

Developing a strategy to speed up large-scale adoption of compressed-natural-gas-driven (CNG) cars

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Abstract

Large-scale adoption of environmentally friendly, clean, silent and CO₂-neutral technological innovations into the market is necessary to reduce the human causes of the greenhouse effect and global warming. In theory, an innovation diffuses smoothly into the market following an **S-shaped curve** when the number of adopters is plotted against time. In practice, diffusion of innovation does not move smoothly from left to right on the S-shaped curve. Fundamental differences in the adoption characteristics between the visionary early adopters and the pragmatic mainstream cause diffusion to stop before reaching the mainstream market segment. This “chasm” in the diffusion process is not the result of bad technology or bad products, but rather the result of “incomplete” products that do not meet the needs of the pragmatic mainstream.

In this paper, we report on a case study, conducted in the Netherlands, aimed at speeding up the adoption of the CNG car. This study contains an analysis of the market segments within a target group of local fleet owners. We used survey data covering about 200 local fleet owners. Through structured interviews and a questionnaire, we identified a niche group of the mainstream that would be most likely to adopt the CNG car. This niche is the group to target in a marketing strategy aimed at crossing the chasm. A focus-group discussion held with members of the niche identified the conditions under which the niche actors would consider buying CNG cars.

Based on the results of this focus group and the niche market analysis, we concluded that the marketing of the CNG car is still in its beginning phase and has to focus on the early market. Following our recommendations, car dealers and the municipality of Leeuwarden are now developing a plan for marketing the CNG car. The marketing will focus on the early market as the first step into the mainstream.

Introduction

Reversing the human causes of the greenhouse effect and global warming concerns most governments. Although environmentally friendly, clean, silent and CO₂-neutral technological innovations are available, large-scale adoption of them is essential for reaching this goal. Several innovative options have been developed for the car-of-the-future: a silent, clean and CO₂ neutral car that, preferably, runs on a source of renewable energy. The compressed-natural-gas (CNG) car is one of the innovations that might be a step toward this development. It could, for example, be a forerunner of the hydrogen-car. The Dutch Ministry of Transport, with its so called “transition policy towards sustainable mobility”, is looking for ways to stimulate large-scale adoption of environmentally friendly innovative cars.

Theoretically, in any given market, when the number of adopters of an innovation is plotted against time, diffusion of that innovation into the market follows an **S-shaped curve** (Figure 1). A few visionaries adopt the innovation very quickly but others in the market are much slower to accept and adopt the innovation. In other words, actors in the market adopt at different times and, therefore, belong to different segments of the market, the “early market” or the “mainstream” market seg-

ments. This idealized curve, however, does not depict the “real” market process—innovations do not smoothly enter the market in increasing numbers. Discontinuities in the S-curve cause diffusion to stop before reaching the next market segment.

These discontinuities arise from differing characteristics of the actors in the market segments. Especially, the differing characteristics between the visionary early adopters and the pragmatic mainstream adopters cause a wide discontinuity—a “chasm”. Bridging this chasm is essential to large-scale diffusion of an innovation. This article focuses on bridging that chasm to achieve large-scale diffusion of the CNG car.

A feasibility study of Kooistra (2004) showed that local car fleet owners will most likely buy the CNG car, making these fleet owners a promising target group. This target group can be seen as a market made up of potential adopters that vary in speed of adoption. And adoption will follow, more or less, the S-shaped curve with, of course, a chasm between the early adopters and the mainstream adopters. To identify the chasm, we must know which actors in the target group of fleet owners belong to the early market, and which actors belong to the mainstream. Furthermore, we must know how their decision-making characteristics, regarding buying CNG cars, differ. Based on this knowledge, we can develop a strategy to market the CNG car in such a way that it will cross the chasm and reach the mainstream market. Therefore, our explorative study addressed the following three research questions:

1. Is it possible to identify different adopter segments within the target group of fleet owners?
2. Can we assess the characteristics of these adopter segments?
3. Is it possible to develop a marketing strategy to speed up the diffusion and adoption of the CNG car?

To address these questions, we carried out two studies, applying the marketing theory of Moore (2002). Moore’s theory considers the marketing of innovations and, especially, their diffusion into the mainstream. In the first study, we surveyed the target

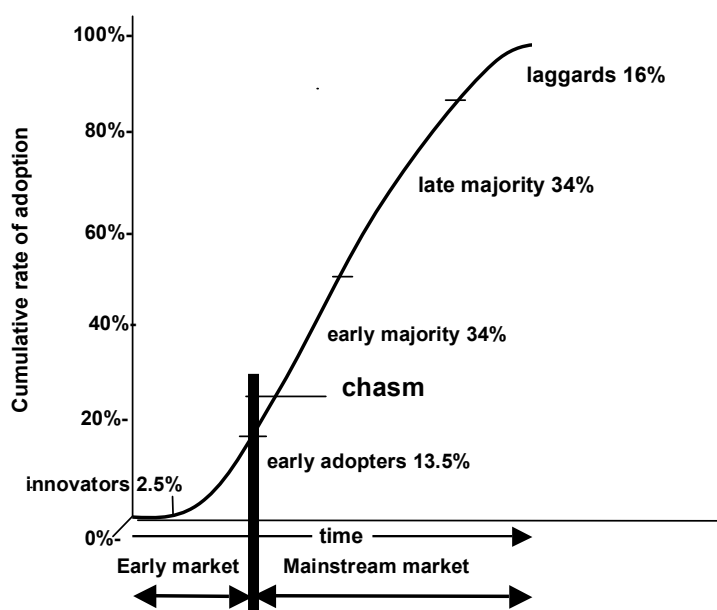


Figure 1: S-shaped curve of the adoption of innovations

group of local fleet owners in the Dutch provinces of Friesland, Groningen and Drenthe to establish the adopter segments and their characteristics. We chose these provinces, known as “Energy Valley”, because they work closely together, have started to build filling stations for CNG cars and because they offer a good scale for introducing this type of car. The first filling station was opened in Leeuwarden in 2007, and 9 more CNG filling stations will be opened in this region within two years.

To gain insight into how the CNG car should be marketed into the mainstream, we carried out a second study. We organized a discussion within a focus group of mainstream fleet owners and the suppliers (dealers and importers) of CNG cars. The study resulted in an outline for a marketing plan for the CNG car. The actual marketing was not investigated in this study.

Theoretical foundation

THEORY OF DIFFUSION OR ADOPTION

Our approach to answering the three questions was based on Moore’s (2002) concept of marketing innovations into the mainstream. With the appropriate name “Crossing the Chasm”, Moore points at the chasm between the early market and the mainstream market. Moore (2002) based his concept of marketing innovations into the mainstream, of crossing the chasm, on the diffusion theory of Rogers (1995). According to Rogers, an innovation is “an idea, practice or object that is perceived as new by an individual or another unit of adoption”. Diffusion of an innovation through an entire market starts with the “innovators” and “early adopters”, is eventually followed by the “early and late majority” and ends with the “laggards”. Because of differences in adoption speed, the diffusion process of an innovation follows an **S-shaped curve** when the number of adopters is plotted against time (Figure 1).

To stimulate diffusion of an innovation through an entire market, marketers should first focus their activities on the innovators and get them to adopt the innovation. The innovators are driven by enthusiasm for technology. Then the marketers should move on to focus on the early adopters, who are driven by vision and strategy. The marketers finally should go on to the mainstream which is subdivided into the “early majority” who will adopt an innovation if it solves a problem—they are driven by pragmatism—and the “late majority” who do not adopt an innovation until most others in the target group have done so—they are driven by competitive pressure. The “laggards” will not adopt an innovation unless forced to do so (Rogers, 2003). Organizations marketing innovative products or services should use each “captured” segment as a reference base for their strategy to approach the next segment.

Rogers points out that the adopter’s perception of an innovation determines the character of an innovation. So when potential adopters are introduced to products that require them to change their current mode of behaviour, their attitude towards innovation determines their behaviour. For that reason, Moore (2002) differentiates between two types of innovations from a behavioural point of view:

Discontinuous innovations, which require the adopters to change their current mode of behaviour. An example of this type of innovation is the introduction of the word processor

that replaced the typewriter. Computers changed text writing, and users required training in word-processing software.

Continuous innovations, which require no change of behaviour of the adopter and are related to the normal upgrading of products. An example is buying an upgrade of the word-processing software.

In practice, the diffusion of an innovation does not move smoothly from left to right on the S-shaped curve. Discontinuities in the S-curve cause diffusion to stop before reaching the next market segment.

The Chasm

A discontinuity between the early adopters, which is part of the early market, and the early majority, which is part of the mainstream, is a “chasm” (Figure 1). It is caused by profound differences in attitude towards change and, thus, different perceptions of innovations, as summarized in Table 1.

The early market actors (users) expect to gain a lead on the competition through either lower product cost, faster time to the market, more complete customer service, or some other business advantage. They are looking for strategic advantages. They expect a radical discontinuity between the old ways and the new, and they are prepared to change their behaviour. Being first, they are also prepared to bear with the inevitable bugs and setbacks that accompany any innovation just arriving on the market. The early market actors have a more visionary attitude: they are motivated by future opportunities, are self-referencing, avoid the herd, and will seek the best technology. We define “visionarity” as the disposition of an actor whose decision-making behaviour, related to innovations, is guided by ideology and is related to strategy towards the future.

The mainstream actors, however, want to buy a productivity improvement for existing operations. They aim to minimize discontinuity with the old ways: they simply want to solve their problems. The mainstream market actors have a pragmatic attitude. They are motivated by current problems, seek and buy the best solution or functionality from a market leader. They identify with others perceived as similar, and they stay with the herd. But the mainstream is not homogeneous: as we saw before. The early majority actors, as part of the mainstream, are driven by pragmatism, and are interested in innovations insofar as they contribute to solving problems. Often these innovations are of the continuous type. The late majority actors, on the other hand, are driven by competitive pressure: they adopt an innovation only after most others in the market have done so. And the laggards will not adopt an innovation unless forced to do so (Rogers, 1995). We define “pragmatism” as the disposition of an actor whose decision-making behaviour is guided by the judgement of facts as related to core business and problem solving.

The more discontinuous the technology and the more it deviates from the status quo, as perceived by the mainstream actors, the more likely that a chasm will occur. This chasm is situated between the early market and the segment of the mainstream that is nearest to the early market. This segment is called the “early majority”. The chasm is not the result of bad technology or bad products, but rather the result of “incomplete” products (Wieffels, 2002). The products are incomplete insofar that they do not meet the pragmatic needs of the mainstream actors: they

Table 1: Comparison of the early market and mainstream market (Adapted from Wieffels, 2002)

Characteristics of the actors:	
Early Market: visionaries	Mainstream: pragmatists
seeking for revolutionary advances: innovation, creation	seeking evolutionary advances, maintenance, problem solving
motivated by future opportunities	motivated by current problems
self-referencing	reference others perceived as similar
avoid the herd	stay with the herd
risk-taking	risk-aversion
intuitive	analytic
contrary	conformist
seek what is possible	pursue what is probable
will seek best technology, and innovative products	will seek the best solution or functionality to buy, they focus on leader of the market
momentary, local and specific	continuously, everywhere and everybody
not better, but different	more of the same
often curative	preventive
fast	slow

are not reliable enough, they are not serviced well, they are too expensive etc. And because the mainstream actors do not identify with the early market actors who have adopted the innovation, they will not follow.

CROSSING THE CHASM

In his “high-tech” marketing model, Moore (2002) developed his method to cross the chasm between the early market and the mainstream market. In our case, this means to induce mainstream actors to adopt an innovation which has already been adopted by the early market actors. In essence, his method consists of (1) identify a small segment of the mainstream market—a niche segment—which is part of the early majority, (2) determine which “problem” of this niche the innovative product or service could solve and (3) make the innovation complete so that it solves that problem of the niche segment and, thereby, gives the niche actors a compelling reason to buy (Moore, 2002). According to Moore, the marketing and sales of the innovation will then reach the rest of the early majority segment within the mainstream. And after the early majority, the late majority will follow because the late majority will adopt an innovation after mainstream actors, with whom they identify, have done so.

Moore advises us to find a group of customers in the mainstream, the “niche”, for which the innovation can have a compelling reason to buy. The actors of this niche segment belong to the early majority, the segment of the mainstream nearest to the early market who are, therefore, less change resistant. To be compelling for the pragmatic mainstream, the innovative product must solve a problem or provide an efficiency improvement. This often means that the innovative product has to be “completed” or augmented with a variety of services and ancillary products to become the “whole” product that solves a problem or improves efficiency. Moore emphasizes that we must focus on the pragmatists in the mainstream; they want, evaluate and buy “complete” products. Several partners often have to work together to complete a product (Moore, 2002).

The niche, being part of the mainstream market, consists of actors with common needs, wants and problems. They usually use common or similar technology, and they reference each

other when making a decision to buy. In general, actors in this niche of the mainstream market need applications that meet specific requirements. They do not weigh alternative solutions on the basis of technology or the product itself, but rather on how complete each alternative is compared to others. They evaluate alternatives based on demonstrable results and, especially, return on investment.

The target group study: the survey and focus group

The target-group study consists of two studies: the survey and the focus group discussion. In this section, we report our methods, the results of the survey, and the results of the focus group discussion. Following the advice of Moore, we concentrated on finding the niche segment in the mainstream of the target group of local fleet owners.

METHODS

To establish the adopter segments and their differing characteristics we interviewed 166 (61 %) of 271 fleet-owners in the northern Dutch provinces using a questionnaire. These questionnaire-guided interviews were carried out with a computer-aided telephone interview (CATI) system. The respondents included staff members authorized to purchase cars.

Construction of the questionnaire

To construct the questionnaire, we first held focus interviews wherein the responses to a checklist were recorded. We then constructed the questionnaire around clusters of predisposing, enabling and reinforcing factors of behaviour as defined in our behavioural model. The questionnaire addressed the following issues, and the answers to the questions (items) were of an ordinal and nominal type (3- and 5-point scale).

- A. Characteristics of the fleet (8 items): questions about number, and type of vehicle, ownership, maintenance, and fuel mix of the vehicles;
- B. Experiences with sustainable mobility (3 items);
- C. Decision making process of the fleet owner (8 items): Who takes the decision to buy, what are the motives, and which parties have influence;
- D. Attitude of the drivers and maintenance department (3 items);
- E. Advantages and disadvantages of renewable fuel (19 items);
- F. Behaviour and intention, and policy about renewable fuel (5 items);
- G. Adoption rate (3 items): based on the self-designating method (Rogers, 2003, p. 308) (see next section).

Construction of the variable "adoption rate"

To measure the adoption rate, we used Rogers' (2003, p.308) "self-designating" method. We applied this method in the study reported in "Target group segmentation makes sense: If one sheep leaps over the ditch, all the rest will follow" (Egmond et al., 2006). The self-designating method consists of asking each respondent a number of questions to determine the degree to which he perceives himself or his organisation to be an early adopter. In the reported survey, we had included items related to this subject. To establish the adoption rate, we ana-

lysed the responses to the following items in the questionnaire - the scores at each answer are needed to construct the variable "adoption rate".

1. Is your organization more active in the field of sustainable transport?
Answer: (a) yes, a lot more active than most others (score = 4), (b) more active (score = 3), (c) equal active (score = 2), (d) a bit less active (score = 1), (e) less active (score = 0), (f) no (score = 0).
2. If you compare the attitude towards innovations in the field of sustainable transport of other fleet owners associations with your organization.
Do you find: (a) your organization more positive than other fleet owners (score = 4), (b) your organization more negative than other fleet owners (score = 0), (c) equal to your own organization (score = 2), (d) don't know (score = 0).
3. If you qualify your association as to the speed with which decisions are made about innovations in the field of sustainable transport is your organization?
Answer: (a) a trendsetter (score = 4), (b) a trend-follower (score = 2), (c) a laggard (score = 0), (d) don't know (score = 0).

These three items form a scale of *adoption rate* having a minimum score of 0 and maximum score of 12 (Table 2, Cronbach's alpha¹ was 0.61).

RESULTS

At the time of our survey, market introduction has just started. The early market had purchased a few vehicles running on sustainable fuel: bio diesel cars, hybrid cars and even a few CNG cars. Our early market consisted of 9 municipalities, 3 housing associations, 5 taxicab companies, 2 driving schools, 2 home-care institutions and 2 transport companies.

Adoption segments

Table 2 presents the scores of the constructed variable "adoption rate" for the different market segments, and the relative size of each market segment. Note that the early and late majority and the laggards are sub segments of the mainstream.

Table 2: early market and mainstream

Adoption segment	Adoption rate score	percentage
Early market	9-12	18%
Mainstream market	0-8	82%
of which:		
early majority	6-8	44%
late majority	4-5	22%
laggards	0-3	16%

1. Cronbach's alpha is a measure of internal consistency, how well a number of items measure a single unidimensional latent construct. It is based on average inter-item correlation and has a minimum score of 0 and a maximum of 1. A Cronbach's alpha of $\geq .60$ is considered acceptable for this type of explorative study.

Different characteristics between the early market and mainstream segment

The following four characteristics differed between the early market and the mainstream.

- Firstly, there is a difference in size of their fleets;
- Secondly, their investments in and attention for sustainable transport are different.
- Thirdly, they judged pro and contra arguments about buying natural-gas-driven cars differently.
- And fourthly, they differ in motivators.

We analyzed the differences in detail and found the following.

Difference 1: Size of their fleet.

The mean size of an early market fleet is 39 and the mean size of a mainstream fleet is 21.

Difference 2: Investments in sustainable transport. (Table 3)

Difference 3: Attitude towards natural gas as car fuel.

Table 3: investments in sustainable transport

investments in sustainable transport	Early market % yes	Mainstream % yes
1. Investments as part of policy	66	33
2 specific investments in:		
soot filters	45	24
Eco-driving	62	37
in car computers	45	34
3. transport management systems	59	26

We discern scores on pro arguments (Table 4a) and scores on contra arguments (Table 4b).

In Table 4b, we show the scores on contra arguments.

Table 4a: differences on scores on pro arguments towards gas as car fuel.

% finds strong pro arguments for buying natural-gas-driven cars	early market	main-stream
1. natural gas is cheaper	62	68
2. air quality	76	46
3. less CO ₂ emission	69	40
4. less stench or smell	63	37
5. serve imago of the organization	59	34
6. less noise	42	23
7. following international agreements	55	11
8. safety	26	14
8. role-model (municipalities, n= 53)	78	51
9. part of social responsibility (commercial organizations, n= 112)	80	36

Table 4b: differences on scores on contra arguments towards gas as car fuel.

% finds strong contra argument for buying natural-gas-driven cars	early market	mainstream
1. few service stations	69	73
2. investments too high	52	67
3. uncertainty about future tax policy	62	63
4. more expensive car	26	48
5. knowledge experience service-staff	54	35
6. uncertain reliability	30	38
7. smaller action radius	30	37
8. uncertain rest value	36	29

Difference 4: The fourth difference between the early market and mainstream is on motivating factors to invest in cars which drive on sustainable fuels.

- (1) The early market found the exemplary role of peer organizations more important;
- (2) the investments of the early market match the environmental policy of the organization,
- (3) Their investments meet the needs of customers or citizens.

Identifying the niche-segment

From Table 2, the early majority adoption segment is particularly interesting, because this segment contains the actors of the niche segment. From theory, we know that the niche segment has a more pragmatic attitude. To identify this niche, we first constructed the variable “pragmatism” from the following items (contra-arguments) in the questionnaire: (1) the range of natural gas cars is shorter; (2) the availability of service stations too limited; and (3) the uncertainty about future tax developments. These three items resulted in the variable “pragmatism” (Cronbach’s $\alpha = 0.51$), with the following range:

score	0	1	2	3	4	5	6
percentage	3	5	9	14	26	19	24

n= 146, mean score= 4.08 standard deviation = 1.61

Then, we defined the actors of the niche segment as being those actors in the early majority with an above average score on pragmatism, i.e. a score of 5 or 6.

This resulted in 14 actors belonging to the niche: 4 municipalities, 5 taxi-cab companies, 3 driving schools, 1 homecare institute and 1 transport company.

Significant differences between the niche and the rest of the mainstream are:

1. Investments in sustainable transport are more often part of a niche organization's policy (64 % versus 30 %);
2. Actors in the niche have invested more in New Driving (71 % versus 33 %);
3. And actors in the niche have invested more in car computers (71 % versus 30 %);
4. The niche finds driving on natural gas good for its image;
5. The niche finds driving on natural gas fitting in societal-responsible business.

RESULTS OF THE FOCUS GROUP

To develop a marketing strategy to speed up the diffusion and adoption of the CNG car, we need to know how the CNG car can be made "complete" so that actors in the niche segment will seriously consider it when replacing cars. In a focus group consisting of members from the niche and CNG car dealers, we asked "When deciding to replace, which are the most important barriers related to the CNG car, and how can these be solved, and what can be done?"

The first obstruction is the fuel tank to store the natural gas. Extra cylinders are necessary and they take space and have weight. And this is a problem for taxis and pick-up trucks. The car dealers argued that, in some models, the manufactures have solved the problem of space by building in small cylinders under the chassis, or they install a smaller petrol tank of 15 litres, and the rest is space for gas- cylinders.

The second large obstruction is the availability of natural gas filling stations. And the distance between filling stations should be not more than 80 kilometres. Some of the niche members said that if the natural gas filling station is around the corner, than the CNG car would be a serious replacement candidate.

The members of the niche have a need for knowledge on the following themes: 1. Availability of the fuel; 2. Range (radius) of action; 3. Loading capacity; 4. Fuel consumption; and 5. Operating costs.

The car dealers remarked that there are some disadvantages in the car's action radius and the availability of fuel. They think that the natural-gas-driven car, given there is a filling station in the area, is a good car for local car fleet owners, and for private use, if they do not drive more than 20 000 km per year. Home filling stations are too expensive for individuals, but for a large fleet an own filling station can be a justifiable investment depending on how many cars and the distances travelled. From experience, natural gas is cheaper than other fuels. Furthermore, car dealers mentioned that the CNG car is a clean car and contributes to solving local problems of air quality.

Concerning the stimulating factors that would persuade local fleet owners to consider the CNG car as a serious replacement candidate, the answer was very clear: **cost reduction**. Total costs including purchasing costs, taxes, fuel costs and maintenance costs, driving on natural gas should be cheaper

than driving on other fuels. The car dealers said that the purchasing costs of CNG cars are the same as those of petrol cars, also the maintenance costs are the same. The saving on fuel is about € 1.50 to € 2.00 per 100 kilometres. So the business situation of the fleet owner determines whether it is advantageous to consider the changeover to the CNG car.

We also asked their opinions on the role of the government. Firstly, the government should arrange to make it financially advantageous to drive a CNG car: by tax measures and subsidies, and by labelling the cars. Secondly, the government should stimulate the building of natural gas filling stations, by guaranteeing the risks of exploitation, and by playing an exemplary role. Furthermore, especially local governments could make CNG cars more attractive by giving CNG cars free parking, and when local authorities use cars from local fleets, they can make demands on the type of car and can give preference to local fleet owners with CNG cars. For example in Sweden, local authorities have a strong policy on promoting environmental friendly fuels and the national government has introduced some tax policy.

Discussion and conclusion

Our study addressed three questions: (1) is it possible to identify different adopter segments within the target group of fleet owners, (2) can we assess the characteristics of these adopter segments and (3) is it possible to develop recommendations for a marketing strategy to speed up the diffusion and or adoption of the natural gas car? The survey of the fleet-owners shows that the self-designating method resulted in a consistent scale, which measures the adoption segment.

With this method, we can identify the adoption segments in a target group and identify a niche segment in the mainstream. We found significant differences between the early market and the mainstream. They differ in size of their fleet. And the early market invests more in sustainable transport. We conclude that the early market finds environmental arguments, such as air quality, less CO₂ emission, and less stench and noise, important. Furthermore, we conclude that exemplary role and social responsibility are important issues for the early market. With the constructed variable "pragmatism" we could identify the most pragmatic actors within the early majority and, thus, zoom in and identify a niche.

Further research should be directed toward constructing a more reliable variable "pragmatism". Although Cronbach's α of 0.51 indicates a small measure of consistence between the items in the variable, it was sufficient for our practical purposes. But we recommend developing a validated scale for "pragmatism", to be used in future research on speeding up adoption of innovations.

The niche in our target group consists of 4 municipalities, 5 taxicab companies, 3 driving schools, 1 homecare institute and 1 transport company. By identifying the niche actors and their characteristics, we can give direction and advice for the marketing of the CNG car. We conclude that to speed up the adoption of the natural-gas-driven car the following measures are to be taken. Concentrate marketing activities in the neighbourhood of a natural gas filling station in, for example, Leeuwarden. These activities must be executed together with the CNG car importers and the local dealers. The local authorities

of Leeuwarden should provide extra benefits for CNG car drivers: free parking and a subsidy of € 1 000. The CNG car should be positioned as a car that makes sustainable driving possible at a reasonable price. But from our analysis, we also conclude that the marketing of the CNG car is in its very beginning. Therefore, the marketing should focus on the early market segment and the CNG car positioned as a specific means to contribute toward sustainable driving. After the CNG car begins to enter the early market, then the niche segment of the mainstream can be approached.

In 2007, we started these activities, and we will report these in due course. If marketing of the CNG car is successful—a sales figure of 100 cars—than we can conclude that the crossing-the-chasm-approach, with its target group analysis and segmental approach contributes to the transition approach.

Because other countries, for example Sweden, have a very active policy on stimulating the adoption of environmentally friendly cars, we also recommended to analyze their influence and strategy. Especially their national and local policies focus on adoption and seems to be successful.

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