Views on Indicators of Resource Efficiency



General Remarks

Resource Efficiency should yield optimum solutions to the trade-offs that exist between different environmental objectives and the environmental, social and economic imperatives of Sustainable Development. The result should be an economy that optimises its use of resources and, therefore, results in improved living conditions and reduced waste globally. The European extractive industries fully support the premise that life cycle management approaches are required to describe and monitor Resource Efficiency.

The adopted indicators of Resource Efficiency must incentivise the *optimal use* of materials. Simply minimising *material inputs* based on presumed impacts, without considering further control of impacts in the use phase, is extremely inefficient and wasteful.

A full set of bottom-up indicators is therefore required to visualise the trade-offs needed to achieve a Resource Efficient Europe. The proposed set of EU indicators of Resource Efficiency (a lead indicator; a dashboard of macro indicators; and a set of theme specific indicators) must be fit for the following purposes:

The European Commission Proposal	Must be Able to,...
Full set of data and indicators	help harmonise understanding of the issues involved
A new lead indicator	measure improved economic performance and simultaneous reduction of pressure on natural resources define existing or potential levels of ambition (i.e., the 2050 Vision target) monitor progress towards the target
A dashboard of macro indicators on Materials, Water, Land and Carbon	account for the EU's global consumption of key natural resources disclose potential unfavourable trends (e.g., improvements in domestic resource efficiency, through use of less efficient processes outside the EU)
A set of theme-specific indicators	measure progress towards the specific thematic objectives guide public and private decisions on policy and investment

A single lead indicator could be useful to track progress of the whole EU economy towards a political target, but risks being a misleading distraction if used to compare countries or products. Such a high-level indicator, with its attendant uncertainties, is not appropriate for policy-making.

Resource Efficiency Indicators

"Eco-efficiency", "Green Growth" and "Resource Efficiency" are just some of the terms that have emerged to capture the idea that both economic and environmental efficiencies can be accomplished simultaneously. The latest application of Eco-Efficiency appears in the EU Roadmap to a Resource Efficient Europe – which signals the development of indicators of Resource-Efficiency. Life Cycle Assessment (LCA) is proposed for determining economy-wide eco-efficiency through the normalisation, grouping and weighting of data to derive an "Overall Impact Indicator".

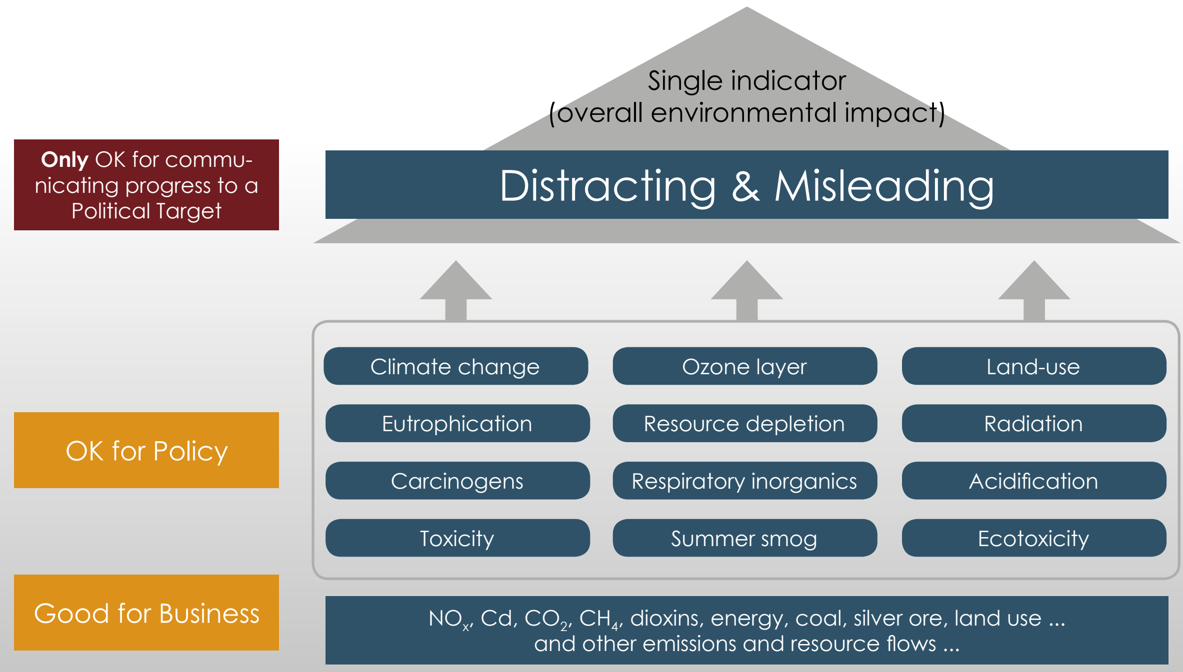
Eco-Efficiency	Eco-Efficiency = GDP/Overall Impact Indicator
Resource Specific Impact	Resource Specific Impact = Impact/kg, ha, m³ etc.
Resource Productivity	Resource Productivity = GDP/Domestic Material Consumption

The Environmental Footprint work of the European Commission is expected to provide those Resource Specific Impacts considered most important (material, water, land, and carbon). Resource Productivity has already been adopted by the EU as its temporary measure of Resource-Efficiency – recognising that it hides relocation of resource use to third countries.

Meaningful Data makes Meaningful Indicators

To adopt EU-wide indicators of Resource Efficiency, there is an urgent need to understand data quality and uncertainty and the impact they have on sound understanding of the issues. The European Commission Joint Research Centre provides The European Platform for Life Cycle Assessment with guidance on consistent and quality-assured life cycle data. Coupled to this is the need to find ways to effectively communicate information on data quality to policy makers – e.g., reporting all results together with error bars.

One strength of Life Cycle approaches is that they allow decision makers to find lower level information to increase certainty about the consequences of their actions. High levels of aggregation come at the expense of transparency, but they also significantly increase uncertainty. When highly uncertain data is combined, attention can be diverted to false priorities. Acceptability of data for each level of decision-making, based on an appropriate level of quality/uncertainty is therefore crucially important.



The certainty of the data must be sufficient for the decision that needs to be made.

Making Indicators “Life Cycle Based”

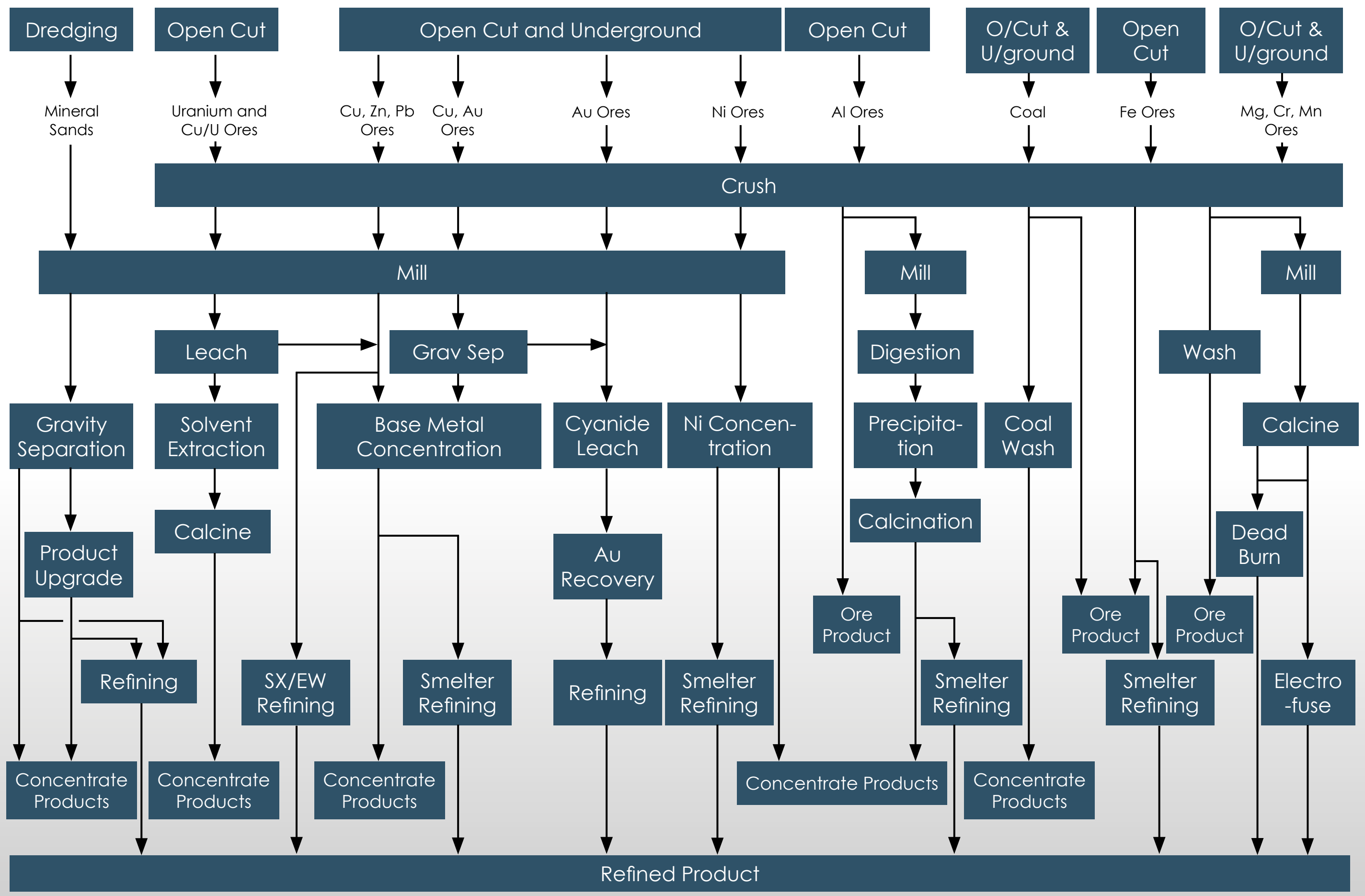
Life cycle management (LCM) incorporates different strategies and tools needed to answer questions about the life cycle of a product, service, project or process. LCA is one tool (as is Material Flow Analysis, Substance Flow Analysis, Environmental Footprinting etc). Unless the overlying strategies and concepts are clear one cannot be sure that LCA is the right tool to use. The selected tools must match the decision that needs to be made.

Therefore, it must be clarified which questions the EU Resource Efficiency indicators should inform. For example, should the indicators monitor progress towards “smart, sustainable and inclusive growth” (as phrased in the EU2020 Strategy[1]), or only towards “de-materialisation” of the economy (as referred to in the Roadmap to a Resource Efficient Europe[2])?

Life Cycle Management in the Mining Industry

Mining of metals and minerals is an essential step in the life cycle of many products. Demographics, combined with thermodynamics dictate that even with 100% recycling at end-of-life, there will be a need to fill supply gaps through primary production[3] (at least until 2050). Hence, a Resource Efficient Europe must include extraction of raw materials.

The mining industry has practiced LCM for decades to maximise the competitive life-time of its investments. The last 15-20 years have seen this extended to social and environmental performance – notably through continuous improvement approaches including Total Quality Management and Environmental Management Systems. Experience has shown that due to the extremely complex nature of mineral value chains, variation in performance within the sector is vast.



LCA alone is not suited to extremely complex value chains[4].

Large differences in water and reagent use exist between different mining industries. Differences in the estimated global warming potential of different gold mining regions have revealed how improved equipment purchasing practices could contribute to significant energy savings.

Whilst LCM has been central to identifying such opportunities, none of this variation is captured by life cycle inventories commercially or publically available today - thus limiting the role of conventional LCA in achieving resource efficiencies in highly complex value chains.

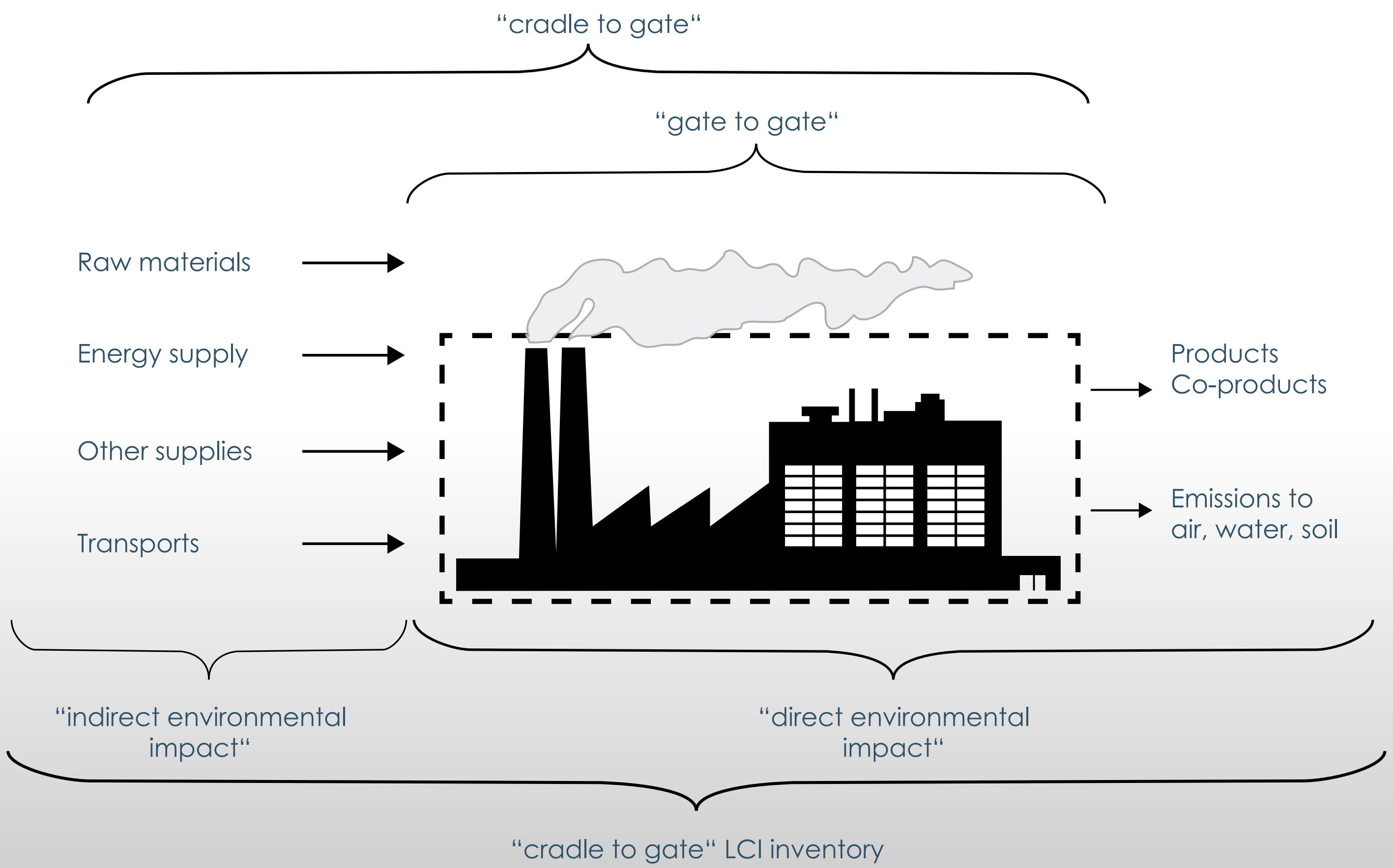
Life Cycle Assessment: its Value and Limitations

According to ISO 14040 and 14044 standards, an LCA consists of the following four steps:

I. definition of the goal and scope
II. Inventory analysis
III. Impact assessment and
IV. Interpretation of results.

The definition of the goal and scope (step I) can cover parts of the life cycle (“cradle to gate” – from mining to manufacturing) or the full life cycle (“cradle to grave” – covering also use and disposal; “cradle-to-cradle – covering also recycling). In practice, most LCAs of materials (e.g., “1kg of copper”) are necessarily “cradle to gate” only.

In the Inventory analysis (step II), inputs and outputs are investigated. Examples of inputs are materials, energy and chemicals. Examples of outputs are air and water emissions and waste. The inventories do not directly measure *impacts*, but can point assessors to areas where an in-depth impact or risk assessment is warranted.



Conventional LCAs of materials typically do not cover the full life-cycle.

1 EU2020 Strategy http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF
2 Resource Efficiency Roadmap http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0571:FIN:EN:PDF
3 UNEP International Resource Panel, upcoming report on “Environmental Aspects of Metal Cycles”
4 Source: Stewart, M. and J. Petrie (2006) Journal of Cleaner Production, 14 (12-13), 1042-1056

The impact assessment (step III) evaluates the potential contribution to certain impact categories such as global warming, acidification etc. These are then allocated to "Areas of Protection" of concern to the study (e.g., Human Health or Natural Resources). The choice of impact categories is subjective and often decisive – sometimes magnifying inherent uncertainties to unacceptable levels. Such "end-point modelling" also masks information about where the greatest potential for environmental impact may occur (as in complex supply chains as described above).

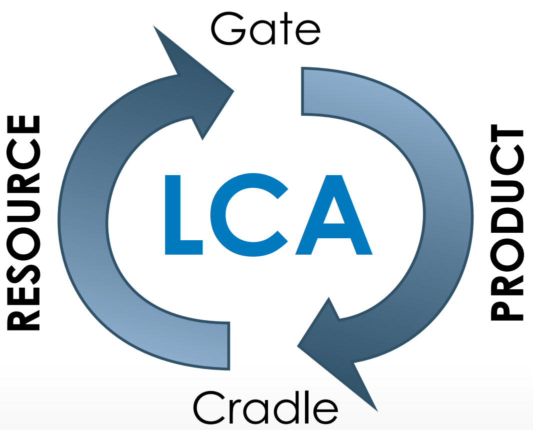
The interpretation (step IV) analyses major contributions to potential impacts and model sensitivities. All conclusions are drafted during this phase. Sometimes, an independent critical review is undertaken. However, regardless of statistical uncertainties, or the consensus surrounding the methodology applied, there can generally be no "right" or "wrong" interpretation of an LCA. Rather, it provides insights that might support or moderate a certain decision.

Some Serious Methodological Issues to Resolve

The European Commission wishes to provide market incentives for good environmental performance of products throughout the whole life cycle – "transforming the economy". For this, finalisation of sufficiently accurate indicators by the end of 2013 will be extremely difficult. The work should continue beyond 2013.

Goal and scope

Important distinctions are to be made between resources; materials; and products. Current misunderstandings are reflected in the focus on depletion of mineral resources (as opposed to consumables); on cradle-to-gate LCAs of metals (as opposed to cradle-to-cradle); and on use of data from one material for LCA of another. Published LCAs of products containing metals and minerals often suffer from poor scoping, e.g., incomplete accounting of the energy intensity of production and the energy consumption of products in use. Additionally, LCA is not easily adapted to the fact that the mining, smelting, refining and use of a metal do not usually result in significant emissions of the metal itself, despite the large tonnages involved.



LCAs of raw materials should only be considered together with a product in which they are used

Only complete product LCAs can begin to account for benefits in use (e.g., conductivity, malleability, strength, durability, recyclability etc.). Therefore, LCAs of raw materials ("cradle-to-gate") should only ever be considered in combination with the products in which they are used ("gate-to-cradle"), such that a "cradle-to-cradle" scope is constructed.

Life Cycle Impact Categories

Characterization models for Life Cycle impact assessment (LCIA) have been developed to cover a variety of substances and circumstances which are typically assessed within a life cycle. Such generic models show obvious weaknesses in situations where the cause-effect chain is particularly complex (e.g., mining and minerals) and in case of poor scientific consensus on the modelling approach to be used (e.g., abiotic resource depletion). These need to be kept in mind.

Many input categories are sufficiently well developed. The UNEP/SETAC Life Cycle Initiative has improved incorporation of metals toxicity into LCAs[5][6]. The next priorities, from a Euromines perspective, are likely the assessment of resource depletion, water consumption and land-use. None of these have sufficiently robust impact characterization models available and all of them are central to current EU proposals, so urgent development work is clearly required.

5 http://www.leidenuniv.nl/cml/ssp/projects/declaration_of_apeldoorn.pdf
6 Diamond, M. L., N. Gandhi, W. J. Adams, J. Atherton, S. P. Bhavsar, C. Bulle, P. G. C. Campbell, A. Dubreuil, A. Fairbrother, K. Farley, A. Green, J. Guinee, M. Z. Hauschild, M. A. J. Huijbregts, S. Humbert, K. S. Jensen, O. Jolliet, M. Margni, J. C. McGeer, W. Peijnenburg, R. Rosenbaum, D. van de Meent and M. G. Vijver (2010). The clearwater consensus: the estimation of metal hazard in fresh water. Int. J. Life Cycle Assess. 15(2):143-147

Resource Depletion (materials & water)

If applied incorrectly, "resource depletion", "material footprint" and "material consumption" concepts divert attention away from the environmental impacts of dispersive use and release by over-estimating the environmental impact of resource extraction (e.g., mining of phosphate rock, abstraction of water). Recent EU-funded research has revealed that current assessments of "Abiotic Resource Depletion" vary by several orders of magnitude and that there is no consensus amongst LCA practitioners on the issue of concern that this impact category should be addressing[7]. In practice, some LCAs have prioritised "conservation" of abundant mineral resources over more pressing environmental concerns such as emissions of CO2, eutrophication and habitat fragmentation. Insufficiently informed interpretation of these studies (e.g., by a member of the public confronted with an aggregated indicator), is likely to lead to counter-productive diversion of effort.

As several geologists and resource economists have shown, "depletion" of mineral resources is not likely enough to be systematically included as an impact category in LCIA[8][9][10]. "Scarcity" of these raw-materials is an economic issue arising from a lack of efficient forward-looking use of capital and not indicative of any environmental impact. Rather than being depleted, the majority of mineral resources are used to continuously serve valuable purposes in the built environment. The Resource Depletion impact category should therefore only be included in LCIAs of products that are consumed (typically those derived from biotic resources such as fish, crops, some forest products, livestock, foodstuffs, oil, gas, peat and coal) for which there may be imminent risk of environmental impacts if stocks cannot be regenerated.

Assessment of water "consumption" is plagued by significant differences in water quality and abundance in specific locations. LCM tools other than LCA and the Water Footprint are needed to address potential impacts on the water needs of communities and the environment (e.g., assessment of process or project life cycles, rather than product life cycles).

Waste

LCA tries to make visible the fact that emitting 1kg of mercury does not have the same environmental impact as emitting 1kg of sand. However, current LCA models make no distinction between the size and content of different waste streams, and the likely release of pollutants from their treatment, recovery and disposal. For this reason, the European Commission Joint Research Centre specifically recommends excluding extractive wastes from macro-economic indicators of Resource Efficiency. Command-and-Control legislation is already in place to prevent damaging emissions from these wastes.

Balancing Positive and Negative Impacts

Mining can bring social and economic benefits to local populations (e.g. better education and living conditions, improved income and better stewardship of the surrounding environment), but a lack of appropriate governance can mean that sometimes it doesn't. Even where good governance is relatively assured, the social benefits accrued along the value chain of metals and minerals– including the continuous societal value of stable and durable materials in use and in recycling loops - are not captured by LCA alone. LCA must be supplemented with other tools to provide valid indicators of Resource Efficiency.

7 http://www.lc-impact.eu/workshop-resource-depletion
8 Crowson (2011), "Changing yields and ore grades", Mining Journal, October 7, 2011
9 Soderholm (2011), "Taxing Virgin Natural Resources: Lessons from Aggregates Taxation in Europe" Submitted to Resources, Conservation and Recycling, 2011
10 http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/report-b_en.pdf

Conclusions

A single lead indicator could be a useful concept to provide a snapshot of the EU economy as a whole, but risks being a misleading distraction because it is not an appropriate basis for policy-making, assessment of policy measures or detailed comparison of countries or products. There is an urgent need to better understand the issues of data quality and uncertainty and the impact they have on sound understanding of the indicators and issues.

A series of pilot exercises should be undertaken to quantify the proposed indicators for the years 2001 and 2010, to understand their workability, their added value, and how to ensure they successfully feed into a structured decision making process at EU level beyond what can be achieved at the level of Member States.

Some serious methodological issues remain to be resolved before the proposed indicators can be used to reliably measure the environmental impacts of resource use or to set legally binding resource efficiency targets. LCA and the Environmental Footprint are not sufficient on their own. Other LCM approaches are also required (e.g., for best management of water resources). Finalisation of sufficiently high quality data and robust indicators by the end of 2013 will be extremely difficult. The work should continue beyond 2013. The EU must never accept the view that an incorrect result under time pressure is better than no result at all.

Several geologists and resource economists have shown that "resource depletion" of mineral resources is not sufficiently likely to justify its systematic inclusion in LCIA or Environmental Footprints. The Resource Depletion impact category should only be included in LCIAs of products that are consumed (typically those derived from biotic resources). Alternatively, a uniform model should be developed that adequately reflects the full range of depletion potentials (from extremely low to high), so that efforts are not diverted away from more acute pressures on the environment.

It is essential that the adopted indicators of Resource Efficiency incentivise the optimal use of materials rather than the minimal use of materials. Simply limiting material inputs, without considering realised impacts in the use phase, is not only unjustified, it is also inefficient and wasteful. Current LCA practice is already a useful tool for continuous improvement within the mining sector, but it requires further development to contribute to regulatory policy at the level envisaged by the Resource Efficiency Roadmap. Other LCM tools and concepts are likely to be needed as well.

The European mining industry stands ready to support efforts to assemble appropriately quality-controlled input/output data and develop solutions to the methodological problems raised in this paper before the adoption of EU-level indicators of Resource Efficiency.

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