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《产业生态学报》

2005 年冬，第 9 卷第 3 期，15–30 页

题目：汽车产业生态学的再设计

作者：Peter Wells, Renato J. Orsato

关键字：汽车工业，分布式经济，地方生产与消费，微型工厂零售(MFR)，供应链管理，可持续商业

摘要：本文探讨了如何利用产业生态学来帮助重构汽车产业，包括汽车的生产、销售和维护。这涉及到经济规模、产品设计技术、过程技术等概念以及如何根据汽车产业的特点利用产业生态学原理重组上述概念，从而促进该行业的可持续性。本文认为生产与消费的经济、技术和空间组织共同决定了某一产业的产业生态学特征。对比汽车行业的主流产业模式，微型工厂零售模式从产业生态学的角度来看能够带来巨大的改观。

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Redesigning the Industrial Ecology of the Automobile

Peter Wells and Renato J. Orsato

KEYWORDS:
automotive industry, distributed economies, local production and consumption, micro factory retailing (MFR), supply chain management, sustainable business

SUMMARY:
This article explores the potential of industrial ecology to inform the redesign of an existing industry: that which is concerned with the production, sale, and support of automobiles. In so doing, it brings together the concepts embedded in industrial ecology with issues of economic scale, product design or technology, process technology, and the way in which new combinations of these features can result in an alternative structure for the automotive industry that has the potential to enhance sustainability performance. In so doing, the article advances the general argument that the economic, technical, and spatial organization of production and consumption are co-determined in a manner that collectively shapes the industrial ecology of an industry. In contradistinction to the prevailing industry, the article then advances the concept of micro factory retailing as an alternative framework for the industry that would result in significantly different performance in terms of industrial ecology.

《产业生态学报》

2005 年冬，第 9 卷第 3 期，31–50 页

题目：基于互联网的环境综合评价系统：计算模型共享的本体理论应用

作者：Steven Kraines, Rafael Batres, Michihisa Koyama, David Wallace, Hiroshi Komiyama

关键字：模型集成，本体工程，知识工程，知识集成，知识表述，语义网络

摘要：互联网与计算机建模技术的最新进展为产业生态学不同研究领域间的合作与发展提供了机遇。新兴信息技术如基于本体理论的语义搜索引擎可帮助研究者综合来自世界不同研究机构的知识成果。假设有四个学者，都希望寻找合作者来发展其各自的研究。以此为背景，本文提出了基于互联网的环境综合评价系统信息集成的四级架构，并详细阐述了其中的前两级。该架构确信不同的专家知识可通过计算模型有效集成。由此出发，架构的第一级由描述建模者专家知识的各类计算模型构成。第二级通过标记和界面定义工具阐述了每个模型所包含的知识类型及所能提供的信息服务。在上述两级研究的基础上本文构建了产业生态学环境综合评价的信息集成环境。有关第三级(模型搜寻与匹配)和第四级(模型参数集成与求解)的研究工作将在后续论文中发表。

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Internet-Based Integrated Environmental Assessment: Using Ontologies to Share Computational Models

Steven Kraines, Rafael Batres, Michihisa Koyama, David Wallace, and Hiroshi Komiyama

KEYWORDS:
model integration, ontological engineering, knowledge engineering, knowledge integration, knowledge representation, semantic web

SUMMARY:
New advances in Internet technologies and computer modeling provide opportunities for collaborative systems to support research and development in the field of industrial ecology. In particular, new information technologies such as semantic search engines based on ontologies could help researchers to link fragments of knowledge generated at research centers from around the world. Using a storyline of four imaginary researchers who hope to find collaborators in order to develop their research findings, we illustrate two levels of a four-level architecture for an Internet-based knowledge integration and collaboration environment for integrated environmental assessment. The foundation of the proposed architecture is a belief that computational models are an effective medium for conveying expert knowledge of various phenomena. Drawing from this premise, the first level of the architecture stands on a base of computational models that in some way represent the expert knowledge of the model builder. At the second level, we provide markup and interface definition tools to describe the type of knowledge contained in each model, together with the types of information services that can be provided. The results of research at these two levels of an Internet-based knowledge integration environment for integrated environmental assessment in industrial ecology are presented in this article. Our work on the third level of model searching and matching and the fourth level of parametric model integration and solving will be presented in subsequent articles.

《产业生态学报》

2005 年冬，第 9 卷第 3 期，51-65 页

题目：平均与最佳能效差异的评价方法：“能源之星”工业能效指数

作者：Gale A. Boyd

关键字：能效，能耗强度，产业生态学，产业用能，工厂级，随机前沿面

摘要：区分参数/统计模型与工程经济模型的一种方法是：前者通常基于平均使用情况而后者往往代表最佳实践。代表平均水平的能耗强度数据对企业能源管理和公共政策的制定并无太大的参考价值。重要的是给出企业或工厂一级能效指标的统计分布，并指出一个具体企业在其中所处的位置——该企业究竟是接近还是远离最佳工业实践？本文根据参数/统计模型方法推算出最佳工业实践，并进而估计工厂、企业乃至整个行业水平上的能效差异。这一方法基于工厂级数据，同时应用了“能源之星”工业能效指数(EPI)描述能源强度时所用的随机前沿面回归分析法。随机前沿回归法将能耗强度析分为三：系统效应、无效性和统计随机误差。在方法概述的基础上本文还以酿酒和汽车装配产业为例，分析了 EPI 的具体应用。汽车工业随机前沿回归所得的 EPI 指出该行业能效差的中值约为 27%。

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A Method for Measuring the Efficiency Gap between Average and Best Practice Energy Use: The ENERGY STAR Industrial Energy Performance Indicator

Gale A. Boyd

KEYWORDS:
energy efficiency, energy intensity, industrial ecology, industrial energy use, plant level, stochastic frontier

SUMMARY:
A common feature distinguishing between parametric/statistical models and engineering economics models is that engineering models explicitly represent best practice technologies, whereas parametric/statistical models are typically based on average practice. Measures of energy intensity based on average practice are of little use in corporate management of energy use or for public policy goal setting. In the context of company- or plant-level indicators, it is more useful to have a measure of energy intensity that is capable of indicating where a company or plant lies within a distribution of performance. In other words, is the performance close to (or far from) the industry best practice? This article presents a parametric/statistical approach that can be used to measure best practice, thereby providing a measure of the difference, or “efficiency gap,” at a plant, company, or overall industry level. The approach requires plant-level data and applies a stochastic frontier regression analysis used by the ENERGY STAR™ industrial energy performance indicator (EPI) to energy intensity. Stochastic frontier regression analysis separates energy intensity into three components: systematic effects, inefficiency, and statistical (random) error. The article outlines the method and gives examples of EPI analysis conducted for two industries, breweries and motor vehicle assembly. In the EPI developed with the stochastic frontier regression for the auto industry, the industry median “efficiency gap” was around 27%.

《产业生态学报》
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题目：社会系统的多级锌循环

作者：T. E. Graedel, Dick van Beers, Marlen Bertram, Kensuke Fuse, Robert B. Gordon, Alexander Gritsinin, Ermelinda M. Harper, Amit Kapur, Robert J. Klee, Reid Lifset, Laiq Memon, Sabrina Spatari

关键字：填埋，物料流分析，再循环，资源利用，物质流分析，废物管理

摘要：本文基于 1994 年左右的锌元素开采、加工、生产、使用、废弃、回收和填埋数据，构建了一个一年期的锌存储和流通的综合循环系统。该系统由三级循环组成：国家级包括了 54 个国家和 1 个国家组的锌循环，是世界锌循环系统的基本组成单元；区域级囊括了世界的 9 大区域；全球级循环则在上述两级的基础上加和完成。文中还提供了一个全球锌循环的最佳估计模型，以消除国家级和区域级循环加和所造成的误差。文章的电子版附录提供了上述所有各级的锌元素循环图，以作为产业生态学者研究锌物流的参考。本项研究最为引人注目的结论包括：(1)国家、区域和全球级的锌累积率(即使用存量的净增量与进入使用阶段的锌物流之比)为很大的正值(约 2/3)；(2)不同区域间的锌元素二次输入率(定义为再生锌在进入加工阶段的锌物流中所占的比例)之差高达 6 倍；(3)在全球级上约 40%以各种形式废弃的锌最终得以回收或再利用；(4)锌循环可通过一系列比率加以描述，较为典型的有利用效率(加工制造阶段的废物与产出的比率，全球级数值为 0.090)和加工废锌率(加工废锌与输入加工阶段的锌物流之比，全球级数值为 0.070)。由于在初级锌物流输入中回收废锌所占的比例较大，如能进一步提高废锌回收的比率，必将显著减少全球的锌矿开采。上述结论提供了一个有助于资源存量、产业资源利用、能源消耗、废物管理、产业经济和环境影响等方面综合研究的基本框架。

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The Multilevel Cycle of Anthropogenic Zinc

T. E. Graedel, Dick van Beers, Marlen Bertram, Kensuke Fuse, Robert B. Gordon, Alexander Gritsinin, Ermelinda M. Harper, Amit Kapur, Robert J. Klee, Reid Lifset, Laiq Memon, and Sabrina Spatari

KEYWORDS:
landfills, materials flow analysis, recycling, resource use, substance flow analysis, waste management

SUMMARY:
A comprehensive annual cycle for stocks and flows of zinc, based on data from circa 1994 and incorporating information on extraction, processing, fabrication, use, discard, recycling, and landfilling, was carried out at three discrete governmental unit levels—54 countries and 1 country group (which together comprise essentially all global anthropogenic zinc stocks and flows), nine world regions, and the planet as a whole. All of these cycles are available in an electronic supplement to this article, which thus provides a metadata set on zinc flows for the use of industrial ecology researchers. A "best estimate" global zinc cycle was constructed to resolve aggregation discrepancies. Among the most interesting results are the following: (1) The accumulation ratio, that is, addition to in-use stock as a function of zinc entering use, is positive and large (2/3 of zinc entering use is added to stock) (country, regional, and global levels); (2) secondary input ratios (fractions of input to fabrication that are from recycled zinc) and domestic recycling percentages (fractions of discarded zinc that are recycled) differ among regions by as much as a factor of six (regional level); (3) worldwide, about 40% of the zinc that was discarded in various forms was recovered and reused or recycled (global level); (4) zinc cycles can usefully be characterized by a set of ratios, including, notably, the utilization efficiency (the ratio of manufacturing waste to manufacturing output: 0.090) and the prompt scrap ratio (new scrap as a fraction of manufacturing input: 0.070) (global level). Because capturable discards are a significant fraction of primary zinc inputs, if a larger proportion of discards were recaptured, extraction requirements would decrease significantly (global level). The results provide a framework for complementary studies in resource stocks, industrial resource utilization, energy consumption, waste management, industrial economics, and environmental impacts.

《产业生态学报》
2005 年冬，第 9 卷第 3 期，91–108 页

题目：社会系统多级锌循环的数据分析初探

作者：T.E. Graedel, Marlen Bertram, Barbara Reck

关键字：突发行为，填埋，再循环，资源利用，物质流分析(SFA)，废物管理

摘要：本文利用数据分析工具分析了锌金属存储和流通的综合循环系统。此项研究在国家级(包括 54 个国家和 1 个国家组基础锌循环系统)、区域级(总揽世界 9 大区域)和全球级三个空间尺度上展开，有关结论如下：(1)探索型数据分析是一种宝贵且独特的分析方法，提供了有关物流特别是跨越多级空间尺度的物流的重要信息；(2)国家级锌元素存量和流量的数值分布极不均匀，少数国家的数值很大，但多数国家的存流数值较小；(3)各国含锌制品的加工物流量与锌矿开采量之间的相关性很差，说明很多国家采掘但并不大量加工锌，反之也成立；(4)所有国家在使用阶段的锌存量(表现为使用中的镀锌制品、锌铸件等等)都在增长。各地区锌存量的净增量与进入使用阶段的锌流量高度相关，同时地区的发展越强劲则锌存量的增幅越大；(5)各国锌的填埋量与废弃量在较低置信度下强烈相关；(6)区域级的锌物流参数接近对数正态分布；(7)空间级越低则规范化后的锌物流统计分布范围越宽，但使用(流入使用阶段)与废弃(流出使用阶段)的锌物流有所例外，其区域级物流的四分位极差较国家级物流的极差为大。

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Exploratory Data Analysis of the Multilevel Anthropogenic Zinc Cycle

T.E. Graedel, Marlen Bertram, and Barbara Reck

KEYWORDS:
emergent behavior, landfills, recycling, resource use, substance flow analysis (SFA), waste management

SUMMARY:
A comprehensive multilevel contemporary cycle for stocks and flows of zinc is analyzed by the tools of exploratory data analysis. The analysis is performed at three discrete organizational levels—country (53 countries and 1 country group that together comprise essentially all anthropogenic stocks and flows of zinc), world region (9 world regions), and the planet as a whole. The results demonstrate the following: (1) Exploratory data analysis provides valuable and otherwise unobtainable information about material flows, especially those across multiple spatial levels. (2) All distributions of country-level zinc stock and flow data are highly skewed, a few countries having large magnitudes, many having small magnitudes. (3) Rates of fabrication of zinc-containing products for the countries are poorly correlated with rates of extraction, reflecting the fact that many countries that extract zinc do not fabricate products from zinc to any significant degree, and vice versa. (4) Virtually all countries are adding zinc to stock in the use phase (in galvanizing applications, zinc castings, etc.). These rates of addition are highly correlated with rates of zinc entering use in all regions, and are higher in regions under vigorous development. (5) With weak confidence, the rate of zinc landfilling by countries appears to be highly correlated with the rate of discard. (6) The statistical distributions of regional-level zinc cycle parameters are approximately log normal. (7) The extremes of normalized statistical distributions of zinc flow values are broader at lower spatial levels (country versus region, for example), but regional interquartile ranges for zinc entering use and zinc discards are higher at regional level than at country level.

《产业生态学报》
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题目：英国的小麦混合品种：一种高效且环境友好的生物乙醇生产原料

作者：J. Stuart Swanston, Adrian C. Newton

关键字：生物燃料，生态效率，能量平衡，减量输入，可持续农业，品种混合

摘要：对石油供应的担忧促使各国加强对可再生燃料和可再生能源的开发。虽然产业生态学能够提供比较不同能源的优劣的工具，但在讨论以植物为原料替代不可再生能源时，有关植物学特别是物种遗传特性变化的知识也不可或缺。鉴于耕作方法决定了植物物种的遗传潜力能否实现，所以不同耕作方法产生不同程度的环境影响。开展大麦的品种混合实践的初衷在于减少化学品的投入，结果增加了产量，减少了病害，保持甚至改善了作物质量。产量随着混合种子品种数量的增加而提高。另有研究表明小麦同样适于混合种植。本文从寻找英国生物乙醇生产所需的节能高效经济型原料出发，为此制定了一种软粒小麦的品种混合方案：由谷粒生产乙醇，并将秸秆用于供热或发电。研究的基本前提是发展综合农业系统下的品种混合可促进系统的能量代谢平衡。分析表明种植作物的主要能耗来自化肥生产和农机设备消耗的燃料。谷物蛋白含量与乙醇产量之间呈紧密的负增长关系。一旦确定关键品种，混合品种在保持谷物产量基本不变的前提下，极大地提高乙醇的产率。不同形态的品种加以混合还能提高总的生物质产量和能量生成量。减少杀虫剂的用量对混合品种的能量平衡有较小但正面的影响，取消预防性喷药可以减少农用燃料消耗，同时可以在不减产的前提下，促进了低毒有机农业的发展。本文还讨论了秸秆等农业副产品的替代用途。

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Mixtures of UK Wheat as an Efficient and Environmentally Friendly Source for Bioethanol

J. Stuart Swanston and Adrian C. Newton

KEYWORDS:
biofuels, eco-efficiency, energy balance, reduced inputs, sustainable agriculture, variety mixtures

SUMMARY:
Concerns about access to oil supplies have encouraged the exploration of renewable fuel and energy sources. Industrial ecology offers tools to compare the energy implications and benefits of differing strategies, but using botanical sources of raw materials to replace nonrenewable ones also requires appreciation of plant science, especially the variation in genetic potential within species. Whereas cultivation methods determine whether genetic potential is realized, different methods impact the environment to varying degrees. Experience with barley variety mixtures, aimed at reducing chemical input, has shown them to improve yield and reduce disease, while maintaining or even enhancing quality. Yield improvements still occurred in the absence of disease and increased in proportion to the number of component varieties. Because other research showed mixtures to be similarly effective in wheat, a protocol to grow and exploit a complex mixture of soft wheat is proposed, offering a cost-effective and energy efficient feedstock for a possible bioethanol industry in the United Kingdom. Ethanol would be produced initially from grain, with the straw used for heating or electricity generation. Fertilizer production and use and vehicle fuels have been shown as the main forms of energy consumption in growing a crop, and targets for enhancing the energy balance, by growing mixtures under an integrated farming system, are postulated. A close but negative association between grain protein and alcohol yield is demonstrated and a mixture giving comparable grain yield, but superior alcohol yield, to its best component is identified. Mixing varieties differing in plant morphology may also increase total biomass yield and, therefore, the energy generated from the crop. Pesticide reduction has another positive, though small, effect on the energy balance, from using mixtures. Eliminating prophylactic spraying also reduces vehicle fuel consumption, and may provide the low-toxicity benefits of organic agriculture without the yield penalty. A range of alternative uses for straw and other by-products is also discussed.

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题目：多目标技术评价：以工业涂覆技术为例

作者：Jutta Geldermann, Otto Rentz

关键字：决策支持，生命周期评价(LCA)，物流能流管理，优势排序，灵敏度分析，挥发性有机物(VOCs)

摘要：环境政策逐渐趋向于集成污染预防，并综合考虑所有环境介质(空气、水、土地)及能耗等因素。因此，评价与环境相关的装置时同样需要考虑经济、技术尤其是生态方面的标准。用于描述生产过程的物流和能流模型构成了生命周期评价(LCA)清单分析的基础。而解释 LCA 结果并综合衡量各类影响的权重则有赖于多指标分析(MCA)，以便广泛包容生态以及经济和技术方面的指标。最新的 LCA 侧重于为决策者或决策委员会提供决策支持。但有关环境设施建设投资的有效决策支持尚不多见。

本文用 MCA 方法分析了表面涂覆工艺部门的相关环境设施建设情况。以移动电话和汽车用聚氯乙烯(PVC)零件的涂覆过程为例，在物质与能量流管理系统的帮助下，作者建立了各类溶剂减量化材料和环境友好型工艺的不同应用情景，并通过一个多指标决策支持模块对上述情景作了分析。本文阐述了 MCA 的一类重要方法 PROMETHEE 优势排序法，并通过灵敏度分析法深入研究了排序结果。文中还对比了 PROMETHEE 法和其它多指标分析方法(如多变量效用法和层级分析法)的不同结果。

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Multi-criteria Analysis for Technique Assessment: Case Study from Industrial Coating

Jutta Geldermann and Otto Rentz

KEYWORDS:
decision support, life-cycle assessment (LCA), mass and energy flow management, outranking, sensitivity analysis, volatile organic compounds (VOCs)

SUMMARY:
Environmental policy is oriented toward integrated pollution prevention, taking into consideration all environmental media (air, water, land) and energy consumption. Therefore, methods for assessing environmentally relevant installations are needed which take economic, technical, and especially ecological criteria into account simultaneously. Mass and energy flow models are used for the representation of production processes and form the basis for the inventory phase in life-cycle assessment (LCA). For the interpretation of LCA results and the weighting of the aggregated impact assessment indicators, approaches of multicriterion analysis (MCA) have been proposed. These can analyze ecological aspects as well as economic and technical criteria. Recent developments in LCA focus on decision support for policy makers or decision boards. Appropriate support for investment decisions on environmentally relevant installations, however, is rare.

Based on a case study of the sector called surface coating, an MCA of environmentally relevant installations is described. With the help of a mass and energy flow management system, alternative scenarios, depicting the use of solvent-reduced materials and environmentally friendly techniques, are modeled for the job coater processes in case studies of coating of mobile phones and coating of polyvinyl chloride (PVC) parts destined for the automobile industry. The modeled scenarios are further analyzed by using a multicriterion decision support module. The application of the outranking approach PROMETHEE is illustrated. A further investigation of the derived ranking can be obtained through sensitivity analyses. Moreover, the results derived by PROMETHEE are compared with the outcomes of the multicriterion approaches multiattribute utility theory and analytical hierarchy process.

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题目：从公共健康的角度反思环境表现：工业比较分析

作者：Dinah A. Koehler, Deborah H. Bennett, Gregory A. Norris, John D. Spengler

关键字：致癌风险，化学品排放，二恶英，投入产出生命周期评价，多环芳烃(PAH)，有毒化学品排放清单(TRI)

摘要：目前评价工业部门乃至企业和工厂的环境表现时最常使用的指标是污染物或有毒物质排放量。然而这些排放数据并不一定能全面地反应健康方面的影响。本文提出了另一种环境表现的度量方法，即通过经济系统投入产出的生命周期评价分析有害废气的产业链延伸及公共健康风险。CalTOX 是一个多媒介、多路径的环境危害和暴露评估模型，其中一个基于美国有毒化学品排放清单(TRI)的损害函数可用于评价美国人口的致癌风险。以 1998 年的排放数值为参考，本文计算了 116 种 TRI 化学品的 260 类致癌案例，主要包括多环芳烃的摄入风险和制铝及水泥工业的二恶英释放。研究表明少数工业部门的直接排放是美国人致癌风险的主要来源。对大多数工业部门而言，每 100 万美元产出的致癌风险主要来自供应链上游的污染排放。全供应链(直接加上游)风险分析提供了不同于传统的基于单位产出污染排放评价的工业环境表现排序结果。

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Rethinking Environmental Performance from a Public Health Perspective: A Comparative Industry Analysis

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KEYWORDS:
cancer risk, chemical emissions, dioxins, input-output life-cycle assessment, polycyclic aromatic hydrocarbons (PAH), toxic release inventory (TRI)

SUMMARY:
To date the most common measures of environmental performance used to compare industries, and by extension firms or facilities, have been quantity of pollution emitted or hazardous waste generated. Discharge information, however, does not necessarily capture potential health effects. We propose an alternative environmental performance measure that includes the public health risks of toxic air emissions extended to industry supply chains using economic input-output life-cycle assessment. Cancer risk to the U.S. population was determined by applying a damage function to the Toxic Release Inventory (TRI) as modeled by CalTOX, a multimedia multipathway fate and exposure model. Risks were then translated into social costs using cancer willingness to pay. For a baseline emissions year of 1998, 260 excess cancer cases were calculated for 116 TRI chemicals, dominated by ingestion risk from polycyclic aromatic compounds and dioxins emitted by the primary aluminum and cement industries, respectively. The direct emissions of a small number of industry sectors account for most of the U.S. population cancer risk. For the majority of industry sectors, however, cancer risk per $1 million output is associated with supply chain upstream emissions. Ranking industries by total (direct + upstream) supply chain risk per economic output leads to different conclusions about the relative hazards associated with these industries than a conventional ranking based on emissions per economic output.

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题目：废电器的生产者延伸责任制：英国打印机回收的案例研究

作者：C. Kieren Mayers, Chris M. France, Sarah J. Cowell

关键字：电子垃圾，产业生态学，生命周期评价(LCA)，生命周期成本核算(LCC)，产品回收，废电子电器设备(WEEE)

摘要：2003 年 2 月，欧盟开始实行一项废弃电子电器法案（“WEEE” Directive），要求生产者对其所生产的在使用寿命终结后的废弃电子电器产品负责。生产者需要组织、资助废旧电器的回收、处理和再生，使得回收循环达到物质数量的一定比例。这项法令是废电器生产者延伸责任制的一部分，有助于推动世界经济向资源循环利用模式转变。本文以英国打印机回收为例，通过生命周期评价和生命周期成本核算研究了 WEEE 法案可能产生的环境效应。

本研究设定了四种废物管理情景，涉及九类环境影响，结果存在很大的差异，但并无某一种情景绝对优于或劣于填埋处理。环境影响的大小取决于具体的材料类型与废物处理方法。另外，在 WEEE 法案设定的物质回收目标下，回收率、环境影响及回收处理成本之间的作用关系十分复杂，可能会造成一些所料未及的不理想结果。这也许出乎欧盟的意料之外，即基于物质质量的回收目标无法保证厂家根据生产者延伸责任制的目标改进其产品设计。

因此，欧盟需要重新考虑 WEEE 法案的作用范围以确保所有生命周期的环境影响都能得以解决。特别需要研究通过对废物回收处理阶段设定具体的环境目标和技术标准以取代原有的完全基于物质质量的回收利用目标的可行性。

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Extended Producer Responsibility for Waste Electronics: An Example of Printer Recycling in the United Kingdom

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KEYWORDS:
e-waste, industrial ecology, life-cycle assessment (LCA), life-cycle costing (LCC), product take-back, waste electrical and electronics equipment (WEEE)

SUMMARY:
In February 2003, European Union (EU) policy makers implemented a Directive that will make producers responsible for waste electrical and electronic equipment at end-of-life (known as the “WEEE” Directive). Under this new legislation, producers are required to organize and finance the take-back, treatment, and recycling of WEEE and achieve mass-based recycling and recovery targets. This legislation is part of a growing trend of extended producer responsibility for waste, which has the potential to shift the world’s economies toward more circular patterns of resource use and recycling. This study uses life-cycle assessment and costing to investigate the possible environmental effects of the WEEE Directive, based on an example of printer recycling in the United Kingdom.

For a total of four waste management scenarios and nine environmental impact categories investigated in this study, results varied, with no scenario emerging as best or worst overall compared to landfilling. The level of environmental impact depended on the type of material and waste management processes involved. Additionally, under the broad mass-based targets of the WEEE Directive, the pattern of relationships between recycling rates, environmental impacts, and treatment and recycling costs may lead to unplanned and unwanted results. Contrary to original EU assumptions, the use of mass-based targets may not ensure that producers adapt the design of their products as intended under producer responsibility.

It is concluded that the EU should revise the scope of consideration of the WEEE Directive to ensure its life-cycle impacts are addressed. In particular, specific environmental objectives and operating standards for treatment and recycling processes should be investigated as an alternative to mass-based recycling and recovery targets.

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题目：美国制浆造纸工业的分区动态模型

作者：Brynhildur Davidsdottir, Matthias Ruth

关键字：资本年代，动态建模，能量流，温室气体(GHG)排放，物料流，技术变化

摘要：本文提出的模型框架有助于人们深入理解现有政策对产业系统未来可持续发展的影响。该框架定量地分析了美国制浆造纸工业的物料投入与废物流、设备使用年限和投资行为之间的关系。区域设备使用年限模型除纸制品需求之外，还包含了投资决策、设备年限结构及物流能流等信息。对每一个特定时期的设备，该模型给出了其数量、产出结构和各年度设备退役率，以及纸纤维使用和能耗强度数据。本模型考虑了内涵及外在的技术变化、燃料的温室气体排放以及废物的分解及焚烧等因素。对这样一个复杂非线性微分方程系统，本文利用经验估计等式对直至 2020 年的造纸业发展进行了模拟。

本研究揭示了物流、能流之间的经济–物理依赖关系以及能源价格对决策的关键作用。例如在其他因素保持不变的前提时，能源涨价必将不利于废纸的回收，进而对温室气体排放及能源强度变化产生一定影响。数据分析显示美国的能源自给率逐渐降低，同时设备寿命延长，这些都阻碍了资本投入和碳排放强度的快速变化。要通过设备加速更新来促进产业的可持续发展，采取投资推动战略十分重要。

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Pulp Nonfiction: Regionalized Dynamic Model of the U.S. Pulp and Paper Industry

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KEYWORDS:
capital vintage, dynamic modeling, energy flows, greenhouse gas (GHG) emissions, material flows, technological change

SUMMARY:
This article presents a modeling framework that enhances our ability to analyze the implications of policy for future sustainability of industrial systems. The framework quantifies the relationship between physical input and waste flows, capital vintage, and investment behavior in the U.S. pulp and paper industry. A regional vintage model is developed that simultaneously incorporates investment decisions, vintage structure of the capital stock, and physical material and energy flows, in addition to paper demand. Each capital vintage is specified by size, output structure, and age-specific retirement rates, as well as fiber use and energy intensities. Both embodied and disembodied technological change are incorporated, as well as greenhouse gas emissions from fuel use, and decomposition and incineration of waste. Estimated equations are used to simulate industrial futures until 2020, from a system of nonlinear differential equations.

Our results demonstrate the economic and physical interdependence between material and energy flows and the central role energy prices have in decision-making. For instance, an increase in average energy prices, ceteris paribus, will on average discourage paper recycling, which has implications for greenhouse gas emissions as well as for changes in energy intensity. The analysis of the data reveals diminishing rates of energy self-generation, and the immense longevity of capital, which hampers rapid change in input and carbon intensity. This stresses the importance of investment-led strategies in facilitating faster capital turnover to enhance future sustainability of the system.