"Green Servicizing" for a More Sustainable US Economy:

Key concepts, tools and analyses to inform policy engagement

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US Environmental Protection Agency
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This report builds on the conceptual foundations of the 1999 Tellus Institute report commissioned by US EPA’s Office of Resource Conservation and Recovery (then called the Office of Solid Waste): *Servicizing: The Quiet Transition to Extended Product Responsibility*. Its approach and analysis are substantially informed by the experience of the 3-year Green Product Service System research initiative of the Institute for Global Environmental Strategies, Japan.

**While affiliations are provided for purposes of identification, these experts contributed in an individual capacity, not as representatives of their organizations. Their mention here does not imply that they endorse the findings of this report.*

Submission Note

This report was developed by Mark Stoughton, Ph.D. (mstoughton@cadmusgroup.com), Chris Frantz, Thomas J. Votta, P.E. and Richard Krop, Ph.D. of The Cadmus Group, Inc., under US EPA Contract No. EP-W-07-003, subcontract No. 26OR00221, at the direction of Priscilla Halloran of US EPA’s Office of Resource Conservation and Recovery.

Dedication

This report is dedicated to the memory of Thomas J. Votta (1967—2009), an extraordinary person who, in his short career, combined a warm and outgoing nature, enormous imagination, deep respect for the environment and keen business acumen to make the world a better place by rethinking the nature of commerce in our society in fundamental, innovative ways.

Disclaimers

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Abstract

A sustainable economy requires economically successful business activities and models that achieve fundamental reductions in energy, material and water throughput in the delivery of necessary goods and services. The primary environmental policy interest in these sustainable business models is that they provide an environmentally superior alternative to the "business as usual" (BAU) ways that existing economic needs are served and functions delivered.

Sustainable *service-led business models* are particularly required, both to address the challenge of the "services transition" and to exploit the promise of the "functional economy." The focus of inquiry for service-led business models that constitute a more sustainable alternative to BAU are innovative or emergent product service systems (PSSs) or "servicizing" models.

The PSS concept describes the economic space in which products and services are combined in value propositions to meet customer needs. While PSS activity is poorly captured by economic statistics, "BAU" PSSs are ubiquitous—e.g., mobile telephony, car rental, pizza delivery, capital equipment leasing—and are an important determinant of the overall performance of the US economy, both in environmental and traditional terms.

Innovative and emergent PSSs that intensify the service component can improve eco-efficiency over BAU approaches to delivering key economic functions and services. Examples of such *Green Servicizing* include: leasing/sharing arrangements (e.g. car-sharing; "lifecycle solutions" for IT equipment); functional procurement and efficiency services (e.g. Chemical Management Services, Resource Management, Energy Services Companies), among others. International experience indicates that "Green Servicizing" approaches can achieve eco-efficiency improvements ranging from marginal to radical, with the latter generally obtained by models focused on the sale of "function" rather than products *per se*.

The US Environmental Protection Agency's Office of Resource Conservation and Recovery, long interested in and supportive of these types of business models, commissioned this work to obtain critical tools, concepts and analysis needed to consider policy engagement to achieve the potential of "green servicizing." Towards this end, the report briefs the Green Servicizing concept; provides a working definition of high-potential Green Servicizing models; identifies 10 such models and briefs their market status and environmental performance; provides analysis and methodologies to assist in weighing policy engagement; and identifies possible next steps to begin more substantive engagement.

The report finds that Green Servicizing can make a significant contribution to a more sustainable US economy by providing more eco-efficient alternatives to the BAU delivery of environmentally problematic and economically critical functions and products. However, achieving its full potential will require policy engagement. Towards this end, a possible key initiative for US EPA would be to develop and implement a strategy to achieve the full eco-efficiency potential of *functional procurement and efficiency services models*.

These models, which include the Energy Service Company (ESCO) model, Resource Management, Integrated Pest Management (IPM) Services, Chemical Management Services, etc., can reduce the consumption of environmentally problematic goods and services by transforming their procurement into performance-based service arrangements. Collectively these models address the critical elements of the "environmental footprint" of the economy generally and of many individual enterprises and institutions.

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Acronyms

3PL	Third party logistics
3R	Reduce, reuse, recycle
B2B	Business-to-business
BAU	Business as usual
BEA	(US) Bureau of Economic Analysis
BTU	British Thermal Unit
C&D	Construction and demolition
CM	Chemical management
CMS	Chemical management services
CSP	Chemical Strategies Partnership
DOE	(US) Department of Energy
EC	European Commission
EPR	Extended producer responsibility
ESCO	Energy services company
ESPC	Energy Savings Performance Contract
EV	Electric vehicle
EU	European Union
FP5	5th Research Framework Program of the European Commission
GAO	(US) Government Accounting Office
GDP	Gross domestic product
GHG	Greenhouse gas
HVAC	Heating, ventilation and air conditioning
HUD	(US) Department of Housing and Urban Development
IGES	Institute for Global Environmental Strategies (Japan)
ILSR	Institute for Local Self-Reliance
IPM	Integrated pest management
IT	Information technology
K-12	Kindergarten through 12th grade
KNCPC	(South) Korea National Cleaner Production Centre
LCA	Life-cycle analysis
METI	(Japan) Ministry of Economy, Trade and Industry
MKE	(South Korea) Ministry of Knowledge Economy (previously MOCIE)
MLTMA	(South Korea) Ministry of Land, Transport and Maritime Affairs
MOCIE	(South Korea) Ministry of Commerce, Industry and Energy (became MKE in 2008)
MOE	(South Korea) Ministry of Environment
LEED	Leadership in Energy and Environmental Design
MUSH	Municipal and state governments, universities, schools and hospitals
NAESCO	(US) National Association of Energy Services Companies
NAHB	(US) National Association of Home Builders
NAICS	North American Industrial Classification System
NAPCS	North American Product Classification System
NRDC	Natural Resources Defense Council
NRCS	(US) National Resources Conservation Service
O&M	Operations and maintenance
OEM	Original equipment manufacturer
ORCR	(US EPA) Office of Resource Conservation and Recovery (formerly the Office of Solid Waste)
PC	Personal computer
PRO	Producer responsibility organization
PS	Product-service
PSS	Product service system
REACH	(EC) Registration, Evaluation, Authorisation and restriction of CHemical substances regulation
RFP	Request for Proposal
RM	Resource management
SCORE!	Sustainable Consumption Research Exchange
SCP	Sustainable consumption and production
SME	Small and medium enterprise
SPS	Sustainable Product Services
ULEV	Ultra-low emission vehicle
US	United States
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
VMT	Vehicle miles travelled.
WEEE	(EC) Directive on Waste Electrical and Electronic Equipment

Executive Summary

The US Environmental Protection Agency's (US EPA's) Office of Resource Conservation and Recovery (formerly the Office of Solid Waste) commissioned this work to obtain critical tools, concepts and analysis needed to identify appropriate, substantive and effective next steps for using *green servicizing* to aid in decoupling material, energy, water and chemical use from economic growth.

The need for *sustainable service-led business models*

A sustainable economy requires economically successful business activities and models that help achieve fundamental reductions in energy, material and water throughput while providing necessary goods and services. The primary environmental policy interest in these sustainable business models is that they provide an environmentally superior alternative to the "business as usual" (BAU) ways that existing economic needs are served and functions delivered.

Sustainable *service-led business models* are particularly required, both to address the challenge of the "services transition" and to exploit the promise of the "functional economy."

The Services Transition

The services transition refers to the growth in importance of services in the US and other wealthy and fast-developing economies, including the increasing service content of many product-producing industries. In early efforts to consider the environmental implications of this change, a number of researchers and experts speculated that a service-led economy could separate economic growth from growth in material and energy throughput, leading to an overall greening of the economy. However, while services tend to be less material and energy-intensive per dollar of output than manufactured goods, the service transition has *not* reduced absolute material and energy throughput in the economy. Why?

The service economy depends fundamentally on the industrial economy; most of the fastest-growing, most dynamic service sectors in the US economy (e.g., logistics, health care, and telecommunications) require corresponding growth in the environmentally problematic products and infrastructure that support them. Further, the US environmental regulatory system is heavily oriented around large manufacturing facilities, with many service enterprises unaware of and in poor compliance with the regulatory requirements that do apply to them. In short, the system deals poorly with services from both *de jure* and implementation perspectives.

Thus, if we are to achieve meaningful movement towards a truly sustainable future economy, we *must* find a way to make a service- and information-led economy a green economy. Put another way, we must find ways that services can change—for the better—the ways that products are designed, made, used and dealt with at end of life.

The Promise of the *Functional Economy*

Since at least the mid-1990s, the potential of a *functional economy* to decouple economic growth from environmental pressure has had a central place in conceptions of the sustainable economy. In a functional economy, products serve as means, not ends: *"What we want from these products is not ownership per se, but the service the products provide; transportation from our car, cold beer from the refrigerator, news or entertainment from our television"* (Hawken 1993). And as Tukker writes: "Many authors…quickly understood that, if one could really take final consumer. needs (rather than the product fulfilling the need) as a starting point, the degrees of freedom to design need fulfillment systems with factor 4–10 sustainability improvements are much higher. The idea that needs-focused solutions could be inherently more sustainable than products was borne" (Tukker 2006).

Product-Service Systems and Servicizing

The focus of inquiry for service-led business models that constitute a more sustainable alternative to BAU are *innovative or emergent* product service systems (PSSs) or "*servicizing*" models.

The PSS concept describes the economic space in which products and services are combined in value propositions to meet customer needs. While PSS activity is very poorly captured by economic statistics, "BAU" PSSs are ubiquitous—e.g., mobile telephony, car rental, pizza delivery, capital equipment leasing—and are an important determinant of the overall environmental performance of the economy.

PSSs are generally classified into three categories (see box).

> ### PSS Categories
>
> **Product-oriented** PSSs are dominantly geared towards the sale of products, but added services are a source of additional value. These services include, e.g., extended warranties, maintenance, upgrading, and end-of-life management. Product ownership lies with the consumer.
>
> **Use-oriented** PSSs are centered around provision of products, but they offer value by providing consumers with access to the product and the function it provides without the need to own the product. Leasing and rental models are in this category
>
> **Results-oriented PSSs** offer value by directly providing a function to the customer, who in turn pays for this function rather than use of or access to a particular product. The function may be tangible (i.e., waste management) or intangible (i.e., communication.)

Innovative or emergent PSSs business model often provide an alternative to BAU means to achieve a given economic function. When this involves *intensifying* the service component and employing services to add value in ways that are different from "business as usual," than the PSS is a *servicizing* business model. (See table beginning on page ES-6 for examples.)

Under some servicizing models, consumers may no longer purchase the product itself, but the function (or service) that the product provides. In other cases, the changes from BAU are less radical. Regardless, emergent PSSs *restructure the economic relationships that mediate how products deliver function or utility*. As a result, the manufacture, use, or end of life management of products or infrastructure changes in some way.

The promise of "green servicizing"

This restructuring can improve the eco-efficiency of the economic function by closing materials cycles, dematerializing economic activity, improving energy efficiency, and other mechanisms. **Where such eco-efficiency improvement occurs, this report terms it "Green Servicizing."** (See table beginning on page ES-6 for examples.)

There is now an extensive body of research, especially in Europe, regarding the environmental potential and promise of servicizing approaches.[1] This body of research indicates that the eco-efficiency improvements obtained *in practice* by servicizing approaches range from marginal to radical, with the latter generally obtained by models focused on the sale of "function" rather than products *per se*.

However, because mandatory take-back is rare in the US context, servicizing models that include take back and recycling/re-use/remanufacturing may achieve much higher improvements over BAU than they would in the Western European/EU context, where mandatory forms of Extended Producer Responsibility (EPR) are far more common.

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[1] Most European research focuses on *Innovative or emergent PSSs* without using the term *servicizing* per se. This is a difference of terminology, not substance.

In this body of literature and accumulated experience. it is also clear that the details matter, and the environmental performance of different implementations of the same basic servicizing model can differ significantly.

What does "high sustainability potential" mean?

The "sustainability" or "greening" potential of a business model is a function of four factors:

Micro-level environmental performance. That is, eco-efficiency gain over BAU at the level of the individual customer or unit of function.

Market potential. The potential of a model to become the BAU means to obtain a particular economic function or service.

Environmental Significance. The portion of national emissions, pollutant loads or resource demands that can be attributed to the manufacture, use, delivery and end of life management of the principal goods or services to whose BAU consumption the servicizing model constitutes an alternative.

Potential Social impacts. Models of very high potential have readily identifiable characteristics. A model *must* be high-potential if *all* the following are true: (1) micro-level environmental performance is a significant improvement over BAU; (2) market potential is high; (3) the market the model operates in has high environmental significance *and* (4) the model presents no obvious social concerns.

Similarly, poor micro-level improvements over BAU *OR* poor market potential *OR* low environmental significance will alone generally assure low potential.

The challenge for US EPA

With respect to servicizing, the current challenge and opportunity for US EPA specifically and for environmental policy-making generally is to:

> **Identify** innovative and emergent servicizing business models of high sustainability potential (see box),
>
> **Validate** this potential, and, where *appropriate and feasible*, to
>
> **Design and implement policies** that foster market and regulatory environments that help such models become business as usual, and best assure that the "greenest" versions of these models are the ones that grow.

In general policies can be designed to (1) reinforce drivers, (2) reduce barriers, and/or (3) strengthen the determinants of "green" performance. Policy engagement may involve, but is not uniquely synonymous with, regulatory actions. Support for pilots, development of market information, manuals and information portals, establishing voluntary "green standards" or certifications, and developing voluntary programs and alliances based on these approaches are all important but non-regulatory forms of policy engagement in the area of "green business."

Justification for policy engagement

As discussed below, this report identifies and briefs 10 high-potential green servicizing models. While some of these models are well-established in key niches and market segments, none have reached their full market potential—nor is it a foregone conclusion that all will achieve broad adoption. Further, there are often *greener* and *less green variants* of these models—and experience shows that current market conditions do not necessarily assure that it is the greenest version that grows.

Fully exploiting the environmental benefits of green servicizing therefore requires evaluating the case for and—*where appropriate and feasible*—formulating and implementing policy to help foster market and regulatory environments that would help high-potential "green servicizing" models become business as usual, and would best assure that the "greenest" versions of these models are the ones that grow.

There is a long-standing aversion in US policy-making to "picking winners" (whether technologies, enterprises or sectors), rooted in the conviction that this is best left to market forces. It is important to understand that in the context of this study, policy support for green servicizing is (1) not contemplated on the level of individual enterprises, but at the level of business models and value propositions; and (2) is predicated on a clear performance-based criterion: does or can the model offer significant environmental performance improvements over BAU approaches? Both serve to distinguish "green servicizing support policy" from "picking winners" as the term is usually understood.

To further assure that policy engagement is—and is seen as—*appropriate*, policy engagement should be guided by and generally limited to three well accepted justifications:

(1) **Leveling the playing field.** The existing policy regime and market environment, almost by definition, tends to favor BAU approaches. Policies can "level the playing field" by, e.g., reducing information asymmetries, internalizing pollution or other environmental costs, and/or offsetting the advantage that externalized environmental costs may confer on BAU approaches.

(2) **Reducing entry barriers.** Market forces are understood to function least effectively at the earliest stages of a new offering, where, for example, customer awareness and information is highly imperfect, financing is scarce for unfamiliar business concepts, and past performance "success stories" are scarce. Policy engagement can address these and other barriers to entry, including the entry of proven models into new customer sectors.

(3) **Formal and informal standard-setting.** Standards, whether formal or informal, are essential for markets to function efficiently, and standard-setting usually requires a facilitating actor.

Responding to the challenge: Objectives and contributions of this study

In addition to serving as a primer on green servicizing concepts, this research was designed to directly respond to the policy challenges identified above.

- **Identifying models of high sustainability potential.** The economic data to support a systemic, economy-wide scan to identify high-potential innovative and emergent servicizing business models does not exist. Therefore, this report used a methodology that combined literature review with gap analysis and targeted search. The result was the identification of 10 models[2] that, at first examination, had the potential to offer significant eco-efficiency improvements over BAU in environmentally critical sectors. (See table beginning on page ES-6)

- **Validating potential.** 3–5 page *Business Model Briefs* were developed for each of the 10 models. These b*riefs* synthesize publicly available information regarding environmental performance and market information, describe value propositions and provide links to cases studies and business offerings.

  The *briefs* do not undertake a rigorous, quantitative assessment of each model against the four criteria that define sustainability potential. However, the information provided by the briefs does support less formal evaluations of sustainability potential against the four criteria, and on this basis *the models selected should be considered of high sustainability potential*.

[2]In some cases the selection process did not identify a specific business model, but rather a "core component" (e.g. re-manufacturing) of a *set* of servicizing business models serving different sectors, focused on different types of products, or having multiple variants within a single sector. For simplicity, however, the term *model* is used to refer to all selections.

- **Identifying targets for policies.** The mandate of this research did not extend to recommending specific policy measures. However it does provide information, analysis and tools to support this process:

  Going beyond the basic information in the model briefs, an analysis of barriers, drivers and determinants of environmental performance for three performance-based "functional procurement" or "efficiency services" models is presented.

  These models were chosen both because the research results strongly suggest high sustainability potential and to assess the hypotheses that these models share strong similarities in drivers, barriers and value propositions—and that therefore government policy engagement around these models as a *class* may bring significant synergies and economies.

  For these three models, the analysis is taken one step further: barriers, drivers and determinants of environmental performance are mapped to policy "targets." Policy targets are not specific policies, but rather a statement of the immediate goal or effect that a policy or policies are intended to achieve. Policy targets have a clear, logical relationship to the barriers, drivers or determinants to which they correspond—they weaken the barrier, reinforce the driver, address the determinant.[3]

  This analysis framework is intended to be useful in undertaking similar exercises for other models, and for guiding stakeholder discussions under the "functional procurement/efficiency services initiative," a key consideration for US EPA in engaging with green servicizing.

Models excluded from the study

Four classes of "green servicizing" models were excluded by the search methodology:

1. Models identified as high-potential in the literature, but with uncertain application or utility in the US market.

2. Well-publicized "servicizing" approaches that are either arguably "business as usual" or which do not have obvious "green" dimensions. For example, the 1999 Tellus report included case studies of IBM and Xerox as examples of traditionally product-based companies that had embraced product-based services as a core business strategy. Service/product integration is arguably a "business as usual" strategy in the IT sector, and this integration—of itself—does not have intrinsic green dimensions.

3. Large number of "niche market" models identified in the case literature.

4. Models dealing with products currently covered by national-level EPR initiatives in the US for which PRO (Producer responsibility organizations) are already constituted and active (e.g. batteries, carpet). The rationale is that the dominant business approach to addressing product disposal has already been determined, and it is largely outside a for-profit servicizing approach.

Servicizing models identified and briefed; environmental performance results

The table on the overleaf summarizes the models identified, their primary customer sectors, and their environmental performance. The models were selected via the literature search/gap analysis methodology described above.

[3] For example, in recently completed research in the Japanese market, (Stoughton et al 2007) note that the environmental performance of the 3PL model is strongly determined by the environmental performance of 3PL assets such as vehicle fleets and buildings. In consequence, they identify "Making 3PL assets (including fleets, buildings and siting of facilities) as green as possible" as a policy target. As an indicative example of a policy that would support this target, they suggest making "existing [Japanese] tax benefits for efficiently sited logistics infrastructure investments contingent on adoption of green building standards."

Business Model	Environmental Performance: Improvement Mechanisms & Findings
Car-sharing Car-sharing is a "personal mobility PSS" that provides short-term use of cars located in special reserved parking spaces distributed throughout a service area (e.g., an urban area or campus.) Primary customer sectors: Institutional campuses; Individual & corporate customers in middle & upper-income urban areas,.	Reduced vehicle miles travelled (VMT) per customer: Car-share members reduced VMT by 44% across several studies. According to a Zipcar survey, car-share members increase public transit trips by 47%, increase bike trips by 10%, and increase walking trips by 26%. Reduced total vehicles/service population: Every US car-share vehicle "removes" between 6 and 23 vehicles from the road, depending on the study. Cleaner vehicles: 30% of US car-sharing vehicles are hybrids or powered by alternative fuels.
Chemical Management Services (CMS) CMS is a "strategic, long-term relationship in which a customer contracts with a service provider to supply and manage the customer's chemicals and related services. Under a CMS contract, the provider's compensation is tied primarily to quantity and quality of services delivered not chemical volume. Primary customer sectors: Chemical-intensive manufacturers (e.g. auto, electronics, aerospace)	Improved Environmental Data: 100% of CMS customers reported improved environmental data. Reduced Total Amount of Chemicals Being Applied: Over 50% of CMS customers reported reductions in total chemicals being applied. Increased Recycling/Reusing of Chemicals: Over 45% of CMS customers reported increased chemical reuse/recycling. Technological Process Efficiencies & Chemical substitutions Over 30% of CMS customers reported increased process efficiencies; approximately the same number reported beneficial chemical substitutions. (Data from Chemical Strategies Partnership's *2004 CMS Industry Report.)*
Deconstruction Deconstruction is the process of selectively dismantling or removing materials from buildings before or instead of demolition. Primary customer sectors: Property owners and developers	Recovery of Waste for Reuse and Recycling: Deconstruction has the potential to reduce the materials sent to incinerators and landfills and alleviate demand on virgin materials. According to the Institute for Local Self-Reliance, US deconstruction could recover an estimated 24 million tons of Construction and Demolition (C&D) waste for reuse and another 6 million tons for recycling. This represents a 46% total recovery rate.
Energy Services Companies (ESCOs) An ESCO provides energy-efficiency-related and other value-added services and assumes *performance risk* for their project or product—that is, their compensation and profits are tied to energy efficiency improvements (and thus, savings in purchased energy costs) actually obtained by the client. Primary customer sectors: Manufacturing facilities, institutions, and offices, including government.	Reduced Energy Consumption: According to a 2007 review of the ESCO industry completed by the Berkeley National Laboratory, ESCO projects on average reduce energy consumption by 23% or 47 kWh/m^2/yr. Using US EPA's Emissions & Generation Resource Integrated Database, this corresponds to average reductions of 67.42 lbs of CO_2/ m^2/yr, 0.34 lbs of NO_x/m2/year, and 0.15 lbs of SO_2/ m^2/year. Reduced Water Consumption: A small percentage of ESCO projects also result in reduced water consumption.
IPM & Performance-based Pest Management Services In *performance-based pest management*, a pest management services provider commits to achieving a certain standard or level of pest control, rather than being compensated for a particular treatment or application. Intergrated Pest Management services are the green implementation of this concept. Primary customer sectors: Structural: Institutions, housing authorities, school districts, corporate and government facilities; Agricultural: Model is embryonic in agricultural applications, but most likely market are larger agricultural producers and/or those growing "high value" crops (e.g. fruits, vegetables).	Reductions in the Use, Toxicity, and Dispersion of Pesticides: Multiple case studies have shown that IPM can achieve significant reductions in pesticide use, toxicity, and dispersion, with reductions as high as 93% in grams of pesticide active ingredients applied.

IT "Lifecycle Solutions" IT Lifecycle Solutions are business offerings that bundle provision of corporate IT equipment (particularly personal computers, servers and printers) with associated services. The "solutions provider" is responsible for most or all configuration, maintenance, repair, and upgrade. Primary customer sectors: Large corporations & institutions, government	Reduced Incidence of Improper Disposal and Uncontrolled Recycling: End-of-lease responsibilities are placed on the equipment provider, which is much more likely than individual customers to have appropriate disposal and recycling practices in place. Increased Reuse, Recycling, and Parts Salvaging: Equipment providers have a strong financial incentive to reuse, recycle, or salvage the equipment they lease. According to one study, enhanced recovery and re-leasing together may reduce PC lifecycle impacts by ~50%.
Remanufacturing Remanufacturing is the process of restoring used, durable products to a 'like new' condition. Remanufacturing is not a specific PSS model, but there are many remanufacturing-based PSSs. Primary customer sectors: Varies by the product involved (e.g. corporate fleets are a key customer for remanufactured tires.)	Reduced Energy Consumption: One landmark study calculated that remanufacturing in the US requires on average 85% less energy than manufacturing a new product. Using US EPA's Emissions & Generation Resource Integrated Database, this corresponds to savings of about 35bn kWh or ap. 47bn lbs of CO_2, 73mn lbs of NOx, and 190mn lbs of SO_2 in avoided air emissions. Reduced Need for Raw Materials: Remanufacturing also uses fewer virgin raw materials than manufacturing "from scratch." One study estimated in the US over 14 million tons of raw materials are saved annually by remanufacturing.
Resource Management Contracting (RM) Resource Management (RM) Contracting is a performance-based approach to waste management. It centers on an innovative contrac- tual partnership between a waste-generating organization and a qualified waste contractor that changes BAU compensation structures and otherwise incentivizes waste minimization and recycling. Primary customer sectors: Manufacturing facilities, institutions, schools districts, commercial property managers.	Increased Reuse, Recycling, and Overall Waste Minimization: RM moves waste up the reduce, reuse, recycle hierarchy, and more truly makes disposal the waste management option of last resort. For example, General Motors, which pioneered the model, realized an average reduction of 20% in overall waste generation, a 65% increase in recycling, and a 60% decrease in disposal tonnage across 50 North American plants.
Telepresence Telepresence allows individuals/groups in different locations to communicate in a simulacrum of "face to face" exchange far superior to that achieved by traditional video-conferencing. This is achieved via high-quality, high-definition audio and visual feeds, the use of multiple cameras and screens, and specially designed, dedicated rooms. Primary customer sectors: Large Business, Educational institutions, Conference facilities providers (e.g. hotels)	Reduced Physical Travel & Associated Energy Consumption: Studies indicate substantial CO2 reductions on average compared to physical travel & that savings increase with avoided travel distance; e.g. an NTT study of actual videoconferences in Japan estimated 60%-90% reductions in lifecycle CO2 emissions as compared to physical travel.
Third Party Logistics (3PL) Third-party logistics (3PL), also referred to as logistics outsourcing or contract logistics, focuses on improving resource utilization and process efficiency in order to reduce costs and improve service. 3PL providers deliver comprehensive logistics-related services, including delivery, storage, inventory, customer service, cargo handling, supply/distribution information systems, etc. Primary customer sectors: Manufacturers, retailers, government.	Reduced Energy Consumption: The logistics efficiency improvements achieved by 3PL tend to improve logistics *energy* efficiency, even without specific "green" contract incentives. In the case of automobiles, these incidental gains have been estimated at between 0.5 and 2% of *lifecycle* CO2 emissions (including the use phase). A specific focus on greening would be expected to increase efficiency gains.

Findings

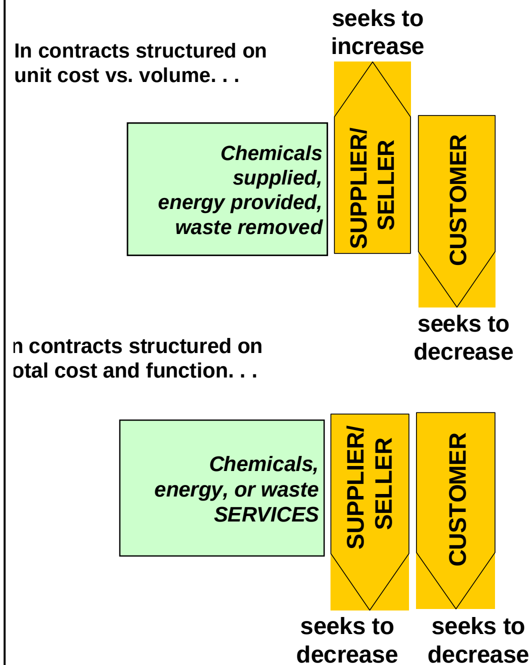
1. Real and significant eco-efficiency gains.
Review of the *environmental performance* sections of the business briefs (see summary table above) confirms that, while the quality of quantitative environmental performance data varies significantly across the models, the green servicizing business models identified and briefed can produce significant eco-efficiency improvements over BAU. *This is significant because the models provide alternatives to the BAU delivery of environmentally critical economic functions and products.* The implication is that at their full market potential, these models possess significant potential to improve the eco-efficiency of the overall economy.

This is consistent with key findings of research outside the US, which indicate that while servicizing *generally* is not necessarily green, certain models can be strongly so, and these are clustered under "results-oriented" models.

2. Scope and need for policy engagement.
The business briefs and the more detailed analyses of barriers, drivers and determinants of environmental performance conducted for three functional procurement/efficiency services models indicates that there is scope for—and at least in some cases strongly suggests the *need* for—policy engagement to achieve this potential, for two reasons: (1) without policy engagement, adoption of many or most green servicizing models is likely to be slower; and (2) without policy engagement, it may not be the greenest version of these models that become market standards.

3. Special potential of performance-based "functional procurement"/"efficiency services" models
Of the 10 models selected, half are "functional procurement/efficiency services" models. These include: CMS, RM, performance-based Energy Services (ESCOs), 3PL, and IPM-based pest management services.

Aligning economic incentives for use reduction in efficiency services models



These models were selected because, in principle, they can transform the procurement of environmentally problematic goods and services into performance-based service arrangements—and in so doing, incentivize the service provider to reduce the customer's consumption of the environmentally problematic good or service in question (see figure above). Collectively, these models address the majority of most organizations' environmental footprints.

Overall, the findings strongly reinforce the idea that, as a class, performance-based functional procurement/efficiency services models have high potential to achieve very significant eco-efficiency improvements in critical economic functions and sectors:

- Good market and environmental performance information is available for CMS and ESCO offerings, and this information indicates both strong market potential *and* that this environmental performance improvement mechanism is being strongly operationalized.
- Good market information is available for 3PL. While 3PL's ability to drive down distribution-related CO2 emissions has not been an explicit focus of 3PL in the US context to

date, experience outside the US (e.g. Japan), shows that 3PL can be implemented with just such a "green" focus.

- CMS, ESCOs and 3PL are "business as usual" (or almost) in their core markets, though all have substantial room for growth, either within these core markets or in new market segments. Resource Management and structural IPM services, by contrast, are far earlier on the adoption curve, but both have consistently demonstrated strong environmental results in the context of profitable business offerings.

- Agricultural IPM services are embryonic, though US offerings do exist that provide proof-of-concept. (Additional examples exist in the European literature.)

- These eco-efficiency gains that can be delivered by these models are high-value and high-leverage as these models act high on the "3R" hierarchy, functioning as *reducing* agents that shrink the size of the material and energy cycle required to service a given level of economic activity.

4. Strong parallels between different performance-based "functional procurement"/"efficiency services" models

As described immediately above, performance-based functional procurement/efficiency service models possess, by definition, substantially similar "greening mechanisms" and value propositions. Beyond this, the more detailed assessment of barriers, drivers and determinants of environmental performance conducted for the CMS, RM and ESCO models showed strong parallels in these areas as well.

A reasonable working hypothesis is that these similarities would extend to other models in this class, and this is suggested by more limited drivers, determinants and barriers information in the business briefs themselves.

5. Inadequacy of economic information

The research highlighted a basic gap in official economic data and statistics: despite recent progress in the treatment of services, these statistics continue to divide the economy into distinct "product" and "service" sectors, and generally do not characterize how combinations of products and services are packaged as value propositions.

This gap is critical, as product-service systems are important determinants of environmental performance of the economy as a whole. Moreover, understanding how products and services combine to produce value—and how this combination is changing over time—is critical to understanding issues and trends in economic competitiveness, structural economic change, and other fundamental concerns of economic policy. In not capturing PSS and servicizing activity in the economy, current official economic data handicaps not only environmental policy, but other key areas of policy making as well.

Realizing the potential of green servicizing

It is unlikely that high-potential "green servicizing" models are limited to those identified and briefed in this report. But even if they were, "green servicizing" would *still* have strong potential to green the US economy. However, this potential will only be reached fully and expeditiously with appropriate policy engagement.

Thus, it is important for US EPA to consider:

- **Committing to a policy of leveraging and fostering high-potential "green servicizing" models for a more sustainable US economy.**

- As a first initiative under this policy, **developing and implementing a strategy whose objective is to achieve the full eco-efficiency potential of functional procurement/efficiency services in the US economy** by:

  Assuring that the greenest version of the models become market standards; and

  Accelerating the adoption of these models in key/high impact sectors.

Why focus on a subset of green servicizing models? For a number of reasons, successful policy engagement requires model-by-model consideration. US EPA's resources are limited, particularly for discretionary policy initiatives, and focus is essential.

Why focus first on functional procurement/ efficiency services models? Several factors combine to make this class of models the appropriate target:

- **Greening potential.** As noted, the research results strongly suggest that *as a class*, performance-based functional procurement/efficiency services models have high potential to achieve very significant, high-value/high-leverage eco-efficiency improvements across a set of critical economic functions and sectors. Together, these functions and sectors constitute much of the critical "environmental footprint" of the economy as a whole (and of many individual facilities).

- **Playing to economic strengths, addressing key economic issues.** Such a strategy would play to one of the core strengths and capabilities of US Business-to-Business (B2B) markets—widespread and highly sophisticated use of 3rd party technical services to reduce costs and maximize flexibility.

  Critically, in a economic context in which the use of such services goes hand-in-hand with concerns regarding the erosion of the domestic employment base at all levels (e.g. "offshoring"), these models generally do not incur these social costs and concerns. First, the services they provide *must be delivered on-site.* Second, these services support skilled "efficiency professionals" whose salaries are ultimately paid from the efficiency gains they deliver to the client. These services directly support the competitiveness of their customers by delivering cost reductions *not* primarily derived from reductions in US-based staff.

- **Coherent theme; potential policy synergies and economies.** The substantially similar greening mechanisms and value propositions that define these models offer a theme that is at once coherent and, as a first initiative, manageably narrower than "Green Servicizing."

  In addition, the strong parallels revealed by the more detailed assessment of barriers, drivers and determinants of environmental performance conducted for the CMS, RM and ESCO models (see Chapter 6) suggest that policy engagement around these models as class rather than individually may bring significant synergies and economies.

- **Existing engagement and a leadership opportunity.** US EPA already has engaged significantly with these models, but in a generally uncoordinated way. Thus, expertise exists within the agency regarding many of these models, as do lines of communication with key stakeholders. Both are critical significant building blocks for more coordinated policy engagement.

- **International leadership.** Finally, it should be noted that, despite significant policy interest outside the US in these models individually, no country has yet developed a coordinated strategy to fully exploit the eco-efficiency benefits of efficiency services. US international leadership in this area is both possible, and given the national "comparative advantage" in the use of 3rd party technical services in the B2B sector, logical. Further, US EPA's engagement with these services in fact would be and could be presented as an innovative approach to support US commitments made under the G8 "3R" initiative.[4]

Possible key next steps

- **Internal stock-taking.** As a first step, the Agency should take stock of its own past and current engagement in functional procurement and efficiency services. Highlights of this engagement are presented in the business model briefs and in subsequent chapters of the report, but the Agency will require a more definitive stock-taking, including lessons learned, as a prelude to any further (and more coordinated) policy engagement.

- **"Summit" of key actors.** Strategy development will require that the Agency refine its understanding of market status, barriers and drivers. It will also require the engagement and participation of stakeholders in these markets and models.

  An effective approach would be to address these needs simultaneously by convening—or supporting and facilitating the convening of—a 2-day "summit" on functional procurement and efficiency services that draws key providers, progressive customers, and other relevant stakeholders.

  (As an alternative, a set of one-day, model-specific focus meetings could be convened. However a multi-model "summit" would yield interesting and relevant synergies and insights, particularly as there is apparently little communication between these sectors despite common challenges and value propositions.)

  These meetings could be structured around the analytical framework developed in this report, eliciting a picture of drivers, barriers, and determinants of environmental performance from those with direct knowledge as providers and customers. From this base, the goal should be to identify policy "targets" and potential measures to address these targets, with the targets and illustrative measures for CMS, RM and ESCOs developed in this report serving as discussion drafts. Both demand side and supply side issues and measures should be addressed, and focus placed on approaches common to this class of models.

  These recommendations would form an important input to US EPA's "functional procurement/efficiency services" strategy. The intelligence gained from those in the field will sharpen overall strategy, and the gathering and exchange itself will build a network critical to US EPA's own efforts—but also to progressive providers and customers themselves.

Considerations for concurrent actions, looking ahead

Concurrent with the above steps to develop a functional procurement/efficiency services strategy, US EPA programs and offices engaged with *other* green servicizing models should be encouraged to take stock of their engagement using the barriers/drivers/determinants framework of this study. This stock-taking may result in adjustments or additions to the engagement strategy, or proposals for future activities.

Looking ahead, the implementation of a functional procurement/efficiency services strategy should lend insight into the question of whether generalized policy support for green servicizing is feasible, and the forms it might take. Explicit consideration of this question should be part of any internal US EPA review of strategy implementation.

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[4] Most recently, see the "Kobe 3R Action Plan" adopted by the G8 environment ministers' meeting of 24–26 May 2008 in Kobe, Japan. Available at www.bmu.de/files/pdfs/allgemein/application/pdf/g8_kobe2008_3r_actionplan.pdf

Finally, US EPA should explore avenues for engaging in dialogues and participating in fora that shape the evolution of official economic statistics to improve characterization of PSSs and their evolution over time. This will help address a key need of both economic and environmental policy; efforts that US EPA undertakes to gain a more rigorous understanding of green servicizing—including this report and the Agency's engagement to date in individual green servicizing models—should enhance the value-added that the agency can bring to these discussions.

1 Introduction

1.1 Needed: sustainable business models for the sustainable economy[5]

Business[6] is the primary agent in the economy that combines resources, labor and capital into the goods and services that satisfy individual needs and wants.[7] Business is also a primary provider of livelihoods, and the source of the value-added that pays, directly or indirectly, for public and private goods and services essential to present and future social welfare (e.g., public health care, law and order, public and private pensions); environmental integrity (e.g., ecosystem protection and restoration); and economic vitality (e.g., investments in research and development, infrastructure, and education).

The transition to a more sustainable economy—i.e., one that has successfully decoupled economic growth from material consumption and waste generation, and has, in absolute terms, substantially reduced material and energy throughput—is a critical challenge facing society at the global, regional and national levels. A sustainable economy requires *business activities and models* that are environmentally sustainable. That is, they must help achieve fundamental reductions in energy, material and water throughput while providing necessary goods and services.

However, these environmentally sustainable business models must also be *economically sustainable.* This is not because the survival of any particular business enterprise should be a concern or goal of environmental policy, but because business operates according to economic realities. Over the long term, non-viable businesses will fail, providing neither goods and services, nor jobs and value-added.

In some cases, sustainable business models may serve new needs or create new economic functions. However, the primary *environmental policy interest* in such models is that they provide an environmentally superior alternative to the "business as usual" (BAU)[8] ways that existing needs are served and economic functions are delivered.

1.2 A focus on services and "sustainable service-led business models"

For more than a decade, the idea that services have a key role to play in "sustainable business models" has had strong currency in the sustainability research and policy community. There are two principal reasons for this, one derived from the challenge presented by the "services transition" in the economy,

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[5] This section in part adapted from Stoughton et al, 2007.

[6] The term "business" is here used broadly to include public, private, parastatal and non-profit enterprises.

[7] The use of the term "individual" rather than "consumer" is deliberate. Theories of the sustainable economy are rooted strongly both in social justice and functionalist perspectives. (The latter focus on ways to achieve the end-goals of economic activity at reduced ecological scale/environmental cost.) In both perspectives, the fundamental function (or end goal) of the economy is to sustain individuals singly and the community or population generally at an adequate level of material well-being and with abundant and equitable opportunities for the realization of human potential; consumption is a *means* to satisfy needs and help achieve this potential, not an end in itself. The "consumer" is thus just one of the roles taken on by each individual, and the *individual* is the basic, indivisible unit at which "needs satisfaction" must be assessed.

[8] Here, "business as usual" encompasses not just the transaction between a vendor and end-customer that allows the end-customer to fulfil an economic need or want, but the chain of intermediate transactions, extraction and production processes throughout the supply chain that allow the vendor to offer the product or service to the customer.

and the other from the ability of services to provide function-based alternatives to "business as usual." Each is discussed below.

The "Services Transition:" a sustainability challenge

While a sustainability transition of the economy has barely begun, a different type of fundamental, structural economic change is already well underway in all wealthy industrial economies—and many fast-developing ones. This is the growth in importance of services.

In the US, for example, the service sector now generates slightly under 70% of GDP. This represents a 40% increase in relative terms since 1950, with the most substantial increases occurring post-1980.[9] In absolute terms, manufacturing employment has declined 6 percent while service employment has increased 16 percent over the past decade, with the latter now constituting 80 percent of total private employment.[10] And, as discussed later, these absolute figures mask the increasing service content of many product-producing industries. These changes have created enormous opportunities for entrepreneurs and new national wealth on the one hand—and huge social costs attendant to the decline of traditional industries and challenges for public policy on the other.

Similar statistics can be cited even for wealthy economies that are much more oriented to the export of manufactured goods than the US, such as Japan and Germany. Between 1971 and 2001, the percentage of nominal Japanese GDP attributable to manufacturing declined from 43 to 27 percent (a relative decline of more than one-third), while the percentage attributable to services increased from 52 to 72 percent. Over the same period, manufacturing employment as a percentage of the total workforce has dropped from 34 to 29.5 percent, and service employment rose from 47 to 64 percent of the workforce.[11] [12]

Some scholars and commentators speculated—or predicted—that a service-led economy could separate economic growth from growth in material and energy throughput, leading to an overall greening of the economy. For example, the structural transformation of the economy could drive an "environmental Kuznets curve"[13], whereby after a certain level of wealth or stage of development, economic growth is associated with a cleaner and healthier environment.

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[9] This uses the US Bureau of Economic Analyses' broad definition of services which includes utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government. Source US BEA, Gross Domestic Product by Industry Accounts, accessible at www.bea.gov.

[10] Source: US Department of Labor, Bureau of Labor Statistics. Comparison of 1997 to 2006 total annual employment figures for total private employment (Series ID : CEU0500000001) and private services-producing industries (Series ID : CEU0800000001). Accessible at www.bls.gov.

[11] Government of Japan, National census, Ministry of Public Management, Home Affairs, Posts and Telecommunications SNA, Cabinet office. Originally cited in Stoughton et al, 2007.

[12] In these examples, reductions in "manufacturing intensity" of the economy in part reflect the migration of manufacturing—particularly of light manufactures, apparel, electronics assembly—to other countries whose costs are usually lower. However, it also reflects that services account for an increasing portion of the "basket" of consumption by end consumers—and presumably in Business-to-Business markets as well. (See Suh (2006) for documentation of this trend in US personal consumption expenditures.)

[13] The environmental Kuznets Curve is the subject of a large literature. Broadly speaking, this literature indicates that while a service transformation may result in decreasing environmental damage per unit of economic output, it is changes in citizen and public policy values typically associated with rising incomes that achieve absolute improvements in environmental quality. See, for example: Yandle et al, 2004.

However, while services tend to be less material and energy-intensive per dollar of output than manufactured goods, this transformation has not reduced absolute material and energy throughput in the economy. There are at least two reasons for this: The first is that the service economy depends fundamentally on the industrial economy.[14] For example, delivering health care services (one of the fastest-growing service sectors in the US) requires (1) a large and sophisticated set of manufactured goods, (2) an extensive transportation network, and (3) energy- and waste-intensive health care facilities. Nor is the health care sector an isolated example. Many of the fastest-growing, most dynamic service sectors in the US economy require corresponding growth in the most environmentally problematic products. For example, telecommunications and information services require electronic hardware (and power); trade, transport, and logistics services require vehicles, fuels, and significant investments in physical infrastructure.[15]

Second, experience indicates that economic growth in the absence of environmental safeguards puts environmental quality at risk. Our environmental regulatory system was and is heavily oriented around large manufacturing facilities. And many service-enterprises are unaware of and in poor compliance with the regulatory requirements that do apply to them. In short, the system deals poorly with services from both *de jure* and implementation perspectives.

Thus, if we are to achieve meaningful movement towards a truly sustainable future economy, we *must* find a way to make a service- and information-led economy a green economy. Put another way, we must find ways that services can change—for the better—the ways that products are made, used and managed at end of life.

The promise of services: "functional sales" and degrees of design freedom

Since at least the mid-1990s, the potential of a *functional economy*[16] to decouple economic growth from environmental pressure has had a central place in discussions of "sustainability transitions." In a functional economy, products serve as means, not ends:

> *"What we want from these products is not ownership per se, but the* service *the products provide; transportation from our car, cold beer from the refrigerator, news or entertainment from our television."* (Hawken 1993, emphasis added)

Thus, *services* are central to the concept of the functional economy. As Tukker writes: "Many authors…quickly understood that, if one could really take final consumer needs (rather than the product fulfilling the need) as a starting point, the degrees of freedom to design need fulfillment systems with factor 4–10 sustainability improvements are much higher. The idea that needs-focused solutions could be inherently more sustainable than products was borne." (Tukker 2006).

Slower to emerge—but now widely understood—was an appreciation of the barrier to "functional sales" often posed by the intangible value of ownership for goods such as cars, appliances and electronics, particularly in business-to-consumer markets.

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[14] Referencing (Suh 2004), (Tukker et al 2006b) characterize services as often forming an "envelope" around traditional production—i.e., carrying with them all the environmental burdens associated with product manufacture, use and disposal.

[15] See (Suh 2006) for a detailed assessment of the greenhouse gas emission intensity of services versus manufactured goods. He concludes "a shift to a service-oriented economy is shown to entail a decrease in GHG emission intensity per unit GDP but an increase, by necessity, in overall GHG emissions in absolute terms" (6555). (Halme et al 2006) evaluate the sustainability of potentially "green" European household services and arrive at highly mixed results regarding environmental performance. (Suh 2004) shows that life-cycle impacts of services are not substantially different from those of products, reflecting the reliance of services on products. Also see (Salzman. 1999).

[16] See, e.g. (Friend, 1994 & 1996; Pantzar, 1994; Margetta, 1997; Popov and DeSimone, 1997)

The challenge of the service transition and the promise of the functional economy both lead to the need to identify and foster what can be termed "sustainable service-led business models." As noted in the first Chapter, such models are economically viable *and* help achieve fundamental reductions in energy, material, and water throughput while providing necessary goods and services.

2 A re-orientation to "green servicizing"

2.1 From "Servicizing" to "Product Service Systems"—and back again

In 1999, Tellus Institute examined for US EPA's Office of Resource Conservation and Recovery (ORCR) (formerly Office of Solid Waste (OSW)) the potential of one class of potentially sustainable service-led business models to deliver existing economic functions with improved eco-efficiency (or superior levels of environmental performance) over BAU (White et al 1999).These were "servicizing" business models; the particular focus of the report was on the potential of these models to operationalize product stewardship.[17] The Tellus report defined "Servicizing" as:

> *The emergence of a class of product-based services; manufacturers who traditionally delivered "products in a box" are increasingly viewing products as a vehicle or platform to deliver service or function.* (White et al 1999).

The Tellus Institute study reflected both the perspectives discussed above (Section 1.2), and grew from and contributed to growing interest in eco-services, the "functional economy" and related topics. Reviewing the bibliography of the Tellus Institute report shows that in the late 1990s, scholarship and analysis of these issues was relatively equally divided between the US and Europe.

Over the next several years, that balance changed markedly at the same time that the volume of research grew exponentially. Under its Fifth Framework Program (FP5) of funded research, the European Commission (EC) sponsored extensive *product-service system (PSS)* research as part of its "Competitive and Sustainable Growth Programme."[18] As this implies, the research was to explore both the eco-efficiency potential of PSS business models and their potential for providing a sustainable source of competitive advantage to the European private sector.

PSSs are defined and discussed in detail below, but the PSS concept is best understood as defining an "economic space" that includes, in principle, all ways that products and services can be combined in a value proposition.[19] "Servicizing" as defined in the Tellus Institute report, is a *process of change*.

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[17] Then termed "Extended Product Responsibility (EPR). EPR is the principle that actors along the product chain or lifecycle share responsibility for the lifecycle environmental impacts of the whole product system, including up-stream, production and downstream impacts. The greater the ability of the actor to influence particular environmental impacts within the product lifecycle, the greater the share of responsibility for addressing those impacts should be. Internationally, EPR usually means Extended *Producer* Responsibility, as is strongly associated with the regulatory requirements for product take-back. The U.S. continues to define EPR as extended product responsibility.

[18] PSS research funded under FP5 included initiatives on: MEPPS (Methodology Development and Evaluation of PSSs; Homeservices; HiCS (Highly Customerised Solutions); ProSecCo (Product Service Co-design) and Innopse (Innovation Studio and Exemplary Developments for Product Services.) The FP5 archive is available at www.cordis.lu/fp5/home.html.

Also supported was SusProNet, a network to serve as a platform for experience exchange among PSS research initiatives and experts. Summaries of the PSS initiatives under FP5 and many of their results are archived at www.suspronet.org. The successor to SusProNet was SCORE! (Sustainable Consumption Research Exchange; www.score-network.org), supported by the EU 6th Framework Program (FP6) which served "as one of the EU`s central support structures for the UN`s 10 Year Framework of Programs for Sustainable Consumption and Production (SCP)." Support to SCORE! ended in 2008.

[19] This characterization of PSSs is neutral with respect to their environmental performance. This is consistent with the large majority of, but not all, scholarship. Mont, a key researcher and expert in the field, for example, defines product service systems as "a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs, *and have a lower environmental impact than traditional business models*" (emphasis added, Mont 2001 and subsequent publications). This definition also applies equally to innovative, emergent and status-quo product-service

"Servicizing," and "product service systems" are thus not identical concepts. In the narrow sense used in the Tellus report, servicizing moves traditional manufacturers from one portion of PSS "economic space" (in which product sales are the dominant source of profits) to another portion in which services are central to or dominate value propositions and profit models.

Beyond this distinction, however, the PSS concept encompasses a broader range of economic activity than that encompassed by "Servicizing" in the Tellus report.

Under the funded European research, the more inclusive PSS concept became the umbrella for "sustainable service-led business model" research and—while the Tellus Institute and other "servicizing" research was widely cited—the standard term of art in English-language research and policy analysis.[20] This research also led to a more formal and refined understanding of the possible scope and range of these models, and strongly indicated that this broader scope is necessary to capture the full range of service-led environmental performance improvements over BAU. Accordingly this report adopts the PSS concept.

Lagging Europe by a few years, "sustainable service-led business model" research and interest in Japan, and later, Korea emerged strongly.[21] In these contexts, the term "servicizing" has been generally adopted, with the connotation (as in the Tellus report) of *changes* from business as usual that result in service-led alternatives to traditional means of fulfilling economic functions. In Japan, "Servicizing" is used in a broad sense, generally covering the full reach of the PSS concept, not the narrower sense of the term used in the 1999 Tellus report. Policy interest in Korea thus far is focused on servicizing in the area of "sustainable product services"[22]

Thus, this report argues below that use of *both* the "servicizing" and "PSS" terms (and the concepts behind them) is important to achieve clarity in policy discussions about leveraging "sustainable service led business models" to change BAU.

2.2 What is a Product-Service System?

There are a number of definitions of "Product Service System" that have been proposed and used by different researchers and policy institutions.[23] No consensus definition exists, but Tukker, van den Berg

combinations. On this point, the European literature is ambiguous, treating PSS *both* as a concept that can describe any product-service combination, *and* as one that applies purely to product-service combinations that are more service-centered alternatives to BAU. For this latter situation, this report uses the term *servicizing;* see section 2.3.

[20] The closely related term "servitization" does have some current use in Europe, but "Product Service Systems" are by far the dominant term of art. The earliest mention of either "servicizing" or "servitization" that could be identified for this research was (Vandermerwe and J Rada 1988)

[21] For a summary of PSS-related research, pilot activities and awareness-raising in Japan, see (Stoughton et al 2007) Annex A..

[22] At this writing, Korea's Ministry of Knowledge Economy (formerly the Ministry of Commerce, Industry, and Economy Energy (MOCIE)) is actively implementing a "Sustainable Product Services" initiative. See extended textbox "Policy for Green Servicizing in Some Peer Economies" at the end of Chapter 6.

[23] For example, Goedkoop et al, 1999, offered an early and widely-used definition substantially reflected in the Policy Document on Environment and Economy published by the Government of the Netherlands: "a marketable set of products and services capable of jointly fulfilling a user's 'need'". SusProNet, the network of PSS researchers and consultants established as part of the FP5 PSS research, adopted a provisional definition of PSSs as "tangible products and intangible systems designed and combined so they are jointly capable of fulfilling specific customers' needs" (www.suspronet.org). Mont defines "a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs, and have a lower environmental impact than traditional business models." (Mont, O. 2001b); and for UNEP, Manzinni and Vezzoli developed this definition: "A Product-Service System can be defined as the result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services

and Tischner offer the following two-part definition, intended to incorporate the experience of SusProNet,[24] and thus the full experience of the European PSS research conducted under the FP5. It is likely that this definition comes closest to a consensus definition and will be increasingly adopted; we thus adopt it for the purposes of this report:

- “Product-service (PS): a mix of tangible products and intangible service designed and combined so that they jointly are capable of fulfilling final customer needs.
- “Product-service system (PSS): the product-service including the network, technological infrastructure and governance structure (or revenue model) needed to “produce” a product service.[25] (Tukker at al 2006a)

This definition of PSSs is admittedly abstract, but PSSs are very much a part of all developed and developing economies. For example, rent-a-car businesses, mobile telephony, pizza delivery, and utilities are all examples of PSSs that are very much “business as usual” in the US.[26]

“Business as usual” PSSs have changed over time, driven by changes in income levels, consumer preferences, and technological development, among other factors. As shown by the three innovative/emergent PSSs on the overleaf, these changes are environmentally beneficial in some cases.

In other cases, they have not been: for example, rising incomes and technological change have reduced the US market share of PSSs such as laundries, public baths, and public transport systems, replacing them with less eco-efficient—but often more convenient—private ownership of products and infrastructure to deliver the same basic function (i.e., washing machines, in-home plumbing, private automobiles).

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which are jointly capable of fulfilling specific client demands” (UNEP 2002). Additional definitions are available in Tukker et al 2006b.

The lack of a single agreed definition does not pose a significant barrier to identifying sustainable emergent and innovative PSS business models. Stoughton et al (2007) note—and that this appears consistent with the views of most other researchers—that excessive debate over minor differences in alternative PSS definitions or argument over whether a particular business model is or is not a PSS is generally unproductive. This is particularly true as the body of PSS research strongly demonstrates that the simple fact of that a business model is a PSS is no guarantee that it offers environmental performance (eco-efficiency) improvements over BAU. As discussed in Section 2.4, while upper bounds of environmental performance improvement vary by PSS categories, actual environmental performance improvements are highly case-specific.

[24] See footnote 18 for a description of SusProNet.

[25] Tukker et al elaborate slightly on this definition subsequently, adding terminology they explain and develop over the course of the chapter. The revised definition does not have significant content differences from the original, but does not lend itself to stand-alone use. (cf Tukker et al 2006a, pp 24 and 31.) The original definition is thus used here.

[26] While this definition (and previous ones on which it draws) clearly state that the PSS concept defines an *economic space* rather than a process of change, much of the literature simultaneously treats PSSs as representing a change from BAU. As described in 2.3, it seems clearest to use the PSS concept as defined, and to use the term *servicizing* to describe changes from BAU.

Three innovative/emergent PSS examples and their environmental improvement mechanisms

Note: More information about each model is available in the relevant *Business Model Brief* in Chapter 5.

Business models	Mechanism for potential environmental improvements over BAU
Car-sharing Car-sharing is a "personal mobility PSS" that provides short-term use of cars located in special reserved parking spaces distributed throughout an urban area. Compared to traditional car rental, car-sharing is characterized by short rental periods (15 minutes to a few hours), decentralized location of vehicles, and fee structures that combine membership and time-based usage fees. In this PSS, the *product* is the vehicle and *service* is the mobility provided by the vehicle, as well as the insurance and maintenance included in the fee.	Car-sharing can provide the service or function of car ownership at lower total cost and/or greater convenience than car ownership. This may reduce the total number of cars required by the population of a city or area, reducing the material use, energy and pollution associated with car manufacturing and vehicle disposal at end-of-life. At high levels of adoption, car sharing could reduce traffic congestion & parking problems in urban areas. This can result in shorter trip times, reducing fuel use and associated air pollution Research also suggests that those who use car sharing as an alterative to ownership tend to drive less, thus reducing pollution, fuel use and congestion.
Chemical Management Services (CMS) In CMS, a chemical user outsources one or more chemical management activities (e.g., inventory management, application, collection, disposal). The CMS provider is compensated based primarily on the basis of the *services* the chemicals provide, not the volume of chemicals purchased.* In this PSS, the *product* is the chemicals. The *service* are aspects of chemical management undertaken by the CMS provider.	In traditional chemical procurement, the chemical supplier has a profit incentive to maximize sales of chemicals. In CMS, fees are based primarily on the services provided, not the volume of chemicals used. Contracts feature "shared savings" or other mechanisms that reward the provider for reducing the customer's total costs of chemical use. Often this results in reduced chemical use. In addition, CMS makes handling and disposal of chemicals more professional and thus should lead to improved compliance with environmental regulations, reduced chance of accidents.
Telepresence (High-end Videoconferencing systems) High-end video-conferencing ("telepresence") allows people in different locations to communicate in a simulacrum of "face to face" exchange far superior to that achieved by traditional video-conferencing. This is achieved via high-quality, high-definition audio and visual feeds, the use of multiple cameras and screens, and specially designed, dedicated rooms. In this PSS, the *product* is the hardware and the *service* component includes bandwidth, network functionality, and support services.	In principle, videoconferencing offers a substitute for physical travel. To the extent that videoconferencing replaces physical travel, the energy consumption and emissions associated with travel are prevented.

*For more information about the CMS model, see www.chemicalstrategies.org; (Stoughton and Votta, 2003); and (Mont et al, 2006).

Source: adapted from (Stoughton et al, 2007)

The examples of "BAU" PSSs cited above indicate that such well-established PSSs play a significant role in defining the patterns of consumption and production in the current economy, and that the environmental performance of these PSSs is thus one important determinant of the overall environmental performance of the economy as a whole. More quantitative assessments of the economic and environmental performance of PSSs is limited by data constraints (see Section 2.5).

2.3 Servicizing: Innovative/emergent PSSs that intensify the service component

However, US EPA's primary interest is in finding ways to change the status quo and move meaningfully towards a more sustainable economy. The examples cited in Table 1 indicate that in some cases, *innovative or emergent*[27] *PSSs* should constitute significantly more eco-efficient alternatives to BAU.

The defining characteristic of these *innovative or emergent PSSs* business models is that they *intensify* the service component, employing services to add value in ways that are different from "business as usual" ways to achieve a given economic function. In some cases, consumers may no longer purchase the product itself, but the function (or service) that the product provides. In other cases, the changes from BAU are less radical. Regardless, emergent PSSs *restructure the economic relationships that mediate how products deliver function or utility*.[28] As a result, the manufacture, use, or end of life management of products or infrastructure changes in some way. **Generically, this report terms such a change from BAU "Servicizing."**

This restructuring can improve the eco-efficiency of the economic function by closing materials cycles, dematerializing economic activity, improving energy efficiency, and other mechanisms. The box on the previous page describes these mechanisms for each of its three examples. **Where such eco-efficiency improvement occurs, this is termed "Green Servicizing."**

Innovative or emergent PSSs are the primary focus of this report. However, it should be noted that environmental policy also has an interest in "BAU" PSSs where changes to them may substantially improve their environmental performance. (For example, if all delivery fleets were upgraded to ULEV standards, significant environmental performance improvements would result.)

2.4 Classifying PSSs and "Green servicizing" mechanisms

As numerous definitions of PSSs have been developed, so have numerous classification schemes. In general, however, there is a convergence of these schemes around three PSS categories:

[27]In strict economic usage, "innovative' refers to the first commercial application of an invention or an original process or value proposition. Here, also of interest are in *emergent* PSSs—i.e., those that are commercially available, often offered by several providers, and which may be firmly established in one or more market niches, but which are currently well-short of fulfilling their full market potential. In general, the term *emergent* will be used informally throughout this document to include the concept of *innovative* as well.

[28] Tukker , van den Berg and Tischner characterize this differently, noting that a focus on needs fulfilment as the end rather than on a particular product as means can open up additional "degrees of design freedom" necessary to decouple needs and wants fulfilment (and economic growth) from material inputs. (Tukker et al 2006a).

Product-oriented, Use-oriented, and Result-oriented.[29] The table below reproduces the descriptions of these categories from (Tukker et al 2006a, 32) and (Stoughton et al 2007, 19).

Tukker et al write in synthesis of the SusProNet experience, and synthesize and extend a set of previous schemes.[30] The scheme by Stoughton et al is likewise based on a broad review and synthesis of the literature, including early outputs from SusProNet.[31]

Table 1: Primary PSS categories

PSS Category	As described in Tukker et al*	As described in Stoughton et al
Product-oriented	Here the business model is dominantly geared towards sale of products, but some extra services are added	Emergent PSSs in this category offer value (and are different from BAU) by **adding services to products** such as extended warranties, maintenance, upgrading, and end-of-life management. Product ownership remains with the consumer.
Use-oriented	Here the traditional product still plays a central role, but the business model is no longer geared towards selling producs. The product stays in the ownership of the provider and is made available in a different form, and sometimes shared by a number of users	Emergent PSSs in this category offer value (and are different from BAU) by providing consumers with access to the product and the function it provides without the need to own the product. Leasing and rental models are in this category, including individual and joint use
Result-oriented	Here, the client and provider agree on a result, and there is no predetermined product involved.	Emergent PSSs and allied models in this category offer value (and are different from BAU) by directly providing a function to the customer, who in turn pays for this function rather than use of or access to a particular product. The function may be tangible (i.e., waste management) or intangible (i.e., communication.)

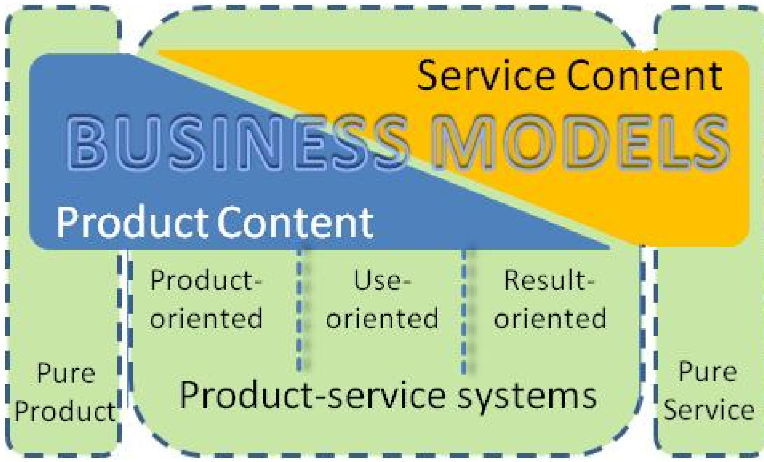
Tukker et al characterize these three categories as describing a spectrum from mainly product-content to mainly service-content. Classification is thus oriented towards the product-service mix; an emphasis conveyed by Figure 2, which also lists the subcategories they identify under each major PSS category.

[29] These categories, and particularly the identification of PSS types within each category (see Table 2), represent a more sophisticated classification scheme than that presented in the 1999 Tellus report (White et al 1999). The 1999 Tellus report organized services (not product service systems) into three categories. See Annex B for a comparison of this scheme and the one adopted for this report.

[30] Tukker et al cite (Zaring et al 2001) and (Tukker and van Halen 2003) as key sources, also noting (Hockerts et al 1994), (Behrendt et al 1999) and (Prepare 2000).

[31] Stoughton et al cite (White et al 1999), (Bartolomeo et al 2003), (Hrauda and Jasch 1999), (Tukker 2004), and (Wong 2004).

Figure 2: PSS Classification scheme of Tukker et al



Adapted from (Tukker et al 2006a)

In recognition of the synthesis of the SusProNet learning and experience that Tukker et al represent, and to maximize ease of communication and exchange with the European PSS community, this report adopts the (Tukker et al 2006a) classification scheme. The key categories and sub-categories of PSS models in this scheme are described in the tables that follow. Except where noted, the category descriptions are adapted from (Tukker et al 2006a).[32]

Also contained in the tables are descriptions of the expected mechanisms whereby innovative or emergent PSSs in each category may improve environmental performance over BAU (in short, "Green Servicizing Mechanisms"). The emphasis in describing these mechanisms is on improvement mechanisms that are (or can be) intrinsic to the structure of or economic incentives created by each type of model.

For example, a car-share service may *choose* to offer only ULEV, "Zero-emission" or hybrid vehicles, or an office cleaning service may *choose* to use only "green" cleaning compounds. These choices may have significant effects on the environmental performance of the PSS in question, and may substantially improve its performance compared to BAU. However, they are not choices driven by the intrinsic structure of the class of PSS models to which each belongs.

Except where otherwise noted, descriptions of environmental improvement mechanisms are generally adapted from (Stoughton et al 2007). In some cases, (Stoughton et al, 2007) have identified classes of models within a sub-category that have distinctly different "environmental improvement mechanisms." These are noted in the scheme.

[32] This classification is versatile and inclusive, but not perfect. As Tukker et al note that, "as with any classification system, there are exceptions for which this classification does not work well. The classification assumes that 'products' by definition have a material character, and for some products—most notably software—this is simply not the case." (Tukker et al 2006a). To this list of exceptions, this report would add "insubstantial products" or "tangible services" such as waste management and electricity.

Table 2: Classification Scheme for Innovative and Emergent PSSs with Definitions and Environmental Improvement Mechanisms

Product-oriented .
PSSs in this category are dominantly geared towards the sale of products, but added services are a source of additional value. These services include, e.g., extended warranties, maintenance, upgrading, and end-of-life management. Product ownership lies with the consumer.

PSS TYPE	"Green Servicizing Mechanism" (How can innovative/emergent PSSs in this class achieve eco-efficiency gains over BAU?)
Product-related services In addition to direct sale of the product, the provider offers services related to the use phase: e.g. maintenance, extended warantees, financing, supply of consumables, take-back, etc.	Environmental performance mechanisms primariliy exist unders three variants of product-related services.* **Product take-back models.** The primary value-added service in these models is product take-back at end-of-life (or once the customer no longer requires the product.) Thus, these models are expected to lead to increased re-use and material recovery. **Recycling/remanufacturing-based businesses** While not PSSs according to some definitions*, we include* them in this category as they add services to the end-of-life phase of a product, and thereby change its final disposition. These businesses recover not products at end of life, but waste material, from which they create new products. Expected environmental benefits are reduced demand for virgin materials and reduced disposal impacts. **Product life extension** The primary value-added services in these models are maintenance and upgrades, both of which should extend product lifetime. This reduces the total number of products over time, thus reducing all impacts in phases prior to use (e.g., extraction, manufacturing), as well as reducing disposal impacts.
Product-related advice/consultancy In addition to direct sale of the product, the provider offers advice or consultancy on the most efficient use of the product, which may extend to logistics systems and management structures,	"Efficiency consultancy" has the potential to reduce the in-use impacts of the product (e.g. energy consumption) and, potentially, to extend product lifetime.

*Notes: Other **"Product-related services**," models may achieve environmental improvements, but this report poses that the three classes of models identified are those to which environmental improvement mechanisms are most intrinsic, and are most likely to achieve environmental performance improvements over BAU in practice.

Use-oriented
PSSs in this category are centered on the provision of products, but they offer value by **providing consumers with access to the product and the function it provides without the need to own the product**. Leasing and rental models are in this category, including individual and joint use approaches.

PSS TYPE	"Green Servicizing Mechanism" (How can innovative/emergent PSSs in this class achieve eco-efficiency gains over BAU?)
Product lease (Individual lease or rental) Models in this category offer the customer exclusive (i.e., individual) use of a rented or leased product over the lease or rental term. Maintenance and repair responsibilities generally lie with the provider. Examples include long-term leases for e.g., IT equipment, vehicle and capital equipment.	. These models place end-of-life responsibility for the product on the provider and also should place a premium on product durability and maintainability. Thus, these models may provide incentives to producers to pursue Design for Environment (DfE) approaches, creating more durable products with increased proportions of recyclable/reusable parts. As a result, environmental loads prior to the use phase (e.g. virgin materials inputs, energy consumption associated with production) may be reduced. In addition, as ownership remains with the provider, proper disposal and/or improved recovery may be more likely. (However, this is not the case when products are disposed by sale to secondary markets.)
Joint use (Sequential and pooled) Joint use models offer product rental or leasing in such a way that a number of individual customers use the same product. This joint use may be simultaneous or, when the rental period is short, sequential. Maintenance and repair responsibilities generally lie with the provider. Traditional car rental and car-sharing both fall in this category. The short rental period of car-sharing and the concept that cars stations are "shared" among users in the vicinity mean that car-sharing is a "pooled use" model; traditional car rental is a sequential use model.	In addition to the potential benefits under "individual lease or rental" enumerated above, these models should reduce the *total number* of products required to deliver a given level of economic function. Thus, they may further reduce all impacts in phases prior to use (e.g., extraction, manufacturing), as well as further reducing disposal impacts.
Pay-per-service unit In Pay-per-service-unit models, the customer pays for the output of a product on a per-unit basis. In contrast to "functional result" models (below), the user is responsible for operation of the equipment. "Well-known examples include the pay-per-print formuls now adopted by most copier producers. In this formula, the copier producer" (Tukker et al 2006a).	In addition to the potential benefits under "individual lease or rental" enumerated above, these models can provide a clear, utilization-based price signal to the user, which may stimulate conservation behaviors, reducing the utilization of the product and attendant use-phase environmental impacts.

Notes: Tukker et al distinguish between sequential and pooled joint use. They term the former "product renting/sharing" and the latter "product pooling."

Results-oriented

PSSs and allied models in this category offer value by directly providing a function to the customer, who in turn pays for this function rather than use of or access to a particular product. The function may be tangible (i.e., waste management) or intangible (i.e., communication.)

PSS TYPE	"Green Servicizing Mechanism" (How can innovative/emergent PSSs in this class achieve eco-efficiency gains over BAU?)
Activity Management/Outsourcing In these models, the provider undertakes responsibility for a service that a customer would otherwise undertake in-house, with its own employees. Examples include outsourcing of cleaning, mailroom, or customer-service functions.	As Tukker et al note "in many cases, the way in which the activity is performed does not shift dramatically" [compared to how the customer would perform the function in-house]. (2006a, 34). Potential environmental benefits arise when the provider realizes cost savings and efficiency gains in material and energy inputs, not via the utilization of lower-priced labor. (Tukker et al 2006b) In addition to this general situation, we identify two types of models, spanning both the Activity Management and Functional results categories, in which environmental performance improvements are most likely to arise: **IT Dematerialization** IT dematerialization models utilize information technology to deliver a function to a customer in such a way as to substantially eliminate the need for the products and services that deliver this function under BAU. Examples include Video conference and tele-presence systems (in principal reducing the need for travel) and e-learning (in principal reducing the need for travel and instruction facilities). Benefits arise when the IT-based approach indeed reduces material and energy intensity compared to physical presence. **Performance-based "functional procurement"** Performance-based services provide functions such as chemical management, waste management, energy services, and logistics management (3PL). In these services, traditional compensation mechanisms (e.g., fees per ton waste hauled, per BTU used) are replaced by performance-based compensation mechanisms that give the service provider incentive to reduce the customer's generation of waste, their use of energy, or consumption of other environmentally problematic goods or services. This category includes *"efficiency services,"* which may not have a clear product associated with them, but do alter the utilization of products and infrstructure (e.g., ESCOs, 3rd Party Logistics*).*
Functional results Tukker et al characterize functional results models as those in which the provider is engaged to deliver a result, without reference to a specific technological system (i.e., the means of delivering the result are at the provider's discretion.) Examples cited include Integrated Pest Management (IPM) services, in which IPM providers promise to keep farmer's losses to an agreed minimum rather than selling pesticides. In reality, however, this may be a difficult standard to meet; results provision is rarely fully detached from a specific technological system. This report poses that the basis of compensation is the sounder criterion on which to identify "functional results" models. (See "performance based functional results" immediately at right.)	

2.5 What is known about the "sustainability potential" of Green Servicizing?

The discussion to this point, and particularly the discussion of greening mechanisms in the tables above, raises a critical question: what environmental performance gains does "Green Servicizing" achieve *in practice* over BAU? (Or more generally, what *sustainability performance gains* are achieved, where sustainability requires consideration of social, not just environmental, performance.)

Researchers have assessed greening or sustainability potential in a number of different ways, but in general, there is an effort to account for both environmental and social dimensions, a recognition that environmental performance needs to be assessed with attention to several *performance dimensions* (e.g. energy, materials, etc.) and that the analysis requires at least a sensibility to lifecycle impacts.[33] (The approach adopted for this report is discussed in Section 4.1)

A consistent conclusion of these efforts to assess the environmental (or more broadly, the sustainability) potential or performance of "Servicizing Models" and cases is that details matter, and "most authors hence conclude that the question of whether a PSS is better than a product system has to be answered on a case-by-case basis" (Tukker et al 2006b).[34]

However, accumulated experience with servicizing approaches does support some general conclusions. Results from recent, multi-model/case assessments are summarized below:

- **(Tukker et al 2006b).** In a comparative analysis of the environmental performance of "Servicizing" approaches over BAU, Tukker et al examined more than 200 cases compiled under the SusProNet synthesis of European PSS research. Their analysis indicates:

  Product-oriented models & product-lease models. Only when product-related services include take-back and recycling [or better, reuse or remanufacturing] are these models likely to result in substantial environmental gains. Such gains should only be ascribed to the PSS in markets where end-of-life recycling/energy recovery under BAU is limited. (Thus, where take-back and recycling is mandated, these activities, if carried out under the PSS, will not represent an environmental performance gain over BAU).

  Maximum typical eco-efficiency gain: With recycling/reuse/remanufacturing, up to Factor 2; otherwise less, with worse-than-usual performance possible in some leasing cases.

  Use-oriented models (except product-lease). Product renting, sharing and pooling can achieve significant environmental performance gains when either (1) the use phase of the product is not a significant source of its life-cycle impacts; or (2) the use phase is a significant source of impacts, but the model results in significantly reduced use levels of the product by individual customers. (Car-sharing is a "pooled use" model with this effect.) Pay-per-use models also will tend to reduce use levels.

  Maximum typical eco-efficiency gain: Factor 2

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[33] The most common assessment approach is simple scoring (e.g. on a 5 point scale) of performance gains/losses in each dimension, based on expert judgement (e.g., Tukker et al 2006b; Halme et al 2005.) A more limited—but still substantial—number of formal quantitative evaluations have been performed, including formal LCAs. Some of these more quantitative evaluations are referenced in the Business Model Briefs section of this report.

[34] Tukker et al do not use the term "Servicizing." In the terminology adopted for this report, this sentence would be rendered "most authors hence conclude that the question of whether a "*Servicizing*" *approach* is superior to the *BAU alternative* must be answered on a case-by-case basis.

Results-oriented models: Activity management/outsourcing should result in environmental performance gains when the economic efficiency improvements achieved (i.e., the value proposition to the customer) derive in some part from increases in material/energy efficiency, not simply labor inputs.

Maximum typical eco-efficiency gain: Factor 2

Results-oriented models: Functional results models *are the only PSS type to which "factor X" potential can generally be attributed*. (Factor X suggests radical eco-efficiency gains of up to the "Factor 10" thought to be necessary in wealthy economies to achieve a sustainable global economic system.)

- **(Stoughton et al 2007).** Based on a detailed assessment of 25 Japanese cases (chosen by a screening process that considered almost 300), Stoughton et al find that as a class, performance-based "outsourcing" models "have high potential to reduce the size of the materials cycle and/or to reduce energy use (and associated environmental loads) for a given level of economic function." They note that models in this class include ESCOs, 3PL, and performance-based water-services. (Their sample did not include Chemical Management Services and resource management, which are poorly represented in Japan, but these models are "close kin" of those they do list.)

  In the context of this report, all are "performance-based functional procurement" or "efficiency services" models in the "functional results category." They also find that telepresence (an IT dematerialization model) had high potential.

- **(Halme et al 2005**) assessed more than 200 household service cases in six Western European countries thought to offer potentially more sustainable alternatives to BAU. (Household services were defined as "services offered to the consumer on the housing premises—namely in their dwelling, in their building or on the building grounds"). These included energy services, repair and recycling services, "ecological groceries" home delivery, among others.

  They find that particular services (and classes of services) in their sample do achieve "substantial" and in some cases "major" eco-efficiency improvements in key environmental dimensions (e.g., material use, energy use, water, waste, etc.) No class of services achieves "substantial improvements" in *all* environmental dimensions, and if the scores for all cases are averaged, the result in each dimension is a *moderate* eco-efficiency gain: i.e., something between the "status quo" and a "substantial improvement."

The results of (Tukker et al 2006b) and (Stoughton et al 2007) strongly emphasize that *functional results* models as a class have special potential—though this does not exclude "outlier" high performers in other PSS categories. However, because mandatory take-back is rare in the US context, servicizing models that include take back and recycling/re-use/remanufacturing may achieve much higher improvements over BAU than they would in the Western European/EU context, where mandatory forms of EPR are far more common. And, again, throughout this literature and accumulated experience, it is clear that environmental gains within a model are not automatic, but depend on the details of its implementation at the business or case level.

2.6 PSS Classifications vs. treatment of services in economic statistics

While current knowledge permits general conclusions about the eco-efficiency potential of "green servicizing," far less can be said about the prevalence of either PSS activity in the economy generally, or about servicizing as a type of *change* in PSS activity and offerings over time. Both are very poorly captured by official economic statistics.

The basic problem is that the PSS concept and the classification scheme above conceive of "production," offerings in the market, and value-added as non-separable combinations of product and service, official economic statistics generally view "output" as *either* a product or a service.

For example, US BEA statistics are based on the North American Industry Classification System (NAICS). A basic division in the NAICS is between "goods-producing sectors" and "services-producing sectors."[35] Output and value-added produced by the former are generally ascribed to goods, irrespective of the service content of the offering. Likewise, service sectors are assumed to produce services, even when the service has a substantial product component (e.g. newspapers).

This poses a fundamental problem to a rigorous statistical understanding (or even rough estimates) of the "deepening" of service content in "goods-producing sectors," the extent to which product sales are being displaced by function-based alternatives, or similar questions critical to understanding the evolving role of PSSs in the economy (that is, servicizing).

This said, significant efforts are being made to standardize classifications of the "products" of the service sector, and to improve economic characterization of statistics. In a landmark study of Productivity in the US Services Sector, Triplett and Bosworth note:

> "The trend toward services claiming a growing share of the economy was long ignored by a statistical system originally structured to report the production and consumption of goods. For many years the outputs of major services-producing industries were estimated by making simple extrapolations of their past relationships to employment or some similar partial indicator. The research reported in this book highlights the progress that has been made in the US statistical system in expanding the range of surveys of the services-producing industries and in developing an improved methodology for measuring both the output of services and the contribution of critical new high-technology products. (Triplett & Bosworth 2004)

Development of the North American Product Classification System (NAPCS)—a joint effort of the statistical agencies of Canada, Mexico and US—has to date focused on service "products" and should over time support improved statistics collection regarding trade in and domestic production of services.[36]

However, these efforts do not yet address the statistics and data needed to understand the evolving role of PSSs in the US economy.

2.7 Comparison to the "Tellus Report" Classification scheme

The PSS classification scheme of (Tukker et al 2006a) adopted for this report is more sophisticated than the services classification scheme presented in the 1999 Tellus report (White et al 1999), and incorporates the results of subsequent scholarship. The 1999 Tellus scheme is compared to the current classification scheme on the following page.

[35] Mostly broadly: utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government. Additionally, construction is counted as a service when traded internationally.

[36] See the NAPCS home page at http://www.census.gov/eos/www/napcs/napcs.htm.

Tellus/US EPA 1999 (text from (White et al 1999))		Tukker et al 2006			Additional sub-divisions introduced in this report
Major Categories	Sub-Categories	Major Categories		Sub-Categories	
		Pure Product			
Material Services Material, or product-based, services use an established, physical product as the vehicle, or platform, for delivering services related to the product for customers.	**Product Extension Services** Characterized by customer ownership of the physical good, and thus represent only a minimal departure from a traditional, pure sell-buy arrangement which places full responsibility for the product in the hands of the buyer. Product extension services enhance the utility that ownership of the product delivers to the customer. The most familiar versions of these services include warranties and maintenance agreements.	**Product Service Systems**	**Product-oriented**	**Product-related service**	Product take-back Product life extension Recycling /remanuf. -based businesses
				Product-related advice/ consultancy	
	Product Function Services In this category of services, ownership of goods resides with the service provider. Customers have the use of the product, but maintenance as well as end-of-life disposition are the responsibility of the service provider. Thus, the customer gains the function of the product is provided without ownership. Thus, traditional rental or leasing arrangements fall into this category. . . Also in this category are non-traditional leasing arrangements [functional sales].		**Use-oriented**	**Product leasing**	
				Joint use (Product renting/shariing + product pooling)	
				Pay per service unit	
			Result-oriented	**Activity management/ outsourcing**	Performance-based functional result
Nonmaterial services Non-material services are delivered via a supporting infrastructure and goods that remain in the hands of the service provider. Their value to the customer is totally — or near totally — tied to the information or technology embodied in the transaction. Non-material services include,	**Dematerialized Services** In these cases, technology has obviated or drastically reduced the need for products altogether. . . One example is that of centralized voice mail supplanting answering machines (in which the messaging service once provided by a desktop machine is now provided by a combination of remote hardware and information transmission.			**Functional result**	IT Dematerialization
	Other non-material services "Traditional" services, e.g. health care, hair salons, insurance and banking.	**Pure Service**			

3 Information and analysis to inform policy engagement: contributions and limitations of this report

3.1 Leveraging green servicizing with policy

In commissioning this work, US EPA's Office of Resource Conservation and Recovery (formerly the Office of Solid Waste) sought critical tools, concepts and analysis needed to identify appropriate, substantive and effective next steps for using *green servicizing* to aid in decoupling material, energy, water and chemical use from economic growth.

With respect to servicizing, the current challenge and opportunity for environmental policy is to:

> **Identify** innovative and emergent servicizing business models[37] of high sustainability potential, **validate** this potential, and, where indicated, to **make policies** that foster a market and regulatory environment that help such models become business as usual, and best assure that the "greenest" versions of these models are the ones that grow.

As this statement implies, the case for policy engagement may not always exist. Further, policy engagement could involve, but is not uniquely synonymous with, regulatory actions. Support for pilots, development of market information, manuals and information portals, establishing voluntary "green standards" or certifications, and developing voluntary programs and alliances based on these approaches are all important but non-regulatory forms of policy engagement in this area.

Likewise, "validating potential" may be a matter of passive research, or it may entail policy engagement in the form, e.g., of supported pilots. (For example, US EPA has supported pilots of *Chemical Management Services* to test its efficacy outside its "traditional" core manufacturing client sectors.) Any assessments of environmental performance must be conducted with a sensibility to lifecycle impacts.

A second challenge and opportunity for policy is to identify high-leverage changes to *existing* product-service systems that substantially improve the efficiency of these systems. However, this work is primarily concerned with innovative and emergent business models.

3.2 Information and analytical requirements and the contributions of this report

Chapter 2: "A Re-orientation to Green Servicizing" provided essential basic concepts. But what additional information and analyses are needed to address the challenge and exploit the opportunity of "green servicizing"?

Consistent with the discussion in 3.1, above, needs can be divided into two main areas: those supporting *identification* of innovative/emergent models of high "greening" or sustainability potential, and those supporting *policy engagement* with these models. In addition, *information about market status and environmental performance* support both areas.

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[37] The use of the term "models" in this context is deliberate. As noted in the introduction to this work, the survival of an individual business is generally not a concern of environmental policy. "Green business" policy must operate at the model rather than the individual business or case level. The focus on *models* vs. cases is a key difference between this report and the 1999 Tellus Institute report. See discussion in Section 5.1.

These needs are set out in the text and tables below, along with an explanation of how this report addresses these needs.

Model identification and supporting information and analysis

Identifying models of high sustainability potential requires. . .	*This report. . .*
A working definition of high sustainability potential or a process for distinguishing models of high sustainability potential	**A. Provides a working definition,** defining sustainability potential as arising from the interaction of four factors, and provides a simple, qualifitative analytic scheme to identify "high potential" combinations of these four factors.
A scan or survey approach by which to identify such high-potential models in the economy.	**B. Utilizes a "quick search" approach** to identify a set of models for which there are strong a priori reasons to believe that sustainability or greening potential is high. The approach combines (1) a literature search for high potential models and (2) a rough gap analysis to identify key sectors or streams for a more targeted search. **C. Outlines** options and approaches to gain a deeper and more systematic understanding of "green servicizing" business activity in the economy.

D. Key deliverable: ***Business model briefs.*** These three to four-page briefs synthesize publicly available information about the market status and environmental performance of 10 servicizing models identified via the "quick search" approach described above. The *briefs* do not make a formal, quantitative assessment of the sustainability potential of these models, but they do support a less formal appraisal.

Information and analysis supporting Policy Engagement.

Understanding and assessing the need for policy support (if any), potential points of policy intervention and policy approaches requires. . .	*This report. . .*
Information about drivers, barriers and determinants of environmental performance, rendered in terms relevant to the the formulation of policy objectives. This information is required as, generally speaking, policy for "green business" can (1) reinforce drivers, (2) reduce barriers, and/or (3) strengthen the determinants of "green" performance.	**E. Assesses barriers, drivers and determinants of environmental performance for three models**, and illustrates an approach for translating this information into high-level policy "targets" or objectives. (The *business model briefs* also contain less detailed information about drivers and barriers for all models examined.*)*
Information about the existing policy environment, as the design of policies is rarely a greenfield exercise, but must be cognizant of, accommodate, leverage and/or change existing requirements and incentives.	Policies that have a significant and obvious impact on the market for a model are captured in the *business model briefs,* and especially in the detailed barriers and drivers assessment undertaken for three models. In general, however, the research undertakes no systematic assessment of the current policy environment.
Models of policy engagement and synthesis of lessons learned.	**F. Provides a brief synopsis** of policy engagement with servicizing in some "peer economies."

Information about market status and environmental performance

Information about the market status and environmental performance of high-potential models supports both key areas above: Verifying a model as "high potential" requires information about its environmental performance and an indication of its market potential, as discussed in Section 4.1 Policy engagement requires information about customer sectors and market position.

Publicly available information regarding environmental performance and market status is synthesized in the *business model briefs.*

3.3 Limitations

As discussed above, this report and the research effort it represents are intended to help understand the challenges and opportunities of "green servicizing." While the report *is* intended to provide critical concepts and tools, it cannot fulfill all the information and analysis needs identified above. Specifically, the report does not:

- Undertake a thorough characterization or "baseline" of "green servicizing" activity in the economy. Rather, a quick search approach is employed to identify models thought to have high potential with respect to environmentally critical products and sectors, and briefs summarizing publicly available market and environmental performance information are developed for these models.
- Characterize drivers or barriers in detail for most models, and does not characterize the existing policy environment in detail for any model. Both types of information are important to weigh policy engagement and, if appropriate, formulate policy approaches.

3.4 Orientation to the remainder of this report

The remainder of this report presents the information and analysis described in the tables above, and is organized as follows:

- **Chapter 4:** Discusses concepts and approaches critical to identifying high-potential servicizing business models. This includes a working definition of "sustainability potential" and the "quick search" process.

  An extended text box discusses approaches the agency might pursue to develop a more rigorous and systematic understanding of "green servicizing" activity in the economy, focused as appropriate on sectors or mechanisms of interest.
- **Chapter 5:** Presents the results of research on the market status and environmental performance of 10 high-potential servicizing approaches, including a summary matrix and the *business model briefs*.
- **Chapter 6:** Contains a detailed assessment of barriers, drivers and determinants of environmental performance for three "close kin" models, and maps this assessment to "policy targets" (intermediate policy objectives). This information and analysis model is intended to support US EPA in weighing policy engagement, to provide a model for analysis of other models, and to help assess the hypotheses that similarities in drivers, barriers and value propositions exist and that therefore government policy engagement around these models as a *class* may bring significant synergies and economies.

- **Chapter 7**: Presents overall findings, derived from cross-model synthesis and analysis of the information presented in Chapters 5 and 6.
- **Chapter 8**: Presents key considerations for moving forward toward achieving wider adoption of green servicizing in the US economy and possible next steps.

4 Key concepts and approaches for identifying high-potential servicizing business models

4.1 A working definition of "sustainability potential"

As noted above, identifying models of high "sustainability" or greening potential requires a working definition of such potential. Drawing on (Stoughton et al 2007), "sustainability" or "greening" potential can be understood as a function of four factors:

1. **"Micro-level" environmental performance.** As noted above, the basis of environmental policy interest in "innovative and emergent" PSSs or "green servicizing" business models is that they may provide a more eco-efficient *alternative* to the BAU means by which an existing economic function is delivered or achieved. "Micro-level" environmental performance is an assessment of this eco-efficiency gain at the level of the single customer or "unit of function." Micro-level performance needs to be evaluated with a sensibility to the life-cycle impacts involved.

   ("Micro-level performance" is thus distinguished from "Macro performance," which describes the impact of the model on the eco-efficiency or the economy as a whole.)

2. **Market potential.** Market potential is the extent to which a model has the potential to become BAU in the market for the principal goods or services to whose BAU consumption the servicizing model constitutes an alternative. If a model has high market potential *and* this potential is achieved, then the micro-level performance improvements will have maximum benefits to the eco-efficiency of the economy as a whole.

   Determining market potential is always a subjective exercise, but key indications of low potential include situations in which: a model's value proposition to the customer limits it to serving a small niche in its market; regulatory barriers are systematic or comprehensive; barriers include basic and fundamental issues of customer acceptance; and/or providers are thus far unable to offer the model profitably.

3. **Environmental Significance.** Environmental Significance refers to the portion of national environmental loads that can be attributed to the manufacture, use, delivery and disposal of the principal goods or services to whose BAU consumption the servicizing model constitutes an alternative.

   A model may offer significant improvements in "micro" environmental performance over BAU, and it may have the potential to become BAU in its market. But if the market is not environmentally significant, then the model has low sustainability potential—that is, its impact on the eco-efficiency of the overall economy will be very low.

4. **Social considerations.** Social issues are a key dimension of sustainability. Changes to BAU associated with PSS models can bring social benefits as well as social costs. (Costs, for example, may be a particular concern in outsourcing models that may involve labor displacements.) Environmental performance assessment techniques and information are generally more refined than their social counterparts, but at least a rough screening for significant beneficial and adverse social impacts should be a part of assessing sustainability potential.

With respect to these four factors, models of very high potential have readily identifiable characteristics. A model must be high-potential if: (1) micro-level environmental performance is a significant improvement over BAU *and* (2) market potential is high *and* (3) the market the model operates in has high environmental significance *and (4) the model presents no obvious social concerns.*

Similarly, poor micro-level improvements over BAU or poor market potential OR low environmental significance will alone generally assure low potential.

This qualitative integration and assessment is depicted in Figure 3, below. An advantage of the scheme is that it can be utilized with both high-quality/quantitative or lower-quality/qualitative data.

Figure 3: Four-factor analysis for identifying high-potential models

1 "Micro-level" Environmental performance compared to BAU	& 2 Market potential	& 3 Environmental significance of goods & services in market relative to national environmental load	& 4 Social concerns? Benefits?	→ Potential to help achieve Sustainable Economy Goals
LARGE REDUCTIONS	HIGH	HIGH	Benefits only	→ **HIGH**
SMALL REDUCTIONS	LOW	HIGH	Some concerns (e.g. labor losses)	→ **LOW**
MIXED	MODERATE	MODERATE	Mixed benefits & concerns	→ **NOT CLEAR**

Source: adapted from Stoughton et al 2007.

As indicated by the last row in the figure, a qualitative approach to integration does not result in a ranking of models, nor is it able to assess the potential of models characterized by "moderate" or "mixed" results across the four factors.

Trying to reach a rank-order, or to resolve "mixed results" situations (e.g., as represented by the last line of the table in Figure 3) is a non-trivial exercise, even setting aside the difficulties of rigorously quantifying each factor. For example, integrating the four factors into a quantitative "sustainability potential index" requires an ordinal ranking of performance improvements obtained in different environmental media. (E.g. is a 20% reduction in CO_2 emissions more or less significant than a 25% increase in water efficiency?). However, US EPA's current purposes do not require rank-ordering. Further, this framework provides a robust approach to understanding "sustainability potential."

4.2 "Quick search" approach to identifying high-potential models

Why a "quick search" approach?

US EPA's policy interests would ideally be addressed by an economy-wide "scan" of "innovative and emergent servicizing business models" against the four criteria that define high sustainability potential.

However, the underlying economic data that would support such an effort does not exist (see Section 2.5), and the resources available for this current work are inadequate to the task of generating it (see text box at end of this chapter). Therefore, a far more limited and targeted "quick search" approach was adopted for this report.

The "quick search" methodology

The approach employed two identification/selection mechanisms:

1. **Literature review.** First, an initial "core set" of models of high sustainability potential were identified from the literature, particularly recently published syntheses of European research[38] and recent results from Japan.[39]

2. **Gap analysis & targeted search.** These initial "top shelf" models were then characterized by key customer sectors and waste and/or input streams affected (see Section 5.1). This permitted a rough gap analysis against waste or input streams (or sectors) identified as important to ORCR.

   A more targeted search was then undertaken for servicizing models that addressed key gaps. This search was undertaken by revisiting the literature *and* by:

   a. conducting an informal assessment of the highest potential "green servicizing mechanisms" that existed in *potentia* for these streams and sectors, conducted with reference to the PSS classification scheme presented in Section 2.3; and then

   b. searching the web and business press for evidence that such servicizing schemes are in fact being implemented.

The selection process made an *initial, quick, qualitative* evaluation of the models against the four sustainability criteria. The set of models selected should thus be understood as a screening result—that is, based on the preliminary information available and prior to detailed research, there were strong reasons to believe that the models possessed high sustainability potential.

The research on market status and trends and environmental performance presented in Chapter 5 provides basic information to evaluate this hypothesis of "high potential." A formal, quantitative evaluation of the "sustainability potential" of the models against the four criteria was not undertaken. However, as discussed in Chapter 7, *qualitative assessment of the available data support the hypothesis that the models selected are of high sustainability potential.*

In the selection of both the initial set of models based on literature review and those derived from the gap analysis, preference was generally given to "high-level" models—i.e. those that appear to have the potential to change BAU at the sectoral or basic economic-function level rather than in narrow niche markets. This reflected US EPA's need to acquire as broad a perspective on the servicizing phenomenon as possible and its policy interest in changing BAU at the highest feasible level. It also helped assure that models met two key "sustainability criteria" market potential and environmental significance.

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[38] See the SusProNet archive, housed at www.score-network.org; also the discussion in Section 2.5 of this report.

[39] (Stoughton et al 2007; presentations at the "Korea-Japan-US Exchange Seminar on Servicizing" (Kwansei Gakuin University Umeda Campus, Osaka, Japan , 3 July 2007) and the "International Workshop on the Potential of PSS for Sustainable Production, Consumption and Supply Chain" (IGES Kansai Centre, 16 Nov 2004, Kobe Japan.) Proceedings available at http://www.iges.or.jp/en/be/activity.html.

As a result, in some cases the selection process did not identify a specific business model, but rather a "core component" (e.g. re-manufacturing) of a *set* of servicizing business models serving different sectors, focused on different types of products, or having multiple variants within a single sector. For simplicity, however, the term *model* refers to all selections.

Consistent with the research findings discussed in Section 2.4, a high percentage of the models selected were of the "functional results" type.

Models selected

- Car-sharing
- Chemical Management Services
- Deconstruction
- Energy Services (ESCOs)
- Integrated Pest Management/Performance -based pest control services
- "Lifecycle solutions" for IT equipment
- Remanufacturing
- Resource Management
- Telepresence
- Third-party logistics

Types of models excluded

The models selected (see box) represent the outcome of the "quick search" process. The exclusion of certain classes of models was another important outcome of the process, and illustrative of its implementation. Models excluded included:

- Models identified as high-potential in the literature, but with uncertain application or utility in the US market. For example, *Stoughton et al* (2007) identify "skeleton infill" approaches to high-rise housing as being of high potential in Japan, where a key environmental policy priority is changing "demolish rather than remodel" practices in the housing sector. The relatively low prevalence of new high-rise housing in the US, however, means that the potential of this model in the US market is probably low.

- Well-publicized "servicizing" approaches that are either arguably "business as usual" or which do not have obvious "green" dimensions. For example, the 1999 Tellus report included case studies of IBM and Xerox as examples of traditionally product-based companies that had embraced product-based services as a core business strategy. Service/product integration is arguably a "business as usual" strategy in the IT sector, and this integration—*of itself*—does not have intrinsic green dimensions.

- Large number of "niche market" models identified in the case literature. For example, Halme et al (2005) assessed more than 200 "potentially green" household services in six Western European countries, with examples including energy services, repair and recycling services, etc. Many of the cases (and by inference, the models underlying the cases) served relatively small niche markets.

Also excluded were products currently covered by national-level EPR initiatives in the US for which PRO (Producer responsibility organizations) are already constituted and active (e.g. batteries, carpet). The rationale for excluding these products is that the dominant business approach to addressing product disposal has already been determined, and it is largely outside a for-profit servicizing approach.

A model not found: Stand-alone, performance-based water efficiency services for industrial and commercial customers

A gap analysis of the initial models identified against the resource and waste streams they affected determined that models impacting water consumption were lacking. Conceptually, *performance-based water efficiency services* offerings could fill this gap for large industrial and commercial water users. Examples of such services exist in Japan (Stoughton et al 2007) and Europe.

*S*uch services would be analogous to Chemical Management Services or ESCO offerings (see Chapter 5): the provider of water efficiency services would assume *performance risk* for their project or product. That is, their compensation and profits would be tied to water efficiency and/or water quality improvements (and thus savings) actually obtained by the client. The provider might have an ongoing role in operations of water treatment systems and water utilization processes.

Such services are distinct from "one-off" water efficiency consulting and audit services, in which the consultant conducts an assessment, makes recommendations, and may undertake equipment installation or modification, but does not assume performance risk or have an ongoing role in operations. Such consulting and audit services are probably important contributors to overall water efficiency of the US economy, but they are not *servicizing* business models as defined in this report.

Many utilities and firms offer such consulting and audit services. However, significant evidence of stand-alone *performance-based water efficiency services* offerings for industrial and commercial customers could not be found. Of note, performance-based water efficiency services are an element of some CMS and ESCO offerings; this is discussed in the CMS and ESCO business briefs in the following Chapter.

Limited evidence for *performance-based water efficiency services* was found in the landscape irrigation area.[40]

Strengths and Limitations

This "quick search" approach could not capture the full scope of "high-potential green servicizing" in the US economy, and US EPA would clearly benefit from more rigorous and systematic approaches, as outlined in the box beginning on page 50.

Despite its limitations, however, this quick search approach was designed to deliver a robust and defensible performance in critical respects: it should, with high reliability, capture a selection of models that do have significant greening potential, constituting a needed "proof of concept" for US EPA. By focusing search effort on sectors or waste/resource streams identified by US EPA as environmentally important, it should also identify models that respond to identified environmental priorities.

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[40] In the US, 58% of potable water—or most of the 7 billion gallons of water consumed each day by residential and commercial users—is for landscape irrigation. It is estimated that as much as half of that water is lost or wasted "due to evaporation, wind, or improper irrigation design, installation, or maintenance" (Certification Programs for Irrigation Professionals, EPA, 2006). Several different studies have found that the average residential landscape can reduce the amount of water used for irrigation by over 50% using many simple technologies and techniques.

Landscape irrigation professionals design, install, maintain, and/or audit irrigation systems for commercial or residential water use. In principle, these services can be offered via "one-off" consulting/audit arrangements, or in performance-based arrangements, though we found more evidence of the former. EPA has a certification program through the WaterSense Partnership for landscape irrigation professionals adhering to the water efficiency principles. The professionals are part of the estimated $70–75 billion US landscaping services market.

Building blocks and entry points for a deeper and more systematic understanding of green servicizing in the US economy

PSSs and Servicizing as a type of change in economic activity over time are very poorly captured by official economic statistics (Section 2.5). However, US EPA clearly has an interest in gaining a more rigorous understanding of "green servicizing" activity in the US economy than afforded by the "quick search" approach taken in this report.

Approaches the agency could take to improve its understanding of this phenomenon range from the relatively simple to quite complex:

At the simpler end of the spectrum, US EPA could limit its investigations to developing a catalogue of known servicizing activities with green potential in critical sectors or serving critical "economic functions."

At the other end, US EPA could field a full-scale national survey of establishments engaged in (at least potentially) "green servicizing."

Fortunately, these approaches are not mutually exclusive; rather, they can be viewed as building blocks, with smaller scale studies informing and laying the groundwork for more complex analyses.

A. Identifying "Green" Servicizing Activities

US EPA may have a broader interest in understanding the environmental footprint of service activities. However, with respect to *green servicizing,* the Agency's primary interest is not in characterizing *all* PSS activity, but in characterizing potentially green *servicizing* activity—i.e. emerging or innovative PSS business models that represent a change from the status quo *and* which have "greening potential." The starting point for any effort should be to develop a catalogue or list of potentially green servicizing activity.

Focus on critical sectors. This should not be an economy-wide effort, but rather focus on environmentally critical production sectors, products or economic functions identified by US EPA. (For simplicity, "sector" is used as a general term.)

In essence, this requires vetting economic activity in each critical sector against the catalogue of PSS types and "greening mechanisms" set out in the tables of Section 2.3. The objective is to identify "matches"—that is, instances when a "servicizing mechanism" is being actively marketed as a value proposition.

Sectoral expert consultations. To identify these matches, US EPA could convene a mini-panel of five to eight experts for each critical sector.. The panel would review the list of servicizing mechanisms against their knowledge of business activity in the sector.

In some cases, one-on-one interviews with sector experts may be sufficient, rather than convening a panel *per se*. In general, these experts would be drawn from several sources, including industry analysts (from the financial services sector), consultants, trade associations, and select companies in the market.

The panel's efforts would not start from scratch, but would be informed by a list of "servicizing" examples drawn from the (mostly non-US) literature and from the knowledge of general "servicizing experts" supporting US EPA in this process.

A generalist panel or consultation group. It would then be valuable to assemble a panel or consultation group of "business and environment generalists" to screen the sectoral servicizing activity lists for "plausible greenness." In other words, the generalist panel can ascertain whether the servicizing activities identified by the consultations with sectoral experts are "plausibly or potentially green" enough to justify collecting more detailed data

Avoiding duplication of existing knowledge. Note that this effort may not be required for servicizing mechanisms or sector where the servicizing phenonmenon has been well-studied.

In these cases, a desk review of the existing literature or consultation with a key sectoral expert would be sufficient to identify key servicizing activity in a critical sector. This report provides a useful starting point in characterizing the state of knowledge, and the general "servicizing experts" supporting US EPA in this process would quickly determine where desk review or very limited consultation would be sufficient.

Further focus. In addition to focusing on critical *sectors,* US EPA could focus on *PSS types/greening mechanisms* of particular potential or interest.. These should include functional results models, since it is generally agreed that as a class these have higest "greening" potential.

B. Developing an Understanding of the Market Status and Environmental Performance these Activities

Once a sectoral list or catalogue of "servicizing activities of interest" is constructed, the challenge is to develop an understanding of the "market status" and environmental performance of these "plausibly green" servicizing activities within each sector. There are a number of options:

- **Commissioned market reports/industry surveys by sectoral experts** on the model of the Chemical Strategies Partnership's CMS Market Reports (www.chemicalstrategies.org) or surveys of the ESCO sector produced by Goldman, Hopper et al (see ESCO brief).
- **Convening an expanded version of the sectoral mini-panels** recommended in part A to identify green servicizing activity.
- **Conducting detailed searches of the business and economics literature**, both in the US and abroad, that documents the role played by each mechanism in each sector.
- **Reviewing existing NAICS and other government economic data** for sectors and mechanisms that are clearly defined and distinguishable in the data.
- **Surveying establishments** engaged in potentially green servicizing.

As indicated, for some sectors such as CMS and ESCOs, market reports and environmental performance information are available and US EPA would not need to duplicate these efforts.

C. Surveying Potentially Green Servicizing Mechanisms

However, the most rigorous and statistically valid information would come from a survey of a statistical sample of establishments and customers of emerging or innovative green product service systems. As discussed above, this would be limited to critical sectors/mechanisms identified by US EPA.

Fielding a full-scale survey to collect data on “potentially green servicizing” from a national probability sample of establishments and customers entails several steps:

1.**Develop an analysis plan**. What questions need to be answered? What type of data is required to answer these questions? How will these data be analyzed – what summary statistics, models, or other evaluations are needed? The analysis plan should address these questions and will guide both the data collection effort and the analysis of the data collected.

2.**Develop the sample frame**. The frame is the list of elements from which the sample is to be selected. For the sample to be representative, this list (or lists) must be exhaustive. For the producer survey, it must contain each establishment offering one of the “potentially green servicizing” models identified via the process set out above. The customer survey requires a list of all potential customers of the product service system. This step is crucial; without a proper frame, a valid sample cannot be selected.

3.**Develop the sampling plan**. The sampling plan determines the type and size of the sample to be selected. It reflects the data quality objectives of the study. It also must reflect the type of analyses to be conducted.

4.**Create the survey instrument**. Several forms are available for collecting data, including self-administered questionnaires (paper or web-based), on-site interviews, and computer-assisted telephone interviews. This step develops the questionnaires, determining their form and content.

5. **Select the sample and field the survey**. Once the frame has been developed and the sampling plan set, the sample can be selected and data collection undertaken.

6.**Develop data bases**. The data collected must be stored in electronic databases. These databases store the data and allow for computerized quality assurance checks. They also will facilitate analyses of the data.

7.**Analyze and summarize the survey’s results**. The analysis plan will guide the type of statistical analyses of the data that are required. The analyses must take into account the sampling plan, accounting for sampling probabilities, stratification of the data, and so on.

Development of an accurate, complete sample frame is critical and begins with the development of the catalogue or list of “green servicizing activity” as discussed under part A, above.

Once the list of servicizing activities with green potential in the critical sectors is in hand, a list of establishments would be developed from standard sources. A list of their potential customers also would be established to support the demand-side survey.

If US EPA elects to proceed with such a full survey approach, a single survey need not cover all sectors or mechanisms addressed in Part A. Surveys can be conducted where data needs require it on a sector-by-sector or mechanism-by-mechanism basis.

D. Participating in efforts to shape future directions for national statistics

US EPA should not be alone in its interest to acquire a more rigorous, systematic understanding of how products and services combine to produce economic value, and how this combination is changing over time. These issues are important to economic competitiiveness, to understanding and predicting structural economic change, and to other fundamental concerns of economic policy. In not capturing PSS and servicizing activity in the economy, current official economic data leaves other agencies at a disadvantage as well.

US EPA could explore avenues for engaging in dialogues and participating in fora that shape the evolution of official economic statistics. Efforts that US EPA undertakes to gain a more rigorous understanding of green servicizing should enhance the value-added that the agency can bring to these discussions.

5 Market and environmental performance briefs: 10 high-potential models

5.1 About the research process.

Following identification of high-potential models under the "quick search" protocol described in Chapter 4, the key research task was to *search out and synthesize* information regarding their market status and trends (e.g. market share, customer sectors served) and environmental performance. Information about drivers and barriers were noted where available, but detailed assessments of drivers and barriers were carried out only for 3 models (see Chapter 6).

In many cases, research was first required to elaborate and refine a basic description of the model—that is, how a basic servicizing concept or value proposition is actually elaborated and implemented in the market, and the change it constitutes from business as usual.

Information was primarily gathered via public sources: the business and environmental press, academic journals, and publicly available company information. A limited number of interviews were conducted, but resources generally did not permit intensive interviews, original assessments of environmental performance, or other generation of primary data.

The critical difference between this research and that conducted for the 1999 Tellus Institute report is its focus on *models and markets*. The 1999 Tellus Institute report presented a number of servicizing "case studies," but was unable (and was not intended) to assess the broader adoption of the business models that the case studies represented. These briefs, by contrast, are focused on the *market status* of these business models, and present individual cases only for illustrative purposes.

5.2 The business model briefs

This research was synthesized into *business model briefs* of three to five pages each, following the outline in the box at right.

***Business Model Briefs*: basic outline**

Description and value proposition

Environmental Performance

Key Markets and Market Share

Examples

References

These briefs provide the primary data that are the basis for (1) the findings regarding the eco-efficiency potential of *Green Servicizing* and (2) the recommendations for US EPA policy engagement (Chapters 7 & 8, respectively). They are intended to provide adequate basis for US EPA to evaluate these findings and recommendations.

Should US EPA pursue policy engagement, the briefs are the critical base upon which to build a more detailed understanding of market and environmental performance, and of drivers and barriers.

Two points are important to note:

- The individual briefs were current at the time of their original research and writing, ranging between August 2007 and July 2008. No subsequent updates were made.
- The briefs represent an abridged synthesis of many sources and the synthesis process itself entails a significant amount of judgment, exhaustive footnoting was not possible. Footnotes are reserved for statistics or observations of particular note. The references section contains all sources cited in footnotes, as well as those considered to be particularly high-value "entry points" for those seeking more information.

5.3 Summary Matrix: High-potential "green servicizing" business models

This matrix summarizes the key characteristics of high-potential models identified by the "quick search" process. Briefs for each model immediately follow this matrix. Columns relating to environmental benefits specify results expected *in principle;* the briefs contain information to evaluate these assumptions.

Model & brief description	Primary customer sector(s)	Basic mechanisms for environmental benefit(s)	Primary input stream(s) affected	Primary output stream(s) affected
Car-sharing Car-sharing is a "personal mobility PSS" that provides short-term use of cars located in special reserved parking spaces distributed throughout a service area (e.g., an urban area or campus.)	Individual & corporate customers in middle & upper-income urban areas; campuses.	Reduced mileage driven/household (when used as alternative to ownership) Fewer vehicles/capita to meet transport needs	Reduced energy inputs to use phases Reduced energy, chemical, water, materials inputs to vehicle manufacture	Reduced CO_2 and other air emissions generated as a result of energy use Reduced emissions, wastes of manufacturing.
Chemical Management Services (CMS) CMS is a "strategic, long-term relationship in which a customer contracts with a service provider to supply and manage the customer's chemicals and related services. Under a CMS contract, the provider's compensation is tied primarily to quantity and quality of services delivered not chemical volume.	Chemical-intensive manufacturers (auto, electronics, aerospace)**	Improved chemical use efficiency, better chemical use information; substitution with safer chemical alternatives; increased professionalism of chemical handling; chemical substitution	Reduced chemical and energy inputs	Reduced chemical emissions to air and water; reduced chemical waste; reduced spills & improper disposal. Reduced CO_2 and other air emissions generated as a result of energy use
Deconstruction Deconstruction is the process of selectively dismantling or removing materials from buildings before or instead of demolition.	Property owners and developers	Diversion of demolition debris from the waste stream, substitution of reclaimed materials for virgin inputs (e.g. wood.)	Reduced demand for virgin wood and other construction materials	Reduced disposal of demolition debris
Energy Services Companies (ESCOs) An ESCO provides energy-efficiency-related and other value-added services and assumes *performance risk* for their project or product—that is, their compensation and profits are tied to energy efficiency improvements (and thus, savings in purchased energy costs) actually obtained by the client.	Manufacturing facilities, institutions, offices, including government	Improved energy use efficiency via practice & equipment changes	Reduced energy inputs	Reduced CO_2 and other air emissions generated as a result of energy use
IPM & Performance-based Pest Management Services In performance-based pest management, a pest management services provider commits to achieving a certain standard or level of pest control, rather than being compensated for a particular treatment or application. Intergrated Pest Management services are the green implementation of this concept.	Structural: Institutions, housing authorities, school districts, corporate and government facilities. Agricultural: Model is embryonic, but most likely market are larger agricultural producers and/or those growing "high value" crops (e.g. certain fruits, vegetables).	Co-consideration of cultural, biological, genetic and chemical methods, to prevent unacceptable levels of pest damage	Reduced use of pesticides and/or use of pesticides of lower human and ecosystem toxicity	Reduced quantity or toxicity of pesticides residues in soils, run-off, groundwater, and foods.

Model & brief description	Primary customer sector(s)	Basic mechanisms for environmental benefit(s)	Primary input stream(s) affected	Primary output stream(s) affected
IT "Lifecycle Solutions" IT Lifecycle Solutions bundle provision of corporate IT equipment (particularly personal computers, servers and printers) with associated services. The "solutions provider" is responsible for most or all configuration, maintenance, repair, and upgrade.	Large corporations & institutions, government	Incentivizes increased re-use of equipment (thus reducing demand for new equipment) & reduce improper disposal and uncontrolled recycling.	Reductions in all energy * material input streams required for manufacture of new equipment	"e-waste" (many constituents, but lead, mercury, cadmium, brominated flame retardant and other hazardous materials are of greatest concern.)
Remanufacturing Remanufacturing is the process of restoring used, durable products to a 'like new' condition,. Remanufacturing is not a specific PSS model, but there are many remanufacturing-based PSSs.	Varies (e.g. customer sectors for IT, construction equipment)	Reduced need to manufacture new products and to dispose of old ones per customer/unit of use.	Varies by sector – material, energy and water inputs required for new product manufacture	Varies by sector – emissions/effluents derived from product manufacture and wastes
Resource Management Contracting (RM) Resource Management (RM) Contracting is a performance-based approach to waste management. It centers on an innovative contractual partnership between a waste-generating organization and a qualified waste contractor that changes BAU compensation structures and otherwise supports and incentivizes waste minimization and recycling.	Manufacturing facilities, commercial organizations (institutions, hospitals offices, schools, retail, etc.)	Improved resource recovery, reduced waste generation (focused generally on non-hazardous waste)	Reduced inputs (highly mixed, but paper, plastics predominate)	Reduced waste volume, enhanced recovery of recyclables
Telepresence Telepresence allows people in different locations to communicate in a simulacrum of "face to face" exchange far superior to that achieved by traditional video-conferencing. This is achieved via high-quality, high-definition audio and visual feeds, the use of multiple cameras and screens, and specially designed, dedicated rooms.	Large Business, Educational institutions, Conference services providers (e.g. hotels)	Reduced business travel	Reduced Energy inputs to travel	Reduced CO_2 and other air emissions generated as a result of energy use
Third Party Logistics (3PL) Third-party logistics (3PL), also referred to as logistics outsourcing or contract logistics, focuses on improving resource utilization and process efficiency in order to reduce costs and improve service. 3PL providers deliver comprehensive logistics-related services, including delivery, storage, inventory, customer service, cargo handling, supply/distribution information systems, etc.	Manufacturers, retailers, government	Improved efficiency in routing, loading and modal choice reduces trips and miles travelled and increases logistics-related fuel efficiency. Improved building energy use.	Reduced energy inputs to transportation and building use.	Reduced CO_2 and other air emissions generated as a result of energy use

Brief #1: Car-sharing

Description and Value Proposition

Car-sharing is a "personal mobility PSS" that provides short-term use of cars located in special reserved parking spaces distributed throughout a service area (e.g., an urban area or campus).

Compared to traditional car rental, car-sharing is characterized by short rental periods (15 minutes to a few hours), decentralized location of vehicles, remote rental procedures, and fee structures that combine membership and time-based usage fees.

In this PSS, the *product* is the vehicle and the *service* is the mobility provided by the vehicle, as well as the insurance and maintenance included in the fee.

Car-sharing can be an alternative to car rental or car ownership. In both cases, the value proposition to the customer is based on cost and convenience.

- For short rental periods, car-sharing is cheaper than ordinary car rental, and more convenient.
- Where a car is not required for daily commuting, car-sharing can constitute a lower-cost alternative to car ownership without the inconvenience of maintenance, insurance, and fuelling.
- Car-sharing can also alleviate the need to find or pay for parking by providing designated spaces in frequented destinations.

The primary barrier to car-sharing as an alternative to ownership for individual customers is the intangible value assigned to car ownership; incentives to adoption include costs, liabilities, and inconveniences attached to ownership (e.g. shortage of parking). In addition, a significant portion of car share customers are "green consumers," attracted to car-sharing as a car ownership alternative. To retain customers, however, car-share schemes must in practice deliver high levels of convenience to their customers, primarily measured by vehicle availability. This requires a sufficient number of car-share vehicles to meet service needs in strategically located parking spaces.

The most commercially successful car-sharing businesses make extensive use of IT for on-line reservations, vehicle tracking, and remotely enabling customer access to vehicles.

Environmental Performance

In principle, car sharing can reduce environmental loads via three mechanisms or vectors, detailed in the table below. Quantifying actual environmental performance improvements is non-trivial and subject to measurement errors, as it requires defining a base case (or prior condition) for comparison. (For example, how does one verify that car-sharing is serving as an alternative to ownership; how is "before and after" vehicle utilization assessed?)

Even acknowledging these uncertainties, however, existing studies indicate that each of these "improvement vectors" is achieved in practice:

Environmental improvement mechanism	Achievement in practice
Reduced VMT/customer. Car-sharing provides a clear "per unit use" price signal to customers, and requires a minimum amount of "advance planning" for each incidence of vehicle use (i.e., making an on-line reservation).	US car-share members reduce their total Vehicle Miles Traveled (VMT) by an average of 44% across several studies. According to a survey conducted by Zipcar, car-share program members report a 47%

Thus, car-share customers who use the service as an alterative to ownership should tend to drive less, thus reducing pollution, fuel use, and congestion.	increase in public transit trips, 10% increase in biking trips, and 26% increase in walking trips over their pre-membership behaviors.
Reduced total vehicles/service population. Car-sharing is a "shared use" PSS model. When it replaces individual ownership, car-sharing should reduce the number of vehicles required to provide "individual transport services" in the car-sharing service area. This in turn should reduce: (1) the material use, energy, and pollution associated with car manufacturing and vehicle disposal at end-of-life;[41] (2) traffic congestion & parking problems in urban areas (thus shortening trip times, reducing fuel use and associated air pollution); and (3) road maintenance and needs for expanding road capacity. However the latter two effects are likely to manifest only at very high (and as yet unseen) levels of adoption.	Every US car-share vehicle "removes" between 6 and 23 vehicles from the road, depending on the study. Between 11% and 29% of US car-share members sold private vahicles after joining and between 12% and 68% either postponed or avoided a vehicle purchase. The Association of Washington Business estimated that as of 2005, Flexcar had "removed" 7,000 vehicles from the road, eliminating the need for 21,000 parking spots (corresponding to 70,000 tons of concrete), and preventing the emission of 35,000 tons of carbon monoxide to the air.
Cleaner vehicles: Depending on the composition of the car-sharing fleet, car-sharing may put cleaner-than-average vehicles on the road.	**Cleaner vehicles**: 30% of US car-sharing vehicles are hybrids or powered by alternative fuels

Car-sharing has been used elsewhere (e.g. Japan) as a vector for introducing electric vehicles. As car-share parking "stations" can easily be coupled with charging stations, and maintenance and fuelling are the responsibility of the car-share provider, the model may be well-suited to deploy and promote market acceptance of electric, fuel cell, and hydrogen vehicles.

Key markets and market share

Car-sharing can serve individuals, corporations, and universities/colleges or other "campus" institutions.

The business model requires that, for success, each vehicle parking location ("station") must be accessible to a large number of customers; thus car-sharing requires relatively high-density, usually middle to upper-income urban areas or campuses. Experience shows that car-sharing is particularly successful when it exists in combination with public transit.

Currently, the large majority of car-share users are individual members, however, recently there has been a sharp rise in corporate participation and partnerships with universities/colleges. Partnerships with universities/colleges have become increasingly popular, because they allow these institutions to alleviate demand for parking.

For example, Arizona State, which recently partnered with Flexcar, has 52,000 students on its Tempe campus but only 19,000 parking spots. This is a common situation that often results in schools barring undergraduate students from having vehicles on campus. Most of these students are not old enough to use conventional car rental companies, but car-sharing offers an alternative that many schools are taking advantage of.

[41] Car-sharing does not change the end-of-life disposition of vehicles; they will still be sold onto second-hand markets.

As of July 2003 there were an estimated 25,727 members and 784 car-share vehicles on the road in the US (Shaheen et al 2004), constituting an estimated 112% increase in membership and a 52% increase in total vehicles since August 2002. By 2006 US membership had grown to 117,656 and the number of car-share vehicles had increased to 3,337 constituting a growth of 357% and 326% respectively from 2003 (Shaheen et al 2006).

An indication of market growth ("model uptake") since 2003 can be obtained by looking at the operations of Zipcar and Flexcar, which account for over 94% of US car-share customers, based on the 2003 survey.

- According to Zipcar, the company currently has over 100,000 members and operates 3,000 vehicles in the US in 12 states. It has been profitable since July 2004 and has averaged an increase of 4,000 new members each month. It has partnerships with over 30 universities/colleges.
- Flexcar reports over 600 corporate customers that use car-sharing to either reduce or eliminate corporate fleets, as well as partnerships with 27 universities/colleges that make the cars available to 500,000 students. Flexcar operates in over 16 cities in 12 states.

Although the above numbers indicate tremendous growth in recent years, as of July 2006 there were an estimated 136.5 million cars (excluding buses and trucks) registered in the US, making car-share vehicles less than 0.1% of the total.

Of course, car-sharing does not offer an alternative to personal and corporate ownership of vehicles in all segments of the vehicle market. For example, the target individual customer lives in a relatively high-density urban area and does not require a car for commuting. For such customers, car-sharing will often be a viable alternative to car-ownership to meet their needs for "short-haul individual transport services." Unfortunately, public transportation and demographic statistics do not allow us to quantify this car-sharing demographic, and we are unable to offer more refined estimates of the total, potential car-share market within the resources available. The campus market can be estimated more closely: according to the 2000 Census there were 14,375,764 undergraduate students enrolled in US schools.

Examining the major metropolitan areas not yet served by car-share and the portion of campuses also unserved, it is reasonable to expect that the total potential market for car-sharing is at least one and potentially two orders of magnitude greater than the current market size.[42]

Illustrative examples:

ZipCar (www.zipcar.com)	For Profit 100,000 US members 3,000 vehicles Operates in US, Canada, and UK (23 cities total) Profitable since July 2004 Adding an average 4000 members per month
Flexcar (www.flexcar.com)	For Profit 90% of vehicles qualify for US EPA Smartway certification 30% of fleet is hybrid vehicles

[42] To some extent, car-sharing also competes against tradition car-rental services. However, use of car-sharing in lieu of traditional car rental is unlikely to have significant environmental benefits, so we do not attempt to assess this portion of the car-share market here.

	Won Association of Washington Business's 2005 Environmental Excellence Award Recently partnered with TerraPass in an effort to become 100% carbon neutral Operates in WA, OR, CA, AZ, WI, IL, OH, PA, VA, DC, GA, FL and over 16 cities
City Carshare (www.citycarshare.net)	Not for Profit Operates exclusively in the San Francisco Bar Area As of 2001 had 1500 members and 70 vehicles

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www.citycarshare.net

www.flexcar.com

www.zipcar.com

Brief #2: Chemical Management Services (CMS)

Description and Value Proposition

This report uses the definition of chemical management services (CMS) developed by the CMSForum, "a coalition of chemical management service providers, their customers, Tier II chemical suppliers, and other stakeholders interested in promoting CMS."[43]

> CMS is a "strategic, long-term relationship in which a customer contracts with a service provider to supply and manage the customer's chemicals and related services. Under a CMS contract, the provider's compensation is tied primarily to quantity and quality of services delivered not chemical volume. CMS goes beyond invoicing and delivering product to optimizing processes, continuously reducing chemical lifecycle costs and risk, and reducing environmental impact.[44]

Thus, under the CMS model, chemical users shift away from traditional chemical procurement practices and relationships with chemical suppliers to a strategic alliance with a "chemical service provider". Instead of purchasing chemicals, the manufacturer purchases chemical management services: i.e., assistance in purchasing, managing, tracking, and sometimes use, of chemicals. The change in the compensation model described in the definition means that chemical service providers are rewarded for reducing costs, optimizing chemical use and improving environmental performance of their customers.

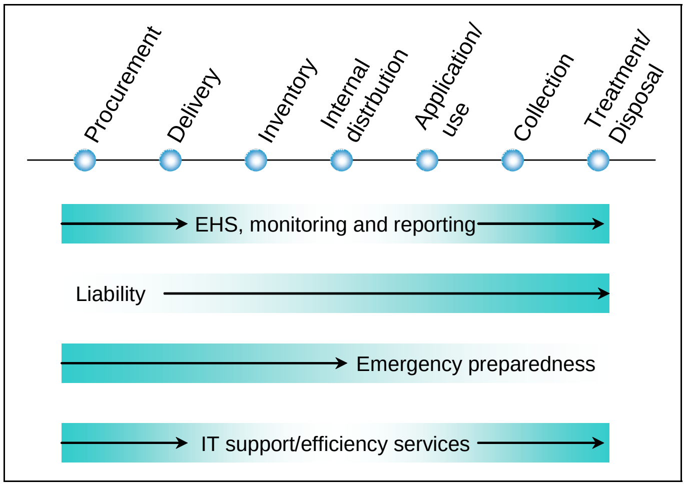
The value proposition to the customers of this model is a mix of cost savings and environmental performance/compliance improvements. In the Chemical Strategies Partnership's (CSP's) 2004 Industry Report, 70% of the CMS customers surveyed stated that the primary driver for them to initiate their CMS program was to reduce costs. This was reaffirmed in the customers' opinions on what is driving the overall market for CMS: the top two answers were operational efficiency and cost reduction. Additional drivers include getting suppliers expertise in logistics, safety and environmental reporting. The environmental function is often the point of entry to introduce the CMS concept, and they work jointly with the procurement and supply chain function in developing the program.

CMS providers generally seek to reduce the customer's *total costs* of chemicals. Total costs are the sum of costs incurred across the "chemical lifecycle" in the customer's organization. The Chemical Lifecycle is depicted in Figure 4; it begins with procurement and extends through use and end-disposition of chemicals. At each stage of the lifecycle, a company incurs quantifiable costs of labor, materials, equipment, liability, safety training, and compliance. The scope of cost reduction the provider can obtain depends on the scope of the CMS program within this lifecycle—e.g., programs that limit the CMS provider to procurement, delivery and inventory functions will have fewer cost reduction opportunities than programs of broader scope.

[43] CMS Forum website, www.cmsforum.org, accessed 13 October 2007.

[44] Ibid. The definition was developed by a group of 14 leading CMS providers in 1999 (www.cmsforum.org).

Figure 4: The Chemical Lifecycle



Source : Chemical Strategies Partnership

Design and implementation of CMS programs is complex, as the chemical lifecycle itself involves many functions/departments in the customer organization.

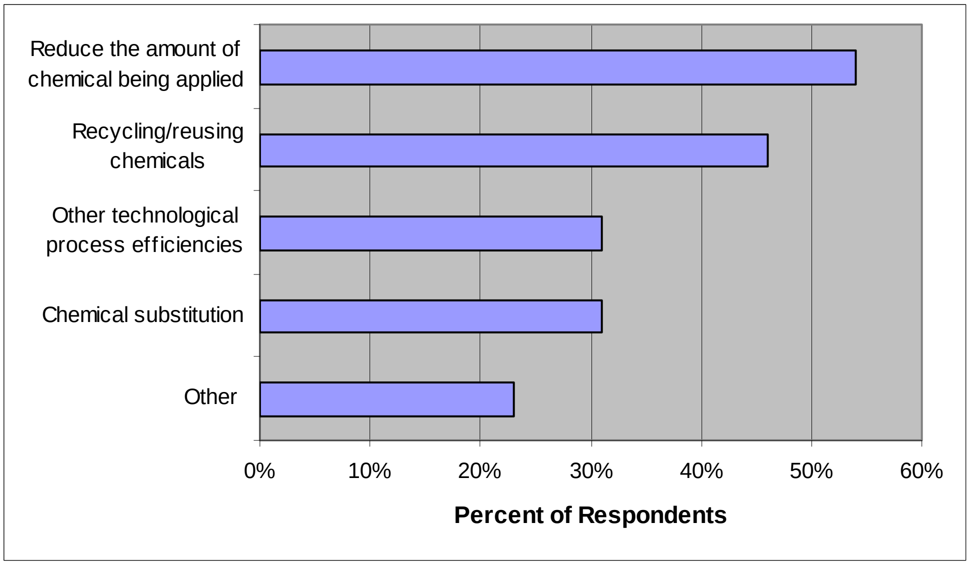
Environmental Performance

Generally, CMS programs offer benefits from reduced chemical volume, reduced emissions[45], and reduced risk. CSP's surveys of CMS customers indicate that most or all CMS programs deliver environmental performance/compliance improvements. Figure 5, below, is based on CSP's 2004 industry report and indicates the types of improvements reported and their frequency. In addition, *all customers* reported improved environmental data as a benefit of CMS programs.

However, environmental benefits realized are highly dependent on the "baseline conditions" at the customer facility prior to implementation of the program. "Baseline conditions" include the types of chemicals and processes involved, and the rigor and efficiency of internal chemical management efforts.

[45] Reduced emissions are achieved by reducing the amount of chemical being applied and by implementing recycling or reuse alternatives. Chemical substitution and process efficiency were also cited as approaches to reducing emissions.

Figure 5: Environmental benefits realized in CMS programs



Source : (CSP 2004)

Key Markets and Market Share[46]

CMS providers surveyed in CSP's 2000 CMS Industry Report (CSP 2000) represented about $800 million in CMS revenue (1999 data) and were active in five sectors: automotive, metalworking, aerospace manufacturing, air transport maintenance, and electronics. (Revenue includes CMS provider management fees as well as the amount of chemicals sold.)[47] In 2003, the CMS providers surveyed were active in eleven sectors representing $1.22 billion.[48] Thus, growth in the CMS market is estimated to be about 50% from 1999-2003.

A CMS provider is generally focused on a few industries, as CMS programs must be tailored to the chemicals used, manufacturing processes employed, and logistics and QA/QC needs. These are often similar within a sector, but vary widely between different sectors. For example, the automotive and heavy equipment industries are large users of lubricants, solvents, and coolants. Their chemical profile is less diverse than the aerospace and electronics industries which generally use smaller quantities of many chemicals.

Table 3, below, presents CSP's estimated adoption of CMS by seven industries. (CSP was not able to gather sufficient information for the remaining four industries to make an estimate.) CMS is now essentially "BAU" in the automotive sector. Since 2000, the greatest growth sectors have been in aerospace and air transport maintenance. However, the strongest growth trend is in the *number of industries* now using CMS.

Several organizations have estimated the overall potential CMS market. These estimates are in rough agreement, giving an overall potential market size for CMS of $17–$19.5 billion (CSP 2004, p 11). The CMS providers surveyed by CSP in 2004 realized about $1.22 Billion in CMS revenue in 2004, which

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[46] This section is modified from "Chemical Strategies Partnership, 2004 CMS Industry Report"

[47] This revenue reflects the CMS activity of an estimated 85% of CMS providers. (CSP 2000, p 11).

[48] Revenue estimate was derived from responses to the CMS provider surveys. This revenue reflects the CMS activity of an estimated 85% of CMS providers. Some revenue figures were specific and some were derived from responses identifying a range of revenue.

constituted an estimated 85% or more global CMS revenues (CSP 2004, p 7), but only 6-7% of the potential $17-19.5 billion market.

The number of sectors using CMS has nearly doubled between 2000 and 2004. This development bodes well for future growth, as CMS adoption rates in these new "toehold" sectors are likely to increase sharply. (For example the aerospace and air transport sectors were relatively new CMS adopter sectors in 2000. The 2004 figures suggest that CMS adoption is likely to be rapid within a sector once it is adopted by a few industry leaders.)

Table 3: Provider's estimates of CMS penetration in key sectors

Sector	Provider Estimates of CMS Penetration 2004	Provider Estimates of CMS Penetration 2000
Automotive	75-80%	50-80%
Automotive Suppliers	30-40%	Included in automotive estimate
Heavy Equipment	15-25%	15-25% (formerly metalworking)
Aerospace manufacturing	25-30%	5-15%
Air Transport Maintenance	40-50%	10-20%
Electronics	30-40%	30-40%
Steel Manufacturers	20-30%	---
Energy/Utilities	Under 10%	---
Misc. Manufacturing	Under 10%	---
Food/Beverage	Under 10%	---
Research/Laboratory	Under 10%	---

Source: Based on survey responses from CMS providers. CSP 2004.

Adoption of the CMS model does however, face a number of barriers. Synthesizing published analyses and expert opinion, these are as follows:

1. Lack of public information about the value of CMS
2. Confusion in the marketplace and lack of standards.
3. Internal barriers within customer organizations. These include lack of management commitment/focus to address what is perceived as a small cost center (i.e., chemicals), the perceived high transaction of CMS program implementation and the operational risk concerns.
4. Customers have poor awareness/knowledge of their "total chemical costs." CSP estimates that the cost of chemical management range from 1 to 3 times the purchase cost of chemicals.[49] Typically, total costs are not known because many chemical management costs are pooled in overhead accounts and/or the chemical management activities are highly decentralized. This issue is compounded by the notion that many companies already believe they are doing the best possible job and there is little room for improvement.

[49] Personal communication, Jill Kauffman Johnson, Director, CSP, January 2008.

5. Both *strategic sourcing initiatives* (leveraged purchasing, which focuses on reducing unit costs of chemicals purchased) and *stand-alone chemical information management software* are probably reducing the total market for "full service" CMS. These narrower services appear to offer customers an alternative to CMS, but generally will not deliver the same level of environmental benefits.

6. The RFP/bidding process is long (6–12 months) and inefficient. In some cases RFPs have been put to bid but contracts never awarded. In other cases, the customer signs a contract with the CMS provider, but does not initiate the program. This adds to the costs and risks of business development activities for CMS providers.

Water efficiency services in CMS programs

As noted in Section 4.2, were were unable to find significant evidence of stand-alone performance-based water efficiency services for industrial and commercial customers.

In such services,the provider of water efficiency services would assume *performance risk* for their project or product. That is, their compensation and profits would be tied to water efficiency and/or water quality improvements (and thus savings) actually obtained by the client. The provider might have an ongoing role in operations of water treatment systems and water utilization processes.

A CMS Forum survey of its members, however, indicated that such services are embedded in many CMS programs. Ten of 13 CMS providers responded, servicing all key CMS customer sectors:

Questions	# of responses
To what extent is industrial water efficiency/water management an explicit focus of your CMS programs?	Most: 7 Some: 2
If "some" or "most," are contract incentives or performance benchmarks usually tied to water efficiency?	Yes: 3 Sometimes: 1
Even if improvements in industrial water efficiency are not an explicit focus of your programs. . .	
. . .are they a common outcome?	Yes: 8
. . .are site managers addressing water efficiency in the context of addressing wastewater constituents or other "mainline" chemical management issues?	Often: 6 Sometimes: 2

Source: Chemical Strategies Partnership/Chemical Management Forum, 2008.

Water effiiciency services are also embedded in ESCO offerings. See the ESCO Business Brief.

Illustrative Examples:

Numerous CMS program case studies can be found at http://www.chemicalstrategies.org/resources_casestudies.htm. Information on provider companies can be found at http://www.chemicalstrategies.org/about_cmsforum.htm.

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Brief #3: Deconstruction

Description and Value Proposition

According to the National Association of Home Builders (NAHB), deconstruction is the process of selectively dismantling or removing materials from buildings before or instead of demolition (Falk, 2002). Deconstruction is literally an ancient practice, but its prevalence in the US economy over the last century has fluctuated significantly over time and by region, reflecting changes in labor and disposal costs and the availability of building materials and demolition equipment.

Structures are, in a very literal sense, product-service systems. They include an initial product (the structure "as delivered") and require the input of a large variety of services over its lifetime—including utilities, maintenance, landscaping, insurance, etc. The product and services are generally delivered by separate parties, though there has been a trend in the market towards "extended warranty service" on new homes and "total property management" solutions. Deconstruction is, in essence, an end-of-life service applied to an existing product that changes the product's final disposition. As such, it is a product-based service in the remanufacturing/recycling category. The customer is the owner of the structure—in many cases, a new developer who has bought the land for a purpose not compatible with the existing structure. The "business as usual" model in this instance is total demolition of a building (also a service) either without attempting to retrieve salvageable material or with "soft stripping" only (see below).

Deconstruction practices are divided into three levels (NAHB 2000):

- **Soft-stripping**—a common practice in which specific components and equipment are removed before a building is demolished. Some example items are plumbing or electrical fixtures, appliances, HVAC equipment (heating, ventilation, and air-conditioning), cabinets, doors, windows, and hardwood flooring.
- **Individual assemblies**—particular building assemblies are removed prior to demolition depending on their condition. Some example items are rafters, floor joists, wall framing members, and sheathing materials.
- **Structure**—an entire building is dismantled and the majority of the components and materials are reused or sold. No demolition takes place.

Deconstruction is an economically viable option in many cases, as it can frequently be cheaper to dismantle a building and sell the salvaged materials than it is to demolish the same building and then pay to dispose of the wreckage. Deconstruction requires an attention to detail that cannot be achieved by machinery; buildings must be pulled apart piece by piece in order to preserve and separate the salvageable material from the waste. This process almost always leads to higher labor costs, but those costs can be mitigated or outweighed by the savings on disposal fees and the value of the salvaged materials, which can be sold or used in another construction project. The more cost effective option depends on the building and the disposal fees in the area, but numerous case studies have shown that deconstruction can be the cheaper method. Below are the results from a study done by the Center for Construction and Environment at the University of Florida:

- 6 wood framed residential homes were deconstructed and the financial results were compared to the cost of demolishing similar buildings.
- Costs were an average of 21% higher for deconstruction before sale of salvaged materials.
- Costs were an average of 37% lower for deconstruction after sale of salvaged materials.

Deconstruction has also been identified as a source of job creation for minimally skilled workers. As noted above, it is a labor-intensive process, and requires more people than demolition. It also requires less technical expertise than building a structure, but provides an opportunity to learn how buildings are put together, and can thus be an entry point for unskilled entrants to the construction sector. (As with all construction and demolition activities, safety hazards on the job are significant, and care is required in addressing them, particularly with new-entrant or unskilled workers.)

Residential buildings in need of removal also are more common in low income areas, where skill levels tend to be lower and unemployment rates higher. This opportunity has been identified by private sector groups and government organizations, including the US Department of Housing and Urban Development (HUD) (Falk, 2002). The Institute for Local Self Reliance (ILSR) estimates that this industry could create as many as 200,000 full-time jobs annually, representing a huge increase from the estimated current total of approximately 8,700.

Environmental Performance

Environmental benefits are difficult to quantify, because of the huge variability between different deconstruction projects. The composition of the structure as well as the extent to which it is deconstructed will determine the level of waste reduction and the type of waste that is eliminated.

According to the ILSR, the construction and demolition (C&D) industry generates 65 million tons of waste annually. Their studies have shown that deconstruction could recover 24 million tons of this waste for reuse and another 6 million tons for recycling. These reductions would eliminate a huge volume of waste that ends up in incinerators and landfills, directly impacting pollution levels locally, nationally, and internationally. The air pollution from incinerators has local, regional, and global ramifications, and disposal facilities often have significant local impacts, e.g. producing airborne toxins and groundwater contamination.

By facilitating the reuse of salvaged materials, deconstruction should reduce demand for virgin materials as well, thus avoiding the extraction, manufacturing and disposal impacts entailed in their production (Institute for Local Self Reliance, 2007). The reuse of lumber has shown particular promise and will be discussed further below.

Aggregate numbers for the pollution abatement resulting from deconstruction were not available; however numerous case studies have resulted in a salvage rate of about 60%-80% by weight for wood framed residential buildings. These studies are all examples of structural (total) deconstruction; the rates are far less for soft-stripping and individual assemblies.

It should be noted that under “business as usual” *demolition*, much debris is recycled, if it is not too contaminated. The debris constituents most commonly recycled in the US are concrete, asphalt, metals, and woods. In 1996, 20% to 30% of the total debris created by C&D operations was recycled (Franklin Associates, 1998). While this is environmentally preferable to disposal via landfill or incinerator, it is far less preferable than *reuse.* According to ILSR estimates, if deconstruction was used to its full potential, 37% of materials embodied in end-of-life structures could be reused and 9% recycled, for a total recovery rate of 46%.

Key Markets and Market Share

It is difficult to measure the market for deconstruction, because many C&D companies salvage some parts of the buildings they eventually demolish, normally intending to use the material in another project. However, in 2006 ILSR estimated that there were about 350 companies in the US and 50 companies in Canada that specialize in deconstruction (ILSR, 2006). This represents an extremely small portion of the industry; in the US there are 80,000 commercial construction firms alone.[50].

The demand for these services has increased significantly since the 1970s, as the market for salvaged products has grown and government incentives have increased as well. According to a report by the National Association of Home Builders (NAHB) research center, government agencies are increasingly including language in their Requests for Proposals that encourage sustainable building practices, including deconstruction. Some examples are HUD's *Economic Development Grants* and *Neighborhood Initiative Programs*. According to the same report "PHAs [Public Housing Agency] and Not-for Profits may be able to partner with local governments to incorporate deconstruction as part of a larger project that aims to stabilize and revitalize a small community or neighborhood." Many of the successful large scale deconstruction projects involve partnerships between non-profits, businesses, developers, and/or general contractors.

The market for salvaged construction materials has grown for two reasons. First, recovered materials are almost always cheaper than buying the same product new. Second, some building materials are becoming scarce. Many deconstructed buildings were built in prior decades when old-growth lumber was readily available. Older wood is considered to be better quality, and can bring a high price even if it is salvaged. Certain characteristics such as nail holes and discoloration that would reduce the price of virgin wood can actually increase the price of salvaged wood, because it can be seen as a specialty item (Falk, 2002). Only 5% of North America's old growth forests are still standing, and so many experts believe the dwindling supply of this lumber will drive the prices of its salvaged counterpart up ("Deconstruction: New Opportunities for Salvage").

Although the deconstruction industry has been growing over the last several decades, there are many barriers to this market:

- It is a labor intensive process, because machines are not capable of carefully deconstructing a building and then sorting the salvaged materials. Labor markets with high costs or low availability can be detrimental to deconstruction.
- The quality of salvaged materials is often questioned, because there are no rating/grading systems for these products.
- In some instances the market value of salvaged goods is so low that it cannot cover the costs of collecting the materials.
- The cost of disposing debris at C&D landfills (tipping fees) fluctuates depending on the area, but these fees are often so low construction companies have little incentive to avoid them through salvaging materials. Increasing these fees has been identified as one of the most effective methods of encouraging deconstruction (Guy et al, 2000).

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[50] http://www.hoovers.com/commercial-construction-contractors/--ID__18--/free-ind-fr-profile-basic.xhtml, accessed October 12, 2007.

Examples

Resource Conservation Group, LLC	http://www.resourceconservationgroup.com/
Nuprecon	http://www.nuprecon.com/
Re-Use Consulting	http://www.reuseconsulting.com/
Heartwood Resources	http://www.heartwoodresources.org/
Lovett Deconstruction	http://lovettdeconstruction.com/

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Brief #4: Energy Services Companies (ESCOs)

Description and Value Proposition:

Goldman et al, in their market surveys of the ESCO sector, define an ESCO as "a company that provides energy-efficiency-related and other value-added services and for which performance contracting is a core part of its energy-efficiency services business" (Goldman et al 2005, Hopper et al

2007).[51] Performance-based contracting in this context is defined as compensation schemes in which the ESCO assumes *performance risk* for their project or product—that is, their compensation and profits are tied to energy efficiency improvements (savings in purchased energy costs) actually obtained by the client.[52]

In general, ESCOs make their profits via the reductions in energy consumption they are able to obtain for their customers, thus the basic profit mechanism of this business model should drive improvements in energy efficiency. These reductions in energy consumption lead to lower "total costs of energy" for the customer, and this is the essence of the value proposition, though improvements in productivity, comfort, and safety may also be important considerations.

As Goldman et al note, this definition excludes "engineering companies, contractors, equipment manufacturers, or construction firms that may offer energy-efficiency services but do not assume performance risk for their projects. It also excludes companies that only engage in other customer-side energy services—such as design and installation of onsite generation or renewable energy systems—without also deploying energy-efficiency measures."

Services typically delivered by ESCOs include the development, design, and finance of energy efficiency projects; installation and maintenance of entailed equipment, energy management and building controls [particularly heating, ventilation and air conditioning (HVAC), and lighting-related] and monitoring and verification of project performance.[53]

A minority of ESCOs are utility-affiliated, and this percentage has been falling, from an estimated 35% in 2000 to 15% in 2006 (Hopper et al 2007).

ESCO projects typically have a significant upfront capital cost—reflecting the acquisition costs of energy efficiency equipment—and relatively long pay-back. Financing is thus part of many projects, and debt repayments are tied to and derive from energy savings obtained. However, there are examples of approaches that focus instead on optimization of existing equipment and patterns of energy use.[54]

Environmental Performance

Generally speaking, ESCOs improve customer energy efficiency by replacing lighting with high efficiency fluorescent lamps and units, installing high efficiency transformers, remodeling and upgrading air conditioning systems for variable fan speeds and variable pump flow, introducing co-generation systems, introducing heat storage pump systems, remodeling ventilation control systems for taking in non-conditioned outdoor air, and designing and implementing operations protocols for this equipment.

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[51] These surveys were commissioned by the U.S. Department of Energy and undertaken in collaboration with the National Association of Energy Service Companies (NAESCO), a trade association.

[52] For a comparison of the services of ESCOs to other energy equipment and services firms, see "Energy Service Companies: Cost-Savings Partners for Industry" in *Energy Matters.* U.S. Department of Energy, Sept. 1999. (http://www.oit.doe.gov/bestpractices/energymatters/sep1999_energy_service.shtml). The National Association of Energy Service Companies (NAESCO) defines an ESCO as a business that "develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to twenty year time period. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project." (http://www.naesco.org/about/esco.htm, accessed 13 Sept 2007)

[53] After NAESCO,. Op cit.

[54] E.g. Energy Education Inc. delivers "People-Driven Energy Conservation" programs to school districts, universities, and large churches, and advertises a performance-based guarantee: that they will pay to the client any difference between verified savings and program implementation costs. See www.energyeducation.com.

ESCOs attempt to reduce the amount of energy that is being consumed by their clients (on a normalized basis), and consequently they reduce the pollution that is associated with energy production. These pollutants include CO_2, NOx, SO_2, etc. On average, 90% of client savings come from reductions in energy costs, while only 10% come from non-energy related areas such as Operations and Maintenance costs.

Industry wide data and averages regarding energy savings are listed below:

- An industry report found as of 2005 the average ESCO project saved 47 kWh/m^2/year of energy (m^2 refers to floor space), or average savings of 23% on total energy consumption. These savings fluctuate somewhat depending on the sector being analyzed, with state/local governments and institutions the highest at 60 kWh/m^2/year and federal government the lowest at 40 kWh/m^2/year. Since ESCOs primarily contract with medium to large sized facilities the above averages translate to substantial reductions in energy consumption (Goldman et al 2005).

- The above averages can be converted to pounds of avoided air pollutants using the US EPA's Emissions & Generation Resource Integrated Database, which calculates average direct air emissions per kWh generated over the US generation base. Based on this database, the average ESCO project saved 64.06 lbs of CO_2/m^2/year, 0.09884 lbs of NOx/m^2/year, and 0.2554 lbs of SO_2/m^2/year. These ratios are based on the average energy mix for the US, and vary widely depending on energy sources. (For example, Coal power plants produce roughly 2.3 lbs of directly emitted CO_2/kWh, while direct CO2 emissions for nuclear plants are zero.)

- ESCO projects can decrease energy use for lighting, climate control, and other building functions in excess of 20% with commensurate reductions in CO_2 emissions.

> **ESCOs and Water Efficiency Services**
>
> ESCOs are engaged to reduce energy costs for a facility. Water use and treatment entails energy use, and water efficiency improvements can result in savings even if energy dimensions are not considered. As a result, water efficiency is often addressed within the context of ESCO programs:
>
> A survey of the U.S. ESCO industry from 2000-2006 reports that water conservation, consulting and master planning, O&M services, and non-energy improvements accounted for 10% of total ESCO revenue (water conservation was not listed separately).
>
> A separate study of U.S. ESCO project data found 10% of projects involved work on plumbing systems (Goldman et al 2005).

Energy savings is assessed in many case studies, though it is reasonable to assume that these studies (many of which are produced by ESCOs themselves) will show a bias towards the top of the range. The following are some representative examples of such studies:

- Amaresco was able to cut annual energy costs for Charleston Air Force Base by $800,000 by reducing energy consumption by 40%. It also helped the Toronto Dominion Centre increase energy efficiency, eliminating 35,000 tons of CO_2 emissions annually.

- By installing improvements in 32 facilities, Energy Systems Group was able to save the Baltimore Public School System $45 million over 15 years. All the savings were due to reductions in energy consumption.

- Noresco was hired to upgrade the energy efficiency of the University of Massachusetts (UMass) Medical Center. After several infrastructure changes, this UMass facility is 43% more energy efficient and consequently will cost $36 million less to operate over the next 10 years.

- Trane was contracted to update the HVAC system at the Sydney Entertainment Center, with a resulting 20% increase in efficiency. The facility won the Energy Smart Green Gold Medal.

Energy efficiency gains, particularly by large facilities, can reduce or eliminate the need for increased electrical and gas supply or transmission and distribution capacity.

Key Markets and Market Share

Market information for the ESCO sector is more extensive than for many of the other models briefed in this chapter, since there is an industry association (the National Association of Energy Services Companies) and publicly available market surveys. Most information in this section is drawn from 2 key sources: Hopper et al, 2007 and Consortium for Energy Efficiency, Inc., 2006.

Historically, ESCOs have been most active with large and medium sized facilities. Most work has been done on existing buildings, although new construction projects can be targeted as well. Contracts tend to be over a period of 7 to 10 years (Musser 2003). The 2006 Industry survey reports that industry revenue was derived as follows:

- 58% state/local governments and institutions (universities, schools, and hospitals)
- 22% federal government
- 9% commercial
- 6% industrial
- 3% residential
- 2% public housing

Overall, revenue for the industry in 2006 is estimated at $3.6 billion, of which 73% derives from energy efficiency projects, 16% from customer-sited generation including renewables, and 11% from consulting/master planning and other services. The industry saw 20% annual growth from 1991-2000. This slowed to 3% from 2000-2004, but has increased drastically to 22% from 2004-2006 with projections for industry revenue in 2008 around $5.25 billion (Hopper et al 2007).

The Hopper 2007 study of the industry suggests the recent growth is due to customer response to rising energy prices, renewed interest in energy efficiency and climate change, re-authorization of energy savings performance contracts (ESPC) in the federal market, the adoption of aggressive energy savings goals for federal agencies, and the ramping up of public-benefit- and ratepayer-funded energy efficiency and renewable energy programs.

During this period of growth the number of companies has consolidated slightly, shrinking from the mid 50s in 2000 to the high 40s in 2006. The majority of ESCOs are independent companies; the rest of the industry is made up of building and equipment manufacturers, utility companies, and other energy and engineering companies.

There is a growing market for these services. In 2006, state governments alone budgeted a total of $2.6 billion for energy efficiency, up 13% from 2005 according to the US Energy Efficiency Programs Report. According to some projections, the industry has an eventual $200+ billion market (Musser 2003). This is a huge percentage of the energy industry; in 2007 the US electric energy distribution industry grossed $220 billion in revenue, and the US natural gas production and distribution industry grossed $100 billion in revenue (www.hoovers.com, accessed 2/28/2008).

Examples:

Ameresco	http://www.ameresco.com/
Energy Systems Group	http://www.energysystemsgroup.com/
Noresco	http://www.noresco.com/site/content/index.asp
Johnson Controls, Inc.	http://www.johnsoncontrols.com/publish/us/en.html
Synergy Companies	http://www.synergycompanies.org/
Trane	http://www.trane.com/Commercial/

Sources

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"Emissions & Generation Resource Integrated Database". US Environmental Protection Agency. Updated April 30, 2007. http://www.epa.gov/solar/egrid/index.htm

"ESG to Save Baltimore Schools Over $45 Million". Press Release. Energy Systems Group (July 11, 2006).

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Musser, Phil. "Utility-Affiliated energy service companies [ESCOs]: Is the Honeymoon Over?". *Transmission and Distribution World* 55 (January 1, 2003).

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"U.S. Energy Efficiency Programs: A $2.6 Billion Industry". Report. Consortium for Energy Efficiency, Inc. (2006).

http://www.naesco.org/ National Association of Energy Services Companies

http://www.ameresco.com/

http://www.energysystemsgroup.com/

http://www.trane.com/Commercial/

Brief #5: IPM & Performance-based Pest Management Services

Description and Value Proposition

US EPA defines *pests* as "living organisms that occur where they are not wanted or that cause damage to crops or humans or other animals." This broad definition includes insects, mice and other animals, weeds (unwanted plants), fungi, microorganisms such as bacteria and viruses, and prions. However, in popular usage, the term *pest management*—the activity or process of controlling the damage caused by pests—has the primary meaning of control of plant and animal pests, including insects.

Pest management can be divided into three broad categories: agricultural, structural, and natural resources/recreational environment applications. This brief focuses on the structural and agricultural categories.

- Structural pest management is concerned with control of pests in and around *structures* (e.g. schools, warehouses, campuses, residential buildings and complexes) that may damage the structures, their contents, associated landscaping, or present health risks to those using or inhabiting them.
- Agricultural pest management is focused on control of pests that damage crops and harm livestock.

Effective pest management in these sectors is essential to human health, quality of life, agricultural production and food security. In general, the damage caused by pests is proportional to their population; and pest management usually focuses substantially on reducing these populations. Towards this end, "business as usual" pest management relies to a high degree on chemical pesticides as both the preventative and curative tool of first resort.

Agricultural pest management can be and is undertaken by farm owner/operators without the assistance of outside parties; property managers or owners likewise undertake many pest control activities. Of interest to this study, however, are *pest management services* provided on a commercial basis by third parties. Green servicizing potential exists specifically in the area of *performance-based pest management*, in which a pest management services provider commits to achieving a certain standard or level of pest control, rather than being compensated for a particular treatment or application.

In such a regime, the provider may have some incentive to reduce the use of pesticides, as pesticides become a cost of service provision rather than a source of profit. However, this incentive may operate with little effect unless the provider is aware of, skilled in, and has a commitment to complementary non-chemical approaches to pest management.

For this reason, performance-based pest management services that explicitly focus on *integrated pest management* (IPM) are the "green servicizing" approach to pest management.

What is IPM? There is not a universal definition for IPM, but the definition put forth by the *National Road Map for Integrated Pest Management* is widely-accepted and conveys the general concept well:

> *Integrated Pest Management, or IPM, is a long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. It coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all arenas from developed agricultural, residential,*

and public areas to wild lands. IPM serves as an umbrella to provide an effective, all encompassing, low-risk approach to protect resources and people from pests.[55]

As a strategy, IPM thus seeks to optimize results across three dimensions: economic, environmental, and human health. IPM is not a single "recipe" for pest management, but fundamentally an adaptive management strategy that draws on a continuum of practices whose choice is determined by location, type of pest, type of crops or facility, and many other factors.

The extent to which IPM is being practiced in the US depends on the benchmark used. With respect to the agricultural sector:

- The "greenest version" of IPM requires that pesticides are used as a last resort after all other methods have been considered to eliminate a given pest. Under this definition, corresponding to Lester E. Ehler's definition of "true IPM," as of 2000 IPM was being practiced on 8% or less of US crop acreage (Ehler et al, 2000).

- This said, most experts agree that "BAU Pest Management" has moved beyond scheduled pesticide treatments and that successful growers tie pesticide applications to field monitoring and, moreover, are using an array of pest management methods, such as pest-resistant varieties, cultural controls, and good sanitation practices. By this standard, "BAU Pest Management" has advanced significantly in the past generation, and now stands on at least the lower rungs of the IPM continuum.

The remainder of this brief discusses agricultural and structural IPM separately due to significant differences in value proposition, environmental benefits, and market share between the two categories.

IPM Value Proposition: Agriculture

US EPA's most recent pesticide market analysis estimates total US pesticide purchases amounted to about $11 billion in 2001, representing about 1.2bn pounds of active agreements. Of this amount, commercial agricultural applications accounted for about $7.4bn in purchases (US EPA 2004).[56] This compares to total farm expenditures in that year of $200.8bn[57] and net farm sector value-added of $45.7 bn, of which owner/operator income and corporate farm profits totaled $28.7bn. (US Census Bureau 2008)

Pesticide purchase costs are thus a significant percentage of farm expenditures (3.7% in 2001; US EPA 2004)[58], particularly in an often low-margin industry. And while pesticides prevent significant crop losses, they do not deliver ideal results: e.g., "despite the widespread application of pesticides in the United States at recommended dosages, pests (insects, plant pathogens, and weeds) destroy 37% of potential crops"—and at least 10% of pesticide costs go to combating increased pest resistance. (Pimental et al, 2005).

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[55] The federal government first started using the term IPM in 1972, when President Nixon directed federal agencies to promote the concept. In 1993 the EPA, USDA, and FDA all called for a commitment to implement IPM on 75% of U.S. farms by 2000. In order to quantify the results IPM was defined as the "prevention, avoidance, monitoring, and suppression" (PAMS) of pests, and any farm using 3 out of those 4 practices would qualify. This definition has drawn criticism from many IPM experts as it requires neither monitoring nor the integration of alternative pest suppression tactics, both of which are central tenets of IPM (Ehler, 2005).

[56] (US EPA, 2004)

[57] USDA, National Agricultural Statistics Service, as cited in (US EPA, 2004.)

[58]This percentage increases if pesticide application costs, the costs of crops lost to market due to over-threshold pesticide residues, and similar "hard" costs of pesticide use are included.

There is substantial evidence that IPM methods consistent with the National IPM Roadmap definition can yield the same if not greater productivity and cost-effectiveness as traditional pest management approaches, while reducing reliance on pesticides. For example:

- According to a 1989 report by the National Academy of Sciences, farmers using alternative pest management strategies can be as productive and profitable as conventional farmers (As cited in Moffitt, 1993). And if a long term approach is taken and soil health as well as human health are considered, then it is likely IPM practices are more profitable than conventional approaches.

- While the value proposition for IPM is dependent on crop types, farm size and location, etc., the extensive IPM case study literature is, in aggregate, persuasive that IPM is at least as cost effective an approach to Pest Management as traditional methods, and can often result in higher yields and lower costs than conventional farming practices.

The cost-effectiveness of IPM as a pest management strategy is—or should be—only the supply side of the IPM value proposition for agricultural producers. On the demand side, adopting IPM should in principle provide producers the ability to offer "IPM-grown" products that command a price premium, analogous to that commanded by organic goods. As in the case of organics, this premium reflects consumer willingness-to-pay for two perceived attributes: lower environmental impact[59] and lower health risks from pesticide residues.

However, this supply side mechanism currently operates at much less than its likely full potential. Achieving this potential would require well-recognized and trusted "IPM labeling" schemes (analogous to the USDA "organic" label). Historically, the diversity of IPM definitions and the nature of IPM as a continuum of practices have presented difficulties to standards development and clear communication to the market. Now, however, region and crop-specific IPM standards are increasingly coming into their own[60]—though as yet their recognition and acceptance in the market still lags that of organic standards, now substantially consolidated around the USDA organic standard and label.

There is a distinction between farm owner-operators adopting IPM as a self-practice and the use of commercial IPM services.[61] The focus of this brief is the extent to which such *IPM services* are or may be a viable vehicle for changing BAU pest management. For this to be true, *IPM services* must either offer superior cost-performance to BAU approaches, or provide agricultural producers with market access otherwise denied them.

IPM Value Proposition: Structural

The IPM value proposition for *structural* pest management services has both supply and demand-side elements:

- **Supply side.** There are numerous studies that show IPM applications are more effective at controlling a variety of pests than conventional methods in many different types of facilities (see Table 4, below). The initial labor required is normally greater, but the number of service requests drops significantly over time—therefore requiring less work for the contractor and

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[59] A 2006 survey of U.S. consumers, ages 13 to 26, found that 89% would be likely to switch to a brand associated with a good cause if quality and price of the product were equal. This demographic includes 78 million people (as cited in Green, 2008).

[60] There are dozens of examples of these certification programs including California Clean, Green Shield Certified, and SYSCO's Sustainability/Integrated Pest Management Program. A more comprehensive list can be found at The IPM Institute of North America, Inc. website (http://www.ipminstitute.org/links.htm, accessed 5/16/2008).

[61] As the discussion above makes clear, IPM based pest management services are of their nature performance-based.

increasing client satisfaction. Greene et al (2002) found a 93% reduction in service requests over 10 years of using IPM practices. This benefit is contingent upon a performance-based contract instead of "per visit" payment.

- **Demand-side.** The efficacy of IPM applications in controlling pests and reducing pesticide use (and consequently the health problems that they cause) is also driving customers to request pest management providers that have IPM capabilities.

  There is a high level of public awareness that the active ingredients in pesticides can cause a variety of negative health effects, from asthma to cancer, and the opportunity to reduce the occurrence of these effects is attractive, especially in structures that are frequented by children such as schools. IPM's proven ability to reduce levels of allergens and irritants for those suffering from asthma is of particular note given the sharp rise in this affliction in recent years (Hoppin, 2007).

Environmental Performance

The environmental performance of IPM *services* is identical to the environmental performance of IPM itself as compared to "BAU Pest Management practices." The most direct environmental benefits of IPM derive from reductions in and changes to pesticide use, although, as listed above, there are other environmental benefits as well.

Agriculture

As noted above, 2005 US pesticide use has been estimated as 500 million kg of 600 different products. From an environmental and human health perspective, it is the side-effects of this use that are of concern. These include: health impacts, ranging from premature mortality, to acute and chronic illness, to the multiple impacts of endocrine disruption; reduction in populations of beneficial species (e.g., honeybee losses and reduction in wild bee pollination—bees are vital to the pollination of many crops including fruits and vegetables); pollution of ground water; and bird and fish kills, among others.

The national system of pesticide regulation is intended to assure, in part, that the benefits of pesticide use for each formulation and application substantially outweigh the risks. However, these "side effects"— while difficult to quantify—without doubt remain very substantial.[62]

Further, the science behind regulatory assessments of pesticide risks is constantly evolving, with the general trend over time that known risks have grown at lower exposure levels for broad classes of chemicals. Thus, both the logic of reducing *known* risks and the precautionary principle indicates that economically effective opportunities to reduce pesticide impacts should be exploited to the greatest extent possible.

It is difficult to quantify the reductions in pesticide impacts thus far achieved by IPM on a national level given the many factors involved, including changes in the types of pesticides used and their toxicity levels. [63] However, national results must ultimately be the aggregate of field- and farm-level results,

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[62] Efforts to rigorously estimate even the hard economic costs of pesticide side effects are difficult and controversial, but these efforts at the very least provide a catalogue of pesticide side effects and indications regarding their potential extent. Pimental at al (2005) quantify the "hard costs" of these side-effects, also considering non-environmental economic costs such as increased pest resistance (at least 10% of pesticide use is to combat increased pesticide resistance in pests), government spending on pesticide pollution control, crop losses & domestic animal poisonings due to pesticides, etc.. This effort of necessity requires a significant number of assumptions and extrapolations, but the study finds that the costs of pesticide use at least double when the above indirect costs are taken into account.

[63] For example, a 2001 GAO report intended to assess the USDA's IPM initiative found "IPM as implemented to this point has not yet yielded nationwide reductions in pesticide use" (Ehler, 2005). This report has been countered by studies that show

and the case study literature clearly indicates—with numerous studies across many different crop types—that IPM tends to significantly reduce the use, toxicity, and/or dispersion of pesticides.[64]

Structural

Agricultural pesticide use is of concern from an environmental and human health perspective because it simultaneously (1) introduces toxic chemicals into the environment in a highly dispersive way; and (2) deposits these chemicals directly on foodstuffs intended for human consumption and livestock feed. Structural applications of pesticides, by contrast, are of concern primarily because they concentrate these chemicals in living and working areas.

Some of the benefits of reducing the use of pesticides in structural applications are a reduction in asthma attacks for individuals for whom cockroach and rodent allergens are asthma triggers, less exposure to high-risk pesticide formulations (e.g. aerosols, foggers, rodenticides), and, in general, improvements in quality of life. Multiple studies on structural IPM implementation show that large reductions in both pesticide application and pesticide residuals can be achieved. Table 1 summarizes some representative studies:

Table 4. Structural IPM Studies

Study & Subject	Results: Pesticide Use	Results: Pest Management	Other Results
Wang et al 2006 Cockroach management in 66 apartments over 7 months.	IPM uses significantly less bait (pesticides).	IPM was more effective and sustainable.	Initial costs of IPM are almost double those of "BAU," but in the long run IPM costs are comparable or cheaper than BAU.
Gouge et al 2006 Transition to IPM practices in 10 school districts in 7 states.	An average of 71% reductions in pesticide applications.	78% reduction in pest complaints.	IPM practices are diffusing throughout school districts. The number of Arizona students in schools using IPM has grown from 1.8% to 18.2% between 2000-2005.
Greene et al 2002 Transition to IPM practices in 55 GSA buildings (offices, storage, warehouses, and miscellaneous) over 10 years.	93% reduction in grams of pesticide active ingredients applied.	93% reduction in tenant service requests.	

many less toxic alternatives are being used at higher rates, and, consequently, toxicity levels have gone down by 14% over the same period (as cited in Green, 2008).

[64] The "win-win" outcomes deriving from broad adoption of agricultural IPM are well-captured in a 2007 Natural Resource Defense Council (NRDC) issue paper: "IPM can help the Natural Resources Conservation Service (NRCS) protect the soil, water, animals, plants, and air, and typically provides benefits to multiple resources. Crop and livestock producers can benefit from IPM practices to manage insects, nematodes, weeds, plant and animal diseases, vertebrate pests, and invasive species. In addition to providing cost-effective pest management, IPM's smarter, prevention-based approach can reduce pesticide runoff and leaching to groundwater, improve air quality by reducing emissions of smog-forming gases, improve soil health, reduce risks to wildlife, improve worker safety, and prevent pesticide drift." (Hamerschlag, 2007).

Williams et al 2005 Compared IPM practices to a calendar based pesticide application approach in 9 North Carolina schools, primarily targeting cockroaches.	Environmental residues of pesticide active ingredients were much lower with IPM.	IPM more effective in eliminating cockroaches.	IPM had higher labor costs, but the total costs of the two approaches were similar. Discovered that many pesticide applications in under the calendar-based approach were unnecessary.

Key Markets and Market Share

Agricultural Sector

In the agricultural sector, "full service" pest management services offerings are responsible for a small portion of pest management activity, with farm owners/operators carrying out much of this activity themselves:

- Use of 3rd party "scouting" (field monitoring) services and "full service" pest management offerings is generally cost-effective only for larger operations; however many large operations employ a full-time, in-house pest management expert.

- For smaller operations, the use of pest management services is usually reserved for high-value crops or applications that require specialist equipment or certifications.

Within this limited full service pest management sector, only a few examples of IPM-focused pest management services could be identified, among them the following:

- Syngenta Crop Protection, Inc. (a major agrochemical manufacturer) runs a program called Citrus Solutions that offers some IPM services, though they appear to retain a significant focus on pesticides.

- Western Farm Service[65] (WFS) offers services that appear to be much more true to the intent of IPM, including crop monitoring, soil testing, and weather station networks. They report particular success with celery farmers.

- The Lodi-Woodbridge Winegrape Commission (established in 1991) runs a program that partners producers with pest managers. One of the goals of the commission is to create an area-wide IPM program, and now membership includes 750 growers constituting 20% of all wine from California. The Commission has a full time IPM director on staff and runs meetings, field days, research seminars, etc. intended to educate growers and pest control advisors. A set of IPM certification standards were created, and the number of growers obtaining certification continues to grow (doubling from 2005 to 2006) each year (Green, 2008).

While this survey could not be comprehensive, the strong indication is that while niche offerings exist and may well constitute critical proof-of-concept for future growth of an IPM services sector, currently the IPM-focused pest management services sector is embryonic.

[65] According to its website, WFS is "an operating segment of Agrium, a global producer and distributor of nitrogen, phosphate, potash and sulfate. WFS has a sister company in the Midwest, Crop Production Services (CPS), which services the Corn Belt to the east coast." (www.westernfarmservice.com, accessed 30 October 2007.)

What could drive the sector to grow from its current low base and where might such growth first occur? The most effective stimulus is likely to be strengthening consumer and intermediate buyer demand for "IPM goods." Existing trends indicate that such demand is growing: the significant developments in IPM labels and certification (cited above) and the efforts of some large buyers (e.g. SYSCO) to impose IPM standards on their supply chain are both responses to and stimuli for consumer demand for "greener and safer" IPM-labeled products.

Implementing IPM effectively and at its full potential requires knowledge and expertise on the part of owner/operators. In the presence of a strong market signal for IPM-labeled products, this need should present a market opportunity for crop consultants who can offer at least partial "IPM services."

Independent crop consultants are already concentrated in high value crops such as cotton, vegetables, and certain fruits whose economics can often support some form of pest management services even for smaller operators. Thus, these crops likely constitute the most fertile market for IPM services. (However, of the estimated 13,500 US crop consultants, about 96% work for pesticide retailers; this group may therefore not be oriented towards pesticide use reduction (Green, 2007)).

Structural

In its structural applications, pest management is already heavily outsourced. That is, the use of specialist pest management providers is BAU, and IPM-based services have had some success in schools, commercial buildings, and other large and heavily trafficked structures. In particular, IPM practices have diffused throughout school districts. The number of students in Arizona school facilities using IPM grew from 1.8% to 18.2% between 2000 and 2005 (Gouge et al, 2006). Public housing buildings have also been the subject of numerous IPM projects; this has been driven by studies that have shown high levels of pesticide residues in these facilities (Julien, 2008).

The food processing, distribution, and retail industries have also taken an interest in IPM. "Driven by current and anticipated growth in consumer demand, companies are incorporating IPM and other health and environmental initiatives into corporate social responsibility (CSR) portfolios that include dedicated leadership at the highest levels of management, a substantial investment in resources, and regular reporting to shareholders, consumers, and the general public" (Green, 2008).

The government has also provided further incentives for this business model to grow. In 1996 the Federal government required that "Federal agencies shall use Integrated Pest Management techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies, and other activities" under Title III, Section 303, of the Food Quality Protection Act, 1996. There are also public agency bid specifications that give a preference to pest management service providers that are certified by an independent third party (Green, 2008). As with agricultural IPM, these third party certifications are becoming commonplace (see footnote above on certification).

Structural IPM appears to have high potential as a "green servicizing" business model. It is already a service industry in which performance-based contracts are common. Numerous studies have shown IPM to be economical and more effective at removing pests than conventional techniques. IPM also reduces the amount of pesticides needed as well as the residues left over after application, which has multiple health benefits, particularly for asthma patients. Federal, state, and local governments are already pushing the adoption of IPM practices through legislation and contracting preferences.

Examples

Syngenta Crop Protection, Inc.	http://www.syngentacropprotection-us.com/citrus_solutions/products/
Western Farm Service, Inc.	http://www.westernfarmservice.com/
Orkin, Inc.	http://www.orkincommercial.com/

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Brief #6: IT Lifecycle Solutions

Description and Value Proposition

IT Lifecycle Solutions is a broad term used to describe business offerings that bundle provision of corporate IT equipment (particularly personal computers (PCs), servers and printers) with associated services. The "solutions provider" is responsible for most or all configuration, maintenance, repair, and upgrade.

This brief will focus specifically on instances in which this equipment is leased rather than purchased. These leases exist in two general forms: *operating leases* in which the lessor retains ownership of the product during and after the lease term, and *capital leases* in which ownership of the product moves from the lessor to the lessee after the lease term. This discussion further focuses on operating leases, because capital leases offer "no [environmental] advantage over an environmentally thoughtful purchase of new or reconditioned equipment" (Federal Electronics Challenge 2006).

Such leasing arrangements allow the user organization to "bundle acquisitions of hardware, software, services, and maintenance into one monthly payment," thereby conserving cash and preserving credit lines (Fishbein et al 2000). Typically, leases last between one and four years, at the end of which the lessee has the option of purchasing the equipment, releasing the equipment, or beginning a new lease with new equipment.

Many of these IT Lifecycle Solutions offerings also include options to upgrade to newer technology during the leasing period (Fishbein et al 2000). This is a particularly useful option, because information technology evolves quickly, and some equipment and/or software can become obsolete in a matter of months. Leasing allows organizations to take advantage of newer technologies without having to remarket or dispose of their existing equipment.

IT Lifecycle Solutions providers also offer equipment at a discount, because of the healthy market for re-leasing or selling previously used equipment (Vosicky 1992). And beyond procurement savings, customers also benefit from significant avoided costs of disposal: the cost of disposal for one PC is on average between $100 and $400 depending on the method.[66] IT Lifecycle Solutions providers, however, reduce these costs with economies of scale, and by resale or release of equipment. In sum, a reasonable rule of thumb seems to be that for organizations requiring more than 1000 PCs, the use of "IT lifecycle solutions" can save up to 12% on acquisition and 15% over the three year cost of ownership compared to traditional purchasing (Fishbein et al 2000).

This mix of customer motivations is reflected in the results of a 1999 report by Dell Financial Services, a major IT Lifecycle Solutions provider, regarding why organizations choose to lease, as compared to purchasing IT equipment:

- Technology transition (i.e., total cost of ownership, technology refresh) 68%
- Ease of acquisition 68%
- More cost effective than purchasing 54%
- Ease of disposal 42%
- Off-balance-sheet financing 20%

IT Lifecycle Solutions also offer benefits to the provider. Configuration and maintenance services allow them to generate additional value-added from an existing product, including at the end of the original lease. As noted above, there is a thriving market for leasing or purchasing used equipment, and IT Lifecycle Solutions providers are well-placed to exploit this: most are business units of the original equipment manufacturer (OEM) or have direct partnerships with the OEM, and thus have easy access to parts for repair and refurbishment (Fishbein et al 2000). Illustrating the importance of these post-lease markets for providers, Fishbein et al find that provider preferences for post-lease disposition of equipment are as follows, from most to least preferable:

- Refurbish and resell directly to end users.
- Resell "as is" to secondary market brokers.
- Utilize for spare parts in service departments.
- Donate to charitable organizations.

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[66] The methods of computer disposal and their corresponding costs are as follows: sell to broker $118.90, throw away $216.75, sell to employee $272.49, donate to charity $343.90, and re-deploy or cascade within organization $397.30.

- Recycle for material value.

In many states, regulations also provide significant demand-side drivers for IT Lifecycle Solutions. For example, in Florida there are strict regulations on the storage and transport of computer monitors if they are going to be landfilled or incinerated but not if they are going to be reused or recycled. Massachusetts has banned the disposal of computer monitors in landfills, and California has done the same with monitors and televisions. The European Union directive on Waste Electrical and Electronic Equipment (discussed below in the remanufacturing brief) creates even stronger incentives, requiring that 60%-80% of electronic equipment be recovered and recycled by the manufacturer (Macauley 2003).

Environmental Performance

IT equipment presents significant in-use, manufacturing/upstream, and end-of-life environmental impacts. IT Lifecycle Solutions generally do not reduce equipment utilization, and thus have little effect on in-use impacts (i.e. impacts of electricity consumption). But, as described below, they can affect the other two impact areas. Of these, while manufacturing/upstream impacts are substantial,[67] it is the end-of-life impacts that are usually viewed as most environmentally significant:

While exact impacts are not well-quantified, the disposal of End-of-life IT equipment ("e-waste") presents a number of significant environmental issues, most related to the hazardous materials they often contain. Of these, lead is normally of most concern,[68] but many toxins and heavy metals can escape when these products are placed in a landfill or incinerated (Macauley 2003).

The issue is significant because the volume of e-waste is so large: it is estimated that from 2000 to 2010 one billion pounds of lead from computers and other electronics will enter the waste stream in the United States. As of 2000, electronic products comprised the largest proportion by weight of sources of lead entering the waste stream in the U.S, and the use of lead in electronic products was the second largest (22%) application of lead overall, behind the transportation industry (65%) (Macauley 2003).

IT Lifecycle Solutions offer the potential to improve the lifecycle environmental performance of IT equipment in two ways:

- *By reducing the incidence of improper disposal and uncontrolled recycling.* IT Lifecycle Solutions place end-of-lease responsibilities for IT equipment with the provider instead of the user. Compared to IT users, IT Lifecycle Solutions providers are more likely to have systems and policies in place to assure proper disposal and/or well-controlled recycling, as (1) this waste stream is directly tied to environmental management of core operations; and (2) proper end-of-life management can be a selling point to customers. Thus, where equipment is immediately decommissioned post-lease, its disposal or recycling should be better-controlled on average than when equipment is directly disposed by users.

- *By moving disposition of post-use equipment up the "3R" hierarchy.* As discussed above, these models provide strong incentives and enabling conditions for providers to (1) extend the life of equipment through post-lease refurbishment and resale/re-lease, and (2) otherwise recover maximum value from post-lease equipment (e.g. via parts salvage). Both should reduce total market demand for new equipment, and thus total manufacturing/upstream and disposal impacts.

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[67] Building a 24 kg PC with monitor requires at least 240 kg of fossil fuels and 22 kg of chemicals. (Thurston & de la Torre, 2007).

[68] Exposure to lead has many well documented negative health effects, including hypertension, stroke, premature death, neurological damage, and interference with nervous system development. Macauley et al, (2003): 17.

The critical question is the extent to which IT Lifecycle Solutions *operationalize* these potential "improvement mechanisms." We could not locate industry-wide data on post-lease disposition of equipment; however, *Fishbein et al* examined the five major US-based PC manufacturers (Dell, Compaq, Gateway, Hewlett-Packard, IBM, and Packard Bell–NEC), who together account for over 50% of the units produced, and found that the majority of post-lease computers are remarketed. Those not remarketed are typically demanufactured for spare parts or recycled for material value and to avoid the potential liabilities of improper disposal. (Data on the end-of-life disposition of remarketed computers is not available, but disposal practices can be assumed to be no worse than average.) Thus, there is good evidence that at least the second "improvement mechanism" is functioning strongly.

Nagashima et al (2005) undertook a lifecycle analysis (LCA) of a stylized PC leasing system. They find that the enhanced recovery rate of end-of-life PCs expected under leasing reduces lifecycle PC "environmental load" (an aggregated measure of all impacts) by 17%, and that *re-leasing* reduced lifecycle environmental loads by 30%.

In principle, leasing could incentivize manufacturers deriving significant revenue from IT Lifecycle Solutions divisions to modify their products in order to increase their end of life value and ease of reuse. However, at least as of 2000, there was no evidence of manufacturers changing product design as a direct result of leasing (Fishbein et al 2000).

Key Markets and Market Share

Customers for IT equipment leasing tend to be businesses, not households, and the vast majority of large US corporations lease at least some portion of their IT equipment. The US IT leasing industry grossed $23.8 billion in revenues in 2003 (down from $26.1 billion in 2000), with 6.5% annual growth forecast through 2007. Of this 2003 revenue, PCs and workstations accounted for $9 billion, and servers and mainframes for $7 billion (*Information Week* Industry Overview).

By comparison, revenue for the US computer manufacturing sector in 2007 was about $75 billion, of which PCs and workstations accounted for 50% ($37.5 billion) and servers and mainframes for 15% ($11.25 billion).[69]

Although these two groups of statistics are for different years, they do permit a reasonable approximation of the relative sizes of these two industries:

- The IT equipment leasing industry is about one-third the size of the computer manufacturing industry (based on revenue).
- The revenues generated from PC and workstation leasing are about one-quarter those generated from PC and workstation manufacturing.
- The revenues generated from server and mainframe leasing are nearly two-thirds those generated from PC and workstation manufacturing.

The above statistics demonstrate that the IT equipment leasing industry is a substantial part of the IT sector and of the US economy.

Examples

Compaq Financial Services	

[69] www.hoovers.com, accessed 2/27/2008

Dell Computer Corporation	
Gateway	
International Business Machines (IBM)	
Fuji Xerox	http://www.fujixerox.co.jp/eng/

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Brief #7: Remanufacturing

Description and Value Proposition

US EPA has defined "remanufacturing" as "the standard term for the process of restoring used, durable products to a 'like new' condition" (US EPA 1997). However, the term is also employed with slightly different meanings, and other terms are used with a roughly equivalent sense to this meaning of remanufacturing. This brief uses the US EPA definition, thus, remanufacturing is a form of "reuse" rather than "recycling."[70]

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[70] For example used tires could be *recycled* into a playground surface, but the purpose of remanufacturing tires (essentially bonding new tread to and verifying the structural integrity of the used tire) is for re-use on a vehicle. Products can also be *reused* without being remanufactured, as in the case of refillable beverage bottles. Some terms that are sometimes used instead of remanufacturing are *restoring* or *refurbishing*.

Remanufacturing is practiced in both closed and open loop systems, meaning the restoration and resale of the used product may be done by the original manufacturer (closed loop) or a third party (open loop). Regardless of who remanufactures the product, the value propositions are the same. Depending on the industry, refurbishing may be cheaper than creating a product from scratch. It also provides a way for manufacturers to recover value from goods that are returned during their life-cycle (commercial returns and warranty returns), on which US companies are losing an estimated $100 billion annually (Harrison et al 2003). These savings are often passed down to the consumer (average remanufactured product costs 30%-80% less than new products), which may attract new consumers that cannot afford new products, or consumers that believe the cost savings outweigh any quality difference between new and remanufactured products.

"Remanufacturing" is not a new practice. Its roots in the modern US economy can be traced back to the Great Depression and World War II when many raw materials were in short supply. Remanufacturing has been evolving ever since, expanding within industries and into new ones. The market status, drivers and barriers, and potential environmental gains are highly sector/product dependent. Therefore, the market and environmental characteristics of the "remanufacturing model" as a whole will be briefly addressed below, followed by a more in depth description of several of the sectors in which remanufacturing is established or emerging. "Remanufacturing," especially in the sense of "refurbishment," is standard and very much business as usual in some industries/sectors. For example, mechanics refurbish a car when they replace major components such as transmissions, windshields, etc. for the owner. Such practices that are entirely 'business as usual" are not addressed here.

Remanufacturing, like deconstruction, applies an end-of-life service to an existing product, altering that product's disposition. However, unlike deconstruction, remanufacturing requires a reverse logistics system. It is less correct to call remanufacturing a Product-Service System in and of itself than to speak of remanufacturing-based PSSs.

Environmental Performance

Remanufacturing has the potential to reduce both the consumption of raw materials and the volume of waste, thus reducing both upstream and disposal impacts. Many products also require less energy to rebuild rather than manufacture from scratch. The types of "avoided emissions" vary depending on the product, but some examples are greenhouse gases such as CO_2, SO_2, NOx, heavy metals and halocarbon materials from batteries, oil from car parts, etc. Some environmental statistics are listed below:

- A limited survey estimated that over the entire industry remanufacturing recoups between 85% and 95% of the materials and energy used to make the original product (as cited, Hauser et al 2003).
- Giuntini et al (2003) estimate that worldwide, the remanufacturing industry annually saves over 117 billion kWh of energy, corresponding to roughly 56 billion lbs of avoided CO_2 emissions annually.

Key Markets and Market Share

Historically, remanufacturing was dominated by heavy and/or durable machinery and machined goods such as automotive parts (e.g. rebuilt engines, carburetors, etc.), construction equipment, refrigeration components (e.g. rebuilt compressors), and textile machinery. However over the last two decades, remanufacturing has extended to classes of new products. Consumer electronics is a particularly new, but promising sector.

A 1996 survey estimated that there were over 73,000 firms in the US selling approximately $53 billion worth of remanufactured goods in 46 different major product categories. These firms accounted for an estimated 500,000 direct employees (25 people in the average company) and estimated annual company sales of $2.9 million (Lund 1996). Lund notes in subsequent work that these figures likely have an upward bias due to imperfect data availability, but they still accurately and strongly indicative of the economic scale and scope of the remanufacturing industry (Hauser & Lund, 2008). The largest single remanufacturer is the US Department of Defense, which refurbishes and reuses a large portion of its equipment (Steinhilper 1998). However, as stated above, remanufacturing is established in many different sectors.

Most remanufacturing has been driven by two factors: the cost savings offered in comparison to new products (see above), and legislative incentives. Laws limiting certain pollutant outputs (Clean Air Act, Clean Water Act, etc.) often create economic environments where it is beneficial to refurbish old products rather than manufacture from scratch.[71] Some states have enacted laws that discourage the disposal of electronic products.

For example: In Florida there are strict regulations on the storage and transport of computer monitors if they are going to be landfilled or incinerated but not if they are going to be reused or recycled. Massachusetts has banned the disposal of computer monitors in landfills, and California has done the same with monitors and televisions (Macauley et al 2003). The European Waste Electrical and Electronic Equipment (WEEE) directive requires a certain amount of reuse and recycling (Seliger et al 2003).

Despite the success of many different remanufacturing enterprises, there are substantial barriers that often render remanufacturing uneconomical. Reverse logistics are often more complicated than new product logistics, because they require the collection of products from a far greater number of locations. A new product is distributed to the retailers, where it can be sold to many different consumers. Collecting these products at the end of their lifecycle into central locations where they can be examined and sorted is a potentially complicated and expensive process. Inspection and sorting is also a difficult process, because it requires expertise, efficiency, and normally cannot be automated. Manufacturing companies considering refurbishing their old goods are also often afraid they will cannibalize the sales of their new goods. Despite these barriers, the industries detailed below have had financial success remanufacturing.

Sector Vignettes

Automotive Industry

As of 1998 remanufacturing had already reached between 45% and 55% of the market share for replacement parts in the automotive "aftermarket" (that is, parts replaced by other than dealer service providers) with some parts as high as 90%, such as alternators and starters. The parts cover a huge range of automotive needs, from water pumps to entire engines, and cost between 35% and 50% less than new parts (Steinhilper 1998). In the US market, an estimated 67,500 tons of discarded auto parts were remanufactured in 2004 ("The best kept secret to US economic growth: Remanufacturing").

One specific example of remanufacturing in the auto industry is the re-treading of used tires. Over 3.8 billion tons of rubber tires were disposed of in 1995 in the US In many cases, new tread can be added to these tires for 30% to 70% of the cost of making a new tire and in such a way that the tires meet all safety standards set by the National Highway Traffic Safety Administration, get comparable mileage to new tires, and can be driven at the same speeds. Each remanufactured truck tire conserves an estimated

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[71] In some instances it is cheaper to manufacturer a new product rather than remanufacture an old product, but the pollution created by building the new product is far greater. Under normal circumstances a company would not engage in remanufacturing, but environmental regulations often impose fines that create an economic environment in which the company chooses to remanufacture instead to avoid the fines or penalties.

15 gallons of oil (610 kWh roughly converted). In 1995 Bell Atlantic began using retread tires for 60% of its fleet; this new policy equated to savings of $430,000 in 1995 and $560,000 in 1996 (US Environmental Protection Agency 1997).

Examples: Black's Tire Service: www.blackstire.com ; BMW: www.bmw.com

Electronics

The potential environmental gains of remanufacturing electronic goods have received significant attention due to the high levels of energy and emissions embodied in electronics—and because 80% of "e-products" disposed of are still fully functional. Goods in this category include, e.g. computers, printers, keyboards, cashier equipment, and most recently, huge numbers of cell phones. In 2006 Americans discarded approximately three million tons of household electronics (Mooallem 2008).

Cell phones illustrate the material volumes and environmental issues involved even in highly compact products; as of 2003 it was estimated that there were over 1.3 billion cellular phone subscribers globally, each of whom requires at least one phone. In 2006 1.2 billion cell phones were sold worldwide. Rapid technological change (and limited durability) has driven short lifetimes: cell phones have an average life span of less than 2 years—and in the US this average drops to about 1 year (Mooallem 2008).

The huge number of users coupled with the short life span of phones has resulted in more than an estimated 500 million mobile phones laying idle (not disposed of and not in use). This equates to approximately 250,000 tons of equipment embodying very significant upstream and manufacturing inputs and emissions. An even larger number of phones end up as domestic waste and have the "potential for release of heavy metals or halocarbon materials from batteries, printed wiring boards, liquid crystal displays, plastic housings, wiring, etc" (Seliger 2003). A 2007 study by the US EPA placed 34 recent model cell phones in landfill conditions and found that on average they leached 17 times the amount of lead that constitutes hazardous waste under federal law (Mooallem 2008).

Although there is high customer demand for cutting edge technology in this market, third party remanufacturers are making a profit selling remanufactured phones to less developed markets. Many of the most prominent carriers and manufacturers in the US have voluntary take-back programs. This industry first started in the US in the 1990s with companies taking advantage of "Charity Recycling," and has grown to an annual sales volume of over 3 million phones in 2003 (less than 1% of the total cell phone market).[72] In 2006, cell phone recyclers and remanufacturers estimated that they received about 1% of the phones that were discarded globally. Phone remanufacturing is expected to show significant growth in Europe due to the WEEE directive (discussed above), which will require 75% of cell phone weight to be recovered (reused or recycled). The growth in many African countries also should be noted. The continent is one of the biggest markets for used cell phones, and in the less developed nations over 75% of phones are cell phones. Demand for these phones is increasing by between 30 and 40 percent per year in some of these countries (Mooallem 2008).

Computers are also characterized by short technological life cycles and high demand for the latest technology, both of which pose barriers to remanufacturing. In 2005 an estimated 250 million computers became obsolete, and those computers pose a substantial environmental threat, because they contain mercury, cadmium, lead, brominated flame retardants, and other toxics ("New Innovative Partnership with Staples, Electronics Manufacturers to Take Back E-Waste from Customers" 2004). Many localities are banning e-waste disposal, so take-back and recycling are becoming increasingly

[72] Indicative Examples: FOB Miami, Inc. http://www.fobmiami.com/, Cornerstone Wireless http://cornerstonewirelessinc.com/about.html

common. Some manufacturers—e.g., Dell and IBM—have started remanufacturing programs by designing products with modular components that can be converted to parts for refurbished computers at the end of their lifecycle. The resulting computers are then sold through Dell and IBM distribution channels to customers who do not require latest-generation performance. Companies are also increasingly noticing that the full capabilities of PCs are not used in any case, and thus are more willing to accept equipment that is less than "cutting edge" (Ferguson et al 2006).

Third parties (e.g. Remanufactured Computers.com: http://www.remanufacturedcomputers.com/) have also become involved in this industry, often selling computers to customers, such as schools, that cannot afford to upgrade to new computers on a regular basis (Ferrer 1997).

One of the best known examples of remanufacturing is the Fuji Xerox model, in which copiers are leased, and either refurbished at the end of the lease period and then leased out again, or used for parts for new copiers. As a result of this system Fuji Xerox recovers as high as 98% of some of their products and reports annual savings of about $200 million due to remanufacturing ("Corporate societal responsibility: knowledge learning through sustainable global supply chain management." 2005).

Examples :

IBM: http://www-132.ibm.com/webapp/wcs/stores/servlet/HelpDisplay?storeId=1&catalogId=-840&langId=-1&subject=2576394&cm_re=masthead-_-products-_-ibmcue

Fuji Xerox: http://www.fujixerox.co.jp/eng/

Dell: http://www.dell.com/content/default.aspx?c=us&cs=22&l=en&s=dfh

Collective Good: http://www.collectivegood.com/

ReCellular: http://www.recellular.com/

Furniture

Office furniture is a recent US growth sector for remanufacturing activity, with US sales of remanufactured furniture growing by around 25% annually. Available remanufactured products cover the spectrum of office furniture, and include desks, desk chairs, filing cabinets, partition panels, meeting tables, chairs, etc. Customers typically realize savings of about 50% over new products, and this has lead to quick growth in the industry. In 10 years, remanufactured furniture has obtained a 10% market share of the $9 billion commercial furniture industry, with many experts predicting an increase in 25% in the next 5 years in the US (Steinhilper 1998). There is also the potential to reduce disposal costs up to $93 million (US EPA 1997).

Examples: Office Furniture Warehouse, Inc.: http://www.myofficefurniture.net/; Kentwood Office Furniture: http://www.kentwoodoffice.com/SWAPPID/87/PCPage/152428

Construction Equipment

Caterpillar, Inc. is the world's largest producer of construction and mining equipment and has been remanufacturing its products since the 1970s. Remanufacturing began with engines and has grown to a large range of products. In 2005, 135 million lbs of components (2.2 million units) were returned to Caterpillar Remanufacturing Services. Of the items returned, 70% were remanufactured and those remaining were recycled. This success has been achieved through leasing machinery and one-for-one exchange programs, both of which eliminate many of the reverse logistics problems associated with remanufacturing. In 2006, Caterpillar signed a letter of intent with China's National Development and

Reform Commission (NDRC) to promote the Chinese remanufacturing industry (Caterpillar Inc. 2006).

Example: Caterpillar, Inc.: http://www.cat.com/cda/layout?m=105410&x=7

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Brief #8: Resource Management

Description and Value Proposition

Resource Management (RM) Contracting is a performance-based approach to waste management. It centers on an innovative contractual partnership between a waste-generating organization and a qualified waste contractor that changes BAU compensation structures and otherwise supports and incentivizes waste minimization and recycling. It can include both hazardous and non-hazardous waste.

Solid waste and recycling contracts directly influence how the vast majority of waste streams are managed. Most BAU waste and recycling contracts incentivize contractors to maximize disposal volumes (hauls), feature a limited scope of service with multiple contractors handling separate waste streams or recyclables, or both. This "fragmented" approach often lacks an emphasis on recycling and resource efficiency[73] and does not tend to support waste minimization efforts.

Under RM, by contrast, a waste contractor's profit model is not based on "haul and dispose more volume," but on attaining performance benchmarks—and thus compensation incentives—to "minimize waste and manage resources better."

More specifically, RM Contracting is based on three premises: (1) significant cost-effective opportunities exists to reduce waste, boost recycling, and otherwise optimize services; (2) contractors will pursue them when offered proper financial incentives; and (3) significant financial incentives to contractors can be financed from the savings generated through cost-effective improvements to a waste producer's current waste/recycling system. (Such savings result from avoided disposal costs, increased commodity revenues for material recycled and other cost savings from waste minimization efforts.)

For example, if contractors identify cost-effective recycling markets for disposed materials or techniques for preventing waste altogether, they receive a portion of the savings resulting from the innovation. RM contracts are generally structured so that base fees cover the cost of service, but profits are derived from such shared savings incentives.

Thus, the value proposition for the waste generator is to increase recycling and receive value added services (e.g. improved reporting, dedicated customer service, and waste stream analysis) at no additional cost or with decreased costs. Benefits should include: reduced total cost of waste and potential liabilities; improved waste-related data tracking and reporting; increased recycling rates for

[73] Resource efficiency refers to source reduction, reuse, and recycling/diversion, or other means to decrease generation and disposal of waste (e.g., enhanced procurement/delivery techniques, material handling, or use).

materials already recovered; and in some cases the extension of recycling/recovery to new components of the waste stream.

For waste contractors, this business model offers a means to diversify revenues, enjoy longer term and closer relationships with customers and differentiate themselves in a very competitive market. Most important for RM contractors is the potential for large profits that can result from substantial untapped opportunities for cost-effective recycling and source reduction. The result is that RM provides a profit-driven "efficiency services market" for waste reduction and pollution prevention.

The term "Resource Management" was coined by General Motors, which began to deploy RM programs at its North American plants in 1997. A few innovative examples of municipal programs exist, but RM's general potential probably lies more strongly in the commercial and manufacturing sectors. The model is new and emergent, and has received interest and promotion from US EPA's Waste Wise program and several states, most notably, Massachusetts and Minnesota[74].

Environmental Performance

The primary environmental benefits of RM derive from moving the management of waste up the reduce, reuse, recycle hierarchy, and more truly making disposal the management option of last resort.

There is no comprehensive study documenting the benefits of RM; improvements are dependent on the types of waste generated by different organizations and the degree to which any organization is recycling prior to implementing an RM contract. However, case study evidence does indicate strong waste performance improvement potential in a wide variety of waste-generating sectors:

- **General Motors (GM)** has comprehensive RM programs covering hazardous waste (including management of waste pad), industrial non-hazardous waste (sludges, grinding swarf, etc.) and plant trash (e.g., MSW). For 50 of GMs' North American plants that have had RM contracting in place for a year or more, they have realized a 20% reduction in overall waste generation (30,000 tons), a 65% increase in recycling (from 50,000 tons to over 82,000 tons), a 60% decrease in disposal, and a 30% decrease in waste management costs (Tellus 2001). Individual assembly plants see greater than 25% reduction in waste per vehicle.

- **Public Services Enterprise Group,** a New Jersey Utility, also was an early adopter of performance based waste contracting and has separate contracts for their hazardous waste and non-hazardous waste. Over the first 8 years of their program, hazardous waste generation was reduced by 93% and recycling of non-hazardous waste was above 94%. Total savings of the program was $1.75 million (equivalent to approximately 30% of "baseline" total waste management prior to program implementation) (US EPA, 2002).

- **Lempel Shattuck Hospital in Massachusetts**, a small 1,000 bed state-run facility, has an RM program that includes all non-hazardous waste and confidential paper. In the first 4 years of the program, it has increased waste diversion by 18% (from 807 tons to the landfill in FY 03 to 659 tons in FY 07). The recycling tonnage increased from 14 tons before the RM program to 108 tons. The program is responsible for creating new recycling programs for cardboard, wood palettes, scrap metal, bottles and cans and a program to compost leaf and yard waste. In 2007, an organics program was being tested which could dramatically increase the waste diversion numbers as food waste makes up a large portion of the current waste stream.

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[74] See websites in the *Illustrative Example* section at end of this brief.

- **The West Des Moines school district in Iowa**, with a student population of 8,600, implemented RM in December 2003. The program had to essentially create a waste minimization program from scratch; in the first year, recycling rates for the District jumped from less than 2% to 20%, with a variability of 15% to 35% at different schools. Central to the program's success was the creation of individual recycling manuals for each school. (The RM provider was able to obtain recycling bins for each school at no cost to the District from a state grant and matching corporate contributions.)

Clearly waste-producing organizations can undertake internal programs to pursue waste minimization and materials recovery, and to obtain the resulting benefits. However, even the most successful internal programs reach a plateau. RM contracting helps to achieve and sustain a higher level of recycling and waste minimization.

Key Markets and Market Share

RM contracting is a very new and emergent model, and market information generally does not exist. However, as virtually all commercial entities contract for solid waste and recycling services and are therefore candidates for RM contracting; an indication of total potential RM market size can be derived from estimates of the total market size of the US commercial solid waste sector:

Figures on the size of this sector are not firm, as there are a significant number of public and private contractors in the market offering a wide range of services, with little public data available on many privately held companies. RW Beck performed an extensive survey from 1999–2001 to gauge the size of the solid waste industry (all waste that was not hazardous[75]) and estimated that in total, the industry managed approximately 545 million tons of waste and had $43.3 billion in annual sales (Repa, 2001). Measuring a more limited number of waste streams, Franklin Associates estimated that 217 million tons of MSW were generated [76] in 1997 (US EPA, 1999).

The higher figure is probably most relevant for deriving RM market size, as RM is applicable to industrial non-hazardous waste, medical waste, and other wastes not included in the lower estimate. To estimate the market for RM contracting for the commercial, business and institutional sector, we must take a portion of this total number. This Franklin report and numerous other sources estimate that between 35% and 45% of MSW is commercial waste. Using the lower end of this range would yield an 191 million tons of "RM-eligible" waste with associated annual revenues of $15 billion.

While these figures are clearly indicative at best, they do suggest a large potential RM market size: even if the estimate is scaled back by 50% to focus on larger waste generators (the most likely customers for RM), the market would be 96 million tons of waste and annual revenues of $7.5 billion.

While there has never been a study to assess how widely used RM contracting is, market penetration is assumed to be low outside of the auto sector. As noted, General Motors originated the RM model and currently has 6 RM service companies who serve their sites. [77] After finding that RM can be profitable,

[75] Solid waste for this study was defined as any non-hazardous waste sent off-site for final disposal, incineration, recycling or composting. Non hazardous waste included household waste; commercial, business or institutional waste; special waste; construction and demolition debris; regulated medical waste; yard waste; sludge; and scrap tires.

[76] Municipal solid waste (MSW) includes wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. Examples of waste from these categories include appliances, automobile tires, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wood pallets, and cafeteria wastes. MSW does not include wastes from other sources, such as construction and demolition debris, automobile bodies, municipal sludge's, combustion ash, and industrial process wastes that might also be disposed in municipal waste landfills or incinerators.

[77] Based on personal communications with General Motors, January 2008.

these same companies have marketed their services to other automakers, and large equipment manufacturers (e.g. Caterpillar, John Deere).

RM does, however, appear to be making inroads into other sectors with large volumes of non-hazardous industrial waste or specialized waste. Known RM customers include refineries, food and beverage processors, and cruise lines[78]. New programs have largely been driven by contractors who market the RM model to their customers, typically large waste generators with high annual waste costs (greater than $1mn).

Seeing the potential of the RM model in the auto sector and other large waste generators, US EPA and several states environmental agencies have sought to test the model in much smaller organizations and in ones with more benign waste streams.[79] Out of these projects, RM has shown promise in K-12 schools, universities, hospitals, retail, hospitality, and other sectors. At least two states have supported pilot RM program development in the past year: Minnesota (Independent School District 196, Mahtomedi School District, and Macalester College) and Massachusetts (Raytheon, Bridgewater State College). The progress of these programs will be important as the annual waste costs or these organizations are as small as $50K and have waste profiles typical of many commercial and institutional organizations.

Illustrative Examples:

US EPA Waste Wise Website	http://www.epa.gov/wastewise/wrr/rm.htm
Massachusetts DEP Website	http://www.mass.gov/dep/recycle/reduce/rmcontr.htm
Minnesota PCA Website	http://proteus.pca.state.mn.us/oea/lc/rmcontracting.cfm

Also see RM reports and case studies at: http://www.ceaconsulting.com/services/resource_management.html.

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[78] Based on personal communications with RM contractor representatives.

[79] For reports and case studies see: http://www.ceaconsulting.com/services/resource_management.html.

Brief #9: Telepresence (high-end videoconferencing)

Description and Value Proposition:

High-end video-conferencing ("telepresence") allows people in different locations to communicate in a simulacrum of "face to face" exchange far superior to that achieved by traditional video-conferencing. This is accomplished via high-quality, high-definition audio and visual feeds, the use of multiple cameras and screens, and specially designed, dedicated rooms.[80]

Telepresence systems are PSS offerings, including as they do room configuration, hardware, installation and maintenance, bandwidth, and control software.

The value propositions to the customer are the avoided costs of travel and the ability to more quickly convene widely dispersed parties. The latter can accelerate strategic decision-making and otherwise improve business response times. While these benefits were promised by traditional video-conferencing, the relatively poor simulacrum of "eye contact" and "face to face exchange" these systems offer has limited the extent to which traditional video-conferencing actually displaces travel.[81]

However, to realize these benefits, potential customers must have sufficient internal demand to offset substantial installation and operation costs. Although prices have been declining (a trend that is projected to continue, both due to competition and technological advances), each individual conference room ranges from $79,000 to $550,000 depending on the company and the number of participants it is designed for, and monthly service fees range from $8,000 to $18,000.

Environmental Performance

In principle, videoconferencing offers a substitute for physical travel. To the extent that it does so, the considerable energy consumption and emissions associated with travel are avoided.

However, the energy and material inputs to the *manufacture* of telepresence systems likewise considerable, as are the energy requirements of the systems *in use*. Thus, in rough terms, the *net* environmental benefits of telepresence as an alternative to travel are the resource and energy savings achieved via travel reductions less the upstream and in-use requirements of the telepresence system.

Environmental savings from travel *increase with the avoided travel distance*, including the distances travelled from home to meeting, and the travel to and from meals, hotels, local sites, etc. They also increase with the portion of the time the videoconference equipment is in-use, as this amortizes upstream and disposal impacts over a larger number of use-minutes. Some indicative results from LCA-based studies follow:

- In a comparison of use-phase impacts (Reichling 2002) finds that videoconferencing requires less energy than travelling to a meeting by air, rail, or car except when very short distances are involved (example: a trip requiring a flight of 1000km consumes 500 times more energy than videoconferencing).

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[80] (Internet video calling provides 2-way voice and visuals on personal computers, normally with one entity supplying the bandwidth and another the equipment.

[81] The *Economist* notes colorfully that "videoconferencing sometimes works so badly that it leaves users feeling alienated, and keener to meet face-to-face than they had been in the first place." ("Far away yet strangely personal: The despised business of videoconferencing is about to get a new lease on life" in the *Economist* 23 Aug 2007.)

- Nakamura et al found that the lifecycle CO_2 “break-even” point for a videoconference system was 13 meetings annually involving 2 participants. (That is, if fewer meetings were held, physical travel was more eco-efficient on a CO_2 basis than videoconferencing. However, if the number of participants or the number of meetings increase from this baseline, videoconferencing becomes markedly more eco-efficient than physical travel.)

- Comparing a sample of actual videoconferences conducted by NTT to the travel that would result had participants attended the meetings in person, (Takahashi et al 2004) estimates that the average conference achieves a 60%-90% reduction in lifecycle CO_2 emissions as compared to physical travel. Again, the result depends on the combined miles that would be travelled by the participants, the mode of transportation they use, and the frequency of use of the videoconference equipment.

  In this and the previous case, Japanese results would be expected to understate environmental benefits in the US context, as business travel in the US involves greater average distances and less use of rail.

- Energy consumption is exponentially less for a video conference as the travel distance for a traditional conference increases past 100km (Stoughton et al 2007).

It should be noted that environmental performance improvements scale directly with the financial savings (that is, avoided travel costs) realized by customers. While airfare is linked to travel distance imperfectly, travel time—and associated labor and per-diem costs—are closely linked to travel distance. Environmental benefits of telepresence are thus tied to a self-reinforcing economic mechanism.

Key Markets and Market Share

As noted, telepresence customers must have sufficient internal demand to justify large installation/acquisition and operations costs.

Current customers are large corporations, especially banks and financial services companies that have widespread (normally international) offices. (Single-office companies are unlikely to need the service.) Current users include, e.g. Price Waterhouse Coopers, Time Warner, Capital One, AOL, Glaxo Smith Kline, Canon, PepsiCo, etc. Frost and Sullivan, a market consultancy, estimate that the corporate sector accounts for 90.3% of the US demand for telepresence.

There are several other sectors that are beginning to show interest and hold promise for future expansion of the customer base. These include luxury hotels, universities, and medical centers. Hotels can meet with their own clients virtually, or offer patrons the same capability. The University of Arizona and Duke University have adopted the technology in order to make classes available to distant students or other schools.

Medical centers also see tremendous value in creating “virtual classrooms” that allow students or teachers to participate from different locations, and get the added benefit of the traditional conference style uses. Clinicians and specialists are also able to use the technology to review cases and adopt or change courses of treatment.[82] (However, both academic and clinical applications may make certain educational or clinical services more widely available, or increase their quality, but it is not clear that they are potentially displacing physical travel.)

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[82] AHA Solutions, Inc., a subsidiary of the American Hospital Association (AHA), recently endorsed Tandberg (equipment provider for the HP Halo Gateway) as its “preferred visual communication solutions” provider. AHA members include 5,000 hospitals and healthcare organizations and 37,000 healthcare professionals.

Cisco, one of the industry leaders, estimates that sales of its telepresence systems will double each year until 2011. One well-cited projection for the industry estimates 56% growth annually, reaching $1.24 billion by 2013 (Frost and Sullivan 2007). BusinessWire reports that as of August 28, 2007 there were 120 HP Halo studios in operation or being installed globally. The HP Halo Collaboration Studio was released in December of 2005 and was one of the first telepresence systems on the market.

Estimating the portion of the US travel market for which telepresence services potentially offer a viable alternative is more difficult. The most immediately relevant sub-market is long-distance intra-office travel within large corporations. The information needed to estimate travel demand in this sub-market is not available, however in 2003 an estimated $174.7 billion was spent on business travel for 37.89 million business person trips.

Illustrative Examples:

HP Halo Collaboration Studio	http://www.hp.com/halo/index.html?jumpid=re_r138/051212xa/Halo
Cisco 1000 and 3000 Telepresence Meeting	http://www.cisco.com/en/US/products/ps7073/products_data_sheet0900aecd80543f46.html
Polycom Viewstation EX	http://www.polycom.com/usa/en/products/video/large_conference_room/large_conference_room.html
Tandberg	http://www.tandberg.com/
Telesuite	

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Brief #10: Third Party Logistics (3PL)

Description and Value Proposition

Third-party logistics (3PL), also referred to as logistics outsourcing or contract logistics, focuses on improving resource utilization and process efficiency in order to reduce costs and improve service. 3PL providers deliver comprehensive logistics-related services, including delivery, storage, inventory, customer service, cargo handling, supply/distribution information systems, etc. 3PL providers are usually not specifically focused on improving environmental performance, but on improving logistics efficiency. Reductions in environmental loads are often achieved as by-products of the efficiency improvements. Strategies intended to reduce fuel consumption and vehicle-miles such as modal shifts, joint delivery, and increased load efficiency also reduce energy consumption and CO_2 emissions.

Logistics outsourcing has been shown to provide substantial economic benefits for the large manufacturing firms that make up the vast majority of 3PL clients. Some of the quantifiable benefits for US companies are listed below (Langeley 2006):

- Reduced logistic costs by 9.9% (11.5% globally)
- Reduced fixed logistics assets by 12.7% (20.0% globally)
- Reduced the average order-cycle length from 11.0 to 8.4 days (12.7 to 9.7 globally)

The same study found that 88% of users believed 3PL providers offered them a competitive advantage, and 62% of the North American users felt these providers implemented "new and innovative ways to improve logistics effectiveness."

Environmental Performance

Although 3PL has the potential to provide environmental benefits, and often does provide those benefits, sustainability goals have not yet become a focus of the industry. According to a 2006 survey only 18% of 3PL providers are pursuing strategies to "go green" by utilizing renewable energy sources. Of that group 69% have only rerouted transportation routes in order to save on fuel costs, 15% are using hybrid vehicles, and 15% have researched solar power options (www.sdcexec.com 2007). An article on 3PLWIRE.com describes the 3PL industry as "behind the curve environmentally."

Despite little specific focus by 3PL providers on environmental performance, they often achieve environmental performance gains for their clients due to increases in overall efficiency of the logistics system, e.g., reduce vehicle-km by optimizing loading and routing. A comprehensive assessment by Facanha and Horvath (2005) estimated the environmental effects that 3PL has had on the automotive industry and then extrapolated those effects to the manufacturing industry. The results are reported as reductions per item manufactured over the *lifetime* of the item, and the ranges given are dependent on the level of involvement of the 3PL provider. The results of the study are summarized below:

- Automobiles: lifecycle energy use is decreased by 0.4%-1.9%, global warming potential (CO2, CH4, N2O, and CFCs) by 0.5%-2.0%, and fatalities by 0.8%-3.3%
- Other manufactured products: lifecycle energy use is decreased by 0.4%-1.7%, global warming potential (CO2, CH4, N2O, and CFCs) by 0.4%-1.9%, and fatalities by 0.7%-2.9%

The above effects are significant (again, note that figures cited are for *total lifecycle performance* and include the use phase of the product) and the potential to achieve even greater environmental performance is frequently cited, because the main goal of 3PL providers is to streamline the supply chain in order to increase efficiency. Increased efficiency almost always leads to a reduction in energy consumption. There is also empirical evidence that suggests logistics competence and environmentally responsible practices are correlated (Facanha and Horvath 2005). If this industry starts to react to the market pressure for sustainable alternatives that is growing in many other industries, then the combination of efficiency and sustainability goals is likely to lead to even greater reductions in environmental loads.

Towards this end, US EPA recently launched its "SmartWay Transport" voluntary program, which the agency describes as "innovative collaboration between the freight industry and government to reduce air pollution and greenhouse gas emissions, improve fuel efficiency, and strengthen the freight sector." Logistics providers are a key class of targeted partner under the program, and a number of 3PL providers participate as partners (US EPA SmartWay Transport website).

It is interesting to note that in Japan, 3PL is being explicitly tied to and promoted as a mechanism to help client companies achieve green house gas reduction targets, developed as part of Japan's strategy to meet its Kyoto Protocol obligations.

Key Markets and Market Share

Large manufacturing companies are the primary clients of 3PLs, and these companies normally purchase a large range of logistics services, from direct transportation to product testing. The automotive industry was the first to use 3PLs on a large scale and remains the most extensive user; according to a 2006 global study 88% of the automotive industry respondents use 3PL services. A 2004 survey of the 500 largest manufacturing firms in the US found that 80% of respondents used 3PL services, up from 38% in 1991. The average user spent 40% of its annual logistics operating budget buying these services. The most common services purchased by these companies are listed below (percentages are the percent of users purchasing those services):

- Direct transportation services 67%
- Customs brokerage 58%
- Freight payment services 54%
- Freight forwarding 46%
- Warehouse management 46%

The reasons that some large manufacturing firms do not employ 3PL providers are varied, but some of the most common are listed below. These are reasons that companies have given and are not necessarily backed by empirical data:

- Logistics is a core competency/expertise of the company
- Costs would not be reduced
- Control would diminish
- 3PL providers do not have the necessary global capabilities

The US 3PL industry has been growing exponentially since the late 1980s. Industry revenue reached $10 billion in 1993, $45 billion in 1999, and $114 billion by 2006. Global revenues in 2006 were $391 billion, with $139 billion coming from Europe (Lloyd’s List 2007).

A major growth area for the industry has been expansion to serve and access international markets, particularly China and Western Europe. The 2004 survey indicated that 80% of US 3PL clients were using the services both domestically and internationally. This is up from 69% in 2003. This expansion has been driven by market demand for single 3PL providers with ‘global capabilities’, although 60% percent of users still employ multiple 3PL providers. The expansion has been achieved with both internal growth and acquisition.

Examples

1stTransport, Inc.	www.1sttransport.com
FedEx	www.fedex.com
DHL	www.dhl.com
United Parcel Service	www.ups.com
Riverside Logistics, Inc.	www.riversidelogs.com

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“US third party sector nets revenue record.” Lloyd’s List. (April 16, 2007).

US EPA “Smartway Transport” website. http://www.epa.gov/smartway/transport/ , accessed 28 August 2008.

Useful “portal” websites:

http://3plstudy.com/index.php?p=home Third Party Logistics Study

http://www.iwla.com/ International Warehouse Logistics Association

http://www.tianet.org/ Transportation Intermediaries Association

6 Toward policy engagement

As outlined in Chapter 3, identification of high-potential business models is a necessary step to fully exploit the environmental benefits of green servicizing. But it is not sufficient. While some of the models identified in this report are well-established in key niches and market segments, the *Business Model Briefs* make clear that none have reached their full market potential—nor is it a foregone conclusion that all will achieve broad adoption. Further, the briefs point out that there are often *greener* and *less green variants* of these models—and experience shows that current market conditions do not necessarily assure that it is the greenest version that grows.

Fully exploiting the environmental benefits of green servicizing therefore requires evaluating the case for and—*where appropriate and feasible*—formulating and implementing policy to help foster market and regulatory environments that would help high-potential "green servicizing" models become business as usual, and would best assure that the "greenest" versions of these models are the ones that grow.

As noted in Chapter 3, policy engagement may involve, but is not uniquely synonymous with, regulatory actions. Support for pilots, development of market information, manuals and information portals, establishing voluntary "green standards" or certifications, and developing voluntary programs and alliances based on these approaches are all important, non-regulatory forms of policy engagement.

There is a long-standing aversion in US policy-making to "picking winners" (whether technologies, enterprises or sectors), rooted in the conviction that this is best left to market forces. It is important to understand that in the context of this report, policy support for green servicizing is (1) not contemplated on the level of individual enterprises, but at the level of business models and value propositions; and (2) is predicated on a clear performance-based criterion: does or can the model offer significant environmental performance improvements over BAU approaches? Both serve to distinguish "green servicing support policy" from "picking winners" as the term is usually understood.

To further assure that policy engagement is—and is seen as—*appropriate*, this report envisions policy engagement as being guided by and generally limited to three well accepted justifications:

1. **Leveling the playing field.** The existing policy regime and market environment, almost by definition, tend to favor BAU approaches. Policies can "level the playing field" by, e.g., reducing information asymmetries, internalizing pollution or other environmental costs, and/or offsetting the advantage that externalized environmental costs may confer on BAU approaches.

2. **Reducing entry barriers.** Market forces are understood to function least effectively at the earliest stages of a new offering, where, for example, customer awareness and information is highly imperfect, financing is scarce for unfamiliar business concepts, and past performance "success stories" are scarce. Policy engagement can address these and other barriers to entry, including the entry of proven models into new customer sectors.

3. **Formal and informal standard-setting.** Standards, whether formal or informal, are essential for markets to function efficiently, and standard-setting usually requires a facilitating actor.

6.1 Needed: information about barriers, drivers and determinants of environmental performance

In most general terms, any policies to exploit the benefits of green servicizing models can be designed to (1) reinforce drivers, (2) reduce barriers, and/or (3) strengthen the determinants of "green" performance of the model in question. Thus, identifying and designing policies requires detailed information about these barriers, drivers and determinants. The briefs presented in the previous chapter treat these issues only in a very general way.

This chapter provides a more in-depth and systematic assessment of drivers, barriers and determinants of environmental performance for three models: Chemical Management Services, Resource Management, and Energy Services (ESCOs). All are "performance-based functional procurement" or "efficiency services" models. They were chosen both (1) because the research results strongly suggest high sustainability potential and (2) to assess the hypotheses that these models share strong similarities in drivers, barriers and value propositions. (If the latter is true, then government policy engagement around these models as a *class* may bring significant synergies and economies.)

6.2 Mapping barriers, drivers and determinants to policy "targets"

For these three models, the analysis is taken one step further: barriers, drivers and determinants of environmental performance are mapped to policy "targets."

Policy targets are not specific policies, but rather a statement of the immediate goal or effect that a policy or policies are intended to achieve. Policy targets have a clear, logical relationship to the barriers, drivers or determinants to which they correspond—they weaken the barrier, reinforce the driver, address the determinant. For example, in recently completed research in the Japanese context, (Stoughton et al 2007) note that:

- The environmental performance of the 3PL model is strongly determined by the environmental performance of 3PL assets such as vehicle fleets and buildings.
- Thus, "Make 3PL assets (including fleets, buildings and siting of facilities) as green as possible" is a policy *target*.
- As an indicative example of a policy that would support this target, they suggest making "existing [Japanese] tax benefits for efficiently sited logistics infrastructure investments contingent on adoption of green building standards."

The identification of policy targets is intended to facilitate US EPA's own evaluation of the case for policy and to indicate the types of policies that may best foster a supportive regulatory and policy environment. To further assist this process, examples of potential policies are provided for many of the targets.

While resources existed to conduct three such analyses only, the process and results presented should be a useful model for similar assessments.

The analysis presented in this chapter does not evaluate the case for policy. And while examples of possible policy measures are provided in many cases, these are intended to be purely indicative. *Recommending* specific policy measures is beyond the intent and scope of this report. Rather, this report is intended to provide critical analysis, concepts, information and tools for US EPA to use in evaluating and undertaking policy engagement, to indicate the focal areas in which these tools and information should be applied, and to suggest key next steps for US EPA to use "green servicizing to aid in decoupling material, energy, water and chemical use from economic growth."

Towards these ends, this chapter is the final "building block" of analysis, concepts, information and tools. Chapter 7 then synthesizes the overall research findings and Chapter 8 provides options and suggestions regarding strategy and next steps for US EPA.

6.3 Analysis: Chemical Management Services

For an overview of the CMS model, refer to Business Model Brief #2 in Chapter 5.

Determinants of environmental performance

As described in the CMS *Brief*, environmental benefits are intrinsic to the CMS model to a significant degree. CMS Customers receive from their providers comprehensive chemical use information (the type of chemicals used, the quantities, where they are used), all of which are linked—at a minimum—to Material Safety Data Sheets (MSDS). Experience shows that this information significantly increases customer awareness of chemical use and leads to strong support for chemical use reduction.

In addition, chemical use often becomes a source of cost to CMS providers, who thus have incentives to reduce it. Beyond these "intrinsic mechanisms," the determinants that will affect and can maximize the environmental benefits of the model include:

1. **The program must first of all have the appropriate scope of services**. For example, some programs simply seek to reduce the unit price of the actual chemical products themselves by outsourcing the procurement function (e.g. "leveraged purchasing"). Programs limited in this way are not "CMS" under the definition used in this report. While they may result in cost savings for the customer, their limited scope precludes the achievement of the full environmental benefits of the CMS model, including reduced chemical use from process efficiency improvements, the substitution of less toxic chemicals, etc.

2. **The inclusion of contract metrics and incentives that explicitly reward environmental improvements.** With a fuller scope of services, the correct metrics and incentives can further maximize the environmental potential of the model.

3. **The inclusion of more detailed health and ecological risk information that goes beyond information in MSDS sheets.** This information can be built into CMS providers' information technology platforms.

4. **The use of CMS providers to introduce the growing number of "green chemistry" products or other environmental best practices.** As each CMS provider has many customers, the deployment of new chemistries and technologies can be more rapidly introduced and implemented.

Drivers and Barriers

Experience over the past decade indicates that the following are key drivers and barriers to uptake of the CMS model:

Table 5: CMS Drives and Barriers

	Drivers to CMS adoption	Barriers to CMS adoption
CMS Customers	*For prospective Customers, CMS programs:* Lower costs. Improve operational efficiencies. Reduce the volume of chemicals used. Improve environmental performance. Provide expertise in logistics, safety, environmental reporting and compliance, particularly in the face of Increasing regulatory complexity/compliance costs (e.g. the European REACH regulations). Are consistent with other business trends (core competency, outsourcing, suppliers as a strategic resource).	Chemicals are a small percentage of overall operating costs. Customers often have a poor understanding of their total chemical lifecycle management costs. Transaction costs to baseline current chemical management costs and processes and develop a CMS RFP and evaluate responses can be high. For prospective customers in sectors where CMS adoption is low, there is a lack of credible information regarding benefits & trackrecord. Resistance to change. Fear of losing process control and internal expertise.
CMS Providers	*For providers, developing CMS offerings:* Can provide a new source of revenues. Forge closer and longer-term relationship with customers. Can provide key intelligence for development of "next generation" chemical products through access to point-of-use in the customer facility.	Poor understanding by customers of their own chemical management costs makes the value proposition difficult to sell. CMS providers who are also manufacturers may have credibility problems; i.e., customer suspicion that they will use the program simply as a platform to push their own products. Narrower chemical-management (CM) related market offerings such as stand alone CM software or leveraged chemical purchasing can divert customers from more comprehensive CMS offerings. The CMS RfP process is inefficient, often taking 6-12 months, and there is no guarantee a contract will be awarded. In mature CMS programs, providers can find it difficult to deliver the "continuous improvement" demanded by most contracts; mature programs may become increasingly low-margin.

Policy targets (Intermediate objectives)

CMS providers can serve as a high-leverage vector for policy that seeks to promote green chemical use practices. That is, a dozen or so CMS providers can reach hundreds of end-user companies. This consideration, and the drivers, barriers and major determinants of environmental performance presented above suggest the following policy targets. They focus principally on shaping CMS programs to strengthen the determinants of "green performance" and on reducing the barriers to adoption of CMS; both should strengthen CMS as a high-leverage mechanism to disseminate green chemical practices and chemistry.

- **Accelerate substitution of green products** (e.g., by providing a clearinghouse for new green chemical products.)
- **Standardize environmental metrics and incentives customers will adopt in programs and assure that these metrics and incentives reflect US EPA priorities.** (For example, "best practice" CMS programs might measure chemical use reduction and the reduction of certain

toxic chemicals and provide significant positive incentives to the CMS provider to reward meeting pre-established targets.)

- **Educate and "break open" new sectors for CMS through better environmental cost accounting around chemical lifecycle costs.** For example, US EPA has promoted CMS in the K-12 school context and this model can be replicated into other sectors.

- **Support environmental performance improvements under CMS** through award or recognition programs (perhaps tie to existing US EPA programs).

- **Increase awareness of CMS and its benefits.** This could be done through case studies, workshops, targeted outreach to specific sectors, establishing peer-to-peer networks, etc.

It should also be noted that CMS is in substantial part a logistics service, and as such embodies many of the potential environmental benefits of 3PL, e.g. CO2 reductions via streamlined logistics. Any policy developed to maximize these benefits under 3PL should also be examined for application to the CMS sector.

6.4 Analysis: Resource Management

For an overview of the Resource Management model, refer to Business Model Brief # 8 in Chapter 5.

Determinants of environmental performance

The core idea and objective of RM is a re-orientation and re-conceptualization of "waste management services" wherein the "reduce, reuse, recycle" hierarchy is implemented as a core contractual objective and source of profit, thereby obtaining the greatest utility from *resources* after their initial useful life is over. The highest level of the hierarchy, reduce, requires considerations around procurement itself. Environmental benefits flow directly from the implementation of the "3R" hierarchy.

The primary determinants of the environmental performance of the RM model in any particular case are the complexity of the waste streams of a given organization, the infrastructure available within an economic distance to support reuse and recycling of these materials, the ability to influence an organization's procurement, and the ability of a service provider to offer innovative solutions for problematic waste streams in a cost-effective manner. The ability to realize environmental benefits will further depend on:

1. **Access and scope of services sufficient that the supplier has the ability to change processes/BAU at the point of waste generation.** Customers must provide access to their data and facilities so suppliers can initiate audits and target appropriate materials. The customers themselves then must work with suppliers to implement new recycling or source reduction programs.

2. **The existence of cost-effective opportunities to reduce waste, boost recycling, and otherwise optimize waste-related services.** Few companies are willing to pay much more to move their waste stream up the 3R hierarchy unless they are very committed to sustainability or have other internal drivers that allow for cost increases. (The fact that the customer company has not already exploited such opportunities does *not* mean that they do not exist. A key part of the suppliers' value-added is the specialist expertise and direct incentive to identify, evaluate or implement opportunities.)

3. **The existence of contractual incentives that provide significant financial benefit to the supplier as it moves waste management up the 3R hierarchy.** This is critical both in

incentivizing the supplier to be the driving force behind 3R activities and fund themselves from cost savings through contract incentives.

Drivers and Barriers

A key challenge to RM contracting lies in the fact that the cost-effectiveness of recycling vs. disposal for most materials is locally or regionally determined by available recycling infrastructure, disposal costs and regulations, and demand for the resulting materials.

With this fundamental reality in mind, experience indicates that the following are key drivers and barriers to uptake of the RM model at the company/institution or site level:

Table 6: Resource Management Drives and Barriers

	Drivers to RM adoption	Barriers to RM adoption
RM Customers	*For prospective customers, RM can* Help meet waste reduction or sustainability goals/commitments, whatever their origin. (E.g. such goals/commitments may arise from stakeholder pressure—employees, regulatory agencies, customers, from leadership commitments to environmental stewardship, etc.). Reduce operating costs—or, at a minimum, provide a means to meet waste reduction goals/commitments without increasing costs. Reduce risks and liability (for hazardous and industrial non-hazardous waste streams).	Waste/recycling does not readily get management attention (particularly as it is often a low percentage of overall costs). Lack of awareness of RM potential and the value-added services that are available under RM programs. Poor understanding of true waste and recyling costs and waste stream composition. A highly dispersed waste and recycling supplier market with limited capability to supply RM services at national scale and in certain customer segments. Lack of contracting expertise (especially in mid size and small companies where waste contractng is handled by operational personnel).
RM Suppliers	*For waste management providers, developing RM offerings can:* Provide a means to diversify revenue. Serve to differentiate them from their competitors in the waste management industry. Secure longer term contracts and reduce customer turnover. Provide a "growth channel" within existing customers, as RM leads to an increased knowledge of customer operations, which can lead the provider to propose additional services.	Economies of scale are important: RM suppliers currently focus on large waste generators due to larger waste volumes. Reducing the volume of waste destined for disposal may pose an internal conflict of interest for waste management companies that own assetts such as landfills, incinerators, etc. A waste management and recyling sales force accustomed to selling and negotiating on a unit cost/volume basis (e.g. cost per container pull on a specified schedule), can have difficulties in selling RM offerings based on more comprehensive services and on-site assistance, and embodying very different compensation schemes.

As noted in the table, RM can pose an internal conflict of interest for companies that own landfills, as their primary financial incentive as a company may be to "feed the hole." Beyond this, another problematic financial incentive can arise between companies in the waste management sector: Often, companies that own waste and recycling assets can greatly determine the local economics of recycling and diversion by what they charge haulers/RMs to bring material to their end use facilities (landfills, material recovery facilities, etc.). This is particularly true in markets where a single company owns the majority of waste and recycling assets. Often the result is that landfilling remains the most financially attractive disposition option.

Policy targets (Intermediate policy objectives)

Continued development of recycled material markets and recycling infrastructure is critical to the development of RM itself, since this will expand the cost-effective opportunities available to RM suppliers to move management of their customers' wastes up the 3R hierarchy. US EPA and state governments are already significantly engaged in this area.

Beyond this larger question of recycling market development, the drivers, barriers and major determinants of environmental performance presented above suggest the following policy targets specifically for the RM model:

- **Build supplier capability to provide RM services.** Most companies within the waste and recycling industry are focused on "haul and remove" and thus compete with each other (and make sales) on a unit cost/volume basis. RM provides an opportunity for forward thinking companies to develop increased revenues through value-added services.

  US EPA could, for example, undertake outreach to forward thinking haulers, recyclers and waste companies to raise their awareness of this new value proposition and how to offer it profitably. To do this, US EPA would need to first understand current supplier capability. Such an initiative could tap successful RM suppliers as a resource for peer to peer networks to help educate new potential RM suppliers—though only so long as the companies operate in non-overlapping markets.

- **Increase awareness of the model among potential customers.** This could include successful case studies as well as the dissemination of contracting assistance tools and a list of qualified RMs.

- **Reduce transaction costs of key knowledge acquisition for RM suppliers.** For many current and potential RM suppliers, the need to become expert in waste and recycling markets and the use of products made of recycled materials is a substantial barrier to entry/expansion, and one which becomes larger as the potential service area grows.

  To reduce this barrier, US EPA could, for example, serve as a technical clearinghouse for such information. As a first step, this would include compiling many of existing state level information and recycling market development studies. A key challenge would be to keep the information current, as many recycling markets are highly volatile.

- **Test cooperative approaches to achieve necessary economies of scale.** RM requires sufficient material volume to make many diversion options cost-effective, and this means that many smaller facilities cannot currently benefit from the model. US EPA can support/facilitate pilot approaches in which smaller sites to form cooperatives to achieve the necessary economies of scale.

- **Leverage materials aggregation potential of RM suppliers to address gaps in recycling infrastructure.** Regional gaps in recycling infrastructure are a barrier to RM growth—for example, there are a very limited number of composting facilities in the US, with significant gaps in regional coverage. At the same time, limited supply of diverted materials is a barrier to infrastructure development. RM suppliers, however, have the effect of aggregating a number of different waste generators, and can rapidly increase the supply of diverted material where the infrastructure exists.

  To take advantage of this potential, US EPA could engage in a dialogue with RM providers to obtain a better understanding of key recycling infrastructure gaps. US EPA could then facilitate the process of determining where RM suppliers may be able to guarantee critical volume of diverted materials to make new facilities viable. In principle, this approach could be used with both large-volume/low toxicity waste streams such as organics and with more problematic waste streams.

6.5 Analysis: ESCO model

For an overview of the Energy Services Contracting model, refer to Business Model Brief #4 in Chapter 5.

Determinants of environmental performance

The source of environmental performance gains offered by the ESCO model is straightforward: the value proposition and the business case for each contract rely on reduced energy usage, with 73% of ESCO sector revenues deriving from energy efficiency projects (Hopper et al 2007).

Efficiency gains (and thus environmental benefits) delivered by ESCOs depend significantly on the degree to which contracts (1) incentivize the ESCO to aggressively seek efficiency improvements on an ongoing basis, and (2) accommodate extended "crediting" of efficiency gains. In addition, efficiency gains also depend significantly on:

- **Energy prices & costs of emissions.** Sustained higher energy prices incentivize customers to reduce energy costs (and thus to seek ESCO services)—but they also strengthen the business case for efficiency upgrade options that are not economical when energy prices are lower. Similarly, if GHG emissions have a firm cost, or if emissions reductions are marketable, then the business case for efficiency upgrade options likewise strengthens.

- **Costs of capital.** Bundled financing, in which the capital costs of energy efficiency upgrades are paid for out of energy savings is a key benefit/attraction to many institutional ESCO customers. As capital costs increase, the business case for many energy efficiency options correspondingly weakens. Overall energy efficiency gains are likely to fall as a result.

- **Scope of services.** Analogous to RM and CMS, the broader the scope of energy-using applications that an ESCO is given license to address, the larger the potential energy savings. (Thus, an ESCO whose remit extends, e.g., to lighting and HVAC, but not to industrial motors or water treatment may not be able to achieve the full, economically efficient set of energy efficiency gains available from a facility.)

- **Expertise of the ESCO.** The more expansive the scope of services, the broader the expertise required of the ESCO (or the team the ESCO assembles). Insufficient ESCO/team capability means that the full, economically efficient set of energy efficiency gains available from a facility will likely not be achieved.

Drivers and Barriers

There are two primary drivers for all market segments:

- **Cost reductions in the face of rising energy costs.** ESCOs trace their start in the 1970's to the sudden rise in energy prices during that period, and the ability to achieve absolute cost reductions continue to be a primary driver for the model—particularly in view of recent sharp rises in fuel and electricity prices.

- **A resurgent concern over environmental impacts of energy use,** including climate change and the impacts of non-GHG emissions such as NOx, SOx, particulates and Mercury from power plants, boilers, etc. While ESCO revenues to date have largely relied on energy efficiency retrofits in the Federal/MUSH markets, trends in green building improvements and a strong interest in developing renewable energy sources is expected to contribute to more diversified revenue streams and growth of the ESCO sector. For example, the Leadership in Energy and Environmental Design (LEED) standards are contributing to significant consideration and adoption of energy efficient design methods and the use of renewable energy in new and existing buildings.

In addition, the federal and MUSH segments have some additional drivers that have fuelled growth in these segments. The first is the Federal Energy Savings Performance Contract (ESPC) authorization, renewed and extended through 2016 by the Energy Policy Act of 2005. This encourages federal agencies to use ESCOs and allows for the longer term contracts required to recoup savings from ESCO funded projects. Additionally, the 2005 Energy Policy Act set goals to: a) cut federal facilities energy use (compared to 2003) by 2% per year in 2006 through 2015 and; b) increase use of renewable energy to not less than 3% of total electricity use in 2007-2009, not less than 5% in 2010-2012, and not less than 7.5% in 2013 and thereafter.

As suggested by the discussion of “determinants of environmental performance,” above, the current tightness of credit market is a general barrier to ESCO projects requiring long-term financing. The barriers to the adoption of ESCOs contracts by specific customers sectors are outlined below.

- **Federal and MUSH market**: The Federal and MUSH (municipal and state governments, universities, schools and hospitals) segments are where the majority of ESCO activity lies (with 80% of revenues) and at least prior to the current economic slowdown, expectations amongst ESCO companies for growth in these segments were quite bullish, with estimates of greater than 20% growth in 2008[83].

  This is not to say that barriers do not exist in this sector, but they center on introducing the model and establishing the contract in compliance with all government purchasing guidelines where appropriate. These are typical sales hurdles for many service companies. It is worth noting that growth was very sluggish when the ESPC authorization expired in 2003 which suggests the importance of specific authorization for federal agencies to enter into long term performance contracts.

- **Industrial market:** The industrial and commercial segments account for 15% of ESCO revenues. The major barriers acting against higher ESCO market penetration in the industrial segment are a set of characteristics intrinsic to industrial customers. These customers: often have the expertise to do energy efficiency projects in-house; have high investment hurdle rates (i.e., they require quick payback or high rates of return); often accord low priority to energy efficiency projects compared to investments with a more direct impact on sales or production; are hesitant to allow outside providers access to core production processes—both for fear of ceding proprietary competitive advantage and because industrial customers consider the process and its control a core competency. In addition, ESCO providers often lack the specific process knowledge needed to address the needs of a given industrial facility.

- **Commercial:** The most important barriers to ESCO growth in this market segment revolve around the split financial incentives intrinsic to owner-tenant relationships. Briefly, while owners of buildings are responsible for making capital investments, operating expenses (e.g. lighting and heat) are generally the responsibility of the tenants. This limits interest by building owners in long-term performance contracts. Other barriers include short tenant leases, high investment hurdle rates for non-owner occupied commercial space and the unwillingness of

[83] Hopper, Nicole, Charles Goldman, Donald Gilligan and Terry E. Singer. “A Survey of the U.S. ESCO Industry: Market Growth and Development from 2000-2006”. Energy Analysis Department, Ernest Orlando Lawrence Berkeley National Laboratory (May 2007).

some owners to take on long term debt, which may limit their ability to sell or "flip" their real estate asset.

- **Residential and public housing:** The most important barrier to ESCO growth in this market segment, which currently accounts for about 5% of ESCO revenues, is achieving feasible economies of scale in individual projects. Individual residential units (or the "common space and services" of public and private housing developments) typically consume much less energy than large institutions and campuses. The high transaction costs of creating individual performance based contracts with individual home owners may not be immediately off-set with the energy savings, especially if the payback period is long and individual homeowners are unsure of how long they will stay in their home.

Policy targets (Intermediate objectives)

It is important to note that, of the "green servicizing" models profiled in this report, the ESCO model is probably the most mature. ESCOs have a 30-year history, and ESCO offerings are well-established in both the Federal and MUSH market segments, where ESCOs have a proven track record of developing comprehensive projects that utilize energy efficiency, onsite generation and renewable energy technology (Hopper et al 2007). And as noted above, there is already very specific federal policy engagement with the ESCO model, in the form of statutory authorization for Federal entities to enter into long-term energy performance contracts.

This said, some of the barriers to long-term performance contracts in key energy-consuming market segments outlined above are likely intrinsic to these segments, and such contracts may not be the optimal mechanism to deliver energy efficiency services to these market segments.

The discussion above, these considerations and the dynamic state of energy related services generally suggest the following policy targets:

- **Enhance access to and reduce cost of capital for energy efficiency investments.** As noted above, the costs of capital to undertake energy efficiency investments is a critical determinant of the environmental performance gains that ESCOs can deliver. This is particularly critical in tight credit markets.

- **Promote environmental co-benefits of energy efficiency improvements**. As noted above, the core of the ESCO value proposition is cost savings via energy efficiency gains. But these efficiency gains are typically delivered hand-in-hand with emissions reductions (including CO2, SOx, NOx, Mercury and particulates), which may have tangible bottom-line, public relations, and regulatory compliance/cost benefits. (E.g. they could affect air emissions permits, major/minor source designations, etc.)

  Case studies are one way to document and promote these benefits. US EPA could also consult with ESCO providers to determine whether any unintentional regulatory or policy barriers exist to fully realizing these co-benefits, and consider appropriate policy changes or regulatory flexibility.

- **Identify and leverage ESCO capability in the context of a rapidly changing energy services landscape.** As noted, ESCOs have a proven track record of developing comprehensive projects that utilize energy efficiency, onsite generation and renewable energy technology, particularly in their core markets. In these markets, ESCOs are high-leverage vehicle for disseminating cutting-edge energy efficiency technologies and practices. At the same time, private equity interest in renewable energy and greenhouse gas mitigation projects as well as in numerous companies in the green design industry is radically changing the energy services field.

This suggests the need for a stock-taking broader than the series of ESCO market surveys commissioned by DOE (of which Hopper et al 2007 is the most recent). Such a stock-taking would seek to (1) first evaluate the current state of the ESCO market in the context of the broader market for energy services and energy efficiency; and then (2) to ask critical questions such as which technologies and markets ESCOSs can best reach, and which are best approached through other market intermediaries (lighting and HVAC contractors, engineering firms, original equipment manufacturers, architects and consultants) and policy approaches (standards, codes); and (3) whether there may be significant synergies to be obtained through networks of ESCOs and other energy related companies serving the industrial, commercial and residential market segments.

- **Encourage private-sector investment (implemented via ESCOs and other energy efficiency services providers) in green buildings and clean energy options (such as renewable generation technologies).** In 2006, the private sector investments leveraged by ESCOs is about the same as authorized spending for all utility and public benefit energy efficiency programs (Hopper et al, 2007). This is a significant addition to the promotion of energy efficiency and should be fully exploited.

Policy for "Green Servicizing" in some peer economies

Outside the US, there has been significant policy engagement in "green servicizing" in some key peer economies/regions. This box provides a high level summary of this engagement.

Europe

A number of European countries have promoted specific "Green Servicizing" models, and these experiences are too many and too varied to summarize here.

As described in Chapter 2, the European Commission (EC) made a significant investment in PSS research under the 5th Framework Program (FP5). At the European level, interest in PSSs has not so much waned as merged into the broader "sustainable consumption and production" research and policy agenda, with an emphasis on the integration of infrastructure, economic activity and consumer behavior. This is evidenced, for example, in the fact that the literature archive of SusProNet, the coordinating network for the FP5 PSS research, is now housed on the Score! (Sustainable Consumption Research Exchange) website at www.score-network.org. Sustainable Consumption and Production research has received significant EU funding under the current (FP6) framework program.

Separately, the EC's Environment Directorate recently funded as study of "new business models with environmental benefits," with the aim of identifying factors for success and to "inform discussion of policy that could promote business models that both reduce environmental impact and generate profit." The research was undertaken by the Danish consultancy COWI; an expert's workshop to review preliminary results was held 30 May 2008 and the final paper published in November 2008 (EC-DG Environment/COWI, 2008). All the models reviewed are PSSs, and there is a significant emphasis on functional procurement/efficiency services models.

Japan

The Ministry of Economy, Trade and Industry (METI) has commissioned formal studies and a consultation committees on "Green Servicizing." METI provides start-up grant support to a limited number of SME-led "Green Servicizing" businesses, selected on a nationally competitive basis.

At the national level, Japan has promoted the ESCO, 3PL and car-sharing models. 3PL (with a focus on EV and advanced vehicle deployment and tie in to eco-city initiatives. 3PL providers are increasingly tieing their offerings to helping clients achieve GHG reduction obligations under the Kyoto Protocol. Car-sharing was actively promotoed in the context of eco-town initiatives, and tied to EV and clean vehicle deployment..

In addition to these national initiatives, there have been support for specific green servicizinging businesses at the local level, also often tied to eco-town initiatives.

Japan has mandated take-back for some white goods and for computers, monitors and printers. Recycling targets have also been established for a number of other goods. Deconstruction is also effectively mandated, tied to recycling requirements for construction and demolition waste.

South Korea

South Korean policy engagement with "green servicizing' dates back to at least 1991, when the Rational Energy Utilization Act was amended preparatory to providing preferential credit for ESCO projects. Long-term and low-interest government loans for ESCO projects were initiated in 1993 and public sector demostration projects in 1998—the latter requiring amendment of the public procurement law to permit energy services performance contracts. Policy engagement was managed by the the Ministry of Commerce, Industry and Energy, since 2008 called the Ministry of Knoweldge Economy (MKE) (Lee et al 2003).

Since 20007, MKE, via the Korea National Cleaner Production Center, has been implementing a multi-year "sustainable product services" (SPS) initiative. To date, this has included support for 11 SPS projects, including CMS and sharing and rental-based business models. A definition of "product servicizing business" has been written into law, as part of the framework "Legislation Promoting the Shift to an Environment-Friendly Industrial Structure."

In 2008, the Ministry of Land, Transport and Maritime Affairs(MLTMA) announced an action plan for greening logistics, with a signficant focus on 3PL. In 2009, MLTMA has announced it will introduce the "Green Logistics Partnership" and and a "Green Logistics Certificate," linked to South Korea's LCGG(Low Carbon Green Growth) policy goal (Kim 2009).

7 Key Findings

Syntheses and comparative analysis across the 10 models yield a set of key findings. While this research was subject to some key limitations—i.e., it was generally limited to environmental and business performance information in the public domain, and it was not possible to undertake a systematic "scan" of the US economy for green servicizing models—these findings emerge sufficiently strongly that it is highly likely they will prove robust to the results of more detailed information-gathering and analysis at the sectoral, model or mechanism level.

1. Real and significant eco-efficiency gains.
Review of the *environmental performance* sections of the business briefs reveals that, while the quality of quantitative environmental performance data varies significantly across the 10 green servicizing business models, all the models can produce significant eco-efficiency improvements over BAU (see Table 7, next page). *This is significant because the models provide alternatives to the BAU delivery of environmentally critical economic functions and products.* The implication is that at their full market potential, these models possess significant potential to improve the eco-efficiency of the overall economy.

This is consistent with key findings of research outside the US, which indicate that while servicizing *generally* is not necessarily green, certain models can be strongly so, and these are clustered under results-oriented models. (See discussion in Chapter 2.)

2. Scope and need for policy engagement.
The business briefs and the more detailed analyses of barriers, drivers and determinants of environmental performance conducted for three functional procurement/efficiency services models indicates that there is scope for—and at least in some cases strongly suggests the *need* for—policy engagement to achieve this potential:

- **Without policy engagement, adoption of green servicizing models is likely to be slower.** For example, poor market information and lack of a performance track record are typical barriers to market adoption for new models and for existing models trying to enter new customer sectors. These issues appear, for example, in the CMS, RM and IPM briefs. Absent supported pilots, case studies, and/or similar policy engagement, the efforts of individual provider companies alone tend to overcome these barriers only slowly.

  Policy engagement needs are not limited to information dissemination and supported pilots. For example, car-sharing success depends on strategically located parking spaces. Such spaces are also a significant business cost (if available at all), particularly on and near the campuses and in the dense urban areas that are the model's key markets. Policy engagement could, for example, make publicly-owned spaces available to car-share operations at concessionary rates; private entities may be more willing to dedicate spaces they control if doing so results in a tax benefit, public recognition, or other benefit.

- **Without policy engagement, it may not be the greenest version of these models that become market standards.** For example, the experience of CMS is that "leveraged purchasing" programs compete with CMS in the marketplace—and in fact are often labeled as CMS, though they do not possess the "green drivers" that CMS programs do.

  The 3PL brief highlights that the 3PL model has significant *potential* to drive greenhouse gas reductions from the transport sector, and that the model is in fact being tapped for this purpose outside the US. However, in the US, this potential has thus far been little operationalized in practice.

Table 7: Green Servicizing Models: Environmental Performance Summary

CAR SHARING

Reduced vehicle miles travelled (VMT) per customer:
Car-share members reduced VMT by 44% across several studies. According to a ZipCar survey, car-share members increase public transit trips by 47%, increase bike trips by 10%, and increase walking trips by 26%.

Reduced total vehicles/service population:
Every US car-share vehicle "removes" between 6 and 23 vehicles from the road, depending on the study.

Cleaner vehicles:
30% of US car-share vehicles are hybrids or alternative fuels vehicles.

CHEMICAL MANAGEMENT SERVICES (CMS)

Improved Environmental Data:
100% of CMS customers reported improved environmental data.

Reduced Total Amount of Chemicals Being Applied:
Over 50% of CMS customers reported reductions in total chemicals being applied.

Increased Recycling/Reusing of Chemicals:
Over 45% of CMS customers reported increased chemical reuse/recycling.

Technological Process Efficiencies & Chemical substitutions
Over 30% of CMS customers reported increased process efficiencies; approximately the same number reported beneficial chemical substitutions.

(Data from the Chemical Strategies Partnership's *2004 CMS Industry Report.)*

DECONSTRUCTION

Recovery of Waste for Reuse and Recycling:
Deconstruction has the potential to reduce the materials sent to incinerators and landfills and alleviate demand on virgin materials. According to the Institute for Local Self-Reliance, US deconstruction could recover an estimated 24 million tons of Construction and Demolition (C&D) waste for reuse and another 6 million tons for recycling. This represents a 46% total recovery rate.

ENERGY SERVICES COMPANIES (ESCOs)

Reduced Energy Consumption:
According to a review of the ESCO industry completed by the Berkeley National Laboratory, ESCO projects on average reduce energy consumption by 23% or 47 kWh/m^2/yr. Using US EPA's Emissions & Generation Resource Integrated Database, this corresponds to average reductions of 67.42 lbs of CO2/ m^2/yr, 0.34 lbs of NOx/m2/year, and 0.15 lbs of SO2/ m^2/year.

Reduced Water Consumption:
A small percentage of ESCO projects also reduce water consumption.

INTEGRATED PEST MANAGEMENT SERVICES

Reductions in the Use, Toxicity, and Dispersion of Pesticides:
Multiple case studies have shown that IPM can achieve significant reductions in pesticide use, toxicity, and dispersion, with reductions as high as 93% in grams of pesticide active ingredients applied.

IT LIFECYCLE SOLUTIONS

Reduced Incidence of Improper Disposal and Uncontrolled Recycling:
End-of-lease responsibilities are placed on the equipment provider, which is much more likely than individual customers to have appropriate disposal and recycling practices in place.

Increased Reuse, Recycling, and Parts Salvaging:
Providers have a strong financial incentive to reuse, recycle, or salvage the equipment they lease. According to one study, enhanced recovery and re-lease may together reduce PC lifecycle impacts by ~50%.

RESOURCE MANAGEMENT (RM)

Increased Reuse, Recycling, and Overall Waste Minimization:
RM moves waste management up the 3R hierarchy, and more truly makes disposal the waste management option of last resort. For example, GM, which pioneered the model, realized an average reduction of 20% in overall waste generation, a 65% increase in recycling, and a 60% decrease in disposal tonnage across 50 North American plants.

REMANUFACTURING

Reduced Energy Consumption:
One landmark study calculated that remanufacturing in the US requires on average 85% less energy than manufacturing a new product. Using US EPA's Emissions & Generation Resource Integrated Database, this corresponds to savings of about 35bn kWh or ap. 47bn lbs of CO_2, 73mn lbs of NOx, and 190mn lbs of SO_2 in avoided air emissions.

Reduced Need for Raw Materials:
Remanufacturing also uses fewer virgin raw materials than manufacturing "from scratch." One study estimated in the US over 14 million tons of raw materials are saved annually by remanufacturing.

TELEPRESENCE

Reduced Physical Travel & Associated Energy Consumption:
Studies indicate substantial CO2 reductions on average compared to physical travel & that savings increase with avoided travel distance; e.g. an NTT study of actual videoconferences in Japan estimated 60%-90% reductions in lifecycle CO2 emissions as compared to physical travel.

THIRD PARTY LOGISTICS (3PL)

Reduced Energy Consumption:
The logistics efficiency improvements achieved by 3PL tend to improve logistics *energy* efficiency, even without specific "green" contract incentives. In the case of automobiles, these incidental gains are estimated at 0.5–2% of *lifecycle* CO2 emissions (including use phase).

Source: Business Model Briefs, Chapter 5.

As these examples show, and as highlighted in Chapter 3, policy engagement can involve, but is not uniquely synonymous with, regulatory actions. Support for pilots, development of market information, manuals and information portals, establishing voluntary "green standards" or certifications, and developing voluntary programs and alliances based on these approaches are important forms of policy engagement.

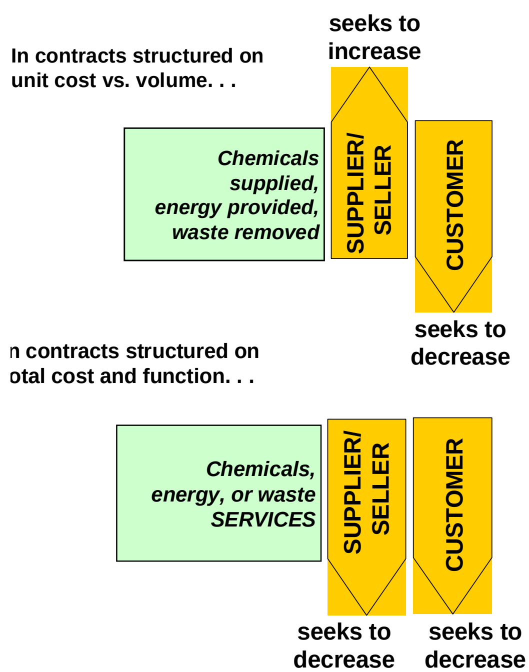
And, as discussed in Chapter 6, such policy engagement should not be burdened with the label of "picking winners," since policy support (1) is not contemplated on the level of individual enterprises, but at the level of business models and value propositions, and (2) would be predicated on a clear performance-based criterion: does or can the model offer significant environmental performance improvements over BAU approaches? Further, it would conform to well-accepted justifications for policy action: leveling the playing field, reducing entry barriers, and standards-setting.

3. Special potential of performance-based "functional procurement"/"efficiency services" models

Of the 10 models selected, half are "functional procurement/efficiency services" models. These include: CMS, RM, performance-based Energy Services (ESCOs), 3PL, and IPM-based pest management services.

These models were selected because, in principle, they can transform the procurement of environmentally problematic goods and services into performance-based service arrangements—and in so doing, incentivize the service provider to reduce the customer's consumption of the environmentally problematic good or service in question (see Figure 7). Collectively, these models address the majority of most organizations' environmental footprints.

Figure 7: Aligning economic incentives for use reduction in efficiency services models



Overall, the findings reinforce the idea that, as a class, performance-based functional procurement/efficiency services models have high potential to achieve very significant eco-efficiency improvements in critical economic functions and sectors:

- Good market and environmental performance information is available for CMS and ESCO offerings, and this information indicates both strong market potential *and* that their environmental performance improvement mechanism is being strongly operationalized.

- Good market information is available for 3PL. While 3PL's ability to drive down distribution-related CO2 emissions has not been an explicit focus of 3PL in the US context to date, experience outside the US (e.g. Japan), shows that 3PL can be implemented with just such a focus, although in the US implementation should consider a range of environmental results to ensure unintended consequences do not arise.

- CMS, ESCOs and 3PL are "business as usual" (or almost) in their core markets, though all have substantial room for growth, either within these core markets or in new market segments. Resource Management and structural IPM services, by contrast, are far earlier on the adoption curve, but both have consistently demonstrated strong environmental results in the context of profitable business offerings.

- Agricultural IPM services are embryonic, though US offerings do exist that provide proof-of-concept. (Additional examples exist in the European literature.)

- These eco-efficiency gains that can be delivered by these models are high-value and high-leverage as these models act high on the "3R" hierarchy, functioning as *reducing* agents that shrink the size of the material and energy cycle required to service a given level of economic activity.

4. Strong parallels between different performance-based "functional procurement"/"efficiency services" models

As described immediately above, performance-based functional procurement/efficiency service models possess, by definition, substantially similar "greening mechanisms" and value propositions. Beyond this, the more detailed assessment of barriers, drivers and determinants of environmental performance conducted for the CMS, RM and ESCO models showed strong parallels in these areas as well.

For example, for all three models, the following are critical determinants of environmental performance:

- **Contracts that strongly operationalize incentives** for the provider to find eco-efficiency improvement opportunities via the performance measures and compensation mechanisms they establish.

- **Sufficient contract scope** to enable the provider to address critical eco-efficiency improvement opportunities and sufficient scale of operations to enable efficiency gains to pay for the cost of the provider's value-added services.

- **Sufficient provider expertise/capability** to identify and exploit improvement opportunities.

In addition, barriers to performance-based contracting (whether institutional, legal, or perceptual) are a key barrier for each model. All face competition from superficially similar offerings that operationalize far less strongly (if at all) incentives for reduction in the consumption of the environmentally problematic good or service in question. CMS and RM share common barriers to growth in the area of "information deficits" such as customer knowledge of total costs, availability of trusted information regarding the model and contracting norms, etc.

A reasonable working hypothesis is that these similarities would extend to other models in this class, and this is suggested by the more limited information regarding drivers, determinants and barriers that is contained in the business briefs themselves.

5. Inadequacy of economic information

The research highlighted a basic gap in official economic data and statistics: despite recent progress in the treatment of services, these statistics continue to divide the economy into distinct "product" and "service" sectors, and generally do not characterize how combinations of products and services are packaged as value propositions.

From US EPA's perspective, this gap is critical as product-service systems are key determinants of environmental performance of the economy as a whole. Moreover, understanding how products and services combine to produce value—and how this combination is changing over time—can be critical to understanding issues and trends in economic competitiveness, structural economic change, and other fundamental concerns of *economic policy*. In not capturing PSS and servicizing activity in the economy, current official economic data can handicap not only environmental policy, but other key areas of policy making as well.

8 Realizing the Potential of Green Servicizing: Key considerations and possible next steps for US EPA

It is unlikely that high-potential “green servicizing” models are limited to those identified and briefed in this report. But even if they were, “green servicizing” would *still* have strong potential to green the US economy. The research in this report strongly suggests, however, that this potential will only be reached fully and expeditiously with appropriate policy engagement.

On this basis, it is important that US EPA consider:

- **Committing to a policy of leveraging and fostering high-potential “green servicizing” models for a more sustainable US economy.**
- As a first initiative under this policy, **developing and implementing a strategy whose objective is to achieve the full eco-efficiency potential of functional procurement/efficiency services in the US economy** by:

  Assuring that the greenest version of the models become market standards; and

  Accelerating the adoption of these models in key/high impact sectors.

8.1 The need for focus

Why a more limited “first initiative”? As indicated by this report, “green servicizing” covers a wide range of sectors and economic activity. Yet, at the same time, policy engagement must be predicated on a detailed understanding of *both* (1) model environmental performance and its determinants and (2) drivers and barriers. The former is known to be highly case- and model-specific (see Section 2.4); regarding the latter, information regarding value propositions and drivers and barriers in the briefs also shows high diversity. Thus, successful policy engagement requires model-by-model consideration. At the same time, however, US EPA resources are limited, particularly for discretionary policy initiatives. This strongly suggests the need for a narrower focus within the “green servicizing” area.

8.2 Why focus first on functional procurement/ efficiency services models?

Why focus a first initiative on functional procurement/efficiency services? Several factors combine to make this class of models the appropriate target:

Greening potential. As noted, the research strongly suggests that *as a class*, performance-based functional procurement/efficiency services models have high potential to achieve very significant eco-efficiency improvements across a set of critical economic functions and sectors. Together, these functions and sectors constitute much of the critical “environmental footprint” of the economy as a whole (and of many individual facilities).

Again, these eco-efficiency gains flow directly from the structure of these models and the value propositions they embody. These gains are high-value/high-leverage since these models act high on the “3R” hierarchy. These models also help to operationalize “sustainable infrastructure” concepts (see box, following page).

Playing to economic strengths, addressing key economic issues. Such a strategy would play to one of the core strengths and capabilities of the US business-to-business (B2B) sector—widespread and highly sophisticated use of third-party technical services to reduce costs and maximize flexibility.

Critically, in a economic context in which the use of such services goes hand-in-hand with concerns regarding the erosion of the domestic employment base at all levels (e.g. "offshoring"), these models generally do not incur these social costs and concerns. First, the services they provide *must be delivered on-site.* Second, these services support skilled "efficiency professionals" whose salaries are ultimately paid from the efficiency gains they deliver to the client. These services directly support the competitiveness of their customers by delivering cost reductions *not* primarily derived from reductions in US-based staff.

Coherent theme; potential policy synergies and economies. The substantially similar greening mechanisms and value propositions that define these models offer a theme that is at once coherent and, as a first initiative, manageably narrower than "Green Servicizing."

In addition, the strong parallels revealed by the more detailed assessment of barriers, drivers and determinants of environmental performance conducted for the CMS, RM and ESCO models (see Chapter 7) suggest that policy engagement around these models as class rather than individually may bring significant synergies and economies.

Existing engagement and a leadership opportunity. US EPA already has engaged significantly with these models, but in a generally uncoordinated way. For example,

- ORCR commissioned this report and the 1999 Tellus Institute report on Green Servicizing (White et al, 1999), highlighted RM in its WasteWise voluntary program, funded several pilots testing the limits and creativity around these models, and otherwise supported and promoting servicizing models and concepts.
- The Office of Pesticide Programs has been significantly involved in IPM issues, including the promotion of IPM-based approaches to structural pest control.
- US EPA recently launched its "SmartWay Transport" voluntary program, which the agency describes as "innovative collaboration between the freight industry and government to reduce air pollution and greenhouse gas emissions, improve fuel efficiency, and strengthen the freight sector." Logistics providers are a key class of targeted partners under the program, and a number of 3PL providers participate.

"Efficiency services" and sustainable infrastructure.

"Performance-based functional procurement" models have been correctly described as creating markets for efficiency. This places these models at the center of any effort to identify sustainable economic mechanisms to increase the eco-efficiency of the economy.

However, the briefs in Chapter 4 suggest another perspective as well: these models *increase the utilization efficiency of infrastructure*.

That is, when widely adopted, these models hold the potential to reduce the investment needed in material, energy, water, transport system, and waste disposal *capacity* to service a given level of economic activity.*

As such, these models may help contribute to more sustainable approaches to infrastructure , a key prerequisite of a sustainable economy.

Further, in view of the escalating costs of such infrastructure capacity and the backlog of infrastructure investment required in the US, these models may, in effect, leverage and conserve scarce public infrastructure funds.

A useful overview of sustainable infrastructure concepts is provided by (Ness 2007).

**Chemicals and CMS can also be viewed in the context of infrastructure. Basic industries such as power, steel, refineries and basic chemicals serve as "pumping stations" for material and energy throughput in the economy, and in essence part of key economic infrastructure.*

- The Office of Pollution Prevention and Toxics promotes CMS in its Green Suppliers Network program. This program is a joint effort between US EPA and the US Department of Commerce's National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP), a leading provider of technical assistance to manufacturers. The Green Suppliers Network works with large manufacturers to engage their small and medium-sized suppliers in low-cost technical reviews that focus on process improvement and waste minimization.

Other examples are cited in the business models briefs.

Thus, expertise exists within the agency regarding these models, as do lines of communication with key stakeholders. Both should provide significant building blocks for more coordinated policy engagement.

Finally, it should be noted that, despite significant policy interest outside the US in these models (see box, “Policy for Green Servicizing in Some Peer Economies” in chapter 6) individually, no country has yet developed a coordinated strategy to fully exploit the eco-efficiency benefits of efficiency services. US international leadership in this area is both possible, and—given the national “comparative advantage” in the use of third-party technical services in the B2B sector—logical. Further, US EPA’s engagement with these services would in fact be and could be presented as an innovative approach to support US commitments made under the G8 “3R” initiative.[84]

8.3 Potential first step: internal stock-taking

As a first step, US EPA should take stock of its own past and current engagement in functional procurement and efficiency services. Highlights of this engagement have been presented above and in the business model briefs, but the Agency should complete a more definitive stock-taking, including lessons learned, as a prelude to any further (and more coordinated) policy engagement. .

8.4 Potential next step: Summit of key actors.

Strategy development will require that the Agency refine its understanding of market status, barriers and drivers. It will also require the engagement and participation of stakeholders in these markets and models.

An effective approach could be to address these needs simultaneously, by convening—or supporting and facilitating the convening of—a “summit” on functional procurement and efficiency services that draws key providers, progressive customers, and other relevant stakeholders.

(As an alternative, a set of model-specific focus meetings could be convened, however, it is likely that a multi-model “summit” would yield interesting and relevant synergies and insights, particularly as there is apparently little communication between these sectors despite common challenges and value propositions.)

These meetings could be structured around the analytical structure developed in this report, eliciting a picture of drivers, barriers, and determinants of environmental performance from those with direct knowledge as providers and customers. From this base, the goal could be to identify policy “targets” and potential measures to address these targets, with the targets and illustrative measures for CMS, RM and ESCOs developed in this report serving as discussion drafts. Both demand side and supply side

[84] Most recently, see the “Kobe 3R Action Plan” adopted by the G8 environment ministers’ meeting of 24–26 May 2008 in Kobe, Japan. Available at www.bmu.de/files/pdfs/allgemein/application/pdf/g8_kobe2008_3r_actionplan.pdf

issues and measures should be addressed, and focus placed on common approaches to this class of models.

These recommendations would form an important input to an US EPA "functional procurement/efficiency services" strategy. The intelligence gained from those in the field will sharpen an overall strategy, and the gathering and exchange itself will build a network critical to US EPA's own efforts—but also to progressive providers and customers themselves.

Policy Tools for a Functional Procurement/Efficiency Services Strategy

As noted in Chapter 6, policy engagement to promote high-potential green servicizing models should satisfy one of three basic justifications: Levelling the playing field; Reducing entry barriers; Formal and informal standard-setting.

What, however, is the set of actual policy tools to be utilized in a strategy to "achieve the full eco-efficiency potential of functional procurement/efficiency services in the U.S. economy"?

Examining (1) the indicative policies suggested by the analysis of drivers, barriers and determinants of environmental performance presented in Chapter 6; (2) the general "toolkit" available to—and used by EPA—in its policy engagement with "green business"; and (3) the specific experience of the CMS and RM models, suggests four relevant categories of policy tools:

Direct support, assistance and training
This category includes supported pilots (e.g. to explore or demonstrate applicability of a model in new customer sectors); financial incentives (e.g. tax credits; preferential credit terms); and training of existing publicly supported technical assistance providers to promote model and provide assistance.

Information and tools disseminatation/ outreach
In this category are development and dissemination of market information, case studies, and benchmarking data; education of key potential customer groups and providers in the "total cost" principles upon which the value propositions of these models are based; and development and dissemination of tools to help potential customers and providers evaluate the business case for adopting the model.

"Green standards" and leadership programs
EPA may be able to function as a facilitator or convenor to develop standards for "green" implementations of the various models, or to further promote existing standards.

There may be opportunities to promote these standards via existing voluntary or leadership programs. Alternatively, or in addition, create a new voluntary/leadership initiative that links and promotes functional procuement/efficiency services models in a coordinated manner.

Regulatory changes
In some cases, key barriers may be regulatory, or certain types of regulatory flexibililty would be a significant incentive to accelerated adoption of a particular model. In this case, EPA may wish to consider regulatory changes. However, experience indicates that key regulatory issues may not be environmental; and that as a matter of feasibility and need, non-regulatory interventions are likely to dominate the strategy.

8.5 Considerations for concurrent actions, looking ahead

Stock-taking of green servicizing engagement outside functional procurement/efficiency services models

US EPA's engagement to date with green servicizing models has not been limited to functional procurement/efficiency services approaches. The programs and offices engaged with other models should be encouraged to take stock of their engagement using the barriers/drivers/determinants framework of this study. This stock-taking may result in adjustments or additions to the engagement strategy, or proposals for future activities.

Consider the question of generalized policy support for "Green Servicizing."

As noted above, policy engagement based on a "drivers/barriers/determinants" framework requires model-by-model consideration. However, the experience of a functional procurement/efficiency services strategy/initiative should lend insight into the question of whether generalized policy support for green servicizing is feasible, and the forms it might take. Explicit consideration of this question should be part of any internal US EPA review and stock-taking of the initiative.

Possible "general support" approaches may include, for example, a competitive funding mechanism for "green servicizing pilots" to support new green servicizing models or the expansion of existing models into new sectors (Japan's METI has such a program, targeting SMEs) or tax incentives attached to savings (enhanced revenues) demonstrably derived from eco-efficiency gains-sharing. Generalized support *within* US EPA for green servicizing might include, e.g., a competitive mechanism making internal Agency resources available to support development and implementation of green servicizing activities proposed by offices and programs.

Explore avenues for engaging in dialogues and participating in fora that shape the evolution of official economic statistics.

As discussed in Chapters 2 and 4, understanding how products and services combine to produce value—and how this combination is changing over time—is critical to environmental *and* economic policy. Currently, official economic statistics and information shed little light on this issue.

US EPA's environmental mission means that the agency does have particular interests in the environmental performance aspects of PSSs and their evolution that are not necessarily shared by other Federal entities. US EPA can independently address these interests, systematically increasing its understanding of "green servicizing" activity in the economy with respect to critical sectors, products and economic functions. (See extended box "on page 49.)

But to address aspects of this issue that should be of more common interest, US EPA should seek opportunities to engage in the dialogues and participate in fora that shape the evolution of official economic statistics to improve characterization of PSSs and their evolution. Efforts that US EPA undertakes to gain a more rigorous understanding of green servicizing—including this report and the Agency's engagement to date in individual green servicizing models—should enhance the value-added that the agency can bring to these discussions.

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