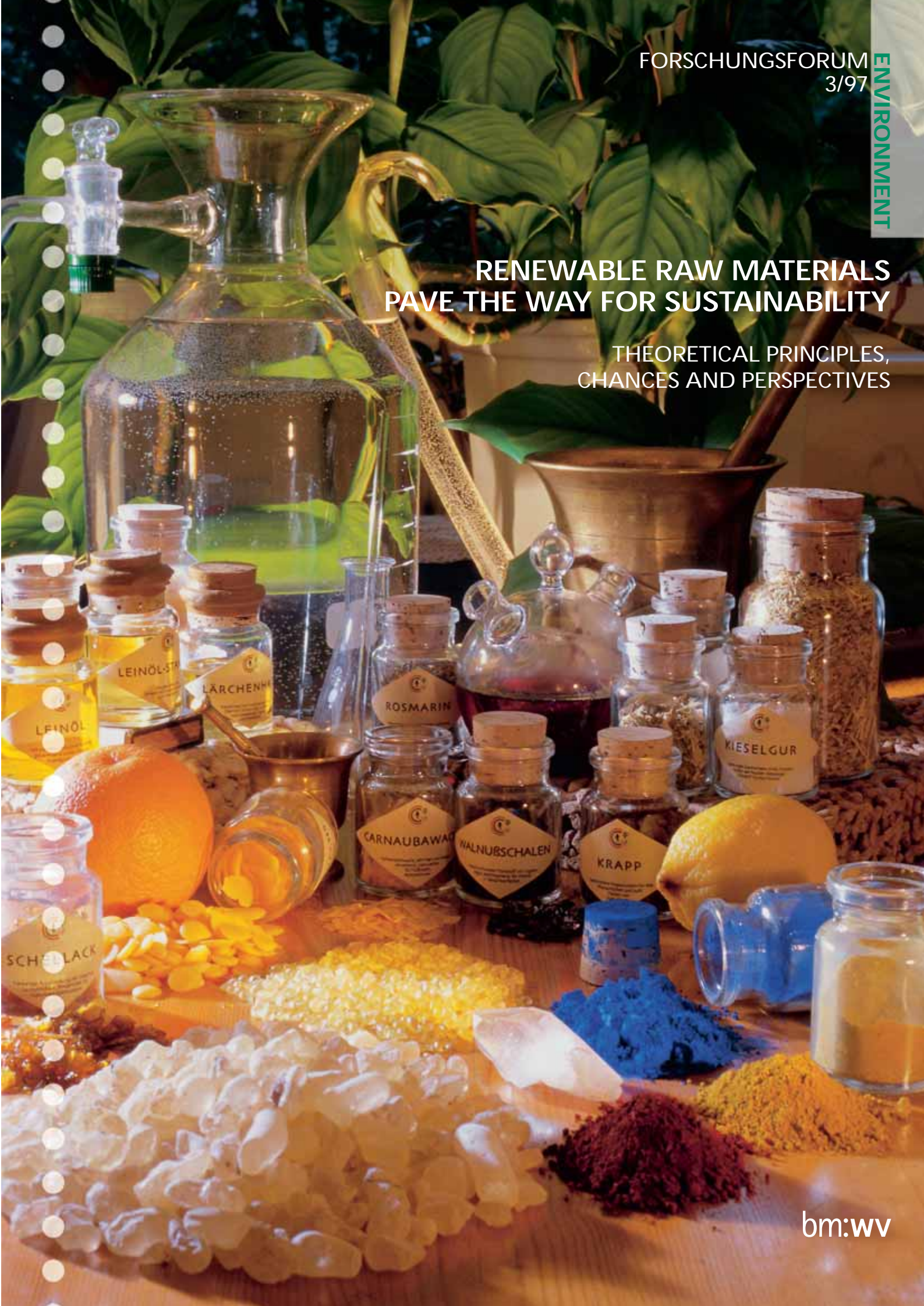


RENEWABLE RAW MATERIALS PAVE THE WAY FOR SUSTAINABILITY

THEORETICAL PRINCIPLES,
CHANCES AND PERSPECTIVES



PAVING THE WAY FOR RENEWABLE RAW MATERIAL RESOURCES

In Austria renewable raw materials are increasingly used. This is an interesting opportunity for the country to improve its technological position on the world market on the one hand, and to proceed another step towards sustainable development on the other.

■ Fossil fuels and raw materials have been essential for the technical and industrial development of our societies. Today, this development appears to be more and more limited and even dangerous, because of the massively increasing exploitation of resources.

According to research studies recoverable raw materials will play a decisive role in future. Nature is producing an enormous amount of plant biomass, approximately 170 billion tons per year. Although renewable raw materials offer many opportunities for use, they have been only rarely applied so far. In particular the increased use of renewable raw materials for the production of chemical products would promote future developments towards a lasting supply of resources.

Renewable raw materials are of advantage because they are part of the closed cycle of the **biosphere**. Therefore, using renewable raw materials is an opportunity to supply all substances needed without polluting the biosphere with foreign and hazardous substances.

Two new studies, sponsored by the Federal Ministry for Science and Transport, demonstrate that the environment is relieved by the use of renewable raw materials as basic substances, however, this is highly dependent on the type of technology and raw material used.

The study ALCHEMIA-NAWARO reports on research and production methods aiming at supplying a new political basis for discussing the use of renewable substances and soft chemistry, and further promoting this discussion with regard to lasting raw material resources. The subject of this project is especially to describe new production and exploitation methods allowing a further development of mankind even after fossil fuels will be exhausted.

The research project discusses basic principles and future perspectives, but also limits and possible undesirable trends (to give a clue: genetic engineering) regarding biogenic resources and soft chemistry based on 20 years experiences gained so far.

The study RENEWABLE RAW MATERIALS USED AS BASIC SUBSTANCES IN AUSTRIA demonstrates that non-invasive technologies for the production of recyclable materials or for the use of highly specialized structures, as present in renewable raw materials, represent a key-technology of the future. They are part of a "hyper-tech", which integrates high-tech measures (biotechnology, complex controls etc.) as well as nature itself as a highly effective synthesis factory.

Biosphere

In this connection the concept of biosphere, mainly based on the "GAJA-hypothesis" and further developed during the last two decades, is of importance. This hypothesis is a supposition that the living organisms in total play the dominant role among all components comprising the global ecosystem. According to the Gaja-hypothesis of James Lovelock it is the permanent activity of its organic cover which makes life on earth hospitable. Therefore, the earth does not just have a biosphere, but it is a biosphere.



A recycling economy based on renewable raw materials is more complex than today's economy based on fossil fuels. It offers a great variety of possible applications for cascades of materials needing an improved organization and coordination of supply and disposal channels, in order to fully exploit ecological opportunities.

This fact will be of high importance for future technological politics. However, let us not only focus on ecological opportunities. It is equally important to point out the opportunity for targeted measures to initiate new organizational networking structures for the promotion of technology, in order to improve regional cooperation as well as product line development. Such networks are the fundamental basis for a lasting development.

The study suggests a number of measures in order to reinforce the use of renewable raw materials in Austria. Among others it is suggested to coordinate projects on this subject in technology clusters and to implement new financing systems.

RENEWABLE RAW MATERIALS AND SOFT CHEMISTRY

■ THE PLANT AS A PROTOTYPE OF SOFT TECHNOLOGY

Only raw materials from recoverable sources can supply organic resources needed globally in a medium and long-term period of time. This supply is implemented by soft chemistry by using safe and readily available substances and structures of primary and secondary metabolisms, such as cellulose, starch, lignin as well as chitin which has been only rarely used so far. But also natural fibers, such as flax and hemp, play an important role as renewable raw materials and are cultivated and processed as considerably as possible. Here it is not only essential to have biogenic raw materials continually available, but also to produce products from such raw materials which can completely return into the natural cycle after being used.

Of course, this is only valid if raw materials are produced by controlled organic farming, i.e. if they are cultivated without any chemical support.

“Simply speaking, the plant produces raw materials from water and atmospheric carbon dioxide by photosynthesis. These materials can be extracted in a more or less pure state and can be treated, refined and further processed resulting in a great variety of finished products, auxiliary substances, additives. The cycle is closed when carbon dioxide and water is released after usage through biodegradation.”

(W. Umbach, Henkel)

“Depth of interference“ is highly important in this respect; interferences in the molecular structures of the biomass developed have to be either excluded or at least carried out only to such an extent that molecular structures may be fast and definitely recognized by decomposing microorganisms. Before developing a new material it is therefore essential to look for a biogenic substance which by itself already has the structural and physical and chemical properties required. Chances are high to be successful, since we know only a few of the plenty structures available in nature so far. The use of biogenic raw materials is also harmless

regarding the development of undesirable by-products: each product of the secondary plant metabolism has its natural function within the environment. None of these products accumulates other substances from its environment and no natural production cycle is endangered by this process.

Energy necessary in chemical processes is another important aspect. Unlike petrochemistry, the synthesis based on biogenic products uses only solar energy. Thus, significant energy savings are of additional value when applying this new methodology.

EXAMPLES FOR CHEMICAL-TECHNICAL PRODUCTS BASED ON MINERAL OIL AND ALTERNATIVE BIOGENIC PRODUCTS (SOLAR MATERIALS)

Industry	Petrochem. Raw Materials	Biogenic Raw Materials	Example of Raw Material	Example of Application
Reinforced Fibrous Materials	Carbon Fiber, GF, Polyamide	Plant Fibers, Plant Resins	Hemp Fiber, Shellac	Toys, Tool-Housings, Furniture and Accessoires
Floor Coverings	PVC	Barks, Vegetable Oils, Plant Fibers and Plant Resins	Cork, Lin Seed Oil, Jute, Naval Stores	Linoleum
Textiles	Polyester	Plant Fibers	Linen/Hemp	Upholseries
Wood Glaze	Polyacrylate, Glycol	Plant Resins, Essential Oils	Dammar Resin, Lemon Peel Oil	Natural Resin Oil Glazes
Colors	Azo-Pigments	Coloring Plants	Dyer's Woad, Madder etc.	Plant Colors
Detergents	(Linear) Alkyl Benzene Sulphonate (LAS)	Vegetable Oils, Carbohydrates	Coconut fat, Sugary Tensides	Household Detergents
Hydraulic Agents	Mineral Oils	Vegetable Oils	Rapeseed Oil, Jojoba Oil	Saw Chain Lubricants Top Performance Lubricants
Adhesives	Polyurethane	Natural Gum, Plant Resin	Natural Latex, Mastiche	Carpet Glue
Packaging Materials	Polyethylene	Polysaccharides	Biopol	Shampoo Bottle
Textiles	Polyester	Natural Fibers	Cotton, Hemp, Linen, Silk, Wool	Outer Garments, Underwear
Thermal Insulation	Styrofoam, Polystyrene	Plant Pulp, Straw, Lignin	Sunflower Pulp Sunflower Straw	New Absorbing Material

■ ABUNDANCE OF STRUCTURES IN NATURE

Ecological farming, which is often applied especially in Austria, is an important part of soft chemistry. Soft cultivation of the land will be increasingly applied also for the cultivation of industrial plants in future.

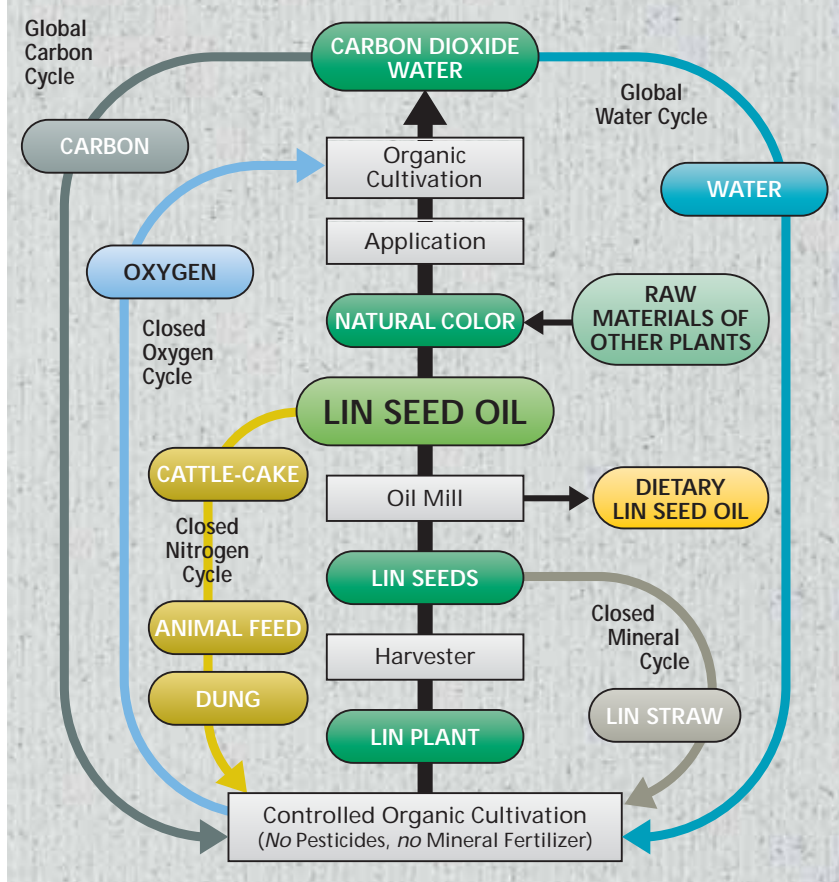
Here **oil plants** are of special importance. Since oils of their seeds own specific fatty acid structures and contain other valuable substances they can be used as the basis for producing a variety of products by industry. In addition oil seeds have the advantage that they can be mostly processed without waste, since after oil extraction they can still be used for the production of highly valuable animal feeds.

Also there are "biologically active" agents of the secondary metabolism available in plants, which can be used for special purposes and according to their "natural function". These are among others coloring substances, resins, tanning agents, waxing agents, essential oils, but also repellents, plant hormones, phytopharmaceutical substances a.s.o.

For example, plant colors offer a great variety of applications, they look attractive, brilliant, they are fast to light also when applied on cotton, linen, hemp. Plant colors do not need more but less and more harmless chemical auxiliary substances in order to stick to the fiber, and many coloring plants can be even cultivated on fallow land.

Even in Austria there has been no comprehensive program developed so far for renewable raw materials. As of today our agriculture is neither techni-

Biography of a Typical Raw Material for truly Natural Colors: Controlled Organically Cultivated Lin Seed Oil



cally, economically nor organizationally prepared for the production of renewable raw materials. There are a number of technological and marketing barriers obstructing the line of supply from the farmer to the consumer. Political decisions and sponsorships are required to solve these problems. It is necessary to provide the basic political and economic conditions for the development of

such new product lines. If we succeed to produce more and more consumer goods from ecologically cultivated renewable raw materials and from minerals readily available, we are on the way to implement a recycling economy in future. Austria has the one-time opportunity to become internationally leading in a future technology.

Lin seed oil, for example, is a fat and dry vegetable oil, which is extracted from the seeds of lin (*linum usitatissimum*). Even the name of this plant ("the most useful") implies the great variety of potential applications. Lin is cultivated as fiber plant as well as oil plant. Lin seed oil can be used for cooking as well as for industrial purposes. It is often used as a raw material for colors, lacquers, glazes, varnishes, inks as well as for pharmaceutical purposes (ointments, antiseptic powder, laxative). Lin seed oil could also replace a number of non-recoverable raw materials applied so far for the production of many other products. Also in Austria lin is a raw material plant of the future regarding its oil as well as its fiber.



WHAT IS SOFT CHEMISTRY

“Soft chemistry” can be defined as the processing of exclusively non-hazardous substances without waste products or by-products except those that can be completely recycled.

RÖMPPS, Dictionary of Chemistry

■ Soft chemistry promotes renewable resources, i.e. the application of recoverable raw materials, the use of such raw materials below the regeneration factor, applying soft and ecological techniques in processing and exploiting such raw materials, substances, agents.

Today mineral oil is the most important raw material for chemical products. Mineral oil is processed to become an industrial consumer good by employing large amounts of energy; however this energy used is nearly exclusively produced by fossil fuels. Therefore, the chemical process does not only result in a finished product but also in a number of by-products (e.g. exhaust fumes like CO₂, SO₂).

Renewable raw materials, however, are part of the natural closed cycle of the biosphere. During the times of evolution structural principles have been developed by natural plant and animal synthetic processes. These principles exclude a maximum use of solar energy input for efficiency reasons by intensively linking and cross-linking many metabolisms, thus avoiding excess energies and consequently by-products which are adverse to the environment.

Nature applies *strategies for the production of materials*, which have already proved efficient and non-adverse to the environment. These natural methods of synthesis are adapted to the conditions of a finite globe.

Soft chemistry is working in such a way that consumer goods are produced without causing non-recoverable damage to mankind and the posterity. Like soft technology soft chemistry focuses on processes of gaining ecological insights. Ecologically soft solutions are produced by processes which interfere in natural cycles as little as possible. The quality and intensity of materials are most important. Basic principle of soft-chemical production methods is “searching before constructing”. The following 5 cross-linked directives demonstrate the essential activities according to this strategy:

■ **Cooperative productivity**

The great variety of life-supporting functions of nature have been recognized and maintained. This variety and productivity has been used at a high level of cooperation.

■ **Conforming technology**

Intelligent and “fault tolerant” technologies have to be preferred which are in conformance with the peculiar properties of natural substances.

■ **Ecological product design**

Service, long-term use, recurrent use, ease of repair have to be promoted on the highest molecular stage possible and by employing the least possible amount of energy and interfering as little as possible.

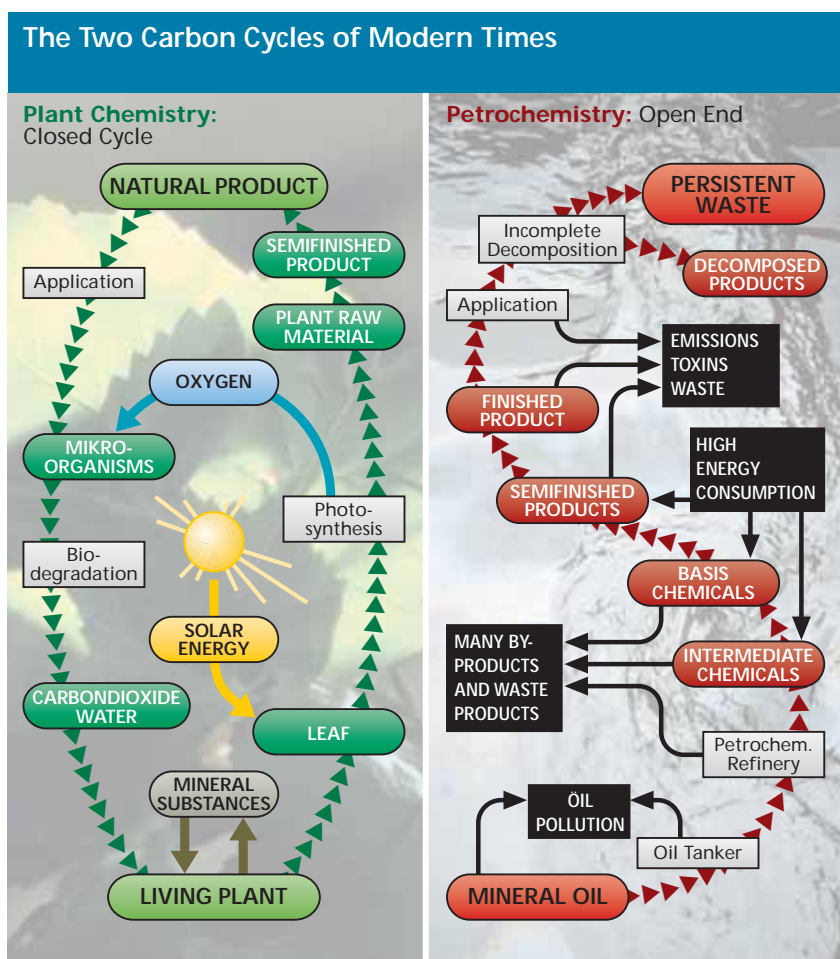
■ **Feasibility**

Technological and economical conditions for successful implementation have to be considered.

■ **Positive absence of knowledge**

Both, depth and range of interference as well as present knowledge of consequences have to be considered for an optimal result.

Plant Chemistry versus Petrochemistry





P E R S P E C T I V E S

PREREQUISITES FOR THE SUCCESS OF RENEWABLE RAW MATERIALS

■ Structures of agriculture will change to a great extent as soon as the cultivation of renewable raw materials will be significantly expanded. However, the overall industrial exploitation of renewable raw materials cannot be implemented without public coordination. Political decisions have to be taken as well as overall structures implemented. Such raw materials can only be successfully used if certain critical factors are defined and implemented:

- sufficient supply of a wide range of raw materials
- use of natural resources
- application of technologies non-adverse to the environment
- production of products with high added value
- implementation of long-term regional programs

The following subjects should be treated by an expert team of representatives from agriculture, industry, trade,

consumer associations, environmental societies, politics and science:

- Coordination of research and development efforts with regard to renewable raw materials by technology clusters and competence centers.
- Scientific and practical examination of domestically cultivated plants regarding their qualification to be cultivated as renewable raw materials.
- Development of new market strategies and structures for renewable raw materials.
- Public promotion of investments in the area of renewable raw materials.
- Definition of quality guidelines (standards and definitions) as well as certification methods to be generally applied for renewable raw materials.
- Definition of key ecological criteria (fertilizers, pesticides, monocultures) for the cultivation of renewable raw materials.
- Establishment of uniform measurements for the evaluation of environmental impacts.

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M. Narodoslawsky, SUSTAIN

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Both project reports are available at:
*Redaktion FORSCHUNGSFORUM
PROJEKTFABRIK, Nedergasse 23,
A-1190 Vienna, Austria,
Tel.: +43/1/367 61 51,
Fax: +43/1/367 61 51-11,
e-mail: projektfabrik@magnet.at*

FURTHER INFORMATION

Special agency "Alchemia Nawaro"
A-1070 Vienna, Siebensterngasse 31
Tel.: +43/1/524 37 73, Fax: 522 19 16

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