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China's supply of critical raw materials: Risks for Europe's solar and wind industries?

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HIGHLIGHTS

- China is an important supplier of raw materials used in wind and solar technologies.
- China's efforts to control its materials industries affect global supply and prices.
- Short- and long-term concerns are less pressing for the European solar sector.
- The competitiveness of some technologies in the European wind sector may be at risk.
- Some short-term solutions reduce exposure to risks but increase dependence on China.

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ABSTRACT

This article examines the dependence of the European Union's solar and wind industries on Chinese supply of five critical raw materials: tellurium, gallium, indium, and the rare earths neodymium and dysprosium. Based partly on interviews with experts, this study reviews China's industrial policies that shape the supply of these materials abroad. We also assess the short- and long-term strategies of the European Union and European solar and wind industries to ameliorate potential supply bottlenecks. While these strategies adequately address short-term challenges, we find they pose several long-term risks, such as increasing the dependence on China and hampering European competitiveness in global markets. There is also divergence in the extent to which these two industries are vulnerable to supply bottlenecks and price volatility; because more options are open to them, European solar manufacturers are less exposed to these risks than their counterparts in the offshore wind sector.

1. Introduction

In order to significantly decarbonize its energy sector (DG Climate Action 22-07-2016), the European Union (EU) has set a target of increasing the share of energy obtained from renewable sources to 27% by 2030. While European renewable energy firms possess the technological expertise to meet this goal, they are heavily reliant on imports of certain raw materials that enable greater complexity, sophistication and miniaturization; indeed, these raw materials have fueled the rapid boom in technological advancements for renewable energies. Given this strong dependence on a single country—China—for the sourcing thereof, both governments and industry analysts have raised concerns over future pricing and availabilities. Taskforces working for the European Commission have identified such raw materials as "critical", meaning that they are of high economic importance to the EU while entailing high supply risks (EU COM, 2014).

This paper examines raw materials deemed critical to the solar and wind energy sectors. These industries are at risk for supply bottlenecks and price volatility because the anticipated rapid growth in demand is coupled with difficulty in expanding capacity for the extraction of indispensable raw materials, the supply of which is concentrated in just a few countries that, in turn, themselves pose political risks (Moss et al., 2013). Our analysis focuses on five elements: tellurium, gallium and indium (used in making photovoltaics); and two rare earths, neodymium and dysprosium (used in manufacturing wind turbines). These industries stand as examples for other sectors, such as electric vehicles, that also require critical raw materials that might be chokepoints for production.

We analyze the supply risks associated with these five critical materials and assess the strategies undertaken by the European

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Commission and European renewable energy companies to preempt such risks. We argue that a clear differentiation between the sectors and technologies—as well as between the five materials themselves—is necessary to understand current and potential risks for the European wind and solar energy industries. Given the different market developments for these elements, our findings suggest that the solar and wind sectors are affected in different ways.

For European solar firms, several options exist to diversify the materials used in photovoltaics (PV); this fact moderates reliance on China for tellurium, indium and gallium. Because prices are currently low and there are alternative supply sources, European solar firms are, relative to their wind sector counterparts, less concerned about possible bottlenecks of raw materials for their technologies. Moreover, we find that the number of purely European solar companies using these materials is very small; many have either gone bankrupt or been taken over by foreign competitors, such as from China, and the global market is currently dominated by larger Japanese and US firms.

In contrast, the European wind turbine manufacturers, particularly those associated with producing offshore wind turbines, are more concerned about sourcing of the two critical materials used in their technologies: neodymium and dysprosium. The separation and processing of these rare earths are almost completely dominated by China. The future of Europe's rapidly expanding offshore wind energy will depend on the stable supply and pricing of these two materials, which, in turn, depend on Chinese interests and policies towards the raw materials industry.

Our research draws on fourteen semi-structured interviews conducted between January and July 2016 with representatives of European solar and wind companies, research institutes and European government agencies. A list of all interviews is included in Table A1 in the appendix. The analysis is also based on documents by the European Commission, as well as on media reports, information published on companies' websites and academic articles. Reports by the Chinese government and media in Chinese language were an additional source of valuable insights.

The next section examines how critical raw materials are used by European wind and solar manufacturers and discusses projections of future EU demand. The article then analyzes where the EU sources these materials and the extent of its dependence on China. The subsequent section provides an overview of China's recent policies towards the raw materials industry, followed by responses and strategies of the European wind and solar sectors. Our study finds that some materials are more critical than others and that the short-term tactics of some European companies to reduce their risk exposure may hinder their longer-term competitiveness on the global market. The research concludes by discussing several concerns and providing policy recommendations.

2. Demand and supply of critical raw materials in the EU renewable energy technologies

This section discusses the respective solar and wind technologies that depend on critical raw materials, reviews projected demand for these materials and provides an overview of the EU's primary and potential suppliers.

2.1. Demand for critical raw materials in European wind and solar sectors

Five raw materials are consistently cited as being at high risk for future supply disruptions in the European wind and solar energy technologies (Institute for Energy and Transport of the European Commission, 2011; Joint Research Center, 2013; Oakdene Hollins and Fraunhofer ISI, 2013). These are tellurium, indium and gallium for the solar industry, and neodymium and dysprosium for the wind industry. The EU's future demand for these materials depends on several factors: which renewable technologies will increase in efficiency, remain successful in the future and expand their EU-wide share (Schriefl and Bruckner, 2016). Thus, there can only be rough estimates for the EU's future demand and associated import dependencies. However, given current trends, political and commercial actors have raised concerns that both the use of renewable energies and Europe's technological competitiveness might be endangered by high prices and supply shortages of raw materials. Numerous factors have led to this emerging anxiety, including growing demand for certain high-tech applications in emerging economies and the domination of the production and supply of critical raw materials by a few companies in a few countries (Glöser et al., 2015; Sievers and Tecero, 2012).

Solar PV manufacturers use tellurium, gallium and indium in the production of thin film solar cells. Two different types of thin film cells use critical raw materials: CdTe (cadmium telluride) and CIGS (copper indium gallium selenide) cells. CdTe cells use tellurium and account for six to seven percent of global solar PV (IN20160203Solar). They are highly controversial because of the toxicity of cadmium, which renders their future in Europe uncertain (Marscheider-Weidemann et al., 2016). CIGS cells use indium and gallium; they currently hold a share of two percent of global solar PV (IN20160203Solar).

The European Commission expects demand for tellurium, gallium and indium to rise in the EU (Joint Research Centre, 2013). Table 1 indicates that the EU's demand for these materials is anticipated to peak around 2020 and then start waning. Demand is rising, as experts believe that the use of thin film cells will expand in the future, but their share of the global PV market is expected neither to exceed ten percent nor to outpace the growth rate of cheaper silicon cells (IN20160202Solar; IN20160203Solar). Experts also stress that the efficiency of thin film cells will increase; thus, in the long term, production of thin film solar cells will require significantly less tellurium, indium and gallium (Marscheider-Weidemann et al., 2016).

Wind turbine manufacturers use neodymium and dysprosium to produce permanent magnets for the generators used in two different types of offshore wind energy: 1, hybrid systems that combine a gearbox with permanent magnets and 2, direct drive technologies that eliminate the gearbox. A key advantage of permanent magnets over alternative technologies is that they reduce turbine size, thereby decreasing overall weight. As permanent magnets can replace mechanical gearboxes or their moving parts, they also allow for greater resilience (IN20160202Wind; SETIS, 2015). This makes permanent magnets crucial for offshore applications, where maintenance is expensive and the size of the turbines is continually increasing.[1]

Table 1
Projected demand of critical raw materials in EU wind and solar energy.Source: Joint Research Centre, 2013, 76

Material	Annual EU Demand *(in tons)*	
	2020	**2030**
Solar		
Tellurium	150	126
Indium	145	121
Gallium	4	3
Wind		
Neodymium-Praseodyium[a]	845	1.222
Dysprosium	58	84

[a] The report treats neodymium and praseodymium together, as they are not always separated out (Joint Research Centre, 2013, 76).

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