ASEAN Australian Engineering Congress 2011

Engineering For Sustainability

25th - 27th July 2011 • Riverside Majestic Hotel
Kuching, Sarawak, Malaysia

Organised by :

Platinum Sponsor :

Gold Sponsor :

Silver Sponsor :

Sponsor :

Gala Dinner Sponsors :

Partner :

Supported by :

Souvenir Programme

Promoting electricity generation from renewable energy sources in emerging and developing countries – Lessons learned from the EU

Reinhard Haas, Gustav Resch, Sebastian Busch

Energy Economics Group, Vienna University of Technology, Austria, Email: haas@eeg.tuwien.ac.at

ABSTRACT: Increasing the share of renewable energy sources for electricity generation (RES-E) has a high priority in the energy strategies of many countries. Of core relevance world-wide is the implementation of proper financial support systems.
Moreover with respect to international trade recently the idea of constructing large solar power plants, e.g. in Northern Africa, and transporting the electricity to e.g. Europe has attracted attention again.
The core objective of this paper is to discuss (i) what is in principle the favourable promotion scheme looking at the additional costs all customers finally have to pay? (ii) how should an international framework look like from financial as well as from the electricity exchange point-of-view to foster cross-border investments in RES-E.
The major conclusions of this analysis are: In Europe FIT systems have proven to be of superior effectiveness and efficiency for promoting RES-E compared to TGC systems. With respect to extended international electricity trade a more complex approach is required: It has to differ between initial inestments and flow of money during the operation of the project. And it has to build on two major pillars: different types of royalties paid to the host country and an international cross-border FIT.

INTRODUCTION

To increase the share of renewable energy sources for electricity generation (RES-E) has a high priority in the energy strategies of many countries. However, to facilitate a breakthrough for RES-E, a series of economic, institutional, political, legislative, social and environmental barriers has to be overcome. It is important to state that these barriers may vary considerably between industrialized emerging and developing (E&D) countries. Of core relevance world-wide is currently the implementation of proper financial support systems. Whether trading-based (e.g. the recently announced Guarantee-of-Origin trade) or technology-specific instruments (like feed-in tariffs (FIT)) lead to preferable solutions for society is still under discussion, see e.g the discussion in Haas et al (2011a).

This issue is discussed very controversially in industrialized countries like EU-27 and USA. However, it is even more controversial and complex if it addresses emerging and developing (E&D) countries. In this context it also of interest that the European Commission puts strong focus on the aspect of International cooperation on promotion of RES-E., see European Parliament and Council. (2008).

Moreover, with respect to international trade in recent months the idea of

constructing large solar power plants, e.g. in Northern Africa, and transporting the electricity to e.g. Europe has attracted attention again. In this context a major question is, to what extent and in which form the population of the "host" country could benefit from such a project.

The core objective of this paper is to discuss the following aspects of regulatory promotion systems for electricity from RES in emerging and developing countries based on the lessons learned from EU-countries (see also Haas et al 2011b): (i) what is in principle the favourable promotion scheme from the looking at the additional costs all customers finally have to pay? (ii) How must a comprehensive international regulatory framework and a financial as well as an electricity exchange framework look like to foster international cross-border investments in renewable electricity and trade?

HOW PROMOTION STRATEGIES WORK

The following analysis is based on the concept of static (and further-on dynamic) cost resource curves of RES (see e.g. Haas et al (2004).

The core question is now how much money producers should receive in addition to the investment costs described in FIG. 1 and FIG. 2 as the area under the cost curve. Of course, investors in new RES-E generation plants should be compensated in a fair way but not by means of exaggerated profits. Hence, the major challenge for policy designers is to strike a reasonable balance between total generation costs and the producers' surplus (PS).

Remark: The producer surplus is defined as the sum of the profits of all green electricity generators.

FIG.1 depicts the relationship between total generation costs and the producers' surplus (PS) for a FIT system with three different tariffs for three technologies. We can see a moderate PS which is – as the experience from some EU-countries shows – accepted by the investors. The total additional costs – which finally have to be paid by the electricity customers – consist of the PS and the additional generation costs (costs above the market price of electricity).

FIG.2 shows the corresponding total costs for customers under a Tradable Green Certificate (TGC) system. A TGC-based quota system works as follows, see FIG. 2: A quota (= certain quantity or percentage of electricity to be guaranteed from renewable energy sources) is set by a government. The generators (producers), wholesalers, retailer or consumers (depending who is obligated in the electricity supply chain) are obligated to supply consume a certain percentage of electricity from renewable energy sources. At the date of settlement, they have to submit the required number of certificates to demonstrate compliance. The total additional costs – which finally also in this case have to be paid by the electricity customers – encompass the whole black rectangle in FIG. 2.

From society's point-of-view it is of course important to minimise these additional costs (fees finally paid by households, commercial and industrial electricity customers) for the following reasons: the lower these additional costs are, the greater is the public acceptance and the larger will be the amount of additional electricity generated from RES per unit of public money.

So the most effective strategy must focus finally on the minimization of total

transfer costs to ensure both, acceptance by customers and by investors. To minimise producer surplus (PS), a stepped promotion scheme that limits PS, see FIG. 1, reduces the resulting producer surplus correspondingly.

If we now compare the total costs in FIG. 1 and FIG. 2 we can clearly see that they are much higher in FIG. 3 and hence, for society it is of course more beneficial to implement a FIT (see also Held et al (2006)).

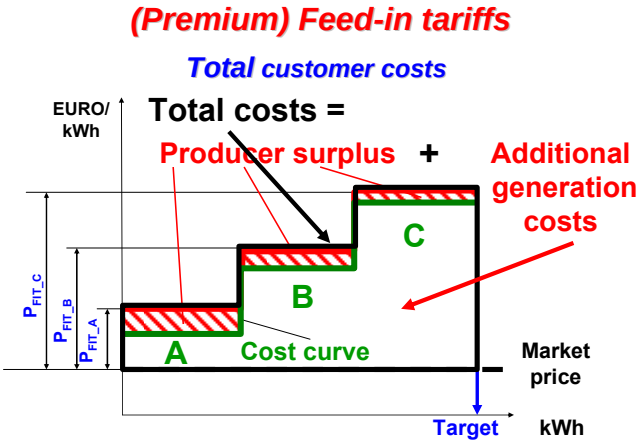

FIG 1. Total costs for customers under a feed-in tariff system (Haas et al 2010)

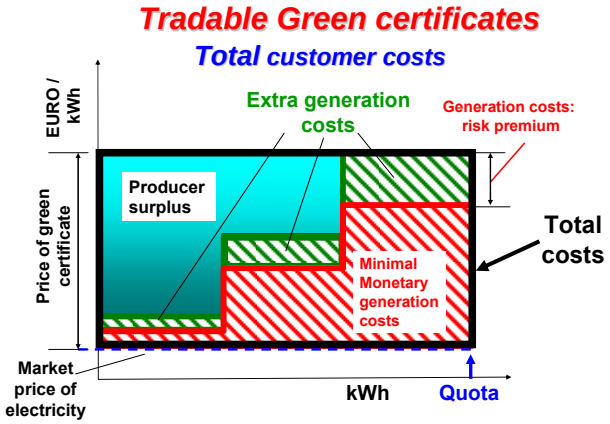

FIG. 2. Total costs for customers under a Tradable Green Certificate system (Haas et al 2010)

To identify the major country-specific lessons learned, next the relation between quantities deployed and the level of support is analysed for some trading and some FIT systems in recent years. It is often argued that the reason for higher capacities installed is a higher support level. Paradoxically, countries with highest support levels – Belgium and Italy for example – are among those with the lowest specific deployment (FIG.1). On the other hand, high FITs especially in Germany and Spain are often named as the main driver for investments especially in wind energy. However, the support level in these countries is not particularly high compared with

other countries analysed here.

Currently in various European countries different strategies are in force. Next the relation between quantities deployed and the level of support is analysed for some trading and some FIT systems in recent years.. It is often argued that the reason for higher capacities installed is a higher support level. And it is accepted that the resource endowments of RES-E vary from country to country.

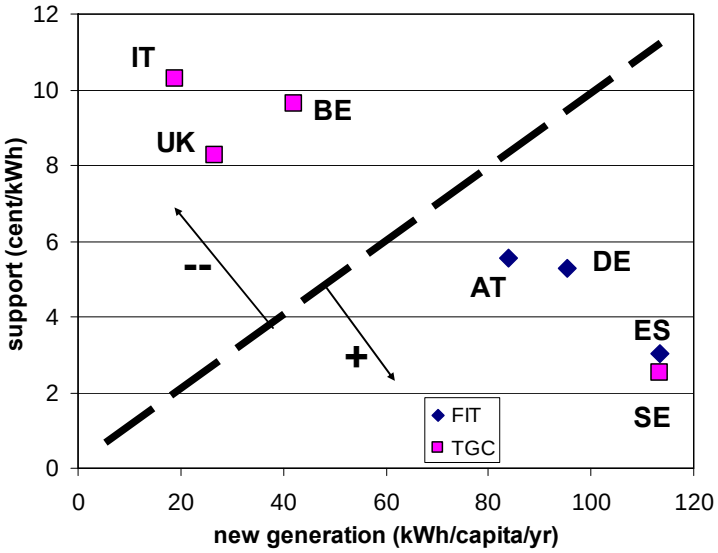

FIG. 3. Effectiveness vs costs of promotion programmes for electricity from RES (except Photovoltaics) in selected countries 2003-2008 (Source: own analyses)

Paradoxically, countries with highest support levels – Belgium and Italy for example – are among those with the lowest specific deployment (FIG.3). On the other hand, high FITs especially in Germany and Spain are often named as the main driver for investments especially in wind energy. However, the support level in these countries is not particularly high compared with other countries analysed here.

AN INTERNATIONAL FRAMEWORK FOR THE TRANSFER OF ELECTRICITY FROM DEVELOPING COUNTRIES

Out of the experiences with the support schemes in the EU a list of "Best Practices" emerged that have either been introduced in the countries or have been recommended. Since both countries we have looked at in this article use FIT, and FIT are the most widespread instrument, we discuss some best practices in the following, that emerged from the experiences with RES-E promotion in the EU:

- RES-E support requires continuity and log term investment policy. Therefore FIT should be accompanied by long term targets and sufficiently long periods for which the tariff is guaranteed. A long term strategy for deploying significant amounts of RES-E generation has to build on fundamental R&D technology development which provides by means of proper technology transfer to E&D

countries successful implementation of projects. In this chain financing in different forms is a fundamental requirement, FIG.4.

- Technology specific tariff levels should be applied in order to reflect the varying electricity generation costs. The levels should be set so that the policy goals of a country can be reached and the most cost efficient RET at a particular location are deployed first. Stepped tariffs can be applied to reflect different power generation costs within the same technology.

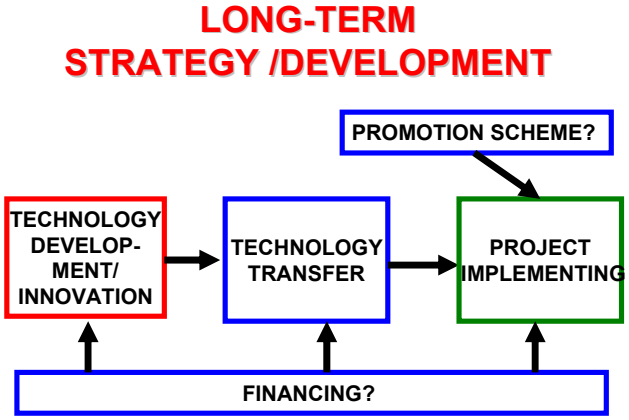

FIG. 4. Financing in different forms for providing successful implementation of projects

- RES-E support policies should consider market integration. In the case of FIT this could e.g. be reached through a bonus tariff. With the option to sell the electricity on the free market. Another important aspect in this context is a forecasting obligation.
- An annual tariff degression provides an incentive for cost reductions and technology improvements.

A specific case of promoting RES-E is to generate and to import it from a third country. The most intensively discussed example currently is to produce electricity in the Sahara and to transport it to Europe.

This is arguable because renewable energy resources e.g. solar electricity are often situated in emerging or developing countries of the south. One of the major current examples in this context is the DESERTEC project. Within this project the intention is to produce solar electricity in the Sahara at lower costs and with higher full load hours than in Europe.

Aside from policy aspects a major challenge in such a project is to set up a framework where the host country (in the south) and the investor country (in the North) both benefit. Of course, this example can be transferred in principle to every case where a rich country invests in a less rich country to benfit from its resources. Such a framework will in detail look much more sophisticated than just looking at investments and transmission of electricity.

In the following we will identify proper regulatory promotion concepts for an international exchange of RES-E mainly between developing countries on the one side and between industrialized countries like the EU on the other side. In this context most

important is to strike a socially and ecologically acceptable balance between local use and international trade. It also has to be considered that local use will be cheaper and energetically more efficient because of a lack of transport losses. FIG.5 depicts the international plant and network structure of target country of RES-E with electricity produced in the host country

When setting up such an international framework we have to consider two major dimensions: The flow of money and the flow of electricity.

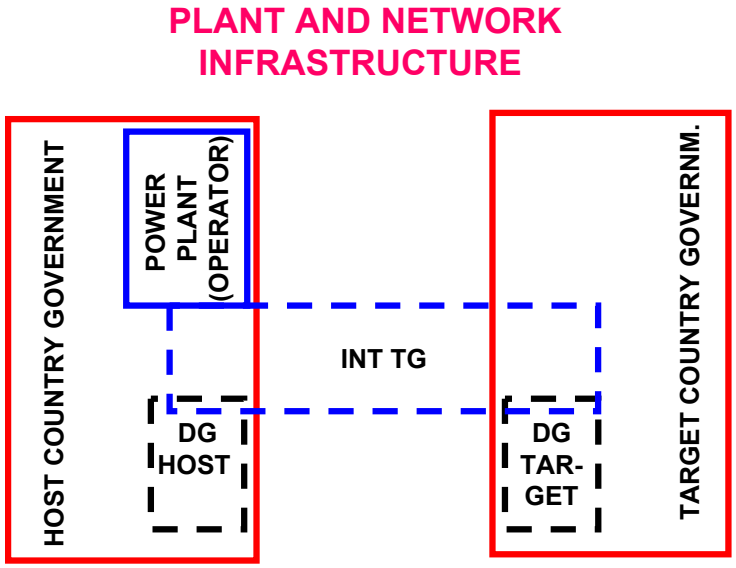

FIG. 5. International plant and network structure of target country of RES-E with electricity produced in the host country

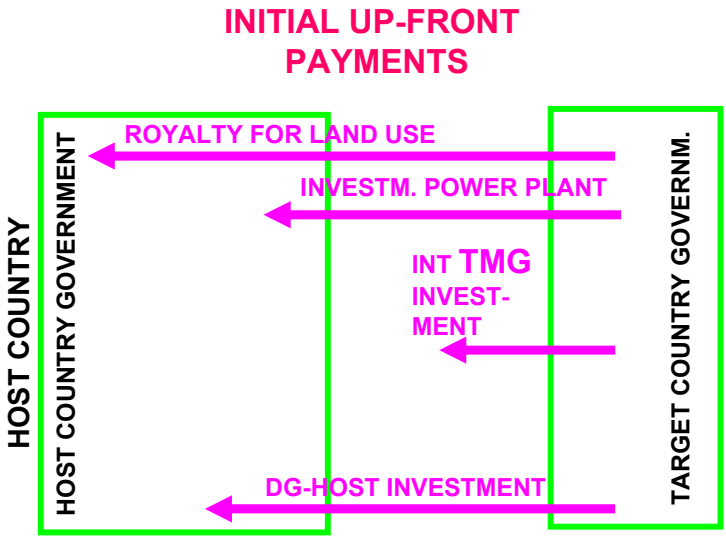

FIG. 6. Initial up-front payments of the target country for RES-E with electricity produced in the host country

First we analyse the monetary issues. We have to differ between one-time initial up-front investments and the flow of money over the time the project is operated. With respect to up-front investments – see FIG. 6 and FIG. 7 – aside from the investment in the power plant also investments in the international transmission grid and the distribution grid of the host country – as a compensation for the acceptance of the deal by its population – has to be borne by the investor country (=target country of RES-E). Moreover, a one-time royalty – purchase of land area – must be considered.

FIG.7 provides a joint depiction of the international plant and network structure of target country of RES-E with electricity produced in the host country and initial up-front investments by target country of RES-E with electricity produced in the host country.

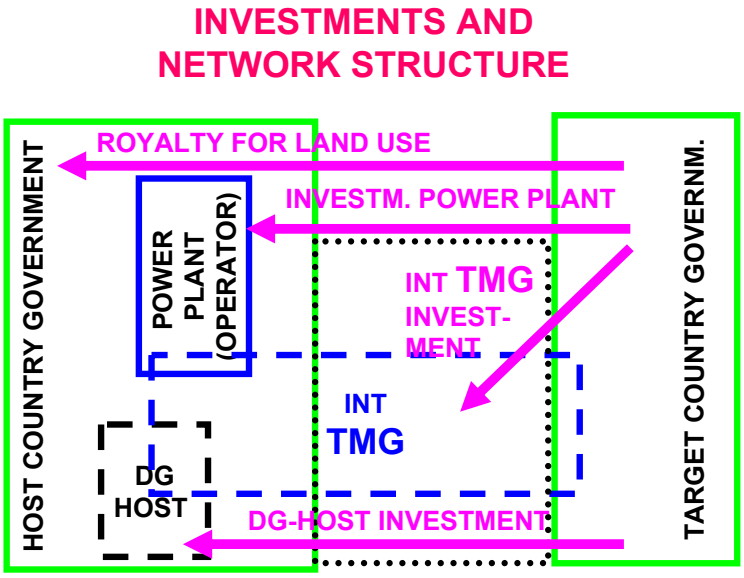

FIG. 7. International plant and network structure and initial up-front investments by target country of RES-E with electricity produced in the host country

Regarding the flow of money during the operation of the power plant a more complex approach for the payments to the host country is required. It may consisting of a permanent payment to the hosts' government ("rent for land use"), a payment for the host country's government support of investments into the local distribution grid a cross-subsidization of a beneficial local electricity tariff, see FIG. 8 and FIG. 9. The revenues come from the international FIT.

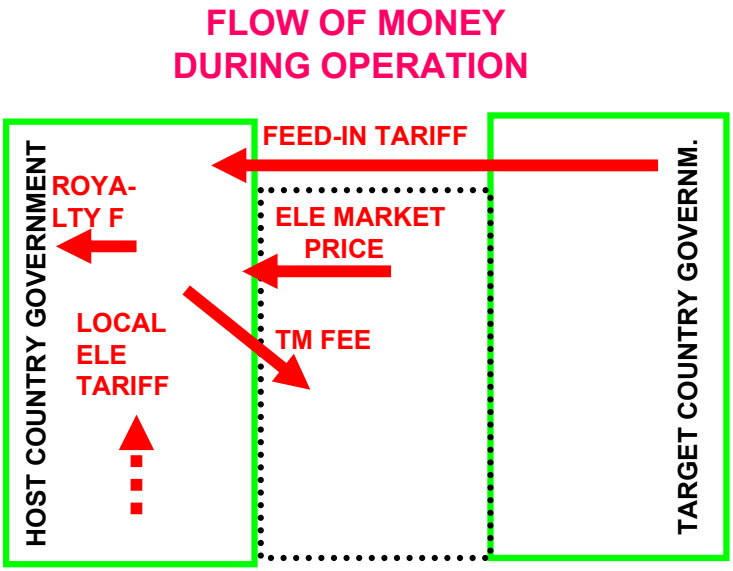

FIG. 8. International flow of money between target country and host country for RES-E during the time of the operation of the plant for electricity produced in the host country

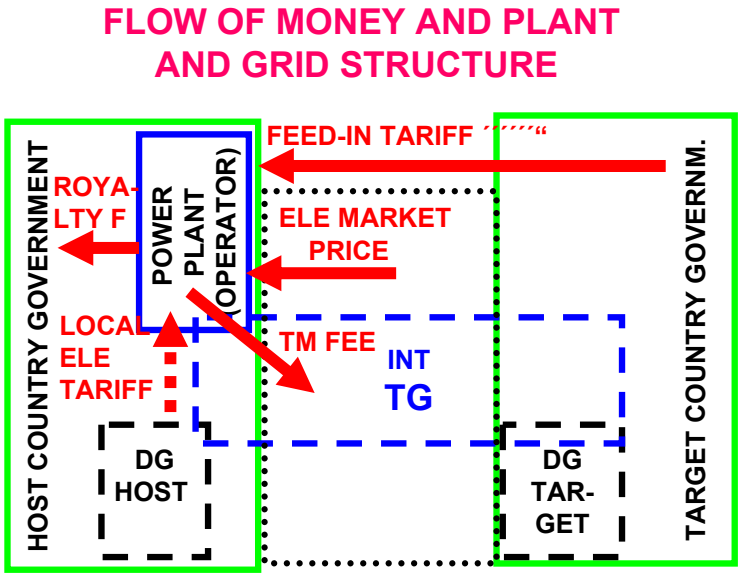

FIG. 9. International flow of money and plant and network structure for target country and host country for RES-E during the time of the operation of the plant for electricity produced in the host country

Finally, given these financial boundary conditions the deal will only come about from the investor country's point-of-view if the following objective function leads to a positive outcome:

$$\text{MAX} \sum_{T=0}^{LT} (E_{IMP} * FIT) - CC(E_{IMP})_t - C_{O\&M}(E_{IMP})_t \quad (1)$$

with:

E_{IMP}……..Electricity imported e.g. by the EU (kWh)

FIT……....international Feed-in tariff (EUR/kWh)

$CC(E_{IMP})_t$ ….Capital costs (EUR) of all investment (see FIG. 6 and 7)

$C_{O\&M}(E_{IMP})_t$..Operation, maintenance & other running costs of imported electricity (EUR)

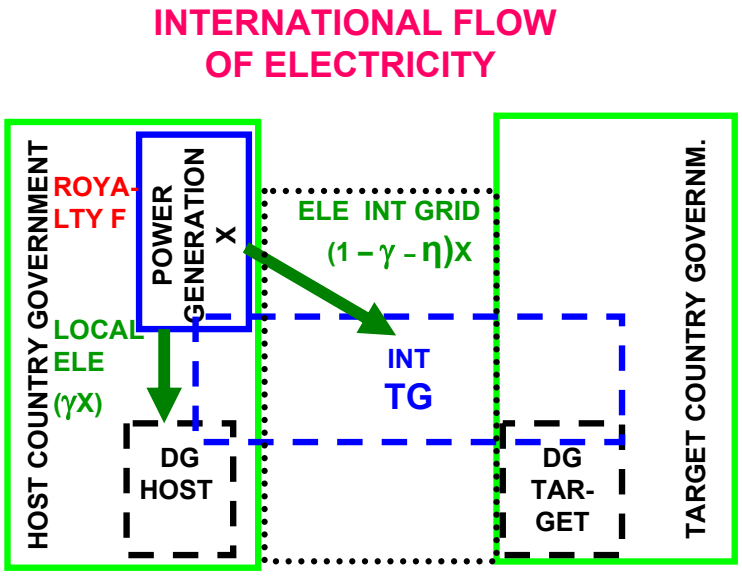

FIG. 10. International flow of electricity from RES between target country and host country with electricity produced in the host country

Regarding, the flow of electricity we have to consider that a certain amount is consumed in the host country and that there are some transmission and distribution losses see FIG. 10.´So the remaing amount to be imported by the target country E_{IMP} is:

$$E_{IMP} = X(1 - \gamma - \eta) \quad (2)$$

With

X …Total electricity generation

γ ….Share of own use of host country

η …Grid efficiency

CONCLUSIONS

The major conclusions of this analysis are: FIT and premium systems in European countries have proven to be of superior effectiveness and efficiency for promoting RES-E compared to TGC systems; Moreover, in these countries also evidence has been provided that RES-E investors accept this approach and provide the necessary corresponding investments; With respect to extended international electricity trade (e.g. from the Sahara to Europe) a more complex approach is required: It has to differ between initial inestments and flow of money during the operation of the project. And it has to build on two major pillars: different types of royalties paid to the host country and an international cross-border FIT.

REFERENCES

Haas, R., G. Resch, Christian Panzer a, Sebastian Busch, Mario Ragwitz, Anne Held: Efficiency and effectiveness of promotion systems for electricity generation from renewable energy sources – Lessons from EU countries, ENERGY-The international journal 2011a (forthcoming).

European Parliament and Council. (2008). Directive of the European Parliament and of the Council on on the promotion of the use of energy from renewable sources of, Brussels, COM 2008 (30) Final.

Haas, R.; Eichhammer, W.; Huber, C.; Langniss, O.; Lorenzoni, A.; Madlener, R.; Menanteau, P.; Morthorst, P.-E.; Martins, A.; Oniszk, A. (2004): How to promote renewable energy systems successfully and effectively. Energy Policy, 32(6): 833-839.

Held, A.; Haas, R.; Ragwitz, M. 2006. On the success of policy strategies for the promotion of electricity from renewable energy sources in the EU. Energy & Environment, 17 (6), p. 849-868.

Haas, R., Busch S., Gustav Resch, Mario Ragwitz, Anne Held: Promoting electricity from renewable energy sources in emerging and developing countries – lessons learned from the EU. In: Energy and Sustainability, 2011b.