Success and Failure of «Green Innovations»

Diffusion Paths of Sustainability Innovations

Summary

The model of sustainable development has been the subject of debate for almost two decades – and yet there has been a serious lack of implementation of the concept in the economy and in society. There has been no lack of innovative technologies and solutions which would permit us to combine economic and social prosperity with resource and climate protection. Why then has there not been more progress?

The Borderstep Institute for Innovation and Sustainability has addressed this issue in its project Diffusion Paths of Sustainability Innovations, which focused on the conditions for the diffusion processes of sustainability innovations, the factors influencing those conditions, and the strategies for action which might push diffusion forward. The project analyzed the diffusion patterns of 100 sustainability innovations in ten product fields which had the potential for contributing to the securing of our natural conditions of life, and to the development of a global mode of economics and consumption which would be continuable in the long term.

The project was able to arrive at the following important results:

- Seven key factors were ascertained which have a significant effect on the dissemination of environmentally friendly products and service innovations
- Five types of diffusion paths of sustainability innovations could be identified, which differed significantly from one another with regard to the manner of their process, their actors, and their options for intervention
- Moreover, barriers and drivers were ascertained, and key actors and diffusion processes of sustainability innovation were identified
- On this basis, recommendation for actions by government, associations and businesses for the accelerated dissemination of «green» innovations, and for the more rapid achievement of the goals of the energy-policy turnaround and of a «green economy» were formulated.

About the research project: All of Germany is talking about the energy-policy turnaround, and yet the transition is moving ahead very slowly in business and society. While there is no lack of innovative technologies and solutions, not all of them succeed in establishing themselves on the market. However, why do certain «green» innovations succeed, while others fail? How are the ideas of sustainability disseminated? The project Diffusion Paths of Sustainability Innovations has addressed these issues. Funded by the Federal Ministry of Education and Research (BMBF) in the context of its Technology and Innovation Analysis (ITA) program, it investigated the market introduction and dissemination of 100 environmentally friendly product and service innovations (funding code 16 I 1601). The study is the first worldwide to systematically analyze the diffusion processes of such a large number of sustainability innovations, and to carry out an empirically supported ascertainment of the key factors affecting diffusion dynamics.

Which product fields and cases of diffusion were investigated?

PRODUCT FIELD	CASES OF DIFFUSION
Organic food	Free-range eggs, Bionade [a soft-drink brand], organic milk, fair-traded coffee, CSA boxes, organically-grown bread, the Tea Campaign, MSC-fish, organic children's food, eco-wine
Renewable resources	Starch-based recyclable synthetic packaging, natural-fiber-reinforced plastics, biogenic lubricants, insulating material from renewable resources, natural dyes, porch floor material of wood-plastic composite (WPC), laundry detergents based on oleo-chemical surfactants from renewable resources, organically-grown cotton, woolen rugs with the Rugmark seal, organic leather shoes
Renewable energy facilities	Biodiesel, biogas facilities, large hydroelectric facilities, small hydroelectric facilities, pellet heating, photovoltaics, sky sails, thermic solar-power plants, onshore wind power plants, offshore wind power plants
Low-exergy energy systems	Absorption cooling machines, block-scale cogeneration plants, bioenergy villages, geothermal and hydrothermal cooling, long-term heat-storage facilities, mobile heat, local heating networks, solar thermal facilities, deep geothermal facilities, heat pumps
Energy-efficient electrical devices and lighting	A++ freezers, A++ refrigerators, A washing machines, A dryers, A dishwashers, energy-saving lamps, induction cookers, LED lighting fixtures, master-slave multiple socket outlets, high-efficiency circulation pumps
Construction and heating technology	Passive houses, prefab wooden houses, composite insulation systems, ventilation facilities with waste heat recovery, windows with insulation glass, condensing boilers, hot-water surface heating, radiator thermostats, timer-controlled radiator thermostats, hydraulic coordination of heating facilities
Green IT user devices	Notebooks, netbooks, nettop/mini PCs, thin clients, LCD monitors, 80+ power supply units, 2" hard disks, Windows energy options, multifunctional devices, inkjet printers
Energy efficiency in computer centers	Blade servers, virtualization, energy efficiency servers, server energy management, solid state disks, efficient independent power supplies, fiberglass cables, cold/warm walk separation, water-cooled racks, free cooling
Telecommunications and online services	E-mail, telephone conferences, video-conferences, virtual telephone answering machines, teleworking, MP3 music files, video-on-demand, online second-hand trading, digital cameras, e-book readers
Sustainable mobility	Small and medium-sized hybrid vehicles, electro-cars, low-energy cars (the 3 L/ 75 mpg car), natural-gas-driven cars, low-rolling-resistance tires, car-sharing, mobile navigation devices which permit avoidance of traffic backups, ride-sharing agencies, the Railcard, car-transport trains

The project «Diffusion Paths of Sustainability Innovations»

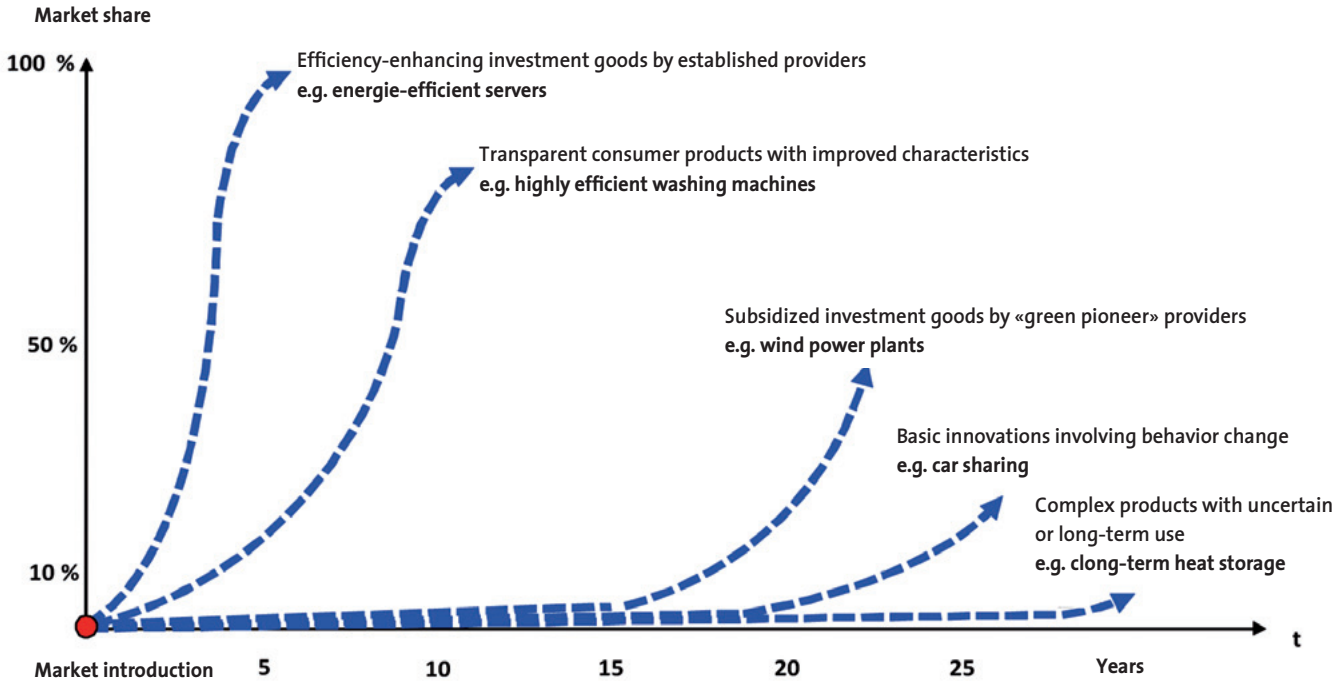
The project focused on the conditions for the diffusion processes of sustainability innovations, the factors affecting them, and strategies for action to push diffusion ahead. The point of departure for the theoretical work was the diffusion model of Everett Rogers, widely seen as the «pope» of diffusion research. However, a number of concepts of the past ten years have gone beyond the work of Rogers (2003), or have supplemented it with new perspectives and views. In view of Rogers' deficits and «blind spots», four perspectives in the wide range of more recent work appear to us to be of particular importance:

- Papers which address the issue of government interventions, and here, specifically, the emergence of lead markets, with which economic power is to be developed on the basis of the diffusion of key innovations
- Evolutionary economics, with its concepts of paths, path dependencies, the role of actors for the course of paths, key events («tipping points»), and options for path creation
- Papers on user integration in innovation processes, which on the one hand precede diffusion processes in time, but on the other also permit knowledge transfer for the formation of diffusion processes, and
- Supply-side concepts such as the «David-and-Goliath model» (cf. Hockerts&Wüstenhagen 2010), which focus on the providers of innovation and their role in the transformation process toward the «green» markets of the future.

On the basis of this theoretical work, 22 factors which influence diffusion could be identified. Based on the empirical analysis of 100 diffusion cases, seven key factors of influence of particular significance for the dissemination of sustainability innovations were identified with the aid of factor analysis:

1. The market power of established providers
2. Political push & pull
3. The influence of pioneers
4. Purchase incentives
5. Compatibility with routines
6. Prices and economic viability
6. The transparency of innovation

A further evaluation of the data on the 100 diffusion cases permitted the establishment of five types of diffusion paths, with the aid of cluster analysis:



Path type 1: Efficiency-enhancing investment goods by established providers

One example for this type is that of energy-efficient servers. Many sustainability innovations of this type achieve market shares of more than 10% even only a few years after market introduction, and after five years, they have often already been above 50%. They develop rapidly to become the dominant technology. The following factors are most important for the high diffusion dynamics of such products: The incremental innovations involve known and widely used investment goods, and are introduced by established manufacturers, often in the IT realm; the degree of innovation is low, and the adapters – professional users, e.g. the operators of computer centers – are familiar with the innovation product; the established manufacturerers generally have long years of experience in the technology and the market, extensive R&D and marketing resources, and established distribution channels and service concepts; improved energy and resource efficiency permit rapid savings; and the economic viability of these incremental innovations is generally high.

Path type 2: Transparent consumer products with improved characteristics

This path type, too, primarily covers known products, such as washing machines, which have been improved in terms of efficiency or other properties. Primarily, these are consumer products for retail sale, characterized by the fact that they are either familiar to the consumer, easy to figure out, or both. Such products as fairly traded coffee, detergents made of renewable resources, or organically grown cotton are less complex with regard to their function, and their handling is easily understandable to the user. Moreover, incremental innovations can generally be tested easily, e.g. with free test samples, or a single purchase, before the consumer decides permanently for or against them. The purchase and use of the products of this path type require little in the way of changed behavior.

Path type 3: Subsidized investment goods by «green pioneer» providers

This diffusion path includes many key basic innovations in the area of environmental technology. Wind and water power, heat pumps, solar-thermal facilities, block-scale cogeneration plants and passive houses are typical technologies and products of this path type. Many products have generated completely new product categories or markets. The products of this product type also have in common the fact that they are investment goods which are used over the longterm, primarily by professional investors (e.g. hydroelectric plants), and also private citizens (e.g. passive houses or solar-thermal facilities). The fact that the products and technologies of this path type are generally technically well compatible and have a high degree of public visibility is also beneficial for their diffusion dynamics. Some uncertainties do limit their diffusion however, since these innovations involve fundamentally new concepts with which there is little or no prior experience. The uncertainty is reinforced by the fact that these products can generally be tested only with great difficulty or not at all, and moreover require a high level of long-term capital investment.

Path type 4: Radical innovations involving a high level of behavior change

Key characteristics of innovations of this path type are a high degree of innovation, and the difficulty in making them routine. Whether bioenergy villages, electro-cars, the use of car sharing, or the use of sky sales by the crews of modern container ships, the innovations of this path type require considerable change in behavior on the part of the adopters. This necessity is shown in the statistical analysis as one of the most significant factors: If the necessity for changed behavior increases, the achievable market share is reduced accordingly. The innovations of this diffusion type are therefore disseminated fairly slowly.

The diffusion dynamics is further restricted by the fact that the previously used technologies and solutions generally have a high binding effect. The predecessor products with which the new solutions compete are therefore strongly path dependent. Innovations in this diffusion path therefore have a particularly hard nut to crack. Empirically, it is apparent that these tasks are often addressed by start-ups and young companies, and by non-profit organizations.

Path type 5: Complex products with uncertain or long-term use

The key characteristics of innovations of this path type are the great complexity of the respective technology or solution (e.g. long-term heat storage), uncertainty regarding the usefulness on the adopter side, and the low level of compatibility. This low technical, institutional or cultural compatibility is not only a current problem; more serious appears to be the fact that many investment goods of this path type will only pay off in the long term if future basic conditions are right. For example, solar collector fields feeding into local heat networks with long-term heat-storage facilities only makes sense if all three technological components exist together. Without a clear future perspective and long-term policy planning and security, dissemination will stagnate. Also, the emergence of economically powerful providers has stalled. Thus, a vicious circle which is often characteristic of this diffusion path type, has emerged.

INTERVIEW: What can ensure the success of a «green» market introduction?

The research project has shown that the success or failure of sustainable products and services depend on the interplay of various factors. How, for example, can «green» radical innovations be disseminated?

Prof. Dr. Klaus Fichter: *The 100 environmentally friendly product and service innovations investigated have shown that fundamentally new products and services are primarily developed and introduced to the market by start-up companies, while incremental innovations are primarily a matter for established companies. For the energy-policy turnaround and the goals of a «green economy», that means that we have seriously underestimated the importance of start-ups for the emergence of «green» lead markets, and that in the future, we will have to more strongly support start-ups oriented toward lead markets.*

Can you provide any examples for this, by way of explanation?

Dr. Jens Clausen: *For instance, pioneer companies are involved in the creation of eight out of ten innovations involved in contributing toward a more climate-friendly supply of heat and cooling. However, since heat is cheap, and new infrastructures, such as local or district heating networks, as well as other heating and cooling technologies, will pay off only in the very long term, better framework conditions are needed. But most small pioneer companies have not succeeded in pushing through these framework conditions. One exception is geothermal heat pumps, which, happily, have been disseminated very rapidly.*

What is the role of government in this process?

Prof. Dr. Klaus Fichter: *The role of government can be seen clearly in the energy-policy turnaround. The successful Energy Feed-In Law has led to the diffusion of wind power and photovoltaics. Now, grid expansion and the construction of storage capacities are being pushed. However, the comparison between electric power and heat shows that the government has concentrated too unilaterally on the former. In order to achieve the goals of the energy-policy turnaround, the supply of industry with process heat and of residences with heating and hot water both have to enjoy top priority.*

How could the diffusion process be better supported in the future?

Dr. Jens Clausen: *A holistic analysis of the diffusion process suggests that support should be provided not only for products and research, but also institutionally. Support for start-ups oriented toward «green» future markets would be one element that would stimulate additional basic innovation indirectly. Support for the creation of association structures in new industries could be important, so that new green sectors could establish themselves in the face of established structures. National master plans and cooperative roadmapping in cooperation between government, associations, business and the scientific community could create the framework, although the important thing here would be the binding nature of long-term goals and concrete measures. One result of roadmaps could be to push the entry of established providers into new markets as a matter of policy, so as to support diffusion and break resistance. Sustainability monitoring of important product and technology fields will ensure long-term success, including readjustment where necessary.*

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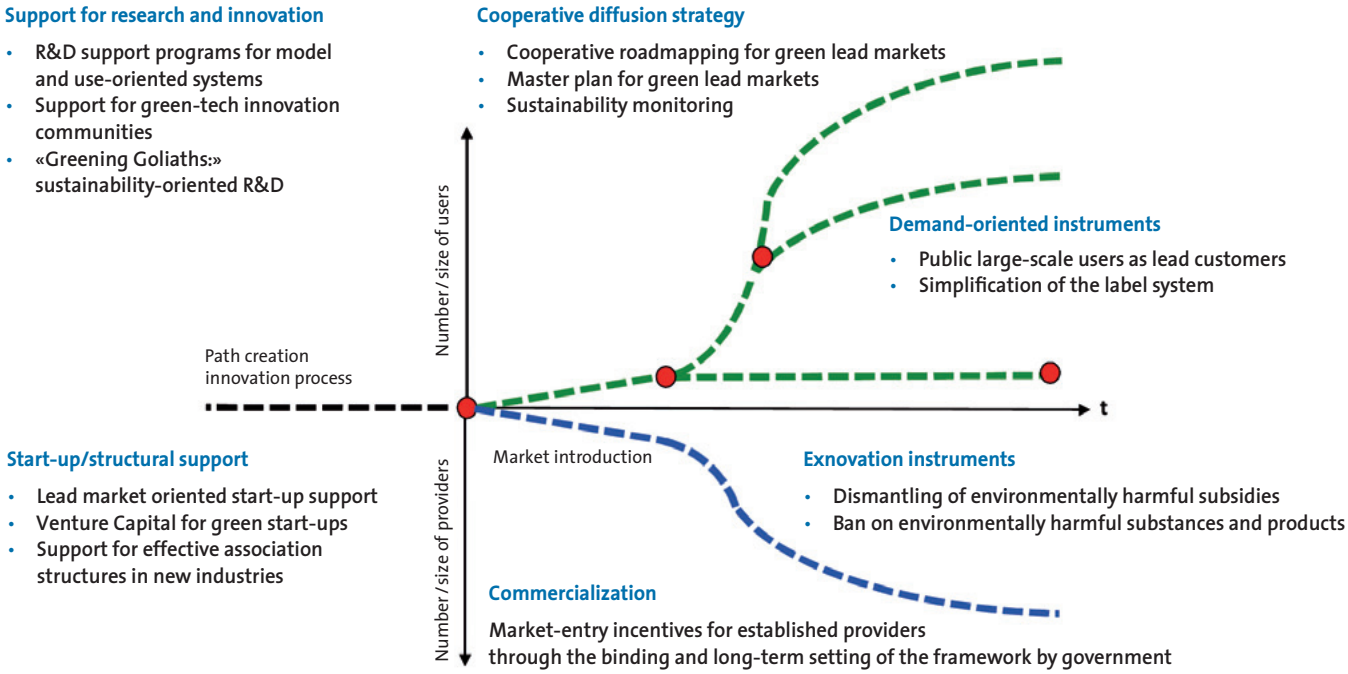
DR. JENS CLAUSEN is a mechanical engineer and the senior researcher directing the Hanover office of the Borderstep Institute for Innovation and Sustainability. Central to his research are questions of research into start-ups, innovation and diffusion, as well as sustainability future oriented markets and the issue of the sustainable supply of heat and cooling.

Approaches and options for intervention for the accelerated diffusion of sustainability innovations



- **Vision oriented innovation support** is standard practice, e.g. through the orientation of tenders of the Research Ministry toward the sustainability goals of the federal government, but it should be intensified, focused in a targeted manner toward essential green lead markets, and oriented toward entire use systems.
- **Lead-market-oriented start-up support** is an approach to stimulate and support start-ups in«green» lead markets in a targeted way, and takes the fact into account that «green» basic innovations are largely developed and introduced to the market by start-ups.
- **Cooperative diffusion strategies** are an instrument which has to date been seldom used, and could take the form of self-obligations. However, the results would have to be binding, and backed up by a sustainability-monitoring process.
- **Demand-oriented instruments,** such as simpler or improved labeling systems, e.g. with the top runner approach, or with public large-scale users as lead customers, could ensure the necessary «critical mass» for green future markets.
- **Commercialization through market entry by established providers** could be the result of roadmapping processes for markets in their demonstration phase.
- **Exnovation instruments** supplement the support of innovations wherever non-sustainable innovations are to be eliminated.

Sources

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