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"Support to Energy Market Integration and Sustainable Energy in the NIS" (SEMISE)

Recommendations for support of electricity production from RES

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1. Introduction

An outline of EU policies in the support for electricity produced using renewable energy sources (RES) is presented. It should be stressed that policies and measures in favour of RES have not been harmonised in the EU and a set of instruments is applied in each country in relation to prevailing barriers, available resources and other parameters. Attention has been dedicated towards electricity from RES, but support towards RES-heating as well as biofuels will be significantly enhanced in the near future. Taking into account the existing status in the target countries and the scope of work to be conducted within this project, the present report will focus primarily on measures applied for RES-Electricity (RES-E).

In following a brief description of the different policy options is drafted and extensive analysis is made for the two major support schemes that have been widely used internationally, feed-in tariffs and quota systems. Particularly for the first which has been the key instrument in fostering RES development in most EU Member States (MS), detailed insights and best practices will be quoted. The report contains the following chapters:

2. International RES Support Schemes

2.1 Outline of the RE support instruments

International experience indicates that low level playing field, subsidies for conventional energy sources and other reasons impose the assistance towards the creation of a favourable climate for RES, to overcome high initial costs and additional market distortions (such as lack of information, higher risk perception) and to mainstream RES in the market place.

RE policy, or better the combination of policies needed, depend on national parameters, such as RE potential[1], existing policy frame, non-economic barriers degree of market liberalisation, infrastructure. Those factors influence the optimal mixture of incentive schemes. RE policies should be structured to enable technological R&D and market development concurrently, within and across the various technologies.

A successful policy support frame for RES should remove regulatory barriers and provide suitable and long-term investment conditions to attract potential RES developers. In general, policy framework for supporting RES followed by most EU countries, entailed an integrated approach including setting targets, revision of the legislation and administrative framework and a package of support instruments.

Concerning the support mechanisms, there are a number of options that have been used to promote renewable energy with the following variations:

- Obligatory or voluntary
- Applied to various target groups ranging from investors, households, industry etc.
- Involve variable level of support according to installed capacity or produced energy
- Entail direct support schemes

Generally, a mix of instruments is essential and a key to success.

A classification of internationally applied instruments, covering all the currently applied strategies referring to the promotion of RES-E deployment is provided in Table 1.

Economic potential: The potential which can be exploited without the need for additional support, *i.e.* whose exploitation is competitive compared with conventional incumbent technologies.

Table 1. **Classification of RES support strategies**

		Direct		Indirect
		Price-driven	**Quantity-driven**	
Regulatory	Investment focused	▪ Investment incentives ▪ Tax Incentive	▪ Tendering system	▪ Environmental taxes
	Generation based	▪ Feed-in Tariffs ▪ Rate-based incentives	▪ Tendering system ▪ Quota obligation based on TGC	
Voluntary	Investment focused	▪ Shareholder Programmes ▪ Contribution Programmes		▪ Voluntary Agreements
	Generation based	▪ Green Tariffs		

With regards to the EU the following conclusions can be driven, on the basis of a multi-year experience and pioneering in the introduction of support schemes:

- The effectiveness and efficiency of support schemes differ widely across the EU Member States.
- Different support schemes are characterised by different levels of maturity whereas policy schemes in some countries – in particular quota obligation systems – are fairly young systems and still in a transitional phase.
- There is scope for greater cooperation between Member States and optimisation of individual support schemes.
- Whilst harmonisation of support schemes was considered a long term objective, market barriers for the increase of RES-E and the low level of competition in the electricity market rendered this harmonisation quite premature.

Member States are continuously fine-tuning existing policy measures aiming to improve the performance of these measures. In fact, since 2005, more than a dozen countries have adapted their support schemes, in the pursuit of adopting best practice or otherwise optimise the efficiency of the system.

Notwithstanding this mobility, two systems are primarily used in almost all EU countries and have been accounted with the increase of RES deployment in the recent years: Feed-in Tariffs and Quota based systems.

◊ **Feed-in tariffs (FITs)** are generation-based price-driven incentives. Under this scheme, there is a legal obligation to the grid operator (or utility companies or supplier) to buy electricity from renewable energy producers at a premium rate, usually over a guaranteed period. The extra cost

is shared among all energy users, thus being reduced at minimum possible levels. The tariff rates are regulated by the government and are scientifically determined for each technology to ensure the profitable operation of the installation. Unlike traditional subsidies FITs are not funded by the government budget but through the system operators though an additional component to the electricity price. FIT usually take the form of either a total price for RES-E production, or an additional premium on top of the electricity market price paid to RES-E producers. FITs allow technology specific and band-specific promotion as well as an acknowledgement of future cost-reductions by implementing decreasing tariffs.

◊ **Quota obligations based on Tradable Green Certificates (TGCs)** are generation-based quantity-driven instruments. The government defines targets for RES-E deployment and obliges any party of the electricity supply-chain (e.g. generator, wholesaler, or consumer) with their fulfillment. Typically, governments mandate a minimum share of capacity or generation of electricity (generally grid-connected only), or a share of fuel, to come from RES. The share required often increases gradually over time, with a specific final target and end-date. Once defined, a parallel market for RE certificates is established and their price is set according to demand and supply conditions (forced by the obligation). Hence, financial support for RES generators may arise from selling certificates in addition to the income from selling electricity on the power market. Certificates can be obtained through: a supplier owning generation plants; from other generation plants; from a broker who often acts as an intermediate.

Other mechanisms for RES support are briefly presented below:

◊ **Tendering systems:** they are quantity-driven mechanisms. The financial support can either be investment-focused or generation-based. In the first case, a fixed amount of capacity to be installed is announced and contracts are given following a predefined bidding process, which offers winners a set of favorable investment conditions, including investment subsidies per installed kW. The generation-based tendering systems work in a similar way. However, instead of providing up-front support, they offer support in the size of the 'bid price' per kWh for a guaranteed duration. Tenders are being used in Denmark (off shore wind), France (wind, biomass, biogas) Latvia (over 0.25 MW) and Portugal (wind, biomass) [11].

◊ **Net metering:** it is a variation of a feed-in tariffs that allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. Depending on the system, the producers pay only for the net electricity used, or producers are paid for every kilowatt hour (kWh) they feed into the grid. Mandated targets

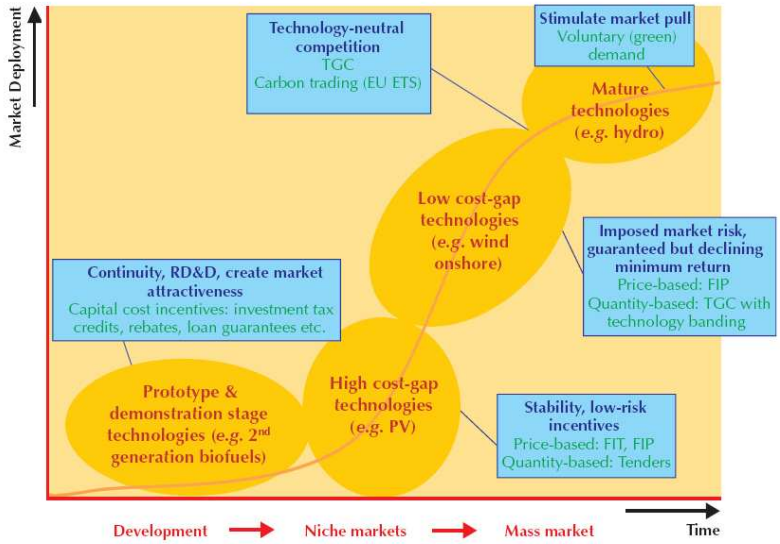
or quotas and net metering can be used simultaneously. In Europe, Belgium, the Czech Republic, Denmark and Italy introduced net metering as an additional support instrument. Net metering without other financial incentives is not enough to advance market penetration of RES, but might have a greater impact if private generators were to receive time-of-use rates for the electricity they put into the grid (applicable in the case of PV installations).

◊ **Financial and fiscal incentives** aim to render RES technology less expensive and encourage the respective industry leading to cist reductions. Fiscal incentives usually work via the tax system and include exemptions from rebates on taxes, tax refunds, lower VAT rates on equipment or favorable depreciation schemes. In addition, financial incentives are usually provided in the form of subsidies for stimulating new technologies and demo projects. Those are analyzed further at a following chapter.

In addition to the regulatory instruments described above, more and more voluntary approaches have appeared with on-going market liberalisation. They include environmental taxes and other voluntary schemes mainly based on the willingness of consumers to pay premium rates for RE. However, in terms of effectiveness so far – i.e. actual installations resulting from the schemes implementation– their impact on total RES-E deployment is negligible.

In most cases, a single support instrument is not effective for the parallel development of the various types of RES available, due to regional variations in resource potentials and differences in renewable technology costs. Hence, very often a combination of support schemes is needed to facilitate investments in a customised approach. A common practice has been to apply investments subsides or soft loans in addition to the main support scheme, being either feed-in tariffs or quota obligations.

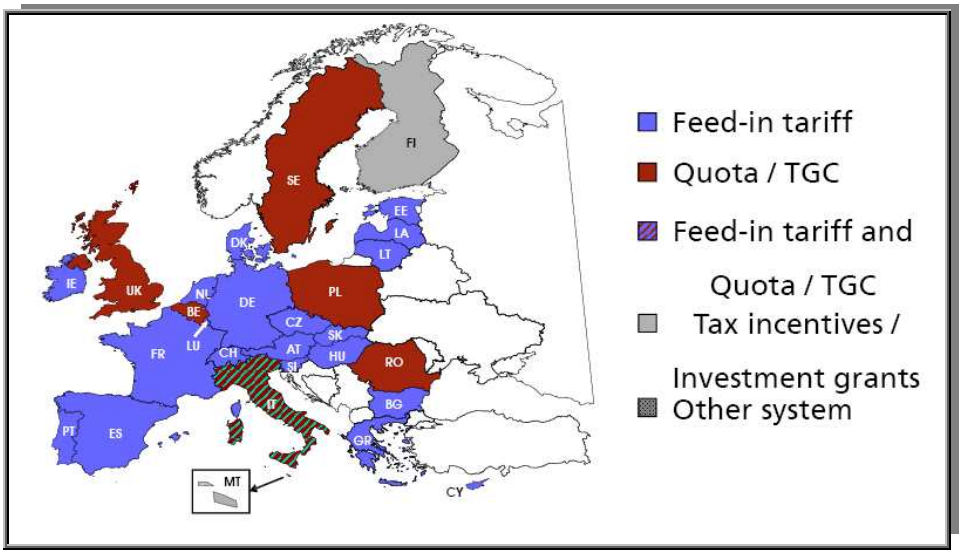
Figure 1 Combination of incentives for RES vs technological maturity



(source: IEA, 2008 [25])

An inventory of the current RE support systems in the EU is illustrated in Annex 1. Figure 3 provides a schematic of the main support systems used in the EU-27 countries in 2008.

Figure 2 Overview of renewable electricity support systems in EU-27, [2]



(source: Ragwitz M., 2010 [23])

[2] As of April 2010 UK has also introduced a FIT scheme for small scale RES applications

EU legislation

Annex 5 presents a number of legislative acts on the establishment (or modification) of RES support schemes, particularly FIT in some of the EU countries, in English. More specifically the following particular documents which can be found available in English have been attached:

Country	Year	Legislation
Bulgaria	2007	Renewable and Alternative Energy Sources and Biofuels Act
Germany	2008	Act Revising the Legislation on Renewable Energy Sources in the Electricity Sector and Amending Related Provisions
Greece	2006	Law 3468/2006- Generation of Electricity using Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions
Hungary	2007	Act LXXXVI on Electric Energy (includes also promotion of RES)
Ireland	2006	Renewable Energy Feed in Tariff (RE-FIT - 2006)
Ireland	2009	Renewable Energy Feed in Tariff Additional Categories- (REFIT – 2009)
Slovenia	2007	D E C R E E on Support for Electricity Generated from Renewable Energy Sources
UK	2006	2006 No. 1004, ELECTRICITY, ENGLAND AND WALES, The Renewables ObligationOrder 2006
UK	2008	Energy Act (including introduction of feed-in tariffs for small scale RES)

2.2 Regulatory instruments

2.2.1 Feed-in tariffs

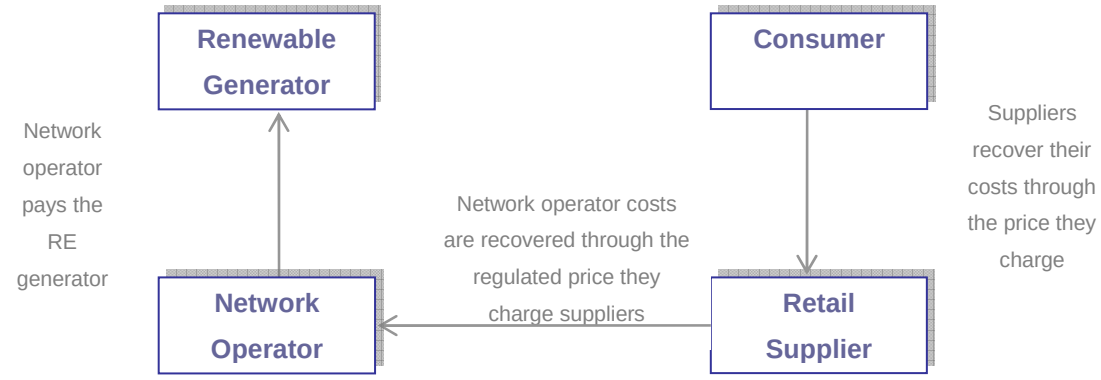
2.1.2.1 Principles

Feed-in tariffs are the primary support instrument for RES electricity in Europe. The system was practically invented in the US (PURPA) whereas in Europe, Germany has established, supported and improved FIT schemes from 1990 onwards. The main option of a FIT schemes are fixed FIT but alternatively premium FIT can be used:

Fixed FIT: In principle they represent a legally determined minimum price and an obligation on the part of the grid operator or utility to purchase "green" electricity. Most commonly, feed-in tariffs are applied to electricity from RES due to more established metering procedures.

Feed-in tariffs are set at different price levels for different technologies, plant sizes, sites, and the type of application. Costs are passed on to final consumers, normally by a levy on the network tariff. Figure 3 shows a simplified example of this for illustrative purposes.

Figure 3 Simplified example of a feed-in tariff



Premium FITs: as an alternative, some systems have a special extra premium tariff in addition to the market cost-related price. The cost for the grid operator is normally covered through the tariff structure. In that case, total price is less predictable, since it fluctuates with respect to the electricity market price.

The tariff or the premium is guaranteed for a period ranging from country to country between 10 – 25 years on average. Guaranteed duration provides a strong long term degree of certainty which lowers the market risk faced by investors. In any case, it is most appropriate that premium FITs operate as alternative to fixed FIT and not substitute them. Since in that case many small RE producers are not willing or capable to sell on the spot market, they would be excluded.

FIT are attractive schemes to investors since they are designed to assure profitability with reasonable payback time. In addition the inherent stability in the price for a long-term is favourable in terms of financial support from the banks by loans to the investors, taking into account that the technical risks of RES technologies are limited.

As of 2009, feed-in tariff policies have been enacted in 63 jurisdictions around the world, including 21 EU MS, Australia, Brazil, Canada, China, Israel, the Republic of Korea, Singapore, South Africa, and in some states in the United States, and is gaining momentum in other ones as India and Mongolia.

2.1.2.2 Advantages and disadvantages

Advantages

FITs enhance the creation of fair market participation conditions for every energy provider and have exhibited a number of comparative advantages, more specifically:

- Support installations of different sizes and technologies
- Facilitate stability and establish clear rules: thus financiers have security for long term loans and equity, change of government does not affect the system, change of tax policy does not alter the system since the needed funds are not taken from the national budgets
- Promote innovation: annual reduction of tariffs for new installations drives technological efficiency
- Drive economies of scale: investment and demand are rising, and manufacturing expansion is taking place globally in response, lowering costs further over time
- Promote public support: through public participation in the scheme, no direct taxpayer costs, simple administration, and increased awareness of the benefits of RE
- Promote ownership of projects. Indicatively it is highlighted that in Germany at least 200,00 people either own a share of a wind turbine or live in a community that owns a wind turbine. The respective figure in Denmark at least until late 90s was over 100,000, due to the successful cooperative schemes implemented [32].
- Assist in <u>overcoming barriers</u> that confront market entry for renewables, which can be summarised as follows:
  - *costs and pricing: distorted 'playing field' through subsidies for competing energy sources; fluctuation of oil and gas prices; high initial capital costs;*
  - *environmental externalities legal and regulatory: lack of legal framework for independent power producers; planning restrictions; grid access; liability insurance requirements*
  - *market performance: lack of access to credit;*
  - *perceived technology performance uncertainty and risk; lack of technical or commercial skills and information*

<u>Disadvantages</u>

- Accused of not being compatible with principles of free market economy
- There is risk of provoking higher burden on consumers in the case that the production cost estimates are not correct. Frequent adjustments based on technology and market prices evolution is necessary
- Can hinder technological learning if proper degression and adjustment mechanisms are not foreseen

- Concurrent purchase obligation might lead to network balancing problem and increase of grid operation costs

2.1.2.3 Success factors

A number of factors are important to make a feed-in tariff a successful support scheme, namely:

- Tariffs must be based on **country-specific calculations** of the threshold for profitable operation of the plant (e.g. break-even point a percentage of risk surplus);
- Tariffs should be high enough to **cover costs and encourage development** however if they are overestimated there is a risk of excessively high input and burden on the consumers.
- Tariffs must be optimized as **output-based** revenues (on kWh not kW installed), so that best sites and optimised technology will be used;
- Tariffs be **valid for a sufficient period**; FIT around the world range from 10 to 25 years; ideally a period of 15 to 20 years is sufficient in order to provide long-term investment security;
- **Costs are shared equally** across the targeted region ;
- Tariffs are applied in combination with **priority access for RES to the grid** and regulation of fossil power plants;
- **Administrative problems** must be addressed: procedures for access should be clear and transparent, permissions, payments must be simple and reliable;
- Tariffs should be coherent with other regulations;
- Tariffs should be independent of state subsidies – costs need to be redistributed to the consumers;
- Procedures for **regular adjustments** are foreseen from the early stages;

2.1.2.4 Key design principles for FIT

In continuation to the above some more **guidelines** on important issues to be considered when **designing a FIT scheme** are:

1. Level of tariffs

FIT systems are designed with almost the same rules, using various calculation tools and taking into account the local conditions in each country. An important aspect is the gap between the consumer price and the FIT figures. This gap is expected in medium-term to be zero or negative due to increasingly price of conventional energy sources and the development of RES technology and market.

The impact of a small gap (e.g. in Germany) regarding the additional cost to the final consumers is low (in Germany, below 3% for the next 20 years) and in that case allowing a significant penetration of RES. In case of a big difference, the penetration of various RES should be scheduled progressively and adjusted to the allowed additional cost to the final consumers for the duration period of the feed-in tariff.

In general, since there is always an argument of creating low FITs to avoid high costs for the consumers (which is actually leads to few RE investments), an important issue is that the methodology for tariff level calculation is clear and transparent, so that FIT are fair and widely accepted.

2. Technology specific tariffs

As noted, FIT must be determined based on specific generation costs. Therefore it is derived that technology specific tariffs are essential to stimulate a wide spectrum of RE options under the same appropriate levels of incentives. It is also often that within a specific group further differentiation is necessary. This is particularly applicable to biomass ,since generation costs for various sources varies considerable, for example expensive energy crops cannot be comparable with forest residues, whilst biogas from manure is more expensive than landfill biogas.

3. Size specific tariffs

With regards to banding by scale this is a common practice at many FIT schemes since technological costs differ among small and large systems. In any case, to avoid administrative complexity, particularly for small scale installations , differentiation by size should be limiter to situations where scale economics justify that.

4. Duration of tariffs

As noted FIT duration can vary between 10 and 25 years. The duration affects in a sense the level of tariffs, i.e. for longer duration remuneration can be reduced, hover in those cases inflation effects are important and must be factored in. In addition, since 20 years is about the average lifetime is

many RE technologies normally this is the maximum period foreseen according to international practice since longer times would among other also not favour technological progress.

5. Degression

FIT are a temporary measure to develop the competitiveness that will result from economies of scale. Competitiveness with conventional electricity sources will be reached in different regions at different times. Therefore they must be adjusted at regular intervals to comply with market developments and also adapted to national conditions. Degression (a variable of which is flexible degression-to be discussed in chapter 4), are considered to be better design options for preventing windfall profits and excess consumer costs than capacity caps, the latter leading to unsustainable market development and temporary market growth.

It is also important that FIT are guaranteed for a certain period since the costs are related to the initial investment. This issue represents an important parameter for assessing the actual financial incentive.

6. Purchase obligation

The purchase obligation is one essential element in designing a FIT scheme. Combined with fixed and long term payment for RES-E produced this term ensures the necessary security for investors and financing institutions. Exemptions from it such as Estonia or Slovakia, in which grid operators are obliged to purchase RES-E only up to the level of their transmission and distribution losses, has resulted in insecurity for potential RES-E developers.

7. Capacity caps

In general capacity caps have a negative effect on the development of RE markets. Experience in many countries has shown that shortly before the cap reaching, markets are very active since all producers race to get connected to the grids, and thereafter market abruptly stop, thus creating non sustainable situations. However in **emerging economies**, in which there is a direct link among RES-E amount and electricity costs for final consumers, being a politically sensitive issue, capacity caps can be introduced, addressing the most cost-effective technologies and entailing provisions for regular review before the limits are reached, to prevent stop-and-go cycles.

8. Monitoring

For this reason, a monitoring system of the RES applications from the beginning with data collection and process is necessary, in order to evaluate the policy in RES, the results of the technology and the impact on the additional cost to the consumer price for the provided period. This evaluation will contribute also to the best mix between RES, based on the elaboration of specific studies, with high

penetration in total and optimization of the benefits with the minimum additional cost to the final consumers. Within that context the establishment of periodic progress reports following the initial legislation on FIT is important.

More advanced concepts will be analysed in the Best-Practice section.

2.1.2.5 Bad practice situations

In some countries FIT tariffs have been introduced since many years, including substantial level of prices to stimulate investments attraction and technological diversity. However it has been occurred that RES development has been far below the technical potential and the targets set.

The reasons for the above situation are:

a. Inappropriate FIT design

It concerns elaborating FIT design options that are counterproductive, in relation to the important parameters mentioned in the previous sub-chapter, for example inappropriate level of tariffs, flat rate tariffs, non guaranteed purchase obligation etc.

b. Insufficient addressing of key RES policy issues

Most common obstacles when referring to sub-optimal operation of the FIT system according to international experience, relate to the inadequate addressing of major policy considerations, that should be integrally tackled. In more particular key hurdles consist of:

- Long term authorisation procedures and planning restrictions, lack of coordination among the different authorities, involving public bodies at national, regional and local levels),
- Lack of transmission grid infrastructure at the locations with the highest potential,
- Lack of social acceptance among the local communities
- Insufficient capacity building and information dissemination among the key stakeholders involved.

2.1.2.6 FIT levels in the EU

A detailed presentation of the specific RES-E prices in all EU MS as well as different approaches implemented per RE technology, time of installation and other factors is quoted in Annex 2. A summary graph with average FIT prices in the EU including contemporary upper and lower values as of 2009 is presented below.

Figure 4 FIT in the EU per technology (in Euro-cent/kWh)

(source: Joan Canton and Åsa Johannesson Lindé, EC, Economic and Financial Affairs [11])

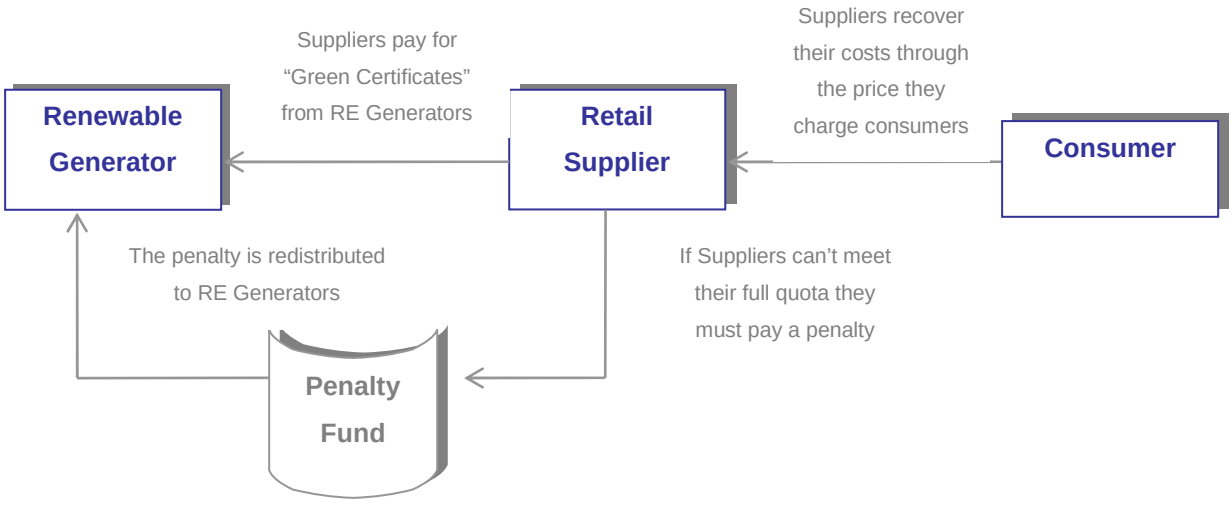
2.2.2 Quota systems with Tradable green certificates

2.2.2.1 Main characteristics

In quota systems (or renewable obligations) governments define quota targets and mandate for specified groups of market participants to purchase or sell a minimum quantity of capacity or amount of electricity from RES. The government allocates certificates in order to ensure compliance with the mandated quantity. Bidding models also exist, under which RE producers compete in individual bidding rounds to cover a previously determined quantity contingent. The winning bidders then receive a fixed-term purchase guarantee for the electricity they generate. The required share increases gradually over time, eventually reaching a final target.

A tradable green certificate (TGC) means the separation of physical electricity from its green value and allows the two components to be sold separately. This enables parties to meet their targets by purchasing a green certificate at a market price. Payments can be placed in a central fund and maybe redistributed to the suppliers that have met their obligation. A simplified chart of the quota system is illustrated below:

Figure 5 Simplified flow chart of a quota system



2.2.2.2 Advantages and disadvantages

Advantages

- Can theoretically be cost-effective since they focus on least cost technologies and trigger competition.
- Provide incentives for technology cost reduction
- In well designed systems, targets can be precisely reached and thus can provide certainty on future share of RES
- Quota systems when combined with TGCs are considered to meet the requirements for market conformity and competitive policies that provide incentives for technology cost reductions. This can be achieved in the case that conditions for achieving a market for green certificates are met

Disadvantages

Quotas can show insecurities for investors. Some key drawbacks of this system on the basis of actual experience gained in countries where it has been carried out are:

- Risk of supporting only lower cost technologies;
- Do not encourage the development of less mature technologies
- Considerable transaction costs for organising, implementing and monitoring. Hence most small and medium-sized companies cannot bear the high risks associated with the required long-term investment in renewables;
- Producers have to sell green electricity as two products, electricity and certificates and the risk on green certificates is added to the risk of the wholesale market.

In any case, unlike minimum-price systems, quota systems have a relatively short and rather fragmented history of application. Therefore, they need considerably more time to prove, beyond a reasonable doubt, their ability and effectiveness to steadily foster RES investment and to promote a healthy and dynamically growing RES industrial sector, under a wide range of national and local conditions. Quotas have been also used in off-grid RES including transport biofuels.

2.2.3 Feed-in vs quota systems- comparative assessment

It is clear that the two most popular systems for RES support now are feed-in and quota systems. Obviously FIT are today more popular in the EU however, quota based models, despite having still a limited outcome in installed capacity might be a subject of future wider application within a harmonised approach involving Guarantees of Origin (GoO). Though this discussion seems still to be premature, the parallel operation of those two systems even at an unbalanced rate will continue for several more years.

Based on international experience the success of those models has in each case, certain preconditions. Their elaboration and adoption on a case by case basis is essential, in order to achieve the maximum of the selected scheme's effectiveness. The most important issues to be dealt for every scheme are presented in the following table:

Table 2. **Preconditions for FIT and quota schemes**

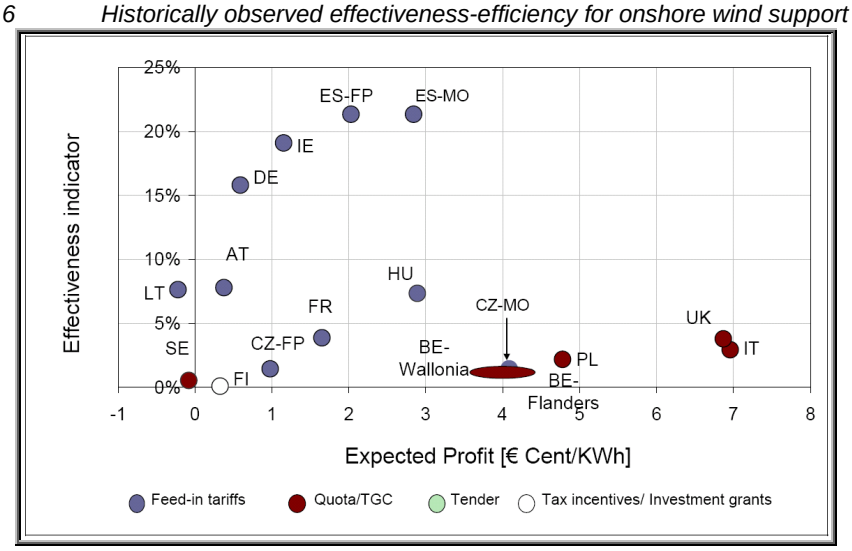
Feed-in tariffs	Quota Systems
Regular tariff adjustments-incremental adjustments built into law;	System must apply to a large segment of the market;
Tariffs according to technology (and location); input from research institutes and renewables industries should be sought;	System must include specific purchase obligations and end-dates;
Tariffs apply to all potential developers, including utilities;	Penalties for non-compliance and enforcement must be adequate;
Tariffs are high enough to cover costs and encourage development;	Different bands by technology type;
Tariffs are guaranteed for long periods to ensure acceptable rate of return;	Requirement of long-term contracts to reduce uncertainty for project developers;
Costs are shared equally across country or region;	Minimum and maximum certificate prices;
Barriers to grid connection must be eliminated.	No time gap between one quota and next should be allowed.

Whereas it is already noted that the encountered advantages and the applicability to non opened energy markets of FIT are more than clear, the following paragraphs presents a comparative assessment of the above two systems, based on selected reviews of recent literature, in an attempt - by showing the principal pros and cons of each system – to illustrate in more depth some key features of each regime and highlight the relative advantages of FIT.

Several comparative analyses can be found from international literature on the above parameters, reflecting the expertise gained throughout the years of functioning of these systems. Within the report released by the EC (COM (2005) 627), the two schemes

compared using two main criteria; effectiveness i.e. ability to deliver an increase of the share of RE consumed and efficiency i.e. comparison of the total amount of support received and the generation cost. Within the main conclusions from this work it is notable that FIT have in most countries higher effectiveness particularly for wind energy, biogas and photovoltaic. Some FIT have also been successful in developing low cost options such as sewage gas and certain types of biomass in the RE portfolio. Effectiveness and efficiency of support schemes have been also been elaborated in the frame of other initiatives. The chart below illustrates the efficiency of wind generation for EU MS:

Figure 6 Historically observed effectiveness-efficiency for onshore wind support (2006)



(source: EC, The support of electricity from renewable energy sources, 2008 [15])

One of the most comprehensive approaches was carried out by Fouquet, Grotz, Sawin and Vassilakos [6]. The key criteria for which the comparative evaluation has been performed in this review are:

- price of renewably-generated electricity
- share of capacity or generation achieved
- prevention of windfall profits
- financial security
- technological innovation and social benefits
- geographic distribution
- technological diversity
- ease of policy implementation, and flexibility.

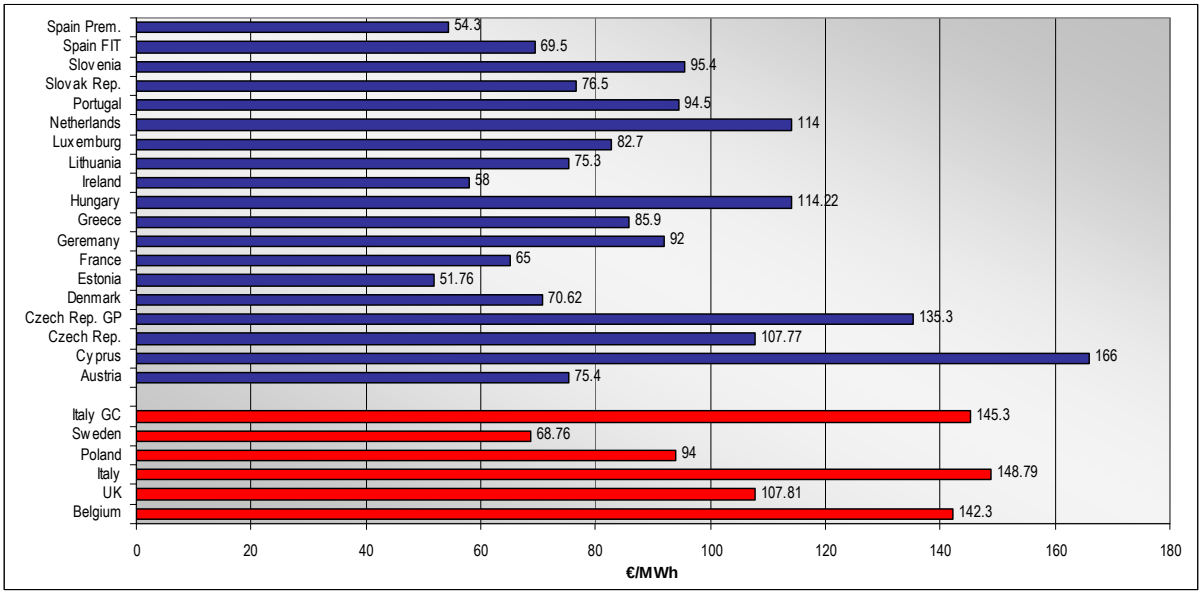
A summary of the analysis from this work is presented in the next paragraphs:

Price of RES-generated electricity	
Feed-in Tariff	Despite arguments that FIT can have higher impact for the national economy, several studies have concluded the opposite. In general, FIT encourage development of local manufacturing industries, thus large number of companies and price competition and drive technological development. It may be also cheaper to provide significant national investment for RE over a period of perhaps 15-20 years to bring RE technologies rapidly down their learning curves, and thus reduce costs very quickly, rather than to introduce RE relatively slowly and over a longer period of time with an associated slower reduction in costs.
Quota/TGC	There is a reluctance to invest in RE projects under quota systems, particularly wind because they produce more uncertainty regarding future prices. Medium and long-term certificate and electricity prices are highly unstable, varying with changes in the market or meteorological conditions. As a result, developers can expect higher risk surcharges from investors and banks, and consequently electricity is not necessarily cheaper even in countries with very favourable RES potential. In addition quota systems theoretically encourage increased competition among RES producers and result to rapidly falling prices for RES-E. An example often mentioned is the price reductions for wind power in the UK that occurred during the 1990s under the Non-Fossil Fuel Obligation (NFFO). However, in most cases this is not the rule for the long-term. There is evidence that at least some shares of past price reductions (e.g., under the UK's NFFO) were due to the pricing policies of other countries, which drove technological improvements and brought down costs. [3]

The following figure illustrates average RES-E prices in EU (in 2009), in which it is apparent that most countries with quota systems have higher prices than average FIT prices.

[3] In addition, some of the later cost reductions under the NFFO were due to changing terms and conditions, including a longer contract period.

Figure 7 Average wind energy prices in the EU for 2009



(source: EREF, Prices for Renewable Energies in Europe:, Report 2009 [1])

Shortcomings - TGC
For the case of onshore wind energy, a comparison of the level of support and the corresponding costs of electricity generation has indicated, that in the three countries with quota systems UK, Belgium and Italy the support is presently significantly higher than the generation costs. At the same time, analysed quota systems were not very effective in increasing wind installed capacity towards realisable potential. This means that RES-E generators possibly make higher profit from the system that would be necessary to incentivise them to invest in new capacity, or that other barriers exist that even a high level of support is insufficient to overcome. The reason for this outcome is the still immature certificate markets, the non-technology- specific application form of the currently applied quota systems, as well as higher risk premiums requested by investors [5].

Prevention of windfall gains

Feed-in Tariff	It is generally assumed that they encourage little competition and discourage price reductions. Many believe that manufacturers and project developers utilise cost reductions solely to increase their profits, rather than passing them on to electricity customers.
Quota/TGC	Many assume that they force manufacturers into price competition during bidding rounds helping to drive down consumer prices.

Financial security	
Feed-in Tariff	They allow long-term certainty resulting from guaranteed prices over long periods (e.g. 20 years), thus companies are willing to invest in technology and training of staff and establish other services and resources with a longer-term perspective. This certainty also makes it easier to obtain financing, since banks and other investors are assured a guaranteed rate of return over a specified period of time.
Quota/TGC	There are uncertainties through many steps in the process from project planning to operation, e.g substantial preparation costs for projects submitted for bids, without guarantee of winning a contract. Without long-term contracts, existing developers could be undersold by future projects, and will always be competing against new developments. Potential investors must assess future supply and demand balance during the lifetime of the project (often 20 years or more) by developing a forward price curve. However, estimating supply is a complex process that requires an understanding of a broad range of factors, e.g. competitiveness of all eligible energy technologies, future costs determined by learning curve effects, and cost-resource curves, impact on costs when the best resources are no longer available. In addition, demand is created by political targets, which could change, thereby resulting in a degree of uncertainty. All these factors encourage uncertainty and banks are less willing to provide financing for RES projects. Financial security is also reduced if there is uncertainty regarding rules related to green certificate trading. For instance, as system designs are altered, such as changes in penalties, borrowing or banking provisions and the status of imports, prices can be affected dramatically. In general, many believe that the higher risks and lower profits associated with quota systems make them less attractive for investors than minimum-price laws.

Shortcomings - TGC
An example is Italy's green certificate trading model, which started in January 2002. Initially it required an additional 2% of renewable electricity share of total electric capacity, meaning 116

MW of additional wind power capacity in 2003. This goal was achieved and quota was scheduled to increase annually for additional 0.35 % between 2005 and 2012. However, because the quota is valid for a period of only 8 years, investor security is limited.

Under the UK quota system with a certificate-trading (Renewable Obligation Certificates), energy supply companies are expected to produce green electricity, purchase certificates, or to buy themselves out of their obligations. Certificate prices rise or fall depending on the number of companies that succeed or fail in meeting their obligations, and resulting supply or demand of certificates on the market. The income obtained through the buy-out funds, provided by certificate purchases, is distributed to the owners of ROCs to help finance future RE projects. The political framework has been set for the long-term: by 2015, RES must account for 15.4% of power consumption. In spite of this longer-term target, the price of certificates continues to fluctuate, and investor insecurity for the medium and long-term has not been eliminated.

Achievement of government objectives

Feed-in Tariff	The system does not favour a direct implementation of policies and targets, since it is not possible to know in advance the increase in capacity or generation or even if the share of RES energy generation will increase over the long-term. However, tariffs can be adjusted up or down to encourage more or less investment in RES and bring installations in line with desired targets.
Quota/TGC	Because they establish specific targets for RE capacity or generation, they provide greater certainty regarding the future RES share of the market. Furthermore, can be tied directly to other government policies, such as emissions reductions.

Technological innovation and diversity

Feed-in Tariff	May not encourage innovation, since generous tariffs alone are no guarantee that a domestic industry will develop. On the other hand once producers achieve a certain level of profit, they can invest in private R&D to lower costs and increase their profit. In addition, FIT encourage a diversity of technologies, assuming that payments vary according to technology type and support easily technologies from early development to market competitiveness. Technological progress and market success in countries with FITs such as

	Denmark, Germany and Spain verify this opinion. Turbine manufacturers in these three countries account for the majority of the world's turbine market, supplying more than 70 percent of the market in 2003, and have driven most of the technological development in the wind industry
Quota/TGC	This system favours least-cost technologies and thus promotes technologies that are closest to market competitiveness. The surplus may go entirely to consumers and as a result, producers do not receive enough profit (or reliable long-term profits) to invest in R&D in order to reduce their costs. At the same time, pressure to minimize costs under quota systems often encourages producers to turn to overseas manufacturers of technology. Consequently, for higher cost RES it is less likely to create markets and drive them down their "learning curves". Specific technology targets or quotas can help, but are not likely to advance these technologies and to reduce rapidly their costs like well-designed FIT schemes. Furthermore, bidding rounds are time-consuming and costly and due to on-off cycles, continuous market development, innovation and a strong domestic industry are not favoured.

Geographic and ownership distribution

Feed-in Tariff	No necessity for negotiated contracts, plus easiness to install RES on the developer's property and sell it into the grid, tends to ease entry into the marketplace. FIT favour smaller companies (even individuals or cooperatives) and incremental investment, leading to varying sizes of companies and projects.
Quota/TGC	Promote the least-cost projects, thus restricting them geographically to the areas with the best resources and encouraging larger-scale, centralised projects. More likely to fully integrate RES into existing electricity supply infrastructures as they put utilities in charge. However can result in serving primarily the interests of major suppliers or utilities.

Shortcomings - TGC
An example of this case refers to the Netherlands: the government established a voluntary quota system with tradable credits that resulted in increased use of renewable energy. But about three-fourths of the credits and accompanying subsidies went to foreign producers, leading the government to abandon this system in 2008.

Ease of implementation

Feed-in Tariff	In general, FIT mechanisms are easy to administer and enforce, whilst being highly transparent. As with quota systems, policy makers are required to establish targets and timetables, and to determine which technologies are qualified (type and scale). Where applicable, tariffs are specialised for each technology. Once the system is established, the only government follow-up required is regular adjustments of tariffs.
Quota/TGC	Under quota systems, there are many more challenging requirements such as selecting the optimal target levels which is critical (if they are set too high, they can push prices up dramatically; if they are too low, they will not produce the economies of scale needed to reduce costs), or the selection of timetables. In addition, policy makers must decide which technologies are eligible, and if there should be technology-specific targets—this will depend on the readiness of technologies, their costs, available resources, and other factors. In order to make successful choices, it is also important to understand the cost and learning curves for the relevant renewable technologies. Policy makers also need to determine which category of parties must meet the obligation (e.g., retail suppliers, grid companies, or distribution companies), and whether all or just a few of those parties are required to meet the targets. The penalty for non-compliance must be established, and the tradability, life-span and price of certificates or credits chosen. These decisions will all determine the impact of the quota system. Once these matters are resolved, government agencies (or other bodies) must certify renewable energy producers, issue and control certificates, monitor compliance, and collect penalties, all of which increases administrative requirements, complexities and costs.

Flexibility	
Feed-in Tariff	FIT are inherently inflexible, e.g. once tariffs are established it is difficult to modify them. However it is possible to adjust these payments up or down to affect the amount of new capacity coming on line as desired.
Quota/TGC	Once targets and timetables are established, they are difficult to adjust. Even as markets change and technologies advance, experiencing major breakthroughs in efficiency and/or cost, it is difficult to alter targets or timetables—or, at least to make them more ambitious—without lead-times of several years.

Conclusions

From the comparative analysis performed it is clear that FIT tariffs are favourable in most of the criteria examined namely:

Price of RES generated electricity	Systems are designed differently from one country to the next, and the duration of specific compensation levels varies from country to country. However it appears that countries with **FIT systems** have generally lower prices on average despite the fact that many minimum-price countries have lesser RE resources.
Prevention of wind fall gains	Under the **FIT** system, possible windfall profits can be avoided by designing the respective system properly to avoid such practices. For example, the German Renewable Energy Source Act (EEG) contains an integrated price degression reaching up to 9 % for photovoltaic. Similar mechanisms were introduced in France and Portugal, for example. Altogether, wind power costs in Germany have fallen in real terms by around 55% since 1991 (when the Electricity Feed-In Law, which preceded the EEG, took effect).
Financial security	**FIT** schemes provide increased long term certainty for investors and are definitely better for financiers who seek security for long term loans and equity
Government policies advancement	Theoretically **Quotas** can provide producers and manufacturers with a predictable, steadily growing market for RE. However success is based on political decision and the level of enforcement and penalties in a given scheme. For example, the UK quota for 2003 under the nation's new Renewable Obligation Certificates systems was set at 3%, yet energy companies fell far short

	of this target, achieving only 1.8%. In contrast, those countries with **FIT** schemes have regularly surpassed national renewables targets. Therefore there is no universally preferable scheme with respect to this criterion, success is also dependent on other parameters.
Technological innovation and diversity	**FIT** systems are more favourable. Technological improvements increase profits, thereby encouraging innovation. In addition they encourage investments from a wide spectrum of RES and technological diversity.
Geographic and ownership distribution	**FIT** systems are more favourable: they allow participation of smaller investors and have minimise negative impacts on public acceptance or intense development in particular regions.
Ease of implementation	**FIT** systems are less complex and easy to administer, less bureaucratic and time-consuming and not open to utility manipulation, therefore are more favourable in that respect.
Flexibility	FIT systems would be a better option in the occasion that a system is set up so that payments can be adjusted on a regular basis to reflect changes in technologies and market conditions.

2.3 Fiscal and financial incentives

Apart from the above mentioned regulatory schemes, fiscal and financial incentives are often used, concurrently, as additional or stand-alone incentives. A brief outlook of them is illustrated below:

Production tax incentives: they are generation-based price-driven mechanisms that work through payment exemptions from the electricity taxes applied to all producers. This type of instrument thus differs from premium feed-in tariffs solely in terms of the cash flow for RES-E producers: it represents an avoided cost rather than additional income.

Duties or import tax exemptions: Although not applicable to the European Common Market, the existence of an import tax on energy is known to hamper the development of RES in an exporting country. Therefore granting RES-E a preferential level or exemption in line with an importing country's RES policy may be a simple and effective incentive to increase the share of renewables. In such case a robust system of Guarantees of Origin for green electricity is needed.

Investment incentives: the represent an incentive for the development of RES-E projects as a percentage over total costs, or as a predefined amount of € per installed kW. The level of incentive is usually technology-specific. Incentives comprise capital subsidies, grants, preferential loans or rebates. Credit support may be offered in the form of loans on preferential terms (so called soft loans with decreased interest rates or delayed repayment), or of state or bank guarantee systems. The level of support usually is technology-specific and often applied as a local or regional policy tool.

Public investment: is often used to promote RES, by means of support to innovative applications and research, or by including a RE technology in public purchasing, serving as a demonstration and best practice tool. Several countries require that the state administration uses a certain proportion of RES. Although direct effects of such support measures on the deployment of RES are negligible, their educational and promotional role cannot be overestimated.

3. Recommendations

3.1 Recommendations for selecting most appropriate policies

In terms of designing effective FIT systems, as already analysed in section 3.1.2, there are certain important parameters that must be elaborated with due consideration, since they determine at a great extent the eventual success of the system. In brief those key issues are are:

- **Level of tariffs:** FIT must be at a high enough level to cover costs and encourage development of particular technologies
- **Period of application:** FIT must be guaranteed for a time period long enough to assure investors of a high enough rate of return.
- **Time differentiation:** FIT are particularly efficient, if rates decrease over time, as experience is gained and in line with the expected learning curve.
- **Administrative procedures**: The existence of simple and quick administration including non complex licensing procedures is a prerequisite for the success of the FIT scheme. Coordination among the various authorities and elimination of lengthy permitting procedures are key to the success of any scheme
- **Grid System:** FIT success is also depending on the sufficiency of the grid system
- **Differentiation by efficiency**: Finally, as a more complex option**, a stepped FIT** according to the RES installations efficiency can also be used, so the guaranteed rate is decreased as efficiency increases.

Further to the above the importance of ensuring sufficient levels of capacity building to the involved stakeholders (government, municipal, etc.) as well as public awareness to diffuse the benefits of RES to the public and attain social acceptance should not be neglected within this integrated approach.

FIT is a successful scheme to provide tailored incentives to different technologies to facilitate market penetration. If designed according to the mentioned criteria and coupled with

the addressing of other important barriers at the same time, could create the conditions for a sustainable increase of renewable energy.

3.2 FIT calculation methodology

Finally, since it is understood that this is an issue of major importance, a few general guidelines on the principles of tariff calculation methodology will be outlined, in addition, to the best practice experience already describe din the particular section regarding the German example.

International experience has show that countries that based their FITs in **real generation costs plus a small premium**, have experienced the most of success in terms of realistic and acceptable return on the investments and deployment of RES. Therefore, today this approach is considered as the **best practice** [31]. The above methodology can be found by different names in different countries, for example within the German FIT scheme it is called "cost-covering remuneration", under the Spanish support scheme "reasonable rate of return" etc. In all these cases the legislator sets tariffs so that a predefined target rate of return is achieved, which is usually between 5 and 10 percent, or even a bit higher for some cases, depending on the actual relevant figures for conventional technologies, which are always the opposite group to compare with.

In the pursuit of determining the appropriate costs of FIT benchmarking and analysis/comparison with countries having similar resource conditions can be a first action, however this is not sufficient since country specific parameters that have an impact to the profitability of a project have to be taken into account. Therefore the key recommended **criteria based on which the calculation of the RE generation costs** must be based are:

- Investment costs for each technology and categories including material and capital costs
- Grid-related administrative costs incl. grid connection, licensing etc.
- Operation and maintenance costs
- Fuel costs (for biomass)
- Decommissioning costs (if applicable)

On the basis of the above data and according to a predefined applicable financial methodology and under relevant assumed financial parameters (depreciation, discount factor etc.), can calculations to extract the nominal electricity production costs per technology be then performed.