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Windows of opportunity in the Lithium-ion battery industry – Europe's attempt to catch-up

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Opportunities arising in growing market. Europe wants to capitalize on this and reduce the current dependency on Asia



Sources: Pillot, C. (2018). The rechargeable battery market and main trends 2017-2025; European Commission, Handelsblatt.com; RoW=Rest of World

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Windows of opportunity for catching up can arise from three key sources



Sources: Lee, K., & Malerba, F. (2017). Catch-up cycles and changes in industrial leadership: Windows of opportunity and responses of firms and countries in the evolution of sectoral systems. Research Policy, 46(2), 338-351.; Landini, F., Lee, K., & Malerba, F. (2017). A history-friendly model of the successive changes in industrial leadership and the catch-up by latecomers. Research Policy, 46(2), 431-446.

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Combining manufacturing plants and patent data provides insights into catching-up processes in Li-ion batteries







Patent network analysis helps identifying most relevant knowledge and enables further analysis of individual patents





"Critical path"

Description

Sub-networks can be extracted which represent x% of total network weight, i.e. the "critical" knowledge and knowledge flows

These patents are then **manually coded** to characterize them in terms of product / process innovation, different technology components (e.g. cathode, anode) and different applications (e.g. consumer electronics, electric vehicles)



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Three phases with differing focus of inventive activity can be observed



Recurring product and process innovation across phases

After 2003, new opportunities in peripheral components, such as pack integration and development of EMS systems



Also, new cell formats, as well as improved anode, cathode and electrolytes



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xEV in focus for Phase 3 – the targeted improvements in service characteristics change with application



Phase 1 and 2 focus on consumer electronics. The accompanying cost reductions enabled new applications

In **Phase 3** is clearly dominated by xEV, but even within this space patents can focus on different service characteristics

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Our global battery policy database shows strong policy efforts in supporting Li-ion development across the globe



Complexity of manufacturing process

Sources: Beuse, M., et al. (2018). A "technology-smart" battery policy strategy for Europe. Science, <u>https://doi.org/10.1126/science.aau2516</u>.; Malhotra, A. et al. (2019). The role of intersectoral learning in knowledge development and diffusion: Case studies on three clean energy technologies. <u>https://doi.org/10.1016/j.techfore.2019.04.018</u>

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Outlook for Europe



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It is **generally possible to catch-up**, as exemplified by the cases of Korea and China. **Policy** interventions have **played a major role** in coordinating innovative activities and ensuring long-term perspective.

Analysis of the industry's **knowledge base** (patents, manufacturing plants) and supporting policies provides insights in how **new markets** were created and **technological windows** of opportunity leveraged.

For Europe to catch-up in battery cell manufacturing, policy could **attract foreign market leaders** and **foster collaboration and knowledge sharing** along the supply chain.

At the same time fundamental and applied **research consortia** could be established to **identify future windows of opportunity** that would warrant an attempt to build-up European-owned manufacturing at scale.

A significant **home market** is a necessary condition to ensure a conducive innovation environment.



Future windows of opportunity will be most successful when they are far away from the current knowledge and capability base of incumbents and effect both design and manufacturing of new cells.



Questions?