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翻译

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《产业生态学报》

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用法用量? 产业生态学及相关领域的循证决策

作者: Junming Zhu

关键字: 产业生态学、生命周期评估 (LCA)、政策评估、政策过程、社会学习

摘要:

对不同尺度与形式的生产、消费活动的物质存量、流量以及相关影响, 产业生态学有一系列成熟、专业的核算研究。但是, 与许多其它科学和社会科学研究领域一样, 如何将产业生态学的研究发现应用于支撑政策和商业决策却并不明确且不尽人意。这一问题对产业生态学在可持续发展中的应用是一个挑战。通过对几支文献的回顾, 本文探究了产生并使用研究发现去支撑决策和社会变革的不同路径。文章认为, 产业生态学的核心方法和新兴方法在提升研究证据的透明度和可靠性方面是相辅相成的; 将当前研究发现拓展, 以对应不同的政策制定和组织决策过程, 可以提升研究证据的信息内涵; 学习的视角可以丰富研究证据的价值, 以更灵活的方式被运用。为了更好地支撑决策以推动社会进步, 需要在不同方法文化的研究人员之间以及研究人员与其他利益相关者之间进行更多的对话。同时也需要一个社会系统的范式转变, 在其中产业生态学者应该更加自觉和主动。

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Suggested use? On evidence-based decision-making in industrial ecology and beyond

Junming Zhu

Keywords: industrial ecology, life cycle assessment (LCA), policy evaluation, policy process, social learning

Summary:

Industrial ecology (IE) research has well established expertise in accounting for the material stocks, flows, and associated impacts of industrial and consumer activities in a variety of scales and manifestations. As with many other science and social science fields, however, the pathways from IE research findings to policy and business decision-making are often unclear and unsatisfactory. This issue creates a challenge for the application of industrial ecology to sustainable development. By reviewing several strands of literature, this article investigates alternative ways to generate and use research findings to support decision-making and social change. It argues that advances in both the core and the emerging methods in IE complement each other to improve transparency and reliability of research evidence; extension and contextualization of current findings corresponding to different stages in policy-making and organizational decision processes make research evidence more informative; a learning perspective makes research evidence valuable and used in more flexible ways. To better assist decision-making for societal change, more dialogues between researchers of different methodological cultures and between researchers and other stakeholders and a paradigm shift in social systems for which industrial ecologists should be conscious and proactive are required.

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中国城市取水量: 核算方法与应用

作者: Zongyong Zhang, Junguo Liu, Bofeng Cai, Yuli Shan, Heran Zheng, Xian Li, Xukun Li, Dabo Guan

关键字: 核算, 中国, 城市, 产业生态学, 清单, 取水

摘要:

在淡水危机的背景下, 核算取水量可以帮助规划人员更好地管理不同部门的用水, 以应对水资源短缺。然而, 中国取水量的统计数据并不完整, 城市层面各部门的用水数据也相对短缺。因此, 我们建立了一个总体框架, 首次估算了中国城市一级的 58 个经济、社会、环境部门的取水量。之所以采用这种方法, 是因为只有城市一级不同数据源收集的不同的水资源统计数据可用。我们将该方法应用于中国 18 个有代表性的城市。与认为农业用水最多的传统观念不同, 在一些城市, 工业和家庭用水所占比例最大。不同城市的城区家庭年人均用水量的差异较小(农村地区也是如此), 但城市和农村地区之间的差异很大。因此, 应更加注意控制特定城市的工业和城区家庭用水。中国应专门制定城市层面的年度水资源账户, 并制定解决水资源短缺的时间表。这是有效且可持续缓解水资源危机的基本步骤。

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City-level Water Withdrawal in China: Accounting Methodology and Applications

Zongyong Zhang, Junguo Liu, Bofeng Cai, Yuli Shan, Heran Zheng, Xian Li, Xukun Li, Dabo Guan

Keywords: accounting, China, city, industrial ecology, inventory, water withdrawal

Summary:

In the context of the freshwater crisis, accounting for water withdrawal could help planners better regulate water use in different sectors to combat water scarcity. However, the water withdrawal statistics in China are patchy, and the water data across all sectors at the city level appear to be relatively insufficient. Hence, we develop a general framework to, for the first time, estimate the water withdrawal of 58 economic-social-environmental sectors in cities in China. This methodology was applied because only inconsistent water statistics collected from different data sources at the city level are available. We applied it to 18 representative Chinese cities. Different from conventional perceptions that agriculture is usually the largest water user, industrial and household water withdrawal may also occupy the largest percentages in the water-use structure of some cities. The discrepancy among annual household water use per capita in the urban areas of different cities is relatively small (as is the case for rural areas), but that between urban and rural areas is large. As a result, increased attention should be paid to controlling industrial and urban household water use in particular cities. China should specifically prepare annual water accounts at the city level and establish a timetable to tackle water scarcity, which is a basic step toward efficient and sustainable water crisis mitigation.

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使用生命周期评估和环境产品声明: 对从业人员的调查

作者: Bruno Menezes Galindro, Sebastian Welling, Niki Bey, Stig Irving Olsen, Sebastião Roberto Soares, Sven-Olof Ryding

关键字: 基准分析法, 交流, 环境产品声明, 产业生态学, 生命周期评估

摘要:

生命周期评估 (LCA) 和环境产品声明 (EPD) 是生态设计和工艺优化等应用中的重要信息来源。然而, 它们在比较和交流中的应用仍然有限。因此, 本文旨在从从业人员的角度, 即具有处理此类信息经验的专业人员的角度, 了解 LCA 和 EPD 信息的使用。本研究调查由两份问卷和两次网络研讨会组成, 问题涉及核心主题: 使用频率和目的、可比性、实际使用的优缺点以及不同展示形式的可靠性。此外, 还提出并讨论了两个建议的基准框架, 随后进行了评论和评估。在 55 名受访者中, 76% 的人表示他们使用 LCA 和 EPD 信息, 主要用于满足客户要求、环境管理系统和营销目的。还有人表示他们使用 LCA (73%) 和 EPD (56%) 的信息进行比较, 但给出了不同的回答, 并且没有既定的程序模式。方法上的局限性和需要统一的产品类别规则 (PCRs) 是不同研究之间进行比较的限制因素。基准框架可能适用于与消费者和公司之间的沟通。结果表明执业人员在不同的应用情景下使用了 LCA 和 EPD 信息, 可能需要增加基准规程的标准化工作, 以改善与非专业受众的沟通。

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Making use of life cycle assessment and environmental product declarations: A survey with practitioners

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Keywords: benchmarking, communication, environmental product declarations, industrial ecology, life cycle assessment (LCA)

Summary:

Life Cycle Assessment (LCA) and Environmental Product Declarations (EPDs) represent important sources of information in applications such as ecodesign and process optimization. However, their use in comparisons and communication is still limited. Therefore, this article aims to understand the use of LCA- and EPD-information from the perspective of the practitioners, that is, professionals with experience in dealing with this type of information. A survey was built consisting of two questionnaires and two webinars, with questions related to core themes: frequency and purpose of use, comparability, and advantages and disadvantages for practical use and reliability of different presentation formats. Also, two suggested benchmarking frameworks were presented and discussed, later being commented upon and evaluated. Out of the 55 respondents, 76% stated that they use both LCA- and EPD-information, primarily to fulfill requirements from customers, in environmental management systems and for marketing purposes. It was also stated that they use LCA (73%)- and EPD (56%)-information to make comparisons but presented different responses and there were no established patterns as to the procedures. Methodological limitations and the need for harmonization of Product Category Rules (PCRs) were mentioned as limiting factors for comparisons between studies. Regarding the benchmarking frameworks, both were indicated to be potentially applicable in communication with consumers and between companies. It is concluded that LCA- and EPD-information is used by the practitioners in different applications and that there may be a need to increase standardization efforts of benchmarking procedures in order to improve communication with nonspecialist audiences.

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环境投入产出情景和循环经济建模的高效运算

作者: Hale Çetinay, Franco Donati, Reinout Heijungs, Benjamin Sprecher

关键字: 循环经济, 排放, 投入产出分析, 投入产出模型, 生命周期评价, 优化

摘要:

产业生态学工具的应用越来越需要大量运算时间。在政策领域, 当实践者想要在响应式网络平台上实时测试各种替代方案时, 这就会成为问题。在研究中, 当分析具有多种干预的大型系统或需要多次运行 (例如, 蒙特卡罗模拟) 时, 研究所需的运算时间就会很高。我们展示了如何显著减少许多常用产业生态学工具的运算时间, 可能是几个数量级的改进。我们以环境扩展投入产出分析 (EEIOA) 中情景优化为案例。与传统的 EEIOA 情景分析不同, 我们并不是在产业间关系发生变化后重新计算里昂惕夫逆矩阵, 而是给出了环境指标变化总值的公式, 并在一个简单的假设系统和完整的 EXIOBASE EEIO 模型中检验了公式的改进成效。这些公式可以将运算时间减少到可以在实时或基于网络的环境中执行这些分析的程度。我们在案例中发现了最多四个数量级的改进。

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Efficient computation of environmentally extended input–output scenario and circular economy modeling

Hale Çetinay, Franco Donati, Reinout Heijungs, Benjamin Sprecher

Keywords: circular economy, emissions, input–output analysis (IOA), input–output model, life cycle assessment (LCA), optimization

Summary:

Industrial ecology tools are increasingly being used in ways that require high computational times. In the policy arena, this becomes problematic when practitioners want to live-test various alternatives in a responsive and web-based platform. In research, computational times come into play when analyzing large systems with multiple interventions or when requiring many runs for, for example, Monte Carlo simulations. We demonstrate how the computational time of a number of commonly used industrial ecology tools can be reduced significantly, potentially by multiple orders of magnitude. Our case study was the optimization of scenario calculations in Environmentally Extended Input–Output Analysis (EEIOA). Instead of recalculating the Leontief inverse after individual changes to the interindustry relations, as is done traditionally in EEIOA scenario analysis, we give formulations to find the total value of the change in the environmental indicators in one calculation step. We illustrate these novel formulations both for a simple hypothetical system and for the full EXIOBASE EEIO model. The use of explicit formulas decreases the computational time to the degree that it becomes possible to carry out these analyses in live or web-based environments. For our case study, we find an improvement of up to four orders of magnitude.

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生命周期解释阶段的方法综述及详细指南

作者: Alexis Laurent, Bo P. Weidema, Jane Bare, Xun Liao, Danielle Maia de Souza, Massimo Pizzol, Serenella Sala, Hanna Schreiber, Nils Thonemann, Francesca Verones

关键字: 完整性和一致性检查、决策制定、国际标准化组织、生命周期评估 (LCA)、结果评估、不确定性和灵敏度分析

摘要:

生命周期解释是生命周期评估 (LCA) 的第四个也是最后一个阶段。作为连接所有其他阶段和生命周期评估研究的结论和建议的“枢纽”阶段,它对从业人员来说是一项具有挑战性的任务。他们因为缺少足够完整、详细和实用的协调准则,无法有效地执行其不同步骤。在这里,我们的目标是弥合这一差距。我们回顾了描述生命周期解释阶段的现有文献,包括标准、LCA 书籍、技术报告和相关科学文献。在此基础上,我们评估和阐明了解释阶段的定义和目的,并提出了一系列支持其在 LCA 实践中进行的方法。建议围绕一个框架重新组织 ISO 14040-44 中定义的五步解释步骤,以提供更实用的解释方法。具体步骤顺序如下: (i) 完整性检查, (ii) 一致性检查, (iii) 敏感性检查, (iv) 重大问题识别, 以及 (v) 结论、限制性和建议。我们提供了工具箱, 包括支持分析、计算、评估或检查点以及每个步骤的反思过程的方法和程序。所有方法都简洁地讨论了相关参考资料, 以了解其应用的更多细节。这个提议的框架以多种方法得到证实, 旨在帮助 LCA 从业者增加他们解释的相关性以及他们的结论和建议的合理性。这是迈向更全面、更协调的 LCA 实践的第一步, 以提高 LCA 研究的可靠性和可信度

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Methodological review and detailed guidance for the life cycle interpretation phase

Alexis Laurent, Bo P. Weidema, Jane Bare, Xun Liao, Danielle Maia de Souza, Massimo Pizzol, Serenella Sala, Hanna Schreiber, Nils Thonemann, Francesca Verones

Keywords: completeness and consistency checks, decision-making, ISO, life cycle assessment (LCA), result evaluation, uncertainty and sensitivity analysis

Summary:

Life cycle interpretation is the fourth and last phase of life cycle assessment (LCA). Being a “pivot” phase linking all other phases and the conclusions and recommendations from an LCA study, it represents a challenging task for practitioners, who miss harmonized guidelines that are sufficiently complete, detailed, and practical to conduct its different steps effectively. Here, we aim to bridge this gap. We review available literature describing the life cycle interpretation phase, including standards, LCA books, technical reports, and relevant scientific literature. On this basis, we evaluate and clarify the definition and purposes of the interpretation phase and propose an array of methods supporting its conduct in LCA practice. The five steps of interpretation defined in ISO 14040-44 are proposed to be reorganized around a framework that offers a more pragmatic approach to interpretation. It orders the steps as follows: (i) completeness check, (ii) consistency check, (iii) sensitivity check, (iv) identification of significant issues, and (v) conclusions, limitations, and recommendations. We provide toolboxes, consisting of methods and procedures supporting the analyses, computations, points to evaluate or check, and reflective processes for each of these steps. All methods are succinctly discussed with relevant referencing for further details of their applications. This proposed framework, substantiated with the large variety of methods, is envisioned to help LCA practitioners increase the relevance of their interpretation and the soundness of their conclusions and recommendations. It is a first step toward a more comprehensive and harmonized LCA practice to improve the reliability and credibility of LCA studies.

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我们是否有足够的天然砂用于建设低碳基础设施?

作者: [Dimitra Ioannidou](#), [Guido Sonnemann](#), [Sangwon Suh](#)

关键字: 发展中国家, 产业生态学, 基础设施, 低碳, 材料强度, 砂

摘要:

全球低碳转型需要发展大型基础设施, 而建设这些基础设施大量用砂。人们广泛认为天然砂资源是丰富的, 而最近的研究表明, 世界许多地区的天然砂供应短缺的风险正在增加。本文研究了低碳基础设施不同发展背景下未来天然砂需求的影响, 估计了未来至 2030 年建筑和低碳基础设施的预计投资, 同时估算了两种建筑类型 (建筑和基础设施) 的用砂强度, 并用投资和用砂强度预测了三种经济发展情景下特定国家的砂需求。研究结果表明, 中国预计将面临最高的砂需求量, 其次是印度; 如果保持当前的采砂率和建设水平, 发展中国家将面临重大的建筑部门用砂供应风险; 在可持续增长的情景下, 预计发达经济体的砂需求将相对稳定; 未来 15 年东南亚和非洲的砂需求将快速增长。最后, 本文还呼吁在低碳转型规划中应关注区域供砂安全。

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Do we have enough natural sand for low-carbon infrastructure?

[Dimitra Ioannidou](#), [Guido Sonnemann](#), [Sangwon Suh](#)**Keywords:** developing countries, industrial ecology, infrastructure, low carbon, material intensity, sand**Summary:**

Global low-carbon transition demands the development of large-scale infrastructure, which is sand intensive. Natural sand is widely considered abundant, whereas recent research has pointed out the increasing risk of supply shortage in a number of world regions. In the current research, we examine the implication of future sand demand in the context of low-carbon infrastructure development. We mapped the projected investments on buildings and low-carbon infrastructure up to 2030 and estimated the sand intensity of the two types of construction. We translated these investments and sand intensity to country-specific sand-demand projections under three economic development scenarios. Our results indicate that China is expected to face the highest sand demand, followed by India, and that should the current sand extraction rates and construction practices be maintained, developing countries will be exposed to a significant supply risk of construction sand. Under the scenario of sustainable growth, developed economies are expected to have a relatively stable sand demand whereas South-East Asia and Africa will see a rapid increase in their sand demand over the next 15 years. Our results call regional sand supply security into attention in low-carbon transition planning.

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预制混凝土建筑外墙构件的生命周期温室气体排放及成本分析

作者: Chunbo Zhang, Mingming Hu, Xining Yang, Arianna Amati, Arnold Tukker

关键字: 建筑外墙、建筑和拆除垃圾、产业生态学、生命周期评估、生命周期成本、预制混凝土构件

摘要:

在欧盟, 建筑的碳排放量约占 36%。随着建筑的逐渐老化, 适应性和灵活性的缺乏往往会导致破坏性干预, 这不仅造成成本的上升, 还会产生大量的建筑和拆除垃圾(CDW)。最近, 一个创新系统(VEEP 项目)获得开发, 以回收 CDW 来制造新建筑施工的节能预制混凝土构件(PCE)。通过运用生命周期成本法(LCC)和生命周期评估(LCA)方法, 本研究旨在确定对于荷兰一个典型的四层住宅楼, 使用 VEEP 预制混凝土构件是否比常规(BAU)预制混凝土构件方案更能降低碳排放和生命周期相关成本。本文以一种独立和组合的方式(通过货币化)对生命周期评价和整合进行了案例研究。文章探讨了碳排放的内部化和折现率对 40 年生命周期成本的影响。模拟结果表明, VEEP-PCE 的经济可行性和环境稳定性的关键在于降低生产成本和优化新型隔离材料气凝胶的热性能; 外部成本的内部化使环境优势货币化, 从而略微扩大了低碳方案的成本优势, 但会导致 LCC 结果更大的不确定性。

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Life cycle greenhouse gas emission and cost analysis of prefabricated concrete building façade elements

Chunbo Zhang, Mingming Hu, Xining Yang, Arianna Amati, Arnold Tukker

Keywords: building façade, construction and demolition waste (CDW), industrial ecology, life cycle assessment, life cycle costing, prefabricated concrete element

Summary:

Buildings are responsible for approximately 36% of carbon emissions in the European Union. Besides, gradual aging and a lack of adaptability and flexibility of buildings often lead to destructive interventions, resulting not only in higher costs but also in a large amount of construction and demolition waste (CDW). Recently, an innovative system (Ref. VEEP project) has been developed to recycle CDW for the manufacturing of energy-efficient prefabricated concrete elements (PCE) for new building construction. By applying life cycle costing (LCC) and life cycle assessment (LCA), this study aimed to determine whether the use of VEEP PCE leads to lower carbon emission and lower associated costs over the life cycle of an exemplary four-story residential building in the Netherlands than a business-as-usual (BAU) PCE scenario. This paper provides a case study on the alignment and/or integration of LCA and LCC in an independent and a combined manner (via monetization). This study examines how the internalization of carbon emission and discount rate will affect the final life cycle costs over a 40-year life span. The simulation results show that the key to economic viability and environmental soundness of VEEP PCE is to reduce production cost and to optimize the thermal performance of the novel isolation material Aerogel; internalization of external cost monetizes the environmental advantage thus slightly expands the cost advantage of low carbon options, but leads to larger uncertainty about the LCC result.

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对交通基础设施环境 LCA 的生命周期阶段和整体评估的再思考

作者: Shoshanna Saxe, Dena Kasraian

关键字: 产业生态学、基础设施、生命周期评价(LCA)、生命周期思想、生命阶段、交通**摘要:**

生命周期评估(LCA)旨在提供对产品近乎整个生命周期影响的完整核算,以避免环境负担在生命周期的不同部分之间转移。然而,这对于交通基础设施来说异常困难,因为其影响的重要部分超出了广泛应用的以工业产品为导向的 LCA 生命阶段:即生产、制造、使用和报废。为了解决这些缺失的影响,我们提出了一个评估交通基础设施生命周期影响的新框架。该框架考虑了交通基础设施和 LCA 最适应的工业产品系统之间的差异。首先,该 LCA 框架适应了交通基础设施在循环寿命阶段的多次迭代,这有别于从材料提取到处置的线性过程。这些反映了交通基础设施的长寿命、耐用性、持久性和反馈循环。其次,该框架认识到拆除先前基础设施或清理土地所产生的生命周期初始阶段的影响。第三,该框架能够刻画交通基础设施引起的紧密联系的外部影响,包括对出行行为、本地土地利用、土地利用、土地利用变化以及林业和网络效应的影响。第四,该框架将“使用寿命终止”重新定性为“部分使用寿命终止”,以反映交通基础设施的广泛重建、重大翻新和持续的间接影响。

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Rethinking environmental LCA life stages for transport infrastructure to facilitate holistic assessment

Shoshanna Saxe, Dena Kasraian

Keywords: industrial ecology, infrastructure, life cycle assessment (LCA), life cycle thinking, life stages, transport**Summary:**

Life cycle assessment (LCA) aims to provide a near full accounting of impacts from the complete life of a product, to avoid burden shifting between different parts of the life cycle. However, this is exceptionally difficult with transport infrastructure because important parts of their impact lie outside the widely applied industrial-product-oriented LCA life stages: production, manufacturing, use, and end of life. To account for those missing impacts, we propose a new framework for assessing the life cycle impacts of transport infrastructure. This framework takes account of the differences between transport infrastructure and the industrial product system to which LCA is most attuned. First, rather than a linear process from material extraction to disposal, this LCA framework accommodates the multiple iterations of transport infrastructure through circular life stages. These reflect the long lifetimes, durability, persistence, and feedback loops of transport infrastructure. Second, this framework recognizes the impact at the start of the life cycle created by demolition of previous infrastructure or land clearing. Third, the tightly linked external impacts that transport infrastructure induces, including influences on travel behavior, local land use, land use, land use change and forestry, and network effects are captured. Fourth, this framework recharacterizes “end of life” as “partial end of life,” in reflection of the widespread reconstruction, major refurbishment of and persistence of indirect impacts from transport infrastructure.

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能源与资本

作者: Christopher Kennedy

关键字: 生物物理经济学, 资本形成, 经济增长, 能源强度, 产业生态学, 十九世纪英国经济

摘要:

能源既被用来建立资本存量, 又被资本存量使用以生产商品和服务。这两种能源需求同时受到宏观经济中可得能源的限制。本文建立了一种数学模型, 将可得能源和资本存量之间的关系表达为一阶微分方程。研究给出了三种具体的解: 具有固定资本存量的稳态经济, 具有线性增长资本存量的经济, 以及指数增长资本存量的经济。英国十九世纪经济的实证数据被用来检验获得能源供应所需的能源、资本形成的能源强度以及资本使用的能源强度。四个经济部门(采矿、住宅、公用事业和铁路)的资本使用能源强度的大小和趋势有所不同。对于线性增加的资本存量的情况, 本文研究了 1850 至 1913 年英国可得能源与资本之比的数据。研究证实了整体理论模型, 并证明了能源资本比率的变化受资本存量大小的影响。对采矿业的进一步分析表明, 在资本投资增加和煤炭产量增加之后, 煤炭价格随之上涨。这有助于说明能源约束在宏观经济中如何发挥作用。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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Energy and Capital

Christopher Kennedy

Keywords: biophysical economics, capital formation, economic growth, energy intensity, industrial ecology, nineteenth century UK economy

Summary:

Energy is required both to build the capital stock and to produce goods and services from the use of the capital stock. These two energy demands are together constrained by the available energy in the macroeconomy. Here, I develop a mathematical theory expressing the relationship between available energy and the capital stock as a first-order differential equation. Three specific solutions are derived for the cases of a steady-state economy with fixed capital stock, for an economy with a linearly increasing capital stock, and for an exponentially growing capital stock. Empirical data for the United Kingdom's nineteenth century economy are used to examine the energy required to access energy supplies; the energy intensity of capital formation; and the energy intensity of capital use. Magnitudes and trends in the energy intensity of capital use differ for four sectors of the economy—mining, residential, utilities, and railways. Data for the United Kingdom's ratio of available energy to capital from 1850 to 1913, are examined for the case of a linearly increasing capital stock. This corroborates the overall theoretical model and demonstrates that the change in energy to capital ratio is impacted by the magnitude of the capital stock. Further analysis of the mining sector shows that higher coal prices follow after increases in capital investment and increased coal production. This helps demonstrate how energy constraints play out in the macroeconomy. This article met the requirements for a gold – gold JIE data openness badge described at <http://jie.click/badges>.

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生物经济转型? 预测到 2050 年消费侧的生物质和化石物质流

作者: Raphael Asada, Tamás Krisztin, Fulvio di Fulvio, Florian Kraxner, Tobias Stern

关键字: 生物经济, 脱钩, 产业生态学, 投入产出分析 (IOA), 社会代谢

摘要:

众多国家在通过实施国家生物经济战略应对不可持续的资源开采、排放增多和废物流增加问题。假设生物经济的目的是通过生物资源的使用来代替化石的使用, 本文采用多区域投入产出方法估算了中高收入国家的生物质和化石原料的消费量 (RMC)。文章进而使用面板固定效应模型对 RMC 进行解释, 解释变量包括经济活跃人口、城市人口、GDP、土地覆盖以及化石/生物质国内物质消费。论文通过这一模型预测了到 2050 年的五种共享社会经济路径情景下的 RMC。预测表明: 2010 年至 2050 年间人均生物质 RMC 会增加, 对于大多数国家和情景, 这将伴随着人均化石 RMC 的增长, 且这一关系在很多情况下是显著的。我们由此得出结论: 如果 GDP 继续以目前的水平驱动化石 RMC, 则即将出现的情况可能会阻碍潜在的生物经济转型, 并导致化石 RMC 的上升而非下降。因此, 增加生物质的使用不必然会带来化石资源消耗的减少。在考虑生物质、土地和水的相对稀缺性时, 需要更多地关注基于生物技术的创新对重构 RMC 驱动因素的重要性。

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Bioeconomic transition?: Projecting consumption-based biomass and fossil material flows to 2050

Raphael Asada, Tamás Krisztin, Fulvio di Fulvio, Florian Kraxner, Tobias Stern

Keywords: bioeconomics, decoupling, industrial ecology, input-output analysis (IOA), societal metabolism

Summary:

Countries are responding to unsustainable resource extraction, rising emissions, and increasing waste streams by implementing national bioeconomy strategies. Assuming that the purpose of a bioeconomy is to replace fossil use by biogenic resource use, we estimate biomass and fossil raw material consumption (RMC) by applying multiregional input-output methodology for middle and high income countries. Next, we use a panel fixed effects model to explain RMC with economically active population, urban population, GDP, land cover, and fossil/biomass domestic material consumption. With this model, we project RMC under five Shared Socioeconomic Pathway scenarios up to 2050. The projections show an increase in per capita biomass RMC between 2010 and 2050, accompanied by—in many cases pronounced—per capita growth of fossil RMC across most of the countries and scenarios. We conclude that, if GDP continues to drive fossil RMC at its current magnitude, upcoming conditions are likely to counteract a potential bioeconomic transition and increase, instead of decrease, fossil RMC. Thus, increasing biomass use will not necessarily lead to reduced fossil resource consumption. When considering the relative scarcity of biomass, land and water, more focus needs to be placed on the relevance of technological bio-based innovations in the reconfiguration of RMC drivers.

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国家级以下区域水平的物质消耗核算——一种新的数据降尺度方法

作者: Marco Bianchi, Carlos Tapia, Ikerne del Valle

关键字: 循环经济、国内材料消耗 (DMC)、经济系统物质流分析 (EW-MFA)、产业生态学、区域物质流分析、社会代谢

摘要:

统一且细化的信息对于设计因地制宜的政策和实现更可持续的经济至关重要。然而, 在许多区域和政策领域, 仍无法获得国家级以下的分类数据。在本文中, 我们提出了一种新颖的三阶段计量方法——规范化、优化和外推 (SOE), 从广泛可用的社会经济数据中推算出统一的区域估计量。该方法测试估计了欧洲 280 多个地区的国内材料消耗 (DMC) (NUTS 2 级)。与以往计量经济学方法不同, 该方法通过估计和应用特定国家的弹性系数, 明确了次国家级地区的社会代谢概况。所得 DMC 估计值与针对可获取数据地区的特定物质流研究保持一致。本文提出的 SOE 方法为决策者探索次国家级地区的社会代谢概况和了解循环经济转型政策的潜在影响提供了一个强有力的工具。经简单调整后该方法也可用于支持数据匮乏区域的政策设计。

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Monitoring domestic material consumption at lower territorial levels: A novel data downscaling method

Marco Bianchi, Carlos Tapia, Ikerne del Valle

Keywords: circular economy, domestic material consumption (DMC), economy-wide material flow analysis(EW-MFA), industrial ecology, regional MFA, social metabolism

Summary:

The availability of harmonized and granular information is critical for the design of place-sensitive policies toward more sustainable economies. However, accessibility to disaggregated data at subnational levels remains an exception in many geographies and policy domains. In this article, we develop a novel three-stage—specification, optimization, extrapolation (SOE)—econometric approach to infer harmonized regional level estimates from broadly available socioeconomic data. The approach is tested by estimating domestic material consumption (DMC) in more than 280 European regions (at NUTS 2 level). Unlike previous methods based on similar econometric techniques, our method makes explicit the socio-metabolic profiles of subnational territories by estimating and applying country-specific elasticities. Our DMC estimates are consistent with those obtained by ad hoc material flow studies that could be accessed for a sample of regions. The SOE method presented in this paper provides decision-makers with a powerful tool to explore socio-metabolic profiles at subnational level and therefore to understand the potential effects of policies aimed at supporting circular economy transitions at such levels. The method can also be adapted with relative ease to support policy designs in other policy areas challenged by severe data scarcity.

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中国农业领域的灌溉技术和水量反弹问题

作者: Lin Fang, Fengping Wu, Yantuan Yu, Lin Zhang

关键字: 农作物种植, 灌溉面积, 对数平均迪氏指数法 (LMDI), 基于SBM的Malmquist指数, 水资源禀赋, 水量反弹

摘要:

本文利用 1998 年至 2016 年中国 30 个省份的数据, 结合基于 SBM 的 Malmquist 指数法和对数平均迪氏指数法 (LMDI), 估算了农作物种植中的水量反弹效应。我们发现, 平均水量反弹效应为 70.3%, 意味着灌溉技术改进带来的超过三分之二的节水效果被更高的用水量所抵消。我们发现在反弹幅度上存在区域异质性的证据。西南地区最高, 而西北地区最低。不同地区的异质性反弹效应主要是由于水资源禀赋和灌溉土地可用性的差异。我们的结果表明, 要实现农业节水, 不一定要靠灌溉技术的改进。特别是在分区域设计节水政策时, 需要考虑各区域自然地理条件的差异。

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Irrigation technology and water rebound in China's agricultural sector

Lin Fang, Fengping Wu, Yantuan Yu, Lin Zhang

Keywords: crop farming, irrigation land availability, logarithmic mean division index (LMDI), SBM-based Malmquist index, water endowment, water rebound

Summary:

By using the data of 30 provinces from 1998 to 2016 in China, this paper estimates the water rebound effect in the agricultural crop farming by combining Slacks-based Measure (SBM-based) of Malmquist Index and Logarithmic Mean Division Index (LMDI) method. We find that the average water rebound effect is 70.3%, implying that over two-thirds of the water saving from irrigation technology improvement is offset by higher water consumption. We find evidence on the regional heterogeneity in terms of the magnitude of rebound: Southwest is the highest, whereas Northwest is the lowest. The heterogeneous rebound effect across regions is mainly due to the difference in water endowment and irrigation land availability. Our results indicate that irrigation technology improvement is not necessarily sufficient for achieving agricultural water conservation. In particular, the difference in natural geography conditions across regions needs to be considered in designing water conservation policies at a sub-regional level.

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食品生产中水和废水管理的生态效率评估: 以丹麦某大型乳品厂为例

作者: Julie Skrydstrup, Silje Lyster Larsen, Martin Rygaard

关键字: 食物生产, 整体决策, 产业生态学, 资源回收, 价值链, 废水处理

摘要:

水需求和水资源压力的持续增加使工业生产水管理变得尤为迫切。从生命周期的角度出发, 生态效率框架是一种能够结合环境和经济因素, 为水消耗和水处理提供研究支撑的方法。基于增值和价值链评估原则, 本文假设某乳品厂采用膜生物反应器进行分散式废水处理, 并在生命周期系统边界内对该乳品厂废水处理的生态效率进行综合评估。生命周期评价结果表明, 乳品废水的分散式处理和回用将使淡水环境和海水环境分别得到 80%和 51%的改善, 但与常规废水处理相比, 分散式处理方案对气候变化的负面影响会增加将近 27%。价值链评估结果表明, 每立方米乳品废水的分散式处理将增加 1.3 至 1.4 欧元的增值, 但也会给利益相关者(如集中式污水处理厂)带来 1.4 至 1.9 欧元的价值损失。案例研究也揭示了定义良好系统边界的重要性, 需要综合考量研究对象在整个价值链中的影响, 并为决策者提供系统层面和利益相关者层面的利弊衡量。

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Eco-efficiency of water and wastewater management in food production: A case study from a large dairy in Denmark

Julie Skrydstrup, Silje Lyster Larsen, Martin Rygaard

Keywords: food production, holistic decision-making, industrial ecology, resource recovery, value chain, wastewater treatment**Summary:**

Rising water demands and pressures on water resources call for water management in industrial production. An eco-efficiency framework may provide justification for water consumption and treatment by combining environmental and economic dimensions in a life cycle perspective. We used principles of value added and value chain assessment (VCA) in the life-cycle system boundaries for a consistent assessment of eco-efficiency. The method was demonstrated for a membrane bioreactor-based, decentralized wastewater treatment and reuse in a dairy. The LCA results showed that decentralized wastewater treatment and reuse in the dairy will improve the aquatic environment by 80% (freshwater) and 51% (marine water), but increase the negative impact on climate change by 27% compared to conventional wastewater treatment. The VCA revealed that the decentralized alternatives would increase the value added by 1.3–1.4 €/m³ wastewater in the dairy, but also incur a value loss of 1.4–1.9 €/m³ for associated stakeholders such as the centralized wastewater treatment plant. The case study revealed the critical nature of a well-defined system boundary that includes impacts along the entire value chain and exposed pros and cons for decision-makers at both the system level and individual stakeholder level.

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基于可再生能源的脱碳化和钢铁制造迁移: 案例研究

作者: Dolf Gielen, Deger Saygin, Emanuele Taibi, Jean-Pierre Birat

关键字: 商品贸易, 脱碳化, 氢能, 产业生态学, 钢铁, 可再生能源

摘要:

本文结合技术评估、物流分析和微观经济分析, 评估了氢基钢铁制造的前景及其对全球物质流的潜在影响。在二氧化碳(CO₂)价格约为每吨 67 美元的情况下, 可再生氢基铁生产成本最低。获得低成本可再生电力是一个先决条件。澳大利亚是世界上最大的铁矿石生产国, 同时也是一个拥有大量低成本可再生能源潜能的国家。向出口直接还原铁(DRI)的转变可以大幅减少全球二氧化碳排放量, 同时增加澳大利亚铁矿石的附加值, 同时维持将铁矿石加工成钢铁的国家(如中国、韩国和日本)的钢铁产量。这种方法可以推广到世界其他地区和其他能源密集型行业。在气候背景下的迁移分析可以成为一个新的产业生态学研究领域。钢铁行业的 CO₂ 排放量可以减少近三分之一, 即约 0.7 Gt CO₂/年。为了实现这个减排目标, 需要 0.9 万亿美元的投资, 即能源部门总投资需求的 0.7%, 全球 DRI 产量必须比今天的水平增加 7 倍, 所使用的氢能将相当于全球一次能源供应的 1%。如果制定正确的政策, 这种转变可能从 2025 年开始大规模发展。

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Renewables-based decarbonization and relocation of iron and steel making: A case study

Dolf Gielen, Deger Saygin, Emanuele Taibi, Jean-Pierre Birat

Keywords: commodity trade, decarbonization, hydrogen, industrial ecology, iron and steel, renewable energy**Summary:**

The article assesses the future role of hydrogen-based iron and steel making and its potential impact on global material flows, based on a combination of technology assessment, material flow analysis, and microeconomic analysis. Renewable hydrogen-based iron production can become the least-cost supply option at a carbon dioxide (CO₂) price of around United States dollars (USD) 67 per tonne. Availability of low-cost renewable electricity is a precondition. Australia is the world's largest producer of iron ore and at the same time a country with significant low-cost renewable electricity potential. A shift to direct reduced iron (DRI) exports could reduce global CO₂ emissions substantially and at the same time increase value added in Australia, while maintaining steel production in countries that are currently processing ore into iron and steel, such as China, South Korea, and Japan. The approach could be expanded to other parts of the world and other energy-intensive industry sectors. Such relocation analysis in a climate context can become a new industrial ecology research area. Iron and steel industry CO₂ emissions can be reduced by nearly a third, around 0.7 gigatonnes (Gt) CO₂ per year. To achieve these emission reductions, investment of USD 0.9 trillion, or 0.7% of the total energy sector investment needs, would be required, global DRI production would have to increase seven-fold from today's level, and the hydrogen energy used would equal 1% of global primary energy supply. Such a shift could develop from 2025 onward at scale, if the right policies are put in place.

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碳捕获和利用价值链创新的相关经济期望

作者: [Henriette Naims](#)

关键字: 碳捕获与利用、二氧化碳、产业生态学、产业共生、技术创新、价值链

摘要:

国际当局日益认识到, 利用不同行业排放的二氧化碳(CO₂)有助于减缓气候变化, 在开发新型碳捕获和利用(CCU)技术时, 希望为实现循环经济目标和减少化石基原材料消耗做出贡献。然而, CCU 对产业价值链的潜在经济影响尚不清楚。因此, 本研究调查了目前在 CCU 领域进行研发(R&D)的参与者的经济预期。通过对 19 份政策建议报告和 15 份科学论文的系统性文献综述, 确定了有关经济表现的期望水平。基于 R&D 投入-产出-结果系统进行了定性、定向内容分析。首先, 通过工业部门集群识别出三组价值链相关参与者: (a) 设备制造商, (b) 高排放生产商, (c) 材料和燃料生产商, 然后从评审中得出一个标准列表, 最后分析并揭示了 CCU 创新对不同行业的影响。设备制造商可以为促进经济增长做贡献; 对于高排放的生产商来说, CCU 提供了一种“生存”可持续性转型的选择; 同时, 材料和燃料生产商需要通过提供利用二氧化碳的有竞争力的方法以充当“问题解决者”的角色。最后, 识别了有待解决的研究空白, 以更好地从经济和社会层面理解 CCU, 并增加有利于工业和能源系统向更广泛的可持续性转型的创新机会。

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Economic aspirations connected to innovations in carbon capture and utilization value chains

[Henriette Naims](#)

Keywords: carbon capture and utilization, carbon dioxide, industrial ecology, industrial symbiosis, technological innovation, value chains

Summary:

International authorities are increasingly recognizing that utilizing the carbon dioxide (CO₂) emissions from various industries can assist strategies for mitigating climate change. In developing novel carbon capture and utilization (CCU) technologies they aspire to contribute to circular economy targets and reduce consumption of fossil-based raw materials. However, the potential economic effects of CCU on industrial value chains remain unclear. Hence, this study investigates the economic expectations placed on those actors currently conducting research and development (R&D) in CCU. The aspired levels of economic performance are identified through a systematic literature review of 19 policy advice reports and 15 scientific papers. Qualitative directed content analysis is conducted, based on an R&D input-output-outcome system. First, we identify three relevant groups of value chain actors by clustering industrial sectors: (a) equipment manufacturers, (b) high-emitting producers, and (c) producers of materials and fuels. Then, we derive a criteria list from the review. Finally, the analysis reveals how CCU innovations are anticipated to impact different industries: Equipment manufacturers could contribute to economic growth. For high-emitting producers, CCU provides one option for “surviving” sustainability transitions. Meanwhile, material and fuel producers need to act as “problem solvers” by offering competitive ways of utilizing CO₂. We conclude by identifying research gaps that should be addressed to better understand the economic and social dimensions of CCU and to increase the chances of such innovations contributing to broader sustainability transformations of industrial and energy systems.

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环境绩效与环境披露关系的荟萃分析

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关键字: 环境披露、环境绩效、环境报告、产业生态学、测量特征、荟萃分析

摘要:

本研究从概念和实证两方面总结了以往文献中企业环境绩效与企业环境报告之间关联的多个方面, 解决以下问题: (a) 披露是否是可靠的绩效指标; (b) 可变计量特征是否影响实证结果。系统的文献综述和荟萃分析技术被用来产生客观有效的总结效果。这项研究涵盖了 62 个主要研究中的 251 个效应量, 代表了 56387 个观察值。本研究发现环境绩效与环境报告之间存在微弱的负相关关系, 支持了一种社会政治观点, 即环境绩效差的人比环境绩效强的人有更高的动机来提高他们的信息披露水平。同时, 本研究证实了以往研究的异质性, 验证了计量方法对实证结果的影响。

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The relationship between environmental performance and environmental disclosure: A meta-analysis

[My Hanh Doan, Remmer Sassen](#)

Keywords: environmental disclosure, environmental performance, environmental reporting, industrial ecology, measurement characteristic, meta-analysis

Summary:

This research conceptually and empirically summarizes multiple aspects of the association between corporate environmental performance and corporate environmental reporting in previous literature, addressing the questions of (a) whether disclosure is a reliable indicator of performance and (b) whether variable measurement characteristics influence empirical outcomes. Systematic literature review and meta-analytic techniques are employed to generate objective and valid summarized effects. The research covers a total of 251 effect sizes within 62 primary studies, representing a total of 56,387 observations. This study discovers a weak and negative association between environmental performance and environmental reporting, supporting the sociopolitical perspective that poor environmental performers have higher motivations to increase their level of disclosure than strong performers. At the same time, this research confirms the heterogeneity of previous studies in the field and verifies the effects of measurement methods on empirical outcomes.

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比较水基和气基金属加工液的用能和用水量

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关键字: 切削液, 干燥厂, 产业生态学, 可持续制造, 工具寿命, 水-能关联

摘要:

为减轻与金属制造行业普遍使用的水基(水性)金属加工液(MWFs)相关的用水和污染、工业卫生、职业健康和性能限制的担忧, 基于气体的金属加工液被提议作为加工操作中的替代冷却剂和润滑剂。本研究将与水性 MWF 的消耗使用、输送和处置相关的一次能源和水的使用与文献中的三种气体 MWF——最小量润滑的压缩空气(MQL)、液态/气态 N₂ 和液体/超临界 CO₂ 进行了比较, 解释了在同行评审的实验研究中, 几种加工工艺和材料的加工性能的差异。分析表明, 尽管据报道使用 N₂ 和 CO₂ 基 MWF 提高了刀具寿命, 但 N₂ 和 CO₂ 的电力和水密集型分离和净化过程导致其单位体积加工材料的初级能源和水使用量高于水基 MWF。虽然 MQL 的一次能源使用量较低, 但该 MWF 普遍使用的植物油相关的大量消耗性用水导致其总用水量高于在循环系统中运行的水基 MWF。因此, 气基 MWF 将水的使用转移到了制造工厂的上游。与水基 MWF 相比, 通过专注于实现更高的材料去除率和产量, 而不是仅仅针对提高刀具寿命, 可以减少气基 MWF 的一次能源和水的使用。此外, 可以通过优化其流速和输送来最大限度地减少 CO₂ 和 N₂ MWF 的消耗量, 以精确满足特定加工过程的冷却和润滑需求, 而非用这些气体淹没工具和工件。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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Comparing energy and water use of aqueous and gas-based metalworking fluids

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Keywords: cutting fluids, dry factories, industrial ecology, sustainable manufacturing, tool life, water-energy nexus

Summary:

Gas-based metalworking fluids (MWFs) have been proposed as alternative coolants and lubricants in machining operations to mitigate concerns surrounding water use and pollution, industrial hygiene, occupational health, and performance limitations associated with water-based (aqueous) MWFs that are ubiquitously used in the metals manufacturing industry. This study compares the primary energy and water use associated with the consumptive use, delivery, and disposal of aqueous MWFs with three gas-based MWFs in the literature—minimum quantity lubricant-in-compressed air (MQL), liquid/gaseous N₂, and liquid/supercritical CO₂. The comparison accounts for reported differences in machining performance in peer-reviewed experimental studies across several machining processes and materials. The analysis shows that despite the reported improvement in tool life with N₂ and CO₂-based MWFs, the electricity- and water-intensive separation and purification processes for N₂ and CO₂ lead to their higher primary energy and water use per volume of material machined relative to water-based MWFs. Although MQL is found to have lower primary energy use, significant consumptive water use associated with the vegetable oil commonly used with this MWF leads to higher overall water use than aqueous MWF, which is operated in a recirculative system. Gas-based MWFs thus shift the water use upstream of the manufacturing plant. Primary energy and water use of gas-based MWFs could be reduced by focusing on achieving higher material removal rates and throughput compared to aqueous MWF instead of solely targeting improvements in tool life. Additionally, the consumptive use of CO₂ and N₂ MWFs could be minimized by optimizing their flow rates and delivery to precisely meet the cooling and lubrication needs of specific machining processes instead of flooding the tool and workpiece with these gases. This article met the requirements for a gold-gold JIE data openness badge described at <http://jie.click/badges>.

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等离子体辅助和常规氨合成路线的环境影响评价

作者: Aikaterini Anastasopoulou, Robin Keijzer, Bhaskar Patil, Jürgen Lang, Gerard van Rooij, Volker Hessel

关键字: Haber-Bosch工艺, 环境影响评估, 等离子体辅助合成氨, 工艺设计, 可再生氨生产

摘要:

在过去几十年里, 氨在化肥工业中的重要性已得到广泛认可。随着世界人口的增加, 粮食需求上升, 氨的生产可能呈指数级增长。然而, 其生产对自然资源高度依赖, 当代氨合成路线具有密集排放的特征, 同时有严格的环境法规在全球范围实施, 因此, 对开发可持续的替代生产路线的需求变得非常迫切。利用非热等离子体技术在常温条件下实现了一种合成氨的新方法。由于相关技术仍在发展中, 因此强烈建议进行生命周期评估 (LCA), 以此识别化学过程中可作哪些改进以提高环境绩效。为此, 本文提出一个小型等离子体辅助氨厂的工艺设计, 并对采用蒸汽转化和水电解制氢的传统氨合成的具体设计方案进行环境评价。根据 LCA 的结果, 考虑到 1.9 g NH₃/kWh 的能源效率, 对等离子体辅助工艺的大多数生命周期影响类别贡献最大的因素是等离子体反应器的电力消耗, 其份额从 15% 到 73% 不等。在比较的基础上, 在 5% 和 15% NH₃ 产率和 5% 能量回收率 (适用于考察的等离子体功耗值的所有情况) 的两个基准案例中, 由水电提供动力的等离子体工艺表现出更好的整体环境特征。

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Environmental impact assessment of plasma-assisted and conventional ammonia synthesis routes

Aikaterini Anastasopoulou, Robin Keijzer, Bhaskar Patil, Jürgen Lang, Gerard van Rooij, Volker Hessel

Keywords: Haber-Bosch process, environmental impact assessment, plasma-assisted ammonia synthesis, process design, renewable ammonia production

Summary:

The importance of ammonia in the fertilizer industry has been widely acknowledged over the past decades. In view of the upcoming increase of world population and, in turn, food demand, its production rate is likely to increase exponentially. However, considering the high dependence on natural resources and the intensive emission profile of the contemporary ammonia synthesis route, as well as the rigid environmental laws being enforced at a global level, the need to develop a sustainable alternative production route becomes quite imperative. A novel approach toward the synthesis of ammonia has been realized by means of non-thermal plasma technology under ambient operating conditions. Because the given technology is still under development, carrying out a life cycle assessment (LCA) is highly recommended as a means of identifying areas of the chemical process that could be potentially improved for an enhanced environmental performance. For that purpose, in the given research study, a process design for a small-scale plasma-assisted ammonia plant is being proposed and evaluated environmentally for specific design scenarios against the conventional ammonia synthesis employing steam reforming and water electrolysis for hydrogen generation. On the basis of the LCA results, the most contributory factor to the majority of the examined life cycle impact categories for the plasma-assisted process, considering an energy efficiency of 1.9 g NH₃/kWh, is the impact of the power consumption of the plasma reactor with its share ranging from 15% to 73%. On a comparative basis, the plasma process powered by hydropower has demonstrated a better overall environmental profile over the two benchmark cases for the scenarios of a 5% and 15% NH₃ yield and an energy recovery of 5% applicable to all examined plasma power consumption values.