A TEMPLATE FOR RESOURCE PRODUCTIVITY/ SUSTAINABILITY PROGRAMS IN FOREST PRODUCTS MANUFACTURING FACILITIES

This document has been prepared under the direction of a group of forest products professionals with staffing assistance provided by the Center for Watershed and Community Health at Portland State University. It is intended for use by any forest products firm interested in applying resource productivity/sustainability programs and practices. The authors request that readers review this document and provide feedback as to its usefulness, content and presentation. See Appendix E for author contact information. The participants include:

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PART I

BACKGROUND AND CONTEXT

Introduction

This document introduces the principles and practices of resource productivity and sustainable development as they may apply to forest products manufacturing firms and facilities. It was developed by a group of forest products professionals with staffing assistance from the Center for Watershed and Community Health at Portland State University. This is a working draft, and the authors request feedback on content, presentation and usefulness.

The forest products industry is a vital component of the economy of the Pacific Northwest. In Washington and Oregon, the industry generated 20.1 billion dollars of shipments in 1997[1]. Forest products manufacturing firms therefore can play an important role in the regional and global movement toward sustainable development. They can have a major effect on issues such as forest health, energy use, greenhouse effects, air and water quality and community and economic well-being. There is increasing evidence that those firms that continually improve the energy and material efficiency and productivity of their operations, and reduce the toxicity of their products and processes, can gain significant economic and social benefits.

Significant improvements to resource efficiency and toxic reductions are not new to the industry. The amount of wood used to make each ton of industrial wood products has decreased by 23% from 1945 to 1990[2]. The total amount of wood used in the US has grown by only 63% since 1900, despite a tripling of the population[3]. On average, in Washington and Oregon, the industry has also reduced its toxic releases[4]. Lumber industry related onsite toxic air releases decreased by 32% in Oregon from 1995 to 1997. Washington saw a 1% increase. Paper manufacturers reported 7% (Oregon) and 19% (Washington) less air toxic releases. In the two states combined, reported air toxic releases decreased by 25% for the lumber industry and 13% for the paper industry. Still, many firms have found that further improvements to resource productivity and toxic reductions are possible.

Energy efficiency is also an important issue to the industry. The industry uses large amounts of energy in producing and transporting raw materials and finished products. Fifty-five percent of energy used by forest product manufacturers in the US currently comes from biofuels[5]. The use of oil, gasoline, diesel, biofuels, and natural gases all can have detrimental environmental impacts.

Resource productivity and sustainability strategies therefore have much to offer firms seeking to respond to changing market conditions, regulatory requirements and community needs. In an

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[1] US Economic Census 1997.
[2] See Abramovitz & Matton (1999)
[3] ibid.
[4] EPA TRI data
[5] Miner and Lucier (1994)

increasing number of industries, environmental and social performance are emerging as major sources of competitive advantage.

Contents of The Document

This section of the document provides background information on resource productivity and sustainability. It is intended to prepare the reader to use the template outlined in Part II. The template is organized around the steps involved with answering the five key questions that should drive the development of your resource productivity/sustainability program.

On the left margin of the template, examples are provided to show how some companies have responded to each question. They are marked ✓**Examples**, and more details can be found in Appendix A.

At the end of each section, quick "start-up" ideas are suggested. These are easy steps you can take to get going. They are marked ▶ **Start-up Ideas.**

At the end of each section, exercises are suggested to help you assess your firm's or facility's past or current approach to the questions. These are marked ϓ**Exercises,** and more details are found in Appendix B.

Appendix C contains a glossary of terms used in this document. Appendix E provides a contact list of forest products manufacturing professionals who participated in the development of this template. Appendix F offers some selected references.

What is Resource Productivity and How Does it Relate to Sustainability?

The term "sustainable development" was defined by the 1987 U.N. World Commission on Environment and Development (the so-called Bruntland Commission) as: "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs." Key objectives included: "reviving economic growth, but in a new form (less material and energy intensive...); meeting essential needs for jobs, food, water, energy and sanitation; conserving and enhancing the natural resource base; and merging ecological and economic considerations in decision making." To accomplish this, ample, healthy stocks of "natural capital" (e.g. forests, fish, soils, water, air) must be conserved in a manner that allows them to be passed on to future generations.

Sustainable development therefore has social, environmental and economic dimensions. The template provided in Part II focuses primarily on the economic and environmental aspects. From the perspective of a manufacturing firm, sustainable development ultimately means *doing more with less*: producing the same or better quality goods and services with less inputs of material, energy and water, less toxic materials and substances, and consequently less pollution and waste. The ultimate goal should be to strive towards zero waste and zero emissions. Sustainable development is therefore closely linked with increasing the productivity of the firm. We therefore use the term resource productivity/sustainability throughout this document to describe the application of sustainable development principles to forest products manufacturing firms.

To make the concept even more concrete resource productivity/sustainability can be thought of as adopting policies, programs, and practices to maintain and enhance your firm's competitiveness through an interconnected three-step process:

- Continually *reduce the flow* of scarce, toxic minerals, metals and substances purchased or used by your firm (e.g. heavy metals, fossil fuels, dioxins, formaldehydes and volatile organic compounds, old growth, bio-accumulating synthetic substances) by eliminating unneeded inputs and finding non-toxic, environmentally sound alternatives;

- *Get more from the flow* of raw materials, substances and energy as they are used within your operations and processes by instituting measures to continually increase overall efficiency, and;

- *Re-circulate the flow* of all waste materials (solid, industrial and hazardous waste, greenhouse gasses and other releases which are molecular waste) by finding ways to use waste as raw materials for other products or processes within your firm or by exchanging them with other firms or organizations.

Environmental Problems are a Sign of Waste And Inefficiency

Just as endangered salmon are indicators of poor stream health ("canaries in the coal mine"), pollution, waste and other environmental impacts are indicators of inefficiencies, waste and design flaws within a firm. These problems almost always generate unneeded costs, wasted resources and environmental problems. Conversely, a growing pool of research shows that reducing and eliminating design flaws, inefficiencies, toxins and waste can save firms millions of dollars, increase revenues, expand market share, generate new product lines and improve community and stakeholder support. At its core, this is what sustainability is about - reducing design flaws, inefficiencies, toxins and waste. Almost as a side benefit, the environment will benefit.

Some Probable Outcomes of Resource Productivity/Sustainability

Taking steps to squeeze out waste and pollution, to detoxify your operations and to protect native habitats will generate multiple benefits. Some incentives for the adoption of sustainable practices and some related benefits include:

Incentives
- Reduced environmental risk
- Reduced risk to shareholder value
- Reduced regulatory costs
- Greater regulatory flexibility
- Reduced waste management cost and liability

Benefits
- Cost savings and increased revenues
- Improved public and community relations
- Increased shareholder value
- Enhanced competitive advantage
- Maintain or expand market share
- Compatibility with international standards
- Improved organizational performance

The Potential Economic Benefits of Sustainability Programs

Can The Private Sector Save Money?

A growing stream of research shows that while sustainability practices often require initial investments, they generally have a rapid payback, leading to large returns on investment.

For example, Collins Company initiated a sustainability program in one of their plants. The following table shows some steps taken to reduce discharges and emissions and related savings.

Steps Taken	Savings
Captured waste heat from coating oven stacks and using it to heat the plant instead of using wall heaters; savings	$38,000
Reintroduced sander dust into particleboard manufacturing (547 tons less emissions; reduced fiber needs)	$582,550
Reused condensate from the veneer dryer to create flash steam to treat vault blocks	$152,000
Hammermill: Replaced 6 Pallmann with 1 Bliss Hammermill motor (electrical savings over 3 million kwh/year)	$118,200
Scrap hardboard reclaim: Re-ingested waste fiber	$300,000
Installed bag filter for two defibrators (Spent $500,000 to reduce particulate emissions by 28.2 lbs/hour)	Community Benefit
Raimann veneer patch machine develops more solid veneer as foundation for more production of hardwood; used veneer patching waste to make particleboard	Sales realization increased

Collins Company's experience echoes the results of other research. For example, two Portland State University Center for Watershed and Community Health studies found that firms are able to generate savings from making investments in resource productivity.

- *Saving Salmon, Saving Money, Innovative Business Leadership in the Pacific Northwest* (Goodstein, Doppelt & Sable, 1999) found that 137 Northwest firms had saved $42 million over a five year period through the adoption of conservation and efficiency practices. Cost data were available in 25 cases, showing payback periods averaging 4 years for the private sector and 9 years for public sector organizations.

- *Its Just Plain Good Business: The Economic and Environmental Benefits of Sustainability as Exemplified by 160 Case Examples* (Doppelt, Watson, 2000) found that 160 Northwest manufacturing, retail and service sector firms have saved $55 million annually by adopting resource productivity and sustainability strategies.

Moving Forward

Now that you have a basic overview of resource productivity/sustainability programs, you are ready to use the template outlined in Part II of the document. The template provides a step-by-step map to guide the development of resource productivity/sustainability programs.

PART II

THE TEMPLATE

Introduction And Purpose

This part of the document outlines a step-by-step process, or template, that any forest products firm can follow when adopting resource productivity/sustainability programs in its manufacturing facilities. While organized sequentially here, the development of a resource productivity/sustainability program is usually not a linear process. You can start anywhere you want. Some firms may follow the template step-by-step, and start by adopting company-wide policies and guiding principles. Others may initiate pilot projects in order to understand the costs and benefits of the approach. The more effective programs usually circle back and forth through the inter-related steps a number of times as they develop and continually improve their initiative.

This template, therefore, simply outlines the common, major components of resource productivity/sustainability programs in forest products manufacturing facilities. It offers suggestions for how to approach key issues. It also provides examples of how some forest products firms or manufacturing facilities have approached the issues. Though there are commonalities among strategies, there is no one-size-fits-all design. Each firm must develop a program tailored to their unique needs, culture and business environment.

Leadership Is The Key To Success

Before launching your sustainable development initiative, it is important to know the ultimate key to success: *leadership*. Leadership, not management per se, creates successful change in any organization. Leadership is a set of processes that creates organizations in the first place, or adapts them to significantly changing circumstances. Leadership defines what the future should look like, aligns people with the vision, and inspires them to make it happen despite the many obstacles. Management, on the other hand, is a set of processes that keeps complicated systems of people and technology running smoothly. It involves planning, budgeting, organizing, staffing, and problem solving. Efforts to guide firms in new directions that are overmanaged and underled usually achieve limited success. Managing change in your organization is important, but, in most cases, the biggest challenge and need will be to lead change. The organizing questions listed below will help you begin to establish a program with the right balance of leadership and management.

Five Organizing Questions For A Resource Productivity/Sustainability Program

The five organizing questions that should drive the development of your resource productivity/sustainability program, along with the strategies for answering them, are listed in Table 1. The balance of this document elaborates on these questions and strategies.

Table 1: Five Questions, Five Strategies

Question	Strategy
What is our commitment to resource productivity/ sustainability?	→ Develop an initial policy framework that authorizes and guides your resource productivity/sustainability program.
How sustainable are we now?	→ Develop a baseline by assessing your firms economic, social and environmental conditions, trends and risks.
How sustainable do we want to be in the future?	→ Set measurable goals and targets for what you want to achieve in the future.
How do we get there?	→ Develop an implementation action plan.
How do we measure it?	→ Establish indicators and implement an on-going monitoring system.

SECTION 1

What Is Our Commitment To Resource Productivity/Sustainability?

Step One:

Secure a Commitment from Senior Management for the Resource Productivity/Sustainability Initiative

✓**Example 1** in Appendix A describes AssiDomän's commitment to sustainability and its environmental policy. It is one of Europe's largest forest products companies.

To start your initiative, senior management should make a commitment to the resource productivity/sustainability effort. A formal commitment highlights the importance of the initiative, authorizes staff to work on it, and ultimately catalyzes action within the company and individual facilities. The initial commitment may involve a directive from the CEO, the Vice-President of Manufacturing, or other senior management.

At this early point it is helpful to provide an initial definition of what resource productivity/sustainability means in the context of your firm or facility, as well as an initial set of goals and principles that will guide the development of your program.

Every firm needs to decide what definition of resource productivity/ sustainability makes sense for its employees, stockholders and stakeholders. **An example of a commonly used, broad definition** of sustainability is:

 "Using, developing, and protecting resources at a rate and in a manner that enables people to meet their current needs and also provides that future generations meet their own needs" (Brundtland Commission, State of Oregon and many others).

This definition means that ample, healthy stocks of clean water, clean air, fertile soils, forests, agricultural lands, plants, fish, wildlife, and other resources should be passed on to future generations.

All environmental problems eventually lead to economic and social problems and all good solutions to environmental problems should increase efficiency and enhance economic and social well-being. Therefore, your initial definition, goals and principles should make it clear that your resource productivity/sustainability initiative will seek to address economic, social and environmental issues concurrently.

As in the case of Total Quality Management, there is evidence that resource productivity/sustainability initiatives are most likely to succeed in companies that place a premium on leadership and constant communication and participation by key management and employees. Management's initial policy directive should, therefore, consider how human resources strategies complement the required technical work.

<u>Step Two:</u> Establish a Guiding Policy Framework on Resource Productivity/Sustainability

Once leadership has established its commitment to the resource productivity/sustainability initiative, the next step is to establish a management framework to guide the effort. Senior management should clarify the programs goals, program boundaries and guiding principles.

Goals	What the program is trying to achieve.
Program boundaries	How far upstream and downstream beyond the manufacturing phase itself should the program go?
Guiding principles	What resource productivity/sustainability principles will the company follow?

It will not be possible at this point to predict all the changes to existing company policies, procedures or processes that may result from your program. At this point, the need is simply to establish the initial policy framework to guide program development.

✓ **Example 2** shows how Assidomän translated its commitment into policy guidelines.

Sample goals for a company resource productivity/sustainability initiative might include to simultaneously:

- Increase the economic viability of the firm by reducing costs, expanding market share, and/or increasing revenues to target levels;
- Increase the efficiency with which energy, water, material resources and land are used to target levels;
- Reduce releases to air, water and land of substances harmful to human health and the environment to target levels; and
- Achieve high levels of employee education and participation around firm or facility resource use and environmental impacts.

The targets will change over time as new information becomes available. However, targets are important to specify early in the process.

Step Three: Establish a Strong Guiding Coalition

Once the policy framework has been established, a coalition should be formed to guide the initiative. The group should include a mixture of senior management, division managers, line staff and possibly outside stakeholders. The guiding coalition should be chosen based on its ability to provide leadership, credibility and horsepower to the effort. It should be constructed with the explicit understanding that this group will be key to providing the leadership needed to push through the inertia and obstacles that are certain to emerge as your program proceeds.

Start-up Ideas

▶ **Start-up Ideas For Section 1**

✓ Gather examples of resource productivity/sustainability policies, goals and principles adopted by other manufacturing firms. Share them with management and staff.

✓ Have the CEO or senior management host a series of meetings on resource productivity/sustainable business practices.

Invite key managers, employees, directors and/or representatives from firms that have implemented resource productivity/sustainability programs. Local academic institutions can also offer information and assistance. Engage the group in a dialogue on the costs and benefits and ways to initiate resource productivity/sustainability efforts. At a follow-up meeting, see if there is consensus on starting a resource productivity/ sustainability initiative.

✓ Find a leader or champion for your effort.

Behind every successful resource productivity/sustainability initiative, there is a respected individual that champions the cause. It may be the CEO or senior management. Make sure you have an internal champion for the initiative.

Exercise

Section 1 Exercise

Go to Appendix B to describe your directives and framework policy on resource productivity/sustainability.
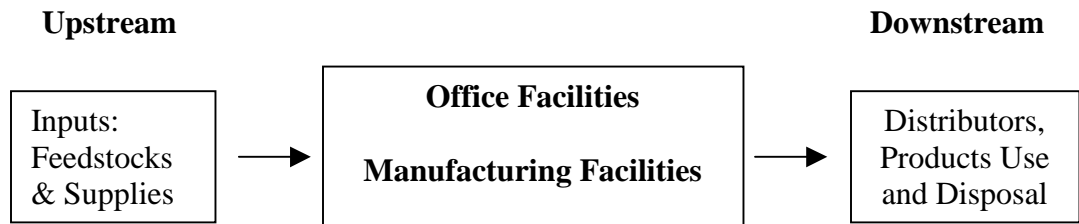
SECTION 2

How Sustainable Are We Now?

Step One: Assess The Sustainability of Company or Facility Operations.

Once the initial purpose, definition and policy framework have been established to guide your initiative, the next step is to identify how sustainable your company or facility currently is. Credible scientific and economic baseline data is needed to determine what your firm is doing well and what future needs and priorities should be.

A useful metaphor here is the "footprint". When calculating the environmental footprint of a firm or facility, you analyze the extent of and relationships between resource and energy use (inputs) and waste production and environmental effects (outputs). A company with a sustainable footprint uses resources in a way and at a rate that does not harm nature's capacity to sustainably produce key environmental goods and services or overload nature's ability to assimilate waste and pollution.

As with policy setting, each firm must decide on the boundaries of its footprint assessment. Some firms may decide to limit the effort to activities occurring within a manufacturing facility itself. In this case, the boundaries are set where the facility takes control of products and materials (the "upstream" side) and where it gives up control of products (the "downstream" side). You may, immediately or over time, extend the boundaries by requiring that all inputs used by the firm be produced sustainably and/or that all downstream uses of your firm's products are sustainable. The chart below provides a conceptual model for thinking about program boundaries.

Upstream   **Downstream**

| Inputs:
Feedstocks
& Supplies | → | **Office Facilities**

Manufacturing Facilities | → | Distributors,
Products Use
and Disposal |

There are two common ways to assess the footprint of a firm or facility: "Input-Output Analysis" and "Principle-based Assessment."

A. "Input-Output Analysis"

An Input-Output analysis identifies and quantifies the flow of material feedstocks and energy into and out of a facility or manufacturing process. With this approach you identify and quantify the waste and pollution (which is a molecular form of waste) that are generated as a result of your operations and processes.

You start by mapping each sequential step in the operations of your firm, facility or process. You then gather information to measure the following in each operational step:

- Amounts, types and costs of all *inputs* (e.g. raw materials, energy, water, products) that the firm, facility or process purchases, uses or consumes;

- Amounts, types and costs of all *outputs* that the firm, facility or process generates as a result of its operations (e.g. products, packaging, all forms of waste, emissions and habitat impacts).

Once the inputs and outputs are mapped, you can uncover ways to:

- reduce unneeded inputs;
- detoxify processes;
- reduce waste; and
- re-circulate waste into new products or beneficial uses.

Input-output analysis can identify how your company can save money or generate income by reducing unneeded inputs, improving energy and materials efficiency, and reusing or recycling waste materials. Examples 3 through 5 in the Appendix A illustrate input-output and process assessments specific to forest products manufacturing.

B. Principle-Based Assessment

You can also assess the resource productivity/sustainability of your firm's operations by determining the degree to which current practices are consistent with, or violate, basic principles of sustainability.

A number of organizations have developed guiding principles of sustainability. For example, The Natural Step, an organization from Sweden with U.S. affiliates has developed four "systems principles." More information about these and other principles can be found in

Appendix A, Example 7. The PSU Center for Watershed and Community Health (CWCH) has modified and linked these with other principles to clarify what sustainability may mean to company managers and employees. The principles are:

1. *Reduce the use and emission into nature of toxic minerals, metals and fossil fuels and synthetic, persistent toxic materials and substances; and enhance the use of renewable energy and non-toxic materials and substances, in processes, goods and services.*

2. *Conserve, protect, and where needed, restore the productivity and diversity of nature (ecological processes and structure) to levels necessary to maintain ecological health (with special focus on key areas such as riparian areas, floodplains, wetlands, native plant habitats etc.).*

3. *Eliminate waste through reduction at the source, and enhanced reuse, remanufacturing and recycling internally within and externally between agencies, institutions and businesses.*

4. *Increase the efficiency by which natural resources and energy are extracted, processed and used by a factor of ten or more.*

5. *Enhance business development, economic competitiveness, job creation, and fairness in the distribution of resources to meet basic human needs, public safety, health care, and education consistent with the principles above.*

✓ **Example 6** describes how Collins Company uses the Natural Step.

✓ **Example 7** provides more detail on the CWCH principles as well as the The CERES principles of sustainability.

Step Two: Identify and Highlight Your Existing Successes and Strengths

Once you have assessed the footprint of your firm or facility, the next step is to identify and shine the light on your successes. Every company has a number of past or existing policies and programs that support resource productivity/sustainability. It is important to highlight these programs and their accomplishments.

Has the company adopted management practices or installed new technologies that reduced emissions or the use of toxic materials beyond compliance standards? Does the company have a recycling program? Has the company reduced waste by recirculating end-of-life materials into new products or processes?

Highlighting these successes reinforces the message that a resource productivity/sustainability initiative does not require inventing the wheel. It also allows senior management, employees, stockholders and/or stakeholders to celebrate and build upon past accomplishments.

Step Three: Identify Gaps, Omissions, Needs and Priorities

Finally, your footprint analysis should help identify areas where significant improvements are needed. The analysis will help identify gaps and omissions in policies, programs and practices. This should naturally lead to the identification of new programs, practices or policies that may be required. It should also help identify the initial priorities of your resource productivity/sustainability initiative.

Start-up Ideas

**▶ Start-up Ideas
For Section 2**

✓ Gather bills and calculate the total annual energy, water use and waste generated by one facility or manufacturing processes. Set reduction targets (e.g. a 10% reduction) and ask employees for suggestions on ways to achieve them. Develop a simple plan and a short timeframe for implementation (e.g. 3 months). Measure and highlight the reductions achieved.

✓ Compare the footprint analysis of your firm or facility to similar past assessments. See if trends are up or down regarding energy, toxic substance or raw material use per unit of product. Share this information with employees and senior management. Ask for suggestions on ways to increase efficiency by reducing the use of materials, energy and toxic substances.

✓ Complete a simple test Input-Output analysis for one facility or manufacturing process.

A small energy and water intensive facility or process is a good place to start. Work with staff to outline the sequence of steps involved with the operation of the facility. Gather past utility bills and materials invoice data and measure total amounts and costs associated with inputs (energy, water and materials) and outputs (waste). Then, look for ways to reduce energy, water and materials use with steps like reducing unneeded inputs, recycling, alternative lighting, appropriate motor sizes and pipe sizing, green-building techniques and HVAC technologies. Consider alternative uses for waste products. Quantify and highlight the reductions achieved.

Exercise

Section 2 Exercise

Go to Appendix B and describe how your company or facility might assess its footprint.

SECTION 3

How Sustainable Do We Want To Be?

Step One: Generate a Vision, Goals and Targets for Your Company or Facility.

Once you have developed a baseline of your strengths and the areas that need improvement, the next step is to determine how efficient or sustainable you want to be in the future. Generating a compelling vision for your firm or company with respect to resource productivity/ sustainability is perhaps the hardest, yet most important, step. The vision you generate should be based on your company's definition and principles of resource productivity/sustainability.

Your vision and goals should clearly define: a) the levels and types of changes to which your company or facility will commit in order to become more resource productive/sustainable; and b) the time frame within which these changes will be made. Achieving the goals within a set time frame will require the development of measurable targets. These are milestones to be met on the way to meeting your long-term goals. The targets should include both environmental and social-economic components.

It will be important for employees, stockholders and/or stakeholders to understand that improving resource productivity/sustainability is more than just a "direction" toward which the company is headed. It is very difficult to turn process-oriented goals into specific action plans. Clear, measurable goals and targets are needed to clarify the specific changes that the initiative is expected to achieve.

Use Outcome or Performance-based Systems to Set Goals

Setting clear, measurable goals and targets is absolutely vital to your initiative. Many firms achieve the best results by using "outcome" or "performance-based" systems to set goals and targets. The first step in such systems is to set the goals your company wants to achieve in the long term (e.g. 2-5 years). For example, a forest products manufacturing company might decide it wants to:

- Cut waste by 75% or achieve zero waste within 5 years;
- Increase energy efficiency by a factor of 4 within 2 years;
- Find non-toxic substitutes for toxic adhesives or lacquers in 2 years.

The next step is to work backwards from that point to set interim benchmarks and targets for achieving those long-term ends.

This is a common strategic planning process used worldwide by business. The Natural Step calls it "backcasting." While traditional planning processes usually lead to small incremental improvements, outcome-based approaches often lead to dramatic leaps forward. This is because people are freed to innovate and find new strategies and technologies to achieve the long-term goals, thus leaping beyond the believed constraints of existing systems.

Achieving the vision generated by backcasting techniques will require a leadership orientation. Key managers in a company will need to generate a sense of importance, organize powerful guiding coalitions, relentlessly communicate the vision, empower others to act, and encourage multiple broad-based actions and innovations. This kind of leadership produces changes in organizational performance, behavior and culture.

Step Two: Adopt Cost Savings Goals and Targets

It is important to set cost-saving goals and targets for your firm or facility, in addition to environmental goals. This enhances creative problem solving. It also makes it clear that your initiative is not just a new type of environmental program.

For example, you may establish a long term goal of reducing energy, water or waste management costs by 40% over five years. You may then set targets of a 10% reduction within one year, a 25% reduction within three years, with the last 5% (usually the most difficult to achieve) in the last two years. These can be linked with environmental targets related to reductions in energy and water use and waste generation. The combination of cost saving and environmental targets can stimulate the adoption of new technologies or management strategies to achieve both goals.

Step Three: Include New Business or Product Line Goals

You may also want to include the goal of developing new business or product lines through your resource productivity/sustainability initiative. This requires thinking about environmental resources and your core business in a new way. One approach promoted by the Zero Emissions Research Initiative (ZERI) is called "Total Resource Productivity." The goals of Total Resource Productivity are:

- All environmental, natural resource and energy inputs must be fully used in organizational and business operations;
- No liquid waste, molecular, gaseous waste or solid waste should be generated in any process;
- When waste occurs, it should be re-circulated for use in other products or processes to create value-added.

Total Resource Productivity is based on the belief that the objective of a sustainable firm is to minimize and detoxify the inputs used in operations and production processes, and to achieve the maximum level of value in the use of all material and energy inputs and outputs. As long a firm fails to achieve maximum productive value from energy and resources use, and as long as it continues to discharge material and energy inputs into the environment as waste and pollution, it is wasting money and resources.

Using energy and environmental resources fully can save money and generate new businesses or product lines. In projects underway in Europe, Asia, Africa, Eastern Europe and Latin America, ZERI says it has found that total resource productivity can be achieved in agriculture in four to five years. Other sectors may require 5 to 10 years or more.

The Five Step ZERI Methodology Involves:

1) *Use Input-Output Assessments To Achieve More Efficient and Cleaner Processes.*

As discussed in Section 2, this should be the key initial focus of you resource productivity/sustainability effort. The goal is to eliminate excess resources and waste and to detoxify production and operational systems. Thus, costs are reduced, firms become more competitive, and the environment is improved.

2) *Search Creatively For Ways To Use All End-Of-Life Materials (i.e. Molecular, Solid, Industrial and Hazardous Waste) For Value-Added Uses.*

Cleaner and more efficient processes are important, but they are often not sufficient to achieve resource productivity/sustainability as few industries or facilities can achieve zero emissions and waste on their own. Money is consistently wasted and business opportunities lost if end-of-life materials (waste) are simply *downcycled* (used for less valuable purposes than possible) such as when waste is incinerated to generate power. However, searching for ways to *upcycle* (add value to) end-of- life materials can turn resources once thought of as waste into valuable new products, such as when wood waste is recirculated into particleboard.

Upcycling end-of-life materials necessitates thinking beyond the core business. It often requires breaking down end-of-life materials into their biochemical components and finding ways to turn the individual components and elements into new products (as the petrochemical industry does when it fractionally distills oil into numerous substances and products).

✓ **Example 10** describes the upcycling of woodscraps into finger jointed moldings. Upcycling generates about $1,300 per million board feet versus about $20 for boiler fuel.

✓ **Example 11** describes some examples of business clusters and model eco-industrial parks in the US .

✓ **Example 12** describes cases where the wood products industry has sold wood waste to create energy in nearby manufacturing facilities.

✓ **Example 13** outlines recent wood products technology developments such as oriented strand board (OSB), bio-pulping & polyoxometalate chemistry. Bio pulping for delignification has been shown to reduce energy use by 30%. Composite technologies like OSB have increased fiber utilization rates.

3) *Create Partnerships and Cluster Your Businesses Together with Ones that Can Use End-of-Life-Materials From Your Processes as Feedstock for Theirs.*

Once new uses are identified for end-of-life materials, the next step is to create business clusters. This means businesses physically locate in close proximity to each other so they can use the by-products of one process as feedstock for new value-added processes or products.

This step can increase productivity and generate new product lines or business opportunities. A series of inter-linked business networks can evolve with creativity and careful engineering.

4) *Identify Breakthrough Technologies.*

Barriers will often be identified in the process of reducing inefficiencies and developing a network of new businesses and products linked together by compatible uses of end-of-life materials. Academic institutions and private sector researchers must be engaged to develop the breakthrough technologies to eliminate technical barriers. Often, the new technologies may be slight modifications of long-abandoned approaches. That a technology is lacking is not a reason to give up. Rather, it provides an opportunity for you to create new product lines or business ventures.

5) *Seek Appropriate Policy Changes.*

The logic of the process described here is often inconsistent with our legal system and community development policies. For example, local zoning ordinances and building codes may not currently encourage or provide incentives for waste-sharing business clusters. Policy changes will be needed to support these strategies.

Business Benefits of Total Resource Productivity

The ZERI approach identifies capital growth opportunities by using materials at high rates of efficiency. The approach brings together clusters of different products or industries that are closely linked on the basis of material needs and cycles. It generates growth, profits and jobs by identifying a wide range of value added products - while dramatically improving environmental performance and eliminating waste to landfills and emissions to land and water.

Start-up Ideas

✓ Your firm's vision and goals might be to achieve zero emissions and waste within 5 years. Use outcome-based planning to envision what this would mean for your firm. What emissions, discharges and waste would need to be eliminated? Then, generate specific environmental goals (e.g. use non-toxic cleaning substances and resins) and targets (e.g. 20% of toxic use within 1 year, 50% within 2 years etc.) as well as cost saving or income generation goals and targets (e.g. reduce emissions control costs by 75%, identify 1 new product line from existing waste materials). Explore many options and then develop a plan to simultaneously achieve the environmental, cost-savings and product line goals.

✓ Identify and quantify all the waste materials your firm generates. Then, gather a team of scientists, technical experts and even line staff to brainstorm ways to use the waste in new products or processes.

Exercise

Section 3 Exercise

Go to Appendix B Section 3 and explain the resource productivity/ sustainability visions, goals and targets for your firm or facility.

SECTION 4

How Do We Get There?

Step One: Determine Your Priorities

Once your goals and targets are clear, you must set priorities. This requires evaluating the range of key economic, social and environmental issues that have been identified in your footprint assessment to determine top priorities. Immediate and secondary priorities will emerge.

The first step is to establish criteria for priority setting. For example, criteria may include an "urgency" factor, a financial "hurdle rate" for investments, the degree of employee support, or the degree to which a project or need achieves multiple environmental-socio-economic objectives. You then establish a method to weigh all possible projects and programs against the criteria. In this way, priorities will rise to the top.

✓ **Example 14** describes how the Collins Company established a number of teams for their resource productivity/ sustainability initiative.

Step Two: Develop Implementation Team and Action Plan

Once your priorities have been established, you can develop a complete sustainability implementation action plan. The plan should identify the sequence of actions to be taken and establish timetables and lines of responsibility. It should outline how the actions will be integrated with existing policies and programs. It should define the structure and responsibility for managing and implementing the initiative (lead staff, teams, etc.). It should identify the human, technical and fiscal resources to be involved. It should include operational controls and feedback mechanisms. It should also include documentation, data gathering and monitoring processes for continual improvement.

Step Three: Educate, Train and Reward Employees and Stakeholders

One of the primary determinants of success for your firms resource productivity/sustainability program will be the degree of employee and stakeholder understanding, buy-in and engagement. Throughout the process a major emphasis should be placed on explaining why the firm has developed the initiative. People will want to know what you hope to achieve, what the process is, how they can participate, and how it will benefit them.

Your initial implementation plan should consequently include continuing education and training opportunities for employees. It should also provide mechanisms for public recognition of employee successes.

Step Four: Involve Senior Management in Continual Review and Improvement

Finally, mechanisms should be established to engage Senior Management in progress reviews. At this point, senior management should consider needed changes and take steps to continually improve the initiative. If your firm has established partnerships in implementing its resource productivity programs, be sure to include key partners in this evaluation.

▶ **Start-up Ideas For Section 4**

Start-up Ideas

✓ Build on the team you organized in Section 1. Empower it with resources and authority to oversee and guide your resource productivity/sustainability initiative.

✓ Develop an implementation plan to conserve energy and water and reduce waste in the facility you assessed in Section 2. Use the results of your Section 2 analysis for clues on the best strategies for efficiency and savings.

✓ Rewrite your procurement, reuse, remanufacturing, recycling, and maintenance procedures to stress source reduction, reuse and finding value-added used of waste.

Section 4 Exercise

Section 4 Exercise

Go to Appendix B and describe your priorities and implementation plans.

SECTION 5

How Do We Measure It?

Step One: Establish Resource Productivity/Sustainability Indicators and Metrics

In order to measure the progress of your sustainability or resource productivity initiative, key indicators must be selected. Indicators are quantitative and qualitative data used for measuring trends. Some indicators measure resource use; for example, the amount of energy consumed. Some measure environmental quality; for example, water quality conditions. Still other indicators might measure behavior or program effectiveness; for example, the percent of employees participating in recycling programs.

Not every resource or issue can be measured. It is therefore important to select indicators that provide a credible *overall* evaluation of progress in achieving the vision, goals and targets of your firm or facility. The selection of indicators may occur when you complete your Step 2 assessments. If so, it is important to reaffirm their usefulness now. There are many resources available to help guide indicator development.

The term "metrics" is often associated with indicators. Metrics specify the way in which indicators shall be measured to provide information for decision-making. The indicator might be "use of toxic materials." The metric might be "aluminum sulfate used per dollar of product sold." The metric provides a clear source of data and a clear calculation rule. Targets then specify a goal for change in the indicator as reflected in the metric; for example, a 30% reduction in aluminum sulfate.

Step Two: Implement Mechanisms to Gather Data, Monitor Progress and Ensure Continual Improvement

Once the indicators are established, mechanisms should be developed to continually gather, integrate and display the indicator data to evaluate conditions and trends. This allows you to track performance. Staff and appropriate resources should be assigned to this task. Procedures should be established for ensuring that a data review stimulates continual improvement.

Every firm should establish a repository where resource productivity/ sustainability data can be integrated, analyzed, maintained and distributed. Appropriate protocols will ensure that good records are kept on actions,

costs, cost-savings and returns on investments, as well as related environmental improvements and resource savings. Periodic performance assessments will update your footprint analysis. In turn, the progress report can be shared with the firms' employees, stockholders, stakeholders.

Start-up Ideas

▶ **Start-up ideas For Section 5**

✓ Use Appendix A, Examples 15 and 16 and your Section 2 assessments to help you to formalize indicators and metrics for your resource productivity/ sustainability program.

Exercises

Section 5 Exercise

Go to Appendix B and describe how firm or facility might establish resource productivity/sustainability indicators and monitoring systems.

SECTION 6

<u>Pulling It All Together</u>

Ultimately, you may find that the best way to organize and implement your resource productivity/sustainability program is to develop a Sustainability Management System (SMS). An SMS is similar to an Environmental Management System (EMS) except that it is based on the principles and practices of resource productivity/sustainability described in this document. A Sustainability Management System outlines the policies, organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, reviewing and maintaining your firms resource productivity/sustainability program.

Your Sustainability Management System should help your firm:

1) Build a systematic approach to manage environmental, economic and social risks and reduce impacts, relying on principles of sustainability, quality assurance principles and continuous improvement.

2) Integrate your resource productivity/sustainability program with other internal organizational management systems, goals and policies.

3) Demonstrate performance objectives (e.g., compliance, voluntary steps beyond compliance, competition, cost savings and economic success).

There are many different management system models to base your SMS on. For example there is the Environmental Management System approach developed by the British (BS 7750), the European Union (EMAS) and the International Standardization Organization's (ISO) EMS standards.

No matter what model you choose, a well crafted Sustainability Management System can provide significant long term benefits to your firm. Perhaps the most important benefit is that an SMS can help you blend fragmented programs and management units into an integrated *system* that continually reduces the environmental impacts of your firm or facility while also generating economic and social benefits.

Contact the PSU Center for Watershed and Community Health for more information on a Sustainability Management System. We wish you good luck with your efforts!

APPENDIX A

Sustainability/Resource Productivity Program Examples

Example 1: AssiDomän's Environmental Policy

AssiDomän is one of Europe's largest forest products companies and the largest private land-owner in the world. The company primarily manufactures packaging paper and sawn timber. The company has made a strong commitment to sustainable forest management and sustainable production. (See http://www.asdo.se/english/pdf/annualreport99_2.pdf) The company uses the following management statements:

- AssiDomän's operations have an impact on the environment, as do all industrial activities. We have a responsibility, however, to reduce this impact on the environment as far as this is ecologically and economically reasonable.
- AssiDomän's commitment to long-term sustainable development means that as far as possible we shall use renewable resources to make products that are of maximum use with minimum consumption of resources.
- Protecting forests, water and air is crucial to the survival and development of our business. Our responsibility to the natural environment is the same that we owe to our customers, employees, shareholders and society in general.
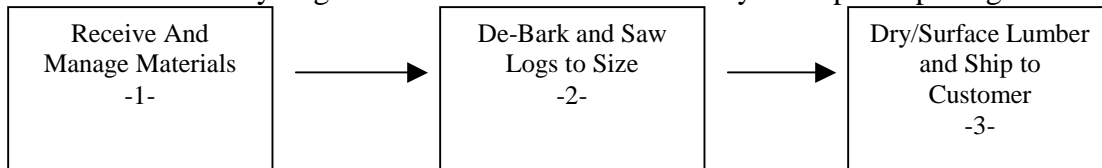
Example 2: AssiDomän's Environmental and Resource Productivity Guidelines

Continual improvement:	Our environmental efforts will be preventative. We will seek continual improvement throughout the full life cycle of our products. Sustainable forestry and protection of biological diversity We will use forestry methods that exploit the forest's own ability to renew and sustain itself while preserving biological diversity.
Conservation of resources:	We will economize on raw materials, conserve energy and minimize use of non-renewable raw materials and fuels.
Benign processes:	Our manufacturing processes and emissions should not harm the environment. As far as possible we will use technology which will increase closure of process circuits and treatment of emissions.
Waste minimization, recycling and sustainability:	We will reduce waste and, as far as possible, recycle waste paper and our own production waste to produce new products or energy. We will also investigate methods to return nutrients in biofuel ash to the forest – all of these measures being ways to promote the sustainable ecological cycle.
Supplier conformity:	We will encourage our suppliers to meet the same standards of environmental awareness and open-ness that we apply to ourselves.
Environmental management systems:	Each unit will have its own environmental policy that reflects the corporate policy and its own systems for implementing environmental controls and audits. Our employees will receive training and information to enable them to take responsibility for the environment in their daily tasks. This will go hand in hand with consideration for the working environment.
Environmental planning and annual environmental statement:	Each year each unit will establish improvement targets and a program of action. They will report progress in an annual environmental statement.
Openness:	Our manner of dealing with environmental issues will inspire confidence among our customers, employees and the general public. We will seek broad scientific co-operation and open dialogue with authorities, environmental organizations and our customers. We will review our goals and methods regularly in the light of new information. This policy is part of the Group's goals and guidelines.

Example 3: Input-Output Analysis

Think about your firm or facility as a system of interrelated activities. Use the following approach to help complete the worksheet for each facility or division of your company:

1. PROCESS: Outline the process for your manufacturing facility as a series of steps. The steps should start relatively large and can be refined as necessary. Sample steps might include:

Receive And Manage Materials -1-	→	De-Bark and Saw Logs to Size -2-	→	Dry/Surface Lumber and Ship to Customer -3-

2. INPUTS: List the inputs for each of these steps. Categories of inputs include:

- Process materials (i.e., materials which become part of the product)
- Energy sources (e.g., natural gas, electricity, wood waste)
- Capital equipment
- Equipment and Maintenance Consumables (e.g., lubricants)
- Air
- Water
- Labor

3. OUTPUTS: List the types of waste or losses from each step. Examples of wastes include:

- Solid waste
- Process wastewater (i.e., water which comes into direct contact with the process and may be contaminated with process byproducts)
- Auxiliary wastewater (e.g., non-contact cooling water)
- Air emissions
- Equipment and maintenance waste (e.g., non-recyclable worn parts and consumables)
- By-products (i.e., materials which are not contained in the primary product but which have a useful purpose either in another step of the process or can be sold).

4. COST: For each of the inputs and outputs, identify the costs associated with them. Hints for completing the materials and energy flow analysis include:

- Consult with employees who are involved in each step of the process.
- Examine your receipts and bills to identify how much each input and output costs you incur at each step. Be sure to include any regulatory fees or disposal costs. Keep track of your costs per month or per year (convert unit costs to costs per month or year).
- Be sure to include intermittent steps and their inputs and outputs (for example: periodic cleaning).

Your processes may be more complicated than the three linear steps shown above. This coarse scale example is simply meant to get you started. The following Example 4 table illustrates how inputs, outputs, and related costs can be identified.

Example 4: Sample Input-Output Analysis Table

INPUT:	COST:	INPUT:	COST:	INPUT:	COST:
Energy (yarder & chain saw fuel, electricity for water pumps sprinklers)	(Energy bill or cost of bio-generated energy)	Energy (fuel for forklifts, power for plant/equipment)	Energy/fuel bills or cost of bio-generated energy)	Energy/fuel bills (fuel for forklifts, power for plant/equipment)	Energy/fuel bills (kiln drying power derived from step 2 waste or cost for natural gas)
Logs	Purchase price, or internal cost	Logs	Internal costing	Green Lumber	Internal costing
Air	Cost of air delivery systems	Air	Cost of air delivery systems	Air	Cost of air delivery systems
Water (log deck sprinklers)	Water costs ($/gallon, energy for pumping, conditioning)	Water (boiler, high pressure water debarker)	Water costs ($/gallon, energy for pumping, conditioning)	Water (boiler)	Water costs ($/gallon, energy for pumping, conditioning)
Labor (Log yard personnel and admin.)	Wages & benefits	Labor (Production and admin.)	Wages & benefits	Labor (Includes Sales, production & Admin.)	Wages & benefits
Capital equipment (yarder, infrastructure)	(Time value of money/interest, taxes)	Capital equipment (plant & equipment)	(Time value of money/interest, taxes)	Capital equipment (plant & equipment)	(Time value of money/interest, taxes)
Consumables (lubricants, replacement parts, etc.).	Cost of materials	Consumables (lubricants, replacement parts, etc.)	Cost of materials	Consumables (Steel strapping & "paper" (Plastic) wrap	Cost of packaging materials
				Transportation of lumber to customer	Fuel, equipment and labor

STEP 1: Receive And Manage Materials		STEP 2: De-Bark and Saw Logs to Size		STEP 3: Dry/Surface Lumber and Ship to Customer	
OUTPUT	**COST:**	**OUTPUT:**	**COST:**	**OUTPUT:**	**COST:**
Slash at remote log deck	Costs to burn, chip or redistribute woody material on forest floor.	Waste bark, saw dust, log trims	Recycled for heat or bio-energy production, or sold for bark dust.	Planer shavings, saw dust and trim ends.	Sold (recycled) as by-product for composite products, such as particleboard.
Air emissions	Emission controls	Air emissions	Emission controls	Air emissions	Emission controls
Water emissions	Process and/or condition water from log yard run-off	Water emissions	Process and/or condition water for plant boilers system, debarker	Water emissions (kiln emissions)	Process and/or condition water for boiler system and
Non-recyclable worn parts and consumables	Landfill charges and cost of consumables	Non-recyclable worn parts and consumables	Landfill charges and cost of consumables	Non-recyclable worn parts and consumables	Landfill charges and cost of consumables
Recyclable worn parts (metal/other).	Revenue for scrap metal. Sorting costs and transportation for recycling.	Recyclable worn parts (metal/other).	Revenue for scrap metal. Sorting costs and transportation for recycling.	Recyclable worn parts (metal/other).	Revenue for scrap metal. Sorting costs and transportation for recycling.
				Carbon sequestration	Value of tying up carbon in the form of lumber for the life of the lumber.
				Lumber (may be sold green or kiln dried)	Costs to acquire logs, manufacture, deliver lumber.
					Value: recyclable, biodegradable product at end of useful life.
				Packing materials	Processing metal banding for recycling. Handling costs and disposal fee for "paper" (plastic) wrap
				Satisfied Customer	None

Example 5.1 Input-Output and Process Map for Plywood (Collins Pine)

Collins Pine developed this input-output process map and developed eco-indicators related to each step.

Plywood Manufacturing Process Mapping and Eco-indicators
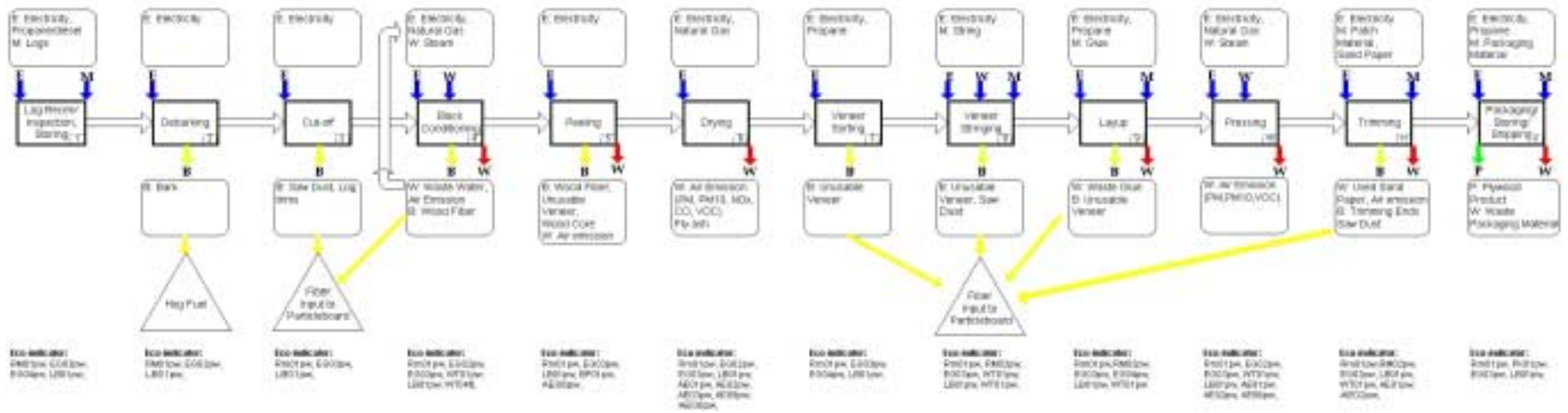
Example 5.2 Input-Output and Process Map for Hardboard Siding (Collins Pine)

Collins Pine developed this input-output process map and developed eco-indicators related to each step.

Hardboard Siding Manufacturing Process Mapping and eco-indicators

Example 5.3 Input-Output and Process Map for Particle Board (Collins Pine)

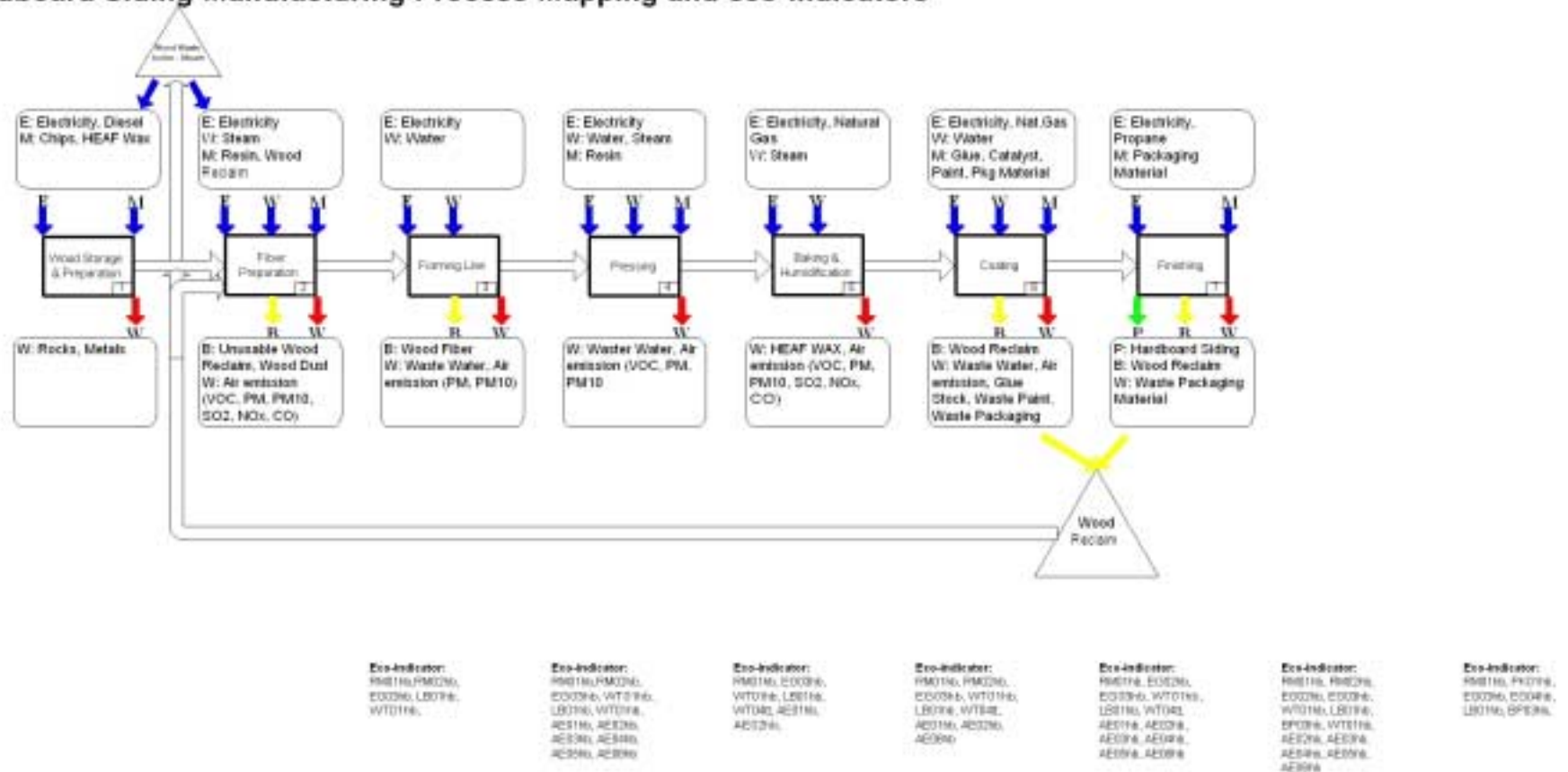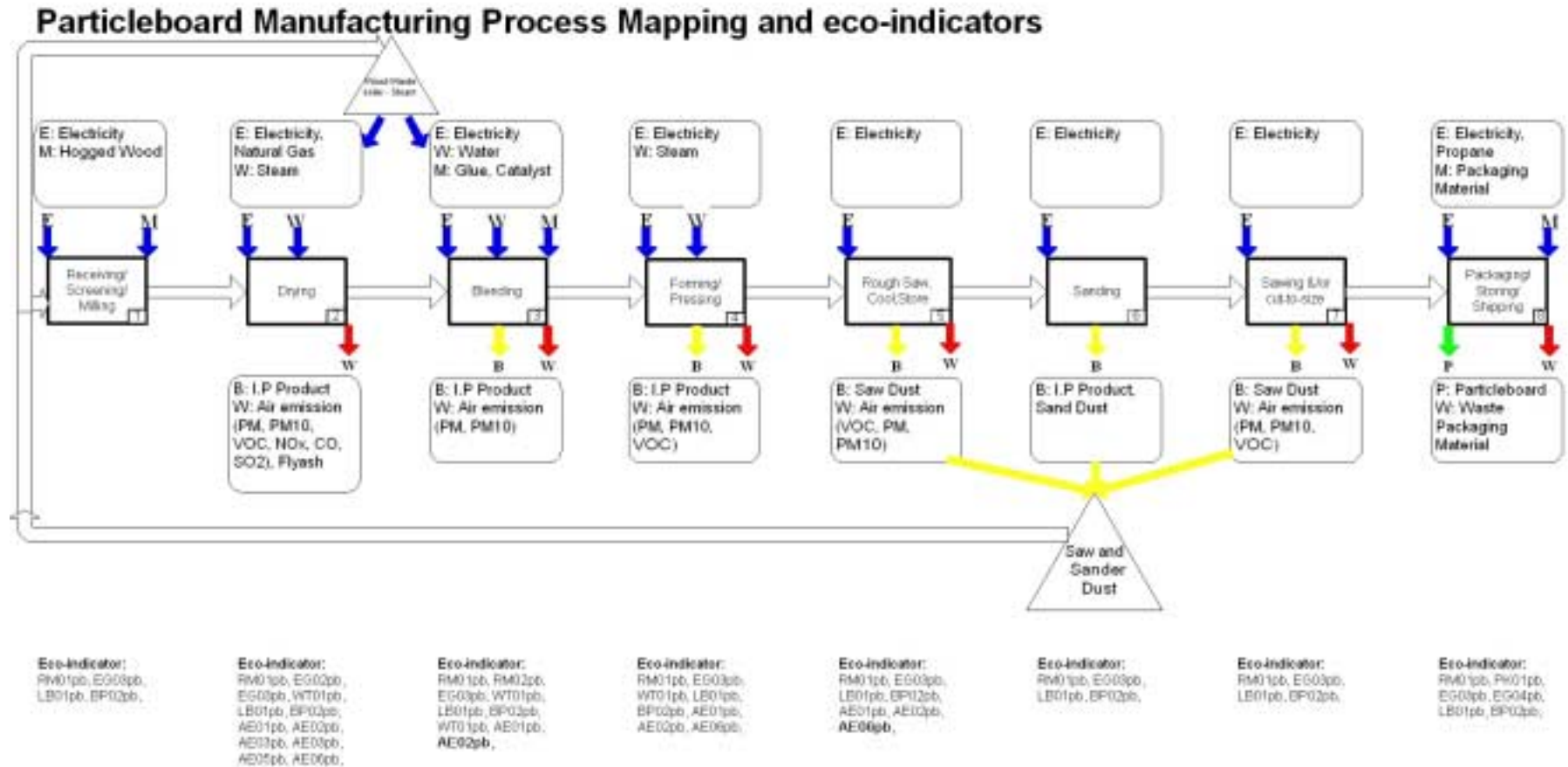Collins Pine developed this input-output process map and developed eco-indicators related to each step.

Particleboard Manufacturing Process Mapping and eco-indicators

Example 6: Using TNS Principles at Collins Pine

The following is largely quoted from the Collins Company website, See:
http://WWW.COLLINSWOOD.COM/M3_HistoryPhilosophy/M3H2_NaturalStep.html

The Natural Step The Natural Step (TNS) is an international environmental organization founded in 1989 by the Swedish cancer researcher and physician, Dr. Karl-Henrik Robért. Its objective is simple: to get individuals and businesses to conserve natural resources by moving away from wasteful, toxin-spreading methods of materials handling and manufacturing processes. Decisions are evaluated against four scientific principles and four system conditions.

The four scientific principles are:
- Matter and energy cannot appear or disappear
- Matter and energy tend to spread spontaneously
- Material quality is in concentration and structure of matter
- Net increases in material quality on Earth are generated almost entirely by sun driven, photosynthetic processes

The four system conditions are:
- Does the action reduce the use of finite mineral resources?
- Does the action reduce the use of long-lived synthetic products or molecules?
- Does it preserve or increase natural diversity and the capacity of ecocycles?
- Does it reduce the consumption of energy and other resources?

By 1998, Collins completed the process of certifying our forests in California, Pennsylvania, and Oregon under the principles and criteria of the Forest Stewardship Council. The next step was to examine the long-term environmental effects of our decision making in every aspect of business practices. The company began the TNS training in 1997 at Collins Products LLC, a composite plant in Klamath Falls, Oregon. Since then, they have introduced these principles to other facilities. Each project undertaken is weighed against the short- and long-term economic impacts and the Four System Conditions.

The Journey to Sustainability (JTS) training/coordinating team developed a training manual and procedures to train all employees at Collins Products in Klamath Falls. All employees have received basic training. All capital project requests are now reviewed by the JTS Committee for fit with the Four System Conditions of The Natural Step. The team initiated the following changes:
- A no paper fax system has been installed on one of our computer network servers.
- A plant-wide cardboard recycling system is under study.
- Now using printer/copier paper that is 80% recycled fiber.
- A team is studying alternatives to paper towels in restrooms and work areas.
- Developing a method to track the economic and environmental impact of various projects that are implemented.
- A product evaluation team is reviewing all products in use and new products against JTS standards.
- Several areas of grass and trees have been planted on the site and non-contact cooling water is being used or will be used to irrigate those areas.
- A water conservation team is now actively studying plant water usage and seeking ways to reduce, reuse, and recycle water.
- Investigating the use of sanitary and industrial sewer discharge to irrigate agricultural crops.
- An energy team has been formed to monitor and reduce energy usage.

Example 7: CWCH's Modified Sustainability Principles

The following table elaborates on principles of sustainability as used by the PSU Center for Watershed and Community Health. They are modified from The Natural Step, ZERI and principles of Industrial Ecology

1	*Conserve, protect, and where needed, restore the productivity and diversity of nature (ecological processes and structure) to levels necessary to maintain ecological health (with special focus on key areas such as riparian areas, floodplains, wetlands, native plant habitats etc).*	Why? Because ecosystem science shows that human health and prosperity depends on the ability of nature to produce a continued supply of physical goods (wood, water, fish) and ecological services (e.g. clean air and water) and on nature's ability to assimilate human waste and turn them into new resources. Today, many resources and ecosystems in Oregon are below the levels needed to provide these goods and services in perpetuity.
2	*Reduce the use and emission into nature of toxic minerals, metals and fossil fuels and synthetic, persistent toxic materials and substances and enhance the use of renewable energy and non-toxic materials and substances in processes, goods and services.*	Why? Because the first and second laws of thermodynamics show that to maintain ecological health toxic materials must not be discharged into nature faster than nature can break them down and reintegrate them into natural cycles. Today, we are emitting toxic materials and substances faster than nature can assimilate them (which causes pollution).
3	*Eliminate waste through reduction at the source and enhanced reuse, remanufacturing and recycling internally within and externally between agencies, institutions and businesses.*	Why? Because to meet the first two principles, materials and substances must be used as efficiently as possible to prevent the overharvest of natural resources and to reduce the discharge of waste and pollution into nature faster than nature can assimilate them.
4	*Increase the efficiency by which natural resources and energy are extracted, processed and used by a factor of ten or more.*	Why? Because to meet the first two principles materials and substances must be used as efficiently as possible to prevent the overharvest of natural resources and to reduce the discharge of waste and pollution into nature faster than nature can assimilate it.
5	*Enhance business development, economic competitiveness, job creation, and fairness in the distribution of resources to meet basic human needs, public safety, health care, and education consistent with the principles above.*	Why? Because to meet all the principles above, Oregon must have healthy economies and communities which benefit all Oregonians. Everyone must be included in Oregon's prosperity to ensure social equity and cooperation, which will lead to better support for and involvement in sustainability programs. This principle is perhaps the most important in terms of setting the overall framework for linking environmental, economic and social goals.

Example 7 (Continued): Other Sustainability Principles

THE CERES PRINCIPLES: COALITION FOR ENVIRONMENTALLY RESPONSIBLE ECONOMIES (formerly the Valdez Principles) http://www.ceres.org/

Protection of the Biosphere: We will reduce and make continual progress toward eliminating the release of any substance that may cause environmental damage to the air, water, or the earth or its inhabitants. We will safeguard all habitats affected by our operations and will protect open spaces and wilderness, while preserving biodiversity.

Sustainable Use of Natural Resources: We will make sustainable use of renewable natural resources, such as water, soils and forests. We will conserve non-renewable natural resources through efficient use and careful planning.

Reduction and Disposal of Wastes: We will reduce and where possible eliminate waste through source reduction and recycling. All waste will be handled and disposed of through safe and responsible methods.

Energy Conservation: We will conserve energy and improve the energy efficiency of our internal operations and of the goods and services we sell. We will make every effort to use environmentally safe and sustainable energy sources.

Risk Reduction: We will strive to minimize the environmental, health and safety risks to our employees and the communities in which we operate through safe technologies, facilities and operating procedures, and by being prepared for emergencies.

Safe Products and Services: We will reduce and where possible eliminate the use, manufacture or sale of products and services that cause environmental damage or health or safety hazards. We will inform our customers of the environmental impacts of our products or services and try to correct unsafe use.

Environmental Restoration: We will promptly and responsibly correct conditions we have caused that endanger health, safety or the environment. To the extent feasible, we will redress injuries we have caused to persons or damage we have caused to the environment and will restore the environment.

Informing the Public: We will inform in a timely manner everyone who may be affected by conditions caused by our company that might endanger health, safety or the environment. We will regularly seek advice and counsel through dialogue with persons in communities near our facilities. We will not take any action against employees for reporting dangerous incidents or conditions to management or to appropriate authorities.

Management Commitment: We will implement these Principles and sustain a process that ensures that the Board of Directors and Chief Executive Officer are fully informed about pertinent environmental issues and are fully responsible for environmental policy. In selecting our Board of Directors, we will consider demonstrated environmental commitment as a factor.

Audits and Reports: We will conduct an annual self-evaluation of our progress in implementing these Principles. We will support the timely creation of generally accepted environmental audit procedures. We will annually complete the CERES Report, which will be made available to the public.

Example 8: New Product Lines: Using Small Diameter Stands for Veneer Production

The Applegate Watershed in Oregon consists of dense, overstocked stands of ponderosa pine, Douglas-fir, white fir, and Shasta red fir. By finding economical and value-added uses for this material, foresters can offset management costs. The USDA Forest Service, Pacific Northwest Experiment and Range Research Station, with cooperation from both the Forest Products Laboratory and State and Private Forestry in Region 6, examined the relationship between nondestructive[6] evaluation of small-diameter timber in the Applegate Watershed and wood product quality. Researchers also examined the potential of producing veneer from this resource. They concluded that the properties of this veneer make it suitable for the manufacture of engineered wood products, such as laminated veneer lumber (LVL).

Collaborators selected sample sites and 25 sample trees of each of three species (ponderosa pine, Douglas-fir, and white fir). The sound wave characteristics of both tree-length and short logs were nondestructively measured. The logs were then taken to a mill where they were cut into veneer and processed into LVL. The quality of the veneer, as determined by ultrasonic grading, was compared to the quality of the logs from which the veneer was made.

The ponderosa pine portion of the study has been completed. Data analysis for Douglas-fir and white fir is in progress.

Information to date indicates that the quality of the veneer produced from small-diameter trees is similar to the quality of veneer produced from old growth. Measurements from both short and tree-length logs correlate strongly to comparable measurements made on veneer obtained from those logs. These findings suggest that small-diameter timber is suitable for the manufacture of LVL. In addition, the collaborators have shown that the quality of logs can be assessed more accurately before they are processed into veneer. This results in more efficient use of the resource and a cost savings to LVL manufacturers. (Quoted from http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr110.pdf page 18)

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[6] See Example 13 for a description of nondestructive evaluation.

Example 9: Generating New Revenue through Environmental Efficiency and Resource Productivity

Louisiana-Pacific Corp is participating in Oregon's Department of Environmental Quality green permit program. The program allows businesses to receive special treatment from state regulators for exceeding regulatory standards. For instance, they may not be subjected to as many inspections and may be able to file status reports in a more flexible manner. At Louisiana-Pacific's wood-products plant in Hines, Oregon, an environmental program has cut toxic-air emissions to only 10 percent of the total annual levels allowed by Oregon law. In addition, Louisiana-Pacific officials say they now make about $100,000 annually selling wood shavings to recyclers; previously it cost the company about $100,000 a year to dispose of them. The companies also can save money by not having to spend so much time on regulatory matters. (See the Wall Street Journal, 12/8/00)

Example 10: Generating New Revenue By Finger-Jointing Woodscraps.

There are numerous strategies for adding value to processing waste. Some companies use wood scraps to make, for example, chop-sticks, sushi trays or desk organizers. Finger-jointing scraps into longer pieces, doors, or molding adds the most value. In the US, scraps used as boiler fuel generate $14 to $24 per million board feet; as inputs for paper making $50 to 125; and as shipping pallets $200. But when they are converted to finger-jointed moldings they command $1,250 to $1,350 (Abromovitz & Mattoom 1999, 65).

Example 11: US Eco-industrial developments and spatial business clusters

In four US locations, demonstration parks are exploring ecoindustrial development's obstacles and opportunities. Brownsville, Texas and adjoining Matamoros, Mexico are examining how port neighbors - a refinery, a stone company, an asphalt company, and tank farms - might interact to curb local environmental problems. Baltimore's Fairfield Eco-Industrial Park (EIP) is a heavily industrialized demonstration site, mainly petroleum and organic chemical companies. Fairfield EIP initiatives include joint pollution prevention and waste reduction strategies and R&D for materials substitution and replacement. The Port of Cape Charles Sustainable Technologies Industrial Park is in rural Northampton County, Virginia. The park leaders hope to attract aquaculture firms, resource recovery industries for agricultural materials, hydroponic gardens, organic farms, and ecotourism companies. Its first tenant is Solar Building Systems, Inc. The Chattanooga Eco-Industrial Park Initiative includes four components - a brownfield reclamation park, a mixed-used site, an ecoindustrial park, and an environmental technology complex. (Quoted from Greenclips; See In Business, November/December 1995, p. 39, by Joe Abe.)

Example 12: Creating Partnerships With Local Businesses … Energy Production from Wood Wastes

"In 1980, the Jack Daniel Distillery in Lynchburg, Tennessee, installed two wood-coal-oil-gas fired boiler systems. The systems were designed to use primarily green wood wastes from area sawmills and lumber yards. This project also has been an economic success. In Concord, New

Hampshire, wood heat supplies energy for several state office buildings. In central Minnesota, Iron Works, Inc., installed a wood-powered combustion system in 1982. Boilers are connected to a steam distribution system and the steam is piped underground to 16 buildings. Customers include a church and rectory, public school, fire department, public utilities building, bank and pizza parlor. The Georgia Forestry Commission is a leader in establishing wood-burning installations among the state's industries and restitutions. Among its projects are a 25-million Btu/h gasifier at the Northwest Georgia Regional Hospital in Rome, and a 30,000-pound/h steam system at the Georgia Industrial Institute in Alto." See Biofuels: production and potential. Zerbe, J.I. Forum for Appl. Res. and Public Policy J. 3(4):38-47.1988. at http://www.fpl.fs.fed.us/documnts/pdf1988/zerbe88a.pdf page 41. This report provides details on a range of biomass energy production technologies; their advantages and disadvantages.)

Example 13: Innovations In Wood Products Technologies Yield Efficiencies and Reductions in Environmental Impact

Staff at the Forest Products Laboratory at the University of Wisconsin have written about the role of forest products utilization technologies in sustainable economies. The tables below summarize critical areas of innovation and research. The following paraphrases or quotes from the report: The Next Century of Wood Products Utilization: A Call for Reflection and Innovation Youngquist, John A.; Hamilton, Thomas E. 1999. In: Proceedings, ICEUPT'99: international conference on effective utilization of plantation timber-"timber and wood composites for the next century;" 1999 May 21-23; Chi-Tou, Taiwan ROC. Taiwan ROC: Forest Products Association of ROC. 16: 1-9. (See http://www.fpl.fs.fed.us/documnts/pdf1999/young99b.pdf)

Wood Products Engineering and Quality Assessment

Oriented Strandboard (OSB)	Composite technologies are generally more flexible in type and quality of material used than are solid lumber wood products. One composite experiencing remarkable growth is oriented strandboard (OSB), a product made from wood particles aligned to obtain the best engineered properties. OSB is being used in place of plywood because of the difficulty of getting veneer-grade logs and because it can be made from a wide variety of species and sizes. OSB now represents more than 25% of the structural panel market, and the demand continues to grow. The raw materials for many OSB manufacturing plants are underutilized species like aspen and yellow-poplar.
Non-descructive Evaluation (NDE) Technology	NDE can be used to determine the stillness and strength of a piece of lumber, which reduces dependence on visual grades (which are species dependent) in favor of mechanical grading (which is species independent). Mechanical grading can allow a wider range of species to be substituted for structural applications, as long as certain stiffness and strength requirements are achieved.
Laminated Veneer Lumber (LVL)	Laminated veneer lumber (LVL) is one type of structural composite lumber that requires veneers from large- or moderate-sized logs. Veneers for LVL are nondestructively evaluated using stress wave technology. LVL has the potential for very high-strength products and is most economical for high-strength applications. The same processing technologies are used for oriented strand lumber (OSL) as for OSB, but OSL has somewhat lower engineering properties than LVL. These engineering properties will likely improve with new and better technologies.

Recycling and Reuse Technologies

Wastepaper to paper	Recent innovations and research have focused on technologies to remove contaminant, inks and adhesives. New ways of recycling many grades of paper (e.g. magazines) have resulted in increased recycling.
Wastepaper and wood wastes to composites	Industry groups are focusing on products such as molding and insulation.
Wood reuse	Companies are re-milling and reselling wood from construction, deconstruction and demolition projects. Companies are also marketing wood-fiber plastic composites for a variety of uses.
Treated wood products	Research has focused on ways to eliminate toxics from preservatives and find appropriate end-uses for treated wood (e.g. telephone poles to energy).

Alternative Processing Techniques and Chemical Substitutes for Toxics

Alternative ink and pigments	There have been rapid reductions in heavy metal content of inks and pigments.
Biopulping Technologies	White-rot fungi, such as Phanerochaete chrysosporium and Ceriopsus subvermisporia, are able to remove lignin, the "glue" that holds fibers together. Research is being conducted to pretreat wood chips with C. subvermisporia prior to mechanical pulping to reduce energy consumption during pulping and increase papermaking properties compared to those of untreated mechanical pulp. Research work has decreased the time necessary to pre-treat wood chips from 6 to 8 weeks to 2 weeks. In addition, fungal pretreatment has been demonstrated to be effective in large (50-ton) chip piles using only 5 grams of fungal inoculum per ton of chips. The treatment can be conducted even in the winter because the metabolic heat of the fungi warms the wood chip pile. Energy savings of about 30% are realized compared to that from untreated controls. Treating pulp with enzymes produced by white rot fungi also appear to make it possible to whiten paper with peroxides.
Polyoxometalate (POM) chemistry.	The second research approach by the Forest Product Laboratory involves the use of polyoxometalate (POM) chemistry. The POMs are a class of chemical compounds that react very specifically with lignin. They are nontoxic and reusable, and they can bleach pulp without attacking cellulose and hemicelluloses or weakening fiber structure. As a result, they do not reduce paper strength properties. POMs also oxidize the organic byproduct compounds produced during bleaching operations, making possible *effluent-free* (closed-mill) bleaching. The only byproducts from POM bleaching are water and carbon dioxide. POMs greatly reduce the environmental impacts of pulp bleaching and its associated economic costs.
VOC reductions in adhesives and finishes	The Forest Products Laboratory is also involved in developing new technologies that will help eliminate the use of VOC-based solvent systems for finishing and protecting wood from weathering and decay. Research is investigating new water-based solvent systems as well as determining the surface degradation mechanisms by which wood and wood-based materials weather. By understanding the mechanisms involved and combining this with knowledge of the performance of water-based solvent finishing systems, new aqueous and dry-powder finishing systems can be devised that do not negatively impact the environment or adversely affect human health.

Example 14: Sustainability Management Teams at Collins Products

TEAM	*MISSION*
Journey to Sustainability Core Team	Be a persistent, positive force in the pursuit of sustainability both at Collins Products and in the communities where we live. Coach and guide teams by utilizing the principles of The Natural Step.
Recycle Team	Actively pursue recycling opportunities for CP and our employees with the focus on identifying and eliminating waste to the landfill.
Energy Team	Reduce total energy consumption on the plant site.
Water Ecological Equilibrium Team	Assure the highest and best ecological use of water on the plant site.
Product Evaluation Team Mission	Evaluate new and existing products purchased for plant site use to assure minimum negative impact on our environment.
Adopt-A-Highway Team	To control litter and improve the appearance of highway 66 between mileposts 55 and 58.

Example 15: AssiDomän's 1999 Environmental Report

AssiDomän's environmental report focuses on sustainability and resource efficiency. The report lays out the company's environmental policy and strategy. Sustainable yield forest management techniques, operations and transport systems eco-efficiency, market integration through certification systems, and community integration through cooperation are clear components of this strategy. The environmental report is organized around prioritized areas for improvement, measurable objectives stated as targets, and key ratios[7]. The prioritized areas and some performance highlights are show here:

(See http://www.asdo.se/english/pdf/annualreport99_2.pdf)

Prioritized Areas

- Environmental Key Ratios (indicators)
- Ecological Cycles
- Acidification (air pollution contributions to acid rain)
- Energy
- Transportation Impacts
- Products (how core products fit with sustainable development concepts)
- Environmental Management
- Communication and Cooperation (International, Regional, Local)

Highlights

- The company felled less than total fiber growth (68%)
- The key ratio for emissions of acid-forming substances (i.e. acid-forming equivalents in relation to value added) decreased by 24% from 1998 to 1999.
- The proportion of renewable raw materials in the company's products is 97%
- The source of 63% of the company's total energy consumption is biofuels
- At year-end 1999, environmental management systems certified according to ISO 14001 and/or registered according to EMAS were in place at operations corresponding to 64% of the Group's net turnover.

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[7] What we might refer to as indicators with a specified metric

Example 16: Sample Sustainability indicators, metrics and targets

Indicator	Target and Metric
Reduction of the usage of toxic materials:	30% reduction of aluminum sulfate use (29,356 to 20,549 lbs)
Reduction in hazardous waste generation:	20% Reduction of lead filter cake waste (79,627 to 63,701 lbs)
Reduction of solid waste generated:	15% reduction of solid waste/increase of reuse and recycling from 312 to 265 cubic yds
Reduction of the use of natural resources:	5% reduction in the use of water from 8.643 M to 8.210 M gal/year
Mass Intensity Metric:	Total Mass (in raw materials, products, packaging) per $ Value of Product Sold
Energy Intensity Metric:	Total BTUs conversion energy consumed/$ value of product output
Green House Gases	Kg. CO_2 equivalents/$ Value of product sold

APPENDIX B

Exercises: Planning Your Sustainability Initiative

Appendix B, Section 1:

Describe your firm's directives and framework policy on resource productivity/sustainability here:

Appendix B, Section 2:

Describe how your company or facility might assess its footprint here:

Appendix B, Section 3:

Explain your resource productivity/ sustainability visions, goals and targets for your firm or facility:

Brainstorm materials savings, cost savings and new product lines your company may be able to generate here:

Appendix B, Section 4:

Describe your resource productivity/sustainability implementation priorities, team structures and plans here:

Appendix B, Section 5:

Use Appendix A, Examples 15 and 16 and your Section 2 assessments to help you to formalize indicators and metrics for your resource productivity/ sustainability program:

APPENDIX C

Glossary Of Sustainable Development Terms[8]

Airshed – the geographic region in which air pollutants tend to aggregate. Generally defined by the characteristics of the source -- either ground-level emissions or elevated plumes from industrial stacks -- and by the surrounding topography and local wind flows.

Backcasting – the technique of identifying desired outcomes first and then backing-up to identify the types and sequences of changes in processes, systems, and management practices required to achieve the desired outcomes. Term used as a comparison to "forecasting" which focuses on incremental steps forward without a stated clear long-term goal. Also called outcome-based planning.

Baseline – information that provides a measurement against which future changes can be compared. Indicators are measured for the baseline year and then again in subsequent years.

Biodiversity – describes all aspects of biological diversity including species richness, ecosystem complexity, and genetic variation. Biodiversity is both a measure of the variety of life and an indicator of the overall health of our planet. Scientists have counted about 1.4 million species to date.

Brundtland Commission – The United Nations World Commission on Environment and Development was named the Brundtland Commission when it was chaired by Prime Minister Gro Harlem Brundtland of Norway. The commission promulgated the commonly used definition of sustainable development in its publication of *Our Common Future* (1982) and in the UN Agenda 21 process (1992).

Business Networks or Clusters – businesses located in close physical proximity to each other for mutual gain. For example, clustering allows one business's waste to be used by another as a raw material, avoiding transportation costs. To be successful, such clusters usually require a diversity of businesses with varying inputs and outputs.

Closed-loop Production (also called Zero Waste or Zero Emissions Systems) – manufacturing systems that fully utilize all energy, water and raw materials in a circular process generating little to no waste or pollution.

Community Sustainability – communities are sustainable when they use and waste resources consistent with the definition of sustainable development below and when community members' basic needs are met consistently over time. Communities must work cooperatively with other communities to fairly distribute resources and responsibilities to achieve broad-based sustainability.

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[8] Source for some definitions: Allaby, Michael 1994. *The Concise Oxford dictionary of ecology.* New York: Oxford University Press.

Continual Improvement – an organizational strategy of constantly tracking and evaluating organizational performance and implementing improvement measures.

Criteria – metrics used to evaluate policy and program development alternatives. For example, cost-minimization and/or toxics-use minimization might be criteria for choosing whether to use PVC piping on community infrastructure.

Detoxify – removing toxic substances and materials from products, processes, buildings and practices.

Downcycling – using materials and energy for lower value uses than their characteristics allow. For example, mulching waste paper for fertilizer may represent a loss in value compared to recycling the material for newsprint.

Ecology – referred to here as: a) the science of the relationships between organisms and their (living and non-living) environments; b) the study of the detrimental effects of modern civilization on the environment, with a view toward prevention or reversal through conservation.

Ecosystem – an ecological community together with its environment, functioning as a unit. A discreet unit consisting of living and non-living parts, interacting to form a stable system. Fundamental concepts include flow of energy via food chains and the yield of nutrients biogeochemically. Ecosystem principles can be applied to all scales. Principles that apply to an ephemeral pond, for example, also apply to a lake, ocean or whole planet. Ecologists study different interrelated ecosystems. For example, a forest ecosystem may be a subset of a larger watershed ecosystem.

Ecosystem Health – when healthy, an ecosystem is able to self-repair after major disturbances such as fires, floods, draught, and major insect infestations. Ecosystems are not static – their characteristics change over time. For example, sometimes there is more old growth species and sometimes less in a forest ecosystem. However, ecosystems can be considered healthy when the characteristic of the system are within normal high and low ranges. Ecologists have been able to identify the "normal ranges of variability" of many ecosystems.

Efficiency – the amount or value of output relative to the amount or value of input needed for the production of goods and services.

Emission – the amount of liquid, gas or solid expelled from a given source per unit of time and space; often refers to pollution.

Feedstocks – raw materials used in production processes.

Firm Sustainability – for the purposes of this template, firms can be considered sustainable when they adopt management policies, principles and practices that reduce and eliminate environmental impacts to specific, measurable target levels.

(Ecological) Footprint – the full extent of an entity's (household, individual, firm, community, state) impact on local, regional and global ecosystems. Ecological footprints are often reported in terms of land units: the amount of land required to provide humans with food, fiber, and assimilation of carbon gases. The per-capita amount of land required to sustain the average North American is estimated at 12 acres.

Green Buildings (also called sustainable construction) - building and site design techniques that improve the quality and performance of buildings while simultaneously reducing stress on the environment (Portland, Oregon, Green Building Initiative). Generally includes high energy and water efficiency measures, use of non-toxic materials and substances (e.g. glues and paints), use of certified sustainable and reused materials such as wood, localized treatment of stormwater runoff, and other measures.

Habitat - The area or type of environment in which an organism or ecological community normally lives or occurs.

HVAC – abbreviation for heating, ventilation and air conditioning.

Indicators – quantitative and qualitative data used to track and measure trends.

Input-Output Analysis – The analysis of the nature (type, amount, costs) of materials and substances used in, and the nature of materials and substances discharged or emitted at the end of, production or operational processes. Inputs might include raw materials, energy and water. Outputs might include waste materials, final products, and pollution (which is a molecular form of waste). Process analysis can reveal opportunities for reductions in costs and environmental impact.

Natural Capital – natural resources and ecological systems that provide life support services. Despite their importance, many such services have no current market value.

Performance-based Systems – (also called outcome-based systems) an alternative to what is known as "command and control" management or regulation. Performance-based systems prescribe specific outcomes and allow the managed or regulated community to devise the implementation strategy to achieve the outcomes. Performance-based zoning, for example, would prescribe outcomes like appropriate noise, pollution, or traffic levels in zones rather than designating the zones "commercial" or "industrial". A performance-based management strategy would specify certain outcomes, like reducing energy use by 10%, and allow staff to figure out how to achieve them.

Pollution – a by-product of human activity that enters or becomes concentrated in the environment where it may cause injuries to humans, ecosystems or species. In addition to the chemical substances, the term also embraces noise, vibration, and alterations to ambient temperatures. Air emissions and water discharge pollution are molecular forms of waste.

Principles – a fixed or predetermined policy or mode of action to guide action.

Principles of Subsidiarity – the idea that governmental functions should be allocated to the lowest level of government possible - the level that is closest to the problem or issue, or to the level that can most effectively resolve the issue or problem. This idea is similar to federalism.

Procurement – obtaining goods and services required to fulfill the functions of firms or government.

Recycling – to break down a product into its original material components and reprocesses into new materials. Recycled glass bottles are typically crushed, melted and re-fabricated.

Reduce -- to cut out unneeded inputs (of energy, raw materials etc).

Remanufacturing -- to refurbish a product and use it again for the same purpose.

Reuse – to use a material or product again in the same form. Reused bottles are simply washed and refilled.

Riparian – the area of vegetation and habitat that is the interface between an aquatic and terrestrial (land based) ecosystem. Of, on, or relating to the banks of a natural course of water. Intact riparian areas are crucial for water quality, fish habitat, habitat for terrestrial and avian species, the prevention of soil runoff and other functions.

Social well-being – a state of wellness that occurs in society when basic human needs are met. These needs include access to resources (high quality water, food, shelter); health-care, education, self-determination, and vibrant social networks. Sustainable development strategies tend to prioritize social well-being over more abstract notions of economic growth. When economic policy narrowly supports growth, it is possible for social well-being to decline. (See http://www.cyberus.ca/choose.sustain/Question/GPI.html)

State of the Environment Report (SOER) – a report that assesses the conditions of environmental resources and ecosystems, on which a community or state is dependent. The SOER can also report on the community's impact on those resources and ecosystems and evaluates policies that mediate that impact.

Sustainable Development (also called sustainability, resource efficiency, resource productivity) – The concept was introduced in the late 1970s and was emphasized strongly in the World Conservation Strategy published in 1980 by the IUCN (the World Conservation Union) in collaboration with the UN Environment Program and the WWF. *Our common future* (the Bundtland commission) defined it as 'development that seeks to meet the needs of the present without compromising the ability to meet those of the future'. Elsewhere the commission defined sustainable development as 'using, developing, and protecting resources at a rate and in a manner that enables people to meet their current needs and also provides that future generations meet their own needs'. In practical terms it means applying policies, programs and practices aimed at achieving zero habitat impacts, zero emissions and zero waste.

Target – a specific objective to be achieved at a determined time (e.g. to decrease solid waste by 10% in 3 years).

The Natural Step – a primarily business-centered organization with an approach to sustainability focusing on four "system principles" (see http://www.naturalstep.org/)

Total Resource Productivity (TRP) – obtaining the full value when using materials; when achieving zero waste there is total resource productivity; when any kind of waste occurs, it is used to create value in other businesses.

Toxic – of, relating to, or caused by a toxin or other poison; capable of causing injury or death, especially by chemical means; poisonous.

Upcycle – using resources or wastes in a way that increases their value. For example, turning spent grain into substrate for mushroom production rather than using it for animal feed adds value - upcycles - the waste material.

Value-added – the value that is gained when transforming a product or resource in some way. The market value-added of a loaf of bread is equal to its market value minus the combined market value of flour, yeast and water.

Watershed - a ridge of high land dividing two areas that are drained by different river systems; a land region draining into a river, river system, stream, or other body of water. A watershed is actually an ecosystem composed of many types of habitats (forests, grassland, aquatic) that are connected by (drained by) flowing water.

ZERI – the Zero Emissions Research Initiative. An international organization founded by the United Nations University in Japan focused on creating zero waste and emissions economic development projects. ZERI based projects are underway in Asia, Africa, Eastern Europe and elsewhere. The PSU Center for Watershed and Community Health is initiating ZERI based projects in Oregon (see http://www.zeri.org/)

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APPENDIX E

Selected Resources And Links

Abramovitz, Janet N. & Matton, Ashley T.. 1999. Reorienting the Forest Products Economy, Chapeter 4 in *State of the world 1999: a Worldwatch Institute report on progress toward a sustainable society.* Editor Linda Stark. 60-77. New York: WW Norton Company.

Miner, R. A. and Lucier, A. A.. 1994. Consideration in Performing Life-Cycle Assessments on Forest Products. *Environmental toxicology and chemistry* 13. 8. 1375-1380

U.S. Forest Products Annual Market Review And Prospects, 1999-2000. FPL-RN-278
http://www.fpl.fs.fed.us/documnts/FPLRN/fplrn278.pdf

Department of Agriculture Forest Service Forest Products Laboratory General Technical Report FPL–GTR–116 U.S. Timber Production, Trade, Consumption, and Price Statistics 1965–1997
http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr116.pdf

US Forest Service: Current And Projected Wood Energy Consumption in The United States
http://www.fpl.fs.fed.us/documnts/pdf1990/high90a.pdf
The Forest Service of the U.S. Department of Agriculture is directed under requirements of the Renewable Resources Planning Act of 1974 and the Renewable Resources Research Act of 1978 to make periodic assessments of the current and long-range demand for and supply of renewable resources from forest and rangelands in the United States. The Forest Service is preparing such an assessment with projections to 2040 to be published in 1989. The assessment of timber resource demand and supply has been prepared in draft form (13). This paper discusses one part of this assessment of the timber situation--the analysis of the demand for and supply of timber for energy.

Extending the Forest Resource: 90 Years of Progress at the Forest Products Laboratory. Zerbe, John I.; Green, Phyllis A.D. 1999. Forest History Today. (Fall)
http://www.fpl.fs.fed.us/documnts/pdf1999/zerbe99a.pdf
This document gives a good historical overview of technological change in the forest products industry. It documents ways the Forest Products Laboratory has worked with industry to improve resource efficiency and deal with environmental problems.

Industrial Wood Productivity in the United States, 1900-1998. Ince, Peter J. 2000. USDA Forest Serv. Res. Note FPL-RN-0272. 14 p.
http://www.fpl.fs.fed.us/documnts/fplrn/fplrn272.pdf
The productivity of U.S. wood and paper product output in terms of wood input is computed and displayed in graphs. Background tables provide supporting data. The productivity trend parallels trends in the recovered paper utilization rate. Recycling and wood residue use are key factors in productivity gains.