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Extractive dependency in lower-income countries

Evolving trends during the transition to a low-carbon future

Magnus Ericsson[1] and Olof Löf[2]

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Abstract: The first objective of this paper is to update earlier assessments of mineral dependence in lower-income countries. In 2018, the mining of metals and coal continued to be an important contributor to the economies of several low- and middle-income countries. As in our previous calculations of the Mining Contribution Index, African countries in particular benefit from this fact. When oil and gas are also included in estimates of export dependence on extractive industries, a number of new countries appear among those with the greatest dependence—again mostly African countries. The second objective of this paper is to analyse the opportunities for developing countries of the present global transition to a world less dependent on fossil fuels. This process, it can be argued, is partly a transition from hydrocarbons to metals. Hence, countries with reserves of metals and minerals necessary for the low-carbon future, and in particular those with an existing mining industry, will be best positioned to take advantage of this transition. In this category are several African countries, including Burkina Faso, Côte D'Ivoire, DRC, Tanzania, Zambia, and Zimbabwe. In Asia there are Kyrgyzstan, Papua New Guinea, and Philippines, while in South America Bolivia is the only country.

Key words: extractives, low-carbon future, mining, oil

JEL classification: L71, L72, Q32, Q54

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[1] Luleå University of Technology, Luleå, Sweden; corresponding author: magnus@gladtjarnen.se; [2] RMG Consulting, Stockholm, Sweden

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Information and requests: publications@wider.unu.edu

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Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

This first aim of this paper is to update to 2018 and expand the statistical data in our previous study 'Mining's Contribution to Low- and Middle-Income Economies' (Ericsson and Löf 2017), which monitored developments between 1996 and 2014. In the calculations of export contributions we now include both minerals and oil and gas.[1] We also make a first attempt to assess the economic challenges that low-income countries (LICs) and middle-income countries (MICs) face in managing their extractive resources as the world moves towards a low-carbon future (LCF).[2]

In our previous research we concluded that in several LICs and MICs rich in non-fuel mineral resources mining makes a highly significant contribution to national economic development, as measured by our proposed 'Mining Contribution Index (MCI-W)' (Ericsson and Löf 2017, 2019). This Index is based on detailed annual country data on mineral production, mineral exports, mineral rents, and exploration expenditure. In Ericsson and Löf (2019) a first attempt was also made to study available social indicators for African mineral-rich countries. One conclusion from that work is that mining countries in Africa seem to perform better than oil-producing countries and non-mineral countries, as measured by indices of human development and governance.

2 Methodology

The methodology used in this update of the MCI-W from 2014 to 2018 is described in detail in our previous work (Ericsson and Löf 2017, 2019). For this present paper we have also studied production and exports of coal, oil, and gas from all countries in the world. The main sources of data on these fuel minerals are Comtrade—the UNCTAD trade statistics database (UNCTAD n.d.)—and the annual BP Energy Outlook (BP 2019). Certain problems are encountered when using Comtrade and the so-called SITC codes. These have recently been eloquently pointed out and discussed in a paper by Phillip Crowson.[3]

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[1] A few definitions of a chemical nature: The periodic table, including all elements, is broadly divided into metals and non-metals. Most of the elements are classified as metals. They are characterized by strength, elasticity, ductility, and conductivity of heat and electricity. The non-metals lack these properties and include gases such as hydrogen and oxygen but also coal and a range of other elements. The division is not clear; some so-called metalloids, such as tin and silicon, exhibit some typical metallic properties such as conductivity but not all. Minerals are naturally occurring inorganic, crystalline homogenous substances with a defined chemical formula and crystal symmetry such as graphite. Metals are extracted out of minerals but not all minerals contain metals. Fuel minerals include oil, gas, coal, and peat (Enghag 2004: 6, 913).

[2] In this paper we use LIC for low-income countries, and MIC for middle-income countries divided into LMIC for lower-middle-income countries and UMIC for upper-middle-income countries, using the World Bank classification. Minerals that should be in especially high demand in the LCF include chromium (Cr), cobalt (Co), copper (Cu), graphite (C), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), niobium (Nb), palladium (Pd), platinum (Pt), rare earths (REE), and tantalum (Ta). On the economic challenges of managing the extractive industries see Addison and Roe (2018).

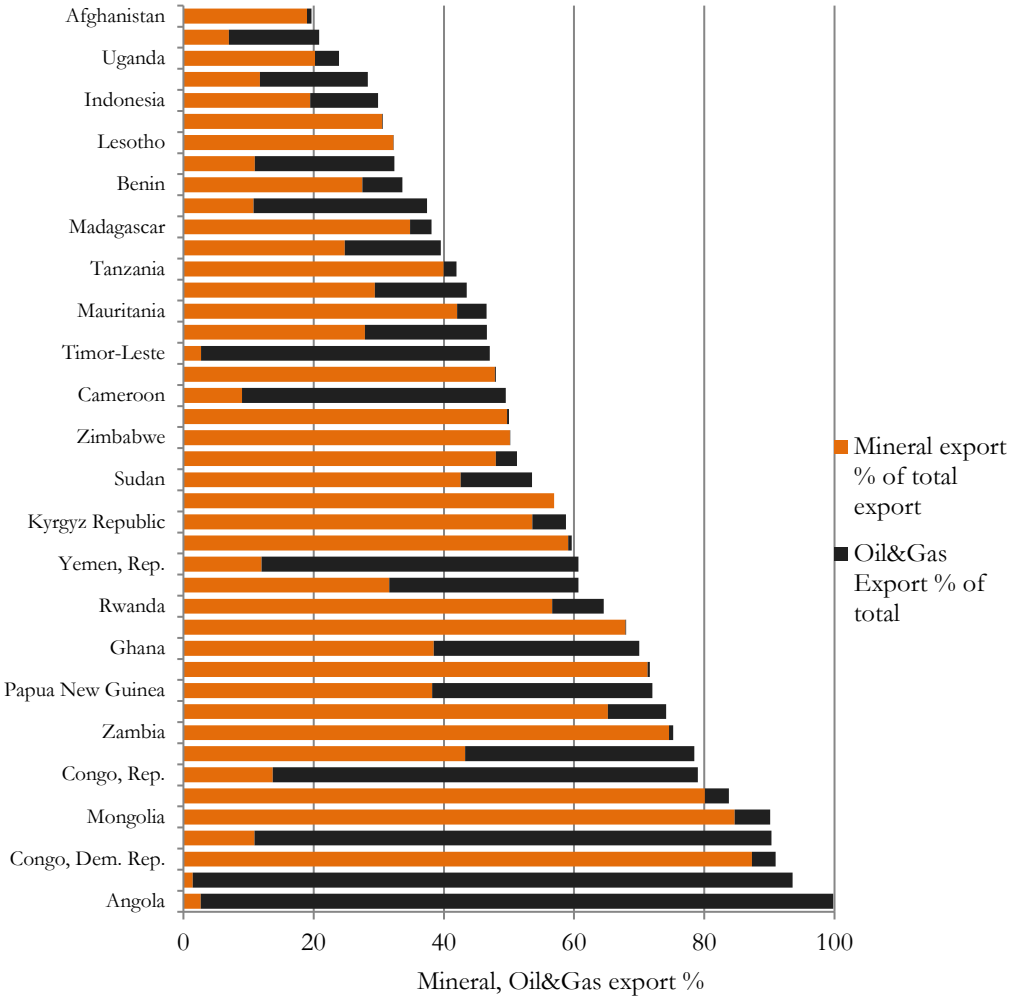
[3] Crowson (2019). Taking his advice we intend to recalculate some of our previous data in order to understand what unintended effects our border definitions (for example, which SITC codes to include) might have had.

3 Extractives in LIC and LMIC—a statistical analysis

3.1 Export contribution

In 2018 there were 77 LICs and LMICs. In no fewer than 43 of these countries, extractives (metals and minerals together with oil, gas, and coal) constitute more than 20 per cent of export revenues. Angola has the highest share, 99.8 per cent of its exports coming from oil and gas. In Chad, DRC, Guinea, Mongolia, and Nigeria, extractives contribute more than 80 per cent of total exports. Of these six countries three are mainly mineral exporters (DRC, Guinea, Mongolia), while in the other three oil and gas exports dominate (Angola, Chad, Nigeria). In 24 LICs and MICs, extractives account for more than 50 per cent of total exports. In this group there are 14 countries where minerals dominate (Burkina Faso, Burundi, DRC, Eritrea, Guinea, Kyrgyzstan, Mali, Mongolia, Mozambique, Rwanda, Sierra Leone, Sudan, Uzbekistan, Zambia, and Zimbabwe), five are mainly oil and gas exporters (Angola, Cameroon, Congo, Nigeria, and Yemen), while the remaining four countries have a balance between mineral exports and oil/gas exports (Bolivia, Ghana, Liberia, and Papua New Guinea (PNG)). Figure 1 shows all countries where the share of extractive exports in total exports is 20 per cent or above.

Figure 1: Mineral, oil and gas exports of LICs and LMICs



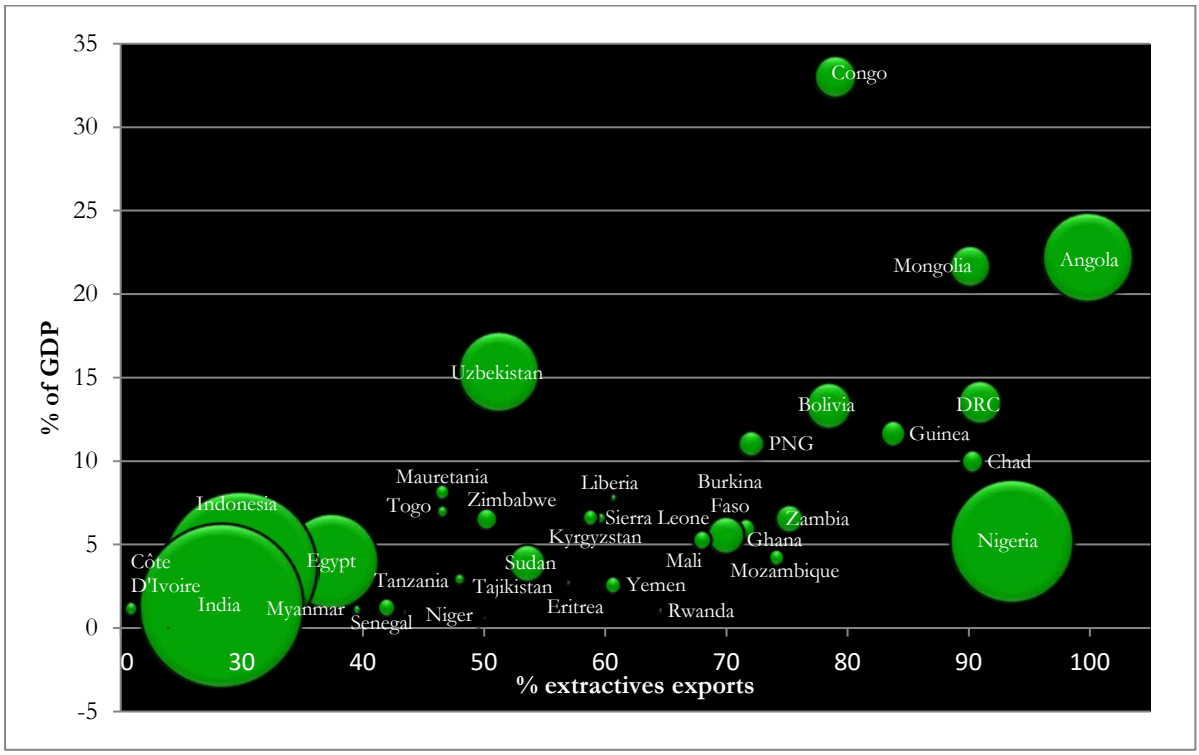
Note: only countries where extractive exports are ≥20% of total exports are included.

Source: authors' illustration based on UNCTAD (n.d.).

The patterns of contribution or dependence, noted also in our previous studies, clearly show that African countries are by far the most prominent among the poorest, but mineral-rich, countries in the world. Specifically there are 30 highly dependent African countries, more than half of all countries in that continent, compared with only 11 Asian countries, 1 South American (Bolivia), and 1 from Oceania (PNG).

In Figure 2 the total value of extractives production as a percentage of GDP is plotted against extractives exports as a percentage of total exports. This adds another dimension to any assessment of the contribution of extractives to national economies. Angola, Congo, DRC, and Mongolia are a group of countries where developments in minerals and oil and gas markets will clearly have a decisive impact on economic and social progress in the future. Bolivia, Chad, Guinea, and PNG form a second group, where dependence on extractives is high but not at the same levels as in the first group of countries.

Figure 2: LICs' and LMICs' mineral and oil/gas exports as percentage of total exports and value of production as percentage of GDP



Note: sizes of circles are proportional to mineral and oil/gas production value.

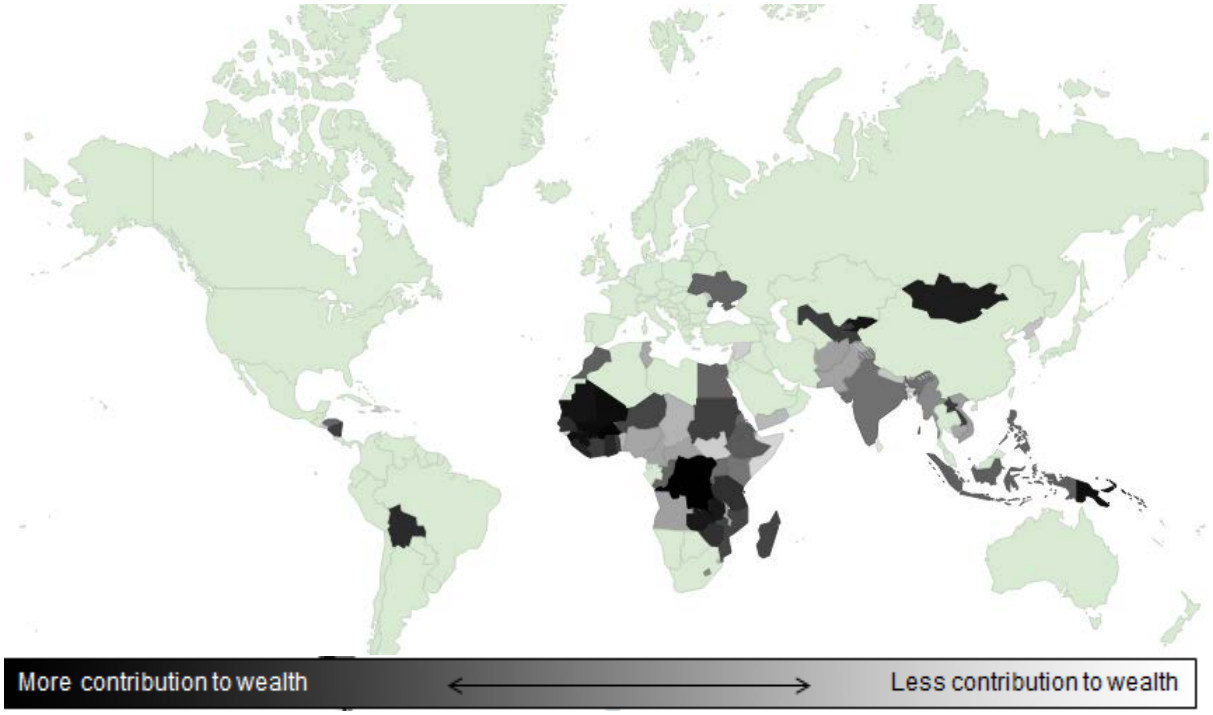
Source: authors' illustration based on UNCTAD (n.d.), British Geological Survey (n.d.), United States Geological Survey (n.d.), British Petroleum (2019), World Bank (n.d.).

The oil-producing countries Angola, Congo, and Nigeria are all outliers in Figure 2. Not only does oil and gas production represent an important share of both their exports and their GDP but also, in *absolute* terms, the value of their production is significant. The non-fuel mineral-producing countries exhibit a less extreme situation, with the possible exception of Uzbekistan, where the value of minerals, only a small part of which is oil/gas, is high in absolute terms and the share of the extractives in GDP is among the highest in the world.

3.2 Mineral Contribution Index

We calculated the MCI-W for 2018 for all the 77 LICs and LMICs in the same way as we did for 2014 and later 2016.[4] In this calculation we included only minerals and coal, *not oil and gas*. The results are presented in Figure 3 and Table 1. The results for additional years can be found in Table A1 in the Appendix. If we arbitrarily choose an MCI-W score of 50 or more to indicate an important contribution by minerals to national economies, the result is a list of 43 countries, of which 27 are in Africa, 8 in Asia, 3 in Latin America, 2 in Oceania, and 1 in Europe. The 10 countries with the highest MCI-W score in 2018 are: DRC, Burkina Faso, Mali, PNG, Guinea, Mauritania, Kyrgyzstan, Zambia, Mongolia, and Sierra Leone. Seven of these are African countries, two are from central Asia, and PNG is in Oceania. A total of 2.7 billion people live in these 43 mineral-rich countries: 865 million of them in Africa, or 68 per cent of Africa's total population. There is an obvious potential for those mineral-rich countries to use their extractives sectors for economic and social development.

Figure 3: MCI-W score in LICs and LMICs



Note: countries in green are not LICs or LMICs.

Source: authors' illustration.

In our earlier paper (Ericsson and Löf 2019), covering the years 1996 to 2016, several mineral-rich countries were shown to have had a positive development in the previous 20 years, moving from low and lower-middle to upper-middle and high income status. Ten of the twenty highest-scoring countries in the MCI-W ranking climbed at least one step in the World Bank classification between 1996 and 2016: Botswana, Chile, Guyana, Kyrgyzstan, Mauritania, Mongolia, Namibia, Peru, Suriname, and Zambia. Zimbabwe became an LMIC in 2018.

[4] Ericsson and Löf (2019).

Table 1: Mineral and oil/gas export of LICs and LMICs (sorted on MCI-W score 2018)

Country	Country classification	Oil/gas / minerals	Mineral export % export 2018	Oil/Gas % export 2018	Minerals+ Oil/Gas % export	18/-95 percentage points	MCI-W score 2018	MCI-W score 2014	MCI-W score 1996	Mineral rich (MCI-W >50)
Congo, Dem. Rep.	L	Minerals	87.3	3.6	90.9	5.5	**94.8**	93.3	72.2	
Burkina Faso	L	Minerals	71.3	0.4	71.6	59.1	**93.1**	90.8	55.6	
Mali	L	Minerals	67.9	0.1	68.0	49.8	**90.9**	87.9	59.4	
Papua New Guinea	LM	Oil+Minerals	38.2	33.8	72.0	12.4	**89.9**	92.0	89.5	
Guinea	L	Minerals	80.1	3.7	83.8	6.0	**89.6**	86.8	91.7	
Mauritania	LM	Minerals	42.0	4.5	46.6	8.3	**88.6**	86.8	84.9	
Kyrgyz Republic	LM	Minerals	53.6	5.2	58.8	43.6	**88.3**	80.0	77.0	
Zambia	LM	Minerals	74.6	0.7	75.2	-12.8	**87.2**	88.6	87.5	
Mongolia	LM	Minerals	84.6	5.5	90.1	30.2	**86.0**	86.9	72.8	
Eritrea	L	Minerals	57.0	0.0	57.0	56.9	**85.2**	89.9	24.4	
Sierra Leone	L	Minerals	59.1	0.5	59.6	32.4	**84.2**	89.9	77.2	
Liberia	L	Minerals	31.6	29.1	60.7	-22.6	**84.1**	92.0	67.6	
Ghana	LM	Oil+Minerals	38.5	31.5	70.0	34.5	**82.6**	79.2	86.7	
Bolivia	LM	Oil+Minerals	43.3	35.2	78.5	27.6	**81.7**	73.3	78.9	
Senegal	LM	Oil+Minerals	24.8	14.7	39.5	14.2	**80.5**	76.1	57.9	
Tanzania	L	Minerals	40.0	2.0	41.9	37.7	**80.0**	80.5	66.9	
Zimbabwe	LM	Minerals	50.2	0.0	50.2	33.6	**79.8**	75.8	81.9	
Lao PDR	LM	Minerals	30.6	0.1	30.6	25.1	**76.7**	59.1	53.7	
Cote D'Ivoire	LM	Oil&Gas	7.0	13.8	20.9	10.3	**76.4**	69.9	36.3	
Tajikistan	L	Minerals	47.8	0.2	48.0	10.7	**76.1**	74.8	80.4	
Uzbekistan	LM	Minerals	48.0	3.2	51.2	24.1	**76.0**	73.8	76.1	
Solomon Islands	LM	Minerals	5.8	0.1	5.8	5.7	**76.0**	72.4	18.6	
Togo	L	Oil+Minerals	27.9	18.7	46.6	6.1	**75.8**	75.5	55.3	
Nicaragua	LM	Minerals	8.4	0.4	8.8	5.2	**75.8**	69.4	65.2	
Sudan	LM	Oil+Minerals	42.6	11.0	53.6	50.3	**75.2**	68.8	42.5	
Niger	L	Oil+Minerals	29.4	14.1	43.5	16.4	**73.8**	70.0	76.5	
Madagascar	L	Minerals	34.8	3.3	38.1	30.2	**73.7**	71.3	67.7	
Mozambique	L	Minerals	65.2	8.9	74.1	65.8	**73.6**	80.0	58.9	
Ethiopia	L	Minerals	9.2	3.7	12.9	10.7	**67.2**	58.2	50.3	
Indonesia	LM	Oil+Minerals	19.5	10.4	29.9	-1.7	**65.6**	64.6	75.1	
Morocco	LM	Minerals	6.4	1.5	8.0	-3.7	**65.4**	65.5	55.2	
Burundi	L	Minerals	49.7	0.3	50.0	13.5	**65.1**	50.0	44.2	
Rwanda	L	Minerals	56.6	7.9	64.5	56.9	**64.9**	60.9	36.6	
Ukraine	LM	Minerals	9.5	1.4	10.9	-1.4	**64.5**	62.5	72.2	
Egypt, Arab Rep.	LM	Oil&Gas	10.8	26.6	37.4	-12.3	**64.3**	49.8	40.2	
Congo, Rep.	LM	Oil&Gas	13.7	65.3	79.0	-2.1	**64.2**	56.3	29.7	
Philippines	LM	Minerals	7.3	1.6	8.8	1.9	**64.1**	66.4	68.7	
Honduras	LM	Minerals	4.9	1.9	6.8	5.9	**63.4**	58.2	55.2	
Uganda	L	Minerals	20.2	3.7	23.9	19.5	**61.2**	48.2	14.7	
India	LM	Oil+Minerals	11.7	16.6	28.3	7.8	**60.1**	56.8	71.1	
Kenya	LM	Oil+Minerals	5.9	5.1	11.0	3.4	**58.7**	54.1	34.1	

Country	Country classification	Oil/gas / minerals	Mineral export % export 2018	Oil/Gas % export 2018	Minerals+ Oil/Gas % export	18/-95 percentage points	MCI-W score 2018	MCI-W score 2014	MCI-W score 1996	Mineral rich (MCI-W >50)
Myanmar	LM	Oil+Minerals	11.0	21.4	32.4	24.9	**52.9**	54.8	46.4	
Lesotho	LM	Minerals	32.3	0.1	32.3	28.6	**52.7**	79.8	14.4	
Bhutan	LM	-	14.3	0.1	14.3	12.2	**45.1**	40.6	46.5	
Viet Nam	LM	-	1.6	3.2	4.8	-14.0	**44.9**	41.7	55.9	
Djibouti	LM	-	5.9	6.8	12.6	-9.6	**44.2**	10.2	16.8	
Afghanistan	L	Minerals	19.0	0.7	19.6	17.0	**43.3**	36.8	9.1	
Malawi	L	Minerals	3.0	0.0	3.0	2.8	**43.2**	46.9	9.6	
Angola	LM	Oil/Gas	2.6	97.2	99.8	1.5	**42.6**	43.4	42.2	
Central African Rep.	L	Minerals	6.5	0.1	6.6	-50.3	**41.6**	55.9	60.8	
Pakistan	LM	-	2.1	2.1	4.2	3.1	**40.2**	32.9	46.5	
Cameroon	LM	Oil/Gas	9.0	40.6	49.5	14.2	**39.8**	31.5	33.6	
Nigeria	LM	Oil/Gas	1.4	92.1	93.6	1.7	**38.7**	25.0	21.7	
Cambodia	LM	-	1.6	0.0	1.6	1.4	**38.3**	5.1	4.6	
Tunisia	LM	-	2.1	7.7	9.7	-0.6	**36.9**	46.0	42.2	
Swaziland	LM	-		0.7	0.7	-1.0	**28.0**	46.0	63.1	
Chad	L	Oil/Gas	10.9	79.4	90.3	90.3	**27.9**	13.6	3.1	
Benin	L	-	27.5	6.2	33.6	27.3	**27.0**	29.9	6.1	
Yemen, Rep.	L	Oil/Gas	12.0	48.7	60.7	-33.5	**24.7**	5.8	5.7	
Korea, People's Rep.	L	-	9.1	1.8	10.9	-1.1	**16.1**	23.2	19.8	
Nepal	L	-	2.1	0.0	2.1	1.9	**13.8**	24.3	2.9	
Comoros	LM	-	5.1	0.0	5.1	5.1	**13.4**	9.3	1.8	
Moldova	LM	-	1.2	0.4	1.6	-1.4	**12.7**	6.4	9.0	
El Salvador	LM	-	1.3	3.2	4.5	2.3	**12.4**	7.1	9.3	
Bangladesh	LM	-	0.4	0.2	0.6	0.3	**11.5**	18.1	4.1	
Gambia, The	L	-	3.1	0.8	3.9	-59.0	**10.8**	16.4	24.4	
South Sudan	L	Oil/Gas			0.0	0.0	**9.9**	0.4	0.4	
Timor-Leste	LM	-	2.7	44.4	47.1	n.a.	**9.8**	1.2	0.4	
Syrian Arab Rep.	L	-	2.4	11.4	13.7	-50.4	**8.4**	7.3	7.0	
Haiti	L	-	2.3	0.0	2.3	2.0	**8.3**	7.0	5.9	
Sao Tome and P.	LM	-	2.1	6.4	8.5	8.4	**7.5**	4.6	10.5	
Cabo Verde	LM	-	0.9	1.0	1.9	-13.0	**4.0**	5.9	10.8	
Somalia	L	-	0.7	0.0	0.7	0.5	**3.2**	17.2	1.9	
Vanuatu	LM	-	0.6	0.7	1.3	1.2	**3.0**	1.7	5.4	
Guinea-Bissau	L	-	0.3	4.4	4.7	-2.8	**2.3**	1.9	2.2	
Micronesia	LM	-	0.2	0.1	0.2	0.2	**1.5**	1.4	1.4	
Kiribati	LM	-	0.1	0.8	0.9	0.3	**1.1**	1.0	7.6	

Note: n.a. = no data for 2018; 'Oil+Minerals' = Oil/gas and minerals. Coal is included in minerals. '18/-95 percentage points' is the increase in mineral, oil/gas exports in percentage points between 1995 and 2018.

Source: British Geological Survey (n.d.), British Petroleum (2019), UNCTAD (n.d.), US Geological Survey (n.d.), World Bank (n.d.).

Many of the mineral-rich LICs and LMICs also have considerable oil and gas resources and exports. Table 1 shows all these 77 countries divided into three categories as indicated in the third column, namely (i) 9 oil and gas-only economies (oil/gas exports combined account for 20 per cent or more of total exports); (ii) 32 minerals-only economies (mineral exports account for 20 per cent or more of total exports); and (iii) 11 countries defined as both minerals and oil/gas economies (both oil/gas and minerals being 10 per cent or more of total exports). In the remaining 25 countries minerals and/or oil and gas play only a minor role in their economies.

Fifteen of the 43 resource-rich countries (MCI-W Index >50) are considered to be fragile states (Alert, High Alert, Very High Alert).[5] Almost all of the other countries have a High Warning in the Fragile States Index. Since 2012, the number of countries with a high mineral export dependence—in other words, countries where mining makes a considerable contribution to their national economies—has nearly doubled.

4 Metals and minerals for a low-carbon future

The second aim of this paper is to answer the following research question: in an LCF scenario, is there potential for today's mineral-rich LICs and LMICs to benefit from global carbon reduction policies in a manner that could contribute in a positive way to their economies even as fossil fuels are phased out?

The threats posed by the increasing levels of CO_2 in the atmosphere and the climate changes that follow[6] make it essential to reduce the use of fossil fuels as a source of energy, and to do this as soon as possible in order to limit the increase in average temperatures to below 2° Celsius. Various scenarios have been put forward to illustrate the likely future demand for coal, oil/gas, and renewables in the light of the current carbon-reducing policies. Several examples are shown in Figure 4 and Figure 5. In two of these scenarios renewable energy will overtake all individual fossil fuels—oil, gas, and coal—as the single most important energy source by 2040. In a less fossil fuel dependent future, renewable energy will become crucial. However, one implication of this is that significant amounts of metals and minerals will be needed to produce enough renewable energy to meet the predicted demand.[7]

The obvious caveat—that projections into the future are always subject to margins of error—must be emphasized. Projections of future mineral and metal demand in an energy transition scenario are often even more uncertain than most economic forecasts for two main reasons. First, the increasingly broad acceptance of the fact that the process of climate change is real is still not universal among politicians in power; hence, the pace of change might turn out to be slower than predicted in the various scenarios. Second, some of the technologies that must be applied when using renewable energy such as batteries, electric motors, and power generators are not yet developed or proven and will most probably change in the future as greater knowledge is accumulated about the alternatives, hence influencing the change in future mineral demands. It is

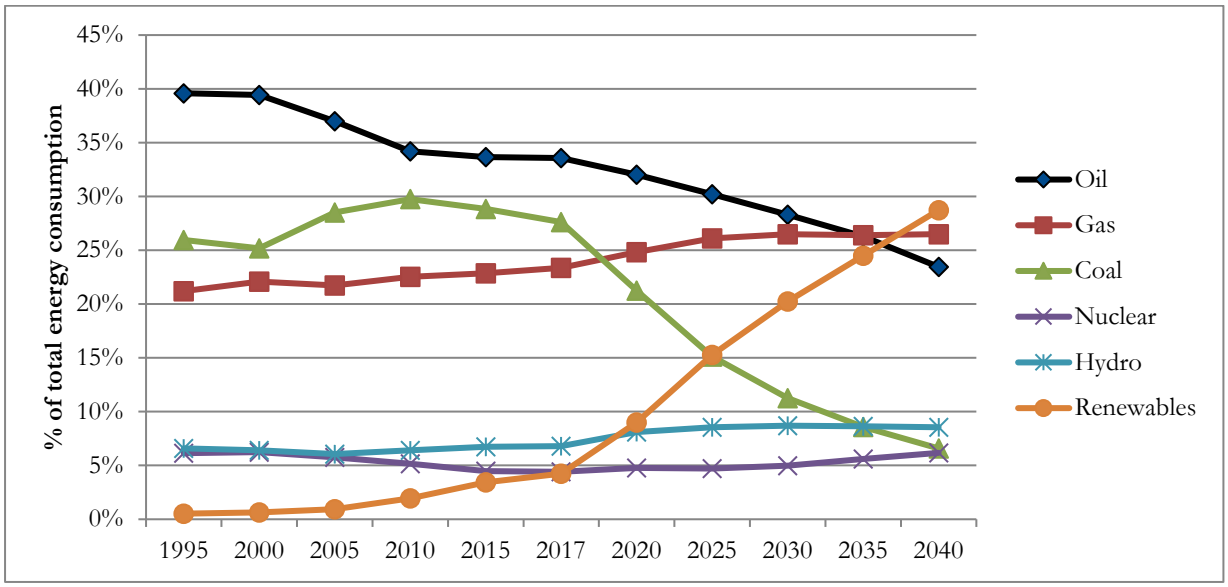
[5] Fund for Peace (2019).

[6] 'Any increase in global warming is projected to affect human health, with primarily negative consequences' (Masson-Delmotte et al. 2018).

[7] Humphreys (2018).

also likely that new technologies will be developed for the methods of producing some or all of the metals demanded, which adds another layer of uncertainty.

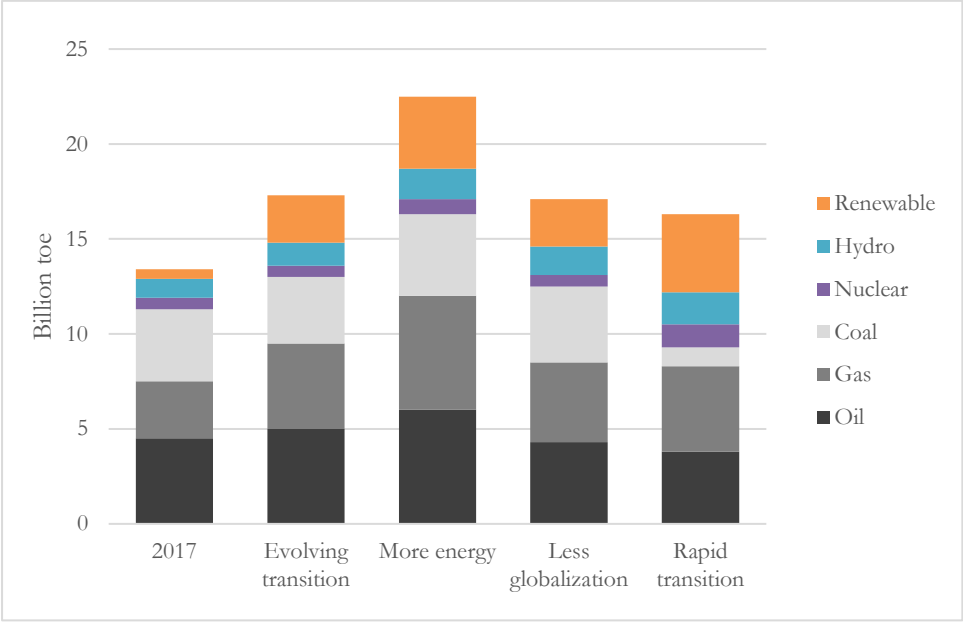
Figure 4: Rapid transition scenario, energy consumption



Note: historical production 1995–2017, forecast 2017–2040.

Source: authors' construction based on BP (2019).

Figure 5: Primary energy consumption—various scenarios

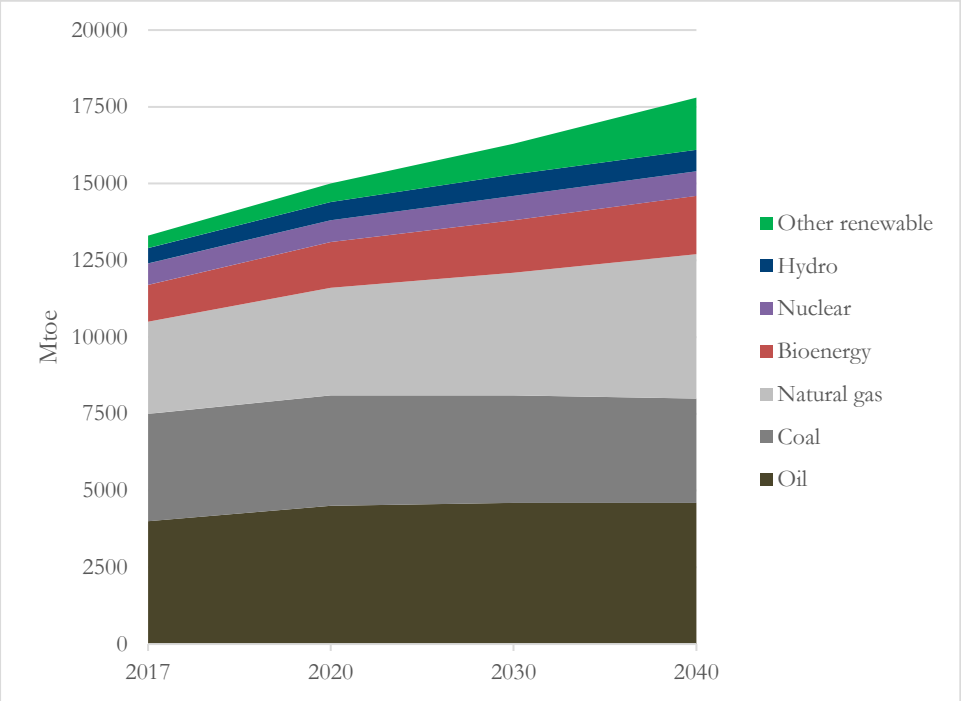


Source: authors' construction based on BP (2019).

There are several scenarios of future energy demand calculated by various organizations and researchers. The International Energy Agency (IEA) has developed what it calls a New Policies Scenario, which includes the policies and targets already announced by governments (Figure 6). While this shows some slowing of the growth in energy demand, there is still no peak in global energy-related CO_2 emissions in this scenario even by 2040. Global energy demand is projected to grow by more than a quarter from 2018 to 2040 due to rising incomes and an increase of 1.7 billion

in the global population—growth that would be twice as large but for continued improvements in energy efficiency.

Figure 6: IEA New Policies scenario—future energy demands



Source: authors' construction based on IEA (2018).

The substantial differences in these projections by the IEA and BP highlight the fact that it is always difficult to make projections into the future and possibly in this case particularly so. First, the renewable energy technologies are new and hence under continuous development, resulting in changing demand for metals/minerals depending on technology choices. Second, the speed at which these new technologies will be accepted and applied depends on a range of political and economic decisions, which adds to the difficulty of projecting future demand. In this study we have mostly used the 'Rapid transition' scenario as described by the BP Energy Outlook 2019 (BP 2019), simply because within the framework of this study we have to limit ourselves to surveying the implications of one scenario. We have, however, also included the IEA's scenario to underline the fact that there is still considerable uncertainty, which needs to be studied and discussed in more detail than is possible here.

The transition to a less fossil-dependent world will have an impact on mineral demand and hence on mineral-producing countries in two major ways:

- Increased demand for the necessary metals and minerals to produce all the renewable energy required;
- Lower demand for fossil fuels (oil/gas and coal).

We treat these two component changes separately in the following analysis.

4.1 Increased demand from renewable energy production

In an LCF, demand for specific metals and minerals like copper, cobalt, lithium, nickel, graphite, and several specialist metals will increase, in some cases dramatically.[8] There will also be continuously increasing demand for high-volume minerals and metals that are used in the infrastructure necessary for renewable energy production, such as steel, aluminium, lead, and zinc.[9] The focus in this paper will be on those metals and minerals most directly related to renewable technologies.

In Table 2 some of the metals and minerals considered important for an LCF (M-LCF) are presented. We will analyse these metals and minerals more closely in the following section. It could be argued that other metals should be included or that some of those chosen should be excluded, but in order to shed light on the likely consequences for emerging mineral-rich countries within the framework of this brief paper, we consider these metals and minerals to be the most economically important.

Table 2: Metals and minerals for a low-carbon future (M-LCF)

Metal/ mineral	Wind power	Photo-voltaics	Carbon capture and storage	Nuclear power	Light-emitting diodes	Electric vehicles	Energy storage	Electric motors	Hydrogen vehicles	Electronics
Chromium	x		x	x	x					
Cobalt			x	x		x	x			x
Copper	x	x	x	x	x	x		x		x
Graphite						x	x			
Lithium						x	x			
Manganese	x	x	x			x	x			
Molybdenum	x	x	x	x	x					
Nickel	x	x	x	x	x	x	x			
Niobium	x									
Palladium									x	
Platina									x	
Rare earths	x					x				x
Tantalum										x

Source: authors' construction based on World Bank (2017).

Most of these 12 metals and one mineral (graphite) are relatively minor in terms of value, but their role in making a fossil-free future happen is of major importance. By 2035, for example, it is estimated that an additional 5.3 Mt of copper (in comparison with demand in 2013) will be necessary to cover the demand created in 42 emerging technologies (Marscheider-Weidemann et al. 2016). Demand for lithium will grow almost four-fold, for heavy rare earths (HREE) including dysprosium and terbium by over three times, and for tantalum by 1.6 times.

[8] See, for example, Herrington et al. (2019), Vidal et al. (2013), and World Bank (2017: 75).

[9] It should be noted that the energy transition is not the main driving force behind the increase in demand for other high-volume metals, which will principally be generated by general economic and social developments caused by the growing global population and its generally increased standard of living. It is realistic to anticipate that these long-term underlying trends will continue.

Table 3 provides an overview of the LICs and LMICs that have existing production and/or identified resources/reserves of the metals and minerals selected as necessary for an LCF scenario.[10] Certainly, several of the countries in Table 3 have geological preconditions that make the discovery of some of these metals/minerals in the future likely, but in order to filter down more precisely to which countries can develop a mine in the not-too-distant future we focus only on existing identified resources.

Numbers in the boxes indicate any existing production values in US$ millions.[11] A green box without a number indicates identified reserves but no production as yet. A red box indicates that the country does not produce any of the metals, at least not at present, but does have identified resources. All the countries in Table 3 are shown in green on the map in Figure 7.

The mine production value of the 13 metals/minerals is almost US$34 billion in 2018 (production volumes 2017 and average price 2018). The countries with the highest value of the 13 items are DRC (US$7.6 billion), Indonesia (US$6.2 billion), and Zambia (US$4.1 billion).

Zimbabwe is the only country that has already established production of most of these metals: 7 out of the 13, including graphite. Copper is the most important in value terms in those LICs and LMICs that mine it along with at least one of the other selected metals/minerals. The value of copper production at the mine stage for the 40 countries in Table 3 in 2018 is US$18.5 billion or 55 per cent of the total value for the 13 materials chosen. Nickel follows with a value of US$6.8 billion (20 per cent), then manganese at US$3.6 billion (11 per cent) and cobalt at US$2.3 billion (7 per cent). All the other metals/minerals together constitute only 7 per cent of the total value. Globally, in an economic perspective, these minor metals might seem negligible but, as stated before, they are all vital for new technologies and also have a strategic value.

All the LICs and LMICs listed with a resource/reserve of one or more of the chosen metals/minerals could benefit from an LCF, in which extractives could contribute significantly to their economic progress. Copper and nickel are the metals for which demand increases from the renewable technologies flagged up in Table 2 will generate the highest levels of potential income in absolute terms, given their high production volumes and relatively high prices. So both could make an important contribution in those economies in which they are present. Laos and Eritrea are examples of countries that have recently started industrial-scale mining in only one or two—mainly copper—mines, but these already contribute considerably to exports and state revenues.

[10] Of the 43 countries with an MCI-W index >50, 10 do not have either production or resources/reserves of the 13 metals/minerals, but 7 countries with an MCI-W <50 do have such production and/or resources; hence the 40 countries included in Table 3.

[11] Production data from 2017 and average annual prices in 2018 have been used.

Table 3: Value of production for M-LCF and resources/reserves in LICs and LMICs (US$ millions)

Country	L/LMIC	Cr	Co	Cu	Gra.	Li	Mn	Mo	Ni	Nb	Pd	Pt	REE	Ta	MUSD	MCI-W
Afghanistan	L														0	43.3
Bolivia	LM			36											36	81.7
Burkina Faso	L														0	93.1
Burundi	L														0	65.1
Cameroon	LM														0	39.8
Congo Rep.	LM														0	64.2
Congo DR	L		1980	5504										157	7641	94.8
Côte D'Ivoire	LM						133		6						139	76.4
Egypt	LM														0	64.3
Eritrea	L			40											40	62.8
Ethiopia	L													26	26	67.2
Ghana	LM						1355								1355	82.6
India	LM	975		169	50		1168						35		2396	60.1
Indonesia	LM		7	3128					3112						6248	65.6
Kenya	LM						4								4	58.7
Korea (North)	L			5	15										20	16.1
Kyrgyzstan	LM			38											38	88.3
Laos	LM			771											771	76.7
Madagascar	L	18	68		9				326						421	73.7
Malawi	L														0	43.2
Mauritania	LM			145											145	88.6
Mongolia	LM			2388				71							2460	86.0
Morocco	LM		46	124			45		2						216	65.4
Mozambique	L				1										1	73.6
Myanmar	LM			508			140		2						650	52.9
Nigeria	LM													9	9	38.7
Pakistan	LM	98		75	14										187	40.2
Papua NG	LM	7	79	534					318						939	89.9
Philippines	LM	6	64	343					2896						3308	64.1
Rwanda	L													166	166	64.9
Sudan	LM	1					4								5	75.2
Tadjikistan	L			37											37	76.1
Tanzania	L			7											7	80.0
Togo	L														0	75.8
Uganda	L														0	61.2
Ukraine	LM				22		793								815	64.5
Uzbekistan	LM			503											503	76.0
Viet Nam	LM			99	5		6								111	44.9
Zambia	LM		78	4009											4086	87.2
Zimbabwe	LM	89		45	4	17			153		376	488			1172	79.8
Sum MUSD		**1194**	**2323**	**18,507**	**119**	**17**	**3649**	**71**	**6814**	**0**	**376**	**488**	**35**	**358**	**33,951**	
% of total value		3.5	6.8	54.5	0.4	0.1	10.7	0.2	20.1	0.0	1.1	1.4	0.1	1.1	100	

Note: only projects with a clearly identified resource (reported according to JORC[12] or a similar international standard) are included in the table; grassroot exploration ideas are not included.

Source: authors' calculations based on RMG Consulting (n.d.), British Geological Survey (n.d.), World Bank (n.d.).

[12] The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) is a professional code of practice that sets minimum standards for such reporting (see www.jorc.org).

Table 3 identifies the countries with potential to benefit from the renewables revolution. But in which countries is mining likely to have the most important economic impact? To help answer this question, a scoring system has been devised and is used here as a second step, i.e. as a further filter. The factors that contribute to the score are:

1. Number of M-LCF already in production: 1 point per metal;
2. Number of M-LCF metals/minerals with a reported resource/reserve: 1 point per metal;
3. Exploration as a percentage of total mine production value: >10% = 10 points; 5–10% = 7 points; 1–5% = 5 points; 0.5–1% = 3 points; 0.3–0.5% =1 point;
4. Country's MCI-W score 2018 divided by 10;
5. An established mining industry (existing mine production value >US$1 billion) = 4 points.

The maximum score is 50 points (13 + 13 + 10 + 10 + 4). Results are shown in Table 4.

Table 4: Ranking of potential country mining benefits from the transition to remewable energy sources

Country	L/LM	Total score	Nr of M-LCF	Production of M-LCF	Exploration % of mine value score	MCI-W score	Established industry value >US$1 bn
Zimbabwe	LM	27	7	7	1	8.0	4
Papua New G.	LM	26	4	4	5	9.0	4
Congo DR	L	24	3	3	5	9.5	4
Tanzania	L	24	6	1	5	8.0	4
Zambia	LM	24	4	2	5	8.7	4
Côte D'Ivoire	LM	23	2	2	7	7.6	4
Philippines	LM	22	5	4	3	6.4	4
Burkina Faso	L	22	2		7	9.3	4
Kyrgyzstan	LM	21	2	1	5	8.8	4
Morocco	LM	20	4	4	3	6.5	4
Madagascar	L	20	6	4	3	7.4	
India	LM	20	5	5	0	6.0	4
Mauritania	LM	20	1	1	5	8.9	4
Uganda	L	19	3		10	6.1	
Ghana	LM	19	1	1	5	8.3	4
Mozambique	L	18	3	1	3	7.4	4
Bolivia	LM	18	2	1	3	8.2	4
Indonesia	LM	18	4	3	0	6.6	4
Mongolia	LM	17	2	2	0	8.6	4
Sudan	LM	17	2	2	1	7.5	4
Congo Rep.	LM	17	1		10	6.4	
Malawi	L	16	2		10	4.3	
Kenya	LM	16	2	1	7	5.9	
Viet Nam	LM	16	5	3	0	4.5	4
Egypt	LM	16	1		5	6.4	4
Myanmar	LM	16	4	3	0	5.3	4
Laos	LM	15	1	1	1	7.7	4
Uzbekistan	LM	15	2	1	0	7.6	4
Ethiopia	L	14	1	1	5	6.7	
Ukraine	LM	14	2	2	0	6.5	4
Eritrea	L	13	1	1	5	6.3	
Pakistan	LM	10	3	3	0	4.0	
Tadjikistan	L	10	1	1	0	7.6	
Burundi	L	10	3		0	6.5	
Togo	L	9	1		0	7.6	
Rwanda	L	8	1	1	0	6.5	
Nigeria	LM	6	1	1	0	3.9	
Korea (North)	L	6	2	2	0	1.6	
Cameroon	LM	5	1		0	4.0	
Afghanistan	L	2	2		0	0.0	

Source: authors' calculations.

As can be seen from Table 4, Zimbabwe scores the highest with a total of 27 points. Zimbabwe benefits from resources/reserves in seven of the LCF metals and there is an established mining industry (4 points) with production of seven of the metals; exploration is 0.46 per cent of total mine production, which gives 1 point; and the MCI-W score is 80/10, which equals 8 points. Among the top 20 countries there are no fewer than 14 African states.

Given the somewhat arbitrary nature of our scoring system, this list should not be taken as a definitive ranking of countries in terms of how likely they are to benefit from an LCF scenario. It is only a first attempt. But it does provide a useful indication as to which types of country are more likely than others to benefit. Resource-rich countries that have an established mining industry are—not surprisingly—most likely to be able to use the energy transition to their advantage, while countries that do not already have a proven mineral-rich geology, lack mining experience, and have undertaken limited exploration are least likely to benefit.

There are in reality huge differences between the countries identified as having the greatest potential to benefit from the energy transition. These differences relate to a variety of practical factors that together may influence a country's ability to take advantage of that potential. These factors can broadly be grouped into three categories: geology, country risk, and investment. To better assess the potential of countries to make use of the potential and develop new mines for metals useful for an LCF, we therefore take the top 11 countries in Table 4, plus Bolivia (as sole representative of South America) and further examine their potential by allocating them a score in terms of three indicators, as follows:

1. Geology (number of LCF metals): score 1–5;
2. Country risk (from MineHutte[13]): score 1–5;
3. Investment (announced project costs as a percentage of GDP): score 1–5[14]

The results are shown in Table 5.

Table 5: Potential to develop M-LCF in selected countries

Country	Geology (no. of M-LCF)	Country risk	Investment	Project cost (US$ bn)	Project cost / GDP (%)
Zimbabwe	+++++	++	++++	2970	7.7
Papua New G.	+++++	++	+++++	22,089	67.2
Congo DR	+++++	+	++++	9568	13.8
Tanzania	++	++	++	3451	2.2
Zambia	+++	+++	++++	6525	10.0
Côte D'Ivoire	+	+++	+	640	0.7
Philippines	++++	++	++	18,957	2.2
Burkina Faso	+	+++	++++	3950	11.4
Kyrgyzstan	++++	++	++++	1874	8.6
Morocco	++	+++	+	289	0.1
Madagascar	++++	+++	++++	5500	14.4
Bolivia	++++	++	+++	3901	4.9

Source: authors' calculations; MineHutte (2018).

[13] The consultancy MineHutte has developed an index or rating to estimate the investment risk in each country from several indicators, including legal (Mining Code), governance (ease of doing business, transparency), social (political stability, conflict, population density), fiscal (royalty rates, tax regime, economic growth), and infrastructure (rails, roads, ports, energy security). For further details see MineHutte (2018).

[14] Calculated as follows: <1% = 1; 1–3% = 2; 3–5% = 3; 5–20% =4; >20% = 5.

We have chosen not to add up the scores for the three indicators, as there is a need for a more thorough study than is possible here to arrive at a meaningful overall score. As with Table 4, the list shown in Table 5 should be seen only as a first attempt, using a few additional indicators, to identify the countries with the greatest potential to benefit from an LCF—as a starting point for a continued discussion. It is not the final answer to the question: which countries are most likely to benefit from a low-carbon future? Our intention is to shed light on some of the opportunities and threats that exist in LICs and LMICs in relation to the energy transition.

It should also be borne in mind that the 'project costs' shown in Figure 5 represent planned investments, which are not certain to be realized. There are naturally many uncertainties: there could be projects that for various reasons that are not announced; projects might be stopped or shelved for political reasons or due to price fluctuations; and so on.

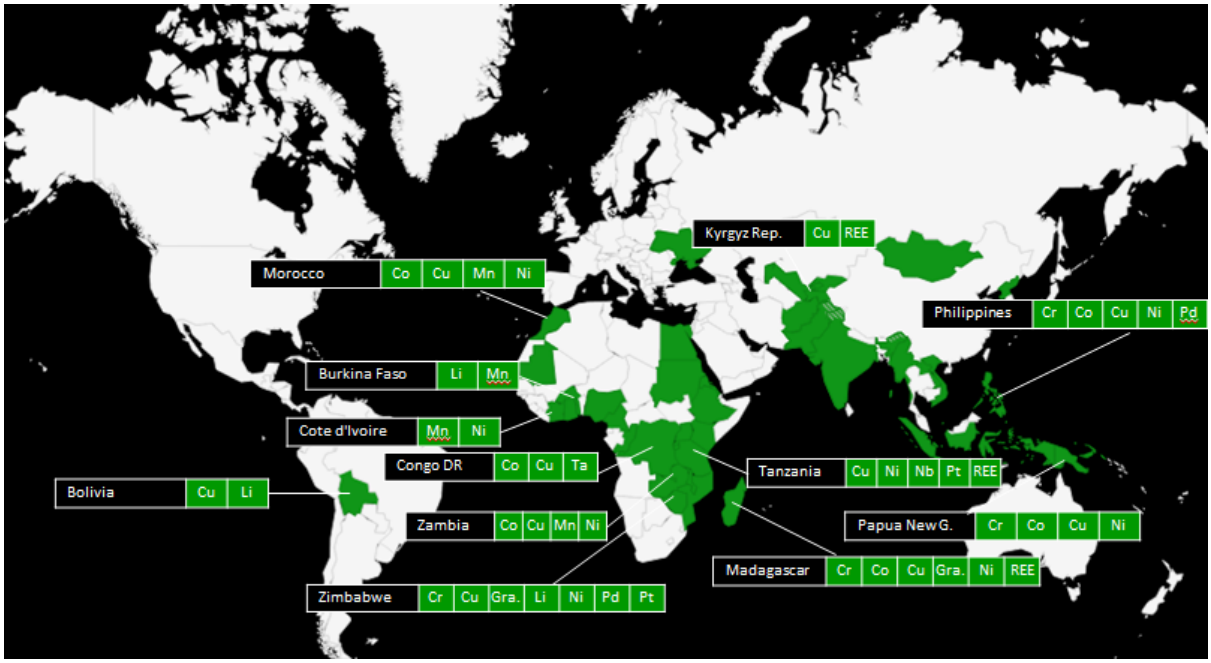
The one metal perhaps most often associated with the electric vehicle (EV) boom, thanks to the name of the lithium-ion battery, is lithium. Bolivia is the only country among the identified LICs and LMICs that has abundant known reserves of this metal, although it has not yet been possible for it to start production. Zimbabwe is the only identified LIC or LMIC country producing lithium today. The other metal often mentioned in connection with a fossil-free future is cobalt. More than 60 per cent of global cobalt production is mined in DRC. Prices for EV metals like lithium and cobalt surged in 2017/18 but came again down in 2019. New lithium mine projects have in recent years experienced difficulties in attracting financing, mainly because of the potentially lower demand when battery technologies are refined. Another example of obstacles that can be faced in this area is Glencore's suspension of production in the Mutanda mine, one of its major copper/cobalt mines in DRC, but this is more likely to be a result of renegotiations of mining contracts by the government than the price decline.

Nevertheless, even though there are no guarantees that any project will be developed into a mine, these planned investments do give an indication of the likely level of future mining activity in a country.

As discussed earlier, copper and nickel constitute more than 70 per cent of the total value of production of the 13 identified metals/minerals (see Table 3). Given that these materials are produced in much larger volumes than many of the others in the list and have established markets and demand patterns, it is reasonable to assume that their combined share is most likely to stay in the same range in the future. Indeed, demand for nickel is expected to surge in the future because of the EV boom and other applications of batteries. This gives an obvious advantage to countries with existing copper and nickel reserves and mines. Indonesia, Philippines, and PNG are among those countries that produce both copper and nickel, while DRC, PNG, and Zambia are all large copper producers.

The 12 countries listed in Table 5 are shown on the map in Figure 7 together with all the LICs and LMICs listed in Table 3.

Figure 7: Mining projects (with a resource/reserve) for LCF metals in LICs and LMICs



Note: the LCF metals and minerals found in the 12 countries of Table 5 are spelled out on the map.

Source: RMG Consulting (n.d.).

There follows a brief discussion of two of the twelve countries, Zimbabwe and Burkina Faso, followed by a few comments on the others.

With its rich geology, which has historically contributed decisively to the economic development of the country, Zimbabwe has great potential to revitalize its mining industry. The lack of FDI in recent years from traditional sources of capital in Europe, North America, and South Africa has made Zimbabwe turn to China and Russia for capital. There is a US$4 billion platinum mine and related infrastructure development at Darwendale, controlled by the Russian-Zimbabwean platinum venture Great Dyke Investments; Russia's Vi Holding, through its JSC Afromet subsidiary, controls half of the shares in Great Dyke Investments, while Zimbabwe's Landela Mining Venture owns the rest;[15] and the Russian diamond giant Alrosa is cooperating with the Zimbabwe Consolidated Diamond Company to start diamond exploration in Zimbabwe. During Zimbabwe's well known and disastrous economic and social problems at the end of Mugabe's reign and beyond, the mining sector's contribution to the economy has provided some stability; without it the situation in Zimbabwe would probably be even worse.

Burkina Faso also scores high in terms of the three additional indicators. The country is, however, almost exclusively a gold producer and almost all exploration is focused on gold; hence the effects of an LCF, if there are any, will probably be limited. That said, Burkina Faso could still profit from its mining industry. Gold is used by the electronics industry, and around 10 per cent of the gold mined there is used in the technology sector. As was pointed out in our previous WIDER Working Paper (Ericsson and Löf 2017), LIC and LMIC countries dependent on gold mining have seen less volatility in state revenues than those economies supported by base metals like copper, zinc, lead, nickel, and iron ore. Gold is also the main mined product in Côte D'Ivoire, Kyrgyzstan, PNG, and

[15] https://www.reuters.com/article/us-zimbabwe-platinum/russia-zimbabwe-platinum-venture-needs-500-million-for-first-phase-idUSKBN1X11OJ

Tanzania, in addition to Burkina Faso. In all these countries, however, other metals are produced and there is active exploration and investment in metals other than gold; hence they are less 'protected' by the stable gold price than Burkina Faso.

Countries without any production of the selected metals today but with resources/reserves that may allow them to benefit are Afghanistan, Burkina Faso, Burundi, Cameroon, Congo, Egypt, Malawi, Togo, and Uganda. These countries could see an upside if a new mine comes into production. There is exploration under way in several of these countries, but almost no known active projects with even an estimated cost attached to them. Any plans are still in the early stages but if even one project does go ahead, there could be positive economic developments similar to those in Eritrea or Laos, where one or two mines already contribute considerably to state revenues and foreign exchange earnings. More basic exploration would help these countries identify possible further commercial deposits to develop and attract investors. The World Bank's 'Billion dollar map' was announced in 2014, with the aim of promoting the standardization and accessibility of geological information and data on Africa.[16]

An example that clearly demonstrates the complexity of the issues discussed is DRC. The country is notorious for a dysfunctional legal setting and mining code, and scores abysmally in a MineHutte comparison. However, there are several major mine projects under development in copper and cobalt. Chinese companies in particular (but also companies from other parts of the world) are increasing their presence in DRC in spite of the objectively poor investment conditions.

4.2 Countries affected by lower demand for oil/gas and coal

Although this paper has not explored the matter in detail, for some countries that are oil dependent like Cameroon and Nigeria, the effect of a rapid transition scenario could have an opposite effect, with less income from oil and gas production.

As shown in Figures 4, 5, and 6, renewables will quickly become a more important energy source in a rapid transition scenario, although coal, gas, and oil will still dominate as late as 2040. In the BP Energy Outlook scenario, illustrated in Figure 4, coal consumption will decrease rapidly from its 2017 level of around 28 per cent of total energy consumption to around 7 per cent in 2040, i.e. a 75 per cent reduction. In absolute terms, coal consumption would be reduced from 3,731 Mtoe in 2017 to 1,079 Mtoe in 2040. That corresponds to a decline from today's production level of roughly 8,000 million tonnes to around 2,300 Mt. Eventually such a reduction will necessarily affect coal mines in the emerging economies negatively, even if the initial effects are small. Even if all the OECD countries including Russia halt all coal production by 2040 and the rest of the world cut its demand by 50 per cent, world demand/production would still be 2,800 Mt. It would be necessary to close an additional 500 Mt of coal mine capacity to reach the 2,300 Mt level of production. This cutback would necessarily have to be done from emerging economies' production of coal.

The share of oil in total energy use will also be reduced, but only from 34 per cent to 23 per cent or by roughly one third. The share of gas will increase marginally to 26 per cent from today's 23 per cent.

Table 6 lists the countries in which exports from oil/gas and coal are currently more than 20 per cent of total exports. The 17 countries in the list include oil-exporting countries like Angola, Chad, and Nigeria as well as countries with a mix of oil/gas and coal exports and countries that export

[16] Ovadia (2015).

only coal, like Mongolia, Mozambique, and Indonesia. Of all the LICs and LMICs it is only these three that have substantial coal exports (38 per cent, 30 per cent, and 12 per cent of total exports, respectively), and a significant reduction in production and exports could seriously affect their economic development.

Table 6: Oil/gas and coal exports in LIC and LMIC

Country	Mineral export % of total export	Oil/Gas export % of total	Coal export % of total	Oil/Gas + coal export
Angola	2.6	97.2		97.2
Nigeria	1.4	92.1		92.1
Chad	10.9	79.4		79.4
Congo, Rep.	13.7	65.3		65.3
Yemen, Rep.	12.0	48.7		48.7
Timor-Leste	2.7	44.4		44.4
Mongolia	46.6	5.5	38.0	43.5
Cameroon	9.0	40.6		40.6
Mozambique	34.9	8.9	30.2	39.2
Bolivia	43.3	35.2		35.2
Papua New Guinea	38.2	33.8		33.8
Ghana	38.5	31.5		31.5
Liberia	31.6	29.1		29.1
Egypt	10.8	26.6	0.0	26.7
Indonesia	19.5	10.4	11.5	21.8
Myanmar	11.0	21.4		21.4
South Sudan*	n.a.	n.a.		n.a.

Note: * there are no export figures for South Sudan in UNCTAD, but the extractives production value as a share of GDP was 15 per cent in 2018, which indicates an economy almost totally dependent on oil/gas, so that exports are probably in the range of 70–90 per cent of total exports.

Source: UNCTAD (n.d.).

In most other LICs and LMICs, coal production is for domestic use in electric power generation. For these countries the effects of reduced demand in export coal markets will be limited. However, the fact that coal is of key importance to their energy production will make it very difficult for them to switch to fossil-free energy sources. The large reduction in global coal consumption is hence unlikely to take place initially in LICs and LMICs but rather in the more advanced economies of the EU, the US, and China. By the same token, the reducing global demand for coal would hit the LICs and LMICs not immediately as a loss of export sales but rather as a possible fall in prices. By how much is difficult or impossible guess at present.

Of the countries listed in Table 6, some export mainly gas and not oil, such as Egypt and Mozambique. In the latter, gas exports are set to increase considerably, as is also the case for Tanzania.[17]

5 Conclusions

The transition to a fossil-free future is in part a transition from hydrocarbons to metals. This means that several countries with the potential to mine the metals (and some minerals) necessary for the production of renewable energy sources, the so-called M-LCF metals, have a unique opportunity to benefit from the expected future growth in demand for these. It is clear that a number of low-

[17] Romsom and McPhail (2020).

and middle-income countries mainly in Africa are extremely well endowed with LCF metals. In a first attempt to assess which of them are best situated to take advantage of this surge in demand we used four indicators to create an aggregated measure of their potential:

1. Number of these metals with a reported resource/reserve (in production or in exploration);
2. Number of M-LCF in production;
3. Exploration expenditure;
4. Whether or not there is an established mining industry.

By applying this methodology to all LICs and LMICs that have a resource/reserve of the metals/minerals, those that are most likely to benefit from the transition to an LCF were identified. The top 10 countries included 8 from Africa plus Papua New Guinea and Philippines. Among the African countries with the highest score were DRC, Tanzania, Zambia, and Zimbabwe.

This methodology was corroborated by also including a number of additional indicators such as country risk, investments planned and/or under way, and general geology, which enabled a more differentiated analysis. Adding to the countries with the best potential in terms of these additional indicators were Kyrgyzstan and Madagascar. If countries have an existing mining industry, the potential to benefit from the transition to a fossil-free world is great. It will not be an easy task, however, and it is not at all inevitable that the potential will result in actual social and economic development that will benefit all the people in these countries. Other factors will come into play, and some countries may need to improve their governance in particular.

On the other hand, countries with important coal exports such as Mongolia and Mozambique might experience detrimental effects to their economies over time if coal prices and/or export volumes decrease.

The MCI-W score—i.e. the contribution of mining to the economy—when updated to 2018 shows no major changes compared with 2016, as might be expected, given that the index is a relative measure. It should, however, be noted that of all countries with a score above 50, Burundi and Ethiopia have increased their MCI-W score most significantly during the past two years, while Lesotho has experienced a significant decline. When the score is measured over the entire period under study (since 1996), Congo, Côte D'Ivoire, Eritrea, Lesotho, Solomon Islands, and Uganda have seen the most dramatic increases. Indonesia and Ukraine have seen their MCI-W index decline more than any others. The reasons behind these swings, whether upwards or downwards, remain to be analysed.

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Appendix

Table A1: MCI-W for 2018

Country	Oil/minerals	L/LM	Mineral export % of total export	Mineral export % of total export	Mineral export % of total export	18/-13 percentage points	18/-95 percentage points	Oil&Gas % Export	Oil&Gas % Export	Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points
			1995	2013	2018	↙↗	↙↗	1995	2013	2018	↙↗	↙↗	1995	2013	2018	↙↗	↙↗
Afghanistan		L	2.5	18.2	19.0	0.8	16.5	0.1	0.1	0.7	0.5	0.5	2.6	18.4	19.6	1.3	17.0
Angola	Oil	LM	4.5	3.4	2.6	-0.7	-1.9	93.8	98.2	97.2	-1.1	3.3	98.3	101.6	99.8	-1.8	1.5
Bangladesh		LM	0.0	0.5	0.4	-0.1	0.4	0.3	0.5	0.2	-0.2	-0.1	0.3	1.0	0.6	-0.3	0.3
Benin	Minerals	L	1.7	11.9	27.5	15.6	25.8	4.7	3.2	6.2	3.0	1.5	6.4	15.0	33.6	18.6	27.3
Bhutan		LM	2.1	16.5	14.3	-2.2	12.2	0.0	0.0	0.1	0.0	0.1	2.1	16.6	14.3	-2.2	12.2
Bolivia	Oil/minerals	LM	40.1	27.4	43.3	15.8	3.2	10.8	54.2	35.2	-	24.4	50.9	81.6	78.5	-3.2	27.6
Burkina Faso	Minerals	L	11.4	49.6	71.3	21.6	59.9	1.2	6.4	0.4	-6.0	-0.8	12.5	56.0	71.6	15.6	59.1
Burundi	Minerals	L	36.5	41.6	49.7	8.1	13.2	0.0	0.0	0.3	0.3	0.3	36.5	41.6	50.0	8.4	13.5
Cabo Verde		LM	5.9	1.6	0.9	-0.7	-5.0	9.0	6.9	1.0	-5.9	-8.0	14.9	8.6	1.9	-6.6	-
Cambodia		LM	0.3	1.4	1.6	0.2	1.4	0.0	0.0	0.0	0.0	0.0	0.3	1.4	1.6	0.2	1.4
Cameroon	Oil	LM	6.7	3.9	9.0	5.0	2.3	28.6	50.2	40.6	-9.7	11.9	35.4	54.1	49.5	-4.6	14.2
Central African Rep.	Minerals	L	56.7	39.1	6.5	-	-	0.1	0.1	0.1	0.0	-0.1	56.8	39.2	6.6	-	-
Chad	Oil	L	0.0	0.1	10.9	10.8	10.9	0.0	92.0	79.4	-	79.4	0.0	92.1	90.3	-1.7	90.3
Comoros		LM	0.0	3.0	5.1	2.2	5.1	0.0	0.0	0.0	0.0	0.0	0.0	3.0	5.1	2.2	5.1
Congo, Dem. Rep.	Minerals	L	75.4	80.9	87.3	6.4	11.9	10.1	12.3	3.6	-8.7	-6.5	85.4	93.2	90.9	-2.3	5.5
Congo, Rep.	Oil	LM	1.6	10.3	13.7	3.5	12.1	79.4	75.7	65.3	-	-	81.1	86.0	79.0	-7.0	-2.1
Côte D'Ivoire	Oil/minerals	LM	0.8	5.8	7.0	1.2	6.2	9.8	23.2	13.8	-9.4	4.1	10.6	29.1	20.9	-8.2	10.3
Djibouti		LM	13.4	3.3	5.9	2.6	-7.5	8.8	22.1	6.8	-	-2.1	22.2	25.4	12.6	-	-9.6
Egypt, Arab Rep.	Oil/minerals	LM	6.0	6.9	10.8	3.8	4.8	43.7	30.9	26.6	-4.2	-	49.7	37.8	37.4	-0.4	-
El Salvador		LM	1.9	2.0	1.3	-0.6	-0.6	0.2	1.6	3.2	1.5	2.9	2.2	3.6	4.5	0.9	2.3
Eritrea	Minerals	L	0.0	38.6	57.0	18.3	56.9	0.0	0.0	0.0	0.0	0.0	0.0	38.6	57.0	18.3	56.9
Ethiopia		L	0.2	3.7	9.2	5.5	9.0	2.0	3.8	3.7	-0.1	1.7	2.1	7.6	12.9	5.3	10.7
Gambia		L	61.8	8.7	3.1	-5.6	-	1.2	3.3	0.8	-2.5	-0.4	63.0	12.0	3.9	-8.1	-
Ghana	Oil/minerals	LM	31.5	23.0	38.5	15.5	7.0	4.0	29.2	31.5	2.3	27.5	35.5	52.2	70.0	17.8	34.5
Guinea	Minerals	L	76.7	52.1	80.1	28.0	3.4	1.1	19.1	3.7	-	2.6	77.8	71.2	83.8	12.6	6.0

Country	Oil/minerals	L/LM	Mineral export % of total export	Mineral export % of total export	Mineral export % of total export	18/-13 percentage points	18/-95 percentage points	Oil&Gas % Export	Oil&Gas % Export	Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points
Guinea-Bissau		L	0.0	0.4	0.3	-0.1	0.3	7.5	4.4	4.4	0.0	-3.1	7.5	4.8	4.7	-0.1	-2.8
Haiti		L	0.2	1.9	2.3	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.3	1.9	2.3	0.4	2.0
Honduras		LM	0.7	6.4	4.9	-1.5	4.2	0.2	4.0	1.9	-2.1	1.7	0.9	10.4	6.8	-3.6	5.9
India	Oil/minerals	LM	18.7	11.7	11.7	0.1	-6.9	1.9	21.5	16.6	-5.0	14.7	20.5	33.2	28.3	-4.9	7.8
Indonesia	Oil/minerals	LM	8.4	16.3	19.5	3.2	11.1	23.2	18.4	10.4	-8.0	-	31.6	34.7	29.9	-4.8	-1.7
Kenya		LM	2.6	4.8	5.9	1.1	3.3	5.0	8.3	5.1	-3.2	0.1	7.6	13.1	11.0	-2.1	3.4
Kiribati		LM	0.6	0.1	0.1	-0.1	-0.5	0.0	1.8	0.8	-1.0	0.8	0.6	1.9	0.9	-1.0	0.3
Korea, Dem. People's Rep.		L	11.1	49.1	9.1	-	-2.0	0.9	4.4	1.8	-2.6	0.9	12.0	53.5	10.9	-	-1.1
Kyrgyzstan	Minerals	LM	14.7	28.5	53.6	25.1	38.9	0.4	6.4	5.2	-1.2	4.7	15.1	34.9	58.8	23.9	43.6
Lao PDR	Minerals	LM	5.4	36.5	30.6	-5.9	25.1	0.1	0.7	0.1	-0.6	0.0	5.6	37.1	30.6	-6.5	25.1
Lesotho	Minerals	LM	3.7	26.4	32.3	5.8	28.5	0.0	0.1	0.1	0.0	0.1	3.7	26.5	32.3	5.8	28.6
Liberia	Oil/minerals	L	81.2	39.3	31.6	-7.7	-	2.1	2.4	29.1	26.7	27.0	83.3	41.7	60.7	19.0	-
Madagascar	Minerals	L	5.2	37.4	34.8	-2.6	29.6	2.7	1.8	3.3	1.5	0.6	7.9	39.2	38.1	-1.1	30.2
Malawi		L	0.2	1.5	3.0	1.5	2.8	0.1	0.0	0.0	0.0	0.0	0.2	1.5	3.0	1.5	2.8
Mali	Minerals	L	17.1	65.7	67.9	2.2	50.8	1.0	0.6	0.1	-0.5	-0.9	18.1	66.4	68.0	1.6	49.8
Mauritania	Minerals	LM	38.0	58.1	42.0	-	4.0	0.3	8.7	4.5	-4.2	4.2	38.3	66.8	46.6	-	8.3
Micronesia, Fed. Sts.		LM	0.0	0.2	0.2	-0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.3	0.2	-0.1	0.2
Moldova		LM	3.0	1.8	1.2	-0.6	-1.8	0.0	1.0	0.4	-0.7	0.3	3.0	2.9	1.6	-1.3	-1.4
Mongolia	Minerals	LM	59.9	80.4	84.6	4.3	24.8	0.0	11.8	5.5	-6.4	5.4	59.9	92.2	90.1	-2.1	30.2
Morocco		LM	9.8	7.9	6.4	-1.5	-3.4	1.9	7.2	1.5	-5.6	-0.3	11.6	15.1	8.0	-7.1	-3.7
Mozambique	Minerals	L	8.3	51.1	65.2	14.1	56.9	0.1	23.3	8.9	-	8.9	8.3	74.4	74.1	-0.3	65.8
Myanmar	Oil/minerals	LM	7.4	19.4	11.0	-8.4	3.6	0.2	33.6	21.4	-	21.3	7.5	53.0	32.4	-	24.9
Nepal		L	0.1	3.9	2.1	-1.8	1.9	0.0	0.0	0.0	0.0	0.0	0.1	3.9	2.1	-1.8	1.9
Nicaragua		LM	2.8	8.3	8.4	0.1	5.6	0.7	0.5	0.4	-0.1	-0.3	3.5	8.8	8.8	0.0	5.2
Niger	Oil/minerals	L	20.4	29.1	29.4	0.4	9.1	6.7	20.0	14.1	-6.0	7.3	27.1	49.1	43.5	-5.6	16.4
Nigeria	Oil	LM	0.3	0.7	1.4	0.8	1.1	91.6	94.5	92.1	-2.3	0.5	91.9	95.1	93.6	-1.6	1.7
Pakistan		LM	0.2	1.8	2.1	0.3	1.9	1.0	2.2	2.1	0.0	1.1	1.2	4.0	4.2	0.2	3.1
Papua New Guinea	Oil/minerals	LM	36.0	37.9	38.2	0.3	2.2	23.7	17.9	33.8	16.0	10.2	59.7	55.8	72.0	16.3	12.4
Philippines		LM	5.4	7.7	7.3	-0.4	1.8	1.5	3.8	1.6	-2.2	0.1	6.9	11.4	8.8	-2.6	1.9
Rwanda	Minerals	L	7.4	44.6	56.6	12.0	49.2	0.3	10.1	7.9	-2.2	7.6	7.7	54.7	64.5	9.8	56.9
Sao Tome and Principe		LM	0.1	1.2	2.1	0.8	2.0	0.0	0.0	6.4	6.4	6.4	0.1	1.2	8.5	7.3	8.4

Country	Oil/minerals	L/LM	Mineral export % of total export	Mineral export % of total export	Mineral export % of total export	18/-13 percentage points	18/-95 percentage points	Oil&Gas % Export	Oil&Gas % Export	Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	Minerals+Oil&Gas % Export	18/-13 percentage points	18/-95 percentage points
Senegal	Oil/minerals	LM	12.0	15.9	24.8	8.9	12.7	13.3	20.5	14.7	-5.8	1.5	25.3	36.5	39.5	3.1	14.2
Sierra Leone	Minerals	L	26.2	93.6	59.1	-	32.9	1.0	0.0	0.5	0.5	-0.5	27.2	93.6	59.6	-	32.4
Solomon Islands		LM	0.1	3.5	5.8	2.3	5.6	0.0	0.0	0.1	0.0	0.1	0.1	3.5	5.8	2.3	5.7
Somalia		L	0.2	10.3	0.7	-9.7	0.5	0.0	0.0	0.0	0.0	0.0	0.2	10.3	0.7	-9.7	0.5
South Sudan		L				0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sudan	Oil/minerals	LM	3.1	27.4	42.6	15.2	39.4	0.2	66.3	11.0	-	10.8	3.3	93.6	53.6	-	50.3
Swaziland		LM	1.7	4.6				0.0	2.1	0.7	-1.5	0.6	1.7	6.7			
Syrian Arab Republic		L	1.0	2.2	2.4	0.2	1.4	63.2	7.6	11.4	3.7	-	64.2	9.8	13.7	4.0	-
Tajikistan	Minerals	L	37.2	59.1	47.8	-	10.6	0.1	0.1	0.2	0.1	0.1	37.3	59.1	48.0	-	10.7
Tanzania	Minerals	L	3.9	38.1	40.0	1.9	36.1	0.3	4.1	2.0	-2.1	1.6	4.3	42.2	41.9	-0.2	37.7
Timor-Leste	Oil	LM		0.2	2.7	2.5	2.7		49.9	44.4	-5.5			50.0	47.1	-3.0	
Togo	Oil/minerals	L	34.3	30.5	27.9	-2.6	-6.4	6.3	11.0	18.7	7.7	12.4	40.5	41.5	46.6	5.1	6.1
Tunisia		LM	1.8	1.8	2.1	0.2	0.2	8.5	15.2	7.7	-7.5	-0.8	10.3	17.0	9.7	-7.3	-0.6
Uganda	Minerals	L	4.4	2.8	20.2	17.4	15.8	0.0	0.2	3.7	3.5	3.7	4.4	3.0	23.9	20.9	19.5
Ukraine		LM	8.9	11.3	9.5	-1.8	0.5	3.4	1.9	1.4	-0.5	-1.9	12.3	13.2	10.9	-2.3	-1.4
Uzbekistan	Minerals	LM	14.3	30.5	48.0	17.5	33.7	12.9	15.4	3.2	-	-9.7	27.1	45.9	51.2	5.4	24.1
Vanuatu		LM	0.0	0.3	0.6	0.3	0.5	0.0	3.9	0.7	-3.2	0.7	0.0	4.2	1.3	-2.9	1.2
Viet Nam		LM	2.0	1.4	1.6	0.1	-0.4	16.8	6.5	3.2	-3.3	-	18.7	7.9	4.8	-3.2	-
Yemen, Rep.	Oil	L	1.0	1.6	12.0	10.4	11.0	93.2	89.2	48.7	-	-	94.1	90.8	60.7	-	-
Zambia	Minerals	LM	87.3	75.1	74.6	-0.5	-	0.8	0.6	0.7	0.0	-0.1	88.1	75.7	75.2	-0.5	-
Zimbabwe	Minerals	LM	16.2	20.1	50.2	30.1	34.0	0.4	1.5	0.0	-1.5	-0.3	16.6	21.6	50.2	28.6	33.6

Source: authors' calculations.