Accelerating the hydrogen economy by using two-sided market effects

A model of a simultaneous market entry of fuel cells and hydrogen production

Christoph Birkner
Ph. D. student at Vattenfall Europe
Puschkinallee 52, 12435 Berlin, Germany
christoph.birkner@vattenfall.de

Boris Heinz
Ph. D. student at Berlin University of Technology
Institute of Energy Systems
Einsteinufer 25 (TA8), 10587 Berlin, Germany
boris.heinz@tu-berlin.de

1 Overview

Since the 19th century we understand the fuel cell technology and know about the advantages. Nevertheless we don't benefit from the economic and environmental advantages of the hydrogen economy, expect some niche markets like navy submarine and space ships [Erdmann 2003]. This paper aims to support the acceleration of the hydrogen economy. Therefore the innovative technology of fuel cells for residential use has been combined with a novel marketing theory. Based on different assumption due to the two-sided markets theory three scenarios will be presented. The modelling of the diffusion process of the fuel cells and the hydrogen production has been modelled with the software package MATLAB.

The hydrogen economy has been defined as an economy where the hydrogen is delivered to the customer and then is converted into electricity and heat by fuel cells. For this purpose the main constituent parts of the hydrogen network have been elucidated. In the paper the special features of fuel cells and hydrogen production will be discussed whereby the hydrogen economy is based on three important groups. In addition to the fuel cells' manufacturer and the hydrogen producer the customer of fuel cells and hydrogen are also important. Thus, this paper presents the innovative marketing concept of two-sided markets which is applied to the hydrogen economy.

2 Theory and Method

In two-sided markets there are content producers (e.g. fuel cell manufacturer and hydrogen producer) on one side of the market and end consumers on the other side of the market. Additionally a third participant exists. This 'platform-intermediary' (e.g. an electric utility) links both sides of the market by producing tools to connect the market [Eisenmann/Parker/Van Alstyne 2006; Parker/Van Alstyne 2005; Rochet/Tirole 2003].

The model is made up of two players on market 1 (business-to-business market): the fuel cell manufacturers and the hydrogen producers. Because both players are reliant on each other (fuel cells need hydrogen to work environmental friendly and hydrogen requires fuel cells to be converted into electricity and heat) network effects occur within one side of the market (intramarket network externalities or same-side effects). Because of product complementarities both competitors can cash in on positive feedback. For this reason they aren't competitors but business partners. Market 2 consists of customers of fuel cells and hydrogen. The hydrogen economy has also network effects across the market. The externalities run from consumers to the content providers (intermarket network externalities or cross-side effects) [Bakos 1997; Katz/Shapiro 1985]. There are cross-side effects because it is more likely that hydrogen producer will start up their business when there are many fuel cell customers and existing hydrogen producer will encourage people to buy fuel cells.

To simulate the spread of the new technologies a diffusion model for energy technologies has been compiled. In such a process, the adoption of technology throughout the economy can be linked to the spread of an epidemic [Decanio/Laitner 1997]. The rate of change of the technology's market share is proportional to the fraction of organizations that have already adopted the new technology, the fraction of the population that have not adopted the new technology, and a

rate parameter. To have a proceeding diffusion process the critical mass has to be reached [Meade/Islam 2006].

3 Results

In the first scenario a diffusion process of fuel cells without any positive feedback of fuel cell manufacturer, hydrogen producer and customer has been modelled. In the second scenario a simultaneous market entry of fuel cells and hydrogen production has been shown. The same-side effects are integrated by linking the growth rate of the fuel cell manufacturer and hydrogen producer. In the third scenario an enhanced diffusion process because of same-side and cross-side effects has been obtained. The cross-side effect has been simulated by an additional growth of the market after each period. These faster emerge the critical mass. Here the rate parameter has been discounted to demonstrate the transaction costs' reducing effect of a 'platform company'.
To gain insights into the stability of the shown results a sensitivity analysis has been conducted for each of the above mentioned scenarios. The analysis shows how changes in the diffusion rates could occur due to variations of the factors included in the rate parameter. Among others these factors are the fraction of organizations/the population that have already adopted the new technology, the operating costs and the capital costs. The factors in the rate parameter are allowed to change over time so that e.g. capital costs and operating costs are declining over time as learning occurs and markets for the new technology broaden.
Scenario 1 indicates a slow diffusion of fuel cells. In a highly fragmented fuel cell market the entrance of hydrogen producers is very unlikely. In scenario 2 the distribution is faster because of the economic utilisation of same-side effects. Finally scenario 3 shows the fastest diffusion process because of same-side and cross-side effects and decreasing transaction cost due to a broker.

4 Conclusion

Using the positive effects of two-sided markets will accelerate the hydrogen economy. Therefore the fuel cell manufacturer and hydrogen producer should work together and build regional clusters. This diffusion process of the fuel cells should be moderated by a broker in order to reduce transaction costs. An introduction of locally distributed fuel cells for decentralized energy supply based on hydrogen then may be a promising alternative to current technologies.

References

- Bakos, Yannis (1997) "Reducing Buyer Search Costs: Implications for Electronic Marketplaces", *Management Science*, 43 (1997) 12, 1676-1692
- Bompard, Ettore, Roberto Napoli and Gianmichele (2007) "Economics evaluation of 5kW solid oxide fuel cell power systems for residential use", *conference paper* on "HYSYDays – 2nd World Congress of Young Scientists on Hydrogen Energy Systems", Turin (2007), 1-8
- Caillaud, Bernard and Bernard Jullien (2003) "Chicken & egg: Competing match-makers, *RAND Journal of Economics*, 34 (2003) 2, 309-328
- Decanio, Stephen J. and John A. Laitner (1997) "Modeling Technological Change in Energy Demand Forecasting", *Technological Forecasting and Social Change*, 55 (1997), 249-263
- Eisenmann, Thomas, Geoffrey Parker and Marshall W. Van Alstyne (2006) "Strategies for two-sided markets", *Harvard Business Review*, 10 (2006), 92-101
- Erdmann, Georg (2003) "Future Economics of the Fuel Cell Housing Market", *International Journal of Hydrogen Energy*, 28 (2003), 685-694
- Katz, M. L. and C. Shapiro (1985) "Network externalities, competition, and compatibility", *American Economic Review*, 75 (1985) 3, 424-440
- Meade, Nigel and Towhidul Islam (2006) "Modelling and forecasting the diffusion of
- innovation – A 25-year review", *International Journal of Forecasting*, 22 (2006), 519-545
- Parker, Geoffrey G. and Marshall W. Van Alstyne (2005) "Two-Sided Network Effects: A Theory of Information Product Design", *Management Science*, 51 (2005) 10, 1494-1504
- Rochet, Jean-Charles and Jean Tirole (2003) "Platform Competition in Two-Sided Markets, *Journal of the European Economic Association*, 1 (2003) 4, 990-1029