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翻译

曹婧 高鉴 高美勋 郭静 李霄 李智伟
蒲广颖 孙昊 汪瑞 辛文 余颢凡 张瑞瑞
朱文松

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Translated by

Jing Cao, Jian Gao, Meixun Gao, Jing Guo, Xiao Li, Zhiwei Li,
Guangying Pu, Hao Sun, Rui Wang, Wen Xin, Haofan Yu, Ruirui Zhang,
Wensong Zhu

《产业生态学报》

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循环经济投融资: 稳赢还是冒险?

作者: Paul Dewick, Magnus Bengtsson, Maurie J. Cohen, Joseph Sarkis, Patrick Schröder

关键字: 循环经济、环境与金融、产业生态学、社会责任投资、可持续性指标、可持续发展

摘要:

为了实现向循环经济的过渡, 私人和公共投资需要进行重大转变。政策制定者、金融业和其他利益相关方最近在循环经济领域的活动激增展现了为促进这一进程提供资源的承诺和进展。在这篇论坛文章中, 我们对这些进展进行了审慎的评估, 并在某些方面进行了批评和纠正。我们强调, 基于有争议的理解、模糊指标和不充分信息做出的战略决定, 将阻碍循环经济的进展。在主要行业参与者执行国际投资标准、启动创新的融资工具并增加投资之前, 我们呼吁进行更有效的监督, 以防止循环经济沦为另一个受到损害并最终无效的可持续性概念。

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Circular economy finance: Clear winner or risky proposition?

Paul Dewick, Magnus Bengtsson, Maurie J. Cohen, Joseph Sarkis, Patrick Schröder

Keywords: circular economy, environment and finance, industrial ecology, socially responsible investing (SRI), sustainability indicators, sustainable development

Summary:

A major shift in private and public investment is needed to forge a transition to a circular economy. A recent surge of activity from policy makers, the financial industry, and other stakeholders suggests commitment and progress toward providing resources to facilitate this process. In this forum article, we provide a measured, and in some respects critical and corrective, assessment of these developments. We highlight the risk that progress toward a circular economy will be curtailed by strategic decisions based on contestable understanding, fuzzy indicators, and inadequate information. Before major industry actors implement international investment standards, launch innovative financing vehicles, and ramp up investment, we call for more effective oversight to prevent the circular economy from becoming yet another compromised and ultimately ineffectual sustainability concept.

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LC-IMPACT: 一种区域化生命周期损害评估方法

作者: Francesca Verones, Stefanie Hellweg, Assumpció Antón, Ligia B. Azevedo, Abhishek Chaudhary, Nuno Cosme, Stefano Cucurachi, Laura de Baan, Yan Dong, Peter Fantke, Laura Golsteijn, Michael Hauschild, Reinout Heijungs, Olivier Joliet, Ronnie Juraske, Henrik Larsen, Alexis Laurent, Christopher L. Mutel, Manuele Margni, Montserrat Núñez, Mikolaj Owsianiak, Stephan Pfister, Tommie Ponsioen, Philipp Preiss, Ralph K. Rosenbaum, Pierre-Olivier Roy, Serenella Sala, Zoran Steinmann, Rosalie van Zelm, Rita Van Dingenen, Marisa Vieira, Mark A. J. Huijbregts

关键字: 伤残调整生命年, 全球灭绝风险, 产业生态学, 矿石提取, 可能消失的部分物种, 空间差异性

摘要:

生命周期影响评估 (LCIA) 是一个活跃的研究领域, 数据和模型在涵盖的影响路径、可靠性和空间细节方面不断改进。然而, 这些进步分散在科学文献中, 使得实践者很难应用新的模型。在这里, 我们提出了 LC-IMPACT 方法, 该方法为三个保护领域(人类健康、生态系统质量、自然资源)相关的 11 个影响类别提供了损害水平的表征因子。人类健康损害被量化为伤残调整生命年, 生态系统质量损害被量化为全球物种灭绝当量(基于物种的潜在消失部分), 矿产资源损害被量化为提取的额外矿石的千克数。七个影响类别包括空间尺度不同层面的空间差异。时间范围数值选择的影响和影响的科学证据水平, 通过四组不同的表征因子进行量化。我们以欧洲不同燃料(汽油或生物燃料)的生命周期评估为例, 证明了所提出方法的适用性。对于某些选定的影响类别, 一般影响和区域化影响之间的差异高达两个数量级, 这突出了 LCIA 空间详情的重要性。本文符合 <http://jie.click/badges> 中所述的 JIE 数据开放徽章的要求。本文符合 <http://jie.click/badges> 中所述的 JIE 数据开放徽章的要求。

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LC-IMPACT: A regionalized life cycle damage assessment method

Francesca Verones, Stefanie Hellweg, Assumpció Antón, Ligia B. Azevedo, Abhishek Chaudhary, Nuno Cosme, Stefano Cucurachi, Laura de Baan, Yan Dong, Peter Fantke, Laura Golsteijn, Michael Hauschild, Reinout Heijungs, Olivier Joliet, Ronnie Juraske, Henrik Larsen, Alexis Laurent, Christopher L. Mutel, Manuele Margni, Montserrat Núñez, Mikolaj Owsianiak, Stephan Pfister, Tommie Ponsioen, Philipp Preiss, Ralph K. Rosenbaum, Pierre-Olivier Roy, Serenella Sala, Zoran Steinmann, Rosalie van Zelm, Rita Van Dingenen, Marisa Vieira, Mark A. J. Huijbregts

Keywords: disability adjusted life years, global extinction risk, industrial ecology, kilogram ore extracted, potentially disappeared fraction of species, spatial differentiation

Summary:

Life cycle impact assessment (LCIA) is a lively field of research, and data and models are continuously improved in terms of impact pathways covered, reliability, and spatial detail. However, many of these advancements are scattered throughout the scientific literature, making it difficult for practitioners to apply the new models. Here, we present the LC-IMPACT method that provides characterization factors at the damage level for 11 impact categories related to three areas of protection (human health, ecosystem quality, natural resources). Human health damage is quantified as disability adjusted life years, damage to ecosystem quality as global species extinction equivalents (based on potentially disappeared fraction of species), and damage to mineral resources as kilogram of extra ore extracted. Seven of the impact categories include spatial differentiation at various levels of spatial scale. The influence of value choices related to the time horizon and the level of scientific evidence of the impacts considered is quantified with four distinct sets of characterization factors. We demonstrate the applicability of the proposed method with an illustrative life cycle assessment example of different fuel options in Europe (petrol or biofuel). Differences between generic and regionalized impacts vary up to two orders of magnitude for some of the selected impact categories, highlighting the importance of spatial detail in LCIA. This article met the requirements for a gold – gold JIE data openness badge described at <http://jie.click/badges>.

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资源核算中金属矿石账户汇编体系存在的问题与改进提议

作者: James West, Mirko Lieber, Stephan Lutter, Heinz Schandl

关键字: 共同生产, 经济系统物质流分析, 产业生态学, 物质流核算, 金属矿石, 矿石品位

摘要:

本文针对经济系统物质流核算(EW-MFA)中金属矿石的汇编过程提出重大修订。通过详细描述当前金属矿石报表系统的重要缺陷, 介绍新修订系统关键功能, 以及说明新系统解决旧缺陷和增加重要新功能的方式, 来论述新系统提议。在国家及较小规模的实际情况, 环境监测以及管理等所需的组织数据方面, 新增的功能尤其值得关注。本文主要使用说明性示例来阐述改进部分的组成元素。这项工作具有双重直接的动机。首先, 拟议的系统将提高现行汇编金属矿石账户的准确性和适用性。更重要的是, 修订后的系统作为资源和环境管理工具, 新增功能可使 EW-MFA 账户的汇编更加引起发展中国家的关注, 进一步促进材料账户汇编。修订系统除了能直接改善资源和环境管理外, 预计也可通过拓展 EW-MFA 的效用, 为各国 EW-MFA 的制度化及维护提供更强大的动力。

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Proposal for a new compilation system for metal ores in economy wide material flow accounting

James West, Mirko Lieber, Stephan Lutter, Heinz Schandl

Keywords: co-production, economy wide material flow analysis, industrial ecology, material flow accounting, metal ore, ore grade

Summary:

The authors of this article propose a major revision of the processes used for assembling the metal ores component of economy wide material flow accounts (EW-MFA). The case for doing this is built by describing in detail important shortcomings of current metal ores reporting systems, introducing the key features of the revised system being proposed, and then illustrating the way in which the new system both solves old shortcomings and adds important new capacities. The new capacities added are of particular interest with regard to organizing the data required for a range of practical resource and environmental monitoring and management tasks, at national and smaller scale. The various components of the case for change are explained largely using illustrative examples. The direct motivations behind this work are twofold. First, the proposed system will improve the accuracy and fitness for current uses of the metal ores accounts being assembled. Second, and more importantly, the additional capabilities of the revised system as a resource and environmental management tool will make the process of assembling EW-MFA accounts more clearly relevant to the concerns of developing countries, which are increasingly being prevailed upon to compile these accounts. In addition to the direct benefits of improved resources and environmental management that should be enabled by the revised system, it is expected that expanding the utility derived from the EW-MFA process will provide a stronger incentive for its institutionalization and maintenance by individual nations.

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<http://dx.doi.org/10.1111/jiec.13027>**评估新兴技术对环境影响的系统方法: CIGS 光伏板的温室气体足迹研究**

作者: Mitchell K. van der Hulst, Mark A. J. Huijbregts, Niels van Loon, Mirjam Theelen, Lucinda Kootstra, Joseph D. Bergesen, Mara Hauck

关键字: 环境经验曲线, 事前, 产业生态学, 生命周期评估, 前景, 技术创新

摘要:

估计新兴技术在不同发展阶段的环境影响虽然尚有不不确定性, 但对于指导投资、研究和开发是必要的。我们在本文中提出了一个系统的程序来评估新兴技术的未来影响。在技术开发阶段 (技术完备水平 < 9), 建议考虑的经验机制是 (a) 工艺变化, (b) 规模扩展效应, 以及 (c) 工艺协同效应。这些开发可基于以往类似技术的经验, 也可通过回归或工程尺寸计算进行量化。产业开发阶段则应包括 (d) 基于经验曲线或路线图的经验学习和 (e) 外部发展。外部发展, 如电力结构的变化, 可以将其纳入综合评估模型中。本文通过对铜铟镓硒 (CIGS) 光伏板的生产进行温室气体 (GHG) 足迹评估, 展示了上述方法的适用性。我们发现, 从试验性生产到成熟的产业化规模生产, 每千瓦峰值的 CIGS 层压板的温室气体足迹预计将减少 83%, 其中最大的缩减来自于工艺变化。如果具备成熟的数据库——包含各种材料、产品和技术的规模扩展和经验率信息, 这套方法在实践中应用的可行性将显著提高。

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<http://dx.doi.org/10.1111/jiec.13027>**A systematic approach to assess the environmental impact of emerging technologies: A case study for the GHG footprint of CIGS solar photovoltaic laminate**

Mitchell K. van der Hulst, Mark A. J. Huijbregts, Niels van Loon, Mirjam Theelen, Lucinda Kootstra, Joseph D. Bergesen, Mara Hauck

Keywords: environmental experience curve, ex ante, industrial ecology, life cycle assessment (LCA), prospective, technological innovation

Summary:

Estimating the environmental impact of emerging technologies at different stages of development is uncertain but necessary to guide investment, research, and development. Here, we propose a systematic procedure to assess the future impacts of emerging technologies. In the technology development stage (technology readiness level < 9), the recommended experience mechanisms to take into account are (a) process changes, (b) size scaling effects, and (c) process synergies. These developments can be based on previous experience with similar technologies or quantified through regression or engineering dimension calculations. In the industrial development phase, (d) industrial learning, based on experience curves or roadmaps, and (e) external developments should be included. External developments, such as changes in the electricity mix can be included with information from integrated assessment models. We show the applicability of our approach with the greenhouse gas (GHG) footprint evaluation for the production of copper indium gallium (di)selenide (CIGS) photovoltaic laminate. We found that the GHG footprint per kilowatt peak of produced CIGS laminate is expected to decrease by 83% going from pilot to mature industrial scale production with the largest decrease being due to expected process changes. The feasibility of applying our approach in practice would greatly benefit from the development of a database containing information on size scaling and experience rates for a wide variety of materials, products, and technologies.

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循环价值创造体系: 制造、结盟、购买或放任

作者: Erik G. Hansen, Ferdinand Revellio

关键字: 商业模式创新、循环经济、消费电子产品、企业可持续发展、伙伴关系、产品设计

摘要:

减缓和闭合循环经济 (CE) 中的产品和相关材料循环需要回收和维修等服务。然而, 循环服务是否应由原始设备制造商、零售商或第三方运营商 (如翻新商) 提供仍未有定论。本篇文献综述植根于经典的制造和购买的概念, 提出了四种通用的协调机制和相关的价值模式: 垂直整合、网络、外包或放任。对于每一种模式, 本文在智能手机领域进行了嵌入式案例研究, 目的是更好地了解核心参与者如何与价值链中的其他参与者协调, 以提供可持续的循环服务。基于上述协调机制, 我们的核心贡献是建立了四类不同的循环价值创造模式 (CVCA) 及其关于循环协调、循环配置和目标水平的详细说明。我们发现, 由于所涉及资产的专用性及其更大的战略相关性, 采用减缓策略 (即维修、再利用和再制造) 的公司比采用闭环策略 (即回收) 的公司追求更高程度的产业链垂直整合。本研究还表明, 更高程度的垂直整合能够实现更高程度的循环闭环 (即从开环到闭环) 和更好的产品设计。此外, 我们通过区分独立循环和自动循环来界定不同的第三方参与者。总体而言, 我们通过阐明循环的参与者、他们的相互关系以及他们如何形成循环价值模式扩展了产品循环中的参与者视角。

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Circular value creation architectures: Make, ally, buy, or laissez-faire

Erik G. Hansen, Ferdinand Revellio

Keywords: business model innovation, circular economy, consumer electronics, corporate sustainability, partnerships, product design

Summary:

Slowing and closing product and related material loops in a circular economy (CE) requires circular service operations such as take-back, repair, and recycling. However, it remains open whether these are coordinated by OEMs, retailers, or third-party loop operators (e.g., refurbishers). Literature rooted in the classic make-or-buy concept proposes four generic coordination mechanisms and related value creation architectures: vertical integration, network, outsourcing, or doing nothing (laissez-faire). For each of these existing architectures, we conducted an embedded case study in the domain of smartphones with the aim to better understand how central coordinators align with actors in the value chain to offer voluntary circular service operations. Based on the above coordination mechanisms, our central contribution is the development of a typology of circular value creation architectures (CVCAs) and its elaboration regarding circular coordination, loop configuration, and ambition levels. We find that firms following slowing strategies (i.e., repair, reuse, and remanufacturing) pursue higher degrees of vertical integration than those following closing strategies (i.e., recycling) because of the specificity of the assets involved and their greater strategic relevance. The typology also shows that higher degrees of vertical integration enable higher degrees of loop closure (i.e., from open to closed loops) and better feedbacks into product design. Furthermore, we differentiate the understanding on third-party actors by distinguishing between independent and autonomous loop operators. Overall, we strengthen the actor perspective in product circularity literature by clarifying the actor set, their interrelationships, and how they form value creation architectures.

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通过供应商—分包商网络的劳动标准扩散：基于主体的建模

作者: Stefan Gold, Thomas Chesney, Tim Gruchmann, Alexander Trautrim

关键字: 基于主体建模 (ABM), 网络不对称、标准扩散、分包、供应网络、可持续供应链管理

摘要:

分包是跨行业供应链中一种流行的商业模式。在隐藏分包的情况下, 分包商超出了 (重点) 采购公司的可见范围。因此购买者必须依赖于连锁效应, 例如通过其供应网络扩散遵守劳工标准等做法。我们以孟加拉服装业为例, 构建了一个以采购商、一级供应商和分包商为供应网络主体的模型, 以研究网络特征对劳工标准扩散的影响。我们的模型遵循基于权力的扩散规则, 强调买方使用强制力迫使供应商采用劳工标准。该规则是基于合规性的供应商管理的一个关键基本假设。通过特定网络组件的中心性和密度以及网络的结构元素 (例如复杂性和距离), 针对不同的行业情景检验关于权力不对称的假设。我们的分析表明, 网络不对称性对劳工标准的采用有很大负面影响, 而复杂性的影响较小。此外, 研究发现, 可持续性扩散的结构决定因素的影响取决于服装行业的特定行业类型。本文结合前人关于分包和多层供应链管理的研究对该研究结果进行了讨论。其中, 我们强调了分包如何增加每个供应链层级的横向复杂性, 以及中间商如可持续性关系供应商可能对行业内劳工标准的采用产生重大影响。

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Diffusion of labor standards through supplier-subcontractor networks: An agent-based model

Stefan Gold, Thomas Chesney, Tim Gruchmann, Alexander Trautrim

Keywords: agent-based modeling, network asymmetries, standard diffusion, subcontracting, supply net-works, sustainable supply chain management

Summary:

Subcontracting represents a popular business model in supply chains across industries. In the case of hidden subcontracting, subcontractors are beyond the visible horizon of the (focal) buying firm. Hence, buyers must rely on a cascading effect for diffusing practices such as compliance with labor standards through their supply networks. Motivated by the case of the Bangladeshi garment industry, we constructed an agent-based model with buyers, first-tier suppliers, and subcontractors as agents in a supply network in order to study the impact of network characteristics on the diffusion of labor standards. Our model followed a power-based diffusion rule that emphasized the coercive power that buyers use to pressure their suppliers into adopting labor standards. This rule is a key underlying assumption of compliance-based supplier management. Hypotheses regarding power asymmetries through centrality and density of specific network components, as well as structural elements of the network, such as complexity and distance, were tested for different industry scenarios. Our analysis demonstrated that network asymmetries have ample negative effects on the adoption of labor standards, whereas complexity plays a minor role. Moreover, the impact of the tested structural determinants for sustainability diffusion was found to be contingent on specific industry types in the garment industry. This paper discusses its findings in light of previous research on subcontracting and multitier supply chain management. Among others, we highlight how subcontracting increases horizontal complexity at each supply chain tier, and how intermediaries such as sustainability nexus suppliers may crucially affect the adoption of labor standards within industries.

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外国跨国公司在欧盟的碳足迹

作者: Mateo Ortiz, María-Ángeles Cadarso, Luis-Antonio López

关键字: 碳足迹, 欧盟, 公司异质性, 外资企业, 产业生态学, 跨国企业

摘要:

虽然欧洲国家为减少其领土碳排放量做出了巨大努力, 但全球排放量仍在增加。在欧洲经营的跨国企业作为跨国机构, 可以在将欧洲的努力转化为全球减排方面做出重大贡献。在此, 我们估计了 2015 年在欧盟 (EU) 内运营的外国跨国企业关联公司 (FMNEs) 的碳足迹, 作为对跨国企业关于欧洲和全球碳减排目标的潜力的首次评估。我们的研究结果表明, FMNEs 产生的碳足迹占欧盟总碳足迹的 17%, 但仅占总增加值的 12%。因此, FMNE 的净影响被认为是环境赤字, 因为它们对环境的不利影响相对高于其积极的经济影响。计算的前提是, FMNEs 使用与国内同行相同的技术进行生产; 因此, 发现的碳/经济不平衡归因于 FMNEs 在各行业的分布。在低收入的欧盟成员中, FMNEs 在碳密集型工业部门的参与度非常高; 因此, 这些国家碳足迹的有效减少在很大程度上受制于外国多国企业总部的决定。此外, 在征收欧洲碳税的情况下, 这些国家更容易发生资本流失。最后, 我们讨论了欧盟内部多国企业环境影响在国家一级的不平等对经济和政策的影响。

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The carbon footprint of foreign multinationals within the European Union

Mateo Ortiz, María-Ángeles Cadarso, Luis-Antonio López

Keywords: carbon footprint, European Union, firm heterogeneity, foreign affiliates, industrial ecology, multinational enterprises

Summary:

Although European countries have made great efforts to reduce their territorial carbon emissions, global emissions are still growing. Multinational enterprises (MNEs) operating within Europe, as transnational institutions, can make significant contributions in translating European efforts into global emissions reduction. Here, we estimate the carbon footprint of the foreign multinationals' affiliates (FMNEs) operating within the European Union (EU) in 2015 as a first assessment of the MNEs' potential regarding European and global carbon emissions reduction targets. Our findings show that FMNEs generate 17% of the total carbon footprint of the EU but only 12% of the total value added. Thus, the net impacts of FMNE are considered to be in environmental deficit because their adverse environmental impacts are relatively higher than their positive economic ones. Calculations are made under the assumption that FMNEs produce using the same technology as their domestic peers; therefore, the carbon/economic imbalance found is attributed to the FMNEs' distribution across sectors. The participation of FMNEs in carbon-intensive industrial sectors are remarkably high in low-income EU members; therefore, the effective reduction of the carbon footprint in those countries is largely conditioned by the decisions of foreign MNEs' headquarters. Furthermore, those countries are more vulnerable to capital leakages in the case where a European carbon tax was to be imposed. We conclude by discussing the economic and policy implications of the country-level inequality of MNEs' environmental impacts within the EU.

《产业生态学报》

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<http://dx.doi.org/10.1111/jiec.13019>**木灰的有益用途对环境真的有益吗? 筛选级生命周期评价和不确定性分析**作者: [Caroline Gaudreault](#), [Ilich Lama](#), [Derek Sain](#)**关键字:** 有益用途、森林产品、产业生态学、生命周期评价 (LCA)、不确定性分析、木灰**摘要:**

本文采用筛选级生命周期评价 (LCA) 方法, 比较了不同木灰的管理方案 (农用地应用、林地土壤改良、林地道路使用、混凝土和砂浆使用以及填埋) 的潜在环境效益和利弊。文章通过不确定性分析了所获结果的可推广性。虽然关于选择有益使用选项的决定因人而异, 取决于当地现有的市场和木灰特性, 但研究表明, 从 LCA 的应用中可以得出一些一般性的结论。所有有益用途 (BU) 选项也都显示出比与垃圾填埋相关的选项更低的环境影响指标得分和更高的潜在的净环境效益。从环境角度来看, 结果表明, 仅在少数情况下, 有益使用木灰才可能不会产生潜在的净环境效益, 但仍优于填埋; 只在极少数情况下, 填埋比 BU 选项更可取。例如, 如果木灰需要长距离运输才能得到有益的利用, 那么净环境效益可能会受到损害。在评估的四个有益用途选项中, 在混凝土中使用木灰来替代硅酸盐水泥显示出最大的潜在环境效益。然而, 如果假设木灰还田替代石灰和肥料施用的潜力都能发挥, 则在农地或林地中使用木灰比在混凝土中使用显示出更大的环境效益。

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<http://dx.doi.org/10.1111/jiec.13019>**Is the beneficial use of wood ash environmentally beneficial? A screening-level life cycle assessment and uncertainty analysis**[Caroline Gaudreault](#), [Ilich Lama](#), [Derek Sain](#)**Keywords:** beneficial use, forest products, industrial ecology, life cycle assessment (LCA), uncertainty analysis, wood ash**Summary:**

In this paper, a screening-level life cycle assessment (LCA) approach is used to compare the potential environmental benefits and tradeoffs of different management options for wood ash, namely, agricultural land application, forest soil amendment, use in forest roads, use in concrete and mortar, and landfilling. Uncertainty analyses are used to evaluate the generalizability of the results obtained. Although decisions regarding the selection of a beneficial use option are site-specific and depend on available local markets and wood ash characteristics, this study shows that it is possible to draw a few general conclusions from the application of LCA. All beneficial use (BU) options showed lower environmental indicator scores than those associated with landfilling, in addition to net potential environmental benefits. From an environmental perspective, results suggest that, only in a few situations, beneficially using wood ash might not produce potential net environmental benefits but would still be preferred over landfilling, and in a very few cases, landfilling would be preferred over a BU option. For instance, net environmental benefits may be compromised if wood ash needs to be transported over long distances before it can be beneficially used. Out of the four BU options evaluated, the use of wood ash in concrete to replace Portland cement showed the greatest potential environmental benefits. However, the application of wood ash on agricultural or forest land showed greater environmental benefits than the use in concrete in cases where both its liming and fertilizing potentials are assumed to be achieved at the same time.

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针对锂离子电池回收过程的特定“电池-化学”生命周期评估

作者: Marit Mohr, Jens F. Peters, Manuel Baumann, Marcel Weil

关键字: 电池回收, 环境影响, 产业生态学, 生命周期评估, 文献综述, 锂离子电池**摘要:**

在回顾现有关于锂离子电池回收的生命周期评估研究的基础上, 我们将最先进的火法冶金回收过程和湿法冶金回收过程模型参数化, 使其能够应用于不同化学性质的电池之中, 包括钠离子电池等超锂离子电池。这些过程被用作评价先进湿法冶金回收过程的基准。该基准利用回收公司所提供的一手数据进行建模, 可以量化循环利用不同化学性质的电池所实现的环境影响潜在削减量。根据电池的化学性质, 回收能够显著地降低电池生产对于环境造成的潜在影响。通过对锂镍锰钴氧化物型电池和锂镍钴铝氧化物型电池采用先进的湿法冶金工艺, 我们能够获取最大效益, 这主要是因为我们实现了钴和镍的回收。特别是在资源消耗方面, 回收这些电池能够使其对于环境的净影响程度变得更低, 这一程度甚至比回收那些使用丰富廉价材料所制成的电池(如磷酸铁锂电池)所产生的“净影响”的程度更低, 其在不考虑回收的情况下表现出更好的性能。但对于这些电池而言, 回收利用不一定会带来好处, 反而会造成额外的环境影响。这表明, 在环境方面, 最大限度的回收材料可能并不总是有利的。特别是对最终的湿法冶金处理而言, 如果想要实现环境效益最大化, 回收过程需要适应特定的电池化学性质。

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Toward a cell-chemistry specific life cycle assessment of lithium-ion battery recycling processes

Marit Mohr, Jens F. Peters, Manuel Baumann, Marcel Weil

Keywords: battery recycling, environmental impact, industrial ecology, life cycle assessment (LCA), literaturereview, lithium-ion batteries (LIB)**Summary:**

On the basis of a review of existing life cycle assessment studies on lithium-ion battery recycling, we parametrize process models of state-of-the-art pyrometallurgical and hydrometallurgical recycling, enabling their application to different cell chemistries, including beyond-lithium batteries such as sodium-ion batteries. These processes are used as benchmark for evaluating an advanced hydrometallurgical recycling process, which is modeled on the basis of primary data obtained from a recycling company, quantifying the potential reduction of environmental impacts that can be achieved by the recycling of different cell chemistries. Depending on the cell chemistry, recycling can reduce significantly the potential environmental impacts of battery production. The highest benefit is obtained via advanced hydrometallurgical treatment for lithium nickel manganese cobalt oxide and lithium nickel cobalt aluminum oxide-type batteries, mainly because of the recovery of cobalt and nickel. Especially under resource depletion aspects, recycling of these cells can reduce their impact to an extent that even leads to a lower “net impact” than that of cells made from majorly abundant and cheap materials like lithium iron phosphate, which shows a more favorable performance when recycling is disregarded. For these cells, recycling does not necessarily provide benefits but can rather cause additional environmental impacts. This indicates that maximum material recovery might not always be favorable under environmental aspects and that, especially for the final hydrometallurgical treatment, the process would need to be adapted to the specific cell chemistry, if one wants to obtain maximum environmental benefit.

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经济部门对水资源匮乏的直接和间接脆弱性——印度经济中的热点分析

作者: Shelly Bogra, Bhavik R. Bakshi

关键字: 环境投入产出分析, 产业生态学, 衡量标准, 供应链管理, 结构路径分析, 可持续性评估。

摘要:

资源匮乏能够影响经济活动。虽然直接用户的依赖性很容易被意识到, 但经济系统下游部门的间接脆弱性却不容易被理解。在整个印度日益缺水背景下, 本研究将印度经济的主要部门的依赖性与印度的取水模式进行对比 (Bogra, Bakshi, & Mathur, 2016)。从供应者的角度看, 结果表明, 最大的直接取水食品部门, 即水稻、小麦和甘蔗 (PWS) 主要被消耗性食品部门间接消耗。然而, 从用户的角度来看, 甚至非食品部门也表现出对 PWS 蕴含的水的巨大依赖性。此外, 水稻和小麦的基于蓝水的结构路径分析 (SPA) 表明对陆路运输、建筑和饮料等的贡献很大, 而陆路运输在绿水方面也很重要。外度量表明经济对电力 (蓝水) 和林业 (绿水) 部门的依赖程度较高。具体来说, 基础设施部门表现出对电力的严重依赖; 而林业产品则对非食品部门有贡献。各州的缺水指数 (WSIs) 表明, 电力对西北和中部各邦稀缺的地表水流的依赖程度较高, 而印度北部和东北部的森林地区的地面 WSIs 最低。通过将区域水流量与部门依赖性相结合, 可以看出, 与食品部门、公共事业部门相比, 电力部门取水的经济产出减少的风险更大。

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Direct and indirect vulnerability of economic sectors to water scarcity: A hotspot analysis of the Indian economy

Shelly Bogra, Bhavik R. Bakshi

Keywords: environmental input-output analysis, industrial ecology, metrics, supply-chain management, structural path analysis, sustainability assessment

Summary:

Resource scarcity is capable of affecting economic activity. Though the dependence of direct users is easily acknowledged, indirect vulnerability imposed on downstream sectors of the economic system is not as easily understood. In the context of growing water scarcity across India, this study maps the dependence of prominent sectors of the Indian economy to the water-withdrawal model of India (Bogra, Bakshi, & Mathur, 2016). From the suppliers' perspective, the results indicate that embodied water of the largest direct water-withdrawing food sectors namely, Paddy, Wheat, and Sugarcane (PWS) is indirectly consumed mostly by the consumptive food sectors. However, from the users' perspective, even non-food sectors exhibit a significant dependence on the embodied water of PWS. Further, blue-water-based structural path analysis (SPA) of Paddy and Wheat indicate significant contributions to Land transport, Construction, and Beverages, among others, whereas Land transport is important in terms of green water too. The out-degree measure indicates a higher dependence of the economy on Electricity (blue water) and Forestry (green water) sectors. Specifically, infrastructural sectors exhibit a significant dependence on Electricity; whereas Forestry products contribute to non-food sectors. State-wise water-scarcity indices (WSIs) indicate higher dependence of Electricity on scarce surface-water flows of north-western and central states, whereas forested areas in the north and north-eastern parts of India exhibit lowest ground WSIs. By integrating regional flows with sectoral dependencies, it is observed that the risk to a reduction of the economy's throughput is higher from water withdrawn by Electricity compared to food sectors, PWS.

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基于产业共生模式的污水处理系统优化: 以中国生态工业园为例

作者: Wanqiu Hu, Jinping Tian, Xing Li, Lujun Chen

关键字: 集中式污水处理厂, 成本节约潜力, 食品工业, 温室气体减排, 工业园区, 产业共生

摘要:

集中式污水处理厂作为中国工业园中的一个重要基础设施, 能够将企业内部预处理过的工业废水进一步净化。由于企业内部的废水预处理环节能够除去大多数的有机污染物, 这样保证了集中式废水处理厂的安全与高效运行。集中式废水处理厂的反硝化过程通常存在碳源不足问题。解决方法是往废水中加入额外的碳源, 例如葡萄糖。在工业园区中, 某些工业废水中存在一些可生物降解的有机物, 例如食品生产废水。这类废水可以在反硝化时作为额外的碳源被利用。因此, 本研究基于此原理提出了一种产业共生模式。该模式通过先进的处理工艺, 将食品废水中的有机物作为集中式污水处理厂的碳源, 来优化工业园区中的污水处理环节。文章以中国的一个生态工业园为案例来验证这一模式的技术和经济可行性。研究案例表明, 该模式能节约成本 655 万元人民币/年, 约占废水处理厂年度运营成本的 20%。此外, 温室气体 (GHG) 减排量为 5977 t CO₂ 当量/年, 占基准情景排放量的 1.7%。此外, 本文还讨论了实施该产业共生模式及相关政策过程中面临的挑战。

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<http://dx.doi.org/10.1111/jiec.13020>**Wastewater treatment system optimization with an industrial symbiosis model: A case study of a Chinese eco-industrial park**

Wanqiu Hu, Jinping Tian, Xing Li, Lujun Chen

Keywords: centralized wastewater treatment plant, cost-savings potential, food industry, greenhouse gas emissions mitigation, industrial park, industrial symbiosis

Summary:

In Chinese industrial parks, the centralized wastewater treatment plant (CWWTP) is an essential shared infrastructure to further purify the in-plant pretreated industrial wastewater. Most of the contaminants, such as organic matter, are removed by in-plant wastewater treatment to guarantee the safety and efficiency of the CWWTP. Carbon source shortages are common in the denitrification process in CWWTPs, and such issues are generally solved by adding external carbon sources, such as glucose. Some biodegradable organics that are abundant in industrial wastewater, such as food production wastewater, can be utilized as the external carbon sources for denitrification. This study proposed an industrial symbiosis-based model to optimize the wastewater treatment system in industrial parks by reusing organic matter in food wastewaters as the external carbon source for advanced treatment processes in CWWTPs. A case study of a Chinese eco-industrial park is investigated to verify the technical and economic feasibility of the model. The case study indicates that the overall cost-savings potential of the model is approximately 6.55 million Chinese Yuan (CNY) per year, accounting for approximately 20% of the annual operating cost of the CWWTP. Additionally, the mitigation potential of greenhouse gas (GHG) emissions is 5977 t CO₂-eq per year, accounting for 1.7% of the GHG emissions of the original model. Furthermore, potential barriers to implementing the IS model and the relevant policy implications are discussed.

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<http://dx.doi.org/10.1111/jieec.13040>**转变煤-钢关联, 服务生态文明: 铁路与能源基础设施相互作用探析**

作者: Qian Zhang, Christopher Kennedy, Tao Wang, Wendong Wei, Jiashuo Li, Lei Shi

关键字: 深度脱碳, 产业生态学, 物质流分析, 铁路, 资源耦合, 可持续性

摘要:

中国 2050 高比例可再生能源发展 (HREP) 情景是深度脱碳的一个可行路径。风能和太阳能的战略部署将重塑其他基础设施领域。深度脱碳情境下, 不仅资本可以从化石燃料基础设施转移到绿色发电, 而且由于不再需要运输化石燃料, 未来的交通基础设施领域也可以节省大量能源和资本。在此, 我们主要以交通运输为中心环节进行物质流分析, 以研究 1985 年、2015 年和 2050 年中国基础设施领域中煤炭和钢铁流之间的关联关系。我们将煤炭和钢铁之间的关联关系定义成一个系统, 用以把握这两种资源之间的相互依赖性和关键联结。结果表明, 过去三十年来中国的煤炭和钢铁关联有所增强, 但到 2050 年可能会面临过渡性变化。预计中国的煤炭和钢铁需求达峰均将在 2030 年之前。尽管铁路网规模远期规划倍增, 但在 HREP 情景下, 三种大宗商品 (煤炭, 铁矿石和钢铁产品) 的铁路货运量预计将从 2015 年的约 2000 兆吨 (Mt) 下降到 2050 年的约 700 兆吨。然而, 对清洁能源和低碳炼钢技术的投资将帮助中国在 2050 年主要依靠二次钢铁资源维持国内需求, 从而进一步减少对煤炭和铁矿石的需求。

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<http://dx.doi.org/10.1111/jieec.13040>**Transforming the coal and steel nexus for China's eco-civilization: Interplay between rail and energy infrastructure**

Qian Zhang, Christopher Kennedy, Tao Wang, Wendong Wei, Jiashuo Li, Lei Shi

Keywords: deep decarbonization, industrial ecology, material flow analysis, railway, resource nexus, sustainability

Summary:

China's 2050 high renewable energy penetration (HREP) scenario is a roadmap for deep decarbonization. This promising strategy, deploying wind and solar energy, will also reshape other infrastructure sectors. With decarbonization, not only can capital be diverted away from fossil fuel infrastructure toward green power generation, but considerable savings in future transport infrastructure sectors could be achieved because fossil fuels no longer need to be transported. Here, we conduct a material flow analysis with a focus on the central role of transportation to examine the interlinkages of coal and steel flows in China's infrastructure sectors between 1985, 2015, and 2050. We define the coal and steel nexus to be a system perspective that captures the interdependence and the critical linkages between these two resources. Our results show that the coal and steel nexus in China strengthened in the past three decades but could face transitional changes to 2050. The peak time of both coal and steel demand for China is expected to come before 2030. Consequentially, the volume of rail freight for the carriage of three main types of bulk cargo (coal, iron ores, and steel products) declines from ~2,000 megatons (Mt) in 2015 to ~700 Mt in 2050 under the HREP scenario with the two-fold planned growth of railway infrastructure. However, investment in cleaner energy and steelmaking technologies will help China mainly rely on secondary steel resources to maintain domestic demand in 2050, further reducing the demand for coal and iron ores.

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维也纳交通部门物质存量的发展

作者: [Andreas Gassner](#), [Jakob Lederer](#), [Johann Fellner](#)**关键字:** 建筑环境, 建筑垃圾, 产业生态学, 物质流分析, 交通, 城市代谢**摘要:**

降低初级原材料消耗, 加强废物回收利用, 减少废物处置是社会的目标。在这方面循环经济的概念得到了重视, 并被应用于政策文件中和城市级别。但是, 为了评估既定目标及其实现情况, 需要对人为材料流动和存量有充分的了解。虽然运输系统的材料周转对总体材料周转有重大影响, 而且在利用回收建筑材料方面有很大潜力, 但尚未对运输系统的材料周转进行充分研究。为了弥补这一空白, 本研究调查了与城市交通系统有关的人为物质存量和流动, 其中包括基础设施和车辆。研究采用自下而上的多年物质流分析方法, 计算了 1990–2015 年期间维也纳运输系统的物质存量和有关的投入产出流动。研究结果表明更为环境友好型的交通模式越来越重要。自 1990 年以来, 机动化个人交通工具的绝对存量有所增加, 但人均存量保持不变在 34 吨/人, 公共交通工具的人均存量 (20 吨/人; + 8%) 和非机动化个人交通工具的人均存量 (4 吨/人; + 10%) 有所增加。然而, 材料消耗的主要 (> 65%) 来源于基础设施的维护。由于输出和输入在质量和材料方面是相等的, 这提供了更加循环的潜力。本研究为制定可持续资源节约型城市交通系统的政策和管理方案提供了系统的分析。

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Material stock development of the transport sector in the city of Vienna

[Andreas Gassner](#), [Jakob Lederer](#), [Johann Fellner](#)**Keywords:** built environment, construction and demolition waste, industrial ecology, material flow analysis(MFA), transportation, urban metabolism**Summary:**

Societies aim to reduce primary raw material consumption, enhance waste recycling, and reduce waste disposal. In this regard, the circular-economy concept has gained attention and is applied in policy papers, also on the urban level. However, to assess set targets and their achievement, a sound knowledge of anthropogenic material flows and stocks is required. The material turnover of transport systems has not been sufficiently investigated yet, although they have a significant impact on overall material turnover and have a high potential for making use of recycled construction materials. To close this gap, the present study investigates the anthropogenic stocks and flows related to an urban transport system, whereby both infrastructure and vehicles are included. A bottom-up, multiyear material-flow analysis was employed to calculate the material stock and the related input and output flows of Vienna's transport system for the period 1990–2015. The results indicate the increasing importance of more environmentally friendly modes of transport. The stock of motorized individual transport has increased in absolute terms since 1990, but the stock per capita remains unchanged at 34 t/cap, whereas the per capita stock of public transport (20 t/cap; +8%) and of non-motorized individual transport (4 t/cap; +10%) has increased. However, the primary source of material consumption (>65%) is maintenance of infrastructure. This provides a potential for more circularity because outputs and inputs are equal in terms of mass and material. The study provides a systematic analysis for developing policy and management options for sustainable resource-saving urban transport systems.

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摩洛哥创新微型光热-生物质能热电厂的可持续性评估

作者: Israel Herrera, Irene Rodríguez-Serrano, Daniel Garrain, Yolanda Lechón, Armando Oliveira

关键字: 热电联产, 产业生态学, 生命周期评估 (LCA), 微型发电, 多区域投入产出分析 (MR-IOA), 太阳能生物质

摘要:

中东和北非地区可以通过微型发电系统开发新的可再生能源技术, 以可持续的方式满足当地能源需求。在本研究中, 我们结合两种可信方法对位于摩洛哥的一个太阳能-生物质微热电联产有机朗肯循环系统进行评估。我们首先采用多区域投入产出分析, 对项目各阶段商品和服务的生产、创造的附加值和就业等经济问题进行了估算。然后, 采用生命周期评价法 (LCA) 对环境影响进行评价。在社会经济分析方面, 商品和服务的生产总值为 1.18 欧元/千瓦时 (以 2015 年价格水平计价, 下同)。增加值和就业创造分别为 0.56 欧元/kWh 和 0.05 名全职员工/MWh。平准化发电成本为 0.218 欧元/kWh, 乘数效应为 2.26。摩洛哥电力部门的产出增幅最大, 农业部门通过生物质供应创造的就业机会最多。关于环境结果, LCA 显示气候变化潜值为 11.8 g CO₂ eq/ kWh, 其中超过 70% 来自锅炉运行, 特别是来自生物质运输的排放。这些研究结果确定了微型太阳-生物质能系统的社会经济和环境效益足以抵消其相较于化石能源技术的较高成本, 有助于在摩洛哥对其进行推广。

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Sustainability assessment of a novel micro solar thermal: Biomass heat and power plant in Morocco

Israel Herrera, Irene Rodríguez-Serrano, Daniel Garrain, Yolanda Lechón, Armando Oliveira

Keywords: cogeneration, industrial ecology, life cycle assessment (LCA), microgeneration, multiregional input-output analysis (MR-IOA), solar biomass

Summary:

Novel renewable energy technologies in the Middle East and North Africa region can be developed through microgeneration systems aiming to supply local energy demands in a sustainable way. In this study, we carried out a sustainability assessment combining two reputable methodologies which have been applied to a facility comprising a hybrid solar/biomass micro-cogeneration organic ranking cycle system located in Morocco. We first applied a multiregional input-output analysis where economic issues such as the production of goods and services generated in all project's phases, as well as the added value and employment created, are estimated. Then, environmental impacts were assessed through a life cycle assessment (LCA). In terms of socioeconomic analysis, the total production of goods and services shows a value of 1.18 €2015/kWh. The added value and employment creation were 0.56 €2015/kWh and 0.05 full-time employees/MWh, respectively. The levelized cost of electricity results in 0.218 €2015/kWh and the multiplier effect amounts to 2.26. The largest increase in sectorial output is produced in the Moroccan electricity sector and the largest job creation takes place in the agriculture sector from the biomass supply. Regarding environmental results, LCA shows a climate change potential of 11.8 g CO₂ eq/kWh, of which more than 70% comes from the boiler operation and specifically from the emissions due to biomass transportation. These results can help in promoting micro solar-biomass systems in Morocco as they identify the socioeconomic and environmental benefits that can counterbalance the higher costs of such systems compared to fossil technologies.