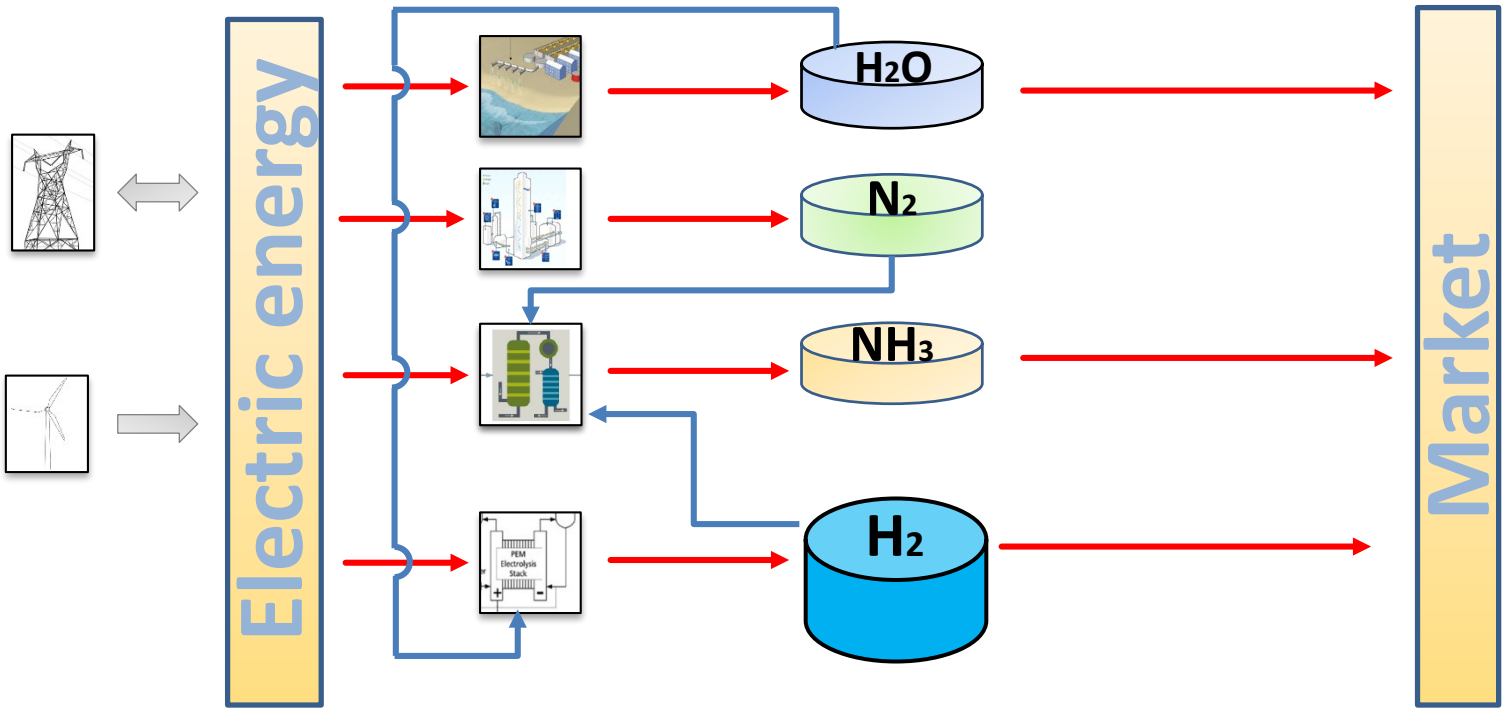


- More than 80% of the food we eat, comes from abroad
- 2.1M residents 15M tourists/year

Spain:	1.9	people / ha cultivated
Canary:	48	people / ha cultivated
Gran Canaria:	92.6	people / ha cultivated

- **Green hydrogen, water and ammonia production**

3ºDesign



3º design

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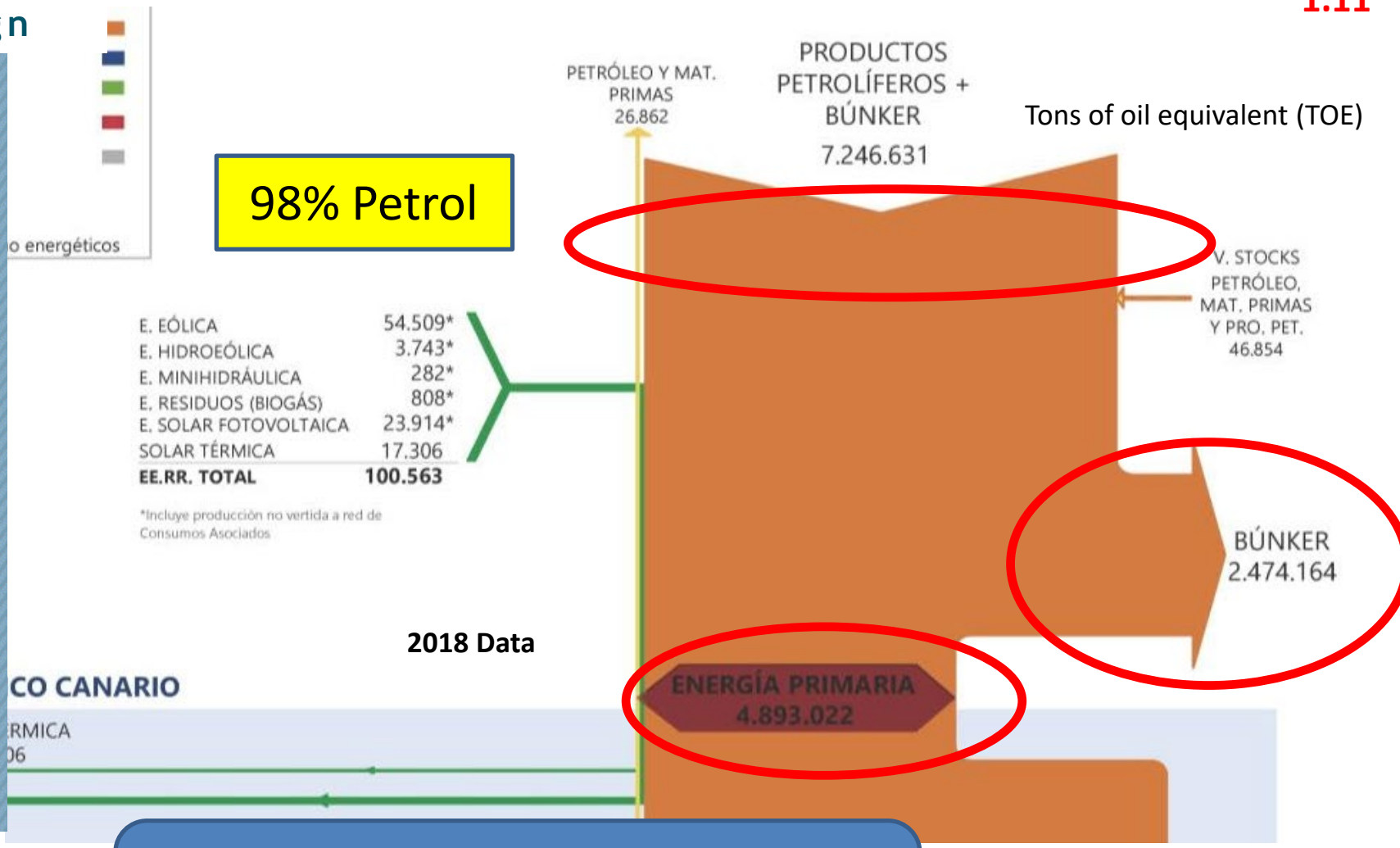
• Canary Energy

3ºDesign

98% Petrol

Tons of oil equivalent (TOE)

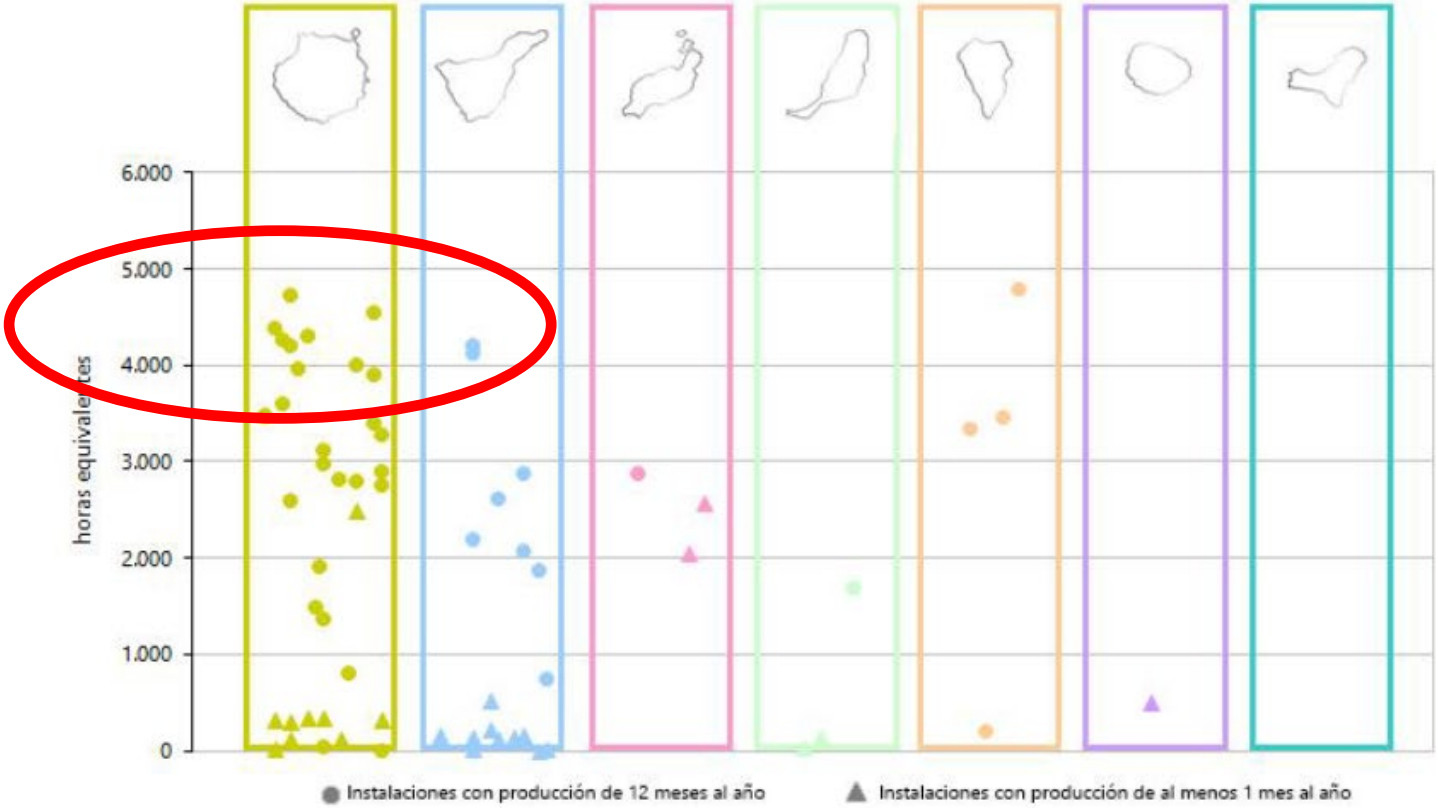


2018 Data

5.- Very low energy diversification
6.- Bunkering service
7.- Very high energy dependence

• Canary Energy

Equivalent annual hours of operation of wind farms in Canary Islands. Year 2018

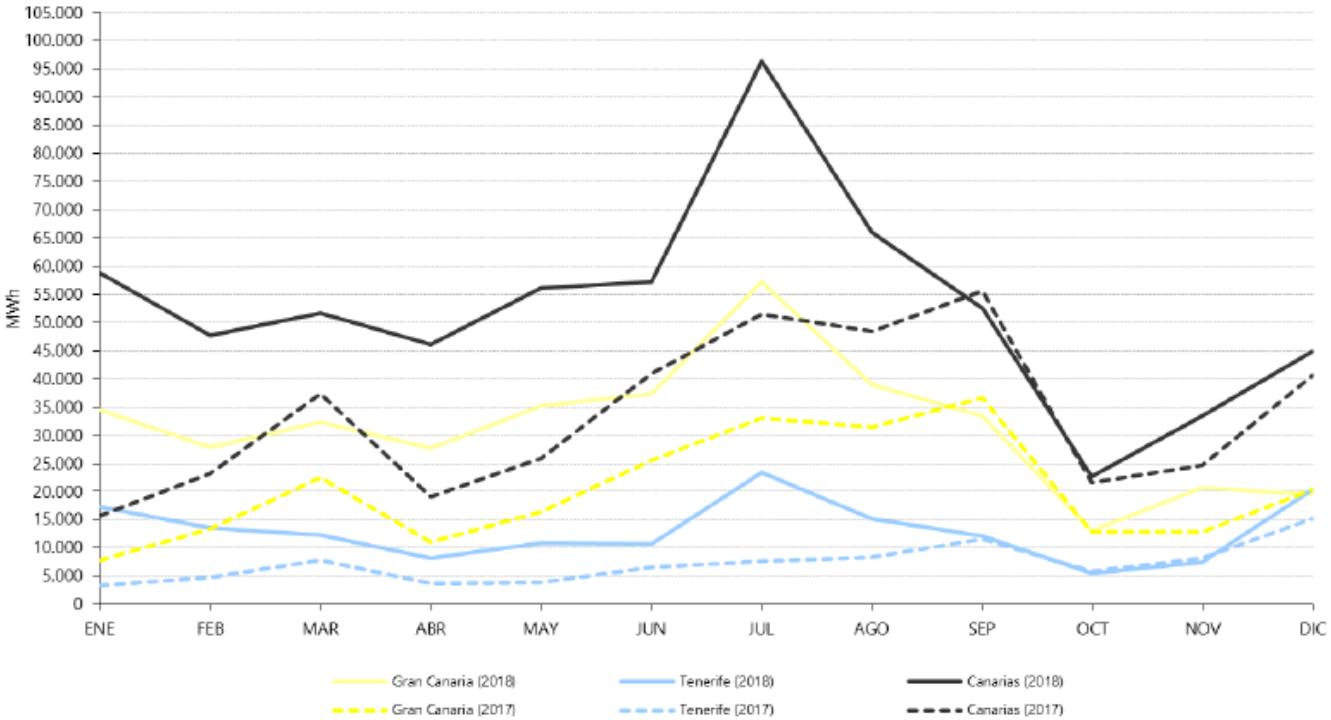


Very high resource

• Canary Energy

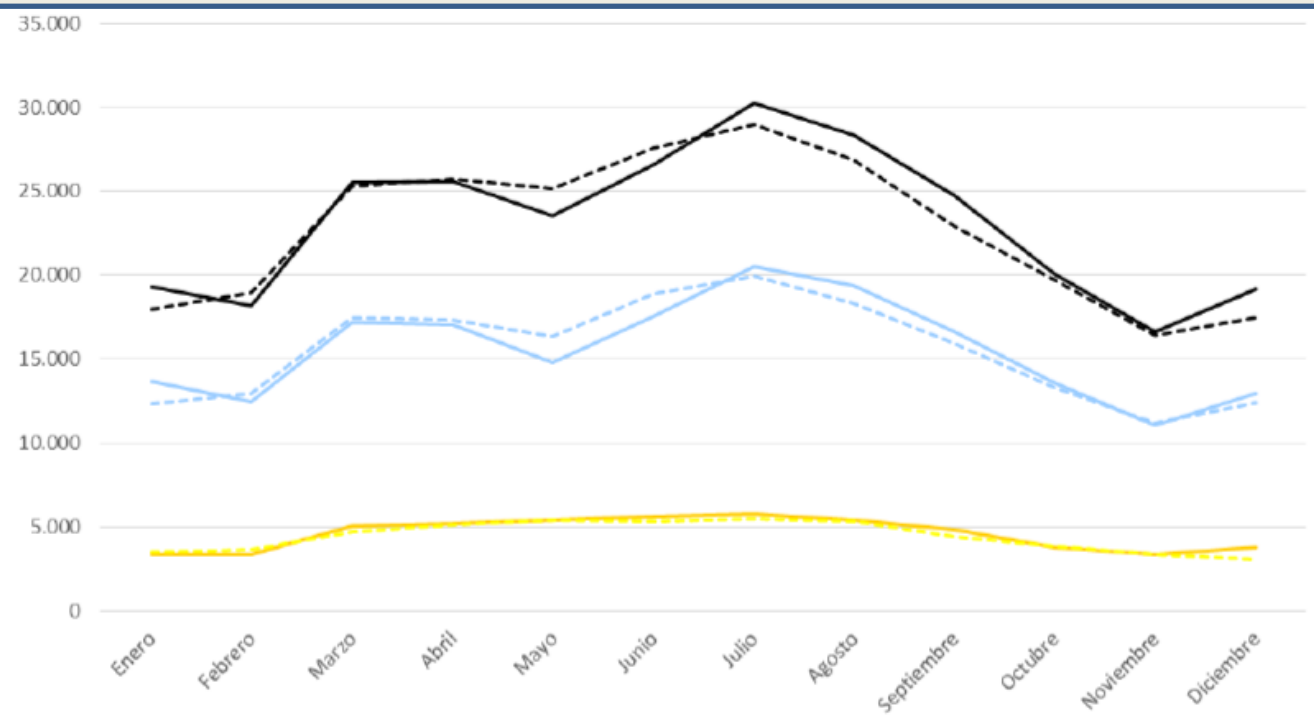
Canary Wind Resource

Monthly electricity production from **wind** farms in Canary Islands, Gran Canaria and Tenerife. Years 2017 and 2018



• Canary Energy

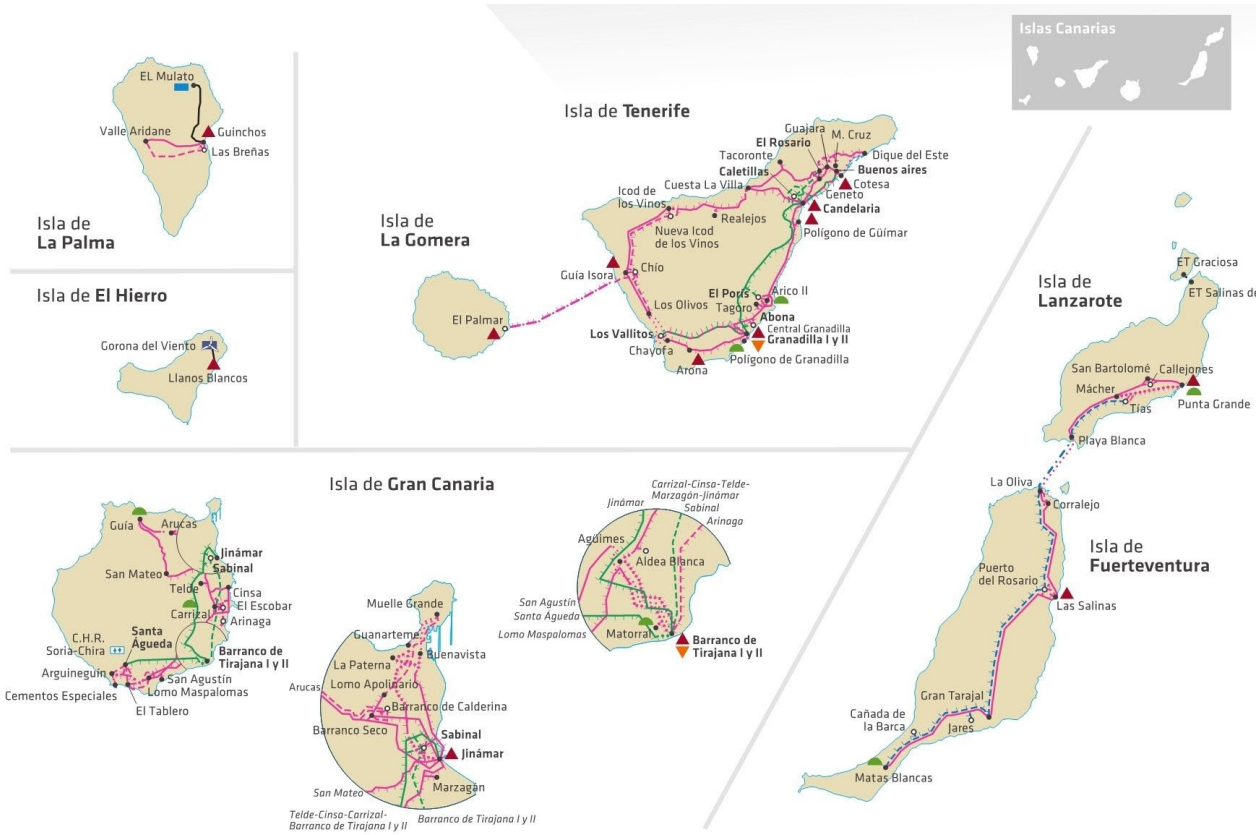
Monthly electricity production from **solar** farms in Canary Islands, Gran Canaria and Tenerife. Years 2017 and 2018



8.- Seasonal Energy Resource

Wind and Sun, greater in summer

• Canary Energy



9.- Six Small Isolated Electrical Systems

- Low penetration of renewables
- Many disconnects to generation

• Canary Energy

Tabla 1: Tecnologías que cubren la demanda en días de limitaciones

	%SNSP	%motores	%Turbina gas	%CC	%Turbina vapor
Tenerife					
30-abr-20	58.7%	4.7%	0.0%	18.8%	17.1%
06-mar-20	47.3%	0.0%	0.0%	35.1%	18.2%
Gran Canaria					
24-abr-20	45.8%	4.3%	0.0%	37.2%	13.1%

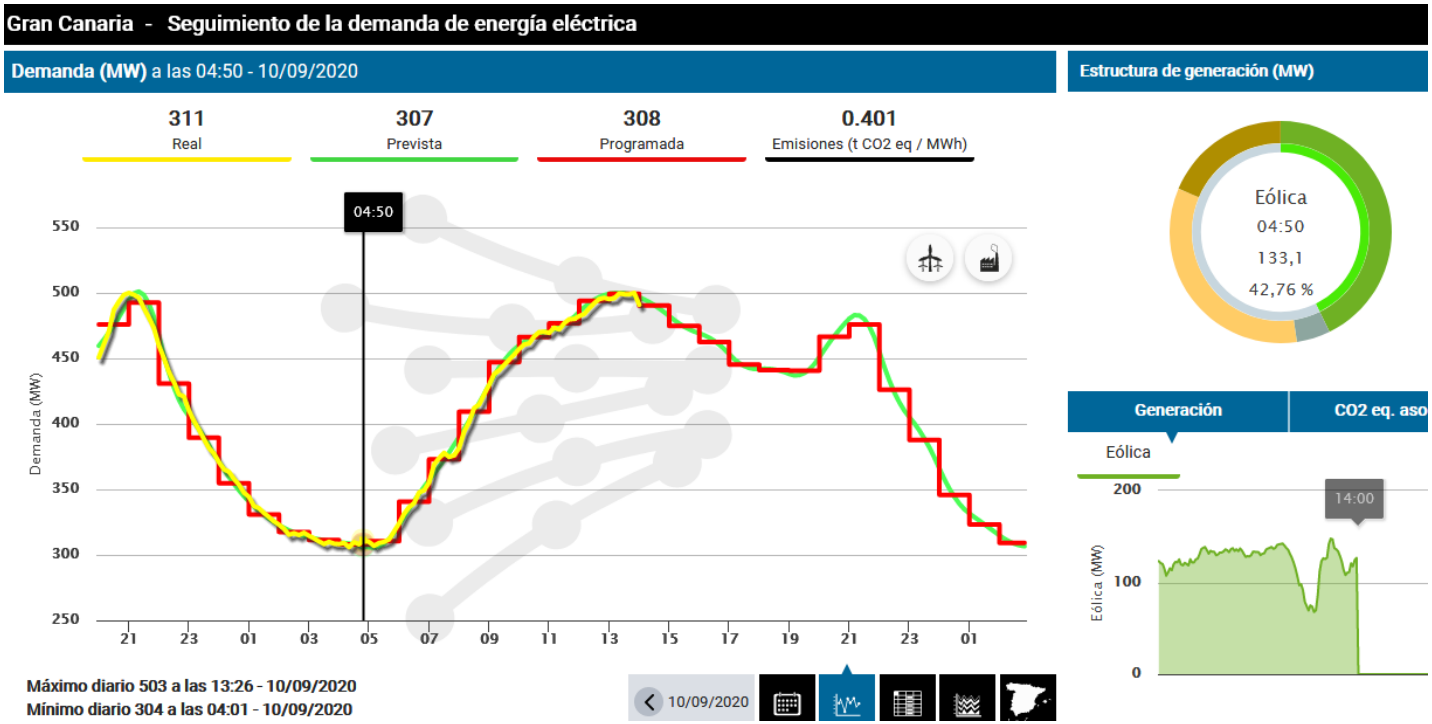
Fuente: Elaboración propia a partir de REE

SNSP (System Non Synchronus Penetration)

https://www.energias-renovables.com/eolica/una-propuesta-para-aprovechar-el-100-de-20200608

Wind farms are disconnected about 200 h/year on average, because the grid can not receive their production

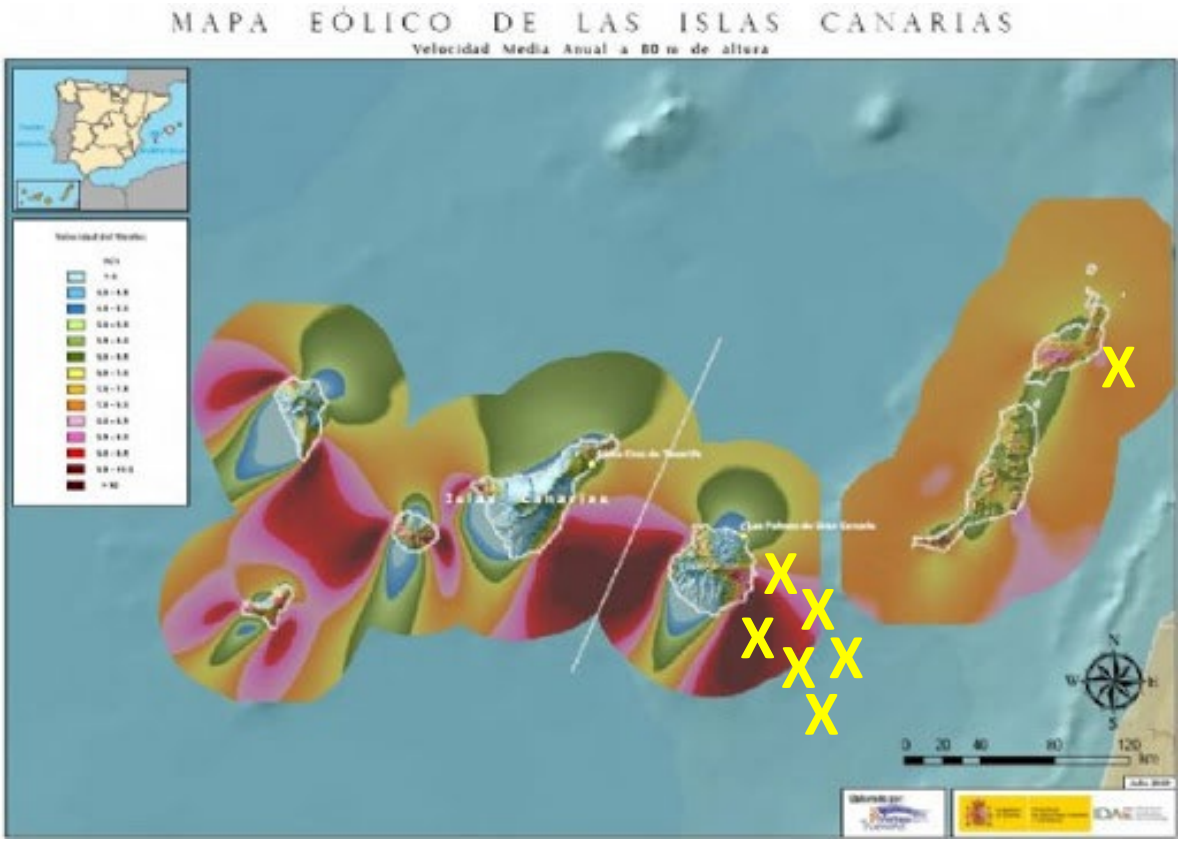
• Canary Energy



REE: Maintain system stability
Unmanageable generation disconnection
In high resource valley hours

• Canary Energy

Proposed offshore wind farms



Many proposal

1,057 MW

Dec. 2018
153 MW

https://www.diariodelanzarote.com/noticia/una-empresa-portuguesa-pide-instalar-cuatro-aerogeneradores-en-aguas-pr%C3%B3ximas-lanzarote

https://www.atlanticohoy.com/economia/hasta-siete-proyectos-avanzan-instalacion-energia-eolica-flotante-gran-canaria_1502164_102.html

https://www.laprovincia.es/economia/2020/09/24/greenalia-proyecta-cuatro-nuevos-parques-14091064.html

https://www.canarias7.es/canarias/gran-canaria/parque-eolico-marino-20201129012454-nt.html

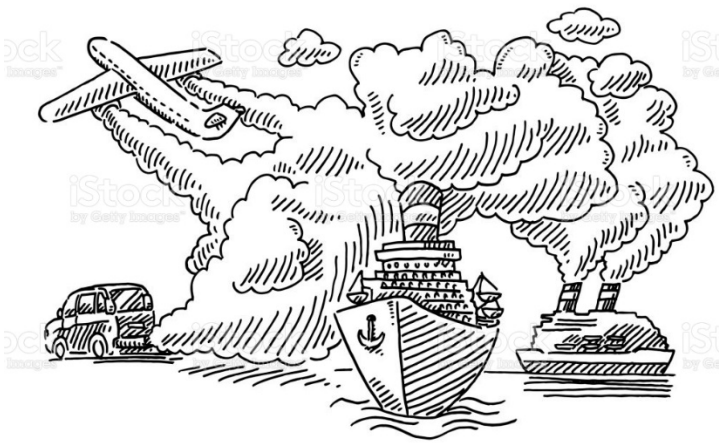
• Canary Energy

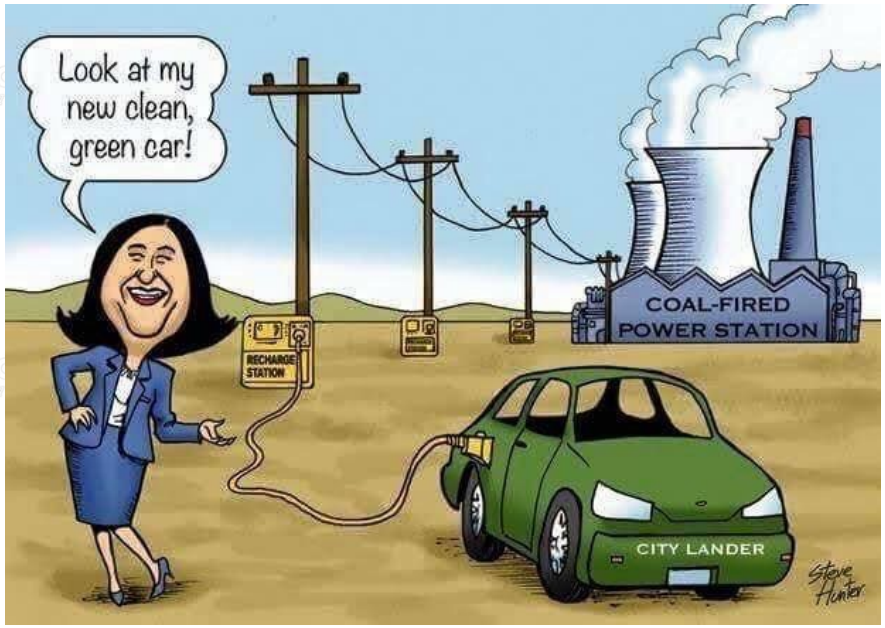
The island administration proposes to generate the equivalent of the consumption of 28,100 homes and 75% of the consumption of the institution and its facilities, that is, 98 GWh per year of the 130 GWh it consumes

https://www.canarias7.es/canarias/gran-canaria/cabido-invertira-millones-20201022202040-nt.html

• Canary Energy

- As of 2023, the delimitation of low-emission zones will be generalized to all cities with more than 50,000 inhabitants in Spain





10.- Decarbonisation Plan for the Canary and the Balearic Islands in 2,040

- Electric Generation
- Transport …..

• Canary Energy

- Little by little, green fuels will be used on vessels

11.- Canary is a bunkering station in the middle Atlantic

• Population and employment

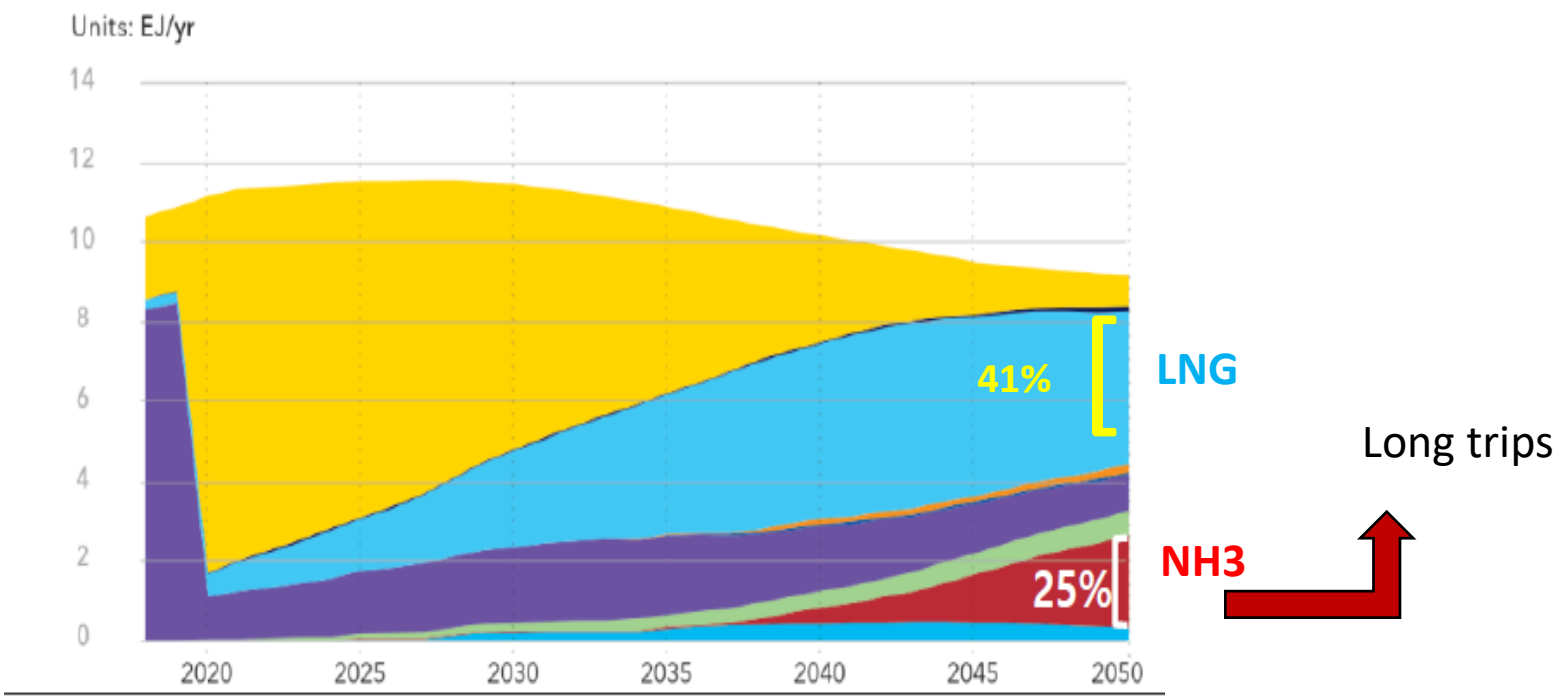
12.- High unemployment rate

- In Canary Islands 04/21, the unemployment rate is 24.1%, 282,523 unemployed
- But for those under 25 years old it is 50%
- In 2018 and 2019 it was 20% and 18.8%

• Distance and transport systems

- The port of Las Palmas. bunkering service

https://www.palmasport.es/es/suministro-de-combustibles/
https://intercop.es/es/puerto-de-las-palmas/bunkering-puerto-las-palmas/



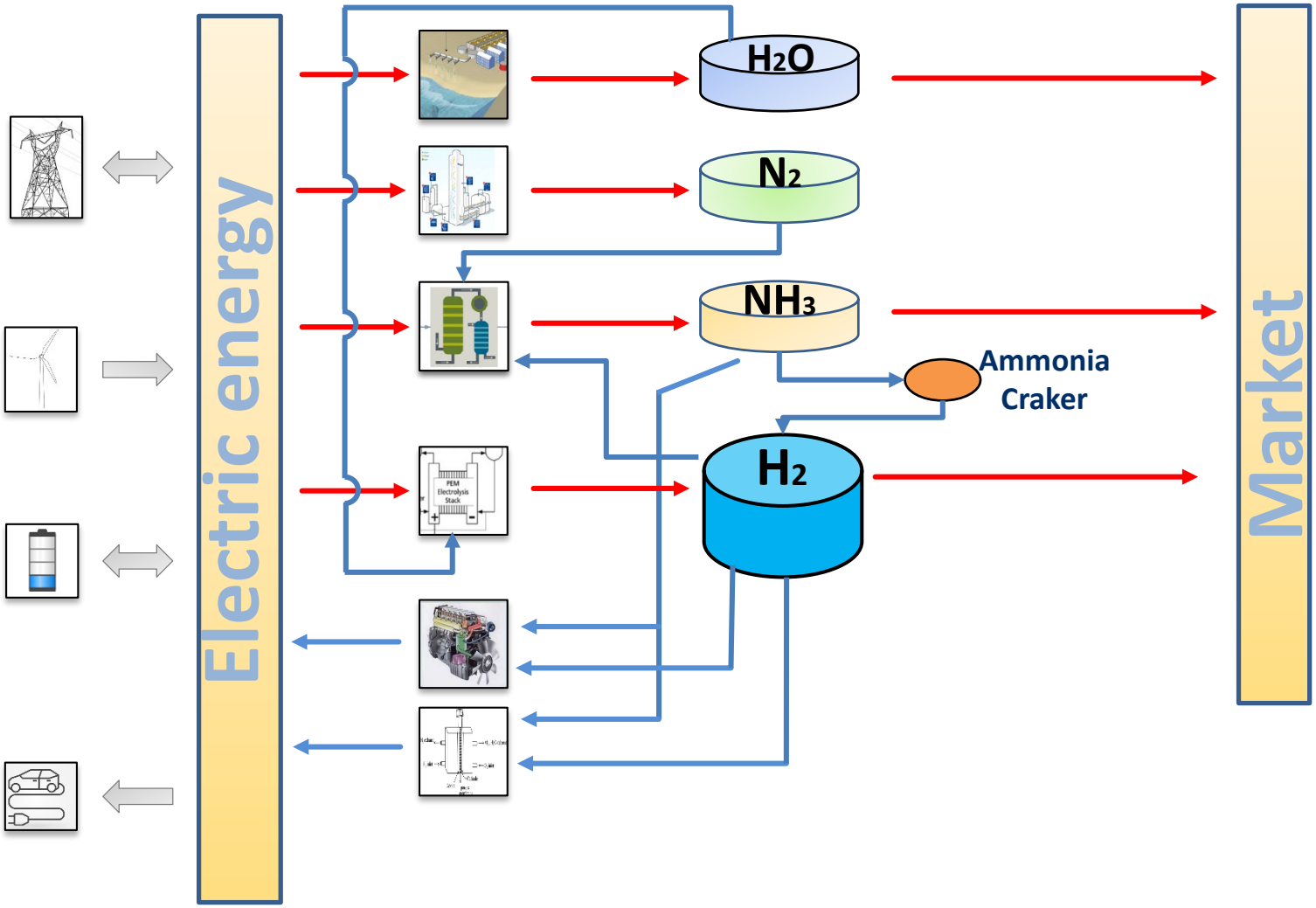
- Port of Las Palmas:14,871 ships, about 20 Mt of goods, and 2.5M passengers
- Port of Las Palmas served 2.3 Mt of fuel and 0.3 Mt of water

• Distance and transport systems

The first zero-emission commercial aircraft, which according to the company's forecasts would enter service in 2035

- **Green hydrogen, wáter, ammonia and electricity production**

4ºDesign



4º design

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• Conversations with a gas company

4ºDesign

- Non energy gas service

Air Products

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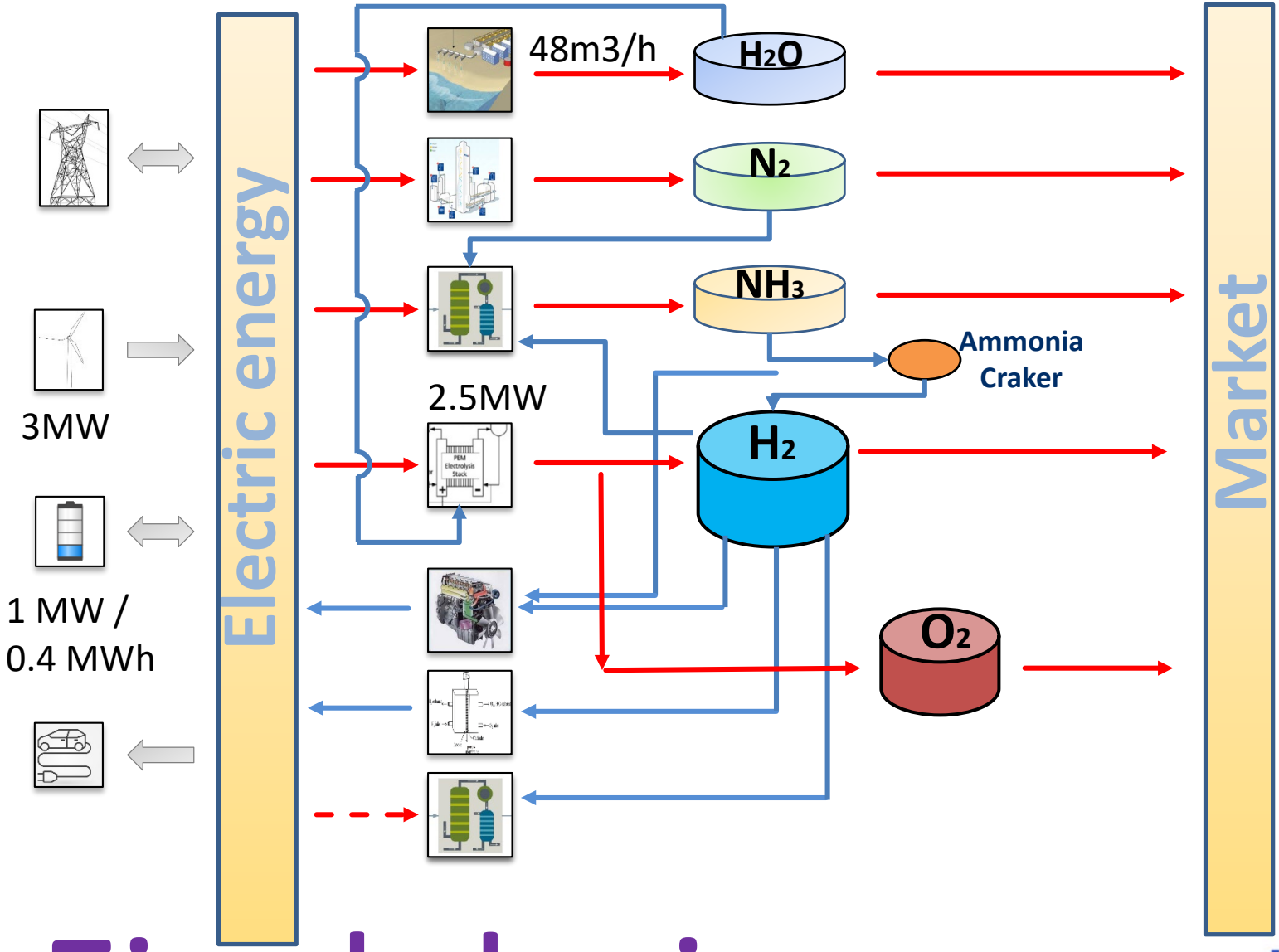
- **Hexageneration project**

5ºDesign



Final design

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Project description

- **Primary energy: Wind**

There will be offshore wind turbines in situ, everything being connected to the electrical grid

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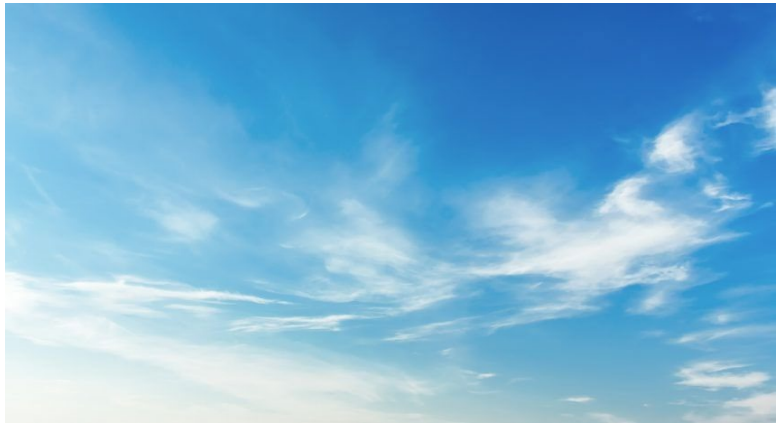
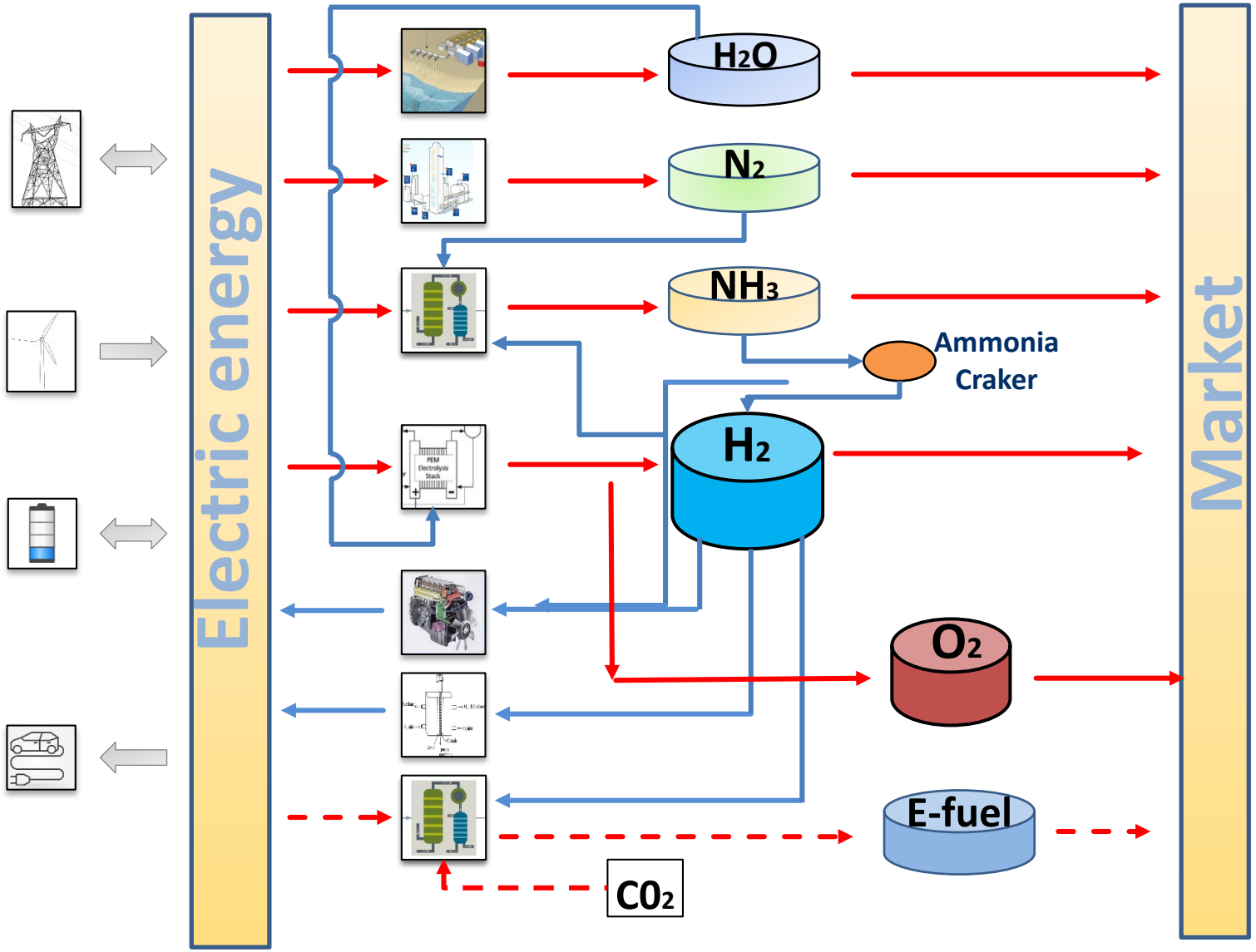
- **Raw materials**



Air and seawater will be the main raw materials for these processes

• Future Project: Hepta-Generation

Project description



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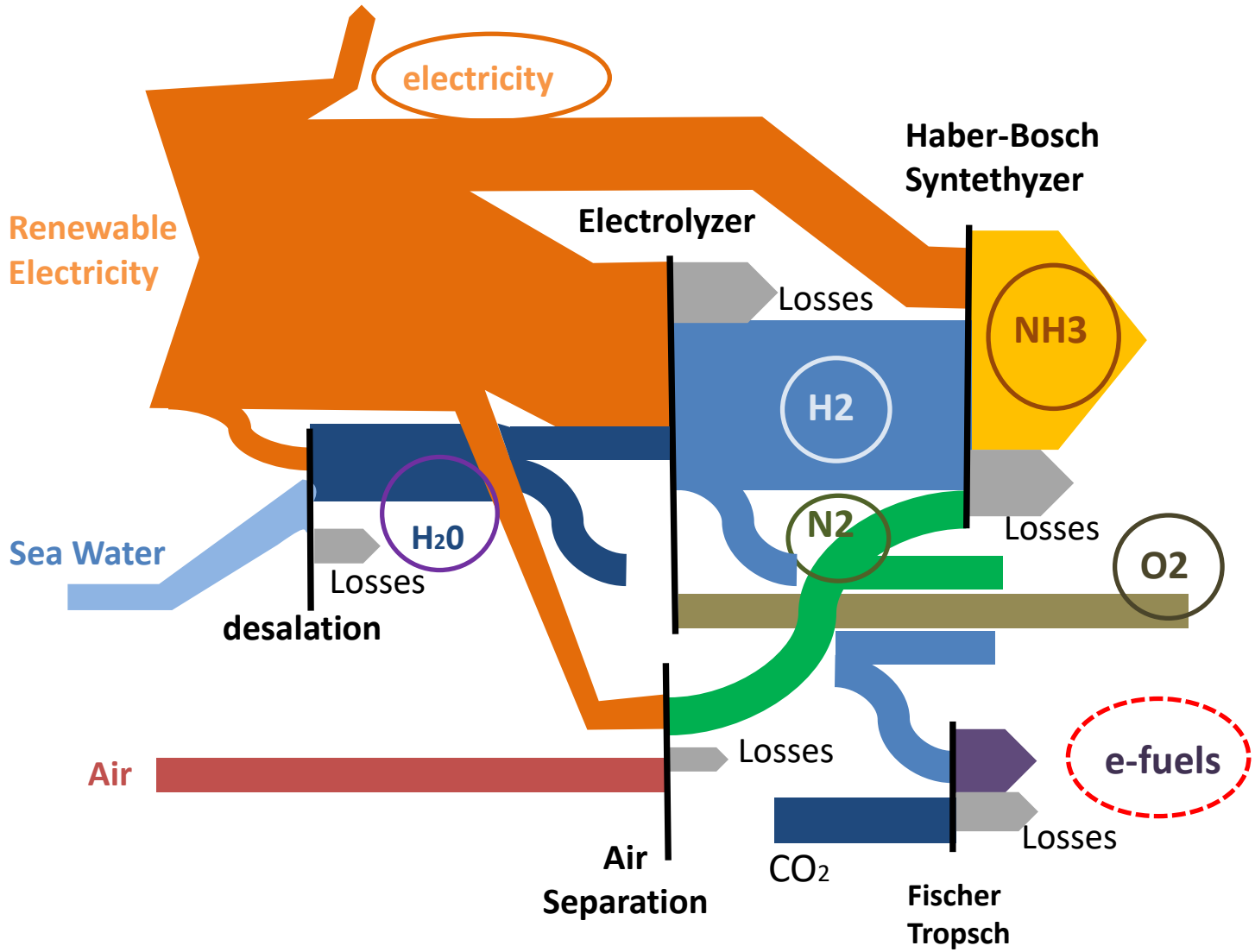
• Proyecto: Hexa-Generación

Project description



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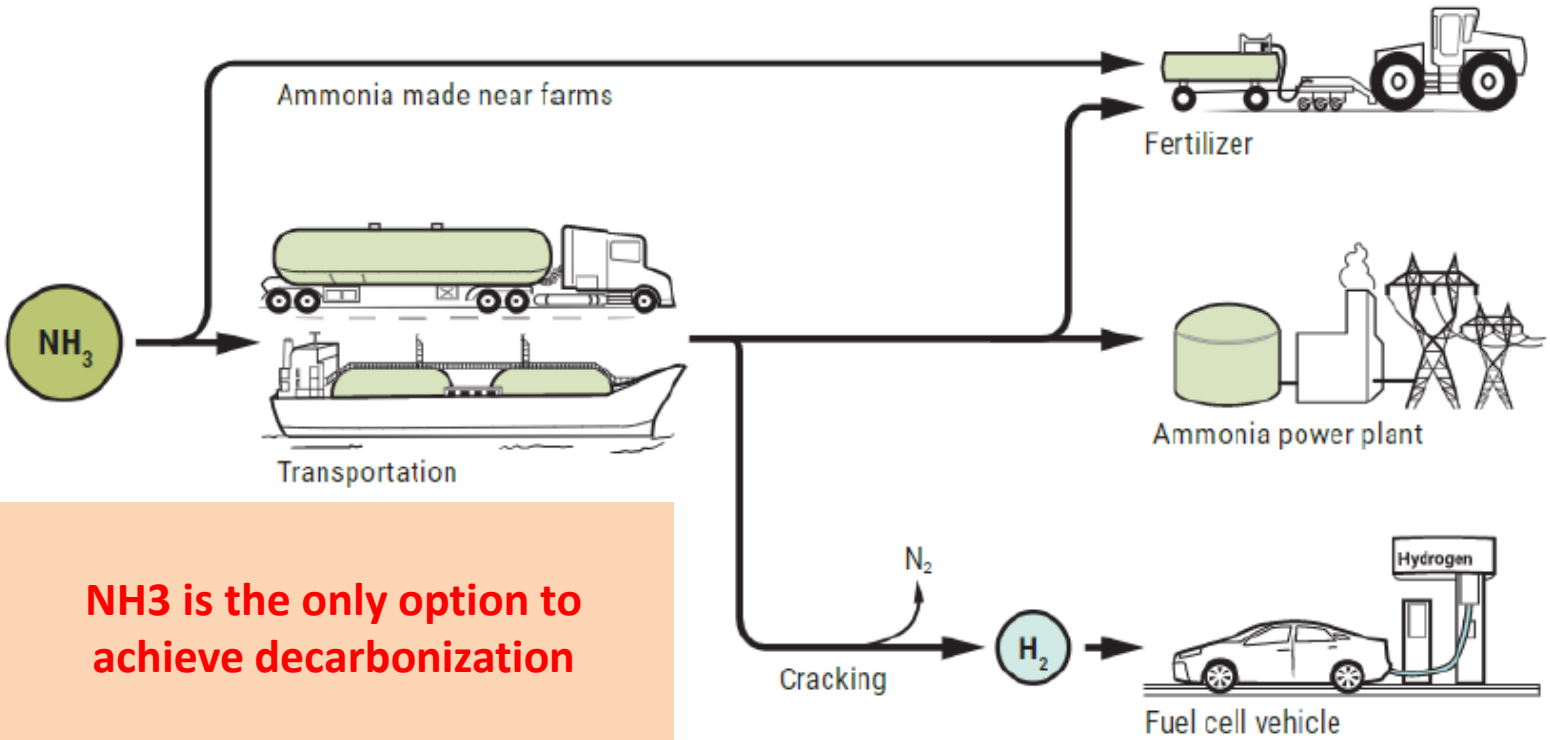
• Ammonia possibilities

Project description



NH3 is the only option to achieve decarbonization

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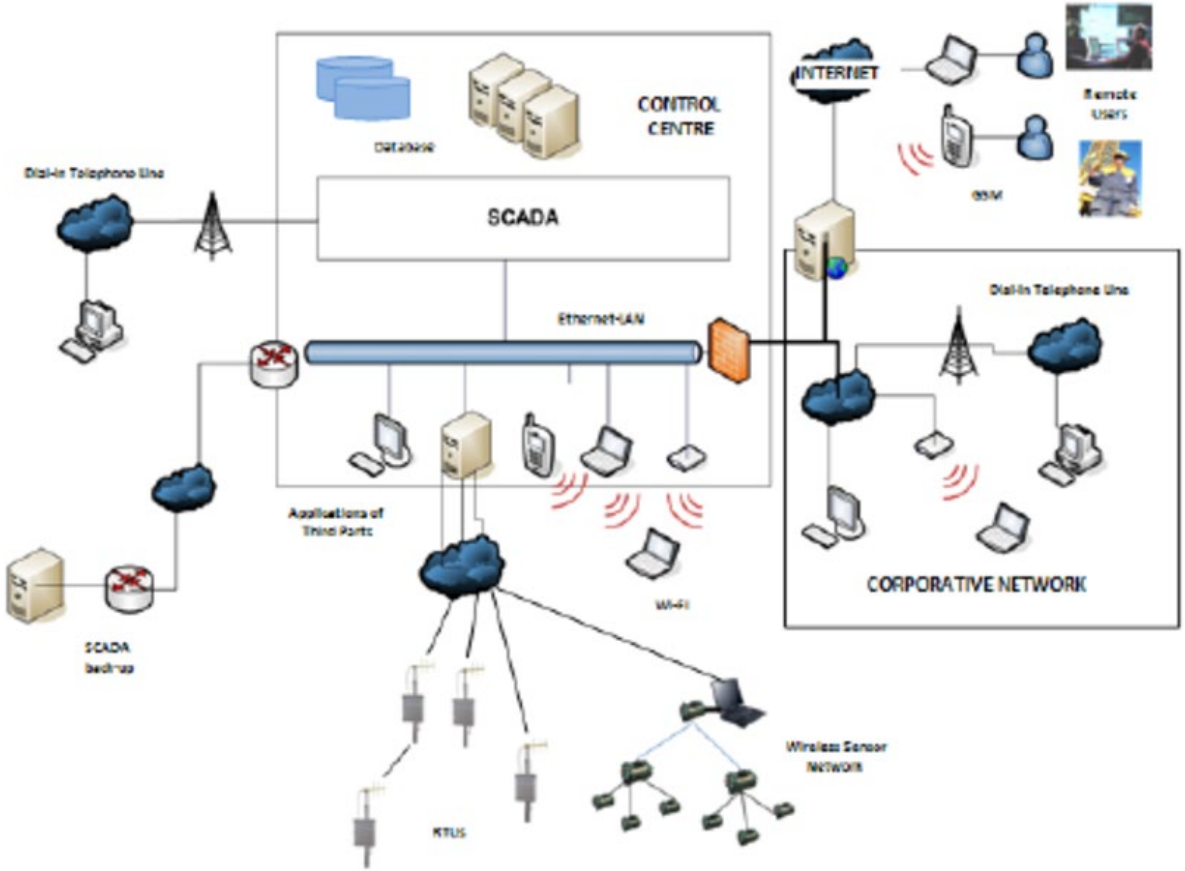
Project description

• Project innovation. Software

We use a Scada network for data and actuator



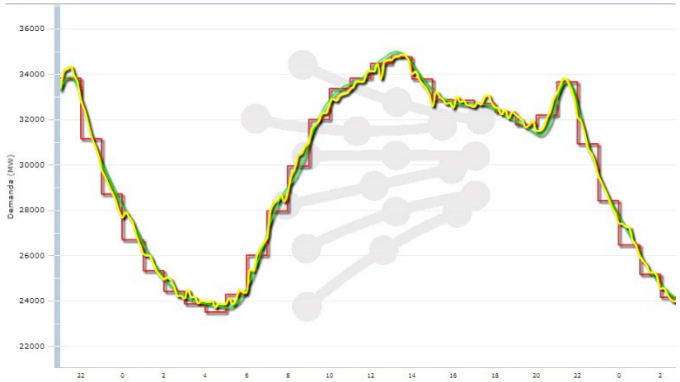
• Inputs Software

Project description

Storage level

Demand forecast

Resource Estimate



Electricity price

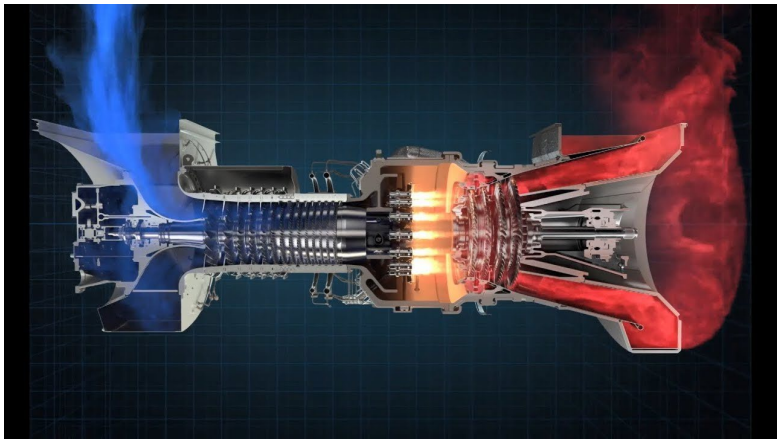
• Outputs Software

Project description

Production of H2, N2, O2, NH3 and/or H2O

Storage Loading or unloading

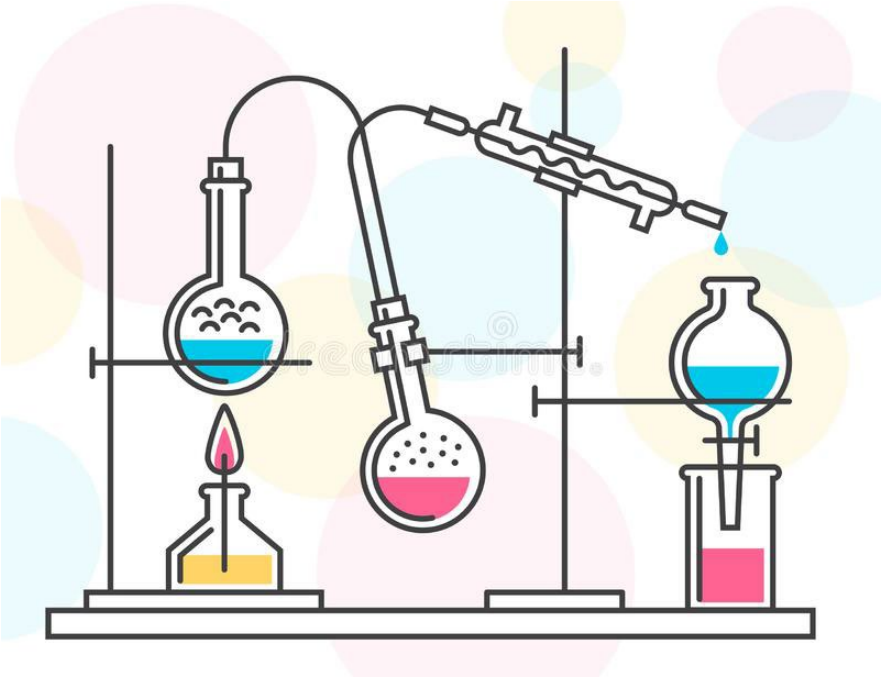
Sale or purchase of the grid



• Each process. Operation

Each process has its various restrictions, such as:

- Performance losses due to alterations in its operating regime
- Stop and start ramps
- Minimum disconnection time after a stop
- Maximum number of stops per day



- **Artificial intelligence Software**

Descripción del proyecto

The use of artificial intelligence will allow the operating software to adjust to each specific project, determining the inertia of each process, the benefit or harm to the efficiency of the system, with each decision.

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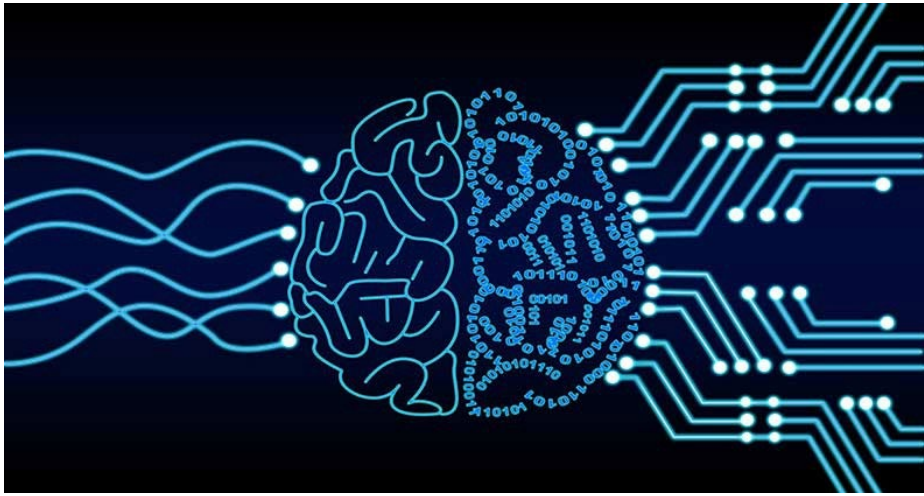
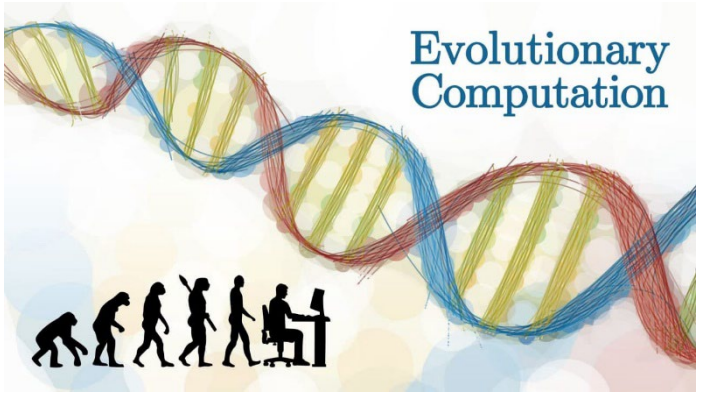
Project description

- **Modular software**

The software will be made up of modules, so that more or less productive processes than those proposed in this project can be associated. Obtaining the optimum in its Global management.



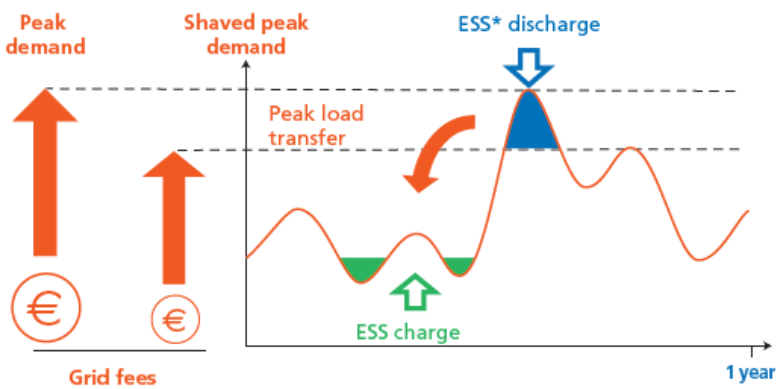
Robust design

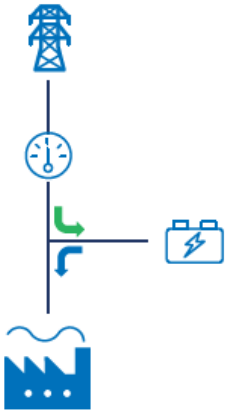


- **Multiobjetive optimization software**

Descripción del proyecto

We can change the weight of the different goals. Minimum carbon footprint, out of stock, maximum integration of renewables, maximum economic benefit ...





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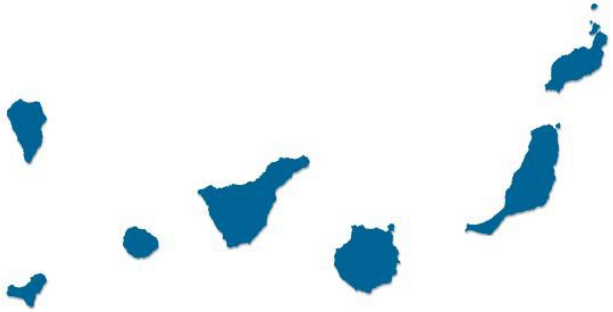
- **Conclusions I.** Project simulation

Conclusions

3 MW wind turbine
2.5 MW electrolizer

3,717 MWh to grid
116.42 t of H2
145.00 t of NH3
21,600 m3 of water
In total, this project will have the capacity
to avoid 4,532 t of CO2 per year.



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• Conclusions II. For Canary Islands

The present study, allows to direct integrated solutions, to all the raised social problems, to a great extent.

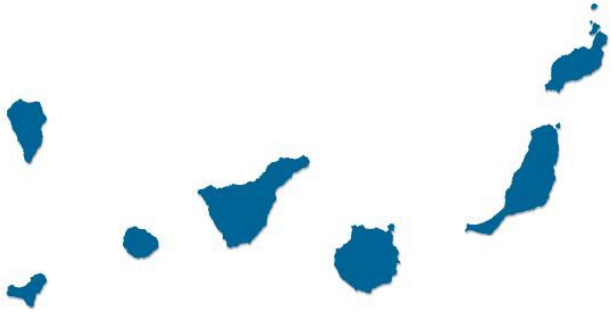
Reduction of energy and food dependency

Increasing the use of renewables

Decarbonization of the economy by joining the European objectives for the first time

Creation of jobs and diversification of the economy and energy

Growth in the services of our ports



• Conclusions III. Similarities with the rest of Spain

It would be like planting a seed, from which we will all learn, in order to implement its replica, total or partial, in various parts of our geography. Analyzing similarities Spain-Canary Islands

Abundance of natural energy resources

High energy dependence

Low economic diversity

It constitutes an energy island, due to its few current electrical connections with the rest of Europe

Deficiency of fresh water for activities

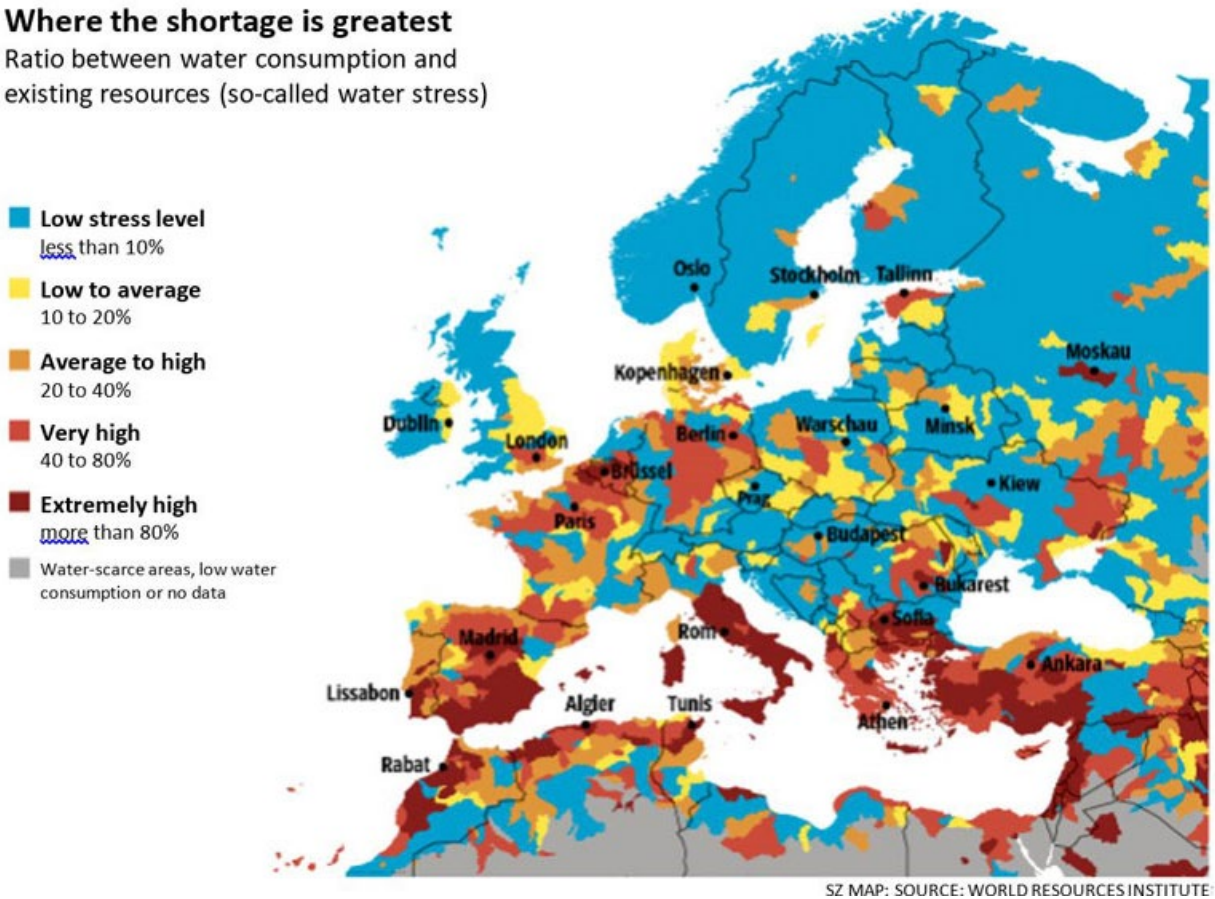
High unemployment rate

Ports of relevant activity

• Conclusions IV. Similarities with Europe (I)

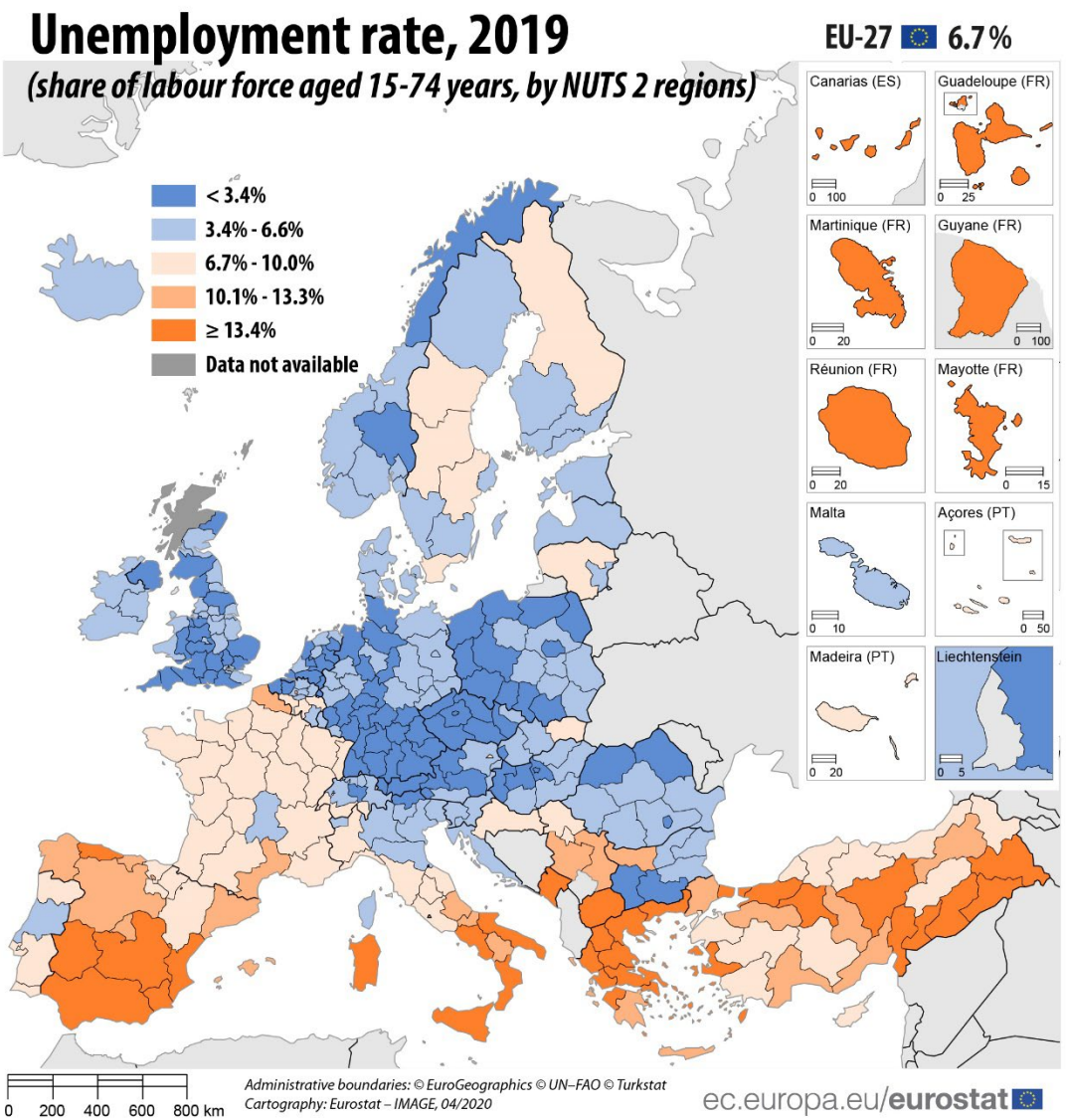
Conclusions

We have seen the energy, the ports, but we would be surprised if the lack of water and unemployment are common problems with part of southern Europe



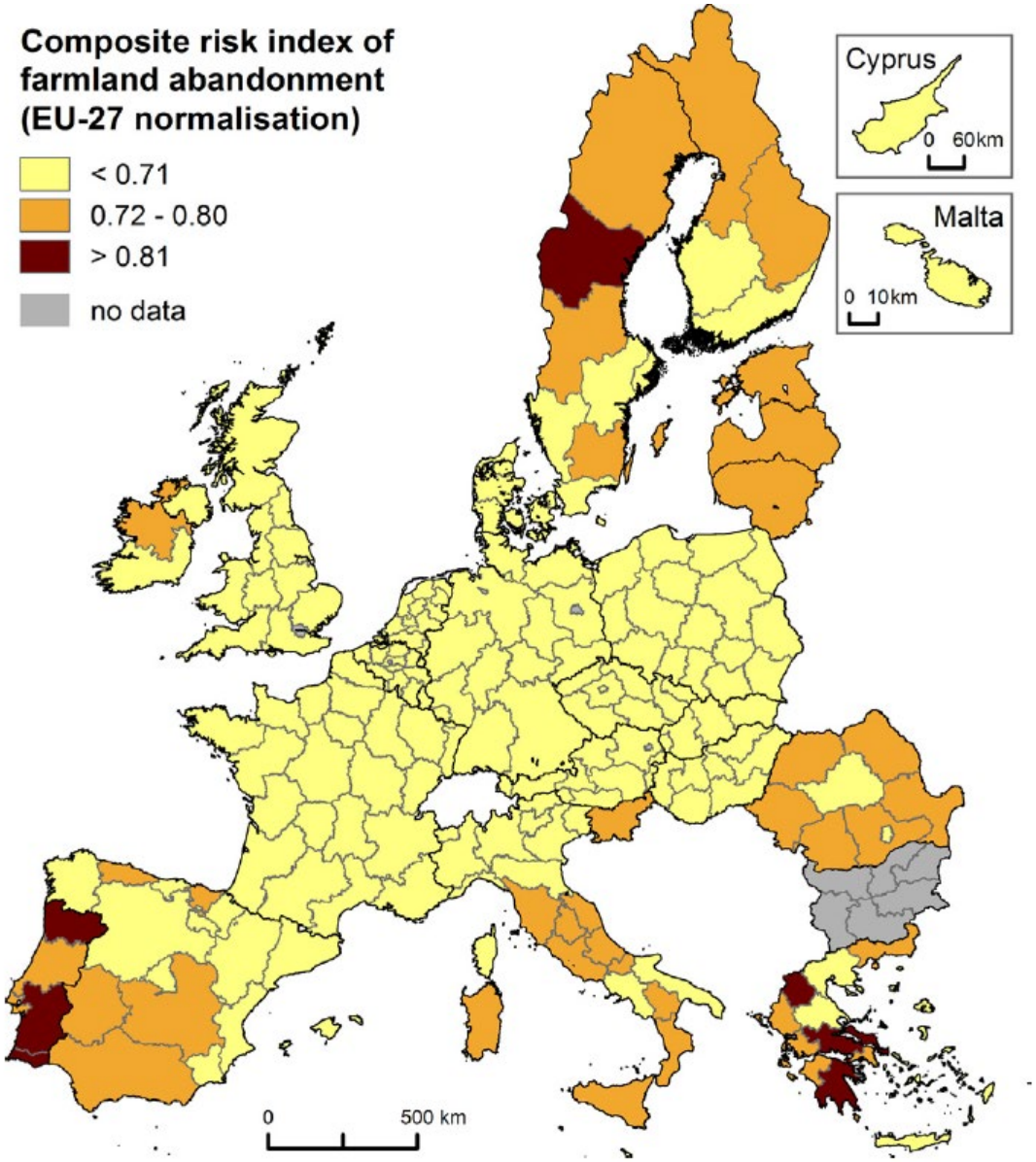
• Conclusions V. Similarities with Europe (II)

Conclusions



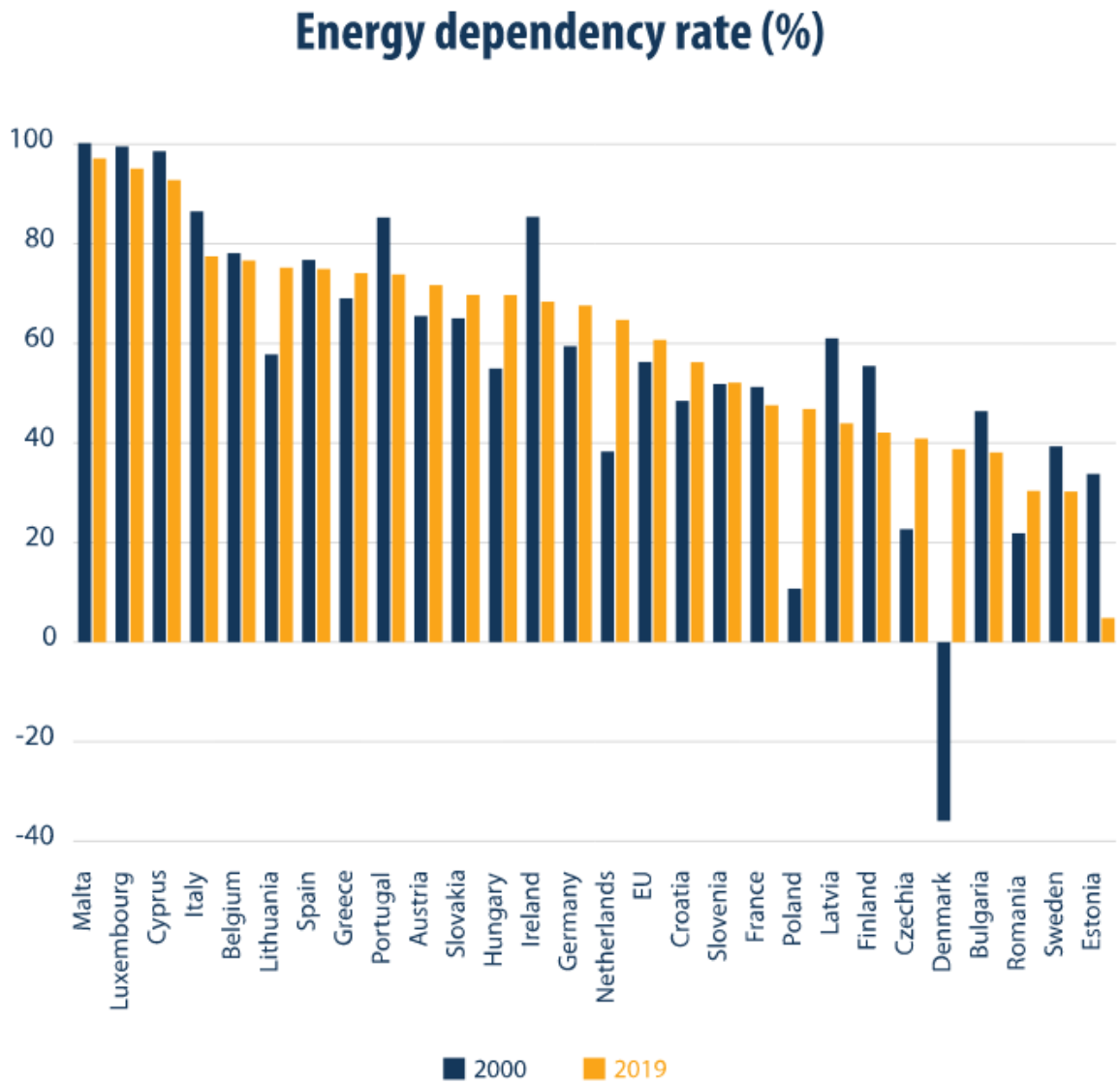
• Conclusions V. Similarities with Europe (III)

Conclusions



• Conclusions VI. Similarities with Europe (IV)

Conclusions



- **Index**

1.- Design Evolution

2.- Description of the final proposal

3.- Conclusions

4.- Nowadays

Real Project

Nowadays

El proyecto producirá hidrógeno y amoniaco verde entre Aragón a Valencia

Miércoles, 02 de febrero de 2022

It will have 1.7GW of wind and solar photovoltaic energy connected to a **500 MW electrolyzer** that will produce **40,000 tons of green hydrogen per year**.

Real Project

Nowadays

Con todo ello, se conseguirá reducir las emisiones de CO2 en un millón de toneladas al año, un descenso que se elevará hasta los 2,5 millones cuando el proyecto esté completamente construido, señalaron desde el consorcio, que insistieron en que estas cifras equivalen al consumo anual de electricidad de casi dos millones de hogares. Además, una vez completado en su totalidad, **el proyecto alcanzará los 5GW de energía eólica y solar fotovoltaica en Aragón que abastecerán** un electrolizador de 2GW, **con lo que podría producir suficiente hidrógeno para cubrir el 30% de la demanda actual** de hidrógeno en España.

"Estoy muy orgulloso de anunciar el proyecto Catalina. España y, en concreto **Aragón**, ofrecen condiciones muy buenas para el desarrollo de esta tecnología dado su excelente recurso eólico y solar, el respaldo político y la proximidad de los centros de demanda", afirmó ayer Søren Toftgard, socio de CIP.

Conforme a los criterios de **The Trust Project** Más información

X 4

Real Project

Nowadays

El proyecto producirá hidrógeno y amoniaco verde entre Aragón a Valencia

Miércoles, 02 de febrero de 2022

That Project will need 360,000 m3/year. In the begining. In the 2º step 1.44 hm3/year

Public water supply in the City of Zaragoza in 2019 was 58.6 hm3 with a population in the city of 716,040

Then the project will consume in the second phase the equivalent of a population of 17,595 inhabitants

Real Project

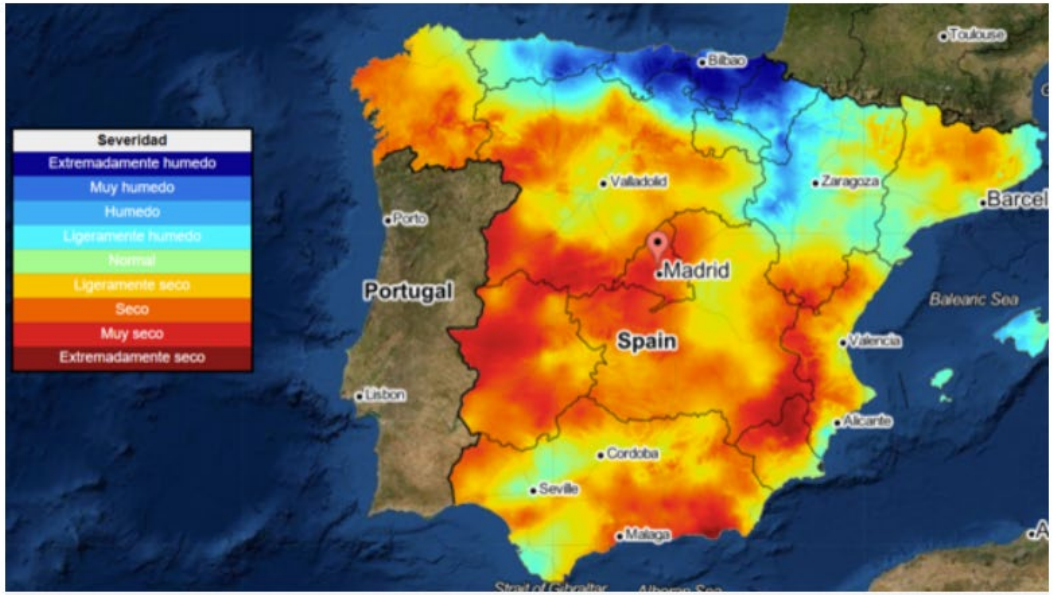
Nowadays

Drought map in Spain this year

Nowadays

Estas son las zonas de España más afectadas por la sequía

- Desde otoño ha llovido un tercio menos de lo habitual y las reservas están al 44,7 %
- Las lluvias regresan a España este fin de semana: qué días y dónde se registrarán precipitaciones
- España sufre el inicio de año con menos lluvias desde 2005



Monitor de sequía meteorológica - CSIC

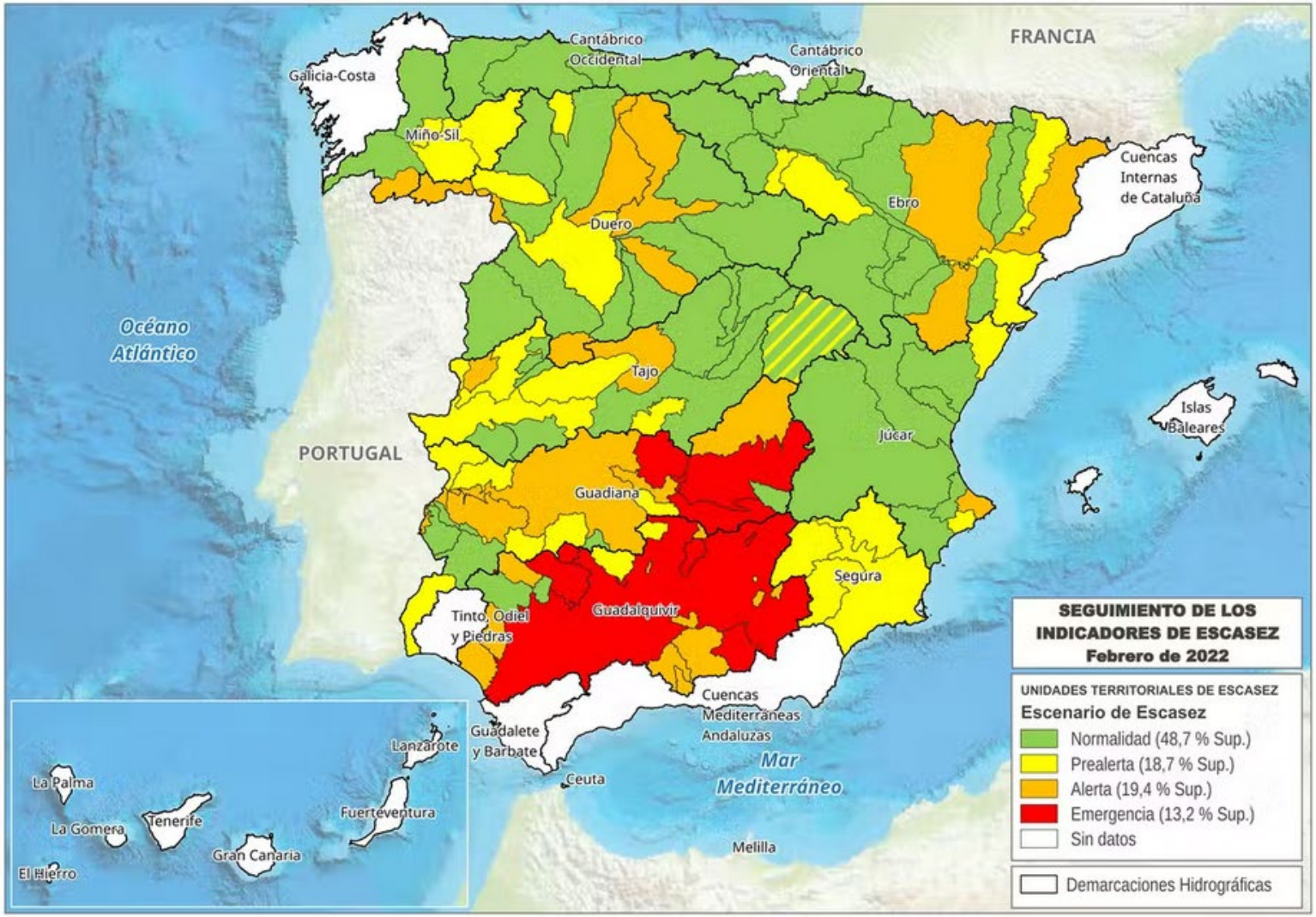
ABC

Actualizado:21/02/2022 18:41h

GUARDAR

Drought map in Spain in 2022

Nowaday



Mapas de indicadores de sequía (arriba) y escasez (abajo) en España a 28 de febrero de 2022. MITECO

Local drought news

Nowadays

La elevación de agua del Ebro a Andorra sigue seca 17 años y 25 millones después

Las obras están paradas desde 2011 tras haber consumido en una primera fase sin continuidad más del 90% del presupuesto

La mancomunidad creada para gestionar el proyecto, diseñado para fomentar el regadío como alternativa al declive del carbón en cinco pueblos de Teruel, ni siquiera llegó a hacer el inventario de lo ya construido

No acabar las obras supondría haber dilapidado más del 6% de los fondos públicos movilizados en dos décadas a través del Plan MINER

Eduardo Bayona Zaragoza — 22 de septiembre de 2019 - 23:00h

"Diecisiete años más tarde e invertidos 25 millones de euros, el proyecto más ambicioso del plan MINER presenta un grado total de ineficiencia al no haberse concluido", señala la Cámara de Cuentas de Aragón sobre la elevación de aguas del Ebro a Andorra, que sigue sin entrar en funcionamiento "ya que falta ejecutar la segunda fase" mientras la mancomunidad creada para construir esta infraestructura "se encuentra desde el 2012 sin actividad ninguna" y ni siquiera "ha incluido en su inventario las obras realizadas en la fase I".

La cosa está parada desde hace casi una década, ya que "desde 2011 no se ha realizado la segunda fase de la obra que, inconclusa, no presta el servicio para el que se proyectó", añade la Cámara.

Regional drought news

Nowadays

La prolongada sequía mantiene en vilo al campo y amenaza la campaña de riego en Aragón

Riegos del Alto Aragón y el Canal de Bardenas empezarán la temporada con restricciones por falta de agua. Vuelve la nieve al Pirineo a partir de este domingo, pero el deshielo se verá limitado por el déficit de la reserva.

NOTICIA ACTUALIZADA 13/2/2022 A LAS 05:00
MARÍA JOSÉ VILLANUEVA

https://www.heraldo.es/noticias/aragon/2022/02/13/prolongada-sequia-mantiene-vilo-campo-amenaza-campana-de-riego-1552463.html

South of Spain drought news

Nowaday

La Región de Murcia se asoma a un escenario de sequía a corto plazo

Preocupa qué puede pasar con el secano, sobre todo con el cultivo de 50.000 hectáreas de cereal

Visita de cultivos de secano en Abanilla / Rudi Ernst

0 comentarios

— Lázaro Giménez Radio Murcia 12/02/2022 - 10:29 h WEST

Lo más leído

La degradación del Mar Menor a vista de satélite: así ha captado Copernicus su evolución en ocho meses
04/05/2022

Detenidas tres personas en la Región de Murcia por elaborar aceites vegetales no aptos para el consumo humano
07/05/2022

El Palmar enloquece con el triunfo de Carlos Alcaraz en el Mutua Madrid Open
El domingo

La Fuensanta regresa este martes a su santuario en Algezares
Ayer

PUBLICIDAD

Topical question

Nowadays

¿Qué cultivos se regarán primero por la sequía?

La Consejería de Agricultura ha enviado una propuesta técnica a la Confederación Hidrográfica del Guadiana con las prioridades para la utilización de agua de riego

Which crops be will watered first?

Clean Energy. Biofuels

Past

Green Energy Biofuel

Clean Energy. Biofuels Plants in Spain in 2007

Past

Leyenda: Planta Biodiesel Planta Bioetanol

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Clean Energy. Biofuels

Past

Source: World Vision (2008)

Clean Energy. Biofuels

Past

Clean Energy. Biofuels

Past

HOME > NEWS

Europe's tryst with biofuels destroyed 10% of world's orangutan habitats

In 2010, the EU set a 10% renewable energy target for transport by 2020. As a result, the demand for cheap crop-based biodiesel, such as palm and soy oil, increased, destroying several acres of forests in Asia and South America

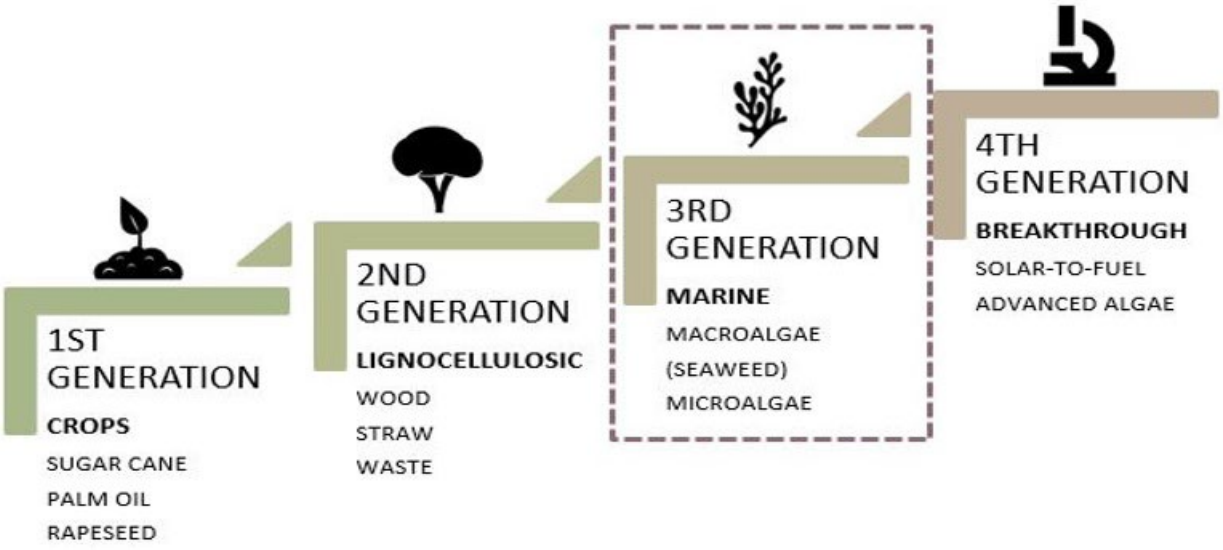
The Federal

6:30 AM, 29 August, 2021
Updated 7:02 AM, 29 August, 2021

0 COMMENTS PRINT A+ A-

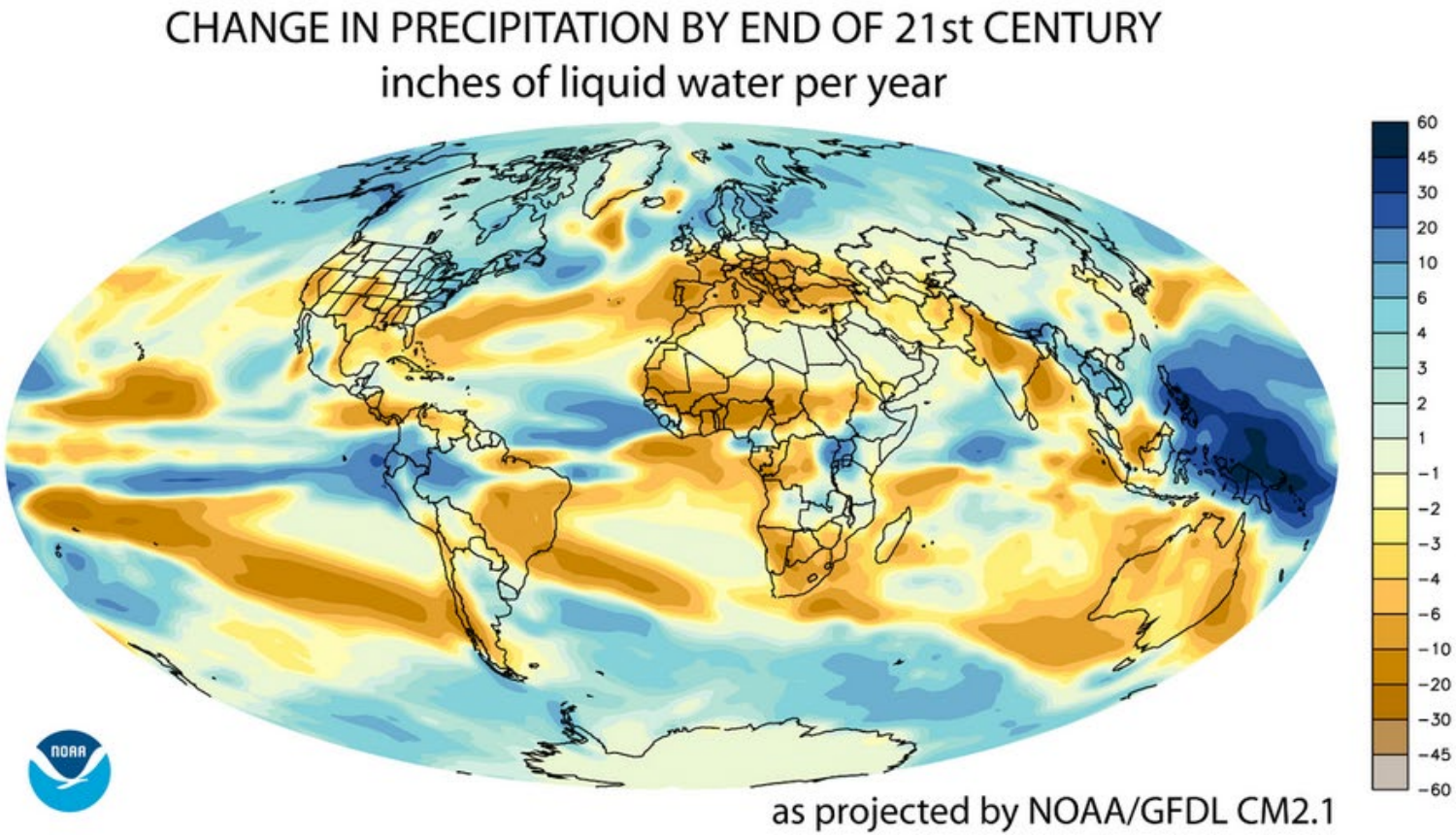
Clean Energy. Biofuels

Past



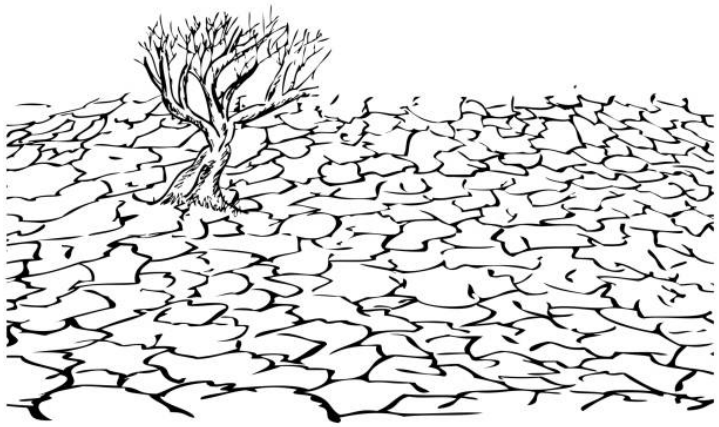
Clean Energy. Green Hydrogen

Present



Clean Energy. Green Hydrogen

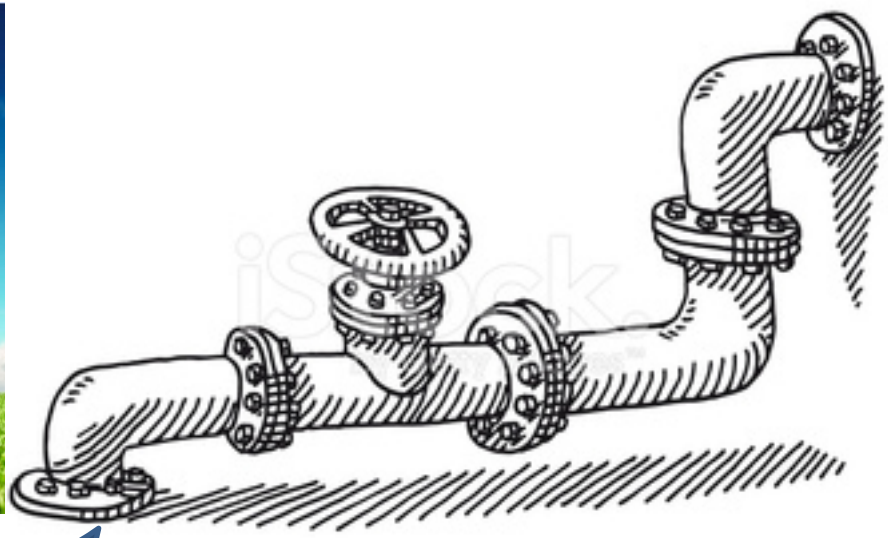
Present



Spain

Clean Energy. Green Hydrogen

Future



H2

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Green hydrogen like clean energy

Future

Important don´t fight for fresh water

Green hydrogen like clean energy

Future

I want to make it clear.

That this is not a criticism of this project, if not a manifestation of my ignorance.

And my strong desire to know the solution of this project to the aspect of water

Nowadays

Good news

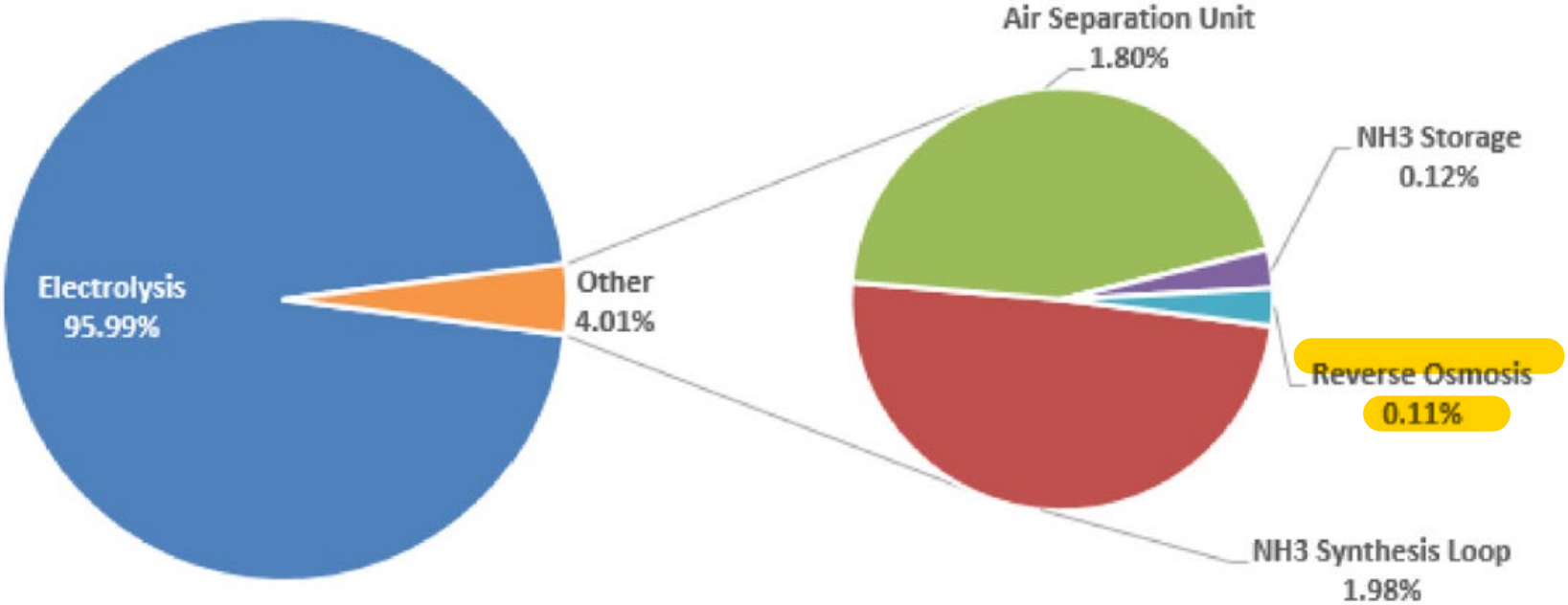

Fig. 6. Power Requirement break-down for the all-electric ammonia plant.

https://doi.org/10.1016/j.jclepro.2020.121627

Thank you very much for your attention

Antonio Pulido Alonso

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