

Alternatives for Saving Energy, Chemicals, and Materials

If existing treatment processes are appropriate, efficient and functioning well; if the quality of water derived from its source and produced by the plant meet drinking water regulations and are of satisfactory quality, what steps can be taken to achieve economies in the use of energy, chemicals, and materials?

Water Conservation

Only if less water is produced will chemical use, sludge production, and the energy costs associated with water production decline. However, water conservation is an anathema to water utility management since the costs of operations must be paid for by the revenues produced by the sale of water. For example, water utility budget shortfalls often occur in those years in which adequate and timely rainfall reduce the peak summer demands for water.

If a community adopts water conservation as a step toward reduced consumption of resources and long-term system sustainability, enlightened municipal management is obligated to ensure that revenues for properly operating and maintaining their water system are secured even in the face of declining water use. In other words, rates must be managed to both promote conservation and maintain economic viability of the utility enterprise. This has recently been defined as *Full Cost Pricing*.

Full Cost Pricing

In 2006, the United States Environmental Protection Agency (USEPA) convened an expert workshop of academics, water utility executives, public utility commissioners, utility rate setting practitioners, and other responsible parties to explore the issue of *full cost pricing* for water and wastewater service.

Full cost pricing was defined as a pricing structure for drinking water and wastewater service that fully recovers the cost of providing that service in an economically efficient, environmentally sound, and socially acceptable manner. The goal of such a pricing structure is to *promote efficient water use* by customers. Full cost pricing is structured to provide the full costs of doing business; the annual revenue necessary to recover costs; and cost recovery through some combination of rates and charges.

Nationally, an estimated seventy percent of all water utility costs are fixed while approximately 25% are variable. However, the revenue structure is reversed; 72% of revenues are variable (i.e., based on quantity sold) and 28% are recovered through fixed charges on bills. Since conservation reduces demand and revenue but capital needs remain unchanged, it is necessary to re-examine rate structures. Decoupling is part of the answer to realizing the benefits of conservation.

Steps toward Sustainability

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." *Brundtland Report, United Nations. 1983.*

1. Appointment of Sustainability Coordinator and Steering Committee

- The establishment of a position (or the assignment of duties to an existing staff member) to advocate and build a coherent program focussed on sustainability; prepare annual sustainability report.
- *Sustainability Steering Committee* to create policy; formulate goals; assess progress in addressing water, energy, transportation, materials, and communications sustainability.

2. Human Resources:-Employee Selection, Training, and Development

- Establish hiring practices to ensure competent employees are recruited and hired.
- Ensure new employees are properly trained, equipped, and rewarded.
- Employee incentives: recognition for efficiency and innovation.,
- Provide employees free public transportation, specialized employee recycling center.,
- Establish employee performance measures with regard to sustainability criteria, planning, purchasing.
- Encourage modified work schedules to reduce time employees are driving.
- *Work Group exercises* to assess opportunities for:
 - increased resource use efficiency,
 - reduction in use of toxic materials,
 - reduced generation of waste,
 - reduced travel and fuel consumption;
 - examination of relationships between crews;
 - opportunities for improved interactions.

3. Customer Service Initiatives

- On-line delinquency notifications and billings to minimize customer travel and paper use.
- Use of *100% post-consumer waste recycled paper* for in-house copying and as stock for billing.
- Use of fixed-based automatic meter reading
 - to eliminate meter reader driving,
 - allow more frequent meter reading,
 - improve detection of leaks and malfunctioning meters.

4. Carbon Footprint (Greenhouse Gas Emissions) Reduction

Establishment of *carbon reductions emissions task force* to evaluate:

- 🌍 Modification of work schedules, flexible work schedules, telecommuting.
- 🌍 Fuel use: sizing of vehicle fleet, driving requirements (e.g., reporting directly to work sites).
- 🌍 Reduced electrical use by turning off equipment and lights when unused.
- 🌍 Materials used and possible replacements for toxic substances; minimization of waste streams.
- 🌍 Number, sizing, variable frequency drives on pumps; surge control to minimize main breakage.
- 🌍 Installation of solar heating and solar electricity panels.
- 🌍 Installation of wind turbines (if economically feasible).

5. Natural Step Framework (See attached history and description.)

- 🌍 Adoption of guidelines of system conditions for sustainability.

6. Water Use Efficiency (Conservation Programs)

- 🌍 Less water use results in less water treatment chemical usage, less sludge production, lower distribution pumping costs and reduced necessity for treatment works capacity expansions.
- 🌍 Reduced water consumption results in less wastewater production and waste treatment costs.
- 🌍 Substantial cost savings are realized from reduced *heat losses* from homes and businesses.
- 🌍 Passive water-saving devices: Flow restrictors on taps and shower heads; low-flow toilets.
- 🌍 Reductions in system pressures reduce total community water use.
- 🌍 Full-cost accounting and water-pricing policies can encourage conservation; Price-water demand schedules by season may be used to reduce peak water demands.
- 🌍 Water audits determine the amount of water lost from a distribution system due to leakage and the cost of this loss to the utility.

7. Participation in Federal and State Economic Stimulus Programs

- 🌍 Federal subsidies may reward readiness of community to install energy-efficient processes.

Organization of a Sustainability Program

Perhaps the single most important factor required for the development of an effective sustainability program is the appointment of a focussed and responsible director to coordinate the efforts of a cadre of workers who truly believe in the need for and objectives of the program.

To make a sustainability program successful, civic leaders (mayors, city council members, ...) must ensure the judicious selection of those who will be charged with defining and implementing the tasks leading toward sustainability. While primarily aimed at achieving economies, efforts to move towards sustainability may lead to unpopular restrictions on energy, fuel, and materials use. Conservation initiatives may require citizens to modify their lifestyles and perform additional tasks, such as separation of household wastes. Citizens may be required to consider their role in broader community efforts, and, even, reconsider their individual behavior.

Political support for sustainability initiatives that will inevitably result in changes in lifestyle is critical lest perceived inconveniences outweigh the benefits of community-wide conservation efforts. A community that is dominated by recalcitrant citizens who reject the concept that their current lifestyle is not sustainable is unlikely to achieve success with implementing sustainability programs.

A sustainability program may also benefit from the establishment of a *Sustainability Steering Committee* charged with recommending policy, formulating goals, and assessing progress in advancing towards water, energy, transportation, materials, and communications sustainability. The Committee may recommend employee incentives, promote voluntary efforts, and urge compliance with governmental controls to provide motivation for the program.

Natural Step Approach:

Questions to ask when deciding upon a decision or purchase.

The **Natural Step** is a nonprofit organization founded in Sweden in 1989 by Swedish scientist, Karl-Henrik Robèrt. The Natural Step has pioneered a "Backcasting from Principles" approach to effectively advance society towards sustainability. The Natural Step has developed through a consensus process a systematic principle definition of sustainability.

Following publication of the Brundtland Report by the United Nations in 1987, Robèrt developed The Natural Step framework, setting out the system conditions for the sustainability of planet Earth. Dr. Robèrt's four system conditions are derived from the basic laws of thermodynamics.

Towards sustainability

Sustainability essentially means preserving life on Earth, including human civilization. Meeting human needs is thus vital in creating a sustainable society. It follows that one of The Natural Step's principles of sustainability is to avoid subjecting people to conditions which undermine their capacity to meet their needs.

The other three principles focus on interactions between humans and the planet. They are based in science and supported by the analysis that ecosystem functions and processes are altered in the following ways:

- 🌍 Society mines and disperses materials faster than they are returned to the Earth's crust (examples include oil, coal and metals such as mercury and lead).
- 🌍 Society produces substances faster than they can be broken down by natural processes—if they can be broken down at all (examples of such substances include dioxins, DDT and PCBs).
- 🌍 Society depletes or degrades resources faster than they are regenerated (for example, over-harvesting of trees or fish), or by other forms of ecosystem manipulation (for example, paving over fertile land or causing soil erosion).

The Natural Step Framework

Overview of the science

The First and Second Laws of Thermodynamics set limiting conditions for life on earth: The First Law says that energy is conserved—nothing disappears. Only its form may change. Another way of stating this is: "Energy cannot be created, or destroyed, only modified in form." The implications of the Second Law are that matter and energy tend to disperse over time. This is referred to as *entropy*. Putting the two laws together and applying them to our planetary system, the following facts become apparent:

1. All the matter that will ever exist on earth is here now (First Law).
2. Disorder increases in all closed systems and the Earth is a closed system with respect to matter (Second Law). However it is an open system with respect to energy since it receives energy from the sun.
3. Sunlight is responsible for almost all increases in net material quality on the planet through photosynthesis and solar heating effects. Chloroplasts in plant cells take energy from sunlight for plant growth. Plants, in turn, provide energy for other forms of life, such as animals. Evaporation of water from the oceans by solar heating produces most of the earth's fresh water. This flow of energy from the sun creates structure and order from the disorder.

In 1989, Dr. Robèrt wrote a paper describing the system conditions for sustainability, given the laws of thermodynamics. He sent it to 50 scientists. He asked that they tell him what was wrong with his paper. On version twenty-two Robèrt had consensus on what was to become *The Natural Step*.

System conditions of sustainability

The Natural Step Framework's definition of sustainability includes four system conditions (scientific principles) that lead to a sustainable society. These conditions, that must be met in order to have a sustainable society, are as follows:

In a sustainable society, nature is not subject to systematically increasing:

1. concentrations of substances extracted from the Earth's crust;
2. concentrations of substances produced by society;
3. degradation by physical means and, in that society. . .
4. people are not subject to conditions that systematically undermine their capacity to meet their needs.

On making change happen

In an article in *In Context* in 1991, Dr. Robèrt described how The Natural Step Framework would create change:

"I don't believe that the solutions in society will come from the left or the right or the north or the south. They will come from islands within those organizations; islands of people with integrity who want to do something..."

"This is what a network should do - identify the people who would like to do something good. And they are everywhere. This is how the change will appear - you won't notice the difference. It won't be anyone winning over anyone. It will just spread. One day you don't need any more signs saying "Don't spit on the floor," or "Don't put substances in the lake which can't be processed." It will be so natural. It will be something that the intelligent people do, and nobody will say that it was due to The Natural Step or your magazine. It will just appear."

Lisbon Principles

In 1997 a core set of six principles was established by ecological economist [Robert Costanza](#) for the sustainability governance of the oceans. These six principles became known as the "Lisbon Principles": together they form one version of basic guidelines for administering the use of common natural and social resources.

- Principle 1: **Responsibility**. Access to environmental resources carries attendant responsibilities to use them in an ecologically sustainable, economically efficient, and socially fair manner. Individual and corporate responsibilities and incentives should be aligned with each other and with broad social and ecological goals.
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- Principle 2: **Scale-matching**. Ecological problems are rarely confined to a single scale. Decision-making on environmental resources should (i) be assigned to institutional levels that maximize ecological input, (ii) ensure the flow of ecological information between institutional levels, (iii) take ownership and actors into account, and (iv) internalize costs and benefits. Appropriate scales of governance will be those that have the most relevant information, can respond quickly and efficiently, and are able to integrate across scale boundaries.
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- Principle 3: **Precaution**. In the face of uncertainty about potentially irreversible environmental impacts, decisions concerning their use should err on the side of caution. The burden of proof should shift to those whose activities potentially damage the environment.
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- Principle 4: **Adaptive management**. Given that some level of uncertainty always exists in environmental resource management, decision-makers should continuously gather and integrate appropriate ecological, social, and economic information with the goal of adaptive improvement.
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- Principle 5: **Full cost allocation**. All of the internal and external costs and benefits, including social and ecological, of alternative decisions concerning the use of environmental resources should be identified and allocated. When appropriate, markets should be adjusted to reflect full costs.
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- Principle 6: **Participation**. All stakeholders should be engaged in the formulation and implementation of decisions concerning environmental resources. Full stakeholder awareness and participation contributes to credible, accepted rules that identify and assign the corresponding responsibilities appropriately.