



Digital strategies for greater material efficiency in German industry

Main results from a German company survey

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Contents

Executive Summary.....	3
1. Resource efficiency - a perennial topic in politics and business	4
2. Business strategies for greater material efficiency	5
3. Further potential for increasing material efficiency	7
4. The role of digitisation	7
5. Forerunners in material efficiency: companies with a digital strategy.....	9
6. Outlook.....	11
References	12

JEL Classification:

Q55: Environmental Economics: Technological Innovation

Q32: Exhaustible Resources and Economic Development

D22: Production and Organisations Firm Behaviour: Empirical Analysis

O32: Technological Change: Management of Technological Innovation and R&D

Executive Summary

This study delivers the first empirical findings on the relevance of digitisation to improving material efficiency based on the German company survey 'IW-Zukunftspanel'. Traditional efficiency-raising measures that optimise manufacturing processes are still predominant in the manufacturing sector, but new techniques and materials are also used. In many companies the basic course for a modern circular economy is not yet set: saving materials on a grand scale as early as the product design stage, through materials cycle management or new business models are not very common so far. The material savings potential in industry has not yet been exhausted. In the companies' view, they could save a further 3 to 4 per cent if they made optimum use of all technical possibilities. With reference to the value of Germany's purchases of mineral raw materials from both domestic and foreign sources, this translates into a realisable savings potential of 2 billion euros.

German manufacturing firms have up to now only rarely digitised material efficiency measures to a great extent. If they are - particularly in large companies - they tend to be used for process optimisation. Around two fifths of the companies are at least moderately digitised in relation to the most important industrial efficiency measures, namely process optimisation and the use of new techniques, but there is still more than a third that is not at all. Companies have most frequently digitised cross-company materials cycles, but this instrument is only applied by two fifths of industrial companies.

There is still potential for more digitisation of measures relating to product design, materials cycle management and new business models. At least every second manufacturing company reuses residue and waste materials via internal circulation systems. Nevertheless, for two fifths of these companies digital networks do not play any part and in the case of a further two fifths, the part they play is minor. Only one in ten companies is heavily digitised. More than half of industrial companies use resource-saving measures that begin at the product design stage. To date, almost half of these companies are not digitally networked, or if they are, it is only to a small extent. One third of the industrial companies up to now have considered new business models as an efficiency-raising way. Of these, three out of ten have not been digitised yet with a further two fifths having only a minor level of digitisation. Companies that have already embedded digitisation in their strategy are frontrunners for greater material efficiency, since they more frequently use material efficiency measures intensively, are more likely to recognise further potential savings and their efficiency-saving approaches are also clearly more often highly digitised.

1. Resource efficiency - a perennial topic in politics and business

A recent report by Neligan/Schmitz (2017) provides the first empirical findings on the extent to which the digital transformation has already found its way into material efficiency measures in the German manufacturing sector. The analysis is based on responses from almost 600 manufacturing companies taking part in the regularly carried out German company survey 'IW-Zukunftspanel' during the summer of 2016. The responses are weighed representatively. The main results from this study are presented in this report.

The efficient use of natural resources has been on the political and economic agenda for years - firstly in order to increase competitiveness and secondly in order to spare the environment. The political objective of achieving a further decoupling of the use of natural resources from economic development and climate protection is not only anchored in the German Sustainability Strategy and the German Resource Efficiency Programme at national levels but gains international importance due to the Global Sustainability Goals (SDGs) and the G7 Alliance on Resource Efficiency. At the G20 meeting in 2017, the topic is also to be on the agenda and to remain there in the long term. In parallel, at European level the aim is to achieve greater resource efficiency through resource-saving product design, so-called eco-design, in the context of the EU Action Plan for the Circular Economy.

In order to safeguard the future supply of raw materials, the German economy faces the challenge of dealing sparingly with available resources. As an industrial nation, Germany has a high need for raw minerals. Germany is able to obtain a large proportion of its raw materials supply of non-renewable (abiotic) raw materials, in particular raw materials from quarrying, from domestic sources. In relation to these raw materials Germany can fully or at least partly meet its own needs.

Although the greater part of Germany's raw materials in terms of volume are domestic, a significant portion - particularly in terms of metal raw materials, many high-tech raw materials and most energy raw materials - come from abroad. Germany's metal ore requirements, for example, are almost entirely imported. In the case of metals, a large number of ores arrive in Germany not in the form of raw materials but already as metals or semi-finished products in the form of intermediate products such as pipes, sheet metal and wires or end products such as castings and forgings as well as machine parts. According to BGR (2016), in 2015 Germany's purchases of mineral raw materials amounted to 48 billion euros coming from both domestic sources (7.5 billion euros) and foreign supplies (including indirect imports of metals in the form of semi-finished goods) (41 billion euros). Germany imports metals

in particular from abroad. A thriftier use of materials could therefore also reduce our dependence on imports.

As a result of limited natural resources in the face of an increasing global demand for raw materials many German companies are already taking measures to minimise their resource consumption as much as possible. In addition, material consumption constitutes a considerable cost factor. In order to counter the over-consumption of valuable resources, there are two significant approaches open to companies:

- To use less material: increasing resource efficiency and preventing waste by better eco-design of products and
- to use resources more than once: increasing the use of secondary raw materials via improved reuse and recyclability (circular economy).

The increasing intertwining of modern information and communications technologies (ICT) with traditional industrial processes offers further possibilities for increasing resource efficiency in companies. Digitisation and networking of industrial production, much discussed about as Industry 4.0, are raising high expectations in terms of more resource-efficient production methods.

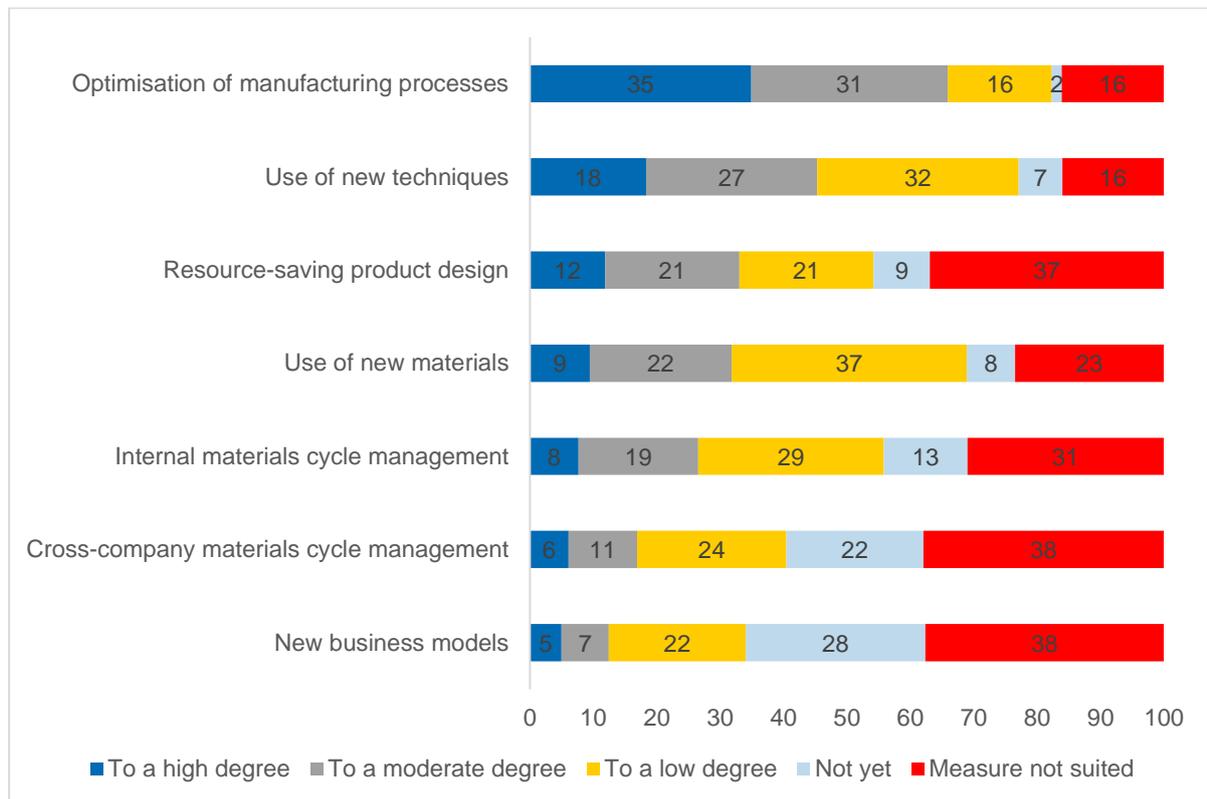
2. Business strategies for greater material efficiency

There are several possibilities for optimising the deployment of materials at the various levels of the value chain: saving on materials (efficiency in a narrow sense), recycling and substitution. The recent company survey 'IW-Zukunftspanel' shows what German manufacturing firms undertake in this respect. In the German manufacturing sector the emphasis so far has been on traditional efficiency-increasing measures that optimise manufacturing processes. Examples are to prevent waste and rejects or to achieve a better utilisation of machinery (Diagram 1). In one third of the cases, this approach is applied to a high degree. However, new techniques and materials are also used, albeit to a lesser degree.

In future, however, thinking in complete cycles by looking at the entire life cycle/spectrum of a resource - from its preparation (extraction/processing) through its use (production/consumption) up to its aftercare through recycling (circular economy) will be crucial to further increase resource efficiency. The basic course for a modern circular economy is not set yet in many manufacturing firms: saving materials on a broad scale as early as the product design stage, through materials cycle

management or new business models are not very common yet. These measures are applied considerably less frequently, and where they are, their application is at a low to medium level. However, cycle management measures are considerably more common among large companies.

Diagram 1: Measures used to increase material efficiency
Shares as a percentage of companies in the manufacturing sector



Sources: Neligan/Schmitz (2017)

Depending on their size, industrial companies act differently in some cases in applying different material efficiency measures. With some measures, medium-sized manufacturing companies (20-249 employees) adopt a somewhat different strategy from other companies in their sector. Nearly half of the medium-sized companies optimise their manufacturing processes to a high degree and use resource-saving product design at least to a medium degree to increase efficiency. Large companies (over 250 employees) prefer to use new materials, such as, for example, new material types. Almost half of the large companies use new materials to a minor extent, while a further third makes moderate use of them.

3. Further potential for increasing material efficiency

According to the company survey 'IW-Zukunftspanel', German manufacturing companies - taking account of the varying levels in their material requirements - have been able to save 8 per cent of the materials originally required through material efficiency measures in the past five years. The material savings potential in industry has not been exhausted yet (see also VDI ZRE, 2015; Schröter/Lerch/Jäger, 2011). In the companies' view, they could save a further 3 to 4 per cent if they made optimum use of all technical possibilities. With reference to the value of Germany's purchases of mineral raw materials from both domestic and foreign sources (including the indirect import of metals in the form of semi-finished products) totalling 48 billion euros, the absolute savings potential comes to 2 billion euros. This is significantly smaller than indicated in previous studies for Germany (see Schröter/Lerch/Jäger, 2011; Arthur D. Little/Wuppertal Institut/Fraunhofer ISI, 2005).

Often, the recalculation of the materials saving potential is related to the cost of materials indicated in the German cost structure survey (20 employees and more) for the manufacturing industry (Statistisches Bundesamt, 2016). In that case, the savings potential of 3.6 per cent (20 employees and more), based on the survey results, would correspond to almost 30 billion euros. However, the savings potential would be considerably overestimated in this calculation. This is mainly to the fact that material expenditure in the German cost structure survey does not only include raw, auxiliary and working materials but also bought-in intermediate products, such as building components. In particular, in the case of finished goods that solely need to be built into the products, German companies have no or hardly any possibilities for increasing material efficiency themselves.

Theoretically, additional savings of a similar magnitude would be possible. Main reason is that 40 per cent of Germany's accumulated imports of mineral raw materials are finished goods alone. In the case of ores, it is even 50 per cent. A key requirement would be that international suppliers raise material efficiency to the same extent and pass on the resulting cost advantage fully. However, this is very unlikely to happen.

4. The role of digitisation

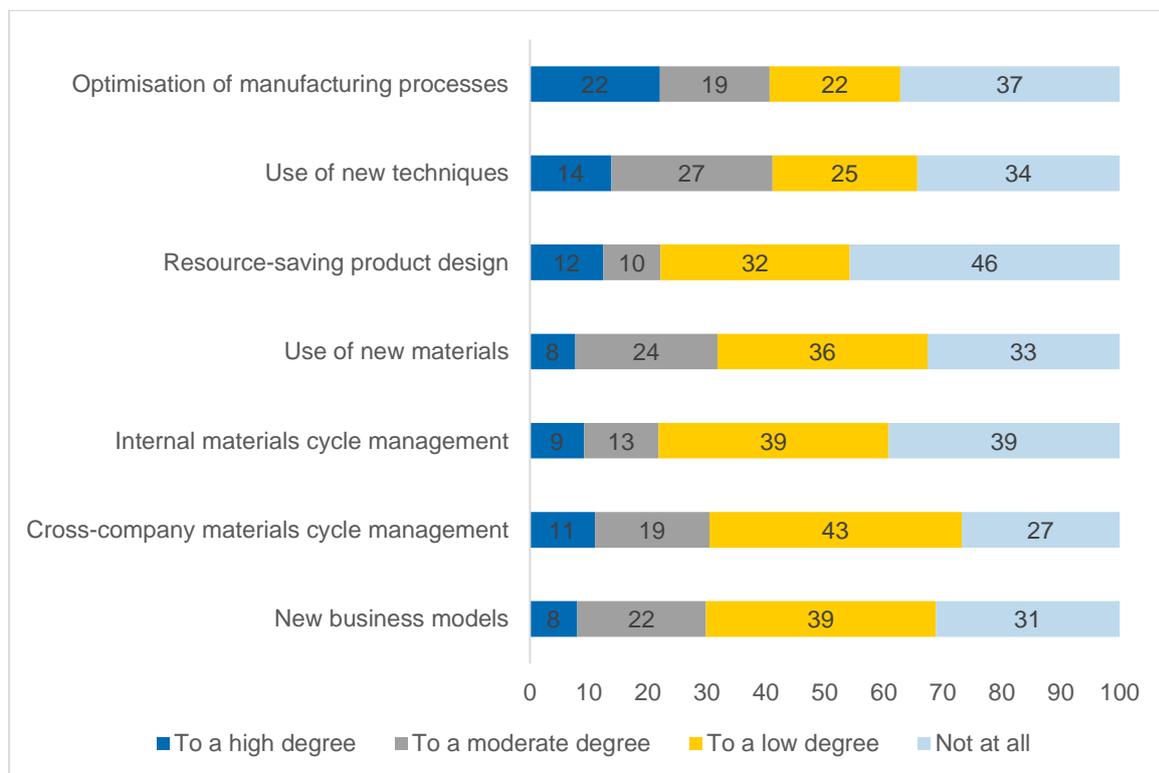
Companies face the challenge of making digital networking a core component of their business strategy. The increasing digital networking in complex industrial production and process sequences offers new potential for saving resources. Digitally integrated

and cooperating networks within and along value chains make it possible to observe, follow up on and optimise the use of resources. The availability of all relevant information in real time and the bringing together of different players through intelligent automation technology in industrial manufacturing processes provides consistently high quality and planning security in production. Furthermore, it also ensures a thriftier and more efficient use of resources. In addition, new business fields can be opened up, for example the sale of a service instead of a product.

The possibilities of digital networking of material efficiency measures have only been exploited to a limited extent so far (Diagram 2). Today, digitisation - particularly in the case of large companies - is taking on an important role, most often in combination with the optimisation of manufacturing processes and the use of new techniques, the most prevalent industrial efficiency-raising measures. Companies have most frequently digitised cross-company materials cycles, but this instrument is only applied by two fifths of industrial companies.

Diagram 2: Digitisation of material efficiency measures

Shares as a percentage of companies applying the respective measure in the manufacturing sector



Sources: Neligan/Schmitz (2017)

There is still potential for more digitisation of measures relating to product design, materials cycle management and new business models. At least every second

processing company reuses residue and waste materials via internal circulation systems. Nonetheless, for two fifths of these companies digital networks do not play any part and in the case of a further two fifths, the part they play is minor. Only one in ten companies is heavily digitised. More than half of industrial companies use resource-saving measures that begin at the product design stage. To date, almost half of these companies are not digitally networked, or if they are, it is only to a small extent. One third of the industrial companies up to now have considered new business models as a way of increasing efficiency. Of these, three out of ten have not been digitised yet with a further two fifths having only a minor level of digitisation.

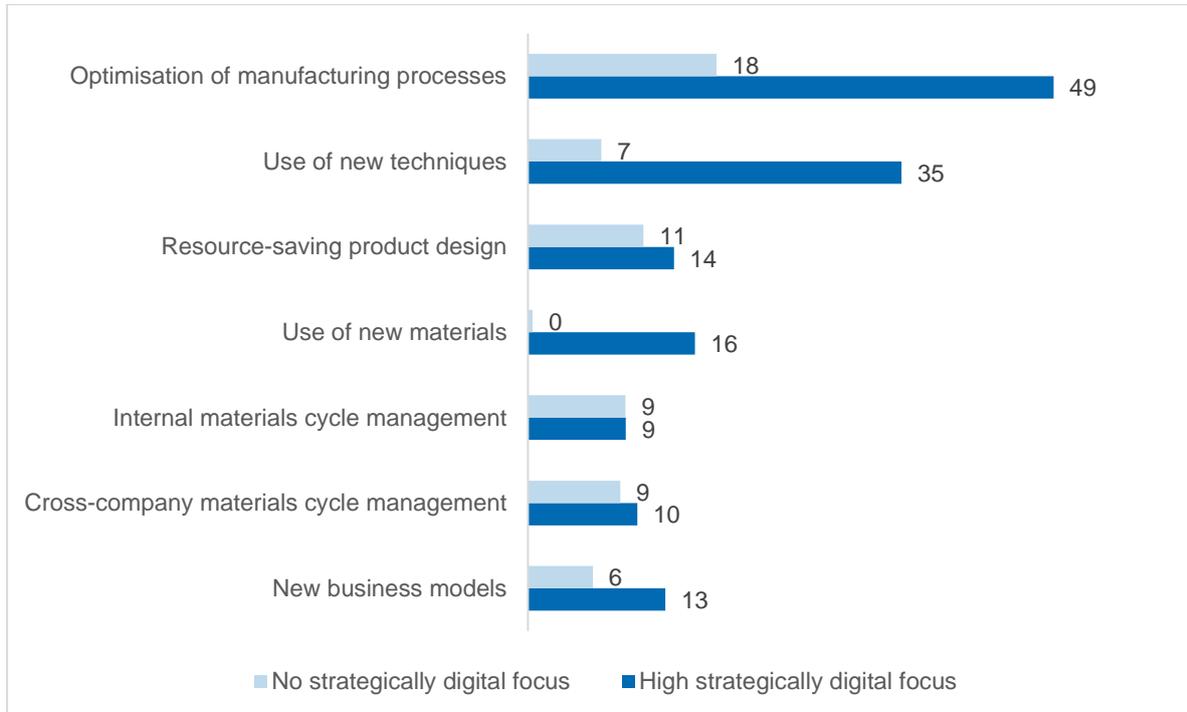
5. Forerunners in material efficiency: companies with a digital strategy

Companies that have already embedded digitisation in their strategy are frontrunners for greater material efficiency, since they more frequently use material efficiency measures intensively, are more likely to recognise further potential savings and their efficiency-saving approaches are also clearly more often highly digitised. Industrial companies with a highly developed digitisation strategy make considerably more intensive use of new techniques and optimisation approaches in manufacturing processes and also rather avail of new materials or new business models than companies without a digitisation strategy (Diagram 3).

The material savings potential is also assessed differently depending on the degree of digitisation in the company. While only one in four manufacturing companies without a digitisation strategy will see additional savings potential, a third of the companies with a highly developed digitisation strategy recognise here further potential. However, companies that up to now have only integrated digitisation into their strategy to a small or moderate degree expect more often further savings potentials. Almost half of the companies with a moderately developed digitisation strategy see still additional savings potential if they make the optimum use of all technical possibilities. This also applies to over a third of the companies with a minor strategic focus on digitisation.

Diagram 3: Important measures according to digitisation strategy

Shares as a percentage of companies in the manufacturing sector applying the respective measure to a high degree according to strategic focus on digitisation



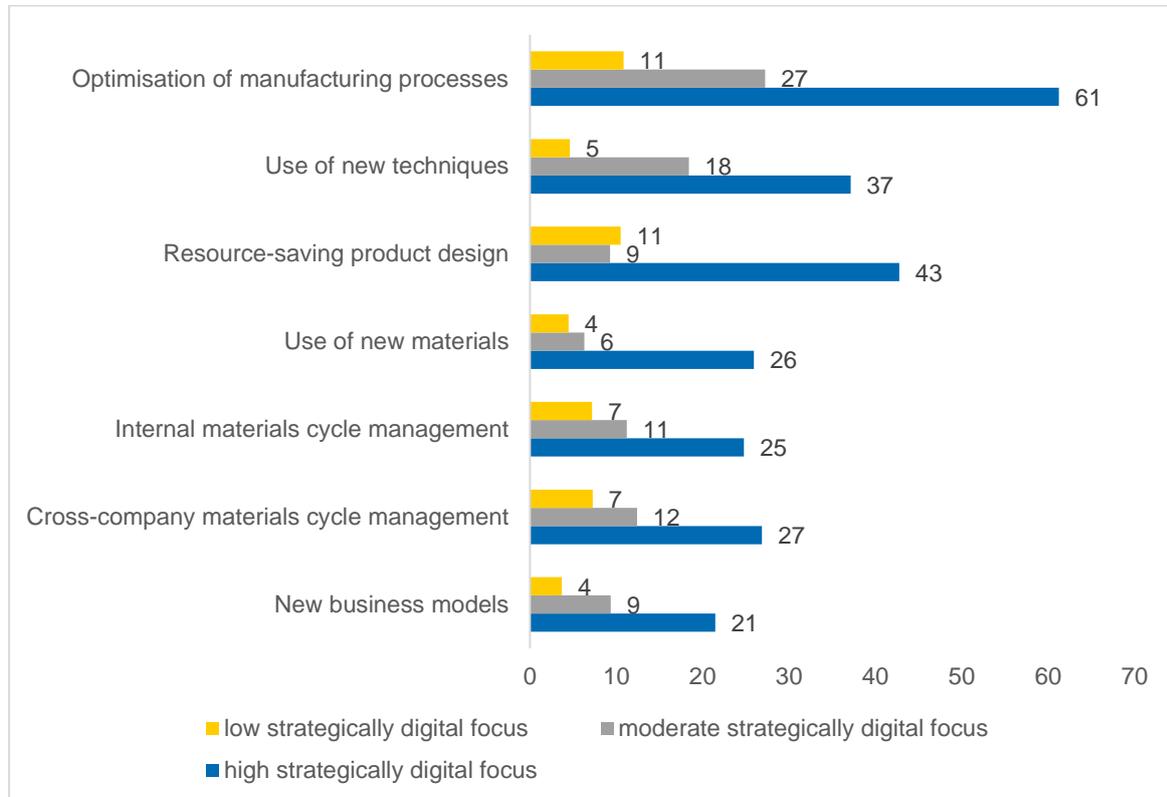
All possible indications of the level of usage: to a high, moderate, low degree, not yet, measure not suited.

All possible indications of strategic focus on digitisation: to high, moderate, low, no focus.

Sources: Neligan/Schmitz (2017)

Companies that already have a strong focus on digital transformation in their strategy also tend to have a considerably greater digital emphasis in their material efficiency measures (Diagram 4). Differences in the intensity of using digital networks in material efficiency measures can be seen in particular in the optimisation of manufacturing processes. Roughly two in five industrial companies with a clear digitisation strategy are also highly digitally networked in the areas of resource-saving product design and the use of new technologies, while the digitisation level in other companies is considerably lower. As an overall average, it is somewhat more than one in ten companies. With the other measures too, one out of four companies with a highly developed digitisation strategy is already well digitally networked concerning material efficiency measures, while this is far less often the case for companies with a minor or moderate strategic focus on digitisation.

Diagram 4: Highly digitised measures according to digitisation strategy
 Shares as a percentage of companies in the manufacturing sector having the respective measures highly digitised according to their strategic focus on digitisation



All possible indications of the level of digitisation: to a high, moderate, low degree, not at all.
 All possible indications of strategic focus on digitisation: to high, moderate, low, no focus.

Sources: Neligan/Schmitz (2017)

6. Outlook

A task that still has to be undertaken in future is to determine the specific digitisation-related savings potential and compare it with the associate costs. Furthermore, the reasons for a lack of digitisation should be investigated.

In addition, it is still necessary to identify the significant drivers for increasing material efficiency in businesses. One striking finding is that firms that are already prepared for digital transformation today are also frontrunners on the road to improved material efficiency. Assuming that primarily innovative companies have already placed digitisation at the core of their strategy, then innovations could be relevant drivers for greater material efficiency. Hence, questions that remain unanswered are whether less innovative companies up to now have underestimated their possibilities for greater material efficiency and whether innovations lead to improved material efficiency.

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