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energy cooperative research centre

La política industrial de Euskadi en Redes Eléctricas

"Novedades en el desarrollo de las redes eléctricas"

Bilbao, 9 de mayo de 2018

2018

1. **Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.**
2. **Tecnologías, retos y apuestas globales.**
3. **El litio ahora y en el futuro.**
4. **Conclusiones.**

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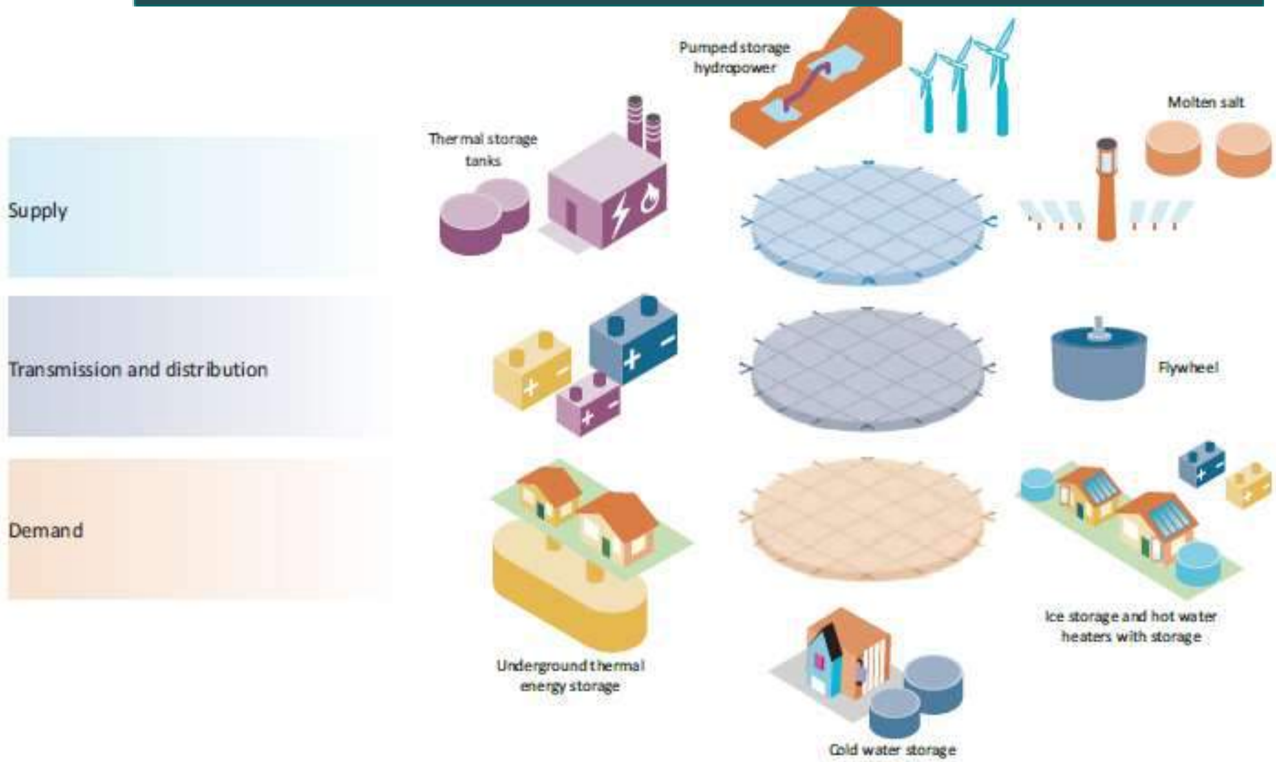
1. Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.

Los sistemas de almacenamiento son activos de red…

Hypothetical deployment of storage assets across an electric power system



Source: modified from EIA (Energy Information Administration) (2012), "Electricity storage: Location, location, location.....and cost", *Today in Energy*, Washington, DC, United States, www.eia.gov/todayinenergy/detail.cfm?id=6910.

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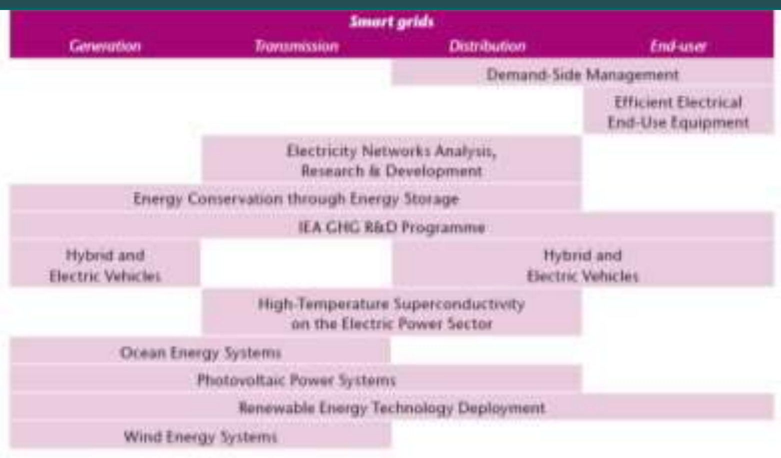
1. Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.

… Que hay que conocer para su mejor gestión…

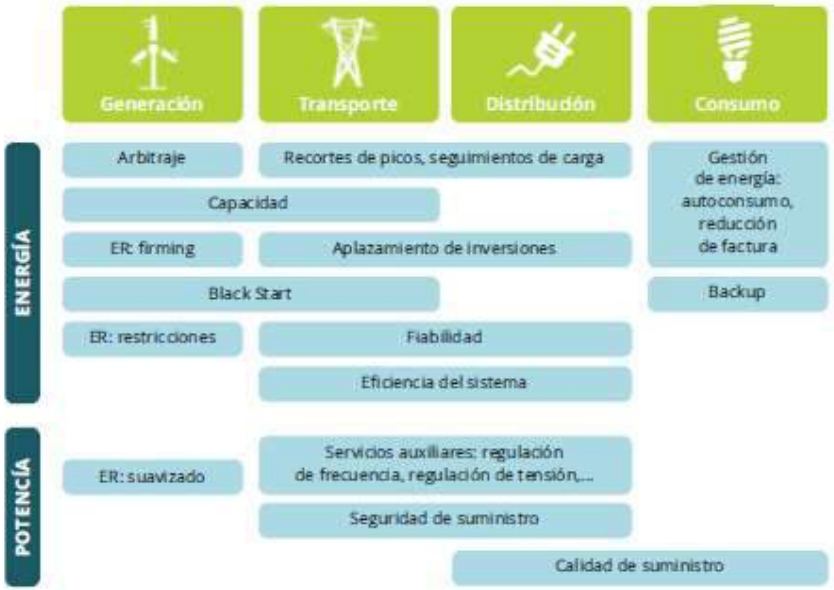
Electricity sector focus for IEA ECG Implementing Agreements



Note: The diagram indicates the primary area of the electricity system where the IA focuses. Most IAs engage with sectors beyond those indicated. Website addresses can be found on page 48.

Source EIA

Distribución de las diferentes aplicaciones



Nota: Las aplicaciones relacionadas con las energías renovables se indican con las letras "ER". Así, por ejemplo, ER firming se refiere a la obtención de una potencia de salida constante mediante la aportación de energía cuando la producción está por debajo del valor previsto.

Source GIA

Stationary Energy Storage – Potential segmentation

Source Avicienne Energy 2016

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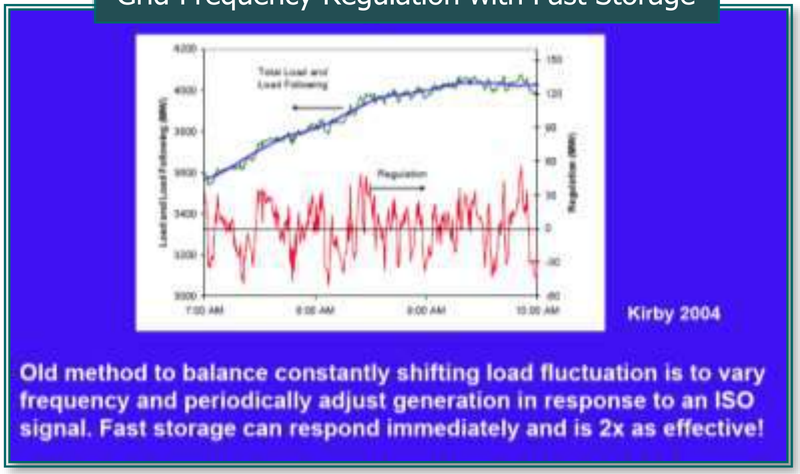
… Aportando ventajas importantes…

Grid Frequency Regulation with Fast Storage

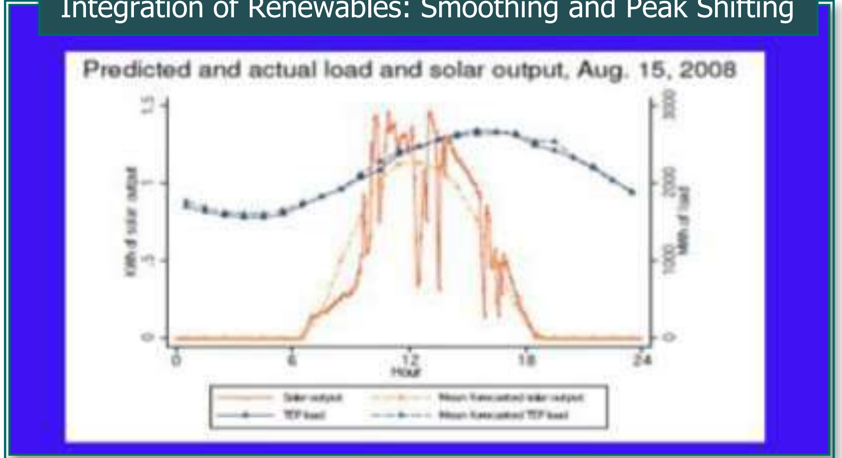


Source: **DOE, Dr.I.Gyuk**

Storage for Renewable Energy Integration: Arbitrage

Source: **DOE, Dr.I.Gyuk**

Integration of Renewables: Smoothing and Peak Shifting



Source GIA

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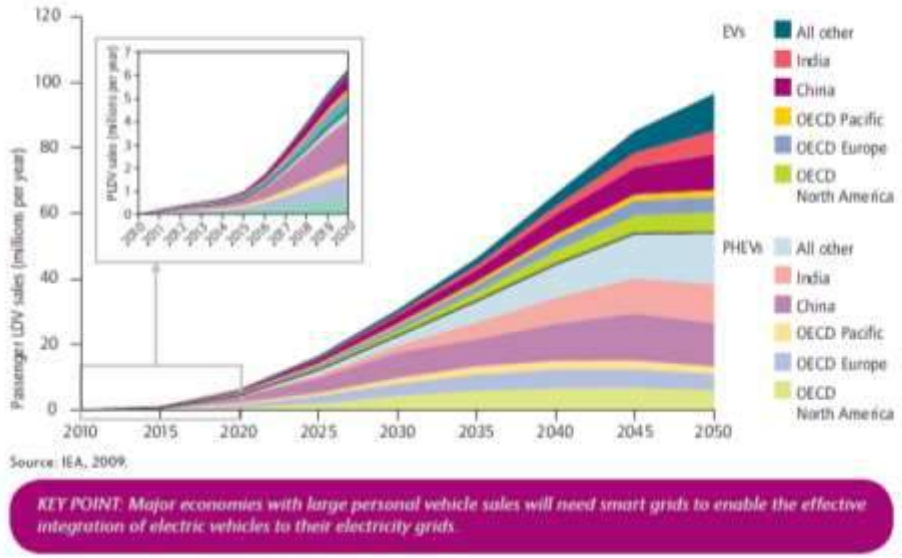
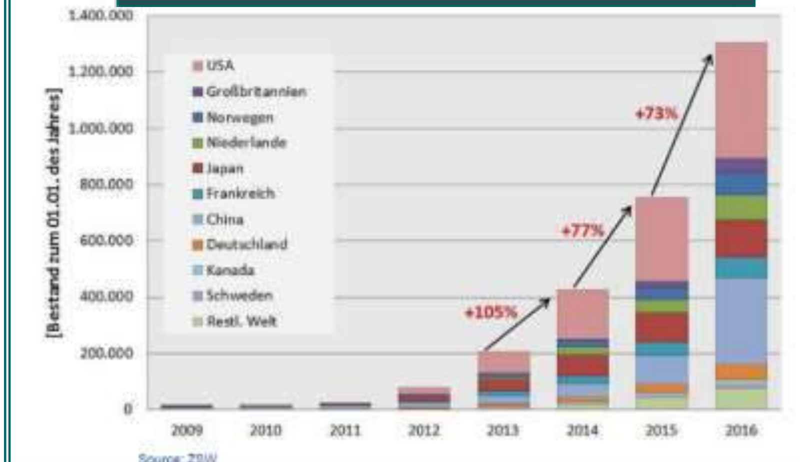
1. Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.

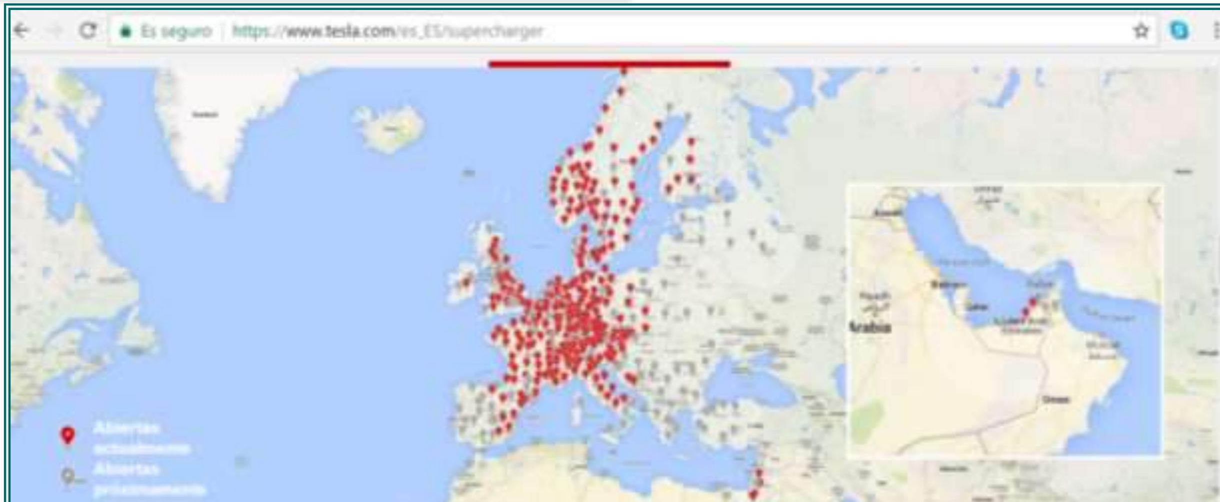
… Y que afrontan nuevos retos…

Deployment of electric vehicles and plug-in hybrid electric vehicles



Number of Electric Cars Worldwide 1.3 Million





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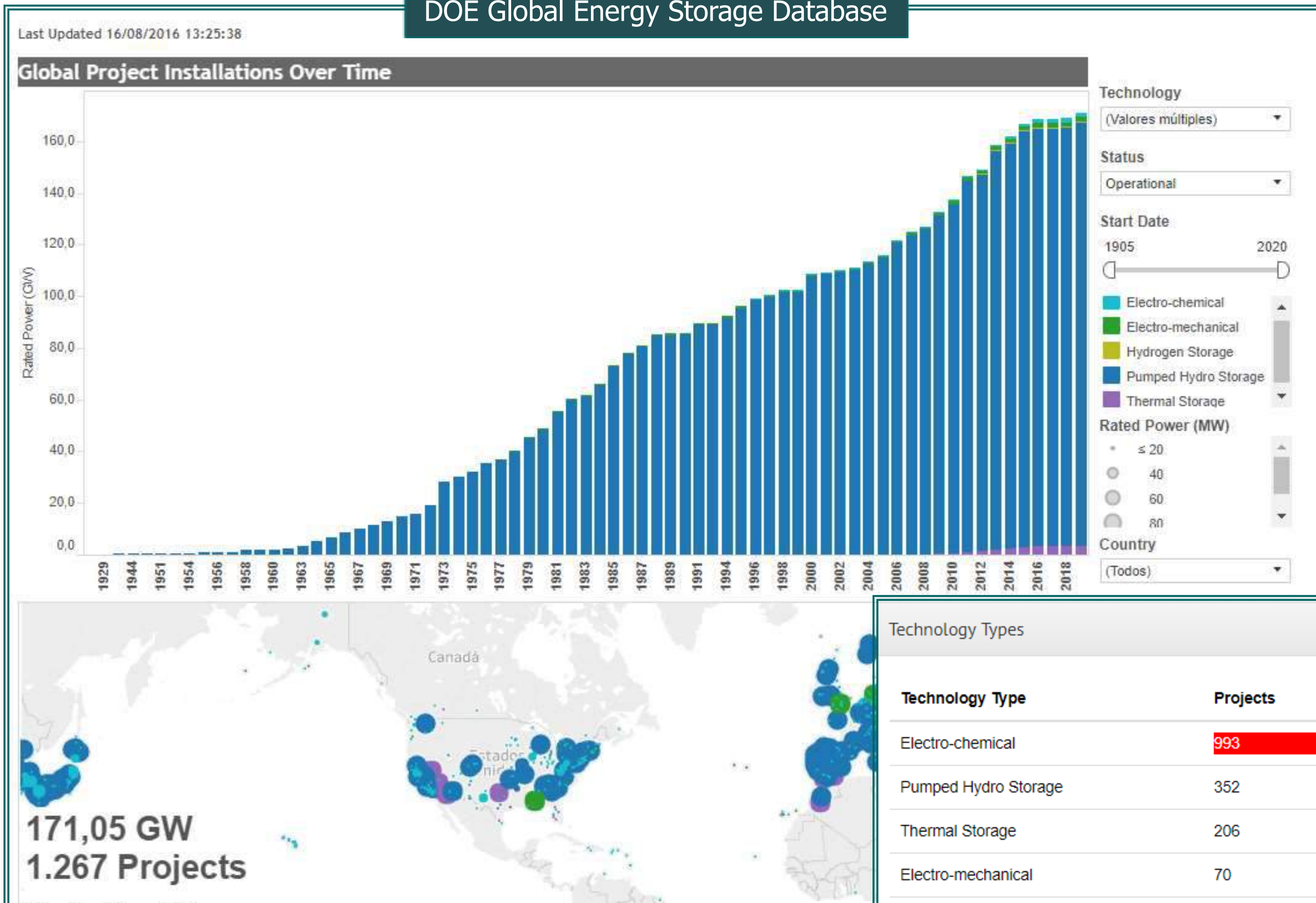
1. Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.

Proyectos en el mundo con almacenamiento instalado

DOE Global Energy Storage Database



Technology Types

Technology Type	Projects	Rated Power (MW)
Electro-chemical	993	3279
Pumped Hydro Storage	352	183800
Thermal Storage	206	3622
Electro-mechanical	70	2616
Hydrogen Storage	13	18
Liquid Air Energy Storage	2	5

http://energystorageexchange.org/projects/data_visualization

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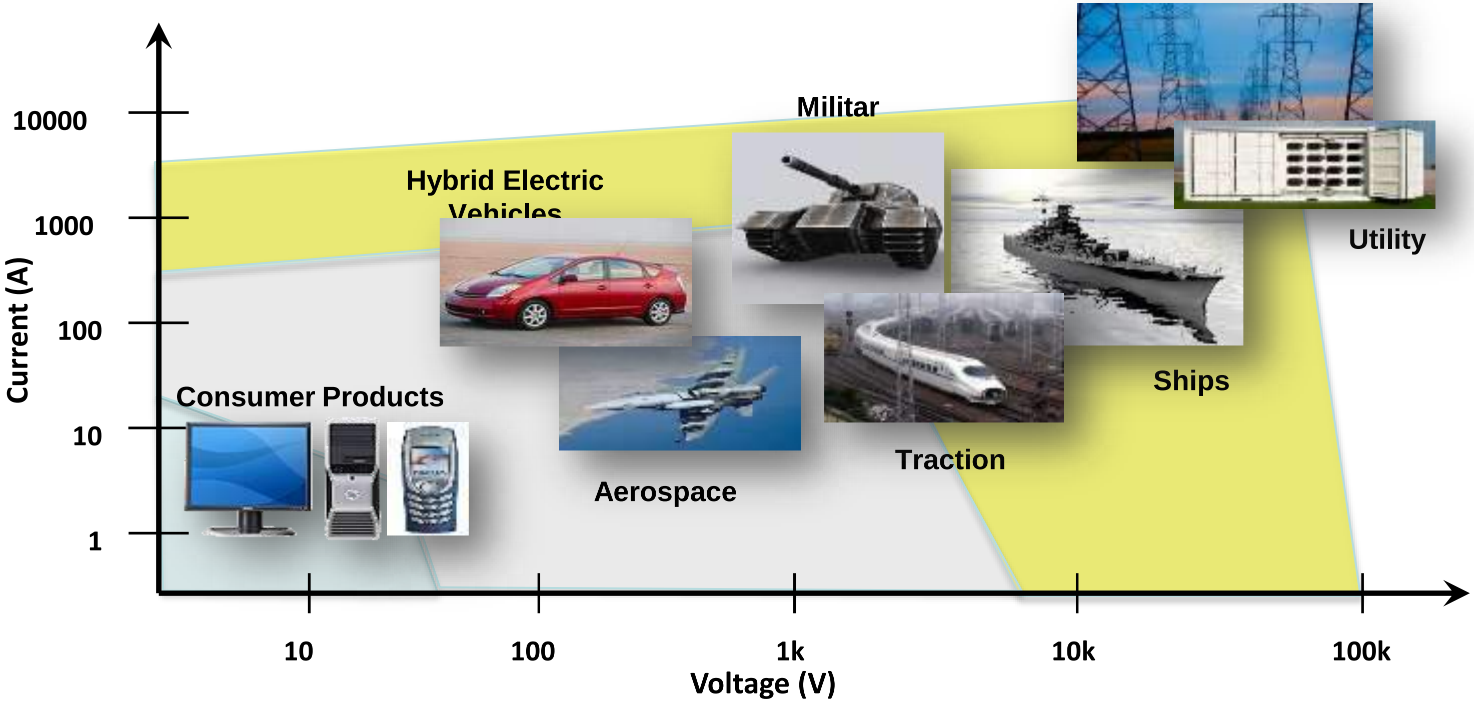
2. Tecnologías, retos y apuestas globales.

Scales of power



Grado de madurez tecnologías almacenamiento electroquímico

Tecnología	Estado actual	TRL
Baterías de plomo	Tecnología comercial madura	9
Baterías de níquel	Tecnología comercial madura	9
Baterías de sodio	NaS - Demostración a gran escala ZEBRA - Demostración a pequeña escala Na-ion - Laboratorio	8 6 - 7 2 - 3
Baterías de ión litio	Aplicaciones para electrónica portátil - Tecnología comercial Aplicaciones a gran escala - Demostración Materiales avanzados - Laboratorio y pequeños prototipos	9 7 - 8 2 - 3
Baterías de litio-azufre	Demostración	5 - 6
Baterías de metal-aire	Li-aire recargable y Al-aire recargable - Laboratorio Zn-aire recargable - Prototipo	2 - 3 4 - 5
Baterías de flujo	Vanadio - Demostración Zn-Br - Demostración Otras	7 5 - 6 3 - 4
Condensadores electroquímicos	EDLC - Tecnología comercial temprana Híbridos - Prototipo	8 - 9 4 - 5
País líder en generación de patentes	Japón con compañías líderes en casi todas las tecnologías (Tabla 15)	

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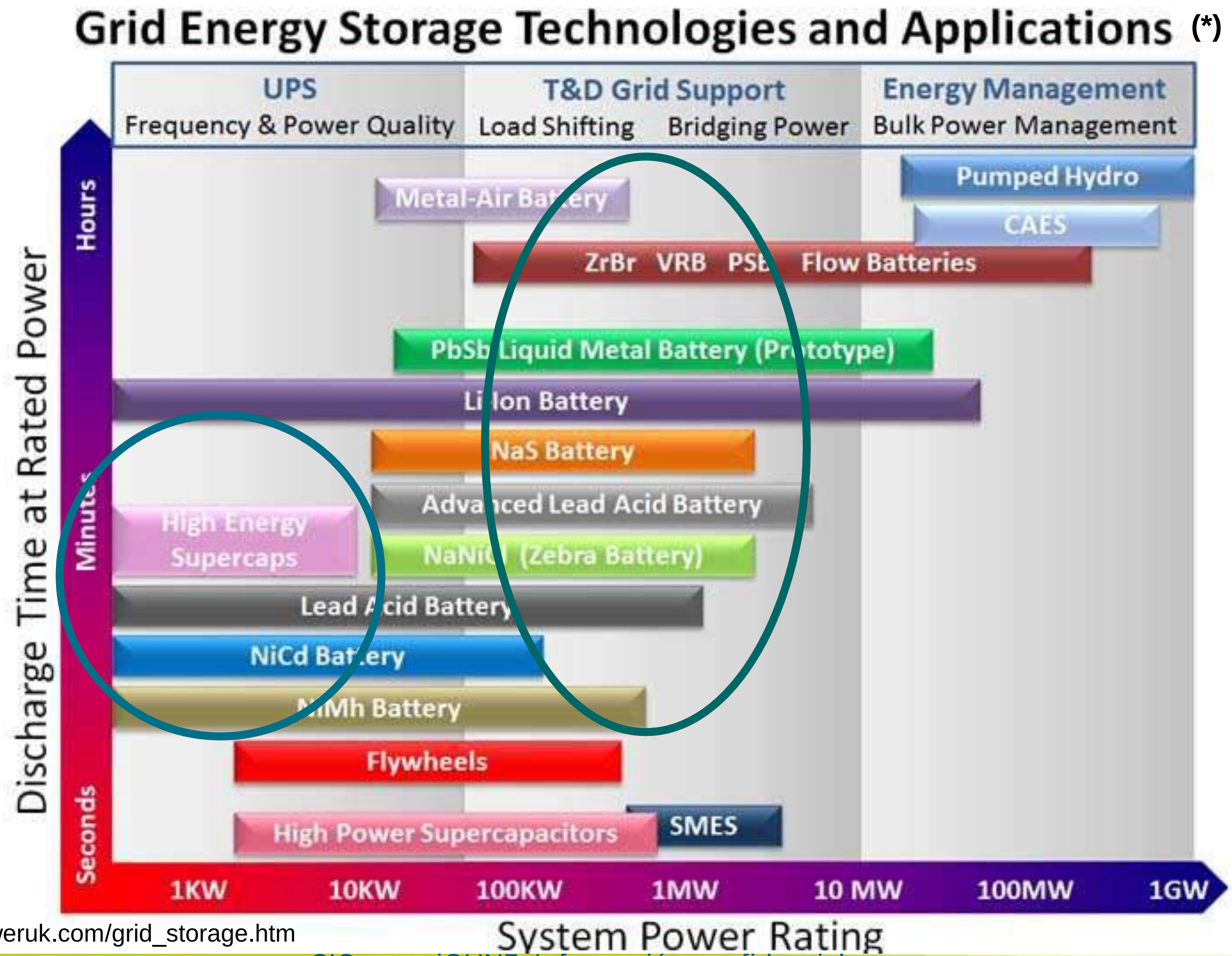
2. Tecnologías, retos y apuestas globales.

Y donde no hay una tecnología ganadora para todas las aplicaciones…

Apoyo Red T&D

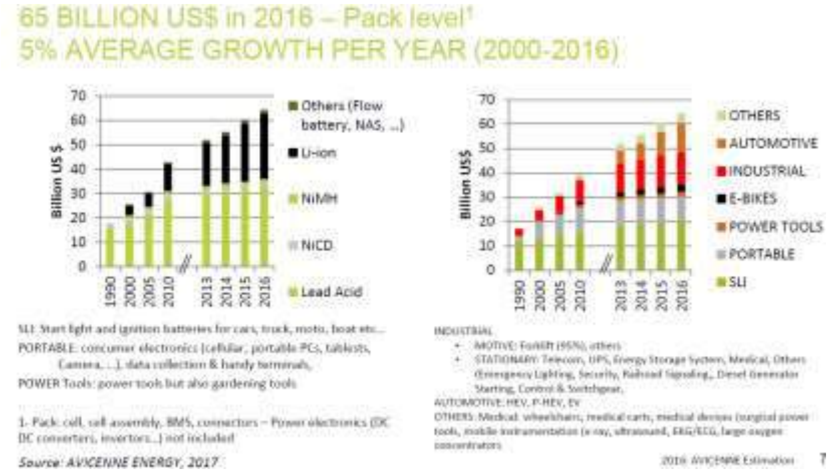
Serv Aux Red

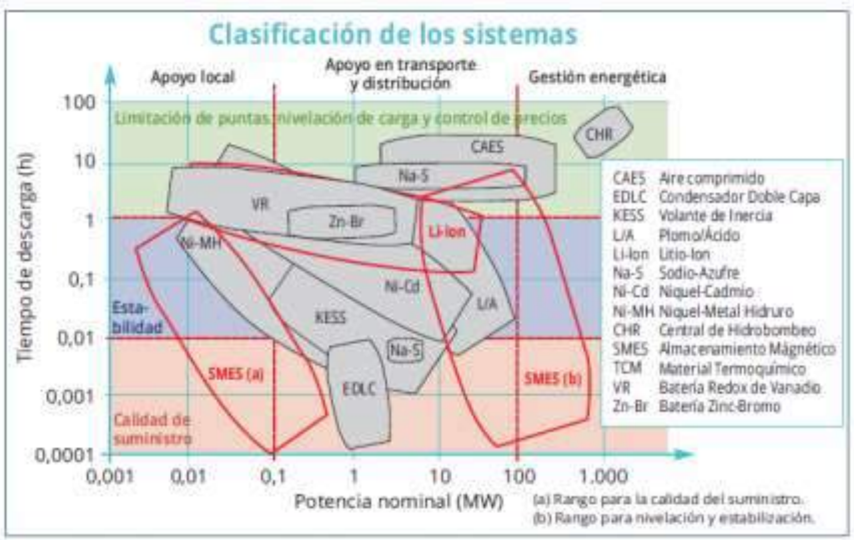


(*) http://www.mpoweruk.com/grid_storage.htm

2. Tecnologías, retos y apuestas globales.

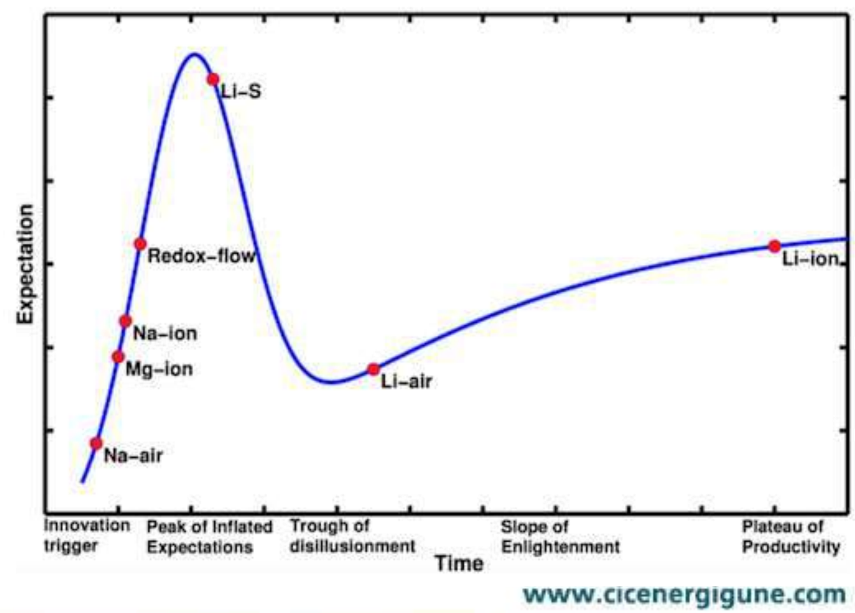
A nivel de red Litio Ion parece destacar… Pero es necesario gestionar las expectativas





Fuente: Elaboración propia a partir de los datos compilados durante el trabajo del GIA

Source GIA

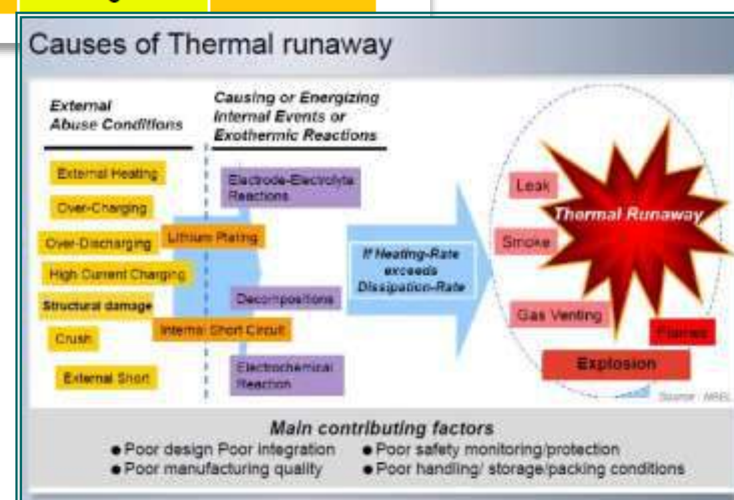


2. Tecnologías, retos y apuestas globales.

LIB: diferentes tecnologías, diferentes niveles de madurez

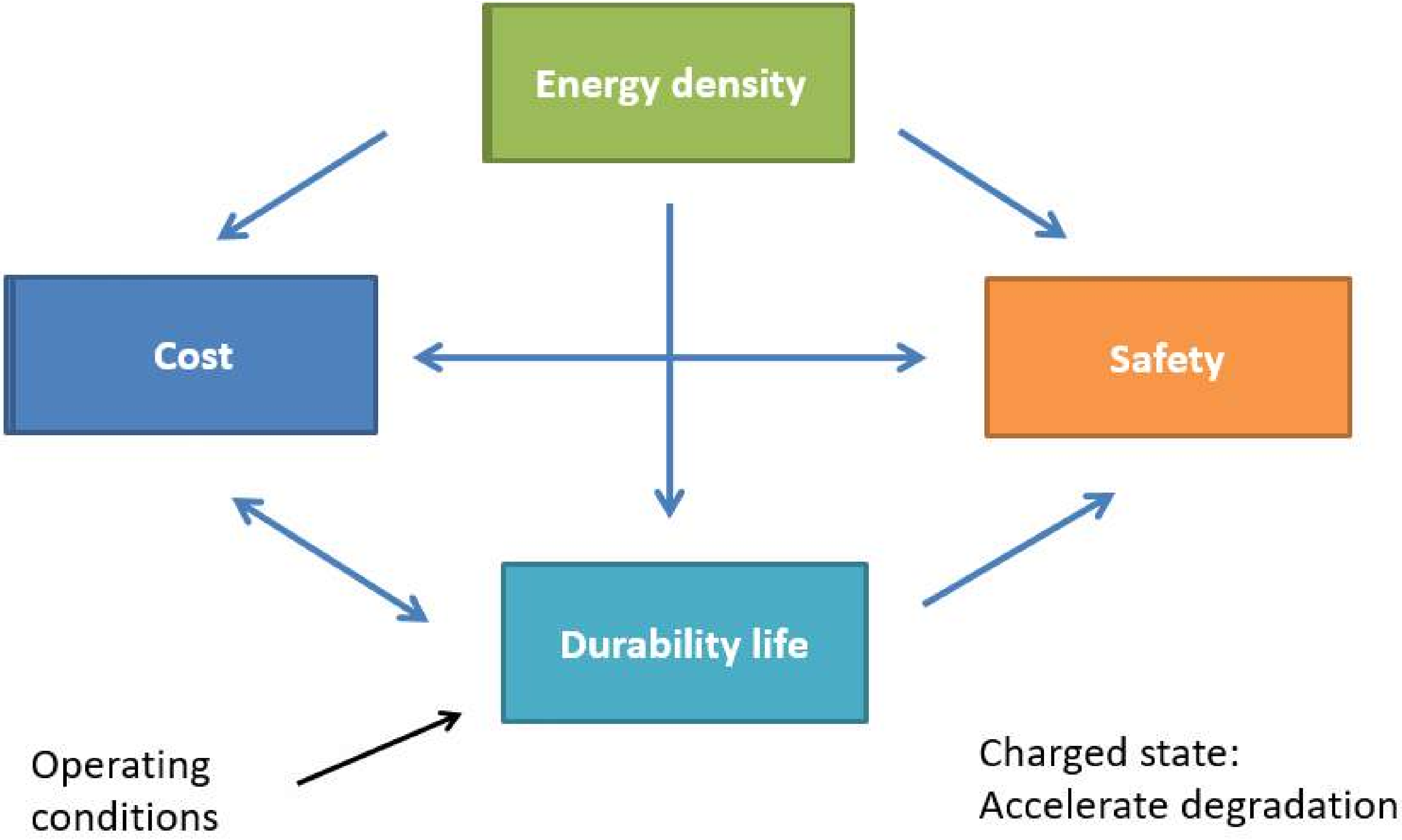
Cell chemistry	Energy	Power	Lifetime	Low temperature capability	Safety	Maturity
G/NMC	+	o	++	-	-	+
G/NCA	+	+	+	-	--	+
G/LFP	--	+	++	-	++	+
G/LMOS	--	+	-	-	+	o
G-SiO/Ni-rich NMC	++	o	o	-	o	o
G-LTO/NMC	o	+	+	o	o	+/o
LTO/NMC	--	++	++	+	+	+
Si alloy/Ni-rich NMC	++	o	-	-	o	o
Si/HV spinel	++	o	--	-	o	-

J Affenzeller *EGVIA*



2. Tecnologías, retos y apuestas globales.

Aspectos clave de la investigación



Chemistries must improve to satisfy all four criteria

2. Tecnologías, retos y apuestas globales.

Europa apostando por VE y redes eléctricas

http://www.nextminingboom.com/lithium-explorer-plh-intent-catching-much-bigger-european-peers/

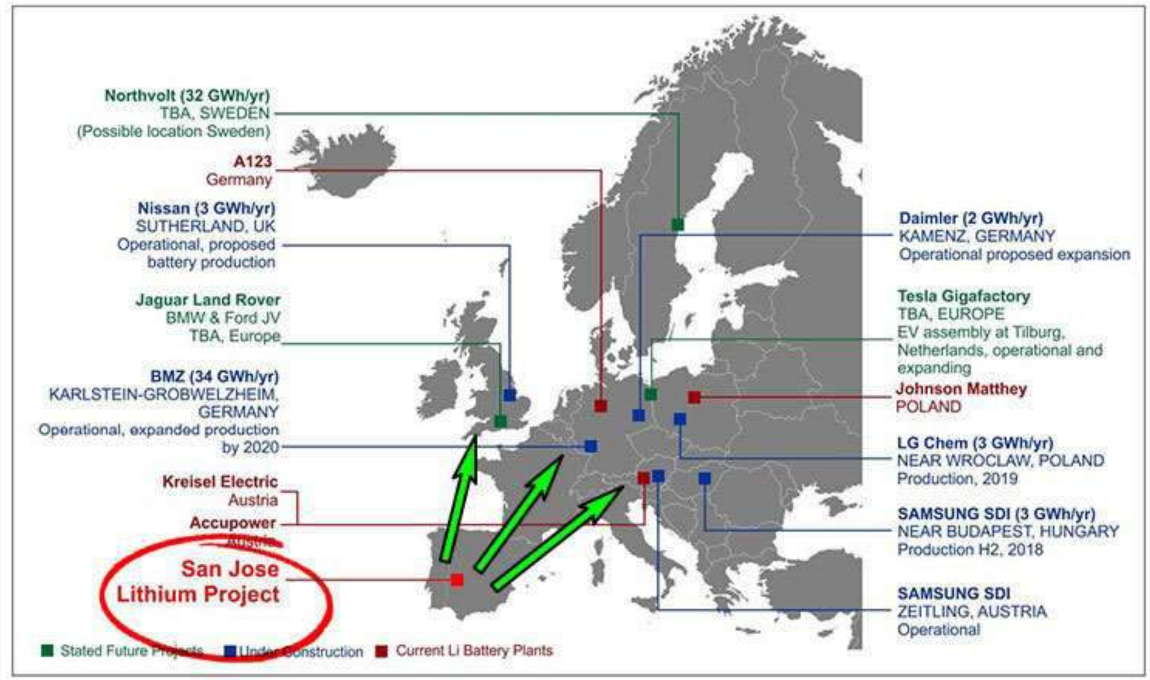


FIGURE 2: LOCATION OF PROPOSED GIGAFACTORIES IN EUROPE

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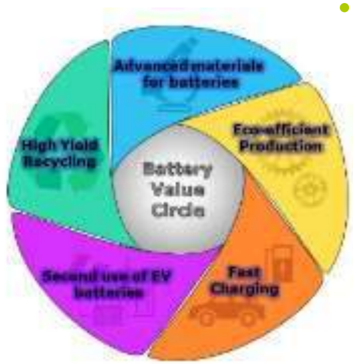
2. Tecnologías, retos y apuestas globales.

Battery Alliance

EU's leadership in many sectors of the battery value chain, from materials to system integration and recycling.

EU Battery Alliance

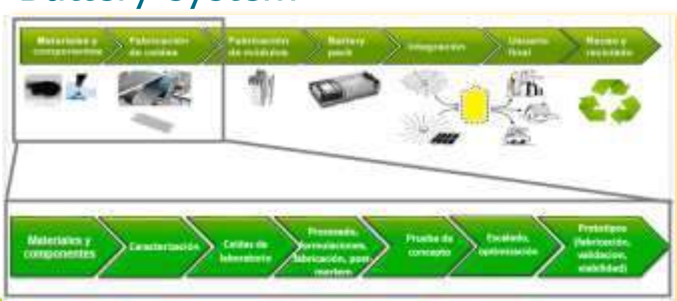
- Energy storage strategic plan
- €2.2 billion in EU funding –Comprehesive Roadmap in Febrery 2018
- 7 key issues to work in at technological level:
  - ✓ **Anode**
  - ✓ **Cathode**
  - ✓ **Solid state electrolyte**
  - ✓ **Interface optimization and aging**
  - ✓ **Advanced modeling**
  - ✓ **Upscaling and manufacturing**
  - ✓ Battery system

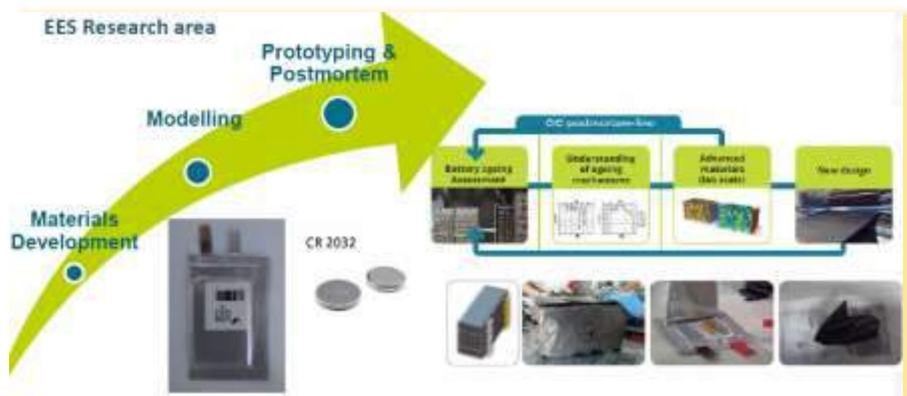


Activity at CIC

SET-Plan – Key Action 7 (TWG)

- Clear definition of requirements for the different automotive and stationary applications.
- The R&I activities for 2018-2030 structured around 3 focus areas:
  - ✓ **Material/Chemistry/Design + Recycling**
  - ✓ Manufacturing
  - ✓ Application and Integration

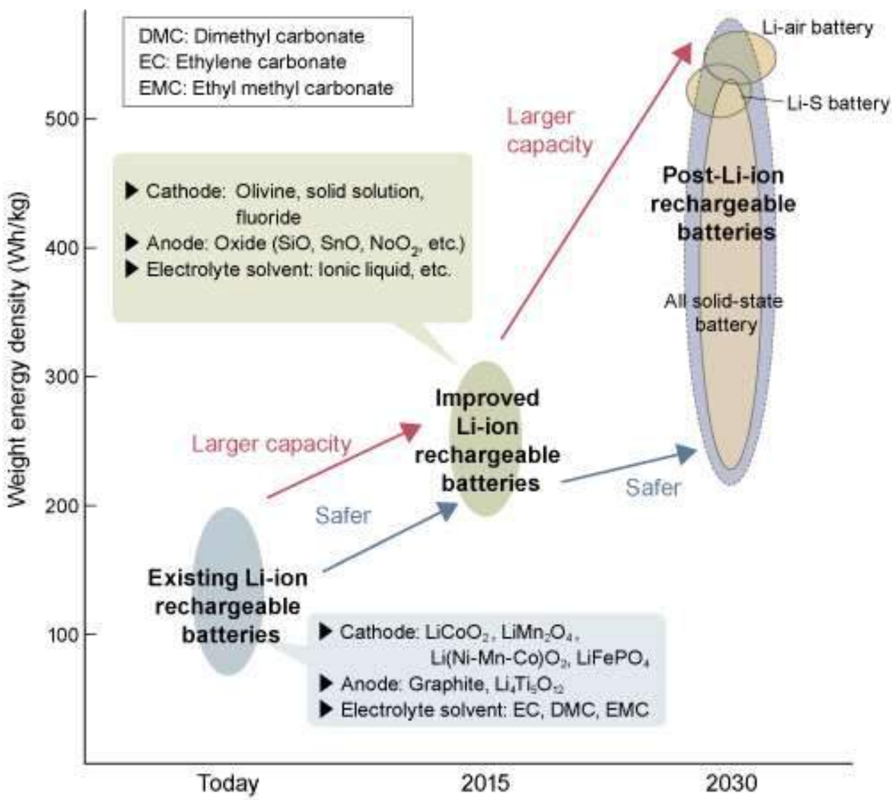




2. Tecnologías, retos y apuestas globales.

Tendencias: electrolito sólido – línea prototipado

MIXER → COATER → DRYING → CALENDER → NOTCHING → STACKING → TAB WELDING → 3 SIDE SEALING → ELECTROLYTE FILLING



Línea de prototipado en dispositivo pouch de 1 Ah – 5 Ah orientada a:

- ✓ Nuevos materiales.
- ✓ Proceso 100% integrado en sala seca → adaptable a materiales novedosos sensibles a humedad o reactivos a ella.
- ✓ Requerimientos de material mínimo: a partir 100-200 ml
- ✓ Estudios de procesabilidad y escalabilidad.
- ✓ Validación conceptual.

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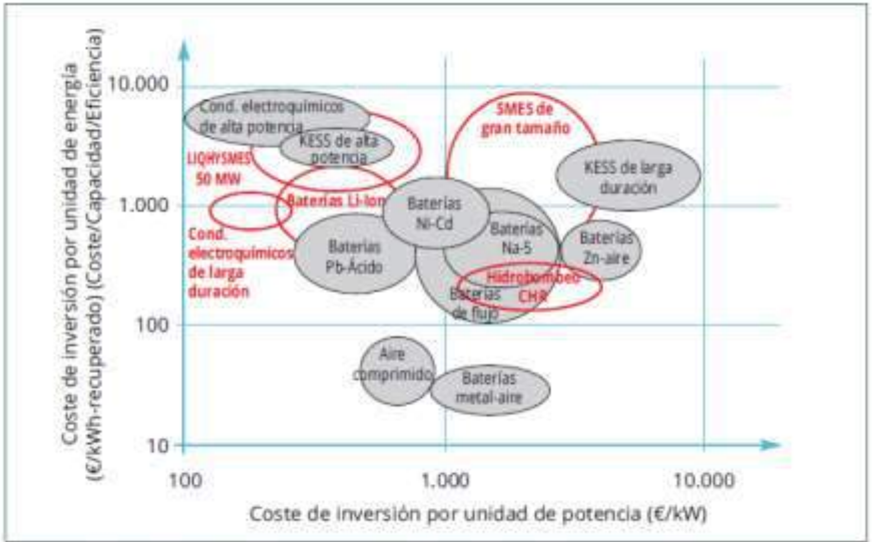
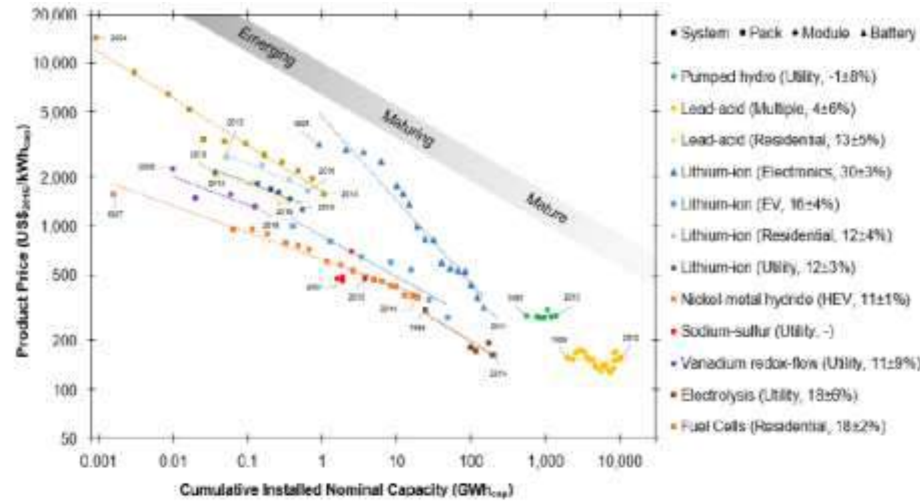
2. Tecnologías, retos y apuestas globales.

Coste de las tecnologías

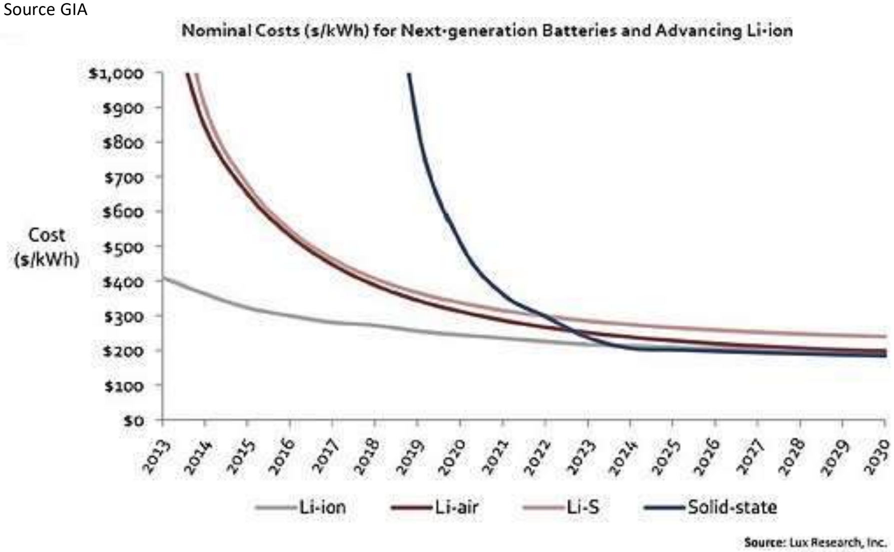


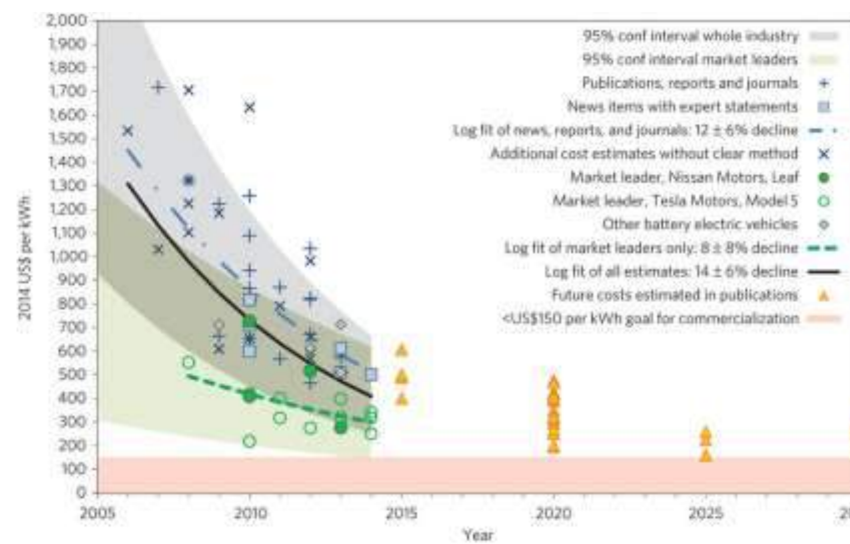
Fuente: Elaboración propia a partir de los datos compilados durante el trabajo del GIA.

Source GIA



Source: The future cost of electrical energy storage based on experience rates





Source: rapidly falling costs of battery packs for electric vehicles –nature climate

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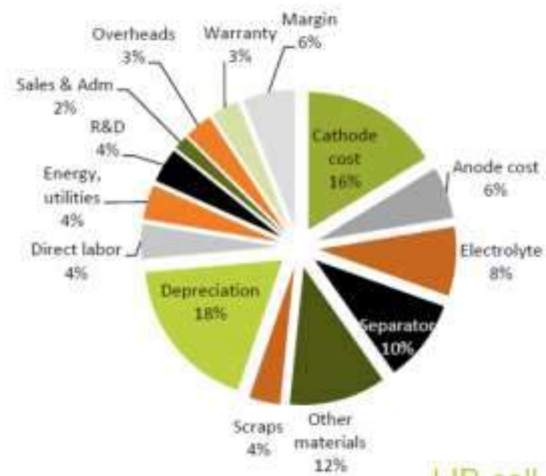
3. El litio ahora y en el futuro.

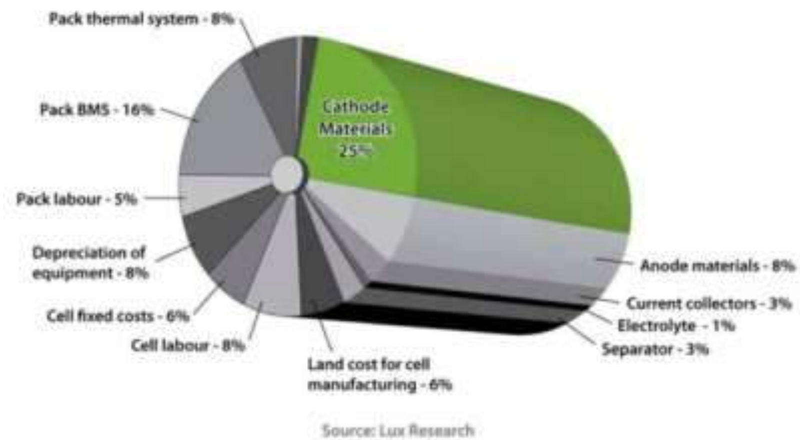
Coste de la celda vs. BP

Average cost structure of Li-ion cell in 2015

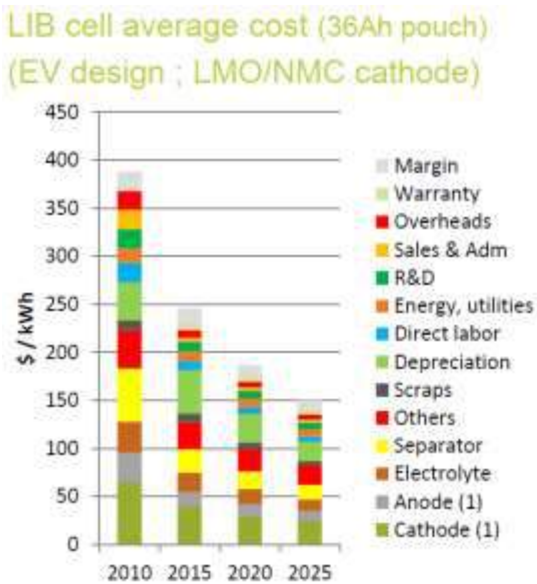


Los materiales suponen 40-60% del coste de la celda y el 35-40% del BP

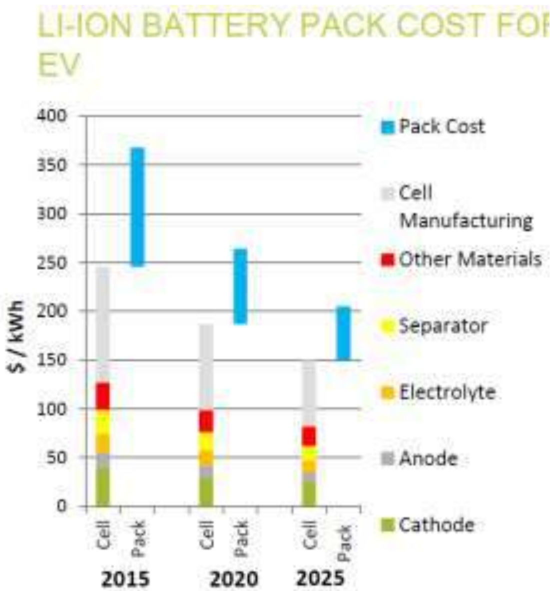
Cost Structure of a Li-ion Battery in 2015
(for an NMC pouch, made in South Korea 1 GWh factory)



Lithium ion cell average cost



(1) Active materials only
Source: AVICENNE ENERGY 2016



** For Production > 100 000 packs/year*

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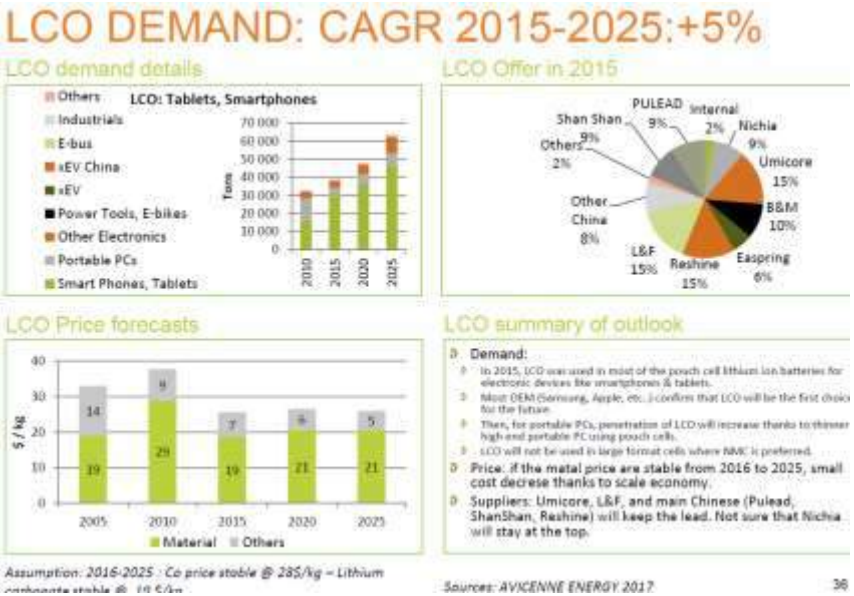
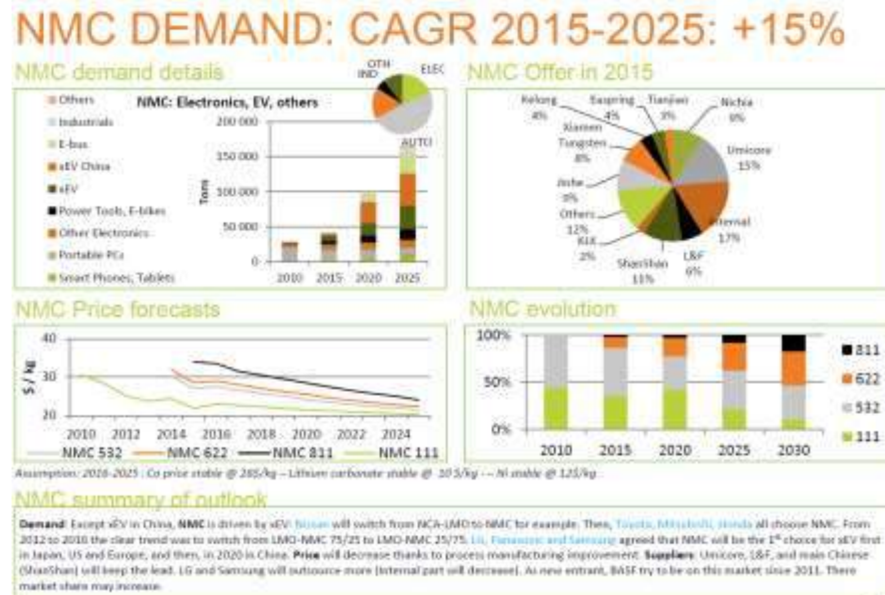
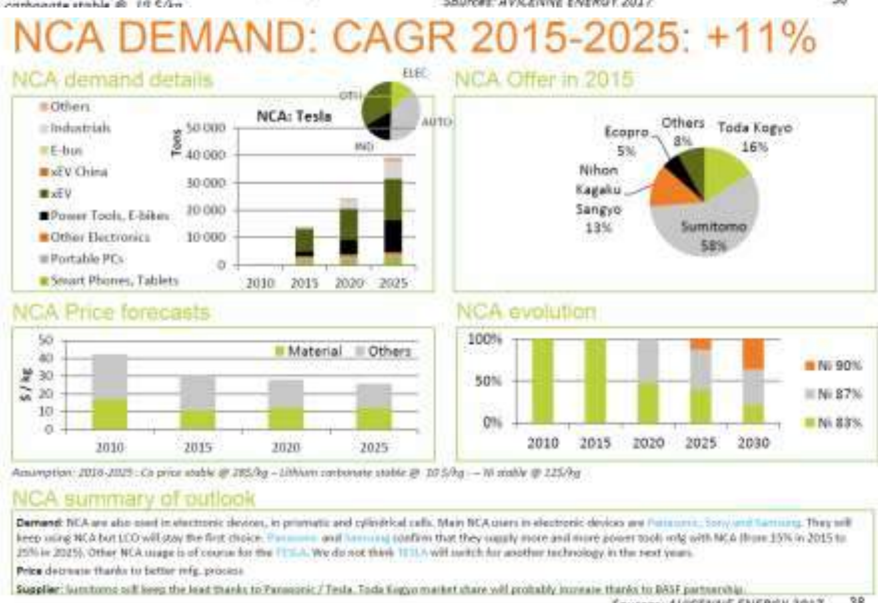
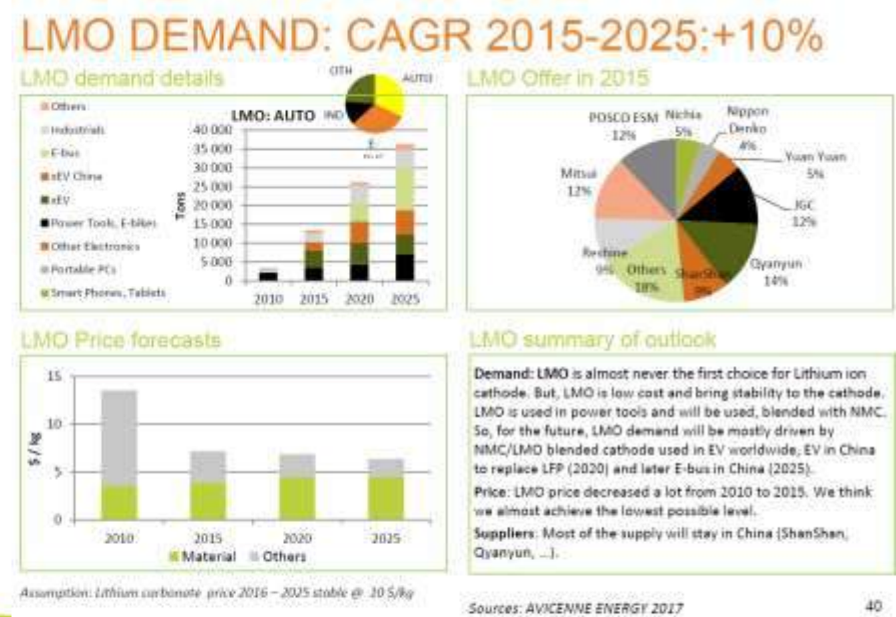
3. El litio ahora y en el futuro.

Litio Ion: tendencias de coste por tecnología







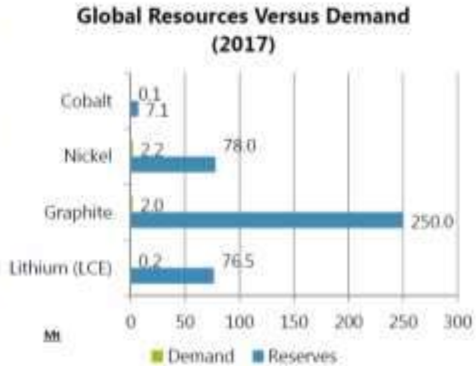


3. El litio ahora y en el futuro.

Accesibilidad de los materiales

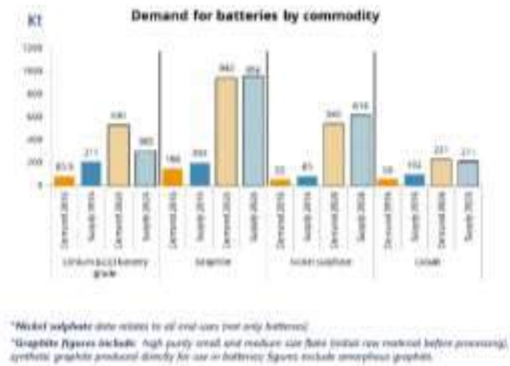
Resources of key battery minerals

- Current resources are plentiful enough to meet future demand for battery uses, and are being added to with further exploration
- Converting resources into reserves requires demonstration of suitable extraction method and cost effectiveness
- For example, lithium reserves account for only 20% of known resources, but that is still almost 100X 2017 demand
- Not all resources are suitable for battery-grade product output, for example low-grade lateritic nickel, some grades of graphite



Roskill

Present and future impact on key materials



Roskill

- Supply potential for lithium and cobalt currently not sufficient to meet demand by 2026 based on capacity build-out
- Supply potential for graphite and nickel currently sufficient to meet demand by 2026 based on capacity build-out
- But this depends on:
  - Projects coming on time (financing, permitting, development, commissioning etc.)
  - Pricing and incentives (economics and feasibility)
  - Feedstock availability for cobalt and nickel sulphate

Lithium: Difficult to achieve the necessary supply

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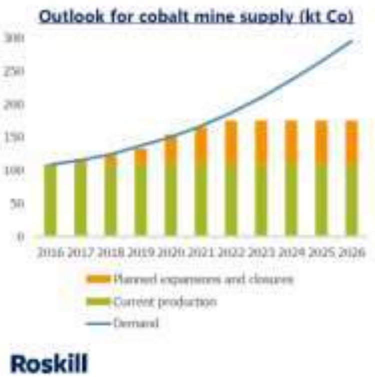
3. El litio ahora y en el futuro.

Accesibilidad de los materiales

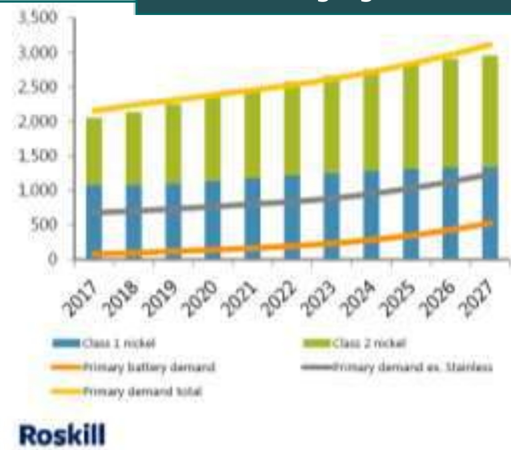
Where will the feedstock come from? There is considerable uncertainty after 2021



- Most feedstock supply will come from existing producers over the next 5 years
- In particular, Glencore (Katanga) and ERG (tailings) are set to bring additional large sources of supply on-stream in the DRC and Zambia
- After 2021, additional sources of feedstock will be required:
  - Further expansions?
  - Improved recovery techniques?
  - New mine projects?
  - Increased artisanal supply?
  - Additional tailings potential?
  - Re-start/production at Ni operations?
  - Recycling?

Source: Roskill

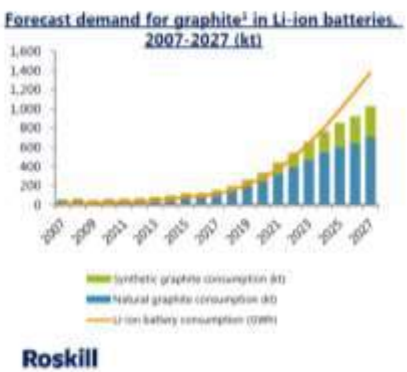
Nickel: High-grade feedstock as a bottleneck



- Availability of high-grade feedstock will be a key concern, however
- At present, production of Class I nickel is in excess of demand of batteries and other, non-stainless applications. Some Class I nickel is therefore also used in stainless steel
- Supply of Class I nickel may increase with some new projects, but will become increasingly tight
- Stainless steel will need to rely increasingly on lower-grade ferronickel, NPI and scrap, and reduce its consumption of briquettes, carbonyl powder, and other Class I nickel

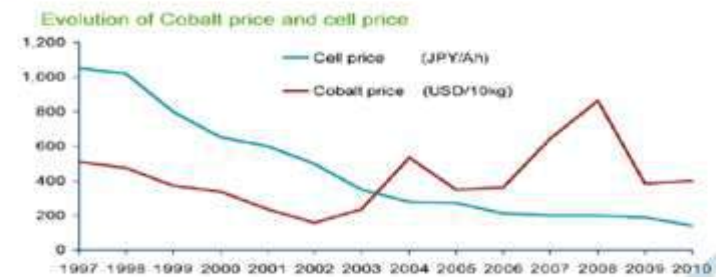
Source: Roskill

Supply expected to meet demand (for now at least) but long-term?



- Demand for graphite in Li-ion growing at 28%py until 2027
- Synthetic demand growing more strongly than natural
- Electrode manufacturers diversifying into anode powders
- Growth to be initially met by increased Chinese production, reducing current overcapacity
- China or ROW? BTR expanding domestically and purchasing from Syrah (Mozambique)
- In the long-term, new sources of graphite will be needed to meet demand growth from ROW

In 10 Years 80% price decreasing despite a fluctuating Co price



Source: UMICORE, march 2011

What do battery producers worry about?

[illegible]	[illegible]	[illegible]	[illegible]
Ni ($/kg)	11	13	18%
Co (99.3%, $/kg)	21	30	43%
Mn (99.7%, $/kg)	3	1.8	-40%
LiOH 99.5%, $/kg)	10	23	130%

Tier 1 Producer price increases based on raw material prices = up to 12% increase per unit

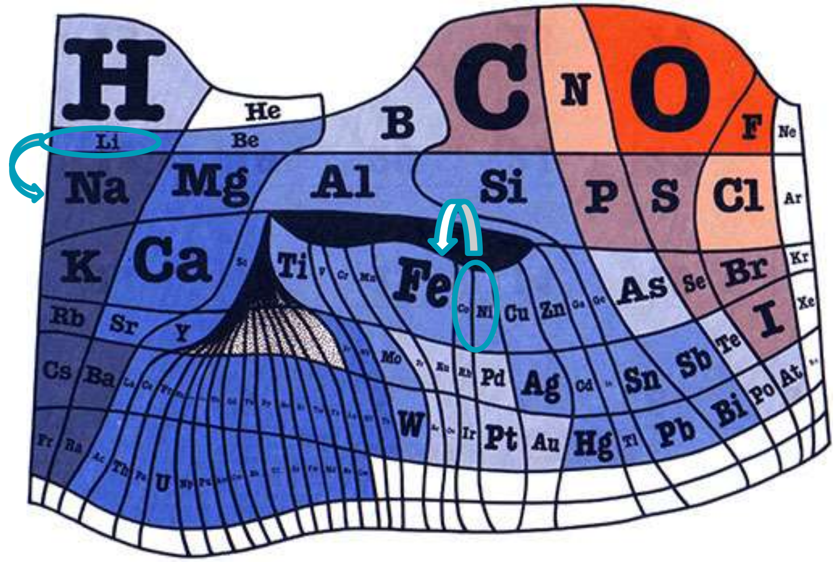
3. El litio ahora y en el futuro.

El reto de los materiales

Battery chemistries

Battery type	Features	Environmental impact
Ni–MH (established)	Low voltage, moderate energy density, high power density Applications: portable, large-scale	Nickel not green (difficult extraction/ unsustainable), toxic. Not rare but limited Recyclable
Lead–acid (established)	Poor energy density, moderate power rate, low cost Applications: large-scale, start-up power, stationary	High-temperature cyclability limited Lead is toxic but recycling is efficient to 95%
Lithium ion (established)	High energy density, power rate, cycle life, costly Applications: portable, possibly large-scale	Depletable elements (cobalt) in most applications; replacements manganese and iron are green (abundant and sustainable) Lithium chemistry relatively green (abundant but the chemistry needs to be improved) Recycling feasible but at an extra energy cost

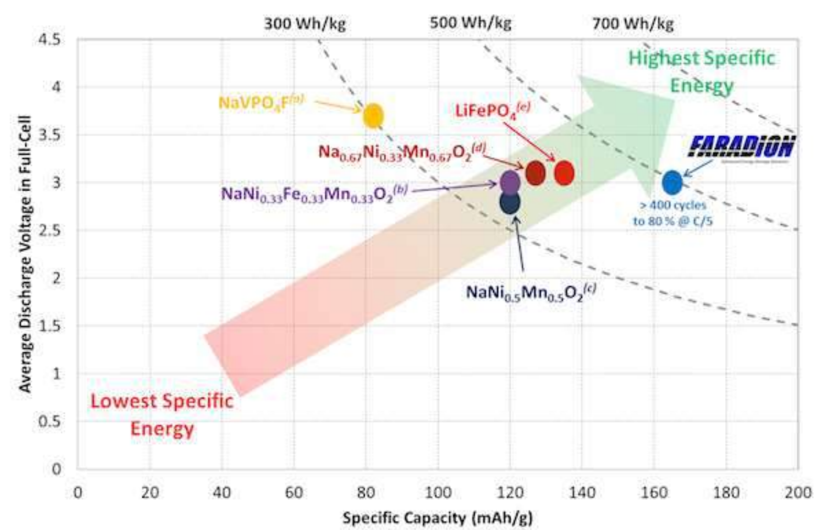
Source: Armand, M., & Tarascon, J. M. (2008). Building better batteries. *Nature*, *451*(7179), 652-657.



Wm. F. Sheehan, (1976). C*hemistry*, *49(3)*, 17-298

Principales impactos ambientales tecnologías almacenamiento electroquímico

Tipo	Origen de riesgos ambientales
Baterías de plomo	Toxicidad del plomo, pero tasa reciclado elevada (>90%)
Baterías de níquel	Toxicidad del cadmio, pero tasa de reciclado elevada
Baterías de sodio	No relevantes. Temperaturas elevadas en algunos casos
Baterías de ion litio	Reacciones violentas del Li. Tasa reciclaje baja (40%)
Baterías de flujo	Riesgo de fugas de líquidos corrosivos
Baterías de metal-aire	Presencia Metales muy reactivos: Li, Na...
Condensadores electroquímicos	Toxicidad del acetonitrilo como disolvente



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Source GIA

1. Desarrollo de las redes eléctricas, necesidades, y el valor del almacenamiento como palanca del cambio de paradigma.
2. Tecnologías, retos y apuestas globales.
3. El litio ahora y en el futuro.
4. **Conclusiones.**

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4. Conclusiones.

Almacenamiento “next big thing”

No habrá una sola tecnología ganadora

Objetivos 2030

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Thank you!

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