



ESTADO DE LAS TECNOLOGÍAS DE ALMACENAMIENTO

*Tecnologías disponibles y grado de madurez /
capacidades españolas / proyectos de I+d+i más
relevantes*

ALMACENAMIENTO DE ENERGÍA Y TRANSICIÓN
ECOLÓGICA: TEMAS CLAVES

18 de mayo de 2022

Luis Santos, BatteryPlat





91
Miembros



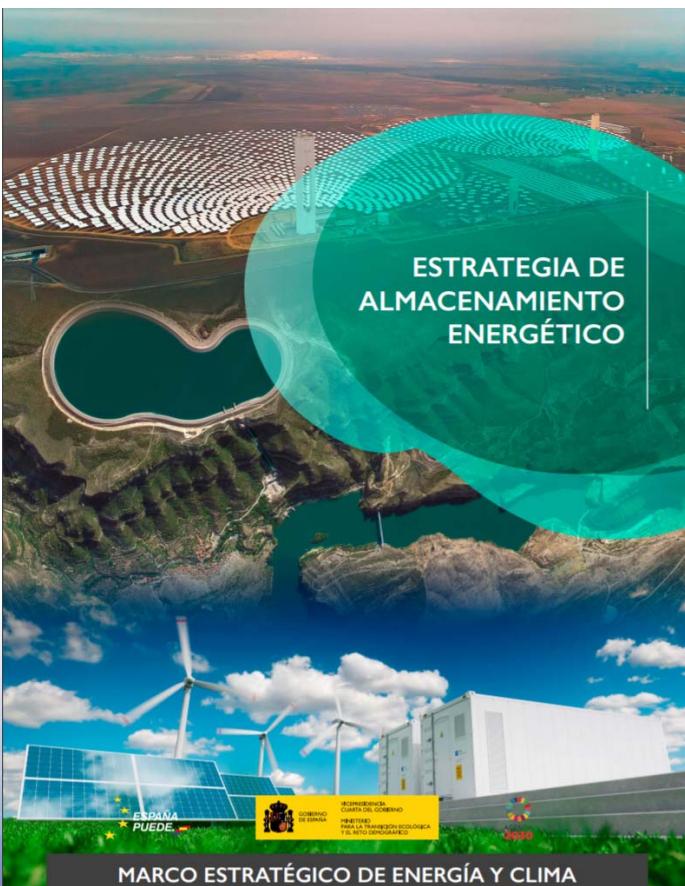
Financiada por:
PTR -2018-
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Plataforma Tecnológica para el Almacenamiento Energético de España

ABERVIAN	ABO WIND	Acciona	AIRBUS	AMPERE ENERGY	AXTER AEROSPACE	idea materiales	MATENERCAT INCAR CSIC	INL INTERNATIONAL NANOTECHNOLOGY LABORATORY	IE Instituto Ingeniería Energética	IDAE	IREC
BALEARIA	BIM	BePlanet factory	bia The Wireless Grid	Bellergy	capital energy	ISI	ITE INSTITUTO DE INVESTIGACIONES EN TECNOLOGIAS	Instituto tecnológico de galicia	InnoEnergy	KETTER BATTERIES	LEiTAT Technological Center
ceit HENESIS OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE	CDTI	CENER	cen solutions	Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas Hidrógeno	LIFTEC	LOMARTOV	μ	torres	Naturgy	norvento enerxía	
CIEMAT	cobra	cidetec	circie	CIC energi GUNE HENESIS OF SPANISH RESEARCH & TECHNOLOGY ALLIANCE	ELFED	nutai	POWER ELECTRONICS	PROTERMO SOLAR	Qualitas Equity	INTA	
DÜRR	edp	E22	ELÉCTRICAS PITARCH DISTRIBUCIÓN	endurance MOVE ON	ENFASYS	SYNAPSIS	tecnalia	TSK	Tekniker INGENIERIA Y TECNOLOGIA ALLIANCE	UNIVERSIDAD COMPLUTENSE MADRID	UNIVERSIDAD DE CÓRDOBA
envirobat	EnergyNest The Thermal Battery Company	etra	full&fast	HESSE	Grennanova	uc3m Universidad Carlos III de Madrid	recyclia	UCLM UNIVERSIDAD DE CASTILLA LA MANCHA	UNBAT	UNIVERSIDADE DA CORUÑA	Universidad de Oviedo
GTFE energy optimization	FAEN Fábrica de Aluminio de Navarra	Floatech	Highview Power	HR	IBERDROLA	POLITÉCNICA	USC UNIVERSIDAD DE SANTIAGO DE COMPOSTELA	UNIVERSITAT JAUME I	ZELEROS	CIEMAT Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	
ICMAB CSIC	ingeniería de diseño Industrial	ICN2 Institut Català de Nanociència i Nanotecnologia	eurecat Centro tecnológico de Colaboración	ikerlan	idea energía	ASEALEN Asociación de empresas de energía					



Estrategia de almacenamiento energético en España



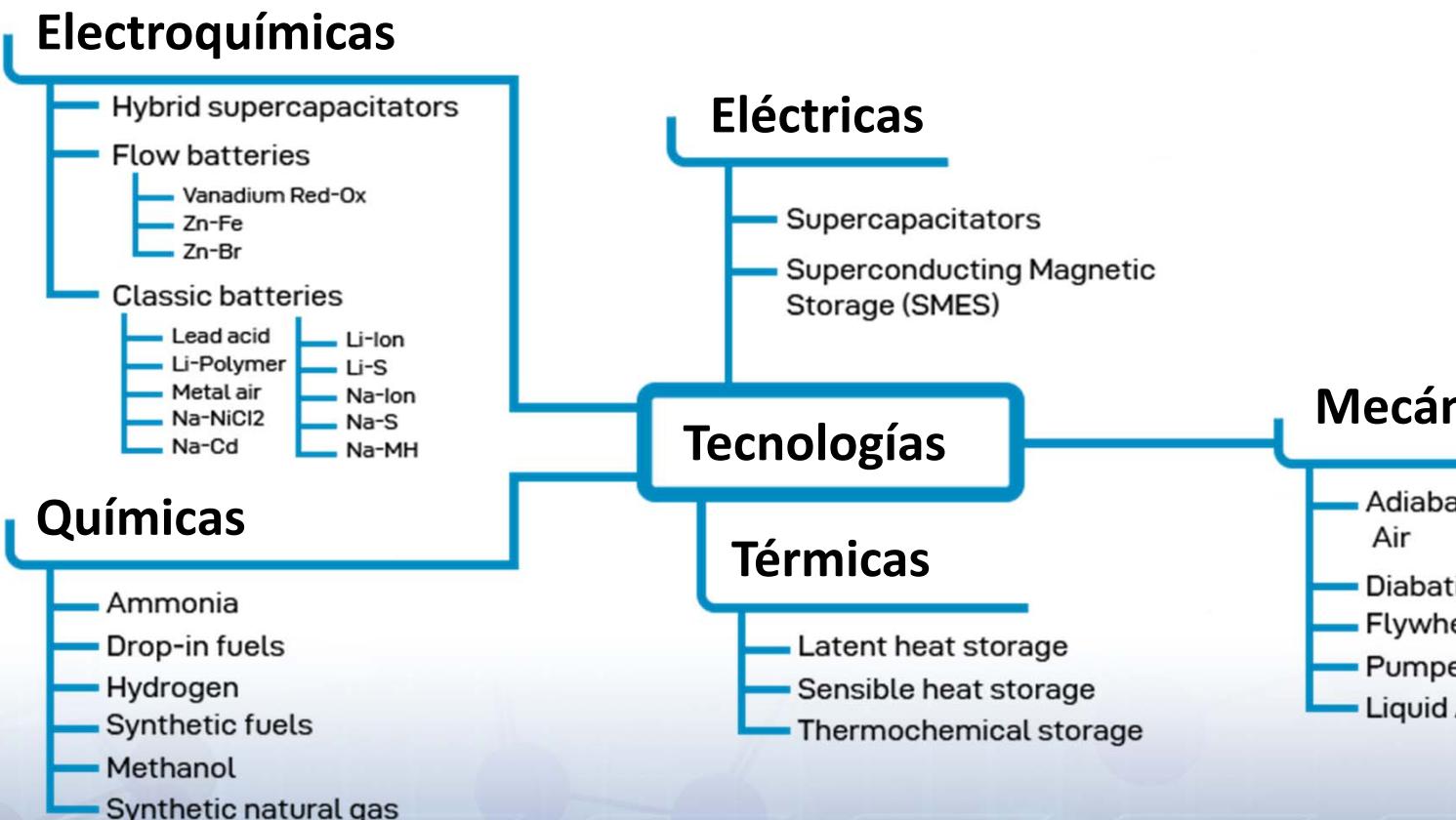
Regulación	<ul style="list-style-type: none">• Modificar Procedimientos Operativos del Sistema• Promover la integración del sector• Eliminar doble tarificación de la red
Nuevos Modelos de Negocio	<ul style="list-style-type: none">• Promover el rol de agregador independiente• Promover la industria doméstica• Fomentar las comunidades de energías renovables
I+D	<ul style="list-style-type: none">• Desarrollar estudios prospectivos• Fomentar la colaboración entre academia, industria y gobierno

MEDIDA 6.1. Promover la creación de plataformas de laboratorios experimentales y de investigación que aprovechen sinergias

La existencia de un tejido disperso de laboratorios hace necesario posibilitar el mutualizar los medios de ensayo a través de plataformas experimentales y tecnológicas, abiertas al conjunto de actores del sector, que cree sinergias, permita un uso eficiente de recursos y facilite la distribución y aprovechamiento de los resultados. En este sentido, en España ya se dispone de iniciativas como la Plataforma Tecnológica Española de Almacenamiento de Energía – BatteryPlat, cuyo objetivo general es consolidar a los principales actores españoles que trabajan en todas las tecnologías de almacenamiento energético, para potenciar una visión común y elaborar una agenda estratégica de investigación y así acelerar el desarrollo innovador del sector para situarlo en la vanguardia a nivel mundial. Otro ejemplo es la plataforma multidisciplinar (PTI FLOWBAT) del CSIC, donde se integran todas sus capacidades para el desarrollo de baterías de flujo redox.

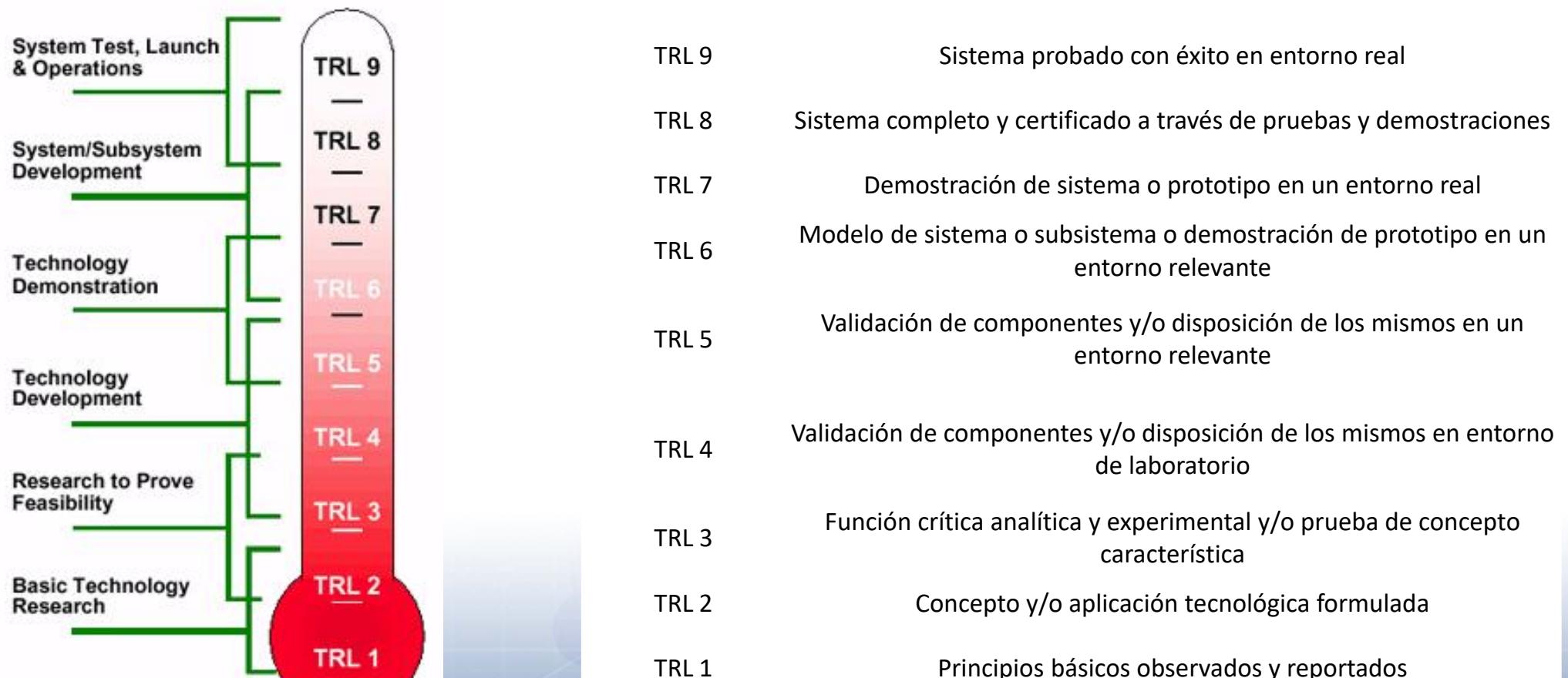


Árbol de Tecnologías





Escala TRL de madurez tecnológica



Madurez tecnológica: disparidad de fuentes

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A comprehensive review of stationary energy storage devices for large scale renewable energy sources grid integration

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ABSTRACT

Currently, the energy grid is changing due to the increasing energy demands but also to support the rapid penetration of renewable energy sources. As a result, energy storage devices emerge to add buffer capacity and to enhance residential and commercial usage, as an attempt to improve the overall utilization of the available green energy. Although various research has been conducted in the field including photovoltaic and wind applications, there is still a lack of research in the field of stationary energy storage devices. The main reason for this type is still the gap observed which needs further study and verification. The review performed fills these gaps by investigating the current status and applicability of energy storage devices, and the most suitable type of storage technologies for grid support applications are identified. Moreover, various technical, economic and environmental impacts of these devices are taken into consideration for the selection of these devices' capacities and potentials. The comprehensive review shows that, from the electrochemical storage category, the lithium-ion battery has both low and medium-size applications with high power and energy density requirements. From the electrical storage categories, capacitors, supercapacitors, and superconducting magnetic energy storage devices are selected as appropriate for high power applications. These energy storage is identified as suitable in seasonal and bulk energy application areas. With proper identification of the application's requirement and based on the technical, economic, and environmental impact investigations of energy storage devices, the use of a hybrid solution with a combination of various storage devices is found to be a viable solution in the sector.

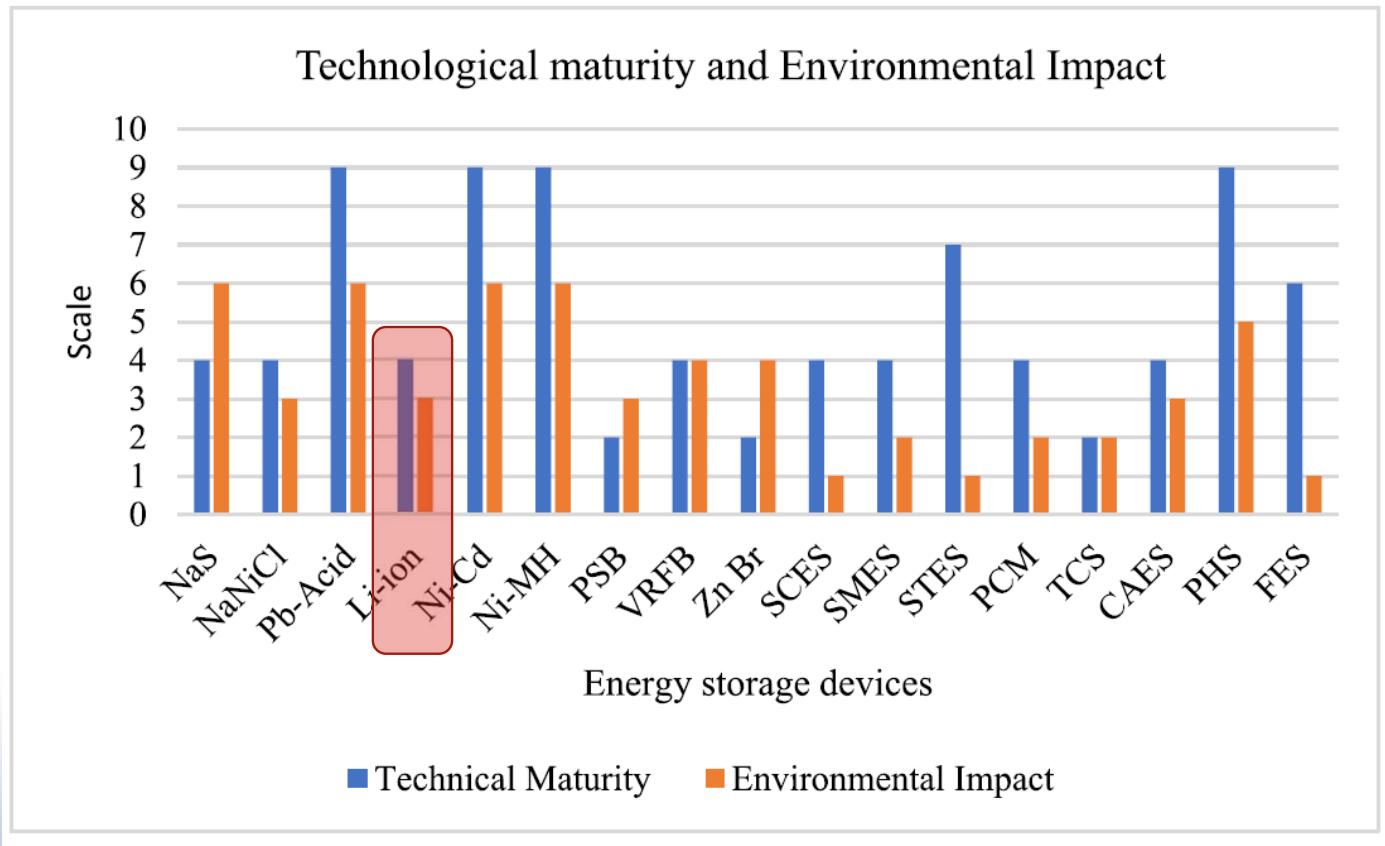
1. Introduction

Currently, the globe is still facing a challenge in the sector of energy with the lack of reliable energy sources at moderate charges and energy can be regenerated by polluting energy sources, such as coal. For resolution of this problem, our focus is on various types of renewable energy sources (RESs). Wind and solar RESs are predicted to supply 50% of the world's energy demand by 2050 [1] while the electricity demand only from the electric vehicles (EVs) is going to reach a 4% increase, approximately 1 PWh by 2040 and total energy consumption will increase [2]. According to the INERI, the global power generation mix, from 1970 to 2017, compared to renewable sources, fossil fuels have a large share in the generation mix and energy supply system. However, from 2018 onwards, the energy contribution share of fossil fuels including coal and gas gets decreased and will fall to 31% by 2050. Moreover, the expected renewable energy sources (hydro, wind, solar, and others) will have a dominant share accounting for more than 62%. Among these, solar and wind, in particular, will have a large generation mix rate around 40%. This means as the global growth of grid integration and storage increases around the globe. Consequently, by 2040 (accounting on a 9GW/17 GWh deployed at 2018) the market will rise to 109 GW/2, 350 GWh, making a more than 120-times increase, based on a recent study published by Bloomberg new energy finance (BNEF) [3].

The following figure illustrates the global cumulative energy storage installations in various countries which illustrates that the need for energy storage devices (ESDs) is dramatically increasing with the increase of renewable energy sources. ESDs can be used for stationary applications in every level of the network such as generation, transmission and distribution as well as local, residential and commercial domains. Nowadays, in addition to the utilization of existing ESDs in stationary

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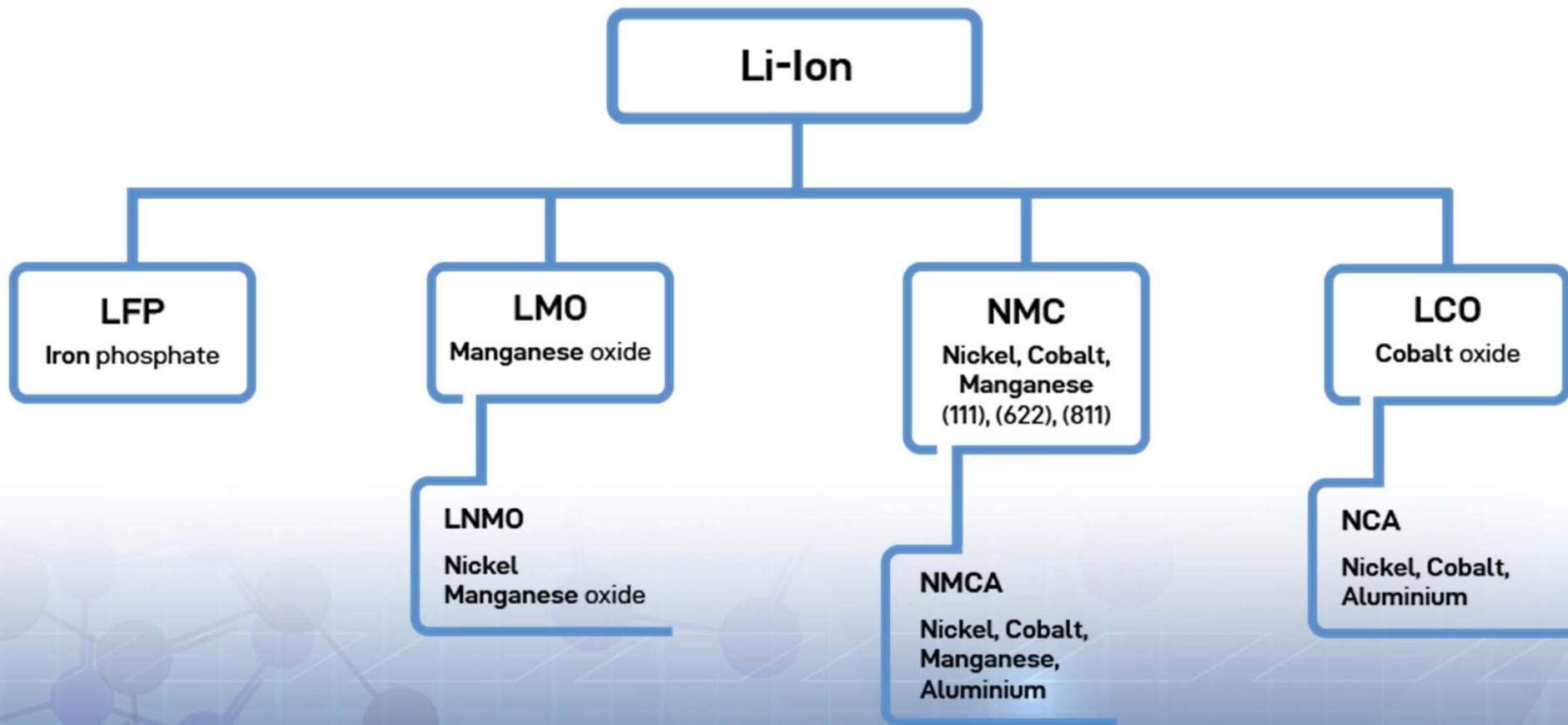
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Fuente: A.A. Kebede et al, "A comprehensive review of stationary energy storage devices for large scale renewable energy sources grid integration" enero 2022

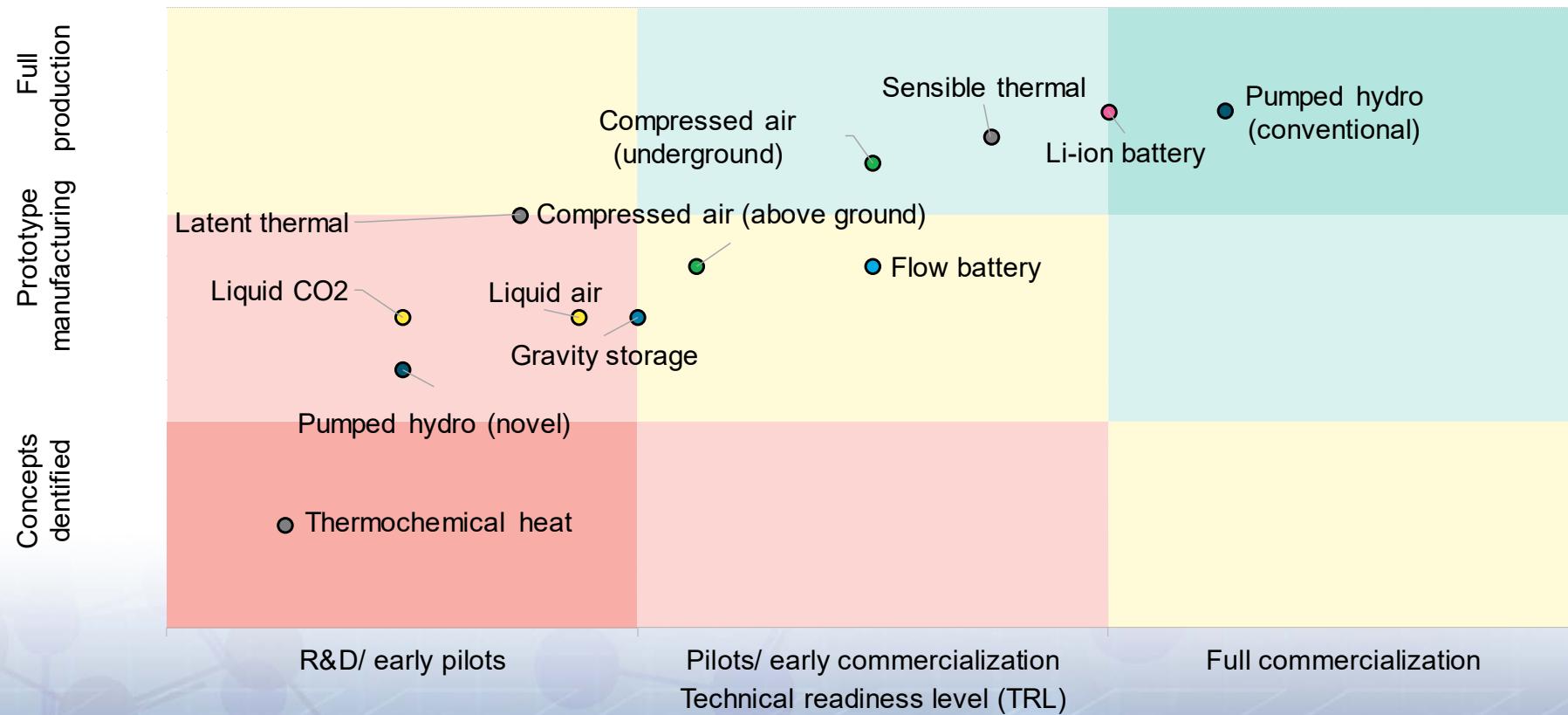


Árbol de Tecnologías



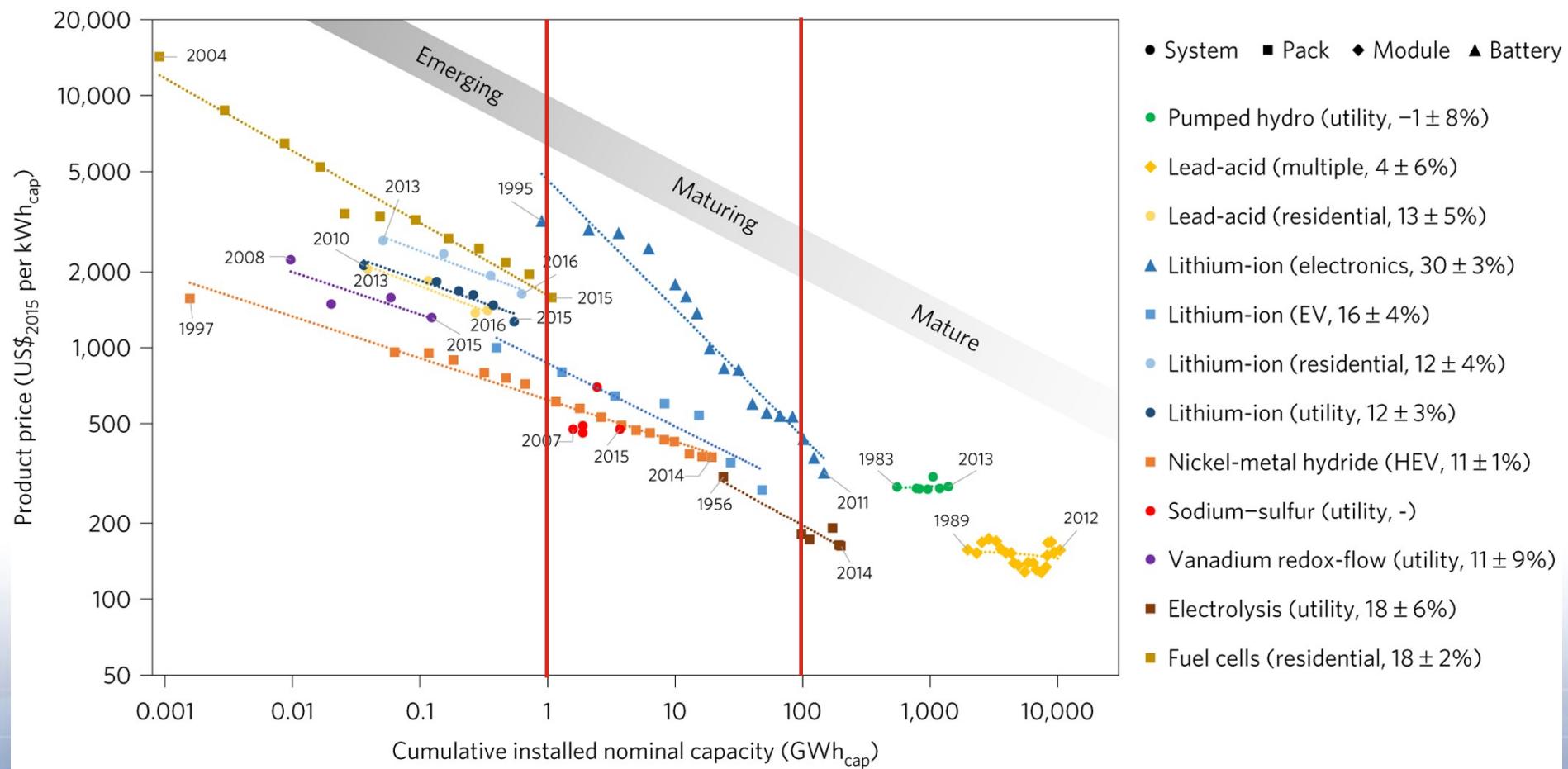
Madurez tecnológica y madurez de fabricación

Manufacturing readiness level (MRL)



Fuente: BloombergNEF "Beyond Lithium-Ion: Long-Duration Storage Technologies" abril 2022

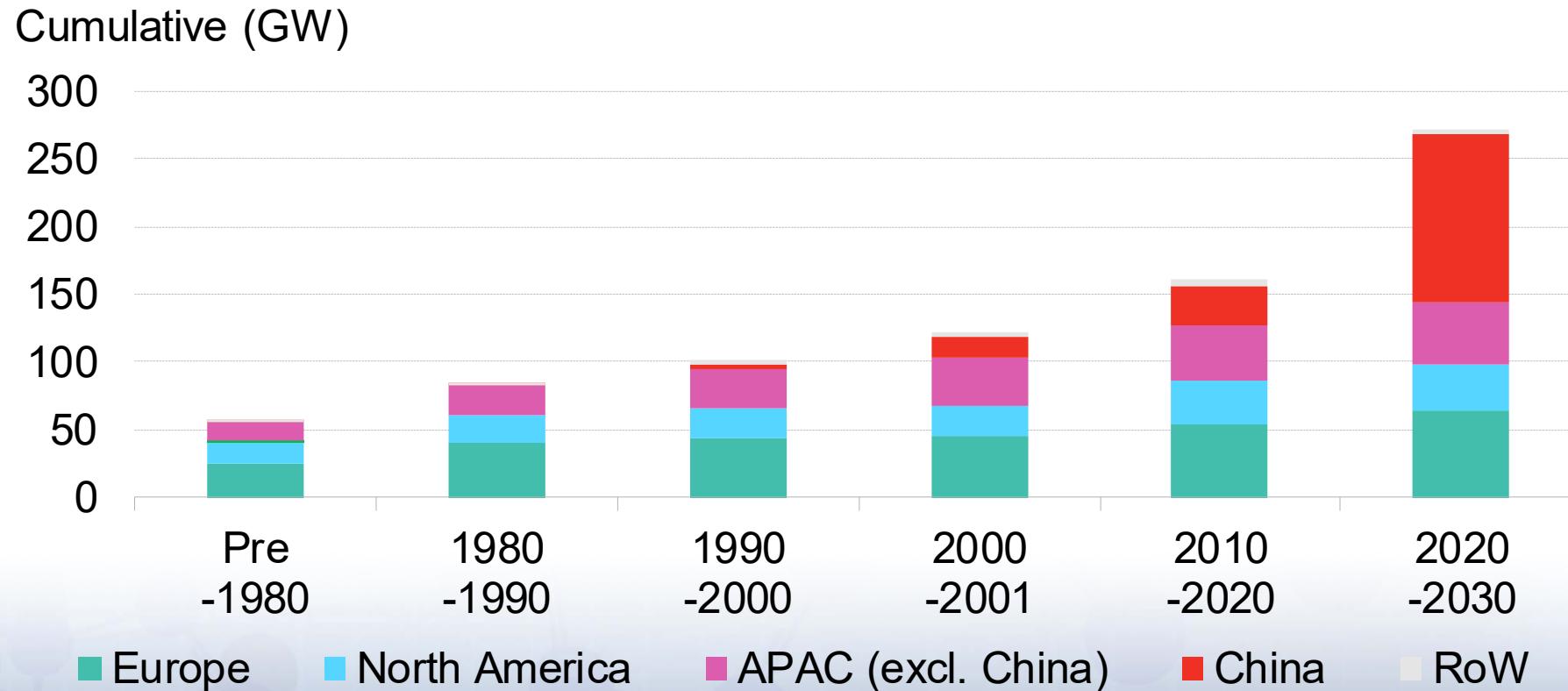
Curvas de aprendizaje



Fuente: Schmit et al. Nature "The future cost of electrical energy storage based on experience rates" julio 2017



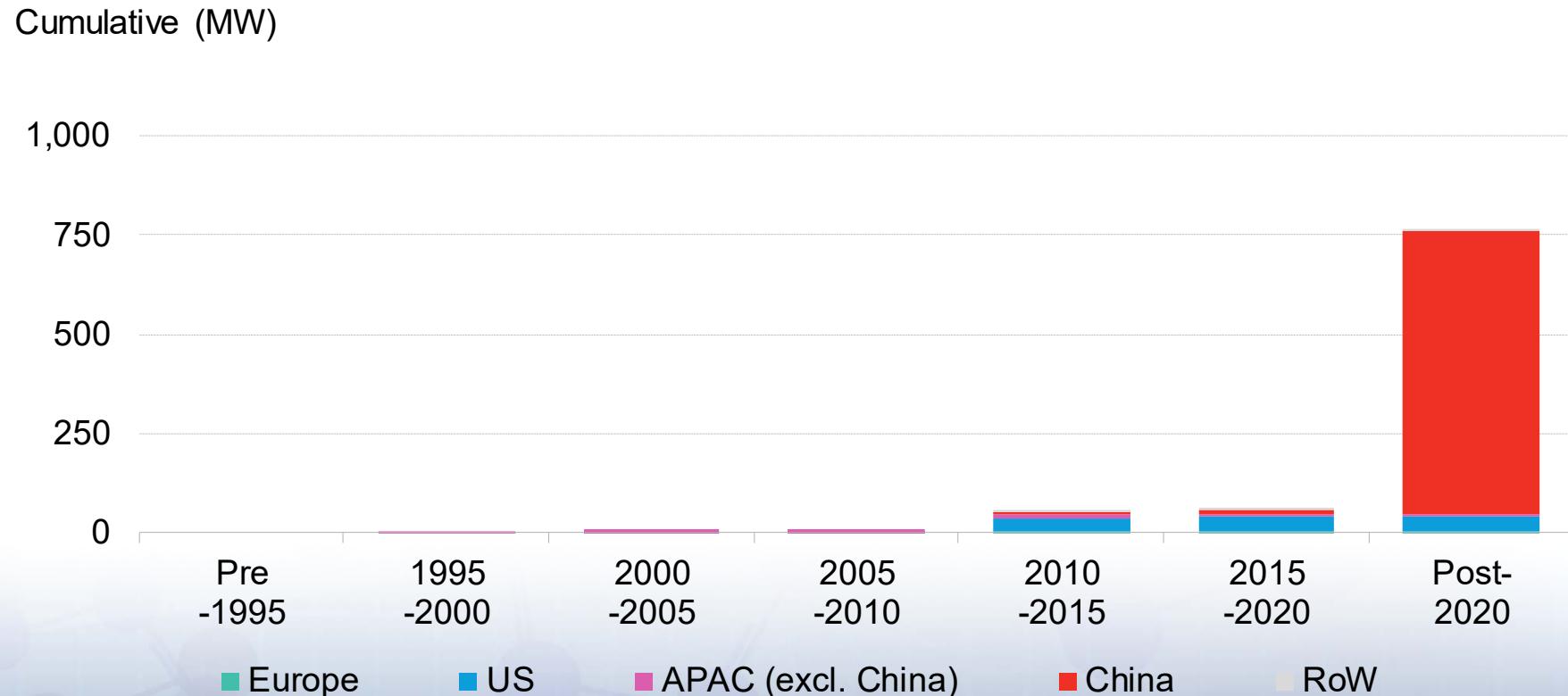
Evolución de la potencia instalada en bombeo



Fuente: BloombergNEF "Beyond Lithium-Ion: Long-Duration Storage Technologies" abril 2022



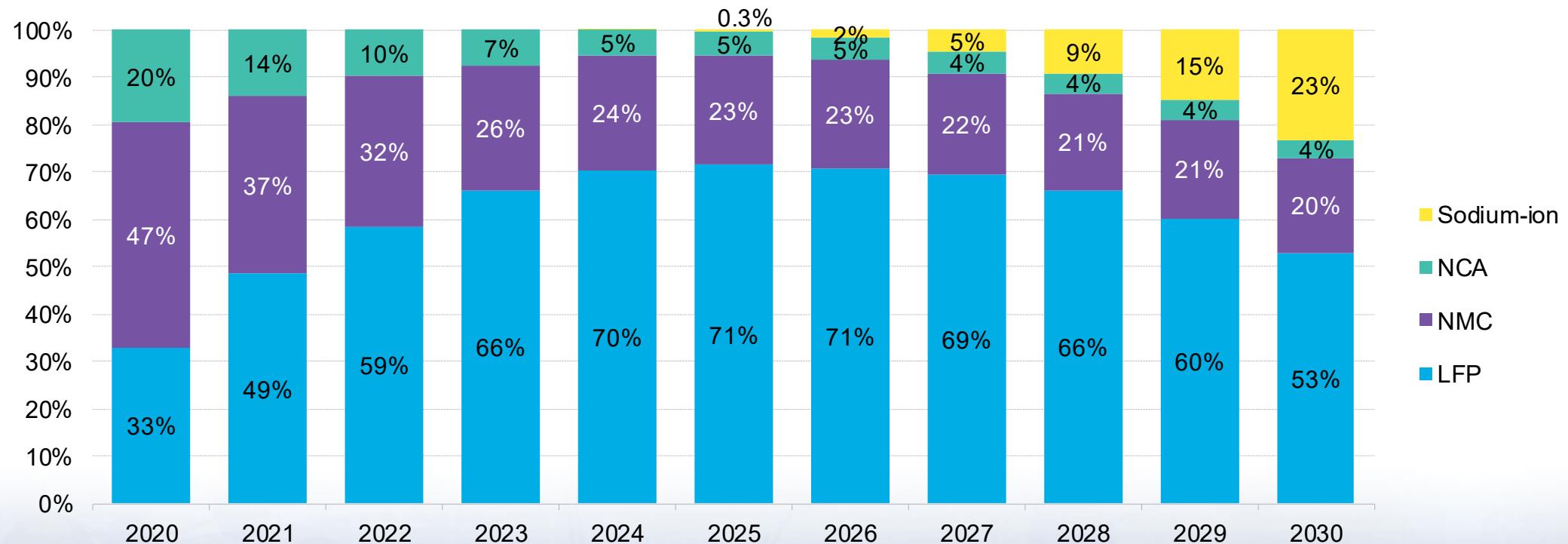
Evolución de la potencia instalada en flujo redox



Fuente: BloombergNEF “Beyond Lithium-Ion: Long-Duration Storage Technologies” abril 2022



Dominio comercial de la baterías de Litio Ion



Fuente: BNEF "Global Energy Storage Outlook 2021" noviembre 2021

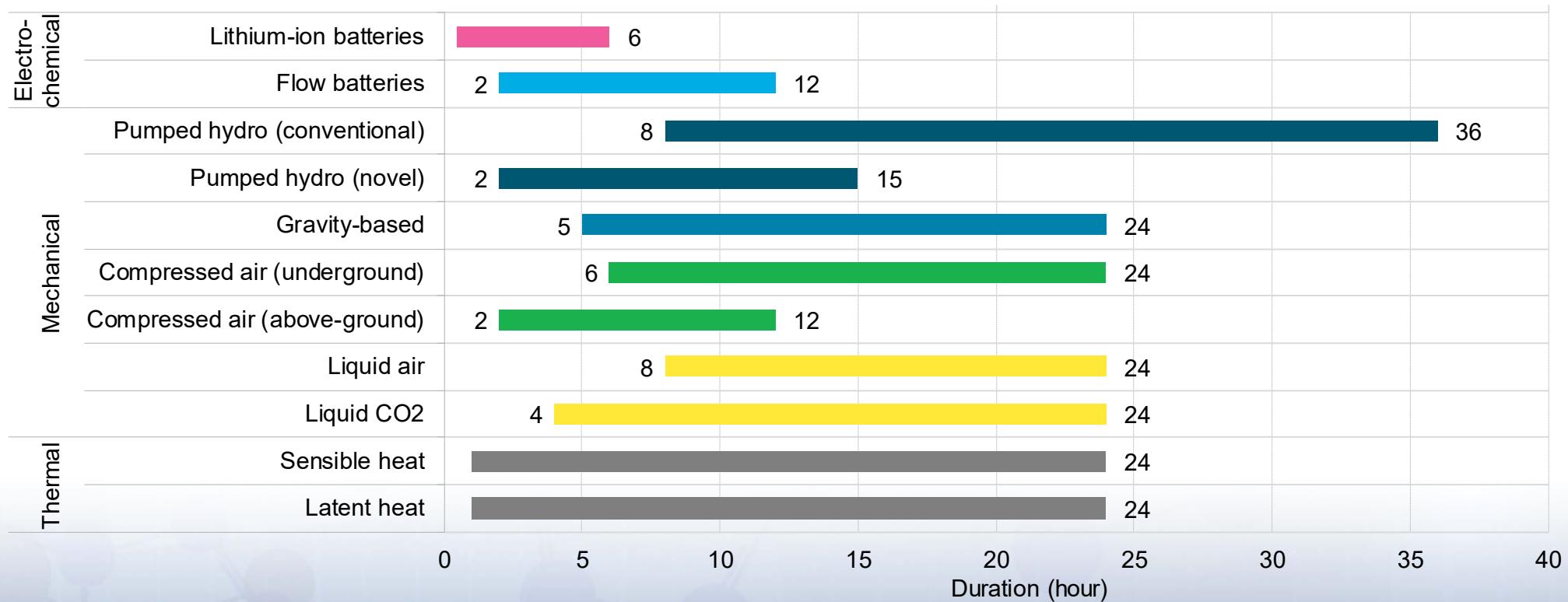
Aplicaciones por Tecnologías

Application areas		Energy Storage Devices														
		Electrochemical				Electrical		Mechanical		Thermal						
		NaS	NaNiCl ₂	Pb-Acid	Li-ion	Ni-Cd	Ni-MH	VRFB	PSB	Zn Br	SCES	SMES	CAES	PHS	FES	All Thermal
Renewable energy integrations	Time shifting	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Firming capacity	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Bulk Energy	Peak Shaving	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Arbitrage of energy	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Ancillary Services	Voltage Support	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Load balancing	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Spinning reserve	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Black Start	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Frequency balancing	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Energy Management	Enhancing Power quality	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Power reliability	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

Fuente: A.A. Kebede et al, "A comprehensive review of stationary energy storage devices for large scale renewable energy sources grid integration" enero

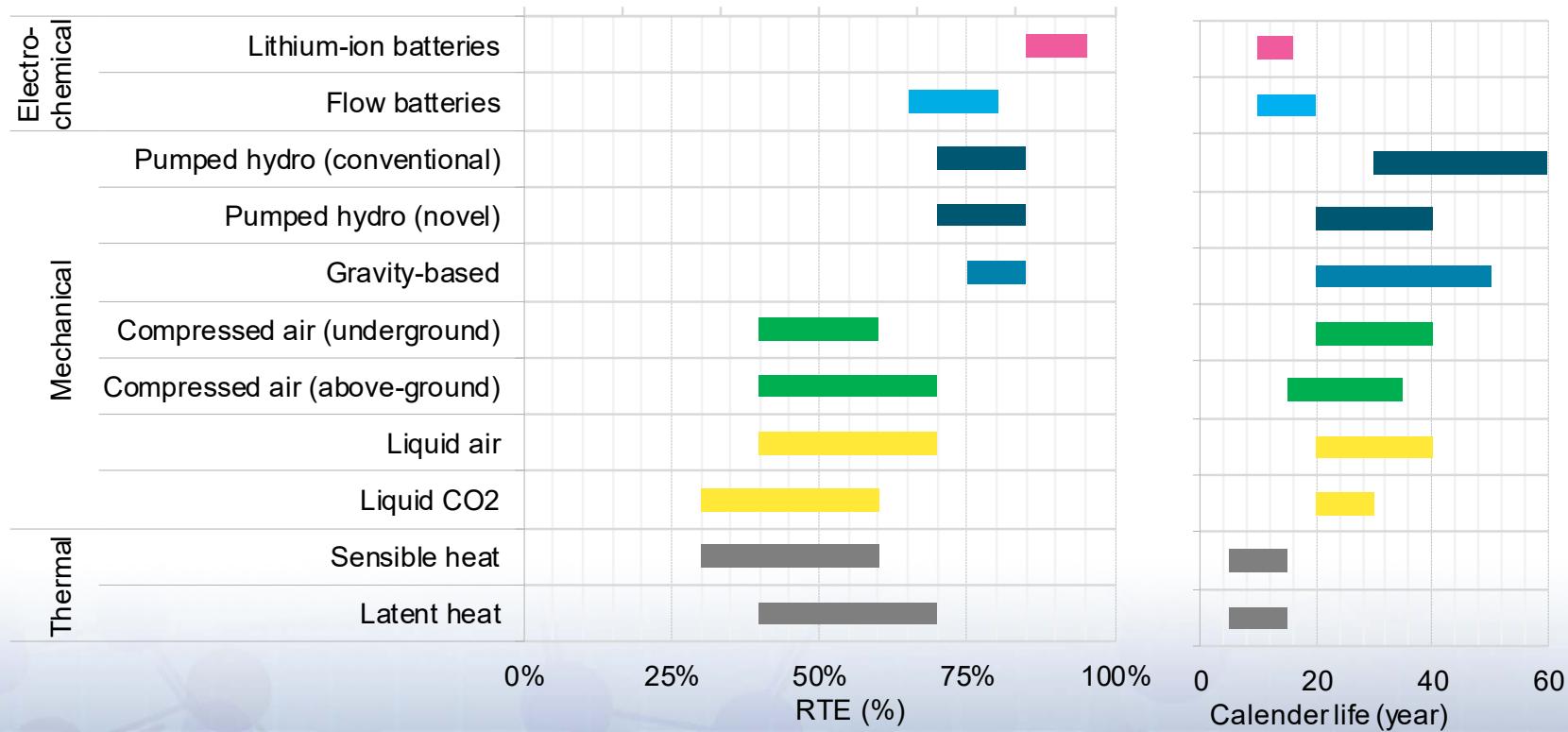


Duración de descarga típica por tecnologías



Fuente: BloombergNEF, DNV GL, McKinsey, company filings. Note: above chart represents a typical duration range. Their maximum duration can be extended.

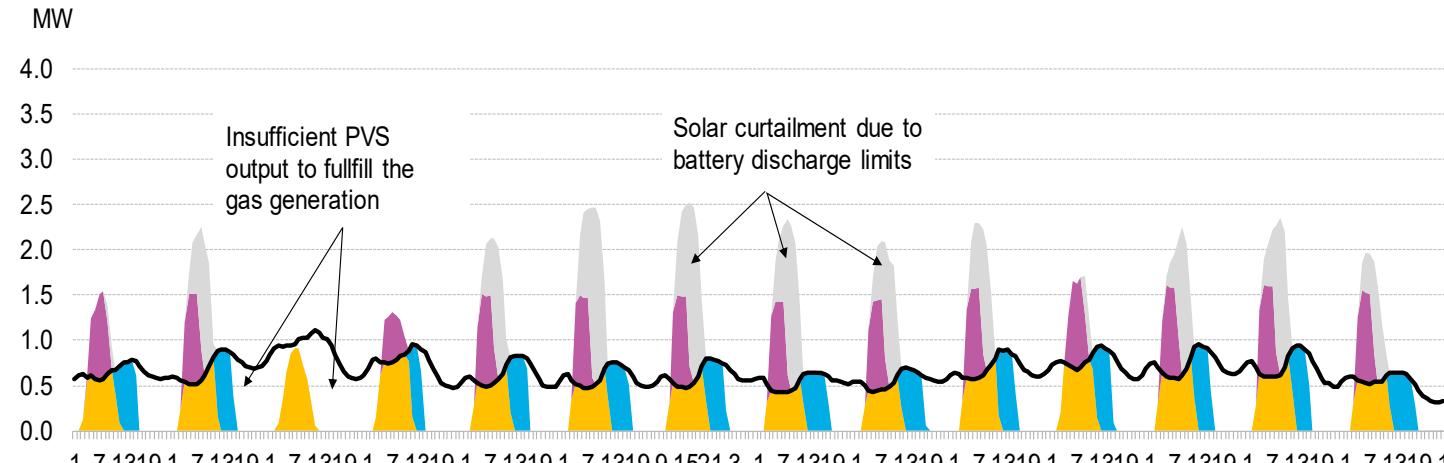
Eficiencia y vida útil por tecnologías



Fuente: BloombergNEF, DNV GL, McKinsey, company filings. Note: above chart represents a typical duration range. Their maximum duration can be extended.

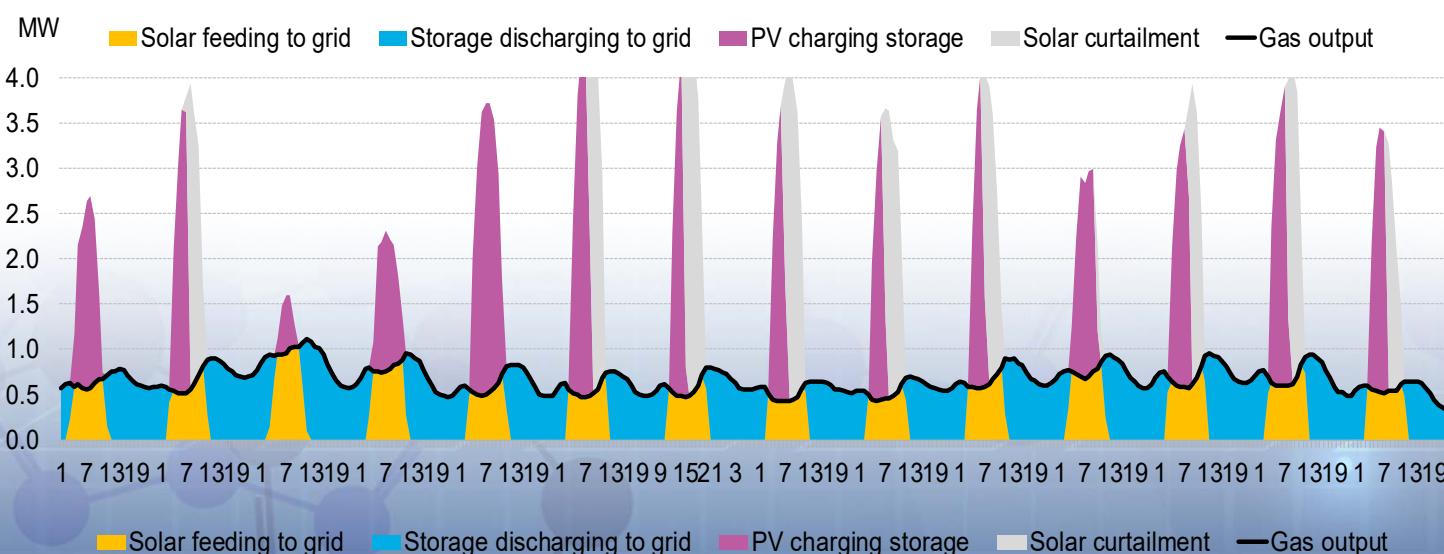


La rigidez potencia/energía en el Litio lleva a sobredimensionar



co-located PV (4MWDC) plus storage (1MW/4MWh)

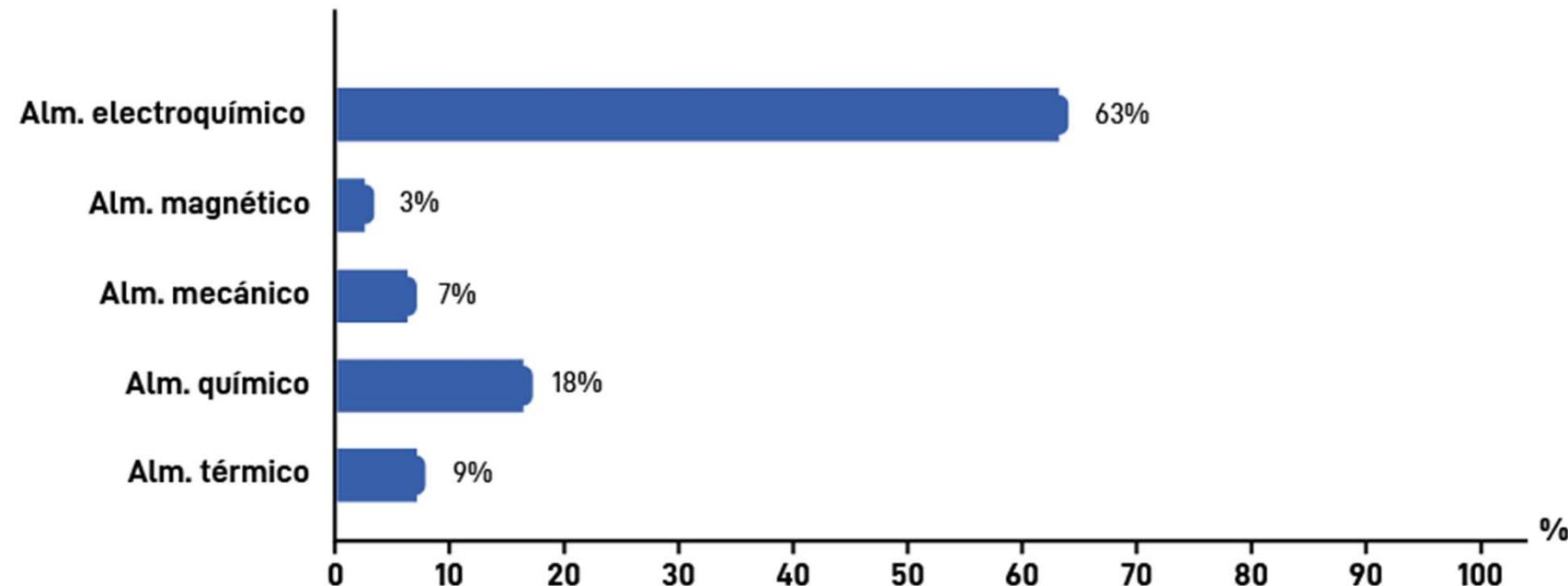
A un incremento del 75% de la generación fotovoltaica le corresponde un incremento del 600% del almacenamiento



co-located PV (7MWDC +75%)
plus storage (6MW/24MWh
+600%)

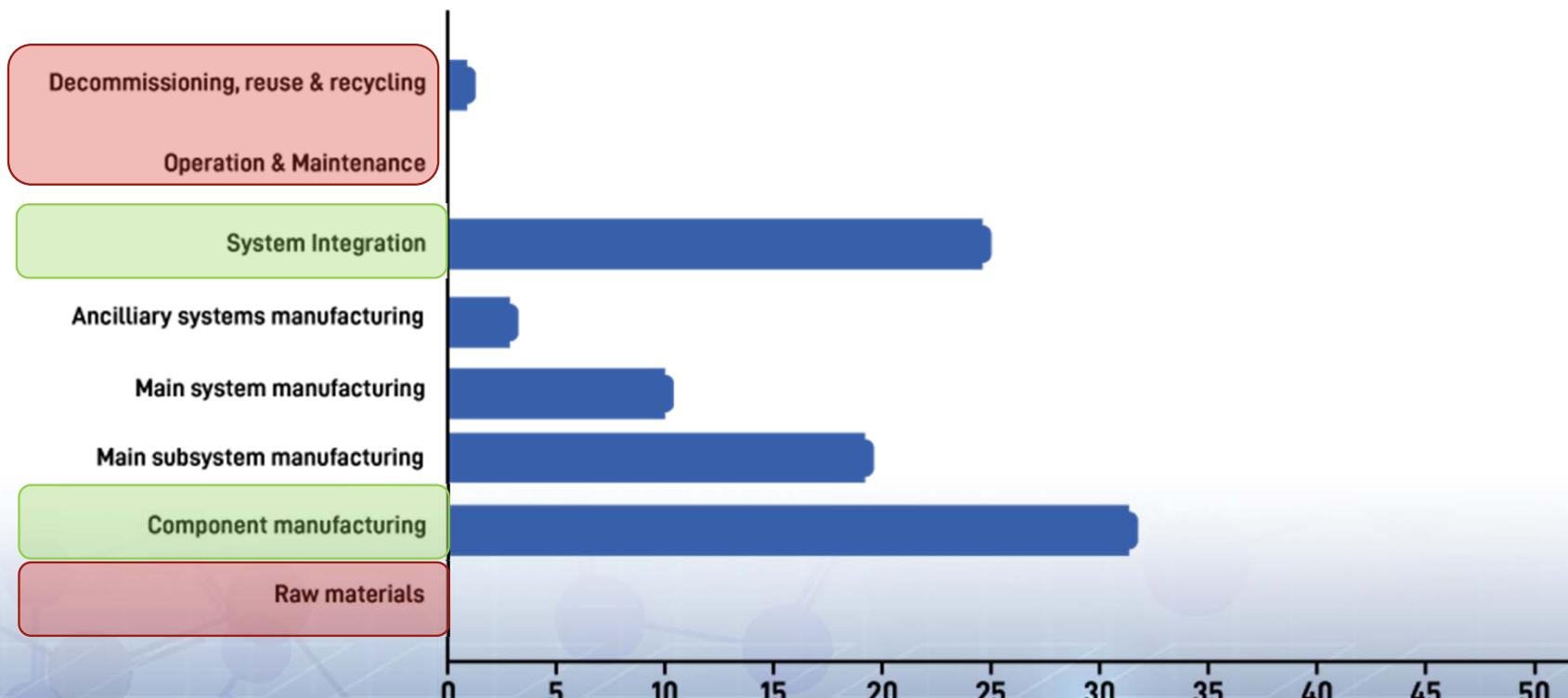


Capacidad de las tecnologías de almacenamiento (% de entidades)



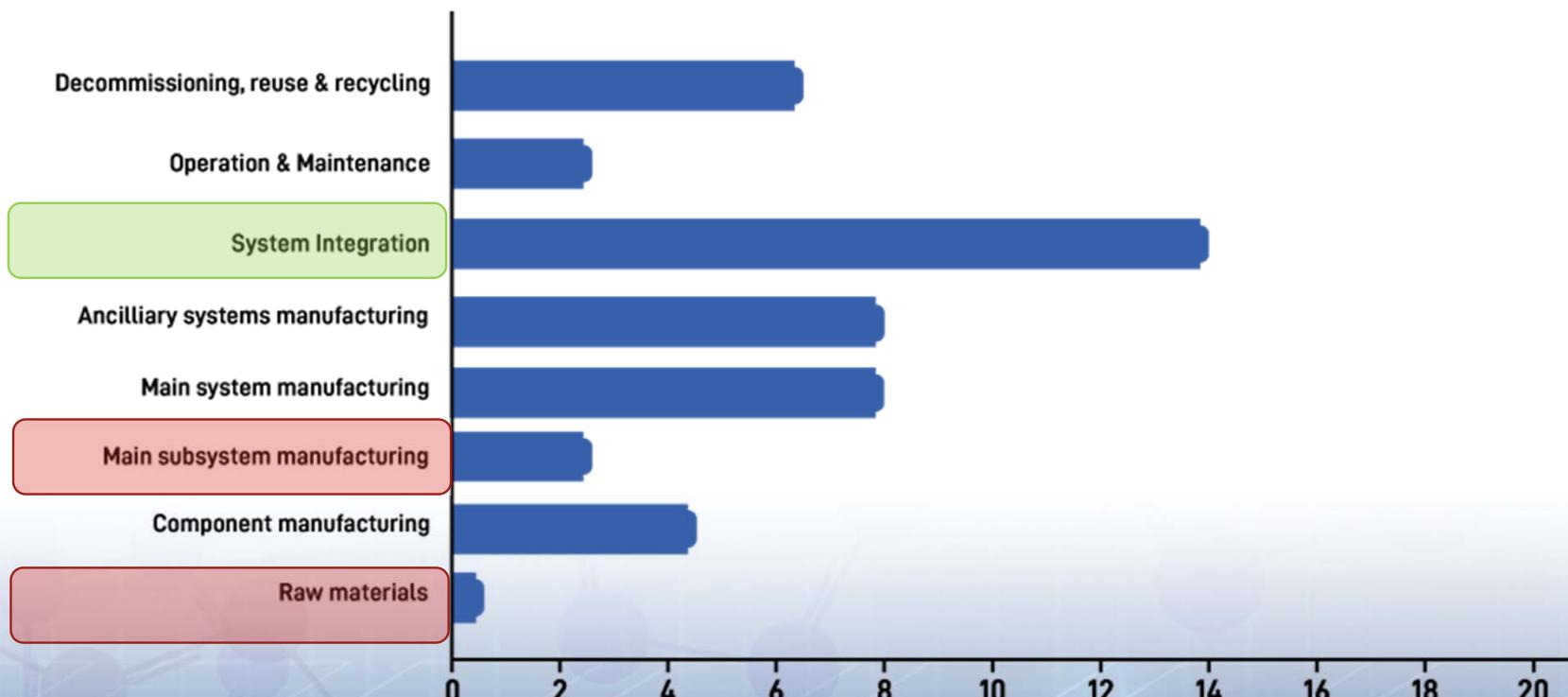
Miembros en la Cadena de Valor ámbito Académico (N.º entidades)

CdV — Centros I+D, Centros Tecnológicos y Universidades



Miembros en la Cadena de Valor ámbito Industrial (N.º entidades)

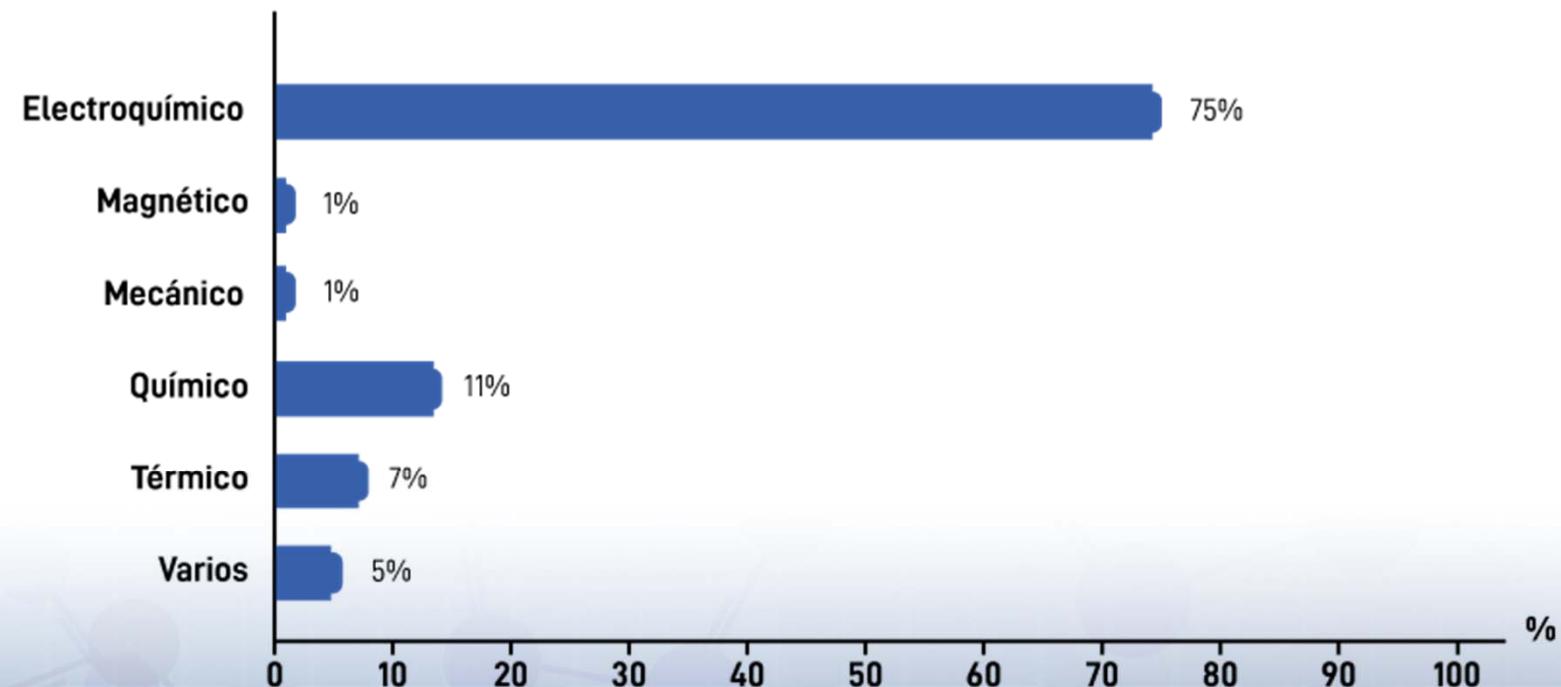
CdV — Empresas y asociaciones empresariales





Proyectos por familia Tecnológica

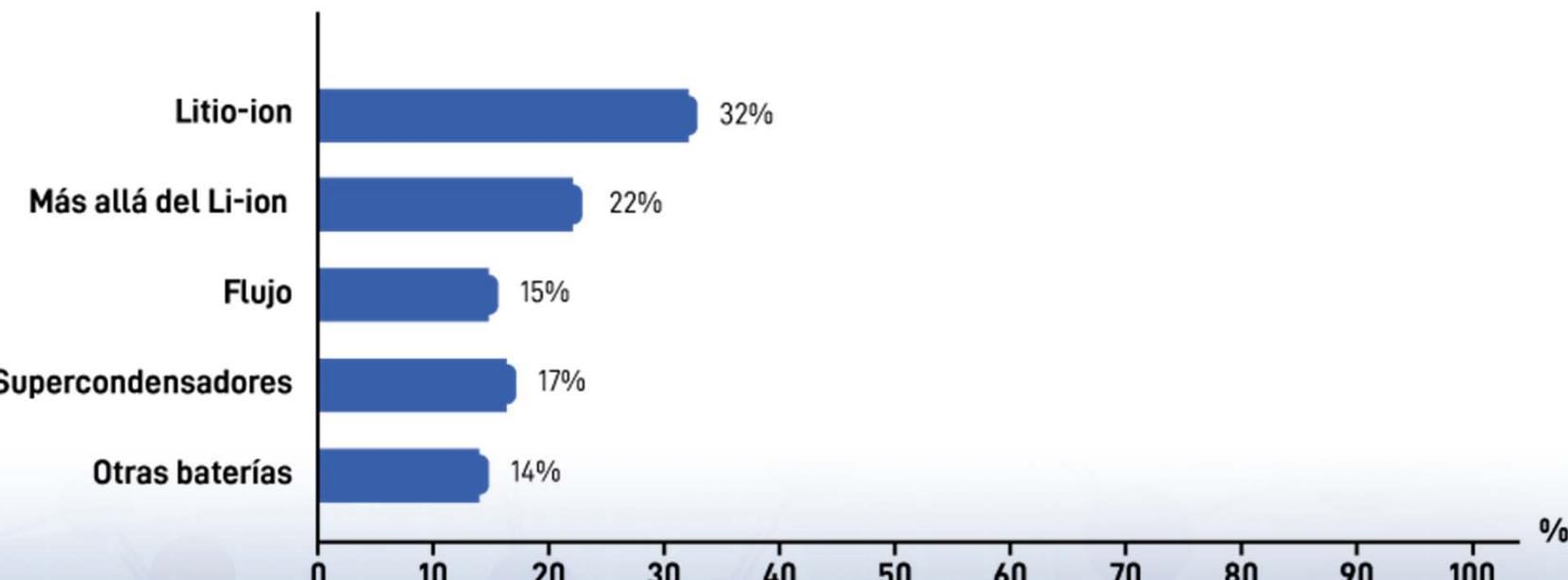
Tecnologías Proyectos

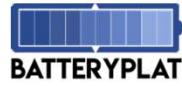




Desglose Almacenamiento Electroquímico

Almacenamiento electroquímico





Conclusiones

1. Las tecnologías más maduras son el bombeo y las baterías de Litio
2. Además de la madurez hay que considerar las distintas funcionalidades
3. En España las capacidades a nivel industrial y académico son diferentes
4. Hasta ahora, se han identificado varios huecos a nivel de capacidades
5. Las entidades de Batteryplat son activas en la presentación de proyectos

¡Gracias!

¿Tenéis dudas?

Aquí están nuestros contactos:



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