United States Environmental Protection Agency

Advancing Resource Efficiency in the Supply Chain – Observations and Opportunities for Action

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This document provides U.S. EPA's perspectives on the discussions at the G7 Alliance on Resource Efficiency U.S.-hosted Workshop on the Use of Life Cycle Concepts in Supply Chain Management to Achieve Resource Efficiency that was held March 22-23, 2016. It does not reflect consensus views of workshop participants.

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Contents

Advancing the Use of Life Cycle Thinking to Achieve Resource Efficiency: Challenges and Opportunities for Action

U.S. EPA's Reflections on the U.S.-hosted Workshop on the Use of Life Cycle Concepts in Supply Chain Management to Achieve Resource Efficiency
March 22-23, 2016

INTRODUCTION

In their June 2015 Elmau Summit Declaration and Annex, the G7 nations affirmed the importance of resource efficiency[1] when they established the Alliance on Resource Efficiency. Resource efficiency under the Alliance relates to the protection and efficient use of natural resources throughout their life cycle and the positive impact it has on all three equally important dimensions of sustainability – economic, environment, and social. The Alliance serves as an important voluntary international forum to promote best practices and foster innovation on resource efficiency by sharing knowledge and creating information networks across all sectors of society, including large and small businesses and other relevant stakeholders. Importantly, the Elmau Annex states that "improving resource efficiency and managing materials sustainably through their life cycles are important elements of delivering environmental and climate protection, employment, social benefits and sustainable green growth."[2]

After assuming the G7 presidency from Germany in January 2016, Japan continued the focus on resource efficiency. Japan hosted a G7 Environment Ministers' Meeting May 15-16, 2016, the first G7 Ministerial since 2009. The resulting G7 Toyama Environment Ministers' Meeting Communique and "Toyama Framework on Material Cycles" reaffirmed the Ministers' strong commitment to resource efficiency and to the G7 Alliance on Resource Efficiency, in combination with the 3Rs. The May 27, 2016 G7 Ise-Shima Leaders' Declaration endorsed the Toyama Framework on Material Cycles. In addition to establishing the Alliance, the 2015 Elmau Summit Declaration and Annex had requested that the Organisation for Economic Cooperation and Development (OECD) and the United Nations Environment Programme International Resource Panel (UNEP IRP) develop reports on resource efficiency for the G7, and these reports were completed in May 2016.

[1] The overarching principles that inform resource efficiency are shared by a number of other strategies related to conserving natural resources that have been advanced by G7 countries and other organizations to achieve sustainability goals (including economic considerations). These strategies include Sustainable Materials Management, Circular Economy, Industrial Symbiosis, and the 3Rs (Reduce, Reuse, and Recycle). It is important to note that the G7 countries have adopted the term "resource efficiency" under the G7 Alliance on Resource Efficiency and have emphasized common, shared principles in a way that does not detract from country-specific approaches.

[2] Annex to the Leaders' Declaration G7 Summit 7-8 June 2015, p. 6.

On March 22-23, 2016, the United States hosted a workshop in Arlington, Virginia, under the G7 Alliance on Resource Efficiency. During the workshop, participants shared challenges, "best" practices,[3] and ideas for action that spanned efforts to address life cycle considerations to achieve resource efficiency. The U.S.-hosted workshop was not designed to produce consensus recommendations or agreements among participants, but rather to share information about practices, tools, resources, and programs; provide a forum for industry, policy makers, researchers, and interest groups to explore key challenges; and generate potential ideas for voluntary individual and collective action. The U.S. EPA views the workshop as an important step toward identifying actions that will help institutionalize the application of life cycle concepts in supply chain management to achieve the effective and efficient use of material resources.

While the workshop used several examples from the auto sector to generate discussion, many conversations transcended any particular industry sector and identified more universal challenges and best practices. This was due in large part to the diversity of workshop participants. The workshop included approximately 190 representatives from the governments of nine countries (all G7 countries, as well as from South Korea and the Netherlands), individual industries and industry associations, non-governmental organizations (NGOs), international organizations, academia, and others.

The purpose of this report is to distil the robust and constructive workshop discussions captured in the Workshop Summary Proceedings released in June 2016[4] into critical areas for targeted life cycle-based resource efficiency dialogue and action[5] that can facilitate efforts to mainstream and institutionalize resource efficiency. In particular, the seven critical needs areas that the U.S. EPA has identified for this report, based on workshop discussions, can inform future focused dialogues in appropriate forums on short- and long-term actions which individuals and organizations from various sectors of society can champion. Under each critical needs area, questions are posed that should be addressed in the context of the challenges, "best" practices, and potential actions which can be found in Appendix 1.

THE CHALLENGE WE FACE

The challenge we face is to establish mechanisms to scale up and institutionalize resource efficiency broadly across economies globally. The traditional media-specific, end-of-pipe approach has been important in protecting the environment, but we must also adopt a new and more holistic, systems-based lens through which to address environmental, as well as economic and social challenges.

[3] For the purposes of this report, "best" practices include those practices or activities shared at the workshop that are yielding positive results for the organizations implementing them. The applicability of transferring these practices will require further deliberation and analysis. Moreover, these examples are not necessarily the only practices that are being used. However, they provide good starting points for advancing resource efficiency efforts.
[4] https://www.epa.gov/smm/workshop-summary-proceedings-document-g7-alliance-resource-efficiency-us-hosted-workshop-use
[5] Our future conversations and actions should build on the important observations and innovative approaches identified by the U.S.-hosted G7 workshop participants. It is important to note that, although the practices, activities, tools, and programs captured in this report are innovative and exciting, further examination is necessary to determine whether they are replicable or broadly applicable. In addition, organizations not represented at the workshop may use other successful practices that were not discussed. That being said, the approaches described at the workshop offer excellent examples of what is already being done and provide good starting points for targeted dialogue around critical needs for a resource efficiency transformation.

As noted in the OECD's *Policy Guidance on Resource Efficiency* report (OECD Report),[6] "while the G7 and other OECD countries have gradually decoupled their use of material resources from economic growth, their per capita material consumption remains significantly above the world average. Decoupling in developed countries has also been insufficient to compensate for increased demand for material resources in the rest of the world. Recent decades have witnessed an unprecedented growth in demand for resources. This has been driven by the rapid industrialisation of emerging economies and continued high levels of material consumption in developed countries…..On current trends of population and economic growth, global material resource consumption is expected to double by 2050……Unless environmental management and resource efficiency are significantly improved, natural assets will continue to degrade and become scarcer, with potentially serious adverse economic, social, and environmental consequences."[7] Regarding resource efficiency policy, the OECD notes that:

- "Resource efficiency policies can help to counteract these trends and generate significant positive impacts for the economy and the environment."[8]
- "Realizing the benefits of resource efficiency requires concerted and coherent policy action by governments in order to respond to the systemic challenge that is posed."[9] While their recommendations mainly focus on government policy at the domestic level, the OECD notes: "as the globalisation of our economies continues and value chains stretch across multiple jurisdictions, there is an increasing need for co-ordinated approaches at the international level. The G7 can play an important role in this respect, including by supporting businesses in their supply chain management efforts, addressing trade and investment related obstacles, using official development assistance to support resource efficiency efforts, and improving environmental labelling and information schemes, as well as resource efficiency data and indicators more broadly."[10]
- "Policy instruments generally have been applied downstream in the product lifecycle rather than upstream……Policy mixes would benefit from strengthening instruments that target product design and that increase demand for resource-efficient products……Implement policies that promote resource efficiency across the lifecycle of products."[11]
- It is important to "treat resource efficiency as an economic policy challenge and integrate it into cross-cutting and sectorial policies." In addition, "Opportunities should be sought to exploit synergies with other policies, including climate change: there are many win-win opportunities in pursuing low-carbon and resource efficiency objectives."[12]

Innovation is essential to resource efficiency. The OECD Report notes that "some governments are targeting innovation support on SMEs [small and medium-sized enterprises], often the source of radical innovation."[13] It advises to "avoid policy measures that create barriers to the entry of new firms to markets; establish an enabling environment to facilitate innovation and the take-up of resource-efficient products and processes in SMEs."[14]

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[6] OECD (2016), *Policy Guidance on Resource Efficiency*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264257344-en
[7] OECD (2016) Report, p. 11-12.
[8] OECD (2016) Report, p. 12.
[9] OECD (2016) Report, p. 13.
[10] OECD (2016) Report, p. 17.
[11] OECD (2016) Report, p. 13-14.
[12] OECD (2016) Report, p. 15.
[13] OECD (2016) Report, p.15.
[14] OECD (2016) Report, p.76.

The UNEP IRP's *Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel* (UNEP IRP Report) reflects similar findings to the OECD Report. The IRP observes that "data suggest that while long-run relative decoupling of material extraction from GDP can be observed at a global level, this relative decoupling is not sufficient to prevent a persistent increasing trend in absolute resource extraction. Indeed, in contrast to the long-run relative decoupling trend over the 20th century, recent years' data suggest that resource extraction has begun to increase at a faster rate than GDP, suggestive of 'recoupling'."[15] In a subsequent report, the IRP expands upon this observations: "the material intensity of the world economy has been increasing for the past decade, driven by the great acceleration that has occurred since the year 2000. Globally, more material per unit of GDP is now required. Production has shifted from very material-efficient countries to countries that have low material efficiency, resulting in an overall decline in material efficiency."[16]

The IRP also notes that "improving resource efficiency is indispensable for meeting climate change targets cost effectively."[17] Further, in their "*10 Key Messages on Climate Change*" for COP 21, the IRP concludes that "raising resource productivity through improved efficiency and reducing resource waste … can greatly lower both resource consumption and GHG emissions. Such measures also confer additional, highly desirable social benefits such as more equitable access to resources and invaluable environmental gains such as reduced pollution. Decoupling economic growth and human wellbeing from resource use has, therefore, to be an integral part and prime concern of climate policy."[18]

At the same time, the IRP states "increased resource efficiency is practically attainable. There are numerous examples from countries around the world at very different stages of development of increasing the resource efficiency of different sectors and economic activities, and thereby gaining social, environmental, and economic benefits……The challenge for policy-makers is to learn from and scale-up these good practices, and to conceive and implement a set of transformative policies suitable to countries' specific circumstances." [19]

CRITICAL NEEDS AREAS FOR RESOURCE EFFICIENCY TRANSFORMATION

It is critical to mainstream and institutionalize the use of life cycle concepts in decision-making if we are to achieve the effective and efficient use of natural resources. Life cycle thinking and tools enable us to realize resource efficiency and the next generation of sustainable environmental improvement by strategically applying a range of solutions across the life cycle of products and services. These strategically applied solutions can maximize positive environmental, social, and economic results and minimize unintended negative impacts.

Leading organizations have embraced life cycle thinking and are already demonstrating the effectiveness of systemic approaches in advancing resource efficiency. They are saving valuable resources (e.g., water, energy,

[15] UNEP (2016*) Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel*. Ekins, P., Hughes, N., et al., p. 15.

[16] UNEP (2016). *Global Material Flows and Resource Productivity. An Assessment Study of the UNEP International Resource Panel.* H. Schandl, M. Fischer-Kowalski, J. West, S. Giljum, M. Dittrich, N. Eisenmenger, A. Geschke, M. Lieber, H. P. Wieland, A. Schaffartzik, F. Krausmann, S. Gierlinger, K. Hosking, M. Lenzen, H. Tanikawa, A. Miatto, and T. Fishman. Paris, United Nations Environment Programme. Page 16.

[17] UNEP (2016) *Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel*. Ekins, P., Hughes, N., et al., p. 4.

[18] UNEP (2015a). The International Resource Panel: 10 key messages on Climate Change. Paris, France: United Nations Environment Programme.

[19] UNEP (2016) *Resource Efficiency: Potential and Economic Implications. A report of the International Resource Pane*l. Ekins, P., Hughes, N., et al., p. 5.

extracted materials), reducing toxic releases, and preventing greenhouse gas (GHG) emissions in ways that contribute positively to their bottom line. By working with government agencies and involving partners across the supply chain, private-sector organizations are engaging in new ways of doing business that ensure more resilient operations and add value throughout the economy.

Both the OECD and UNEP IRP reports note the key role life cycle approaches play in achieving resource efficiency. According to the OECD, "resource efficiency policies should target the entire life-cycle of products," and "national policies should put more emphasis on aligning sectoral policies in diverse areas like innovation, investment, trade, education and skills development with resource efficiency objectives." Further, "Life cycle approach and policy coherence could be explicitly supported by the G7."[20] Given the sense of urgency that led the G7 Leaders to create the Alliance on Resource Efficiency, which was reinforced by the recent OECD and UNEP IRP reports to the G7, international cooperation and collaboration across all parts of society are an integral piece of realizing the promise of resources efficiency.

Workshop discussions point to seven areas that are critical to advancing resource efficiency broadly in the supply chain and the economy. The summary of challenges, best practices, and potential actions identified during the U.S.-hosted G7 Workshop, which are found in the appendix of this report, support and bring additional context to the seven critical areas that follow.

COLLABORATION AND INFORMATION EXCHANGE FOR RESOURCE EFFICIENCY INNOVATION ACROSS THE LIFE CYCLE

Life cycle thinking and solutions are critical to achieving resource efficiency, and this requires collaboration – including cross-industry collaboration as well as collaboration among public, private, academic, and non-profit institutions – and information exchange across the life cycle. Workshop participants clearly emphasized the need to break down silos and organizational barriers and communicate effectively across the life cycle. Designers, suppliers, recyclers and refurbishers, customers, government representatives, competitors, and NGOs such as environmental organizations and academia – as well as representatives from other industry sectors or fields of practice – all must be engaged. Because resource efficiency ideas and information can come from anywhere, it is critical that this communication be frequent, open, and solution-oriented. Further, resource efficiency must be a priority when engaging with supply chain networks. Getting commitments from first-tier suppliers to champion resource efficiency measures to lower-tiered suppliers can spur progress across the full product life cycle. Resource efficiency and sustainability topics should be included in meeting agendas, even if manufacturers do not have specific life cycle-based resource efficiency targets in supplier agreements.

Neutral forums for business innovation are key to collaboration around resource efficiency**.** Existing government policies and practices, as well as the competitive nature of business, can make it difficult for companies to collaborate, whether it is across sectors, within sectors, or within supply chains. It is important to create "frictionless environments" that facilitate resource efficiency across the supply chain. Industries and institutions must work together to overcome challenges they may encounter in resource efficiency efforts – these challenges are often the source of innovation and opportunity. For example, promoting more standardization across materials can help drive efficiency by facilitating reuse, recycling, and remanufacturing. Changing perceptions about the quality of recycled or remanufactured goods can enhance their desirability and open new markets for these

[20] OECD (2016) Report, p. 9.

materials. Opportunities to reduce friction also exist with respect to building codes, regulations, insurance rates, and product and part warranties.

Both more immediate and longer-term opportunities for operationalizing and scaling up best practices and tackling common issues can be realized with the use of neutral forums that facilitate dialogue and collaboration. During the workshop, the Suppliers Partnership for the Environment (SP) and the Automotive Industry Action Group (AIAG) were offered as two examples of organizations that have successfully created an environment for pre-competitive collaboration. The SP was created by a group of leading original equipment manufacturers (OEMs) and suppliers who were looking for constructive ways to work within the supply chain and between small and large businesses. AIAG is a not-for-profit association whose membership includes retailers, suppliers of all sizes, automakers, manufacturers, service providers, academia, and government. They work collaboratively in a non-competitive, neutral, legal, and open forum to streamline industry processes through global standards development and sharing of harmonized business practices. Neutral forums can come in many forms, including:

- Opportunities for manufacturers to work with suppliers and recyclers or refurbishers in non-competitive or pre-competitive situations.
- Cross-industry collaboratives that promote information sharing and joint problem solving for common challenges.
- Public-private partnerships to advance innovative approaches in more flexible regulatory environments.

The following key questions can help guide targeted exploration using collaboration and information exchange to generate resource efficiency innovation across the life cycle:

- What more can government agencies do to create and expand the use of neutral forums?
- How can these types of collaborative models be replicated in other sectors and expanded within existing sectors?
- How can industry use pre-competitive forums to advance material life cycles and resource efficiency across supply chains?
- What barriers and opportunities exist to using these forums to address both international and domestic needs: How can barriers be addressed and opportunities realized?

PUBLIC AND PRIVATE SECTOR PROCUREMENT PRACTICES THAT DEMAND RESOURCE EFFICIENT PRODUCTS AND SERVICES

Public and private sector procurement practices can stimulate the development of products and services that are more resource efficient over their life cycles. Procurement has long been an important tool for achieving sustainability goals by sending market signals to encourage innovation in product design and helping to create new markets for environmentally preferable products and services. Because of its buying power, government has an important role to play in advancing resource efficiency through procurement practices. Many workshop participants noted the important work they were doing to ensure procurement professionals within their organization are well versed in sustainability and life cycle thinking and are spreading these messages across the supply chain. These efforts ranged from annual meetings with suppliers to discuss sustainability and resource efficiency goals, to robust supplier training programs to ensure supplier understanding of life cycle information

requests, to mentoring programs to promote competencies across the supply chain that encourage life cycle thinking and resource efficiency.

In the U.S., the Sustainable Purchasing Leadership Council (SPLC) works with over 150 leadership organizations across the public, private, and civil society sectors that collaborate to develop a shared program for guiding, benchmarking, and recognizing leadership in sustainable purchasing. SPLC equips procurement professionals with resources to make strategic institutional purchasing decisions that send a collectively harmonized message down the supply chain regarding the value of sustainable products. In Italy, Green Public Procurement regulations dictate the mandatory use of goods and services that meet "minimum environmental criteria," while the "Made Green in Italy" program aims to increase the competitiveness of Italian eco-products. France is also focusing on a more sustainable public procurement policy in order to meet national goals of halving landfill use and increasing recycling rates to 65% by 2025.

Workshop participants observed the need to continue work to reduce confusion and overlapping ecolabels and standards programs in the marketplace, which are important for procurement decisions. This point was echoed in the OECD Report: "Ecolabels are an effective way to promote resource efficiency through more informed purchases by consumers and institutions, as long as the labels are meaningful." However, the Report also noted that "some degree of harmonisation in the growing field of environmental labelling and information schemes" is needed.[21] The workshop participants cited, as a good start, the role of U.S. EPA, in collaboration with other federal agencies, in piloting the Draft Guidelines for Product Environmental Performance Standards and Ecolabels for Voluntary Use in Federal Procurement, which assists federal buyers by addressing the challenge of greenwashing in ecolabels and standards.

In general, workshop participants felt that developed countries should continue to serve as serious change agents in the area of resource efficiency. In particular, these countries should continue to work to achieve improved industry and international standards and certifications on resource efficiency and more standardized and accepted consumer-side eco-labelling to drive positive change.

The following key questions can help guide targeted exploration of public and private sector procurement practices that demand resource efficient products and services:

- How can government agencies and procurement officials become more aware of and involved in developing credible ecolabels and standards? How might this work inform procurement both domestically and internationally?
- What are the key barriers and opportunities that exist in terms of ecolabels for organizations that operate internationally, and what sort of international effort is needed to address them?
- How do we effectively develop multi-attribute labels that better reflect the life cycle impacts of products?
- How can procurement play a role in securing the economic and environmental benefits that can be achieved through the use of more resource efficient alternative business models?
- U.S. EPA hopes that the current efforts to educate, galvanize, and call procurement professionals to action to advance resource efficiency will continue and that public and private sector organizations can work together to address key questions such as the following:

[21] OECD (2016) Report, p. 10 and 49.

- How can procurement professionals in both the public and the private sectors be better informed about the importance of resource efficiency, and how can they better apply techniques to help their organizations procure resource efficient products and services?
- How can "standardized" contract language be employed to facilitate resource efficiency?
- What additional tools are needed to ensure that organizations of every size are aware of and make resource efficiency a priority in their procurement practices?

- As the demand for life cycle information grows, procurement professionals will play an increasingly important role in ensuring that consistent data are collected across the supply chain to meet information needs. It will be important that these requests are clear and compelling. U.S. EPA knows there are tremendous opportunities to improve information flow and quality. Answers to the following two questions may advance resource efficiency and reduce burdens across product life cycles:
  - What can be done to simplify or standardize surveys/questionnaires sent to suppliers? This includes company-specific surveys and questionnaires, as well as those developed by NGOs organizations such as the Carbon Disclosure Project, Dow Jones Sustainability Index, Global Reporting Initiative, and Sustainability Accounting Standards Board.
  - How can government agencies and procurement officials become more aware of and involved in developing credible ecolabels and standards? How might this work inform procurement both domestically and internationally?

MECHANISMS FOR SHARING RESOURCE EFFICIENCY INFORMATION AND RESOURCES WITH A RANGE OF AUDIENCES

Effective public and private mechanisms for collecting and synthesizing resource efficiency information – including life cycle data and case studies, as well as providing access to other resources, technological advances, and innovations – are essential to advancing resource efficiency goals and life cycle thinking. Sharing mechanisms will enable organizations to monitor and capitalize on emerging trends (e.g., in technology, digitization affects how products are connected to each other and to their users) that may impact resource efficiency efforts and innovative business models (e.g., that can change design and use of products and value creation) in ways that advance resource efficiency.

A number of organizations have already created "sharing" mechanisms. For example, in the public sector, resource and energy efficiency and life cycle thinking are integral to work underway by UNEP to promote sustainable consumption and production (SCP) in both developed and developing countries. UNEP has created a Sustainable Consumption and Production Clearinghouse to help develop and share information through workshops, webinars, and other means. In the private sector, the World Business Council for Sustainable Development, a CEO-led organization dedicated to businesses' role in sustainable development, offers guidance, tools, case studies, and other important applied information to businesses and organizations. In addition, governments have mechanisms for sharing resources and information, an important function of government.

In general, workshop participants felt that the G7 should continue conversations on resource efficiency and life cycle thinking topics and use existing international mechanisms (e.g., UNEP, WBCSD, etc.) to promote standardized nomenclature, encourage disclosure of and access to resource efficiency data and information, and share best practices. These efforts should engage business-centric organizations as well as intergovernmental organizations to ensure that all business types can capitalize on resource efficiency information to advance their efforts.

The following key questions can help guide targeted exploration of mechanisms for sharing resource efficiency information and resources to the full range of potential users:

- Are there existing mechanisms or platforms that can be used to broadly share resource efficiency information? If so, what information is being shared or should be shared through the existing mechanisms or platforms, and how? What can be done to gain broad use of these mechanisms to resource efficiency purposes?
- What appear to be the more effective mechanisms in supporting the adoption of resource efficiency and life cycle thinking and approaches?
- What mechanisms seem to be more appealing or effective with public sector users, NGOs, and private sector users? What makes these mechanisms successful?
- How are these existing mechanisms meeting customer or stakeholder needs and what gaps remain? How can these gaps be addressed?
- What are the biggest challenges faced in developing, implementing, and replicating effective mechanisms to ensure continuity and consistency? How can these challenges be addressed?

RESOURCE EFFICIENCY BUY-IN WITHIN AND ACROSS ORGANIZATIONS

Effective actions that are resource efficient align with and create business value. Advances in resource efficiency will come from embracing a learning and adaptive mindset that builds on successes, promotes safe exploration of new ideas, and continually responds to changes in markets and customer needs. Resource efficiency accomplishments require visionary leadership, must be clearly important at the highest levels of an organization, and need to be incorporated into the organization's overall strategy.

Business cases and pilot projects play an important role in demonstrating the importance of resource efficiency efforts and in conveying related best practices by explaining how life cycle thinking is applied in practice and documenting successes. Many individuals and organizations are not fully aware of the opportunities associated with resource efficiency and life cycle thinking and do not fully understand that resource efficient practices can also be good business practices. Business cases and pilot projects can also serve as important tools to help convince decision-makers to explore resource-efficient approaches and help transfer practices across industry sectors.

Metrics and measures are key tools for making progress toward goals. Internally, they drive corporate action. Externally, they convey priority and direction.

Recognition of resource efficiency achievements motivates and reinforces the right practices**.** Both public recognition programs and acknowledgement by corporate leadership of the importance of life cycle-based resource efficiency and the use of life cycle thinking in business decisions can be important motivators to changing behavior, raising awareness, and advancing innovative practices. Numerous organizations and governments have successfully used environmental and sustainability related awards and recognition to transfer knowledge and lead change. However, workshop participants observed that currently there is no public award or recognition program, either domestically or internationally, specifically for life cycle approaches to achieve resource efficiency. Such a recognition program could acknowledge incremental improvements, as well as innovative practices, and could provide significant benefits in advancing understanding and awareness related to resource efficiency and the life cycle thinking that must underlie it.

The following key questions can help guide targeted exploration to advance resource efficiency buy-in within and across organizations:

- What are good sources of business case studies that already exist and pilots that are already underway related to resource efficiency? What do those case studies and pilots cover? How can these existing business case studies and pilots be communicated more broadly among and within business sectors, and among suppliers to build greater buy-in on resource efficiency approaches?
- What metrics and measures are being used successfully by individual organizations to advance resource efficiency? What makes them successful? How do metrics and measures vary within and across sectors and what are the reasons for differences observed? How can they be aligned? What additional metrics and measures are needed?
- What fiscal incentives are in use to advance resource efficiency? Which ones are most effective? What additional incentives could be used?
- What would an international recognition program for life cycle approaches to resource efficiency look like? How would achievements be evaluated? Who would lead such a program?
- How would governments, businesses, and NGOs work together to develop or sponsor a meaningful recognition program?
- For those organizations that already have awards and recognition programs, consider the following questions:
    - How might existing awards and recognition programs be adapted to better incorporate life cycle thinking, or would a separate program make more sense?
    - How can awards and recognition programs be used to promote consumer awareness and demand for life cycle information?
    - Within public and private organizations, how can recognition be used more effectively by leadership to help make life cycle thinking an integral part of an organization's culture?

LIFE CYCLE THINKING IN DESIGN AND DECISION-MAKING TO ACHIEVE RESOURCE EFFICIENCY

Data describing the life cycle of materials and their impacts must be transparent, consistent, and readily available to achieve resource efficiency across global supply chains. Workshop participants recognized the importance of life cycle thinking in design and decision-making to achieve resource efficiency and noted the challenges of doing so. They noted that life cycle data and its use need to be made more consistent and transparent across supply chains. More consistent data and more consistency in how data are used across organizations will help identify cumulative impacts. Similarly, the OECD Report notes the importance of life cycle thinking in the creation of policy mixes that cover the full product life cycle and of strengthened data and analysis to support policy development, including improving economic analysis of resource efficiency.

Workshop participants also recognized that purpose drives analysis, affects data collection, and frames answers. When conducting life cycle assessments and related life cycle analytical approaches, the level of analysis, data collection, and the answers that emerge will be framed by the overall purpose of the analysis. As such, it is critical to use the right lens when framing such analytical efforts. The type of life cycle analytical approach may vary depending on an organization's goals and resources. Before beginning any type of analysis, the parameters for the

analysis need to be explored and articulated – this includes the priorities of the analysis and the amount of time and resources available. These factors will help determine the best kind of analysis to be conducted.

A key message from workshop participants was that **life cycle thinking is bigger than just life cycle assessment (LCA).** LCAs are an important tool for determining life cycle impacts; unfortunately, information needed to conduct a full assessment can be difficult to find and the time and cost of an assessment can be prohibitive. Organizations are therefore turning to other approaches for using life cycle information that serve similar goals. Life cycle management (LCM) is a more qualitative approach that can be embedded early in the product design process. Using LCM can lower the barriers to incorporating life cycle thinking into a process and can either serve as an alternative to a full LCA or be a precursor to a more complete assessment. Hotspots analysis is also used to inform decisions by identifying high-priority issues. Like LCM, hotspots analysis is often used as a precursor to developing more detailed or granular sustainability information.

Workshop participants provided concrete examples of how life cycle thinking can be applied using practical tools that fit organizational goals. For example, Whirlpool has used hotspots analysis to look at a variety of different factors to reduce waste and increase the viability of its products. Whirlpool has examined the raw materials used to produce its products, how it packages its products to reduce waste, emissions from the production and use of its goods, and the social and economic impacts its products have. In another example, General Electric has developed a screening LCA tool and a qualitative environmental LCM tool, which is designed to rapidly identify issues which would not necessarily be identified in a typical LCA. Other large organizations such as 3M also embed life cycle thinking in their operations at the earliest stages of product design.

In addition, workshop participations described activities underway to address some of the challenges related to the use of life cycle data, information, and tools. For example, UNEP and the Society of Environmental Toxicology and Chemistry are leading an effort to develop a hotspots analysis methodology framework which can be applied at the product category, sector, city, and national levels. Another example is the development of the Global LCA Database Network which is being led by a UNEP steering committee composed of thirteen governments and facilitated by UNEP. However, it is clear that more work needs to be done – in particular, enabling SMEs to use such information without having to engage in individualized LCA.

The following key questions can help guide targeted exploration, either using existing mechanisms or by creating new opportunities to improve the use of life cycle thinking in design and decision-making to achieve resource efficiency:

- How can we advance the use of more cost-effective life cycle-based tools that produce easy to understand outcomes to help inform business decisions? How can we make it easier and less expensive for SMEs to use life cycle thinking in their decisions?
- How can we institutionalize the use of life cycle findings to inform decisions across the supply chain?
- How can we advance current efforts around life cycle terminology to promote consistency?
- How can we enhance data interoperability? Specifically, how can we balance the need for open, transparent, and high quality interoperable data, while also respecting the need for some data to be proprietary, confidential, or country-specific?
- Government, industry, academia, and NGOs already collect and maintain data that could be used for LCAs in other unrelated programs. How can such existing data sources be more fully utilized and adapted for

life cycle purposes? What issues do existing data sources pose in this regard? What degree of consistency is sufficient if they are to be used most effectively for life cycle purposes?

- Building on the workshop's supply chain focus, how can we advance ideas for actions offered by individual participants, such as standardizing a sector's approach to using life cycle information or collecting information from the supply chain most effectively?

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE

Ensuring the next life of materials and resources needs to be considered throughout the life cycle and must be integral to the design of products and services. Collaborative efforts, therefore, should include players involved in the next life of materials. Early in the design process, designers need to be thinking about how materials can be recycled, refurbished, and reused. Designers should examine how secondary materials can be integrated into the design process. In addition, they should think holistically about the next life of the product and not just how to recycle or reuse individual components. While this critical need area appears to focus more on a particular life stage when compared to the other six areas described in this report, workshop participants consistently identified the next life topic as a priority. In particular, Japan described its research to promote design for environment (DfE) related to recovery and utilization of secondary materials related to vehicles, including evaluating the efficiency of the dismantling process; how to promote proactive selection of "eco-premium" cars; and ways to incentivize higher use of reused parts.

The following key questions should guide targeted exploration to ensure the next life of materials and resources:

- How can government best facilitate the expanded use of remanufactured and refurbished parts domestically and internationally?
- How can government facilitate the purchasing of remanufactured and refurbished parts within the government and more broadly?
- What can government agencies do to expand secondary markets?
- How can industry use pre-competitive forums to advance next life considerations across supply chains?
- What barriers and opportunities exist to enhance the next life of materials? How can barriers be addressed and opportunities realized?
- What would industry need from government to make these things happen?
- How can the design and procurement process be further aligned to incorporate secondary materials? What is necessary to design for resource efficiency (e.g., reduced material loss; increased recycling, refurbishing, and reusing)?
- How can "standardized" contract language be employed to facilitate the next life of materials and resources?
- How can both economic and environmental benefits be achieved through the use of alternate business models in ensuring the next life of materials?

EFFECTIVE USE OF APPLIED RESEARCH AND ANALYSIS TO SUPPORT INNOVATION

Proving that new approaches or ideas are achievable can be difficult without replicable results. Applied research and development play an important role in exploring opportunities and documenting what can be achieved. Academia, non-profit research organizations, and government can all fill important resource efficiency research needs that businesses cannot reasonably explore alone. In collaboration with government and industry, academia and non-profit research organizations are able to conduct research on innovative ideas and facilitate successful adoption of new approaches through the use of case studies. In this regard, partnerships and consortia to conduct applied research and analysis have been and continue to be important in advancing practices that benefit both business and the environment.

Workshop participants provided examples of applied research to address a number of challenges. For example, the U.S. Department of Energy (DOE) develops working relationships with industry and other organizations to connect scientific discoveries with practical application. They offer innovation vouchers to small businesses, which provide them access through U.S. National Labs to world-class research personnel and cutting-edge tools. Cummins described its work with stakeholders (e.g., customers, government agencies) on upfront design to find the best way to achieve desired gains in fuel and emissions efficiencies and noted their work with the U.S. DOE program on the SuperTruck Initiative. Another example of applied partnerships in innovation is the U.S. government's Investing in Manufacturing Communities Partnership (IMCP) program. IMCP is an initiative that enables communities to leverage economic development funds from across government through the use of comprehensive economic development strategies that strengthen their competitive edge for attracting global manufacturer and supply chain investments.

At the workshop, Germany described its major investment in addressing the light-weighting design challenge in the context of resource efficiency. Another example that was provided on applied research included the collaboration of Novelis, Jaguar Land Rover, Innovate UK (the United Kingdom's agency that supports innovation through applied science and technology), and other partners to mitigate the energy and cost-intensive nature of using primary (virgin) aluminum in the production process, which led to a closed loop value chain that minimized the use of primary material and maximized the use of recycled aluminum during manufacturing. Highlighting opportunities for partnerships involving academic institutions, workshop participants learned how the Rochester Institute of Technology works with Cardone, a small company with 5,500 employees that is taking innovative strides to get to zero environmental waste discharge. Cardone remanufactures over 65 different product lines as part of waste elimination efforts.

The following key questions should guide targeted exploration in using applied research and analysis to support innovation in resource efficiency:

- What are the key research questions that need to be addressed to follow up on the UNEP IRP and OECD reports developed for the G7 in 2016?
- How can we better understand the connection between materials use and GHG emissions so that actions to advance resource efficiency also support domestic and international goals related to climate change?
- Who might spearhead these initiatives and what groups need to be involved to maximize their success?

THE PATH FORWARD

The future of resource efficiency will be shaped by many societal factors. We must make evolutionary and revolutionary advances in resource efficiency – both are critical to success. Industry must continue to refine current products and processes to increase resource efficiency incrementally. Industry also must be thinking about how to make revolutionary advances in resource efficiency by setting aggressive targets, capitalizing on technological advances, and developing new, more resource-efficient business models to address changing customer and consumer needs. These considerations can result in more complex products and services, and industry must work across the product or service life cycle to ensure resource efficiency can be achieved in this challenging environment.

The critical needs areas identified in this report help to highlight both the challenges and opportunities that we face in creating a resource efficient future. The time is now to transform resource efficiency from a concept into a reality. The same sense of urgency that led the G7 leaders to create an Alliance on Resource Efficiency and that was reiterated in the recent UNEP IRP and OECD reports to the G7 was voiced by participants at the U.S.-hosted workshop in March 2016. We need to act now on momentum from the workshop and engage in focused dialogues with leaders who will help champion and shepherd change. Both immediate and longer term transformative change is required to institutionalize resource efficient practices that strengthen both our environment and our economy.

All parts of society have an important role to play in identifying resource efficient opportunities and advancing change. We need to build on existing momentum and become champions for the very innovation, collaboration and change needed to ensure the sustainable use of our global resources and economic prosperity. We can meet the challenge if we work together.

Capitalizing on existing synergies and good ideas, the U.S. EPA will continue to play an important facilitative role in advancing sustainable materials management domestically and internationally through the G7 Alliance. We seek to foster additional collaborative conversations, spur information exchange, and encourage the appropriate leadership of government, industry, non-governmental organizations and academia to champion the path forward in implementing key actions. To this end, and by focusing on the critical needs areas identified in our Observations and Opportunities Report, the U.S. EPA is continuing its engagement with stakeholders interested in advancing the dialogue started during our March workshop.

APPENDIX 1 - SUMMARY OF CHALLENGES, BEST PRACTICES, AND POTENTIAL ACTIONS IDENTIFIED DURING THE U.S.-HOSTED G7 WORKSHOP

During the workshop, participants shared challenges, "best" practices,[22] and ideas for action that spanned efforts to address resource efficiency across the life cycle. The table below includes a summary of these inputs, organized by the critical needs areas identified in this report. More detailed information about specific workshop topics and discussions can be found in the Workshop Proceedings document (https://www.epa.gov/smm/workshop-summary-proceedings-document-g7-alliance-resource-efficiency-us-hosted-workshop-use).

COLLABORATION AND INFORMATION EXCHANGE FOR RESOURCE EFFICIENCY INNOVATION ACROSS THE LIFE CYCLE	
Potential Challenge: Communication across the life cycle network is challenging because of the number of actors – many and layered – and barriers, such as perceived loss of intellectual property and regulatory restrictions (e.g., anti-trust laws). This inhibits transparency in the supply chain, making it challenging to identify improvements and increase resource efficiency.	
"Best" Practices	**Opportunities for Further Action**
• Hold regular meetings with members of your supply chain network to share resource efficiency priorities, success stories, and promote consistent practices for sharing information. Ensure that these conversations happen at the "right" level based on the organization and topic. • Request (or require, where possible) first-tier suppliers to incorporate resource efficiency requirements or priorities into their agreements with lower-tier suppliers. This will encourage resource efficiency across the full life cycle. • Participate in forums for company-to-company interaction that occur outside of competitive environments or are designed to limit potential legal challenges.	• Private sector organizations should be more transparent with material flow information to expand knowledge of impacts and generate new resource efficiency ideas. • Increase the presence of manufacturers in pre-competitive consortia that address the need for consistent, standardized sustainability criteria across product categories or specific products. • Develop a formal system that facilitates sharing of data, lessons learned, and best practices related to implementing life cycle-based resource efficient approaches between large and small companies to promote the fast scaling up of positive initiatives. • Develop public-private partnerships to advance resource efficiency to transform the economy and benefit society. These partnerships would include different sectors and could be value chain-specific.

[22] For the purposes of this effort, "best" practices include those practices or activities shared at the workshop that are yielding positive results for the organizations implementing them. They are not necessarily the only ones that are being used, and they may not work in every setting. They provide good starting points for those interested in advancing their resource efficiency efforts.

PUBLIC AND PRIVATE SECTOR PROCUREMENT PRACTICES THAT DEMAND RESOURCE EFFICIENT PRODUCTS AND SERVICES	
Potential Challenge: Multiple and different requests for life cycle information from manufacturers causes fatigue, confusion, non-response, or missed expectations across the supply chain.	
"Best" Practices	**Opportunities for Further Action**
• Equip and empower procurement staff to engage with suppliers on sustainability topics so they can send a consistent message across the supply chain about the value of resource efficiency. • Offer mentorship and/or training programs to help suppliers understand and comply with the standards or requests for life cycle information.	• Include procurement professionals in future meetings of the G7 Alliance on Resource Efficiency. • Raise consumer expectations and awareness so they can make more informed decisions and drive the demand for resource efficient products. • Increase cooperation at the federal level to reduce confusion regarding overlapping labeling and standards programs in the marketplace. The pilot of EPA Guidelines for Environmental Performance Standards and Ecolabels is attempting to address this issue. • Develop standard survey/questionnaire questions or survey/questionnaire templates to alleviate fatigue and confusion for suppliers.
Potential Challenge: There is not yet a good business case for sustainable purchasing, particularly because organizations do not have good measurements on their returns from engaging in the sustainable purchasing process.	
"Best" Practices	**Potential Actions**
• None identified.	• Conduct additional research on the business case for sustainable purchasing.

MECHANISMS FOR SHARING RESOURCE EFFICIENCY INFORMATION AND RESOURCES WITH A RANGE OF AUDIENCES	
Potential Challenge: There is not a central location to find and share life cycle information, including best practices, processes, and case studies. More data and methodologies need to be made available to users.	
"Best" Practices	**Potential Actions**
• U.S. EPA's Virtual Life Cycle Assessment (LCA) Research Center will be a place to help standardize and streamline the assessment process. It can also be a repository for best practices, case studies, and data. • The Global LCA Data Access Network will provide a central user interface and enable access to life cycle databases and information worldwide, ensuring interoperability through agreed nomenclature and metadata descriptors. http://www.lifecycleinitiative.org/activities/phase-iii/data-and-database-management/	• There needs to be further harmonization of LCA data and information. • Find a way to automate collection of life cycle data and categorize it regionally or by industry. This information should also be shared with stakeholders so they can contribute. U.S. EPA should consider including this type of functionality in its Virtual LCA Research Center.

RESOURCE EFFICIENCY BUY-IN WITHIN AND ACROSS ORGANIZATIONS	
Potential Challenge: It is sometimes difficult to convince decision makers that life cycle approaches make good business sense – they are often focused on short-term costs and not long-term value.	
"Best" Practices	**Potential Actions**
• Document benefits and communicate successes to gain internal buy-in and to convince decision makers to engage in resource efficiency efforts. • Conduct pilots as proofs of concept to convince customers to adopt new resource efficiency practices. • Use media recognition (e.g., features on green-themed shows and specials on different programs) to share information about successful projects and programs to consumers and other companies.	• Develop a national or international program to scale resource efficiency through the sharing of best practices across sectors. • Document more case studies and gather best practices to demonstrate the value of life cycle approaches to resource efficiency. Synthesize information into industry-wide guidance that is publically available. Government action in this area could help address concerns about communication directly between competitors. • In the building sector, increase communication about best practices (e.g., model contract language). There may be opportunities for cross-country collaboration in this area. • Gather more data to figure out the true cost of resource efficiency efforts in the areas of water, energy, land, etc. to help overcome institutional resistance to implementing resource efficiency measures.
Potential Challenge: The monetary benefits of resource efficiency projects are sometimes hidden or difficult to calculate and may not always support action. (e.g., direct material costs are not as salient to businesses as energy costs, so they tend to get less attention. True costs are not necessarily reflected in utility prices.)	
"Best" Practices	**Potential Actions**
• Several organizations (e.g., True Cost) have tools to assist in putting monetary value on environmental capital.	• More work is needed to normalize utility costs to make more accurate resource efficiency calculations.
Potential Challenge: It can be difficult to gain widespread support for life cycle approaches across an organization, especially at a large, global organization.	
"Best" Practices	**Potential Actions**
• Align "sustainability" departments with corporate strategy departments to ensure sustainability and resource efficiency are embedded in strategic planning efforts. • Build key performance indicators and other sustainability measures into corporate strategies. These metrics serve as a tool to communicate progress and provide a framework to guide inputs from suppliers. • A corporate commitment to sustainability as reflected in mission statements, direct statements by leadership, and structural alignment helps instill a level of awareness about the importance of resource efficiency across the organization.	• Develop national and international recognition programs or awards for resource efficiency champions. This could encourage others to support resource efficiency. By staging these programs or awards through well-respected national and international organizations, it would encourage buy-in of and magnify the impact of the programs. • Invest in research and development partnerships to explore and prove new technologies and processes.

RESOURCE EFFICIENCY BUY-IN WITHIN AND ACROSS ORGANIZATIONS	
• Provide institutional incentives for employees to support resource efficiency efforts. • Have an internal sustainability champion to get sustainability programs started and keep them going. In small organizations, consider partnering to share a sustainability professional. • Reporting on savings that result from resource efficiency efforts can get projects the attention they need to be replicated or expanded.	
Potential Challenge: Small and medium-sized enterprises may lack the resources to fund resource efficiency efforts.	
"Best" Practices	**Potential Actions**
• Work with other small companies to share the services of a sustainability or resource efficiency professional. • Leverage (stack) funding opportunities from government, foundations, environmentally responsible investment vehicles, and local governments to build a stronger monetary base to conduct resource efficiency programs. • Access government technical assistance programs to build internal expertise in resource efficiency.	• None identified during the workshop; additional work is needed.

LIFE CYCLE THINKING IN DESIGN AND DECISION-MAKING TO ACHIEVE RESOURCE EFFICIENCY	
Potential Challenge: Full life cycle assessments (LCAs) are expensive, time consuming, and require a great deal of expertise. Obtaining the experts or requisite skills to execute an extensive assessment can be very difficult, especially for companies who have limited resources and cannot employ in-house experts.	
"Best" Practices	**Potential Actions**
• Use more qualitative approaches to assess life cycle information to lower the barriers to incorporating life cycle thinking into a process. They can either serve as alternatives to full LCAs or be a precursor to a more complete assessment, when needed. • Establish a dedicated LCA team that is available to anyone across the company to reduce the barriers to using life cycle information. • Develop processes and procedures that integrate life cycle thinking into regular business processes.	• Create mechanisms to share the cost burden of conducting LCAs across industry, government, and other institutions. This will help reduce the overall cost burden and increase awareness. • Industry leaders should collaborate at pre-competitive stages to conduct major materials LCAs to better understand the most resource intensive production stages and improve resource efficiencies across business sectors. • Develop guidelines or best practices to build LCAs to make it easier to conduct future assessments.
Potential Challenge: There is a need to promote standardized education and nomenclature related to life cycle concepts. This is needed across academic programs to ensure that students are being trained to an appropriate level and across regulators, manufacturers, suppliers, and consumers so they can have more productive dialogue.	
"Best" Practices	**Potential Actions**
• The American Center for Life Cycle Assessment (ACLA) is an important asset that promotes the responsible use of LCA information and brings together universities and federal agencies that are currently engaged in this type of work.	• More partnerships are needed with higher education institutions to generate LCA research and, as a broader goal, ensure that life cycle disciplines are promoted among the next generation of engineers, chemists, and other practitioners. • Organizations should work together to develop a common terminology lexicon for talking about life cycle thinking.
Potential Challenge: Smaller companies often do not have the resources to develop LCAs on their own.	
"Best" Practices	**Potential Actions**
• Use more qualitative approaches to assess life cycle information to lower the barriers to incorporating life cycle thinking into a process. They can either serve as alternatives to full LCAs or be a precursor to a more complete assessment, when needed. • Work with other organizations to share access to LCA and resource efficiency expertise.	• Corporations and SMEs involved in life cycle and resource efficiency work should reach out and participate in the larger LCA and resource efficiency communities. This participation will help drive efficiencies – common and interoperable nomenclatures and sharing of best practices and lessons learned.
Potential Challenge: There are a variety of barriers to collecting data for an LCA because of inconsistent country-specific rules, regulations, and definitions; the global nature of the supply chain; proprietary information concerns; and finding information that may be compartmentalized within an organization.	
"Best" Practices	**Potential Actions**
• Integrate resource efficiency requirements and LCAs into supplier contracts.	• Having a single, federally-managed repository or data center where various LCAs could be compared would help organizations from having to reinvent the wheel every time they plan to conduct a full assessment.

LIFE CYCLE THINKING IN DESIGN AND DECISION-MAKING TO ACHIEVE RESOURCE EFFICIENCY	
Potential Challenge: There is an education and communication gap in the way that LCAs are discussed within the life cycle community and those outside of it. It can be challenging to properly communicate the social, environmental, or economic benefits of a product or process for specific audiences.	
"Best" Practices	**Potential Actions**
• Translate LCA information carefully based on the audience (e.g., design personnel, production personnel), because the value of an assessment may vary.	• Build high-level dialogues with both customers and suppliers based on effectively explained LCA data to help customers and suppliers understand the business case for life cycle thinking and sustainability initiatives. • LCA experts should communicate with stakeholders who use life cycle information and work with them to understand their questions and concerns so they can help close this education gap. • Use LCA information in conjunction with social science as well as economic and other environmental information. Social scientists, in particular, can help inform LCAs in a different but significant way that is different from the contribution of analytic scientists.
Potential Challenge: Social impacts along the supply chain can be difficult to identify accurately and can take significant time to address.	
"Best" Practices	**Potential Actions**
• Understand the culture and social environment of the supply chain before taking action. Some things that may appear to be negative may, in fact, be standard cultural practice. • Set realistic targets for demonstrating and communicating progress on social impact issues. • Carefully consider the intended audience when developing messages around social issues – audiences in developed countries can be very different from those in developing countries. • Strong partnerships between companies, industry collaboratives, and the supply chain are imperative for success. • Use data to inform and educate the public to assist them in understanding the issues, impacts, and ways to address social impacts.	• Companies should look for ways to collaborate and address social impact issues collectively – with trust and transparency. There is more power in being a unified force of good.

LIFE CYCLE THINKING IN DESIGN AND DECISION-MAKING TO ACHIEVE RESOURCE EFFICIENCY	
Potential Challenge: The level of assessment is sometimes difficult to determine. It is often bounded by what is feasible and not by what is possible. Because there are so many factors that are considered, these constraints often limit the work that is done.	
"Best" Practices	**Potential Actions**
• Organizations should stay focused on the outcome as the most important consideration for establishing assessment boundaries. • When setting parameters for a new assessment, looking at previous assessments provides information about what has already been done. Looking at the best examples can lead to more innovative results as opposed to looking at the average of previous assessments.	• None identified during the workshop; additional work is needed.
Potential Challenge: Biodiversity, land use changes, GHG emissions, and other indicators are not typically included in traditional life cycle analyses.	
"Best" Practices	**Potential Actions**
• None identified.	• The World Wildlife Fund (WWF) is working to include biodiversity, land use changes, GHG emissions, and other indicators to provide a more accurate analysis of the impacts to the environment.

Additional Challenges to Improving Access to and Use of Life Cycle Data and Information

- Organizations are often making decisions based on the way the world is today and not how it will be in the future. Technologies are changing so quickly that decisions based on how things are may be the wrong decisions when they are implemented in even the near future. LCAs in particular presume an external stasis, but changes could occur during the assessment process that would make the outcome less valid.
- Incorporating the outcomes of an LCA to existing designs (e.g., material substitution) can be difficult and expensive due the need to prove new solutions can provide the desired performance.
- Creating incentives to perform LCAs.

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE	
Potential Challenge: Communication across the supply chain seldom focuses on "next life" of products, which can limit options for recycling, repurposing, remanufacturing, and reuse. Next life players, in particular, are not at the table with design professionals. This will become increasingly problematic as products become more complex.	
"Best" Practices	**Potential Actions**
• Include recyclers, remanufacturers, and other "next life" representatives in design discussions. • Create formal business relationships between manufacturers and recyclers/refurbishers to eliminate organizational barriers to communication, provide new insights on resource efficiency opportunities, and promote new business opportunities.	• Convene a meeting between the Automotive Recyclers Association (ARA) and OEMs to increase coordination on parts numbers and other issues to facilitate the recycling, reuse, and remanufacturing of auto parts.

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE	
Potential Challenge: Many communities do not see the value add of recycling, especially with the downfall in the commodities markets for plastics and glass. In particular, the creation of new landfills alleviates the need for consumers to find alternative solutions for their waste and also does not incentivize them to reuse or recycle products.	
"Best" Practices	**Potential Actions**
• Work through industry-municipal partnerships (e.g., the Curbside Value Partnership) to develop local opportunities in the secondary market.	• More communication and coordination is needed between local governments, municipal networks (e.g., the U.S. Conference of Mayors), and industry groups to realize the potential of local secondary markets.
Potential Challenge: Secondary markets for materials have lagged because of a focus on landfill diversion. Manufacturers are often more interested in lowering disposal costs than on recovering the highest economic value of material at the lowest environmental cost.	
"Best" Practices	**Potential Actions**
• Engage in cross-sector and cross-supply chain "brain trusts" or non-traditional/uncommon collaborations to address technical issues that facilitate secondary markets. • Utilize new tools and technologies (e.g., Materials Marketplace, Stuffstr) that facilitate the identification of secondary markets.	• A market for recycled composite materials needs to be developed. Otherwise, these materials will continue to go straight to landfills. Use of recycled composite materials should be incentivized to help develop this new market.
Potential Challenge: The value of recycled materials fluctuates. They may not always be profitable.	
"Best" Practices	**Potential Actions**
• Do not assume that recycling program costs will be covered by the recycling revenues. Commit to programs even when they do not generate a lot of revenue.	• Researchers should investigate reuse and recycling costs/benefits. This information will help consumers, government, stakeholders, and other industries understand how to minimize costs and develop cost sharing models.
Potential Challenge: Companies that commit to using recycled or recovered materials require robust and steady feedstocks. Recycling rates need to increase to ensure viable secondary materials streams.	
"Best" Practices	**Potential Actions**
• Focus efforts on venues or processes that generate a lot of waste. • Make it easy for people to provide you with materials. • Focus on recycling and recovery efforts internally to learn how to increase recycling in similar external environments. • Reward recycling behavior. • Look for opportunities to educate AND recycle. (e.g., providing rewards to kids' schools for their recycling efforts not only is an effective way to get back material, but it can also instill a recycling ethic that they take with them into adulthood.)	• Continue current incentives to encourage recycling and think of new and different ways to promote the recycling industry. • Industry needs to identify uses for recycled materials when markets plateau as a way to keep up the demand for recycled materials.

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE	
• Identify products that make the most sense to recycle, such as those with the fewest contaminants. • Standardized materials help facilitate resource efficiency efforts related to "next life" of materials.	
Potential Challenge: Several barriers can inhibit "next life" activities – especially remanufacturing and reuse – including lack of electronic data on parts, regulations that may prohibit recycling and reuse of some materials or products, the need to reverse supply chains for remanufactured products, tariffs on packaging that could disincentivize the use of environmentally preferable solutions, and lack of data about previously used materials.	
"Best" Practices	**Potential Actions**
• Look at creative reuse of materials in addition to recycling. For example, materials from old tires are being used in new air bags and shipping boxes used as roof liners. • Remanufacturing efforts should first focus on long-term use goods. These types of goods provide the most remanufacturing opportunities because they may be needed after the manufacturer stops producing original parts. • Utilize logistics chains to enable remanufacturing and recyclability. Suppliers should be set up to receive used parts as raw materials for either remanufacturing or recycling. • Implement a strong service model (such as the one at The Xerox Company) to maintain a high standard of quality and use throughout the life of products. • Promote consistent use of terminology. For example, remanufactured products are different from "as good as new," as they are completely new products. Companies typically offer the same pricing and guarantees for a remanufactured product as for a product made of virgin-sourced materials. • Establish partnerships between manufacturers and recyclers to create take-back programs. This helps control the recycling process and facilitates the tracking of parts throughout the entire life cycle. • Use easily recyclable alloys and other materials to aid in the ability to recycle multiple scrap types. • Educate stakeholders to help them understand more about the products, how they should be used, and how they can be reused or recycled	• Large organizations and governments should set market expectations for 4R material through corporate policies and government regulations that ensure good market conditions for 4R material. • Examine policies that impede remanufacturing opportunities, such as the standardization of remanufactured product warranties that are equivalent to new product warranties. • Explore how to better incorporate remanufacturing and reuse of products into the supply chain. Academia is well position to take a systems or multi-disciplinary approach. This research could then be used to inform government guidance and policy. Industry can support this effort by providing data and resources necessary to complete the research. • Modernize systems to access automotive parts data globally. OEM and recycling company representatives should meet to identify approaches without new legislation. • U.S. EPA and U.S. DOE should coordinate more closely and develop a common message on battery recycling and reuse. Uncertainty or conflicting communication acts as a barrier to corporations acting in a proactive manner. • Look into updating the Digital Millennium Copyright Act to address, or increase, the availability of open systems for parts data and software ownership. • Expand research and development efforts in the areas of recycling and remanufacturing technology so that new innovations can be made to move the industry forward. • Educate the remanufacturing community about the current Enterprise Resource Planning capabilities of the auto recycling industry. • Improve the software to support reverse logistics to increase the efficiency and recovery of parts.

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE	
at the end of life. Plastics and "bio-based" industries, in particular, have educated their consumers about the value and costs of recycled materials to increase recycling rates and promote proper recycling methods. • Understand the economics behind recycled materials and total costs of recycling versus raw materials.	• Create a common set of standard operating procedures (SOPs) for safety for the auto recycling process that will help ensure safe handling of materials to be recycled (e.g., to ensure that all airbags are deployed prior to the vehicle being sent to the shredder).
Potential Challenge: There is a negative perception that recycled, remanufactured, or refurbished goods do not perform the same as their new counterparts, which prevents their use.	
"Best" Practices	**Potential Actions**
• The sharing economy is an approach to enhance the perception and economic value of refurbished and remanufactured products, as the customer is looking for service, not a particular product.	• Supporting leasing, service, and innovative ownership models could have significant impact in encouraging remanufacturing, as customers would then have an incentive to bring a product in for an upgrade, rather than maximizing the use of the product, or just throwing the product out once it has been used. • Explore how to develop new, remanufactured, and recycled materials that exceed current physical properties and uses. • Industry representatives should work together to establish an international standard for remanufacturing similar to ISO 90001 that can be audited, inspected, and certified. • Manufacturers need to work with their customers to get a better understanding about the intersection between consumer demand and recycled content. They need to know when consumers feel that more recycled content is needed and when it may spark concerns about product reliability, quality, and cost. • Companies should work to create alternative business models where consumers use/disuse products, rather than own products. Companies would then decide when and how to recycle products more efficiently. • OEMs and recyclers should explore the potential for "Design to Upgrade" models. For example, design powertrains that can be upgraded later in life to enhance efficiency. • Change government regulations so that commission rates for collision repair shops are generic to a part – a flat fee – so that the part chosen for the repair is the best value for the consumer. Currently, commissions are based on a percentage of the sale, which favors new, more expensive parts. • Government could require remanufacturing and refurbished products when conducting public procurement. Once the policy is proven successful (e.g., recycled parts perform well in government

DESIGN WITH THE "NEXT LIFE" OF MATERIALS IN MIND – END OF USE IS NOT THE END OF LIFE	
	vehicles), the program can be promoted to drive private sector interest in recycled parts. • Work to make remanufacturing "cool" – undertake a campaign to publicize the benefits of remanufacturing to millennials in an effort to enlist their support for remanufactured products. • Define remanufactured parts as equal to new in Free Trade Agreements. • Expand right-to-repair policies so they apply to reused and remanufactured parts, meaning that all parts are warrantied and can be used when repairing or servicing products. • Recyclers would support legislative changes to classify recycled materials as a resource versus a solid waste. Additional outreach, education, and communication are needed to promote buy-in.

Additional Challenges to Ensuring the "Next Life" of Materials

- It is cost prohibitive to recover some materials, and sometimes the recycling process can change the material's functionality.
- Recycled products can be hard to trace when they are comprised of a mix of source materials. There is often little or no downstream data across certain industries and countries, so there are gaps in information preventing full knowledge of the life cycle and creating uncertainty about how to recycle them.

USE APPLIED RESEARCH AND ANALYSIS EFFECTIVELY TO SUPPORT INNOVATION	
Potential Challenge: Proving new approaches or ideas are achievable with replicable results.	
"Best" Practices	**Potential Actions**
• None identified.	• New ownership models and service systems. Research is needed to understand how these new business models impact resource efficiency and change consumer behavior. For example, they may encourage remanufacturing, as customers would then have an incentive to bring a product in for an upgrade. They may also change materials use practices as products are designed for durability and reuse. • The impacts of climate change on industry and supply chains. This should include an assessment of the interconnections between developed and developing countries, especially in the area of potential supply chain disruptions resulting from climate change impacts.

USE APPLIED RESEARCH AND ANALYSIS EFFECTIVELY TO SUPPORT INNOVATION	
	• Designing products with minimal raw materials and transparent supply chains. This design model would allow for increased recycling efficiency and lower environmental impact. Information on the material and energy used throughout the product's life cycle could then be made available to the international community to be leveraged to make more environmentally preferable designs of other products. Systems would have to be developed that would allow the sharing of this information in a manner that does not jeopardize competitiveness. • Developing clear resource efficiency measurement tools across sectors. Driving material to its highest use will require clear measurement tools, metrics, and analytical boundaries. These could be developed through public-private partnerships and encouraged through the use of market incentives. • Explore whether a vehicle could be developed from 100% recycled materials. Research and analysis on such a project would involve the whole life cycle of materials, from sourcing to design to end-of-life management (or next life). Government, academia, industry, and NGOs all have important roles to play in undertaking applied research and analysis of this nature. • Explore the connection between resource use and GHG emissions. This is important for understanding how action to advance resource efficiency also supports domestic and international goals related to climate change.