The pitfalls of green innovation policy: the case of green certificates

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1. Introduction

For about 35 years, governments in many countries all over the world have been attempting to foster the development and diffusion of renewable energy technologies (RETs), especially for electricity generation purposes. Support systems have changed over time, from the R&D centred policies of the mid-1970s to more market oriented measures adopted in many countries in the 1990s and 2000s. One example of this development is Sweden, where government policies to stimulate 'new' RETs (i.e. excluding large-scale hydro) were first implemented in the mid-1970s and have ranged from traditional R&D funding, over funding from demonstration projects to investment subsidies. Since May 2003, the main stimulation measure is a tradable green certificate (TGC) system.

In TGC systems, renewable electricity production is rewarded by certificates corresponding to the amount of electricity produced. The electricity is sold in the electricity market and theses sales are complemented by certificate trading in a separate market. Producers of renewable electricity, thus, have two sources of income. Demand for certificates is commonly created by a quota obligation for obligated buyers (usually electricity suppliers or consumers), who must buy certificates corresponding to a certain share of their total electricity sales or consumption. In the Swedish TGC system, most production based on new renewable electricity sources is qualified to receive certificates.[2] A peculiarity of the Swedish system is that all existing new renewable electricity production capacity was included from the start to create liquidity in the system.

Although the main goal of this policy instrument is to increase renewable electricity production, it was also an explicit request from the Swedish Government that it should replace all other policy instruments, including those directed at stimulating technology development and innovation. The system was, thus, explicitly expected to be able to drive technological development. The purpose of this position paper is, however, to use modern innovation theory to argue that a TGC system like the Swedish one almost per definition is ill suited as an innovation policy instrument and needs to be complemented by other policies for development of new technologies to occur.

[1] Bergek, A. and Jacobsson, S. (2008): En kritisk granskning av det svenska elcertifikatsystemet ("A critical assessment of the Swedish electricity certificate system"), Report to the Swedish Ministry of Finance's expert group on environmental studies, Stockholm. Bergek, A., Berggren, C. and Jacobsson, S. (2008a): Håller Sverige på att missa klimatutmaningens innovationspotential? In: Öhrwall Rönnbäck, A. (Ed.): *Ur startblocken. Svensk innovationskraft II*, Forum för innovation Management, Stockholm, pp. 159-168 (in Swedish). Bergek, A. and Jacobsson, S. (2010): Are Tradable Green Certificates a cost-efficient policy driving technical change or a rent-generating machine? Lessons from Sweden 2003-2008, *Energy Policy* 38 (3): 1255-1271.
[2] Eligible sources include wind power, solar power, wave power, geothermal power, biomass-based electricity generation, hydro power (under certain conditions) and peat.

2. The Swedish TGC system: goals, expectations and basic assumptions[3]

The Swedish tradable green certificate (TCC) system was taken into operation 1 May 2003. Before that, it had been discussed and debated in a series of government bills and committees of enquiry. An analysis of these documents reveals the explicit and implicit goals of policy makers with regards to the system.

As originally formulated, the overall goal of the system was to stimulate further development of electricity production from renewable energy sources and "market dynamics" that create conditions for cost-efficiency and technology development without disturbing the function of the electricity market.[4] The long-term goal was for renewable energy sources to be able to stand on their own feet and compete on equal terms with other energy sources.[5] It was, thus, an explicit goal to increase the competitiveness of renewable energy sources in the market, primarily through technology development and cost reduction.

Although no coherent theoretical framework was presented to explain to what extent and how the TGC system could be expected to fulfil these expectations, three main underlying assumptions can be identified in the official documents. As I will argue later on in this paper, these three interrelated assumptions leads to a flawed view on how to create favourable conditions for technological development and innovation.

(i) Assumptions concerning the rationale for support to renewable electricity

The main official motive for supporting new renewable electricity sources was their apparent lack of competitiveness in comparison to more established electricity sources, such as nuclear power, fossil fuels and large-scale hydro power.[6] The argument was that the positive environmental effects of renewable electricity were not fully integrated in the electricity price, which implied a gap between socio-economic benefit and business profitability for investments in renewable electricity production.[7] In other words, the justification for supporting renewable was that there was a 'market failure' in the form of external effects. Additional funding was therefore needed to achieve a socially optimal level of renewable electricity production. In the TGC system, certificate trading (in combination with a quota obligation) was assumed to "cover the additional cost the producer has as a consequence of using renewable energy sources instead of conventional fuels"[8] and allow renewable electricity to become profitable.[9]

(ii) Assumptions concerning cost-efficiency

A main motive behind the Swedish TGC system was to reduce the costs for support to renewable electricity production. The assumption was that a "market solution" would provide incentives to reduce costs for new electricity production and, thus, the total support cost of the system,[10] minimise the disruption in the electricity market and avoid overcompensation to producers of renewable electricity.[11] The basic idea was that competition between different renewable would ensure that "those investments that are most cost-efficient and easiest to carry out should be brought about first"[12]. A necessary condition for this to work – it was argued – was that the system had to be "technology-neutral", i.e. that all renewable electricity sources should be treated equally under a common quota.

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[3] This section is based on Bergek and Jacobsson (2008), *op. cit.* Ref. 1.

[4] Swedish Government (2000): *Ekonomiska förutsättningar för elproduktion från förnybara energikällor* ("Economic conditions for electricity production from renewable energy sources"), Government Bill (prop. 1999/2000:134), 20 May 2000, Stockholm.

[5] Swedish Government (2002a): *Samverkan för en trygg, effektiv och miljövänlig energiförsörjning* ("Collaboration for a safe, efficient and environment-friendly energy supply"), Government bill (prop. 2001/02:143), 14 March 2002, Stockholm.

[6] Swedish Government, 2002a, *op. cit.* Ref. 5, p. 9; Swedish Government (2002b): *Elcertifikat för att främja förnybara energikällor* ("Electricity certificates to support renewable energy sources"), Government Bill (prop. 2002/03:40), Stockholm, p. 36.

[7] Cf. SOU (2001): *Handel med elcertifikat. Ett nytt sätt att främja el från förnybara energikällor* ("Trade with electricity certificates. A new way of inducing electricity from renewable energy sources"), final report by the government committee of inquiry on electricity certificates, Swedish Government Official Reports (SOU) 2001:77, Stockholm.

[8] Swedish Government, 2002b, *op. cit.* Ref. 6, p. 1-2, my translation.

[9] Swedish Ministry of Industry (2002): Law about electricity certificates, Ministry publications Ds 2002:40, Stockholm.

[10] Swedish Government, 2002a, *op. cit.* Ref. 5.

[11] Swedish Government, 2000, *op. cit.* Ref. 4.

[12] Swedish Government (2006a): *Förnybar el med gröna certifikat* ("Renewable electricity with green certificates"), Government Bill (prop. 2005/06:154), 22 March 2006, Stockholm, p. 29 (my translation).

(iii) Assumptions about the mechanisms underlying technology development and cost reduction

Technology development was discussed in several places in reports and government bills, primarily in relation to the abovementioned "market dynamics". What these market dynamics imply and why they would lead to cost-efficiency and technology development was not really explained, but a recurring assumption was that "competition between forms of electricity from renewable energy sources ... [would] lead to cost efficiency and to the origin of new technical solutions"[13]. This was especially highlighted in comparisons between the TGC system and the German fixed tariff system, where it was argued that fixed tariffs, due to the lack of competition between different renewables, "run the risk of impeding technology development"[14].

To sum up, the Swedish TGC system was chosen and implemented based on the expectation that it would not only induce investments in renewable electricity production, but also drive technology development. These expectations rested on three main, interrelated assumptions: (1) that the main obstacle for further renewable electricity technology implementation was the market failure to internalize the negative environmental effects of conventional electricity generation in the market price for electricity, (2) that a technology-neutral system would be the most cost-efficient solution and (3) that technology development would be induced by direct competition among producers of renewable electricity from various sources. There are many problems with these assumptions from an innovation perspective. In the following section, I will highlight some of them.

3. Reasons why a "technology-neutral" TGC system focusing on competition among electricity producers cannot be expected to drive innovation

In this section, I take my departure in a systems approach to innovation known as the technological innovation systems approach.[15] In general, system perspectives on innovation emphasizes that innovation and diffusion are both individual and collective processes, which implies that technology choice is influenced not only by factors on the level of individual firms, but also on the level of what we may call an innovation system: the actors, networks and institutions (rules, norms, values) that contribute to the

[13] SOU, 2001, *op. cit.* Ref. 7, p. 104, my translation. This assumption has also been repeated in the academic literature (cf. Madlener, R. and Stagl, S. (2005): Sustainability-guided promotion of renewable electricity generation, *Ecological Economics*, 53 (2): 147-167. Menanteau, P., Finon, D. and Lamy, M.-L. (2003): Prices versus quantities: choosing policies for promoting the development of renewable energy, *Energy Policy*, 31 (8): 799-812. Ürge-Vorsatz, D., Rezessy, S. and Antypas, A. (2004): Renewable electricity support schemes in Central Europé: a case of incomplete policy transfer, *Energy & Environment*, 15 (4): 699-721. Verhaegen, K., Meeus, L. and Belmans, R. (2009): Towards an international tradable green certificate system – The challenging example of Belgium, *Renewable and Sustainable Energy Reviews* 13 (1): 208-215.

[14] Swedish Government, 2002b, *op. cit.* Ref. 6, my translation.

[15] Cf. e.g. Bergek, A. & Jacobsson, S. (2003): The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries. In: Metcalfe, S. & Cantner, U. (Eds): *Change, Transformation and Development*. Physica/Springer, Heidelberg, 2003, pp. 197-228. Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. & Rickne, A. (2008c): Analyzing the functional dynamics of technological innovation systems: a scheme of analysis. *Research Policy*, 37 (3): 407-429. Bergek, A., Jacobsson, S. and Hekkert, M. (2008d): Functions in innovation systems: A framework for analysing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers. In: Foxon, T., Köhler, J. and Oughton, C. (eds): *Innovation for a Low Carbon Economy: Economic, Institutional and Management Approaches*, Edward Elgar, Cheltenham. Bergek, A., Jacobsson, S. and Sandén, B. (2008e): 'Legitimation' and 'Development of positive externalities': Two key processes in the formation phase of technological innovation systems, *Technology Analysis & Strategic Management*, 20 (5): 575-592. Carlsson, B. and Stankiewicz, R. (1991): On the nature, function, and composition of technological systems. *Journal of Evolutionary Economics*, Vol. 1, p. 93-118. Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S. & Smits, R.E.H.M. (2007): Functions of innovation systems: A new approach for analyzing technological change, *Technological Forecasting & Social Change* 74: 413–432. Jacobsson, S. and Johnson, A. (2000): The Diffusion of Renewable Energy Technology: An Analytical Framework and Key Issues for Research. *Energy Policy*, 28 (9): 625-640. Johnson, A. and Jacobsson, S. (2001): Inducement and Blocking Mechanisms in the Development of a New Industry: The Case of Renewable Energy Technology in Sweden". In: Coombs, R., Green, K., Walsh, V. & Richards, A. (Eds): *Technology and the Market: Demand, Users and Innovation*". Edward Elgar. Cheltenham och Northhampton, Massachusetts, 2001.

development and diffusion of a new technology.[16] For a new technology to develop, a technological innovation system thus has to develop and become well functioning.

In stark contrast to the abovementioned policy assumptions related to the Swedish TGC system, this perspective highlights (1) that market failures are not the only possible obstacles for the development and diffusion of new technologies, (2) that the formation of early markets for underdeveloped technologies is crucial for their further development and (3) that it is the conditions for and completion within the capital goods industry (i.e. the companies supplying electricity production equipment) that drive technology development, not competition among electricity producers. In the following, I will develop these arguments further, ending up in the conclusion that the Swedish TGC system has little potential to drive technology development and innovation.

Market failures are only one of the many potential obstacles hindering the development of new technologies

As has been described in a large number of empirical studies, the development and functioning of a technological innovation system may be both induced and blocked by internal as well as external mechanisms.[17] In contrast to traditional neoclassical thinking, the system perspective acknowledges that inducement mechanisms do not only come in the form of relative prices but also, for example, in the form of feedback from early users.

In addition, the system perspective demonstrates that the market failure approach is both flawed and insufficient.[18] It is flawed because it is impossible to identify one single optimal outcome of complex system-building processes (as is assumed in the market failure approach). It is insufficient because it focuses on only one, limited part of the context for innovation – the market – and fails to include other potential sources of blocking mechanisms for technology development and diffusion, such as networks obstacles and institutional obstacles (Jacobsson and Johnson, 2000).

Taken together these two points imply that there is more to innovation policy than getting the prices "right" to compensate for market failures. Policy makers thus have to be concerned with a broad set of system weaknesses, including but not restricted to market failures (Smith, 2000; Bergek et al., 2010).

The formation of early markets for underdeveloped technologies is crucial for their further development

As is well known in the innovation literature, there is a clear connection between technology development (and cost reduction) and market diffusion. When new technology is spread, this often leads to improvements in performance and/or cost, which makes it more attractive and stimulates further diffusion. Such effects are known as "increasing returns to adoption" and include, e.g. economies of scale, scope and experience and network effects.[19] In early phases of development, "nursing markets" are needed, where the new technology is protected from competition from other, more established

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[16] Carlsson, B (Ed.) (1995): *Technological Systems and Economic Performance. The Case of Factory Automation.* Kluwer Press, Boston. Carlsson, B (Ed.) (1997): *Technological systems and Industrial Dynamics.* Kluwer Press, Boston. Jacobsson and Johnson, 2000, *op. cit.* Ref. 15.

[17] Bergek and Jacobsson, 2003, *op. cit.* Ref. 15; Johnson and Jacobsson, 2001, *op. cit.* Ref. 15; Hekkert et al., 2007, *op. cit.* Ref.15.

[18] Bergek, A., Jacobsson, S., Hekkert, M. and Smith, K. (2010): Functionality of innovation systems as a rationale and guide in innovation policy, in: Smits, R., Kuhlmann, S. & Shapira, P. (Eds): *The Theory and Practice of Innovation Policy. An International Research Handbook*, Edward Elgar, Cheltenham. Carlsson, B and Jacobsson, S. (1996): Technological Systems and Industrial Dynamics: Implications for firms and governments, in Helmstädter, E. and Perlman, M. (eds): *Behavioral Norms, Technological Progress, and Economic Dynamics*, The University of Michigan Press, Ann Arbor. Carlsson, B. and Jacobsson, S. (1997): In search of a useful technology policy - general lessons and key issues for policy makers. In: Carlsson, B (ed.): *Technological systems and Industrial Dynamics*. Kluwer Press, Boston, pp. 299-315. Malerba, F. (1996): Public Policy and Industrial Dynamics: an Evolutionary Perspective, manuscript submitted to the Commission, December. Metcalfe, S. (1992): The economic foundation of technology policy. Equilibrium and evolutionary perspectives. Mimeo, University of Manchester. Metcalfe, S. (2004): Policy for Innovation, mimeo, ESRC Centre for Research on Innovation and Competition, University of Manchester.

[19] Arthur, W. B. (1988): Competing technologies: an overview. I: Dosi, G. et al (red): *Technical Change and Economic Theory.* Pinter Publishers, London, s. 590-607.

technologies. These can be natural market niches, where customers with special needs have a demand for the new technology and are willing to pay for it, or they can be created in various ways through policy instruments (e.g. demonstration programmes). Nursing markets create a foundation for learning and other self-reinforcing processes, and can thereby result in successive development and adaptation of the technology to other, larger segments ("bridging markets") with higher requirements on performance and cost. Over time, this type of gradual diffusion coupled to performance improvements and cost reductions can make the technology suitable for mass market adoption.[20]

In addition, recent research on technological innovation systems has shown that market formation can be the driving force behind the emergence and growth of entire innovation systems, since "they generate a 'space' for the elements in the technological system to fall in place"[21]. For example, the formation of early markets for wind turbines in Germany was a key factor behind the successful development of a German TIS for wind turbines.[22] Market formation, thus, both induces learning and is a key process in the building up of new TIS.

Thus, in contrast to the policy assumptions underlying the Swedish TGC system, the key aspect of market dynamics from an innovation perspective is not competition, but the creation of opportunities for learning and uncertainty reduction as well as of incentives for entry of various types of actors into the innovation system. The problem with the technology-neutral Swedish TGC system from this perspective is that new technologies are outcompeted by currently more cost-efficient technologies and, thus, denied access to the market in the crucial early phase of development. If we take a look at the plants that are currently included in the system, we see that a vast majority use relatively conventional renewable electricity technologies, such as biomass CHP (boiler and steam turbine), biomass industrial back pressure turbines, small-scale hydro power turbines and land-based wind turbines (see Figure 1). Newer technologies, such as wave power, biomass gasification, off-shore wind and solar cells, make up less than two percent of the electricity production in the system.[23] The huge revenues from the system[24] thus benefit investors in relatively mature renewable electricity technologies instead of rewarding 'entrepreneurial' firms that invest in emerging technologies.[25] The system, thus, corresponds to a late bridging market or an early mass market. This situation is likely to remain for quite a long time unless the quota is set on such a high level that it cannot be met by the more mature RETs.[26]

To conclude, the TGC system deprives emerging technologies of the nursing markets that are crucial for their further development and for the building up of TIS that can drive this development. A 'gap' is thereby created between R&D measures and the more mass market focused TGC system, which implies that the more immature technologies will not have been sufficiently developed once the more mature RETs have been fully exploited and cannot meet the quota anymore.[27]

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[20] Andersson, B. & Jacobsson, S. (2000): Monitoring and assessing technology choice: the case of solar cells. *Energy Policy*, vol. 28, s. 1037-1049.
[21] Jacobsson, S. and Bergek, A. (2004): Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology. *Industrial and Corporate Change*, 13 (5): 815-849, p. 820.
[22] Bergek and Jacobsson, 2003, *op. cit.* Ref. 15.
[23] Swedish Energy Agency (2010): *Elcertifikatsystemet 2010*. Swedish Energy Agency, Eskilstuna.
[24] Bergek and Jacobsson, 2010, *op. cit.* Ref. 1.
[25] To make matters worse – from an innovation perspective – almost 80 percent of the total production in the system comes from plants that were already taken into operation before the system was launched in May 2003 (Swedish Energy Agency, 2010, *op. cit.* Ref. 23). For most of these plants, the system has not even led to market formation for more mature renewable electricity technologies.
[26] Substantially increasing the quota would, however, result in very high certificate prices since they are determined by the production cost of the last plant included in the system.
[27] Cf. Contaldi, M., Gracceva, F. and Tosato, G. (2007): Evaluation of green-certificates policies using the MARKAL-MACRO-Italy model, *Energy Policy*, 35(2): 797-808. Finon, D. & Perez, Y. (2006): The social efficiency of instruments for the promotion of renewables in the electricity industry: a transaction cost perspective, *Ecological Economics,* 62(1): 77-92.

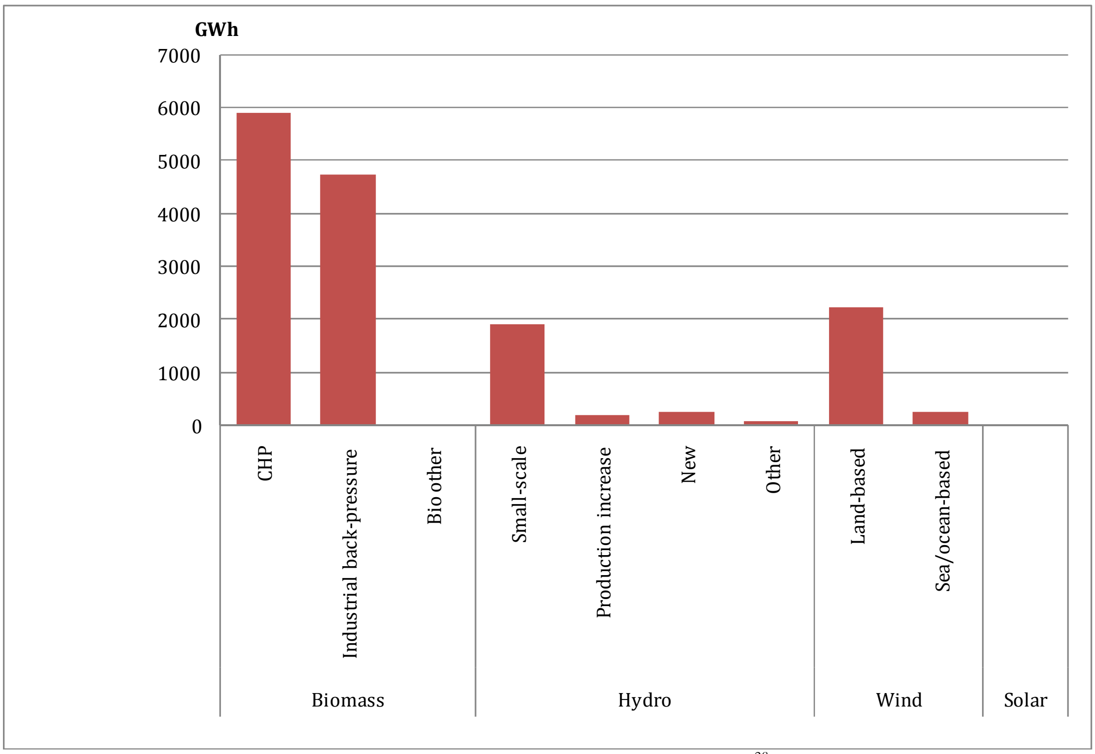

Figure 1: Electricity production 2009 in plants included in the Swedish TGC system.[28]

It is the conditions for and competition within the capital goods industry that drive technology development – not electricity producers

The assumption that it is competition in the production of electricity that drives technology development is associated with several problems. A first problem is that many of the RETs, especially those based on flowing energy sources such as wind, water and waves, have a cost structure where the investment cost make up 80-85% of the total cost.[29] This implies that there is very little potential to reduce costs through production rationalizations once the plant is built. If producers want to reduce their production costs, they have to reduce investment costs, which implies that they are dependent on technology development and mass production in the capital goods industry.

A second problem is that the development of technology by the capital goods industry is not primarily driven by competition in the customers' markets. Although such competition may generally be considered one of several incentives for technology development,[30] there are several reasons why this link cannot be expected to be very strong in this case:

- Different RETs are not perfect substitutes for each other. In particular, the two main alternatives in the Swedish system – wind power and biomass CHP – can hardly be seen as comparable alternatives from the point of view of many investors. In order to build a biomass CHP plant, you need to have access to the district heating network or own a plant in need of process heat (e.g. a pulp and paper plant). Currently, less than 20% of the wind power investors in Sweden meet this criterion. This illustrates that for many investors, the alternative investment is not other RET plants than the one primarily considered, but other types of investments (e.g. a new tractor for a farmer).

[28] Elaboration on Swedish Energy Agency, 2010, *op. cit.* Ref. 23.
[29] Hvelplund, F. (2006): Renewable energy and the need for local energy markets, *Energy*, 31(13): 2293-2302.' Meyer, N. I. (2003): European schemes for promoting renewables in liberalised markets, *Energy Policy*, 31(7): 665–676.
[30] Porter, M. (1980): *Competitive Strategy, Techniques for Analyzing Industries and Competitors*, The Free Press, New York. Rosenberg, N. (1976): *Perspectives on Technology*, Cambridge University Press, Cambridge.

- Even in cases where there is competition between different RETs, mediated by the certificate price, it is doubtful if this drives technology development to any greater extent unless there is a domestic supplier industry. For example, the Swedish market is rather peripheral for leading wind turbine firms such as Vestas and Enercon. Instead, it is the competition on the global market, between different wind turbine manufacturers, that drive their innovation efforts. At the most, the Swedish market for RET could contribute to marginal learning among foreign suppliers.

- Although the use of technology (in this case production of electricity) has been proven to provide important input to innovation in many cases,[31] this presumes that the users are knowledgeable, 'lead' users. In the case of RET in Sweden, however, many of the investors in newer RETs cannot be expected to play this role. For example, in wind power over 60% of the owners of wind power turbines included in the TGC system are individuals, farmers, economic associations or specialized wind power producers, owning one or a few turbines. These types of investors have little knowledge of the technology and do not have easy access to the turbine suppliers since they often buy through specialized project developers.

Taken together, this implies that it is the capital goods industry that drives technology development and that the feedback from electricity production to technology development is limited, especially for 'newer' RETs. Instead, it is the industry-internal competition among suppliers of the same type of technology (e.g. between different wind turbine manufacturers) that matters the most for innovation. The same is true for other, more established, energy technologies, for example combined-cycle gas turbines.[32] Thus, for technology development in a new field to take place in a country, a capital goods industry has to develop within that field. As mentioned above, the innovation system literature tells us that this requires the emergence and development of technological innovation systems in terms of actor entry, accumulation of knowledge and technology, network formation and institutional change.[33] Policy makers, thus, have to create favourable conditions for system-building within a number of different technological fields.

As discussed previously, market formation plays an especially important part in this process, but many other functions have to be fulfilled for a new technological innovation system to develop and perform well: knowledge has to be developed and diffused in the system; uncertainty has to be reduced through entrepreneurial experimentation, there has to be guidance in the direction of search of firms and other types of actors to induce entry into the field, resources have to be mobilized and the new field legitimated in the eyes of important stakeholders.[34] Obviously, the TGC system, with its focus on improving the relative price of a few relatively mature RETs cannot achieve this.

4. Conclusions and lessons for policy

To conclude, the Swedish TGC system is associated with a number of assumptions that give a flawed view on technology development and innovation. This view focuses on a narrow piece of the entire innovation jigsaw puzzle (prices), underestimates the value of long-term learning and system building as prerequisites for innovation and largely neglects the key role played by the capital goods industry in these processes.

The TGC system is designed to remove market failures by getting the price paid for renewable electricity right. However, since it only creates a market for quite mature RETs, it fails to deal with the much bigger issue of nursing market formation for new, immature technologies. This impedes learning and entry of the capital goods industry into new areas and, in consequence, hinders the emergence of well-functioning TIS in new technology fields. This implies that the effect of the TGC system on technology development will be marginal. The country or region that adopts a TGC system thus has to rely on technology development in other countries and regions. However, technology adoption also requires receiver competence or

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[31] See, e.g., von Hippel, E. (1988): *The Sources of Innovation*. New York: Oxford University Press.
[32] Cf. Bergek, A., Berggren, C., Tell, F. and Watson, J. (2008b): Technological capabilities and late shakeouts: Industrial dynamics in the advanced gas turbine industry, 1986-2002, *Industrial and Corporate Change*, 17(2): 335-392.
[33] Cf. Bergek et al., 2008e, *op. cit.* Ref. 15.
[34] Bergek and Jacobsson, 2003, *op. cit.* Ref. 15; Bergek et al., 2008c, d, e, *op. cit.* Ref. 15; Johnson and Jacobsson, 2001, *op. cit.* Ref. 15.

"absorptive capacity"[35]. A TIS is therefore still needed, although not as deep as in a country that leads technology development in the field. If such a receiver competence does not exist, the market will not be able to deliver the necessary capacity, which will lead to long-term imbalances between supply and demand of RETs.

Supporting the development of new TIS require systemic instruments,[36] focusing on, for example, variety creation, formation of 'prime movers', formation of new networks and articulation of demand.[37] A system like the Swedish TGC system, which only focuses on price mechanisms, can therefore never be expected to solve more than a small part of the challenges associated with technology development and innovation. The assumption of Swedish policy makers that the TGC system would replace all other support systems to renewable electricity technology can, thus, be considered naïve.

5. Epilogue

In May 2010, the Swedish Parliament decided to extend the TGC system to 2035. It also decided to promote the implementation of a joint certificate market with Norway in the near future, and with even more countries into the system in a longer time perspective.

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[35] Cohen, W.M. & Levinthal, D.A. (1990): Absorptive Capacity: A New Perspective on Learning and Innovation, Administrative Science Quarterly, 35(1):128-152.
[36] Smits, R. and Kuhlmann, S. (2004): The rise of systemic instruments in innovation policy, *International Journal of Foresight and Innovation Policy*, 1(1/2): 4-32.
[37] Bergek et al., 2010, *op. cit.* Ref. 1.