A Road Map

for

Renewable Energy

Market Acceleration

REMAC 2000

ENERGIE

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If specific authors are not explicitly referred to, the chapters of the Road Map are a joint effort of the REMAC 2000 Research Team.

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FOREWORD

The convergence of several factors emerged recently provides a new opportunity for renewable energy (RE), since it has gained new values and now should be considered as a legitimate, mainstream energy source that is cost effective for many technologies in many applications.

However, for the OECD region as a whole, the share of all RE in total primary energy supply in 2000 was just 6.2% (compared to 4.5% in 1973, at the time of the first oil crisis). Such percentage share reduces to 2.8% if we exclude Combustible Residues and Waste and drops to a minimal 0.5% if we exclude Large Hydropower.

This means that the share in OECD countries did not really change throughout the 90's, in part because overall energy demand in OECD countries was buoyant, and also because the market for new RE technologies is strong, but growing from a small base.

Today the timing of RE increased cost competitiveness is advantageous because there is still a huge and growing demand for new capacity for utility power, and for millions of systems to serve the 1.6 billion people without electricity in rural areas of developing countries.

The benefits from RE amount to more than just their contribution to energy balance alone, because costs of energy output (e.g. per kWh) do not adequately capture a number of important values to society.

Renewable energy adds to the diversity of the energy supply portfolio and reduces the risk of continued – or expanded – use of fossil fuels.

Distributed RE plants provide options to consumers not otherwise available because of their deployment close to use. RE are the ultimate solution for the carbon-free production of hydrogen: in the longer term, if cost can be dramatically reduced, hydrogen can act as the crucial storage medium and carrier of energy produced from RE.

RE is also the most environmentally benign energy supply option available in current and near-term markets. Climate change concerns have created a new impetus for clean, low-carbon technologies such as RE, and the possibility of utilising the Kyoto mechanisms to acknowledge such value.

Given this host of positive attributes, RE could play a significantly bigger role. While there is a convergence of positive factors, RE are being held back from achieving their market potential due to a number of market failures and barriers.

The policy framework to rectify those market barriers and failures is only now slowly emerging but has not yet evolved sufficiently to sustain RE as a commercially competitive alternative.

The challenge is to take this nearly cost effective energy supply option and provide it with an appropriate policy framework that allows the market potential to be achieved, in order to move from the margins of energy supply into mainstream.

In my position of Advisory Board Chairman of the REMAC 2000 research project, I am particularly pleased to present this "Road Map for **R**enewable **E**nergy **M**arket **AC**celeration", where the acronym of the project comes from.

This report is the final output of a two-year research project aimed at identifying policies, stakeholders and business opportunities to foster market deployment of renewable energy in Europe.

A team of experts from CESI (Italy), Ecobilancio Italia (Italy), NET (Switzerland), ECN (The Netherlands) and CNRS-IEPE (France) have worked hard in order to identify the key issues relative to a wider development of RE in Europe and to develop policies and communication tools to overcome the relevant main barriers. I warmly want to thank each one for their commitment, professionality and passion, three qualities they have poured without limits into this exercise.

The research group argues that a transition from the present situation of limited and support-dependent RE market to a future significant and self-sustained RE diffusion, entirely driven by market demand, is both possible and desirable.

In order to achieve this goal, however, the already existing support measures must improve in quality and co-ordination and resources must be aligned towards the same goal.

The present Road Map proposes a set of co-ordinated actions strictly following this approach. It identifies four intervention areas, which tackle at the same time with RE demand, supply and market framework conditions.

In fact, this Road Map has several unique characteristics compared with existing studies, as it takes a holistic and market-oriented approach, it covers multiple RE technologies at the same time, and it addresses both public and private actors along the whole RE value chain (from suppliers of feedstock and raw materials to end-consumers).

A multi-stakeholder approach has also been followed during the whole research process. The draft outcomes – analysis and recommendations – have been confronted periodically with different stakeholders, among them the Renewable Energy Unit of the International Energy Agency (IEA) and the Working Group “Renewables & Distributed Generation” of EURELECTRIC.

The Road Map summarises the main results of the conducted research. I wish to remind that these outcomes are based on an in-depth review of RE crucial features. Technical aspects and their impact on performance improvement and cost reduction have been analysed, as well as the strategic role of energy industry in interacting with policies in place and under definition. Three relevant reports have addressed these issues and are available from the co-ordinator CESI or at the project web site (http://www.renewable-energy-policy.info/remac).

Ultimately, this final report on the Road Map, published with the support of the European Union, represents a step towards a stronger business approach to RE market. I recommend it as a valuable contribution and powerful tool for both public and private decision-makers at EU and country level, in their effort to identify and to shape effective, comprehensive and marketable policies and strategies in the RE arena.

I hope that actions and reactions from critical readers will stimulate and encourage future work both at strategic and local implementation level.

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Roberto Vigotti (Enel Green Power – Italy) served as Chairman of the Advisory Board for the REMAC project and represented EURELECTRIC. Rick Sellers and Mark Hammonds represented the IEA. Graham Baxter represented the views of BP Solar. The contribution of the entire Advisory Board is gratefully acknowledged.

The contributions of Ruggero Bertani (ENEL, IGA), Jos Beurskens (ECN), Gregor Czisch (ISET / IPP), Emmanuel Koukios (NTUA) and Arturo Lorenzoni (IEFE) are particularly acknowledged.

National agencies and private companies, as well as industry associations greatly helped with validating and cross-checking the data presented in this publication. Valuable input from research, industry and policy stakeholders was received during the two REMAC working meetings held at the IEA in Paris (April 2002) and at EURELECTRIC in Brussels (September 2002). This book has also utilised the most recent information about the concept of experience curves and the EXCETP project (Experience Curves for Energy Technology Policy) provided during an IEA workshop (January 2003).

Final preparation and editing of the manuscript was performed by CESI.

CONTENTS

1. INTRODUCTION

1.1 MOTIVATION

The diffusion of Renewable Energy Sources (RES) ([1]) for both electricity and fuel production has a high priority in the energy policy strategy of the European Commission (EC). This is clearly stated in the *White Paper on Renewable Sources of Energy* published by the EC in 1997. More specifically, as far as electricity produced from Renewable Energy Sources (RES-E) is concerned, the *Directive on the promotion of electricity produced from RES* approved by the European Parliament and Council in 2001 (RES-E Directive) sets the ambitious target of doubling the share of RES in the electricity mix by 2010.

The great importance of RES is connected to their manifold present and future benefits which include:

- Environmental benefits, e.g. reduction of greenhouse gas emissions and of local pollution;
- Geo-political benefits, e.g. diversification of supply and increase of security supply;
- Economic benefits, e.g. attract new investments, increase industry competitiveness;
- Social benefits, e.g. increase in local employment and income.

However, to achieve the mentioned targets, further action is needed. Despite supporting policy mechanisms in many countries, diffusion of Renewable Energy (RE) is currently hampered by a set of barriers. The latter are caused by an ensemble of factors, including technical, financial, institutional, organizational, and methodological aspects. Moreover, we argue that existing business opportunities are also not fully exploited.

While we recognise that a lot of support is already in place, we point out that much more coordination and coherence is needed in order to facilitate a very significant diffusion of RE in the energy market.

1.2 CORE OBJECTIVE AND SCOPE OF REMAC 2000

The core objective of the research project REMAC 2000 was to develop a **Road Map for RE Market Acceleration**, i.e. a list of priority policies and actions needed to accelerate the RE market growth so as to achieve the targets deemed feasible over the next 20 years.

This set of proposed actions aims at overcoming present barriers to RE adoption and leveraging on potential acceleration factors for RE diffusion. The actions are presented in a coordinated manner, i.e. they aim at ensuring that all resources and interventions are aligned in the same direction and at reaching a maximum of coherence.

(1) Throughout the entire document the following acronyms are used: RES (Renewable Energy Systems or Sources) refer to energy generation devices that exploit renewable energy sources. RET (Renewable Energy Technologies) define the specific conversion technologies (Photovoltaics, wind turbines, etc.) on which these systems are based. Finally RES-E refers specifically to the electricity produced by means of renewable energy systems.

The Road Map addresses a wide set of public and private stakeholders, ranging from policy-makers to all stakeholders along the RE value chain (from producers to end-consumers).

As explained in chapter 2, we have decided to focus our attention mainly on electricity produced from RES. However, most of the proposed actions of the Road Map actually hold for RE as well.

As far as geographical scope is concerned, proposed actions mostly derive from the analysis of markets and policies implemented in several countries of the European Union (EU-15), plus Switzerland and Norway. A quantitative vision for RES-E in the EU-15 countries by 2020 is given. However, most of the proposed actions actually hold for all of Europe and some recommendations might well be applied outside European countries as well.

1.3 METHODOLOGY USED AND ARCHITECTURE OF WORK

The Research Project REMAC 2000 has been co-funded by the European Commission/DG Research, under the Programme "Energy, Environment and Sustainable Development", Contract No. ERK5-CT2000-80124, and the Swiss Government, with additional support from the International Energy Agency (IEA), and the RE industry (BP Solar).

The analysis has been carried out by a team of experts from CESI (Italy - co-ordinator), Ecobilancio Italia (Italy), NET (Switzerland), ECN (The Netherlands) and CNRS-IEPE (France). Enel Greenpower (Italy) has also provided expertise and leadership through the Chairman of the Advisory Board, which has been established to actively support the project and is composed of representatives from the main sponsors. The project team has also enlisted the support of the International Energy Agency (IEA) and its extensive networks of contacts in national administrations and industry, especially OECD countries. Finally, REMAC has been supported by EURELECTRIC, which has hosted one expert stakeholder workshop and has provided scientific review through its Working Group on Renewable Energy Sources and Distributed Generation.

The project has been organised in three main phases, which have led to the set of Road Map actions presented in this document: analysis, synthesis and actual elaboration of the Road Map (Figure 1).

In the first analysis phase, research has been conducted in three main areas, each addressed in a different working package (WP):

- The Impact of Technology Developments and Cost Reductions on RE Market Growth has been analysed through a comprehensive assessment of the technological potential of different RETs.
- The Impact of Energy Industry Developments on RE Market Growth has been assessed through a survey of RE market structure in different countries and a detailed analysis of the strategies followed by utilities in the field of RE, carried out also by means of a questionnaire.
- The Impact of Market and Policy Framework Developments on RE Market Growth has been evaluated by means of a critical review of policy support mechanisms applied so far in different European countries.

The results of these WP's have allowed to identify main key factors (both barriers and opportunities) for RE market diffusion. The identified factors have been presented and discussed in a first expert stakeholder workshop, held in April 2002.

The validated analysis results have been merged in the second phase (synthesis) and have led to the identification of the vision, i.e. the targets for RE diffusion by 2020 and beyond, and to the set of actions needed to achieve these targets.

A preliminary set of Road Map actions was presented in the second expert stakeholder workshop held at the end of September 2002. The final Road Map presented in this document integrates the main comments and suggestions collected at that meeting.

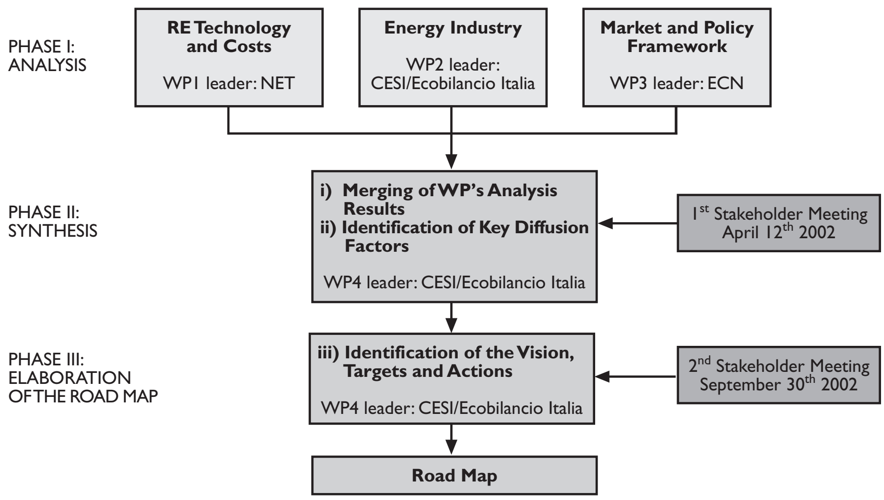


Figure 1: Project architecture.

1.4 ORGANISATION OF THIS DOCUMENT

This document presents a Road Map for the acceleration of RE market, i.e. a set of co-ordinated actions to be carried out by public and private stakeholders in order to significantly increase the diffusion of RES for electricity production (and for RE in general) in Europe. It is structured in 5 chapters:

Chapter 2 – The Value of RE and RES-E briefly highlights the benefits of renewable energy sources and motivates the main focus on electricity;

Chapter 3 – REMAC 2000 : an Agenda to promote RE Diffusion sets our vision for the RES-E market in Europe by 2020, identifies the main key diffusion factors for RES and introduces 4 main areas of intervention aimed at overcoming the main barriers to RE adoption and benefiting from unexploited business opportunities;

Chapter 4 – Road Map Actions describes in detail a set of proposed actions for each main area of intervention;

Chapter 5 – Conclusions and Recommendations summarises the whole set of actions, derives conclusions and recommendations for different stakeholders and puts them into a timeframe.

2. THE VALUE OF RENEWABLE ENERGY AND RENEWABLE ELECTRICITY IN THE INTERNATIONAL ENERGY MARKET

Renewable sources provide a wide range of technically viable, environmentally sustainable and economically attractive alternatives for the supply of electricity and heat in both present and future energy markets.

The reasons that render these technologies increasingly attractive are manifold, and have evolved over time. Initially related to economic considerations and triggered by the limited availability of fossil fuels that promoted efforts to conceive alternative energy scenarios, the recognised advantages of renewable energies have now broadened. These embrace their contribution to sustainable development, the specific environmental benefits produced, and the possibility to use them to increase the security of energy supply in many industrialized and developing countries.

For sake of simplicity these can be subdivided into four broad categories, namely: environmental, economic, geo-political and, finally, social reasons.

The Value of Renewable Energy Sources derives from their:

- **Environmental,**
- **Economic,**
- **Geo-political and**
- **Social Benefits**

First and foremost, *environmental benefits* are certainly among the primary factors that determine the value of RES. Not only might these systems significantly reduce or even eliminate direct emissions and alleviate air pollution at the local level, they may also offer a primary contribution to the reduction of the greenhouse effect and mitigate climate change at the global level. Also, given the widespread geographical availability of renewable resources, increasing RE penetration rates may significantly decrease the need to transport large quantities of fossil fuels and reduce the environmental risks typically associated with this activity.

Stimulating RES diffusion also has important *geo-political* consequences. First and foremost, it is widely accepted that an increase of RE penetration may help most countries diversify their energy portfolio and limit their dependency on fossil fuels, thereby creating a hedge against fluctuations in fuel prices and increasing the *security of energy supply*. Finally, it cannot be neglected that RET diffusion may favour trade and pan-European cohesion. Indeed, the particular geographical distribution of renewable resources, which vary across regions and per technology, may demand different countries to increase exchanges and improve collaboration so as to effectively match and complement the range of resources available over the entire territory.

Economic considerations also suggest that the contribution of RES should be further increased. Besides the fact that in many cases (areas with difficult access, small off-grid systems, etc.) supplying energy through a renewable source can be less expensive than connection to a power grid already today, numerous additional economic rationales suggest that the massive adoption of RE systems for grid-connected applications – even on a larger scale – would be appropriate in the future. First, although precise estimates are always difficult to produce, it is also generally acknowledged that privileging labour-intensive RE sources over capital-intensive systems based on fossil fuels may exert a net positive effect on employment. Second, investing in the relatively young and non-consolidated renewable industry may also help European firms profit from a first-mover advantage effect and take technological leadership in this sector. In turn this will stimulate the entire economy in the area and produce important economic benefits.

Finally, the need for increasing RE penetration is supported by a number of increasingly important *social reasons*. RE support is driven, for instance, by the generalized demand for concrete actions towards sustainable development and improved quality of life, easily perceived in many sectors of our society. It also derives from the fact that the development of RE systems may entail significant investments in areas that were formerly less attractive from an economic perspective, thereby contributing to decreased social and economic differences across regions and promoting social cohesion at the national and European level.

In addition to the above arguments, which apply to renewable energies in general, there are factors suggesting that special attention should be paid to renewable electricity. First, the demand for electricity is increasing at a rate proportionally higher than the demand for energy. Second, the electricity sector is highly polluting, e.g. it is the industry sector that generates the largest amount of greenhouse gas emissions in Europe, thereby calling for a radical technological shift. Third, RE distributed generation systems where RE play a paramount role offer good opportunities and flexible solutions, which can be adapted to specific regional and local requirements. Indeed, small and modular RE generators can meet the need for the urgent deployment of additional generation capacity. This is sometimes difficult to satisfy through conventional large scale systems, because – with a few exceptions ([2]), they typically entail long project development times. Also, – in sharp contrast with some of the current electricity generation systems that are particularly inefficient and not environmentally sustainable – RE provide particularly viable solutions and interesting techno-economic opportunities. Although we acknowledge the potential of RES in the area of transportation and heat production – in particular that of biomass and solar thermal – we have concentrated our attention primarily on the electricity sector for all the reasons mentioned above.

Despite the numerous benefits that an increased diffusion of RES may entail, it cannot be neglected that these technologies also display some peculiar characteristics that may render their utilisation problematic, especially if envisaged on a very large scale. Although these characteristics are not critical deadlocks, they must certainly be taken into account if one envisages a massive increase of the RE share. For instance, and with some exceptions, RE sources are generally dependent on local climatic conditions. In turn, this leads to energy outputs that are not constant over time, which either make grid integration difficult or require energy storage devices, hence further augmenting the cost of the electricity generated. Also, some systems have a low energy density (i.e. low energy outputs for a given amount of natural resource inputs). Therefore, their utilisation for the generation of base load electricity would require a large quantity of natural resources, which may not always be available or easy to utilise (e.g. land for the installation of PV fields or wind farms). Finally, other systems may exert other types of environmental impacts that also require careful evaluation and planning, e.g. the visual impact of wind farms.

(2) For instance, small gas turbines can be used to absorb peak demand without incurring long project lead times.

However, the very same characteristics that cause a massive RES diffusion to be problematic under the current market framework may be less constraining in the future, especially if appropriate changes occur to facilitate their integration.

For instance, the radical changes that are currently transforming electricity markets in most European countries provide new challenges but also open new potential opportunities for renewable energy systems. For example, on the one hand, the increasing liberalisation of electricity markets creates new challenges because fully liberalised markets tend to increase competition on prices, with obvious negative consequences for those RE technologies that still have to reach full cost competitiveness. On the other hand, it also creates new opportunities because the reduced barriers to entry naturally facilitate the arrival of new market players in the industry. These may invest heavily in RES and occupy potentially profitable market niches where these systems offer a competitive edge with respect to incumbent companies.

Secondly, increasing interest in distributed generation and decentralised energy systems may also create new potential opportunities for renewable energies. Indeed the same intrinsic characteristics (small scale, modularity, flexibility to adapt to local needs, non-dispatchability) that hamper the integration of these systems into a fully centralised energy system, become important advantages in a different setting where distributed generation plays a more important role and may render them particularly convenient.

The above discussion clearly suggests that renewable energies are a viable and highly desirable alternative to the systems that currently dominate the electricity market, both in Europe and worldwide. It also suggests that several interesting business opportunities exist for those players who are willing to invest in the sector.

However, the arguments above also imply that appropriate actions must be taken, in order to address these challenges and effectively exploit the opportunities that arise for RES in the short, medium and long term.

3. REMAC 2000: AN AGENDA TO PROMOTE RENEWABLE ENERGY DIFFUSION

by Andrea Masini, Paolo Frankl, Philippe Menanteau

3.1 SETTING THE TARGET: A VISION FOR RENEWABLE ENERGY SOURCE BASED ELECTRICITY

Well aware of the numerous advantages that RE systems can produce, policy makers both at the national and EU level have set ambitious targets to stimulate RE penetration. A representative example of these efforts is, for instance, the objective set by the European Commission, requiring RE to cover 22% of the overall European electricity demand by 2010.

Yet, in spite of these efforts and of the generalized favourable reactions that these technologies receive in many layers of society "at large", their actual penetration in European and world energy market remains well below the desired threshold and is still partly facilitated by dedicated supporting mechanisms. Several studies and simulations suggest that – without a set of dedicated actions that favour the transition from the current condition to a fully sustainable and demand-driven market, the gap between the actual and the desired RE penetration rates is likely to remain significant, at least in the short run.

The recent World Energy Outlook [WEO, 2002] ([3]) published by the IEA illustrates this point. The Reference Scenario forecasts how energy markets might evolve if governments do nothing more than what they have already committed themselves to do. In practical terms, this scenario takes into account government policies and measures already adopted at the beginning of 2002, but not ones still under discussion.

As far as renewable electricity production is concerned, the resulting trend shows a slight increase from 2000 to 2030 with average growth rates 2-3% per annum, from 393 TWh in 2000 to 769 TWh in 2030. It is worth noting that – according to this simulation, the targets set by the European Directive for renewable electricity will not be reached, because the policies and measures adopted are not favourable or effective enough.

Conversely, we believe that EU targets can be reached, but this will require a different "vision" of RE dissemination based on a set of co-ordinated measures and much more favourable policies. This vision envisages the removal of the main barriers to adoption, the implementation of market stimulating policies and the development of ambitious R&D programmes that will significantly accelerate technological progress.

In order to illustrate and motivate this vision, we have estimated the renewable electricity production that will likely occur in the European Union if very favourable policies are adopted. This simple simulation takes into account the properties of logistic curves (i.e. the fact that new technologies do not penetrate instantaneously, even when they are competitive), and it considers conservative assumptions regarding the achievable technical potentials for the most important renewable technologies. Furthermore it also fully respects the indicative targets proposed by the EU Directive for 2010. This exercise forecasts for 2020 an expected RE production of about 1059 TWh, which corresponds to 30% of the total electricity consumption in the area estimated in the WEO Reference Scenario (see Figure 2). Clearly, this symbolic figure is not an accurate forecast but, rather, a

(3) WEO 2002: World Energy Outlook, International Energy Agency, Paris, 2002.

motivating target. It shows that ambitious RE goals can only be reached if an aggressive EU renewable energy policy program is implemented, which entails the design of a set of co-ordinated measures that involve several stakeholders in the sector.

WEO Reference Scenario versus REMAC Vision

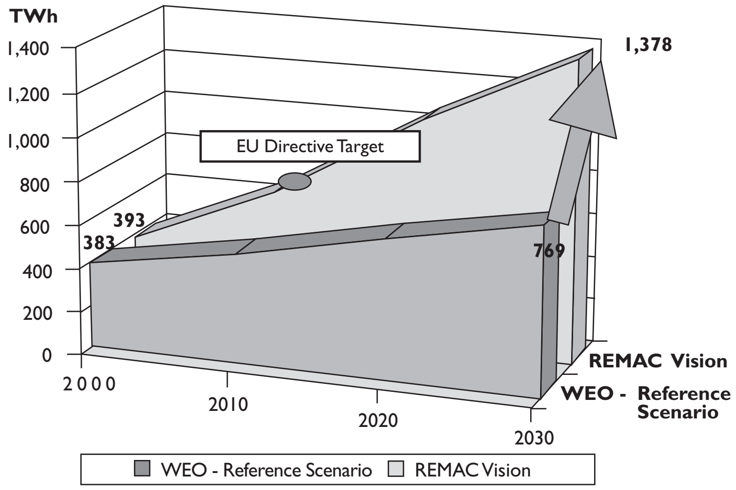


Figure 2: REMAC Vision for RES-E diffusion in the 15-EU countries, compared with WEO reference scenario.

This vision and the accompanying set of actions necessary for its realisation are summarised in the present Road Map for RE market acceleration. The Road Map is the final outcome of the two-year research project REMAC 2000. It proposes a working agenda for the various stakeholders in the energy sector, with the objective being the establishment of a *self-sustained*, *fully competitive* and *demand-driven* RE market by 2020.

To achieve this goal, the Road Map indicates and discusses a set of coordinated actions (at various levels and addressed to different stakeholders) that will help the RE market evolve from the present situation – where RES still play a limited role and needs dedicated policy support – to a new one in which RE diffusion eventually occurs in a self sustained manner and is entirely demand-driven (see Figure 3).

The proposed Road Map focuses on renewable *electricity* and has several unique characteristics:

> **REMAC Road Map Approach:**
> - **Holistic and market-oriented;**
> - **Covers multiple technologies at the same time;**
> - **Addresses both public and private sector along the RE Value Chain.**

- It takes a holistic and market-oriented perspective, embracing the entire process through which RE systems deliver value to the market. This RE "value chain" (Figure 4) includes not only the physical processes that are used to generate RE electricity, but also the upstream, downstream and complementary activities that support these processes. Upstream processes include both the manufacturing of RE systems and the procurement of the necessary raw materials and feedstock.

  Downstream processes embrace electricity distribution, delivery and post-sales activities. Complementary processes embrace RE financing as well as the manufacturing of the infrastructures that are necessary for a proper functioning of RES.

- It has a *multitechnology* nature, as it considers different renewable energy technologies as complementary parts of a unique "system" (as opposed to a collection of individual technologies that compete among each other for diffusion). It is the overall size of this system in the energy market that has to be increased;
- It envisages the involvement of both the *public* and the *private sectors* in a synergistic fashion, especially for those activities (such as R&D) where these actors can assume naturally complementary roles and support one another;

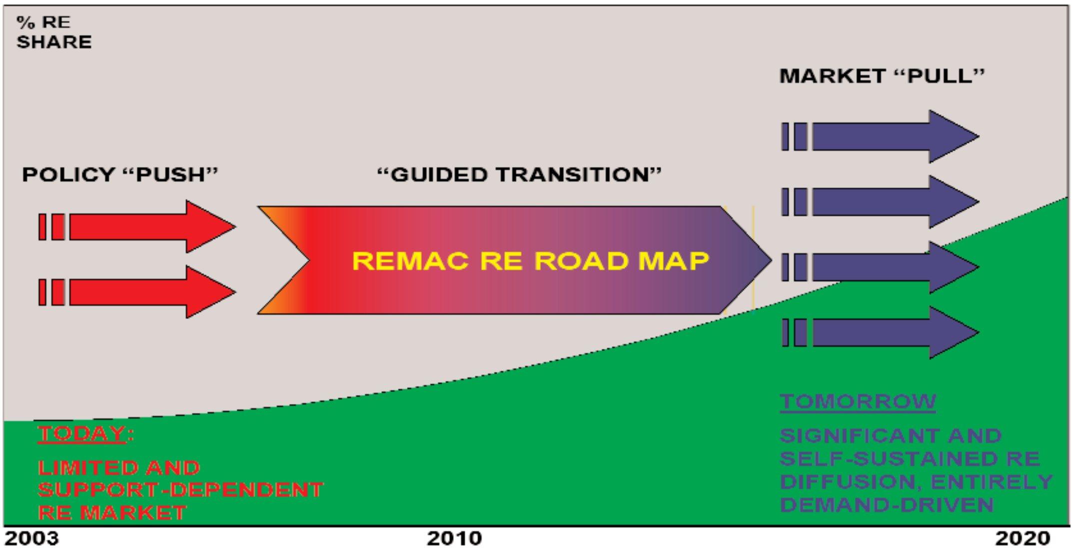


Figure 3: The REMAC Road Map: a guided transition from policy "push" to market "pull".

- It is based on a solid, *theory-driven approach* that considers in a critical fashion the mechanisms that influence RE diffusion. This approach explicitly takes into account both critical "bottlenecks" that constrain the RE value chain at various levels and, also, hidden business opportunities that should be, instead, properly leveraged. The actions proposed are based on a detailed and comprehensive assessment of these factors, which searches for common causes and possible synergies across the actors involved.

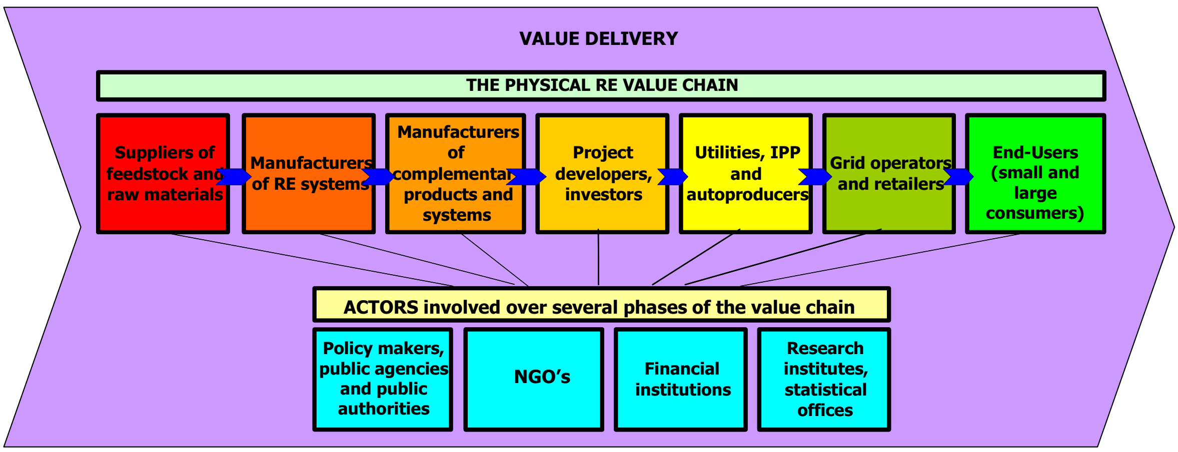


Figure 4: The RE value chain and its major constituents.

3.2 KEY DIFFUSION FACTORS: BARRIERS TO ADOPTION AND UNEXPLOITED BUSINESS OPPORTUNITIES

RE penetration is currently hindered both by:
- **Technical and non-technical diffusion barriers;**
- **Unexploited or hidden opportunities.**

The actual penetration of renewable energy systems in European and world energy markets is affected by a number of complex factors of different natures (technical, financial, political, etc.) that influence both RE demand and RE supply or that render business opportunities less attractive for companies who are willing to invest in this sector.

These critical factors that affect RE penetration include both diffusion barriers and hidden opportunities. The former are constraints, impediments or bottlenecks that hamper RET diffusion by limiting demand, constraining supply or by preventing the deployment of efficient market mechanisms. Conversely, the latter are potentially interesting but currently unexploited business opportunities that – if made visible and properly leveraged – could also significantly contribute to RET penetration.

To be effective, a RE Road Map should be aimed at intervening in a coordinated yet punctual fashion on these targets, with the objective of removing binding barriers and to leverage unexploited opportunities. To this end, and to facilitate the establishment of a link between the mechanisms that affect RE diffusion and the set of actions that should address them, it is useful to classify ([4]) the elements that affect RE penetration into five broad categories, namely:
- Technical;
- Financial;
- Institutional;
- Organizational;
- Methodological.

These Key Diffusion Factors have been identified during the first phase of the REMAC research project, which included:
- A comprehensive assessment of the technological potential of different RETs.
- A survey and a detailed analysis of the strategies followed by European and international utilities in the field of RE.
- A critical review of policy support mechanisms applied so far in different European countries.

3.2.1 Technical factors

Many RE systems display a relatively high technological maturity and efficiency and can provide valuable services and products at competitive costs. Yet, techno-economic performances of RE systems vary greatly across technologies and applications. It is widely acknowledged that this area still offers room for improvement of technical and non-technical issues (e.g. performance, cost, perceived value).

(4) The proposed taxonomy is obviously only one among the many possible. It is based on the attempt to include in the same category all the key diffusion factors whose connected actions will concern or might be directly promoted by the same group of stakeholders.

Technical factors comprise the technical aspects of feedstock, materials, design, manufacturing processes and ultimately deal with increasing system performance and efficiency, system cost (i.e. per unit power or per unit energy generated), and system applicability. The latter includes, for instance, the need to improve the design of the RE generators in a way to better espouse consumer expectations, as well as the exigency to facilitate the connection with other complementary systems. This is particularly critical, for instance, with RE technologies that need to be fully integrated with building components and would largely benefit from a better and more standardised interface between the two (e.g. building integrated PV systems).

Obviously, actions aimed at addressing these issues fall primarily under the responsibility/concern of technology manufacturers and system assemblers. The focus here is on improving the technical characteristics of the system to either increase its competitiveness in a given market (e.g. by achieving better cost/performance ratios) or to extend the range of potential applications. Clearly, large opportunities for cost reduction do exist for all RET (Table 1).

	Estimates of the three main cost reduction opportunities		
	R&D	**Manufacturing volume**	**Economy of scale (generation unit)**
Biopower	**	*	**
Concentrating solar power	***	**	***
Geothermal power	**	*	**
Small hydro power	*	*	*
Solar photovoltaic power	*****	****	**
Wind power	**	*	***

Table 1: RET cost reduction opportunity areas. The table summarises the estimates of the three main cost reduction opportunities (progress through R&D, economy of (manufacturing) volume and economy of scale) for different RE technologies. Each * is the approximate equivalent of 4% - 6% of cost reduction within a decade (including expected technological learning and market growth). Source: NET Ltd. Switzerland.

3.2.2 Financial factors

Often, in spite of their technical performances, reliability and overall adequacy to end-users' needs, RE projects face difficulties in finding adequate financing. This is not only due to their cost, but also to a number of critical "financial" issues that affect the risk perception of the organizations that typically sponsor RE projects or RE manufacturing companies. These factors can include elements even beyond specific economic considerations in a strict sense. They embrace issues as diverse as intrinsic instability due to changes induced by shifting political priorities, or the many changes in the regulatory framework that often characterize the energy sector in many European countries. As such, actions aimed at addressing this category of barriers specifically reflect the viewpoint of the investor. The objective is obviously to remove the obstacles that currently prevent – at various levels – traditional financial institutions and venture capitalists from investing in RE projects.

3.2.3 Institutional factors

In many instances, RE adoption is hampered by a number of external contingencies that are typically related to the regulatory and social framework in which the adoption process takes place. The broad category of "institutional factors" summarizes all those issues that generally derive from the operational environment in which RE market players operate, be they administrative, legal or social in nature. It includes both the regulatory framework (as typically set by legislators) as well as the "society at large" which may be affected by (and therefore react to) the widespread diffusion of RETs.

It is very clear that institutional factors are also crucial for RE diffusion. For instance, from our survey it emerged that utilities believe that RE diffusion is currently limited mainly by non-technical barriers. Among the latter, several institutional barriers, i.e. legal constraints and bureaucratic obstacles, unclear national targets, lack of proper incentives and a still non-harmonised EU electricity market, are perceived as the most important obstacles to the diffusion of RES (see Figure 5).

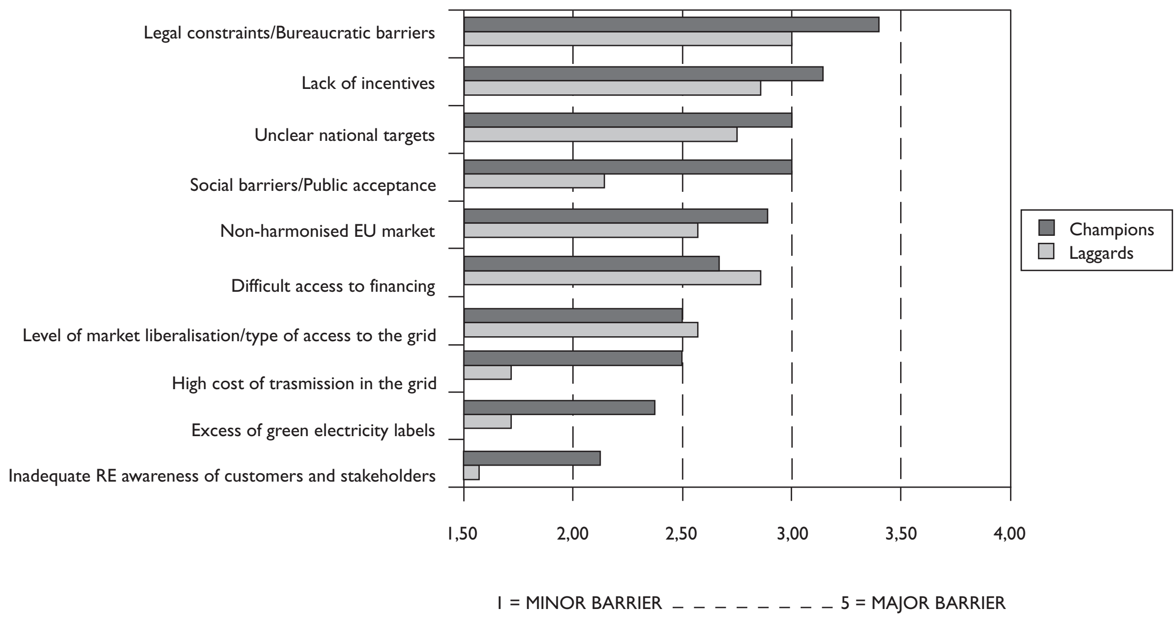


Figure 5: Main barriers to RE diffusion, as perceived by surveyed utilities. The chart distinguishes between utilities that have a fairly large share of RE (RE "champions") and utilities that are still reluctant to invest in these technologies ("laggards").

3.2.4 Organisational factors

The private sector plays a paramount role in the RE diffusion process. This is especially true for utilities, which are at the same time adopters of RE generators (in competition with non-renewable systems) and suppliers of RE energy. Firms in this industry that place renewables at the core of their competitive strategies, and that do so successfully, are likely to significantly affect the rate of RE penetration by virtue of two mechanisms. First of all, they would do so through their direct contribution. Secondly, they would trigger a bandwagon effect in which even those competitors that were initially reluctant to invest in RE, will eventually copy innovative RE strategies when these prove to be profitable.

As for any typical business process, the ultimate success of a particular RE strategy, depends also on a number of internal processes and firm-specific factors that differentiate RE "champions" from firms that do not judge it convenient to carry out significant RE investments. Accordingly, it is appropriate to consider explicitly a category of "organizational" factors, which include firm-specific behaviours that are typically correlated to the adoption of RETs and that should be encouraged to further enhance RE penetration. These factors – be they related to management practices, to the design of the organizational structure or the firms' marketing strategy, can all be regarded as organizational "best practices". If followed, they would help firms generate higher value from their RE investments, therefore encouraging them to further pursue this strategy and increase the overall RE market diffusion.

3.2.5 Methodological factors

A final, yet important, category of factors that influence RE diffusion is connected with the methodologies used to evaluate different energy alternatives. In some instances and on the basis of many criteria, RET could be preferred to non-renewable systems even under today's market conditions. In practice, they are still often neglected because the particular methodologies used to operate the evaluation fail to fully reflect and incorporate their benefits (e.g. environmental benefits and/or increasing security of supply). Accordingly, an entire set of promotional actions should address this issue and favour the development of methods of analysis, which fully appreciate the true cost and benefits of different energy technologies.

3.3 FROM KEY DIFFUSION FACTORS TO AREAS OF INTERVENTION

The critical diffusion factors listed above influence RE penetration by interfering with three main mechanisms that enable a technology diffusion process to occur. First, they influence the magnitude of RE demand. Second, they affect the size of RE supply. Third, they also alter the process that regulates the interaction between the two in a liberalised market economy.

Accordingly, to stimulate RE penetration one can envisage the implementation of a set of coordinated policy actions that intervene simultaneously on the three mechanisms above. Effective policy actions to support RE penetration must aim at removing barriers that shrink RE demand, limit RE supply or prevent market mechanisms from functioning efficiently and transparently. By the same token, effective actions can also facilitate the exploitation of existing business opportunities that would either stimulate demand, increase supply or facilitate market transactions (see Figure 6).

The simplest working agenda for RE support would consider the different problems sketched above separately. Accordingly – it would also suggest a set of specific actions that address the specific issues in a totally non-coordinated fashion. In fact, this is what has generally happened so far. While we acknowledge that a large variety of policy support mechanisms have been applied (and a lot of private investments have been made), we observe that the measures taken have not fully guaranteed an alignment of objectives and resources. For instance, measures supporting a specific RET have sometimes created obstacles for the diffusion of other technologies. Policy support mechanisms applied in one country have created difficulties in others. An integrated strategy to simultaneously support both supply and demand time has been applied very rarely.

Conversely, a sounder approach – like the one followed by REMAC 2000, would exploit existing complementarities across key factors and align efforts at different levels so as to produce a leverage effect and to maximize the impact of the solutions proposed. Indeed, a more comprehensive and holistic analysis of the individual barriers along the different echelons of the RE value chain ([5]), enables the identification of several commonalities across these factors. It is not uncommon that different bottlenecks that hamper RE diffusion at different levels in the system may be the direct or indirect effect of a more general phenomenon that spans across the entire techno-economic system analysed.

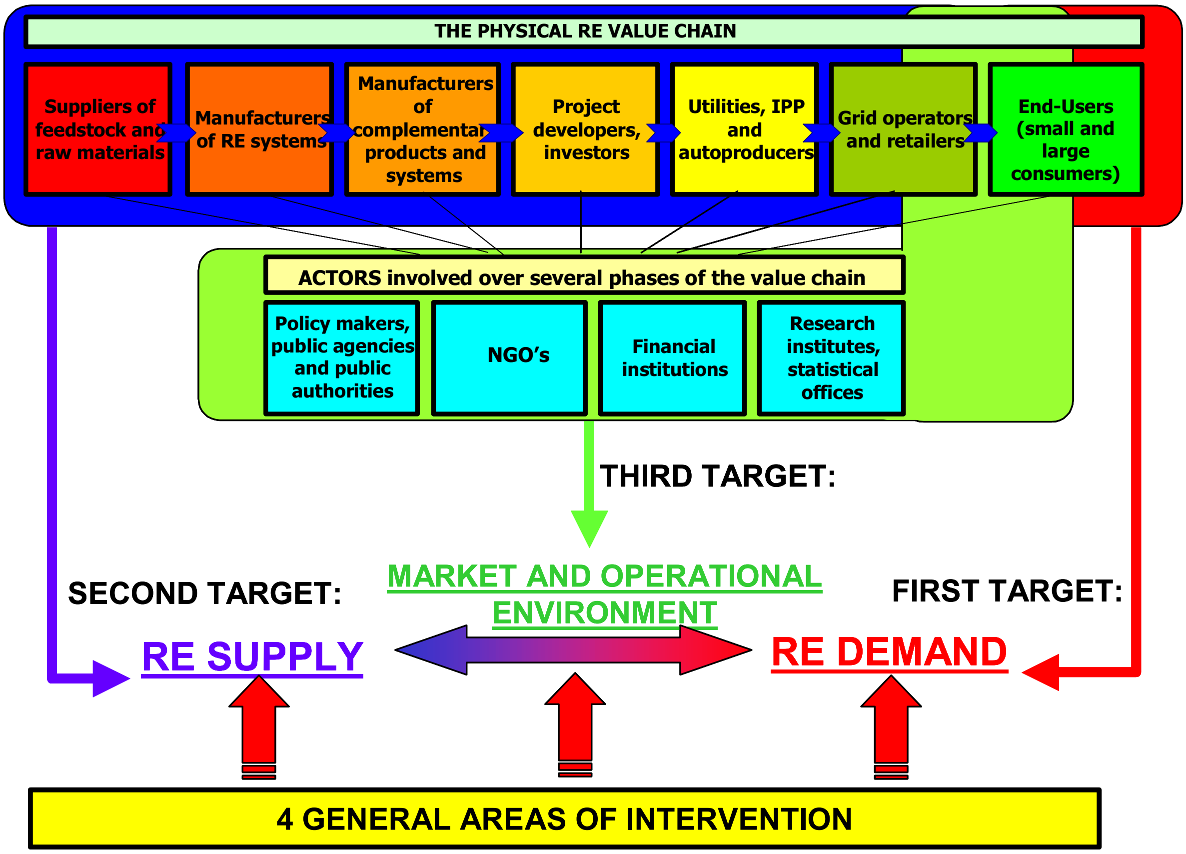


Figure 6: Areas for intervention, targets and the RE value chain.

If this is the case, a limited set of extremely tailored and well-coordinated efforts that jointly address the few ultimate causes that limit RE diffusion would be much more effective than a larger number of uncoordinated efforts that simply cure the various "symptoms".

For instance, difficulties in finding appropriate financial support for RE projects and the high RE electricity costs are often mentioned as two key problems that limit RE diffusion at different levels in the RE value chain. Accordingly, these problems could be attacked through dedicated and independent actions (e.g. by granting capital incentives to RE adopters or by subsidizing the purchase of RE electricity at the consumer level). However, a finer analysis reveals that both problems may also be the ultimate outcome of a common and more general shortcoming, which is the lack of

(5) Such a detailed analysis of the individual key factors is outside the scope of this document.

appropriate evaluation models that account for the special attributes of RES. Failing to correctly evaluate the RE true cost produces at least two effects. On the one hand, it will induce utilities to produce larger-than-normal estimates for the cost of RE electricity, which will obviously be reflected in the price observed at the retail outlet. Second, at the project evaluation phase it may produce artificially inflated estimates of the project pay back times. In turn, longer pay back times may discourage investors both "per se" and because they entail a longer decision horizon and a completely different risk profile.

For the two problems mentioned above, addressing the (or one of the) original cause – lack of methods to compute the true cost of RE systems – would be more effective than dealing with the individual effects in a separate fashion. This is precisely the approach followed in the REMAC 2000 Road Map. The identification of general communalities across barriers (and consequently across the possible solutions that can be proposed to overcome them) naturally suggests the implementation of a coordinated series of actions that address the critical elements of the system in a synergistic – and thence more efficient – fashion.

The REMAC 2000 team has provided a special effort to identify these communalities, by developing a detailed analysis of the individual key factors, of their importance, of their expected temporal positioning as well as of the main actors involved in the process. More than 100 key diffusion factors have been identified during the analysis. They have then been grouped in a limited set of areas, in order to define priorities and intervention areas to effectively support RE demand, RE supply and market mechanisms in an integrated manner.

Preliminary results were presented and discussed in two international stakeholder meetings organised in 2002 ([6]), which enabled the team to further refine and validate the study.

This comprehensive analysis and screening process highlighted that actions for RE support can be effectively categorized into four main groups, or general "key areas of intervention":

I. Increase of **market transparency and awareness** about RE systems;
II. Improvement of **techno-economic performance** of RE technologies;
III. Improvement of **consistency and continuity** of RE support policies;
IV. Development of **new assessment models** that incorporate non monetary aspects.

The first general area of intervention is aimed at improving market transparency and increasing awareness, at all levels of the RE value chain.

In fact, the most important objective of REMAC's vision for 2020 is the transition from the present system characterized by a limited and support-dependent RE market to a significant, self-sustained, and entirely demand-driven diffusion of RE (see also Figure 3). It is argued that, in order to reach this objective and to ensure that RE diffusion is mainly pulled by consumer's choice, significant improvements in market conditions and transparency are necessary.

(6) The two meetings were held respectively at the IEA in Paris in April 2002, and at the EURELECTRIC headquarters in Brussels at the end of September. In total, more than 40 experts (beyond the research team) were involved. See (http://www.renewable-energy-policy.info/remac) for more detailed references.

The high priority of this intervention area is further motivated by the fact that limited awareness about the numerous and unexploited benefits of RE among stakeholders at all levels constitutes a crucial barrier for RE diffusion today. For example, low awareness creates social barriers, hampers public acceptance and generates unnecessary legal and bureaucratic constraints at the local level. At the same time, it prevents business and the financial sector from exploiting opportunities that would already exist.

The second area addresses the fact that in some cases, the high technology and system cost and/or low performance are objectively a factor that prevents many businesses from massively adopting RE systems, even in a fully transparent and efficient market. This category groups together actions at all levels in the RE value chain that can decrease system cost: from direct investments in R&D to more complex efforts aimed at improving system design to render it more appropriate to effective users' needs.

We recognise that a long time passes before the tangible effects of the measures aimed at increasing market transparency and stakeholder awareness become visible. Similarly, measures to improve RET performances and reduce costs will also not be effective immediately. As a consequence, we argue that strong policy support to stimulate RE diffusion, although transitional, is still needed today.

At the same time, while we acknowledge that a significant degree of support is already granted to RE both at the national and European level, we also argue that this support needs to be significantly improved "in quality". Crucial issues here are to ensure the continuity of measures over a reasonable time period and to eliminate inconsistencies across different policy areas at the national level. Both these aspects have been identified as crucial leverage factors to give the business and the financial sector a stable working framework, to decrease the present risk of investments and to attract significant amounts of private capital in the field of RE. Moreover, policies should also aim at strongly facilitating RES-E trade across a single EU market, e.g. by eliminating all unnecessary barriers and inconsistencies, which still exist today across different countries.

Last but not least, the fourth intervention area deals particularly with the fact that most current energy assessment models do not fully reflect the true cost of energy technologies over their entire life cycle. They do not include the cost of environmental externalities and they do not fully account for potential advantages such as an increase of the security of energy supply and stabilization in oil prices. Accordingly, there is ample evidence that RE diffusion can be significantly and actively supported through a radical rethinking of methodologies for energy system assessment. This is therefore one of the primary milestones of the REMAC Road Map.

4. ROAD MAP ACTIONS

This section examines in detail the four areas of intervention together with a set of actions and examples.

4.1 INTERVENTION AREA I: INCREASE MARKET TRANSPARENCY AND AWARENESS OF STAKEHOLDERS

by Paolo Frankl and Emanuela Menichetti

4.1.1 The need for improved information in a demand-driven market

REMAC envisages passing from the present situation of a limited and support-dependent RE market to a significant and self-sustained diffusion of RE in 2020, primarily driven by demand and consumer choice in a single and liberalized European market. To achieve this objective, consumers need to be empowered and make independent decisions. In turn, this requires that they are provided with transparent, reliable and easily available information on renewable electricity.

Today, consumers have generally limited knowledge and limited awareness of these issues. Electricity is a commodity "taken for granted" and it is not a concern for the vast majority of domestic consumers. Despite a rising interest in RES-E in some segments of society, awareness is usually low. In fact, the questions most often asked by interested consumers to utilities that offer green tariffs are:

"What precisely is green electricity?" "How can green electricity be distinguished from electricity produced from other sources?" "What are its benefits?" "Who guarantees me that the electricity I receive actually comes from RE sources?". These questions illustrate the two levels of the issue:

- First, consumers have to be able to *perceive* the value and benefits of RES-E with respect to electricity generated by conventional systems, and, above all, be *aware* of the opportunity they have to improve the situation by buying RES-E instead of conventional one.
- Second, they must be provided with transparent and reliable information and be able to *trust* in the source of information.

Of course, these issues do not just concern household end-consumers but other important stakeholders as well. Awareness of the benefits of RE systems and the availability of transparent and reliable information are the key factors that allow local authorities, financial investors and other businesses to make optimal decisions.

We argue that the availability of transparent information and the fact that consumers must be actually aware of this information, are crucial factors for the increase of RES-E demand.

Therefore, the first two groups of actions proposed in the Road Map tackle these issues directly and respectively focus on:

- Increasing market transparency;
- Increasing awareness of stakeholders.

A third set of actions ("Link with other policy instruments and sustainable consumption") takes into account that RES-E demand can be fostered in an indirect manner through the increase of consumption of sustainable products. Indeed, the use of electricity is involved in a very large set of manufacturing processes. Therefore, in many cases, the life-cycle impacts of products (and/or of services) can be substantially lowered if RES-E is used instead of conventional electricity. In the long-term, fostering the market for sustainable products might be a potentially enormous pulling factor for an increase in RES-E demand.

Finally, it is argued that public administrations can play a crucial triggering role in fostering RE demand by green public procurement, i.e. purchasing either directly green electricity or sustainable products.

4.1.2 Market transparency

4.1.2.1 Rationale

The rationale that justifies the need for market transparency is very simple: In order to make a choice, consumers need to know precisely what they currently buy and what they could buy instead. This implies 3 levels of intervention:

- Consumers committed towards the environment and willing to buy electricity from renewable energy sources should be able to obtain information about RES-E quickly and in a simple and easily understandable way. Moreover, business clients that might need more detailed information should have the possibility to obtain it as well.
- All consumers should be adequately informed about how the electricity they buy is actually produced. This includes information on the actual mix of production and the environmental pollution associated to it.
- All information flows and the whole renewable electricity market should be guaranteed by a reliable system of certificates of origin.

More precisely, there are 3 basic guiding principles for the proposed set of coordinated actions.

The first main principle is to assist interested customers willing to buy green electricity with simple and easily understandable, but at the same time reliable and transparent information.

As far as this is concerned, despite the abundance of green tariffs ([7]) offered by many utilities in several countries, it is not always easy to obtain transparent, exhaustive and reliable information on RES-E, even for interested and "expert" consumers and/or business clients. In order to help solve this problem, concerned producers and environmental and consumer associations in various countries have come together and developed "green labels" on RES-E, i.e. environmental quality labels ("eco-labels") on electricity. These labels are meant to be a guarantee to consumers and to increase their trust in offers received from utilities.

However, so far many competing labelling systems coexist across Europe, or even within a single State (see the example of Germany in the box). Great differences between the schemes do exist in terms of

(7) In the last 5-10 years a constantly increasing number of utilities in various EU countries have begun to offer the possibility of purchasing RES-E to their customers, mainly through the mechanism of "green pricing" or "green tariffs". Both terms are generally used to define a sale scheme in which the utility sells RES-E to customers willing to pay an extra-price with respect to the normal price usually paid for conventional electricity. The offers are sometimes accompanied by a specific product brand developed by the utility itself.

mix of production sources, additionality (8) criteria and/or share of new plants. Some tariffs and labels also include large hydro or gas-fired co-generation plants. Obviously, in many cases consumers get confused by this overflow of – not always transparent – information and by this overlap of tariffs, brands and labels.

In view of the enlargement and full liberalization of the single EU electricity market, this confusion and the proliferation of labels must be avoided. Instead, efforts should be dedicated at leveraging the experience of existing schemes to develop common standards for an "excellence" green electricity label valid for the whole EU market.

Moreover, specific information schemes should be developed for business clients. More precisely, it is not just important to provide more detailed information to other businesses but also to provide tools and product information schemes in order to allow them to communicate their environmental performance related to the use of RES-E to their own customers. This is discussed and explained more in detail in section 4.1.4.

Example: The issue of the jungle of green tariffs and green labels in Germany

More than 300 different green tariffs are currently offered to German customers by more than 160 utilities. They vary significantly in terms of mix of RE electricity production and of extra-price asked to customers. Around half of the green tariffs are guaranteed by one of the 4 main groups of existing and competing labels in Germany:

– Grüner Strom Label (2 labels: Goldenes Label and Silbernes Label);
– TÜV (5 labels: VdTÜV 1303, EE01, EE02, UE01 and UE02);
– Energie Vision – OK Power (1 label, which can be applied to different green tariffs);
– LGA Landesgewerbeanstalt Bayern (2 labels: Öko-Strom regenerativ and Öko-Strom effektiv).

Criteria for the label award vary very strongly from scheme to scheme, with respect to the eligible renewable (and non-renewable) energy technologies, to the age of plants and to additionality (i.e. the obligation to re-invest in new RE plants). For example, some labelling schemes just focus on hydro, others allow (high efficiency) co-generation plants as well. Some labels require 25% of the energy produced to come from new plants. Others have no additionality requirements at all. Therefore, it is neither straightforward nor easy for consumers to always understand precisely what they are offered.

The second basic principle that justifies the need for higher market transparency is that all consumers – and not only those interested in RE – have "the right to know" exactly what they buy. This is a fundamental pillar of consumer choice and to actually empower people to act. In order to achieve this goal we propose to introduce a mandatory disclosure label on all forms of electricity.

It is worth mentioning that such a measure is currently strongly opposed by a large part of industry. Opponents argue that due to the large amounts of electricity traded on the market from country to country and to match demand oscillations, it is very difficult to precisely trace which kind of electricity is actually distributed to final consumers. However, we think that average considerations over a certain time period can be done. Moreover, some approximations (e.g. taking the European average value to tackle with missing information on the exact origin) might be admitted.

(8) I.e. the obligation to re-invest in new RE plants.

Another important motivation for introducing a mandatory disclosure label is the fact that this information would reach all final consumers and not just a limited set of subjects already interested in RE. This would have a significant impact in terms of educating consumers about the environmental consequences of their electricity use, thus indirectly fostering both energy saving and potential interest in RE.

The third basic principle of the actions proposed is to ensure the highest possible level of transparency. With the words of the Directive 2001/77/EC: "…to facilitate trade in electricity produced form renewable energy sources and to increase transparency for the consumer's choice between electricity produced from non-renewable energy sources, the guarantee of origin of (such) electricity is necessary. (…) It is important that all forms of electricity produced from renewable energy sources are covered by such guarantees of origin". The directive requires that such a guarantee system is put in place by Member States not later than October 27, 2003, that one or more competent bodies, independent of generation and distribution activities, are designated in each Member State to supervise the issuing of the certificates, and that appropriate verification systems are established to ensure the reliability of the guarantee system. The certificates shall be mutually recognized by the Member States in order to facilitate trade, which is considered a crucial factor to foster demand and diffusion of RES-E (see also section 3.3). This process has actually already begun with the development of the Renewable Energy Certificate Systems in different countries. We recommend supporting, improving and accelerating this process.

4.1.2.2 Actions

We envisage a set of 3 coordinated actions to increase market transparency:

- Action 1: Develop common standards for voluntary excellence green electricity labels;
- Action 2: Increase market transparency through mandatory fuel mix disclosure;
- Action 3: Support and accelerate the development and use of RE certificates of origin.

<u>Action I.1:</u>

Develop common standards for excellence green electricity labels

Green labels on renewable electricity are recognized as a very important tool for increasing RES-E demand, as they can provide information in a concise and easily understandable form to customers. However, precisely in order to make customers easily and quickly understand what is behind the label and which kind of electricity they are buying, the present jungle of competing schemes with different criteria must be eliminated. Instead, it is necessary to develop common standards and rules to set up an excellence green electricity label to be widely diffused and easily recognized by customers all over Europe.

This process should obviously be based on experience from existing schemes, trying to harmonize the different criteria wherever possible. The label must be highly credible. Therefore, government bodies as well as consumer and environmental NGO's should be involved in the issuing bodies and/or the guarantee committees. The involvement of NGO's is particularly important because they are highly trusted by consumers.

The exact criteria will be decided within the proposed process, but we can already recommend that the scheme clearly differentiate itself on the market as an excellence label, i.e. focused on 100% RE only. As far as the latter are concerned, the definition criteria of the EC directive should apply. Moreover, given the very different technology development status of different RET and the great variance in RE resources from country to country, a certain degree of flexibility must be ensured. We suggest the development of two labelling levels ([9]). Alternatively, a ranking scheme, which mixes hurdle and scoring criteria might be adopted. This choice has recently been adopted for the European eco-label on tourist accommodation. In any case, local differences should be taken into account in the scheme.

Finally, it is important not to confuse green labels with brands. The latter are the marketing tools that companies eventually want to associate with their products in order to differentiate themselves and compete on the market. However, brands are an "auto-declaration" of the environmental quality of products. On the contrary, green labels are a product information scheme certified and guaranteed by an independent third party. Green labels are an additional guarantee to brands; the two tools are actually complementary and can be used together (see box).

Example: Combination of brands and green electricity labels in Switzerland

Many Swiss utilities have recently developed their brands, with which they advertise their RES-E products. If the strict requirements of the green label Naturemade Star are met, utilities apply for the label and use it in combination with their own brand for advertising and marketing activities. Naturemade Star is one of the strictest green labels existing at present in Europe. It involves very advanced criteria such as taking into account the whole life cycle of RET, requiring environmental management systems for plants larger than 10 MW, and taking into account local and regional criteria. It is widely known and highly trusted by Swiss consumers: In two years since its establishment in 2000, the amount of RES-E certified with Naturemade (Star and Basic) reached around 10% of total electricity consumption in the country.

Jade
Courant vert, courant de vie.

More detailed information schemes for business clients are discussed in section 4.1.4.

Action I.2:

Introduce mandatory fuel mix disclosure

The second major objective is to increase the transparency of the whole electricity market. In order to achieve this goal, we recommend that a European-wide mandatory fuel mix disclosure label is introduced and attached to the usual electricity bill. The label should contain information about the electricity sources used and the associated environmental pollution.

(9) This is done for instance in the Grüner Strom (Goldenes and Silbernes Label) in Germany and in Naturemade (Star and Basic) in Switzerland.

The exact format of the label should be decided in a product panel process. It could be either a pure disclosure label with quantitative "non judgmental" information or it could be combined with some sort of ranking comparative label ([10]).

Example: Possible format of fuel mix disclosure label

The advantage of a pure disclosure label is that it does not require any ranking criteria. This is the solution taken in Austria, where a mandatory fuel mix disclosure was introduced in 2002. For the unknown part, the UCTE ("Union for the Co-ordination of Transmission of Electricity") - Mix is taken. Therefore, the format of the label is:

Oekoenergy	......%
Water	......%
Gas	......%
Oil	......%
Coal	......%
Nuclear	......%
Others (known)	......%
Unknown UCTE-Mix	......%
Total	**100%**

By July 2004 at latest a uniform system of disclosure (one labelling for one trader) will have to be established.

However, the disadvantage of pure disclosure labels is the risk that most consumers do not fully understand the message, i.e. they do not know what is "good" and what is "bad" and they do not exactly know what to compare and how.

A possible solution to this problem might be the combination of pure "neutral" information with a comparative rating, which might compare the specific product with the average national power mix, in order to take into account the large differences existing from country to country (Green 2001) ([10]). Comparative rating labels, such the EU Energy label on some durable products (e.g. white goods), have been very effective in transforming the market towards the purchase of more sustainable products. In the Energy Label scheme, products are ranked according to their energy consumption on a scale from A to G. The message is clear and easily understandable, and this is considered a reason for success of the label.

However, in the case of electricity, the situation is more complicated. More specifically, particular care should be dedicated to choosing the environmental dimension(s) to make the ranking. For instance, if the latter is exclusively done on the basis of greenhouse gas emissions, the environmental impacts of nuclear or large hydroelectric plants might not be taken into account. As mentioned, this should be decided in a multi-stakeholder product panel approach.

(10) See also (Green 2001) J. Green et al. "Options for Labelling Green Electricity in Europe" WP2 Report, of ELGREEN – Organising a Joint European Green Electricity Market, Contract NNE5-1999-00003 EC DG Energy and Transport, 30 March 2001.

Action I.3:

Support and accelerate the development and use of RE certificates of origin

We recommend supporting, improving and accelerating the development of RE certificates of origin. The system should guarantee the highest level of transparency and detailed information possible. Moreover, it should be applicable to the entire EU market, overcoming the present inconsistencies of different systems developed in various national countries. For this reason, we recommend building on the experience of RECS (see box) and on its strengths, i.e. a very high level of transparency and international cooperation, and focusing further intervention to ensure the maximum level of reliability and credibility in the system. This includes direct participation by government bodies in the certificate issuing bodies and the involvement of NGO's in strong monitoring and verification systems.

The development and full implementation of such a guarantee certification system, in which every single quantity of produced and traded electricity is traced through a unique registration number, will provide very transparent and valuable information for all electricity market stakeholders. In fact, the availability of transparent information for industry, investors and authorities will have several advantages, because it will:

- Act as basic guarantee mechanism for green pricing and green labels offered by utilities to their customers;
- Foster RES-E trade and commercial business-to-business relations;
- Support the development, assessment and monitoring of incentive mechanisms, both on RE demand and/or supply;
- Avoid double counting and double selling problems (e.g. a producer fulfilling its obligation towards a national mandatory quota re-selling the same amount of energy to someone else) and/or avoid not desired double incentives.

Example: RECS - The Renewable Energy Certificate System group

The RECS Group was established in early 1999, by innovative representatives of energy industry, with the aim of the promoting international trade in renewable energy certificates. The objective of RECS is also to provide a solution to the harmonization problem of the different systems of tradable green certificates (with or without mandatory quota targets) currently in progress in various national countries. According to RECS, the environmental benefits linked to the production of renewable energy are traded separately from the physical energy: The energy is traded and consumed locally against common tariffs, while the environmental surplus value is reflected in certificates issued by internationally certified bodies. These certificates can be traded internationally, with their value determined by open market forces. International trade stimulates overall production of renewable energy by promoting projects at the most productive and economic sites, and removes the need to transport energy over long distances. Hence the separation of energy and certificates by RECS leads to greater renewable energy production for the same investment.

Another major advantage of RECS is that the sale of green energy (green pricing) to consumers can be linked to RECS certificates. Redeeming RECS certificates against green pricing obligations ensures that the related amount of green power has actually been supplied to the transmission or distribution grid. It also ensures that the green energy supplier owns any related environmental surplus value.

Compared to other systems, RECS offers a high degree of freedom to participants; each country is in fact completely free to choose the regime that best corresponds to its particular situation (e.g. quota vs. non quota model, actors subjected to the obligation, etc.), within RECS framework. Currently, 11 EU countries and 90 members are actively involved (other 4 countries and 83 member will be in the near future). As of December 2002, certificates for 11.4 TWh RES-E have been emitted and 3.5 TWh have been used to certify RES-E sold to customers.

RECS offer a very high level of detail with respect to the following information: – Details on generator – Location of the plant – Renewable energy source – Installed capacity – Age of the plant - Date of issue of certificates – Period of production – Amount of electricity certified – Any financial support received for plants.

4.1.3 Awareness of stakeholders

4.1.3.1 Rationale

The mere existence of transparent information and of reliable labelling schemes does not automatically guarantee that consumers actually know them. Of course, one line of reasoning is that companies should take the burden of marketing campaigns, spreading out the knowledge of the labels together with their own brands. This is actually happening in several countries, e.g. Germany, Switzerland and the Netherlands. However, this mainly functions in countries where the general awareness of consumers with respect to environmental issues is high and/or where fiscal incentives on RE demand are applied. In other countries a vicious cycle of "no consumer demand – no offers and marketing by utilities – no demand increase" is observed. In those cases, organizing and supporting campaigns to increase the awareness of consumers about RE and the possibility of buying green electricity might play a crucial triggering role for the increase of demand.

Awareness is not just an issue with respect to end-consumers. As a matter of fact, it might be a crucial bottleneck against RE diffusion in other cases. For example, low awareness of local authorities and local stakeholders is one of the main reasons why RE development projects are sometimes blocked at local level. As discussed later in section 4.3, this can lead to severe policy inconsistencies at national level, i.e. the development of RE decided at governmental level can eventually be completely blocked by local authorities. It is therefore very useful and urgent to dedicate resources to organize focused and targeted campaigns aiming at increasing the degree of awareness of local stakeholders.

4.1.3.2 Actions

Action I.4:

Organise awareness-raising campaigns on green electricity labels

Awareness campaigns on green electricity labels should be organized as soon as standards for a common labelling scheme at European level are fully approved and implemented. Campaigns should run on a combination of public and private money, should be promoted by the issuing bodies and should largely involve NGO's, because the latter are highly trusted by consumers. They shall be primarily organized and focused on those EU countries, in which the general public awareness about RE is low. A basic recommendation in this respect is to always keep in mind national specificities. Less advanced countries can learn a lot from successes and failures in other, more advanced countries.

Example: Marketing management of the major eco-labelling schemes

If one looks beyond the area of energy into the wider arena of eco-labelling schemes for products and services, one notices that the two main and most successful schemes, i.e. the Blue Angel in Germany and the White Swan in Nordic countries – which have certified thousands of products – carry out significant promotion activities. The latter mainly consist in targeted communication campaigns focused on the different stakeholders. More recently, the European Competent Body for the EU-flower has recognised the relevance of this issue and has established a Marketing Management Group. The objective of the latter is to co-ordinate marketing efforts and develop and implement joint marketing initiatives, e.g.:

- identify key target groups and define and implement a strategy for each;
- exchange information about marketing actions and promotional material;
- initiate joint actions and joint promotional material;
- exchange information about where eco-labelled products are sold;
- promote the use of eco-label criteria in public and corporate procurement;
- update and improve the web-site and organise contributions to it;
- develop strategic partnerships with retailers;
- develop resources allocated to marketing (target 50% of resources allocated to product group development).

Whatever the issuing body of the future green electricity label will be, we recommend that it adopts a similar marketing strategy.

Action I.5:

Organise awareness-raising campaigns on RE at local level

When establishing national supporting policies to RE, governmental bodies should also provide for appropriate resources to organise and/or support awareness-raising campaigns for local authorities and other local stakeholders. This is a crucial measure to avoid the risk of project development stops at local level as well as to increase public acceptance. In fact, this is recognised as a major current bottleneck against diffusion of RE (see section 4.3).

The campaigns should actively involve consumer associations and environmental NGO's, which are generally highly trusted by the people, and which can therefore play a crucial role in this process.

Example: Local awareness-raising campaigns by Italian NGO's

One Italian consumer association and two nation-wide well known environmental NGO's have recently identified the issue of raising the awareness about RE and other sustainable consumption aspects among local authorities and other stakeholders as a high-priority area of intervention. Some NGO's even recognised that in many cases decisions taken at their national board level were systematically contradicted by local sections. Accordingly, Italian NGO's are currently starting to organise dedicated seminars, workshops and other communication campaigns at local level, which will cover the whole Italian territory within the next two years.

4.1.4 Link with other policy instruments on sustainable consumption

There are indirect ways of supporting RES-E demand, which might be very effective, particularly in the medium-long term. The RE community should pay attention to other domains besides energy and explore ways to exploit opportunities in the area of Integrated Product Policy (IPP) and of sustainable consumption. More specifically, it is argued that RES-E demand can be fostered in indirect ways through the increase of consumption of sustainable products. Indeed, the use of electricity is involved in a very large set of manufacturing processes. Therefore, in many cases, the life-cycle impacts of products (and/or of services) can be substantially lowered if RES-E is used instead of conventional electricity. In the long-term, fostering the market for sustainable products might be a potentially enormous pulling factor for an increase in RES-E demand.

The key issue here is to explore and exploit motivations and drivers that can lead other companies to buy RES-E and profit from this in their own business. IPP offers a wide set of policy tools in this respect, ranging from fiscal incentives on sustainable products, voluntary agreements and a set of communication and labelling schemes. More specifically on the latter – which are more closely related to RE demand – the key issue is how other businesses buying RES-E can communicate this to their customers and use this as a marketing tool. There are several possibilities for this which should be explored, ranging from including the purchase of RES-E into the eco-labelling criteria of other product or service groups, developing new labels, which may be used by business clients as well, to fostering and further developing Environmental Product Declarations (see boxes below).

Finally, it is argued that public administrations can play a crucial triggering role in fostering RE demand by green public procurement, i.e. either by purchasing green electricity directly or indirectly via sustainable products.

<u>Action I.6:</u>

Link the use of RES-E with Integrated Product Policy and sustainable consumption

The RE community should pay attention to current progress in the area of Integrated Product Policy and more particularly to product and service labels. RE sector representatives should participate and collaborate in other labelling domains. Particular attention should be devoted to these schemes, which allow the use of RES-E to be directly communicated to consumers and/or other business clients. We particularly recommend that the RE community and electricity utilities in general follow and foster the development of Environmental Product Declarations, because the benefits of the use of RES-E in terms of reduction of environmental impacts associated to products are explicitly shown in them.

Example: Environmental Product Declarations in Sweden

Environmental Product Declarations (EPD) are ISO-type III labels providing an environmental profile of a product in quantitative terms, using the results of a Life Cycle Assessment (LCA) study. In contrast with ISO-type I labels, EPD have no selection criteria nor hurdle thresholds to respect. This means that EPD are non-judgemental labels and any product can be certified with them. Consumers make their choices by comparing two EPD of two products.

Since by definition of the label, EPD must refer to the precise product and exact manufacturing process used, the environmental impacts associated with electricity consumption are explicitly shown. As a consequence, for all those products with a significant impact coming from the use of electricity, this information scheme allows the benefits of RES-E use to be explicitly shown.

In Sweden, an EPD certification system was established in December 1999. As of December 2002, 74 products of all types (ranging from sawn timber to refrigerators and washing machines) have been certified with an EPD and other 77 certifications are in progress. More specifically, as far as electricity production is concerned, both Swedish utilities Vattenfall and Sydkraft actively use EPD for their environmental communication to business clients. So far, electricity produced by 2 hydro, 1 wind and 2 nuclear plants has been certified.

Example: The 100% Green Energy Label in Italy for RES-E buyers

In 2001, the label 100% Green Energy was launched in Italy. On the one hand, this label certifies that the electricity sold by a certain producer is 100% derived from RE sources and therefore does not differ from others in Europe in this respect. On the other hand however, its most innovative aspect is that the label can also be awarded to buyers of RES-E, who use it for product-specific environmental communication to their own customers. This applies both to total consumers (i.e. buying 100% of their electricity consumption from renewable sources) as well as to partial consumers (i.e. buying a certain amount of electricity needed to manufacture a certain product or to provide a certain service).

The label can also be used by public administrations for their communication to stakeholders, within initiatives of green public procurement (see below). In this context very recently, the administration of the Regione Toscana has been labelled for its whole electricity consumption of almost 6 GWh/year.

100% energia verde

Figure 7 summarises the main actions and information tools aimed at fostering RES-E demand either directly or indirectly, i.e. involving business-to-consumer or business-to-business communication. As shown in the figure, utilities or other subjects producing and/or selling RES-E to end-consumers should address them by means of a standard green label on RE electricity widely known and recognised in Europe (see the example of EUGENE (11) in the figure). Upstream business-to-business communication between producers and distributors/traders might be further supported by the use of EPD's.

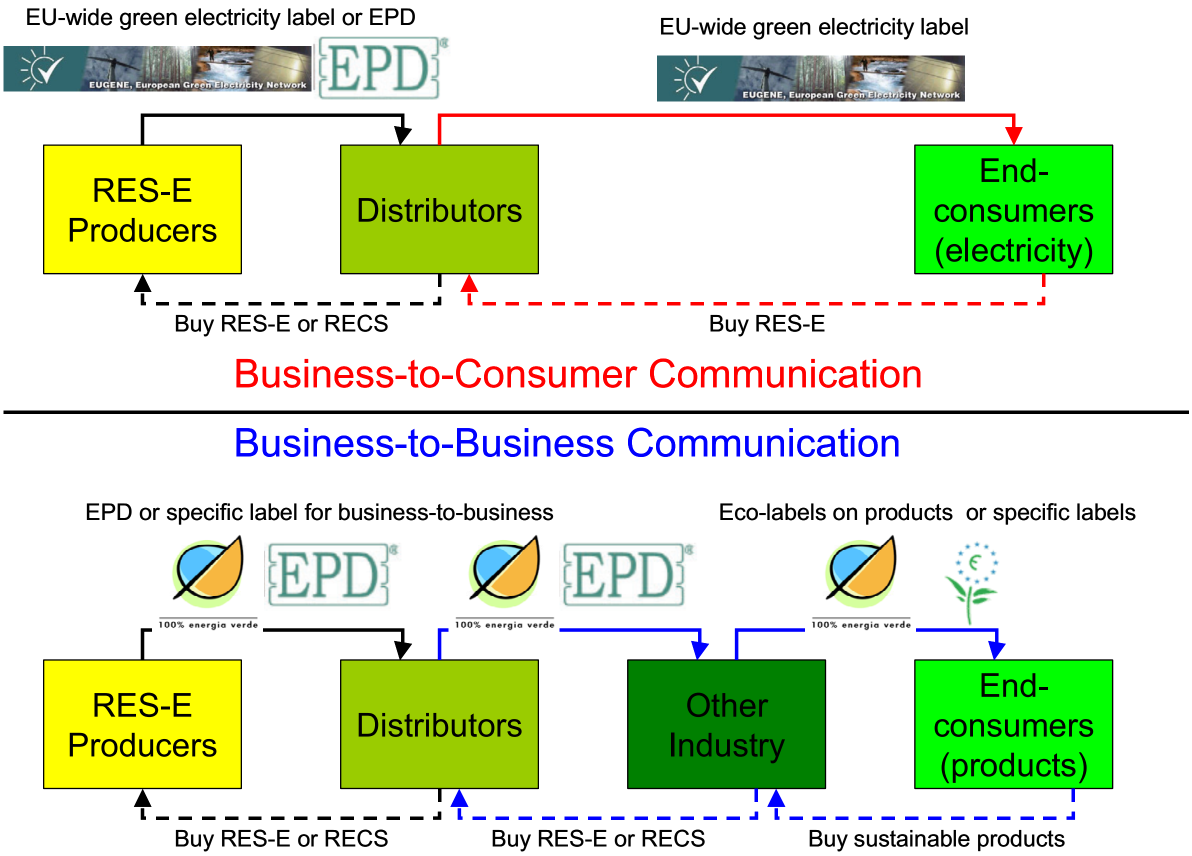


Figure 7: Labels on RES-E for business-to-consumer (top) and business-to-business (bottom) communication.

In the second case, business-to-business information is ensured and guaranteed by the use of EPD's and/or dedicated labels. The latter can then be used by manufacturing industry to inform their end-consumers. Another possibility is that criteria of the EU eco-label include the use of RES-E during manufacturing. This already happens for the European eco-label on tourist accommodations.

(11) The association EUGENE (European Green Electricity Network) was officially founded in 2002 by WWF European Policy Office, Ok Power label, Swiss Naturemade, and Adena (European Consumer Association), with the objective of promoting RE diffusion and creating an international standard for the certification of green electricity.

4.2 INTERVENTION AREA II: IMPROVE TECHNO-ECONOMIC PERFORMANCE

by Stefan Nowak, Marcel Gutschner, Giordano Favaro

4.2.1 Critical issues with current technology development

RES-E technologies have progressed considerably in recent decades through research, development and demonstration (RD&D), as well as market experience. Market deployment and stimulation for these technologies are becoming more important. Yet, further increasing the performance of RES-E technologies and, subsequently, accelerating the RES-E markets also depend on enhancing the quality of the structure and framework of technology development and market deployment. A few critical issues can be highlighted in a broader context without any pretence of exhaustiveness:

Research & Development (R&D) needs a strong long-term policy focused on cleaner and competitive energy system solutions in order to exploit the different market opportunities. The lack of sustained and efficient R&D could lead to accumulated under-investment and decreased progress rates in the medium to long term. Moreover, it could hamper the competitiveness of RES-E technologies and their sectors with respect to conventional technologies.

The existing power delivery grid has grown over more than a century and contributed to economic growth. The **grid** and **RE systems face integration challenges** and should be adapted to future needs. On the supply side, there is a clear trend towards distributed generation (DG), partly due to an increasing share of RES-E. On the demand side, the digital society and economy ask for new services and different quality. Furthermore, deregulation and liberalisation of the electricity markets may lead to less investment in the basic infrastructure.

The **approach of a technology push towards bulk power generation ignores** the enhanced **values** and markets of green electric services and uses. Such an approach might seek targets that are beyond any “useful” horizon and does not take sufficient advantage of sustained business opportunities.

Technology development is a growing defy which can hardly be best handled in an individual or mono-sectorial fashion. There is a risk that appropriate synergies in the public and private sector are not realised due to **research fragmentation** and **poor awareness** about RES-E technologies and their opportunities. Thus, competence, investments and benefits are not made available for developing technologies and markets, ultimately resulting in a lower level of technological and commercial development.

Another set of barriers must be addressed by making choices and setting the right priorities. Basically, a wide range of technology areas need development and can achieve improvements. The challenge is in allocating the resources to developments that are not only a success in the laboratory world but effectively contribute to increased **functionality** and system value of RES-E technologies.

Experience shows that technology development and market deployment are strongly interlinked and commonly presented in a virtuous cycle (see Figure 8) consisting of a technology and market cycle.

Technology development results in new, improved and/or cheaper products. These products can be deployed in the markets meeting the needs of more and new customers. Greater sales allow for higher production volumes and greater use allows for more feedback to the technology development. Thus the (manufacturing) industry, located in the converging area of the two cycles, can benefit in two aspects: from increased sales on the market and from progress in technology development. The two cycles reinforce each other and build a virtuous cycle. The key lesson learnt is that there are positive and reinforcing **technology – industry – market relationships**. By stimulating both the technology and market cycle, policies achieve sustained RES-E market acceleration.

From a technology perspective, the embedded potential in technology – industry – market relationships with regards to **improving the techno-economic performance of RE systems** can be exploited to achieve three main targets:

- Reduction of system **cost**: the system delivers the service *cheaper*;
- Increase of system **performance**: the system delivers the service *more efficiently*;
- Enhancement of the system **applicability**: the system can deliver *new* services.

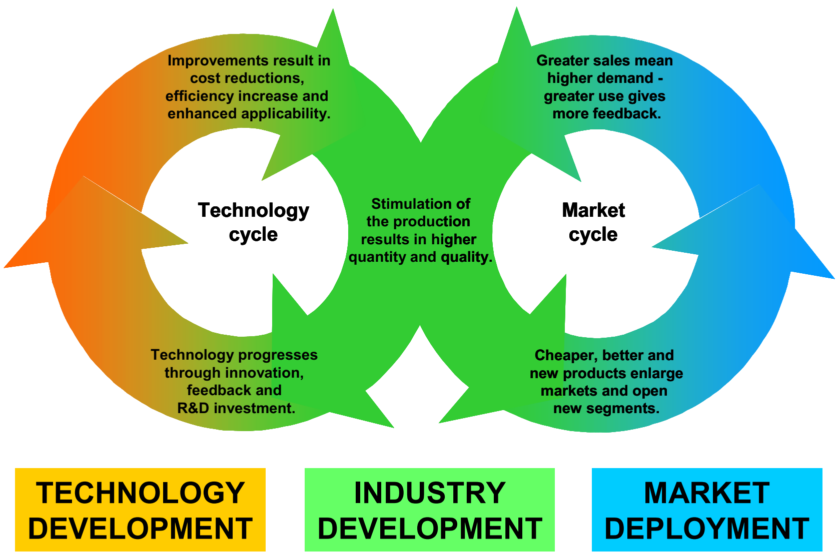


Figure 8: Virtuous cycle of technology-industry-market relationships.

By improving the techno-economic performance, the competitiveness of RES-E technologies and subsequently the acceleration RES-E markets are fostered. As costs play a crucial role in the context of creating and expanding markets, the underlying basic techno-economic mechanisms with respect to reducing costs are considered first.

Observations generally show a) that cost reduction opportunities vary greatly from one RES-E technology to another and b) that the more expensive the RES-E technologies (components and systems) are today, the larger the cost reduction potential should be. Regarding the technology development, we identify five types of interrelated **cost reduction pathways** ultimately contributing to strengthen RE technologies and augment their competitiveness:

- **Progress through R&D**, i.e. improvements related to materials, processes, designs and products leading to cost reductions;

- **Economy of scale I – upscaling of manufacturing volume**, i.e. decrease of manufacturing costs that occur either through higher manufacturing volumes or larger manufacturing plants and platforms;
- **Economy of scale II – upscaling of components size,** i.e. decrease of generator costs that occur by upscaling the size of a module or turbine unit;
- **Economy of scale III – upscaling power plant size**, i.e. decrease of energy generation costs that derives from the progressive increase of the power plant size (for some specific technologies);
- **Economy of scope**, i.e. improvements that occur through co-operative efforts and synergies among different entities possibly at different stages of the RE value chain and through the use of common infrastructures, i.e. for research activities, manufacturing, marketing, etc.

In order to exploit the opportunities represented by cost reduction possibilities, enhanced performance and applicability within the virtuous cycle, **five key issues** (R&D, system orientation, grid, market, synergies) are identified as crucial from a technology perspective. This is part of an effective strategy to improve the techno-economic performance of a RE system and, finally, to contribute to RES-E market acceleration.

The five key issues can be subdivided into two basic perspectives related to technology development improving the techno-economic performance. Both system orientation and synergistic opportunities are highly relevant all along the value chain and focus on important issues dealing with processes and approaches of how to develop technologies. The other three issues – R&D, grid and markets – have a predominantly thematic perspective focusing on what technology options are to be selected and developed.

1. **Research & Development** contributes to technology development and improvement. It should be based on a long-term strategy that emphasises continuity and is oriented towards current and future energy systems and markets.
2. Efforts must be deployed in a **system oriented approach** so that highly functional and valuable system solutions are developed rather than primarily components, by taking into account the structure of power generation and distribution as well as the manufacturing industry.
3. **Grid integration** issues are critical, especially if one envisages a significant increase of the RE electricity share. The mechanisms that regulate grid integration – connection, management and capabilities – must occur in a way that facilitates RE integration, thanks to clear procedures and adapted infrastructure and tools.
4. The development of market competitive **products and applications** is the primary goal of the technology development process. It should reflect a market-oriented (as opposed to technology-driven) approach, which considers customers' and society's needs and choices and attributes the most competitive applications with the greatest probability to initiate and sustain virtuous technology-market dynamics. Creating and exploiting niche markets opens new opportunities for reliable, but yet expensive RES-E technologies.
5. **Synergy opportunities** should be appropriately fostered in every RES-E field and in the whole RE value chain in order to combine efforts, optimise the use of resources and exploit common (technical, financial and communication) infrastructure. Innovation performance can be improved and considerable economies of scale and scope can be developed through this mechanism.

4.2.2 Research & Development

4.2.2.1 Rationale

It is generally not questioned that a) investments in R&D are needed, b) that each technology requests a different level and type of support and c) that, in general, future opportunities are realised based on present and continuous activities. The issue is to find ways to improve R&D and to maintain or increase the investment in R&D in order to accelerate RES-E markets in an effective fashion. That is, by developing technologies that a) cost less, b) perform better and c) can be used for new applications.

R&D involves a large number of aspects, which span from fundamental research in feedstock, materials, processes and designs to the product demonstration activities that occur just before the market introduction. Although RES-E technologies present different characteristics and qualities (e.g. technical performance and "maturity", different applications and markets), and that these must be individually addressed in R&D activities and programming, some key elements are common and merit attention in a cross-technology way.

Action II.1:

Provide continuity and long term strategy for R&D

Clear objectives within a long-term strategy must be set for R&D activities and programmes. R&D should be a continuous process that exploits learning dynamics by doing and searching as opposed to a punctuated one with several interruptions. The latter are known to cause inefficiency, insecurity, the risk of partners stepping out and, ultimately, lead to "forgetting by not doing", i.e. the loss of expertise, skills and related infrastructure.

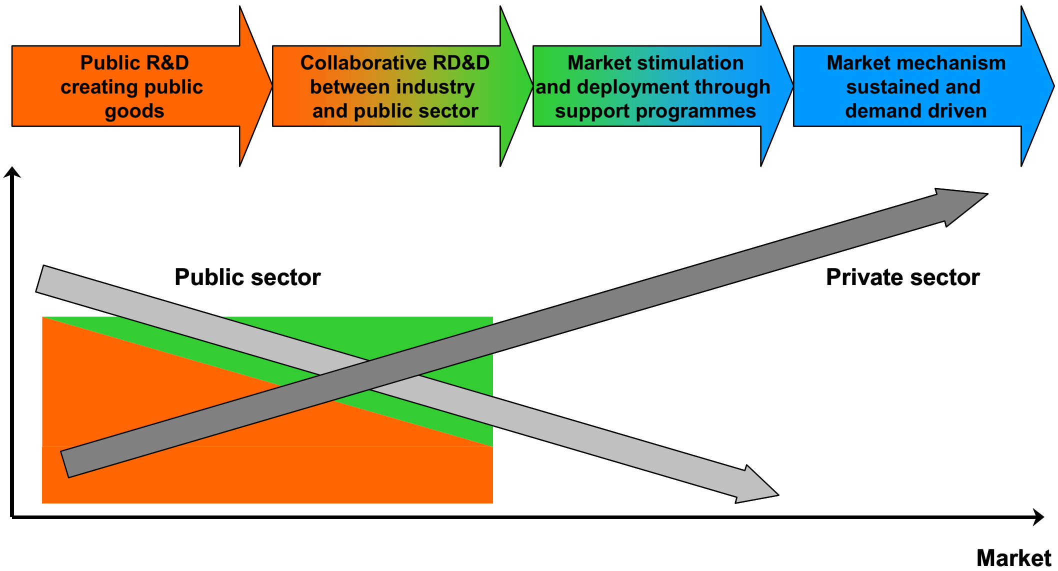


Figure 9: R&D investments and the roles of the public and private sector on the way to markets ([12]).

(12) The public sector is more involved in the early phases of technology R&D (red semitransparent area) whereas the private (industry) sector invests more in R&D (green semitransparent) the closer technology developments are to marketability. In implementing a market-oriented approach, the financial involvement from the government can be limited and phased out earlier due to the fact that industry and markets are more willing to provide the learning investments needed. Further issues and examples can be found in the section about the key issue "synergy opportunities".

The public sector should – besides supporting and stimulating industry in their commitment to short-medium term R&D – strengthen their efforts for mid- and long term R&D as this is still fundamental to guaranteeing further techno-economic improvements and a strong market deployment of RES-E. Traditionally, the public sector and non profit research institutes are strongly involved on the level of fundamental R&D. Private business organisations reach a higher level of involvement for activities that are closer to the final market applications of the technologies researched thus – in general terms – the industry and the private sector have an intrinsic interest in providing R&D resources for developments that are closer to market application in the short or medium term. It is thus important to have a good balance of investments in order to fully exploit the strategic value of R&D in RE.

Skills and interests of these stakeholders from the public and private sector are complementary. Their efforts should be collaborative by developing **synergies** ([13]) between the public and the private sector, so that R&D can optimally capitalise on their experience and strengths and work towards market-oriented results.

Action II.2:

Orient R&D towards markets

Applied R&D must be oriented towards the development of truly marketable products and functional **systems** ([14]) that can successfully respond to real user needs. Towards this end, R&D activities should receive early feedback from the market so as to improve products and applications before the beginning of a mass manufacturing effort. R&D activities should therefore contribute by creating a strong manufacturing sector that produces highly competitive products for a growing RES-E market. Once this is achieved, the industry can maintain competence while increasing efforts to develop effective marketing initiatives and to attack new market segments.

Governments can play an important role in this process and in industry involvement. Firstly, output (know-how and technologies) of the public R&D should be input for industry R&D, otherwise it gets stranded. Secondly, public R&D spending can second industry R&D in the pre-competitive phases. And thirdly, market deployment measures may incite industry risk (even more) investment. Furthermore, governments can implement adequate industrial policies that take into account technology-specific industry structures (multinational companies and SMEs) and their corresponding capacities for participation in R&D activities and programmes.

Playing this role in industry involvement and market orientation means bringing up some efforts but the overall public R&D (spending) is better invested ([15]) as more learning investments – needed to bring a technology globally closer to a competitive level predefined by conventional alternatives – are made available by the industry and other players in the niche markets. This, in general terms, accelerates the virtuous cycle stimulating both the technology and market cycles as well as the industry R&D and manufacturing in the converging field.

(13) Learning investment should not be confused with R&D investment. Learning investment (within the concept of learning curves) are the additional costs for the technology compared with the cost of the same service from technologies which the market presently considers cost-efficient. Industry R&D investment can be considered as being part of learning investment but is subject to theoretical definition and to practical difficulty in assessing accurate figures (see also IEA, Experience Curves for Energy Technology Policy, Paris, 2000).

(14) R&D activities should lead to energy system solutions, i.e. not primarily focused on maximising the technical performance of a singular component. This might turn out very costly and contribute only little to the improvement of a system with respect to techno-economic performance, the truly relevant issue for grid integration and market deployment. Further issues and examples can be found in the section about the key issue "system orientation".

(15) In terms of higher multiplier effect and higher learning investments triggered.

Stakeholders and timeframe: Both the public and private sector are strongly involved in R&D, although at variable levels. Two main stakeholder groups are identified as the primary responsible or the main beneficiaries of the actions suggested, namely: research communities and industry. R&D in general should be continuous with appropriate sequencing of different activities in the technology development chain according to short-, medium- and long term issues.

RTD and R&D programming must be properly managed, organised and structured. Controlling, information and communication are issues which can be strengthened in this context.

Example: Photovoltaic Manufacturing Technology (PVMaT)

PVMaT – started in 1991 – is a research and development partnership between the U.S. Department of Energy (DOE) and members of the U.S. PV industry. It is designed to help U.S. industry:

- improve PV manufacturing processes and equipment;
- accelerate manufacturing cost reductions for PV modules, balance-of-systems components, and integrated systems;
- increase commercial product performance and reliability; and
- enhance the investment opportunities for substantially scaling up U.S. manufacturing capacity and increasing U.S. market share.

Industry participants are selected through competitive procurement. The solicitations are generally open to all companies that believe they can perform manufacturing R&D related to photovoltaics. PVMaT partnerships have helped the U.S. PV industry accomplish several goals (mentioned above) since its inception. The effects and results of the investments provided by the public and private sector are analysed with respect to investment recovery and funding recapture expressed in terms of public benefits and company profits (www.nrel.gov/pvmat).

4.2.3 System orientation

4.2.3.1 Rationale

Given a limited amount of resources available, focus should be on the functionality of the components to be developed. High value and functionality must be assessed on the basis of the techno-economic performance increase as well as the (added) value to the whole system. Technology development must consequently fit into the techno-economic structure shaped by the manufacturing industry, grid and markets. Special attention must be paid to two attractive but partly hazardous factors: Firstly, highest efficiency of a single component does not mean inducing best additional value to a system. Secondly, least cost approach may be based on too narrow a view. It may turn out more efficient to invest in more expensive technology (components) that ultimately presents a higher value to the whole system. On the components level, storage components can be costly and render power generation more expensive. The benefits for the system (dispatchability) may however result in higher profits thanks to the higher tariffs applied and prices paid (see example below). On a system level, the integration of presumably more expensive RE technologies may create additional load capacities preventing the micro-grid operators from over-investing in base load technologies.

It must be admitted that the task of balancing present costs and future benefits is not easy, but is nevertheless indispensable within a system view. A system oriented approach would encourage designers to look concurrently at different components of a system and how they interact, rather than individual equipment or fixtures. Each system can be designed to achieve greater efficiency as a whole, rather than as a collection of components.

From the market and commercialisation perspective, marketing and technology improvement efforts must be directed *first* to RE systems and segments ([16]) that are closer to self sustained competitiveness. Connected to this, components can increase the value of a RE system with respect to grid management and capabilities by providing additional storage capacities.

Action II.3:

Assure energy system orientation in techno-economic development

A clear system approach focuses on functionality of techno-economic improvements. Technology development must provide progress for new, improved and useful energy systems, with respect to the structure of power generation and distribution and the manufacturing industry. Efforts must be deployed in a system oriented approach so that system solutions with improved techno-economic performance are developed and not components that may turn out super-efficient in the lab, but too complicated for the manufacturing and the markets. This, finally, deals with an efficient allocation of resources available in order to yield maximum improvements on the system level.

Stakeholders and timeframe: The system oriented approach should be applied in each phase of technology development and all along the value chain from R&D to end users with right timing. Thus a wide range of stakeholders groups are involved, above all the research community, industry and project developers.

Example: Enhancing the value of a CSP system through thermal storage

Components and systems should be designed for products adapted to the market reality and opportunities. The development of components and systems should take advantage of enhancing the value of a system through improving availability and performance (e.g. back-up and storage systems).

The molten salt storage system showed good results and the concept of thermal storage could be applied and further enhanced for concentrating solar power systems (CSP). Thermal storage improves dispatchability and marketability of solar thermal power plants, allowing them to produce electricity on demand, independent of solar collection. Furthermore, thermal storage gives the CSP plant designer freedom to develop a power plant with a wide range of capacity factors to meet the need of the utility grid. This increases the value and competitiveness of concentrating solar power plants through dispatchability, better economic utilisation of the turbine and other equipment as well as improved overall performance. Furthermore, improvements lead to a generally lower level of power generation costs.

(16) Further issues and examples can be found in the section about the key aspect “market”.

Example: Energy system and mini-grid for rural electrification (17)

By incorporating different RETs in a mini-grid, the overall value of the energy system can be substantially increased due to higher flexibility (e.g. dispatchability) and reliability. Different RETs can complete base load plants such as small hydro power, biomass or even diesel generators. For isolated mini grids, energy storage devices such as batteries or pumped water storage can enhance the value and functionality of the whole power supply system. The structure and portfolio of such a system strongly depends on the natural resources available and the local needs. A system mainly consisting of small hydro, wind and solar PV plants can be particularly well adapted to remote mountainous regions. Modest energy consumption rates in such a region magnify social and local benefits triggered by a combined renewable power supply system.

4.2.4 Grid integration

4.2.4.1 Rationale

One of the obstacles that would seriously prevent a truly large scale diffusion of RE systems is the fact that their rather decentralised, partly intermittent and non-dispatchable nature present new challenges for the grid integration. Accordingly, a sound RE deployment strategy should address this critical issue. Such a strategy should aim at easing grid interconnection, at facilitating the RES integration and at adapting the systems to the requirements of distributed generation (DG). This can be done, for instance, by improving controlling and monitoring devices, essential both for the proper functioning of the single systems and for the reliability of the entire grid.

<u>Action II.4:</u>

Address critical issues in grid integration

There is a trend towards an open-access grid due to changing conditions and features in the field of technology, markets and legislation. These are basically positive signs and present opportunities for RES-E. However, *grid connection* often fails for technical and non-technical reasons because, for instance, technical and administrative regulations are missing or not adapted for different levels and sectors concerned in grid connection issues. In a broader sense, grid extension can also be considered as a particular grid connection issue that merits special attention.

Grid management and capabilities do not only need improvements for a higher RES-E penetration but also in order to respond to the different demand patterns and requirements of the power delivery system that arises from the digital economy advent. Appropriate grid management needs enhanced control tools in order to guarantee adequate power quality, safety and security in a decentralised structure.

(17) Rural electrification is not a main issue for EU right now, but it will turn out to be important with the EU extension in the forthcoming EU-25.

Storage (18) is an issue of prime importance for improving capabilities of both the grid and a singular RES power installation. With respect to a larger RES-E share and matching of supply and demand, storage technologies are likely to become a key issue in the medium term.

Matching supply and demand bears both challenges (e.g. intermittent production) and opportunities (e.g. peak power) for RES-E. Finally, one should not forget that decentralised RES power generation can provide benefits for the utility operations especially in weak grids, thus offering directly exploitable opportunities and benefits.

Stakeholders and timeframe: The actions suggested to enhance grid integration potential of RE systems involve three main stakeholders, namely utilities, electro-technical commissions and their international associations (e.g.: at European level with EURELECTRIC and CENELEC), as well as national energy agencies for guidelines addressed to local decision makers and stakeholders. The feasibility of actions proposed varies greatly. Whereas the promotion of codes and standards for grid connection and the grid extension can be implemented in the short term, actions aimed at improving grid management can be deployed only in the medium to long term. Given the complexity of the phenomena, on hand effects are expected to be visible only in the medium to long term.

Example: Technical and non-technical standards and codes for grid connection

Despite the trend towards an open-access grid, grid connection often fails on a local utility level for technical and non-technical reasons. It is therefore important to advocate clear and compelling (inter)national regulations that clarify the situation (technical requirements, roles and responsibilities, etc.) for the producer and grid operator. Furthermore, the development and dissemination of “easy-to-understand” guidelines can facilitate procedures for both project developers and grid operators.

Example: Developing new tools for improved grid management and capabilities

Grid management is becoming more complex and can be facilitated by power flow control and power electronic devices (e.g. electromagnetic power technology). On the level of RES-E plants, optimisation and improvements should be realised by means of, for instance, storage capabilities, power electronic converters and tools for power control and load prediction.

4.2.5 Products and applications for markets

4.2.5.1 Rationale

The marketability of RE systems and products has to be assessed not only with respect to the mere cost per unit of energy produced, but also in terms of the potential applications of the technologies and of their perceived value for end-users. The liberalisation of electricity markets and the

(18) See also example “Enhancing the value of a (CSP) system through (thermal) storage”.

establishment of green power markets are likely to reinforce the perception that electricity is not just a commodity, but a true consumer product that is valued in a different manner by different categories of customers. Strong trends and features of RES-E and DG are that end-users do not only buy kWh but possibly systems and/or services. This changes traditional patterns and brings about new types of customers, service providers and operators.

Another important feature of RE technologies is that they are neither globally cost-effective nor globally non-competitive. Conversely, their competitiveness has to be assessed on a local basis, after considering the characteristics of the specific market segments in which they operate. The diffusion of RE systems could be strongly enhanced if appropriate market deployment strategies were followed, aimed at creating a virtuous RE cycle. This virtuous cycle would take place when an initial RE penetration in a particular niche spurs enough productivity increases at the manufacturing level to significantly reduce cost and further accelerate market diffusion in larger sectors. Needless to say, to achieve this goal, technology and marketing improvement efforts must be directed *first* to those segments where RE systems are closer to self sustained competitiveness. In further sequences, they should then gradually approach the other segments, as soon as economies of scale and learning by doing render the technologies more competitive in these new sectors and, gradually bring them to a more globally commercial status. This phased approach would also incite the private sector to contribute to the RE learning investments, thereby helping the systems reach full competitiveness more rapidly.

Action II.5:

Develop segment-oriented deployment strategies

Diversification and differentiation of products to deliver the most competitive applications to the most appropriate segments help build successful technology-market relations. RE systems should be diversified and optimised based on the following segmentation:

- Products for *niche markets*, where the high cost is offset by the high value delivered (e.g. solar powered parking metres).
- Products for *multifunctional/multipurpose use*, where the electricity generating device performs other beneficial functions or profit from synergies with a particularly convenient "host system" (e.g. power from organic waste incineration, building integrated photovoltaics).
- Products for *large markets*, where displaying a competitive price versus large capacity installations is a primary concern (e.g. wind in highly suitable sites, biomass in co-firing and/or heat and power production, geothermal power through combined cycles).

Diversification implies also the full exploitation of the different market opportunities. The *refurbishment and the renovation* of older power plants represent a great potential in niche market segments. Attention should also be paid to the *operation & maintenance* (O&M) issue, in order to prevent the premature abandonment of power plants.

Stakeholders and timeframe: There are many stakeholder groups concerned for the segment-phased deployment strategy, mainly industry, utilities, and various groups of (potential) final users. This type of strategy implies that fully competitive and highly valuable products are developed and marketed in order to incite the private sector to contribute to the RE learning investments.

Example: Explore SHP project opportunities adapted to market reality

Multipurpose small hydro power (SHP) project

Dams and weirs can be built for e.g. flood control, irrigation, drinking water supply, etc. Potential exists to adapt these sites to multipurpose small hydro power projects. It is important to disseminate information on the multifunctional use of small hydro power in order to take advantage of the untapped market opportunity, particularly with drinking water supply, waste water "supply" and irrigation.

Renovation, upgrading and maintenance of old/shut down SHP systems

Mostly smaller hydro power plants were built to drive local industrial activities. Many of them have been shut down because they lack competitiveness, expertise or will. New schemes of plant design and systems, as well as of markets, make the revitalisation and refurbishment of these plants interesting. An effort must also be made at the environmental level (fish protection, residual flow, noise reduction) in order to improve the social acceptance of such projects.

4.2.6 Synergy opportunities

4.2.6.1 Rationale

RES-E generation and hardware manufacturing are increasingly interrelated with other sectors and industries. Instead of "re-inventing" solutions, traditional know-how in mainstream industries can be used for new applications in the field of RES-E.

Synergies with other industry should be fostered along the whole value chain, i.e. for research activities, manufacturing, marketing, etc. in order to join efforts and use common infrastructure. It can be expected that bringing together different stakeholders, sectors, know-how and skills will result in enhancing technology through highly innovative applications, increased productivity and, finally, reduced costs by exploiting economies of scale and scope.

Action II.6:

Explore benefits from synergy opportunities between different stakeholders

More synergies can be identified and developed both within the same business area and between different industries. Promising market prospects trigger such partnerships and co-operation. This can be supported by bringing together the different stakeholders by means of fora, platforms and networks, by stimulating intra- and inter-sectorial exchanges as well as by linking and aligning technology, industry and market policies.

Furthermore, cluster requirements and cross-fertilisation opportunities can be defined for each technology and its related sectors. To favour cross fertilisation it would be of particular importance that "other" mainstream industries with their know-how and their products enter the RES-E technology business, despite the fact that they may not yet perceive it as particularly profitable.

Stakeholders and timeframe: Synergies can be used in each phase of technology development and all along the value chain from R&D to service packages for end-users, within intra- or inter-sectorial networks and clustering. Therefore a wide range of stakeholders groups are basically concerned, with some focus on the research community and managers of (inter-) national technology programmes, as well as industry, both in the RES-E sector and other mainstream industries. Efforts in this perspective should start immediately.

Example: Bundling efforts for building-integrated photovoltaic systems

An example for bundling efforts for product development, manufacturing and commercialisation including different sectors is building integrated photovoltaics where the mainstream industries like electronics and glass are part of the technology called PV and where furthermore the building industry should join the technology sector in order to develop products that can be perfectly integrated into the building industry value chain and in the building itself.

Example: Adapted materials from other mainstream industries

Materials should be properly developed to achieve high techno-physical quality at low cost, like plastics for light weight or anticorrosive components or glass for solar applications. Special emphasis must be placed on materials coming from other mainstream industries and on enhancing the functionality (availability and practicability) of materials with respect to feedstock and processes.

Research into the use of newly adapted low-cost materials is required for small hydro power plant applications. Some possibilities include rapid machining steels with good characteristics for cavitations and/or sand erosion, materials such as ceramics to protect sensitive areas against erosion, low-cost machine components made out of plastic, glass-fibre, etc.

Example: Enhanced management of bio-fuel systems

Ambitious bio-power targets – as those set by the EU directive – need enhanced management of bio-fuel and systems including waste, residues, existing and new energy crops as well as adequate logistics for storage and distribution of the bio-fuel. Besides the feedstock (fuel) issue, biopower RTD programming here deals with a particularly heterogeneous technology area comprising mature and new generation based on different approaches and fuels. The advanced management of the bio-power life cycle requires the involvement of several sectors (research, industry, forestry and agriculture, etc.) that are directly and indirectly affected by transforming biomass into power and thus part of the value chain. It basically offers manifold opportunities to a wide range of stakeholders but the process could experience difficulty in aligning the resources that have to come – by nature of this business – from different policy fields and market segments.

4.3 INTERVENTION AREA III: IMPROVE THE IMPACT OF POLICIES

by Annemarije Kooijman-van Dijk

4.3.1 Problems with current policies

REMAC envisages that in twenty years time, the market for renewable energy will be completely demand driven. Within a benign regulatory framework, renewable energy can be independent from government financial support and able to face competition in an open energy market. Until that time, however, additional policy support is still necessary, to improve the technologies and to bring RE supply and demand to a level of maturity at which the sector can compete on a level market.

Over the years, many different policies have been developed and implemented to stimulate renewable energy. Not surprisingly the instruments proposed differ greatly from each other: they serve different national priorities, they need to fit in the existing legal and policy framework, and they are generally influenced by the role of national stakeholders. All in all, it can be stated that there is no one best policy instrument or set of policy instruments.

However, whichever route a government may choose towards the envisioned mature market for renewable energy, it is essential that the policies and the policy framework work in the same direction, and that the final destination is clearly signposted. Experience shows that such a broad perspective is often not taken into account when policy packages are designed. In fact, the short term perspective of policies, the lack of consistency between policy fields and levels of authority and the lack of co-ordination between countries, have formed a major barrier to the implementation of renewable energy technologies. The following issues have been specifically identified as key bottlenecks to the impact of renewable energy support.

- Lack of *security* for investors in RE: given the transitional nature of any financial support, providing an appropriate level of security is key to limiting the financial risk associated with RE investments.
- Lack of *consistency* of policies at the national level.
- Lack of *co-ordination* between countries to prepare a market for international trading of green electricity or green certificates ([19]).

In order to achieve solid growth of the renewable energy sector, the current perspective of policy makers and planners needs to be broadened to include these three aspects; a longer time frame, a comprehensive view of the related policy fields and authorities involved, and an orientation that looks further than the national borders. A Road Map for the renewable energy sector must therefore include actions to improve the impact of policies on these points.

The following paragraphs examine these recommendations in more detail: policies and regulations that hinder the development of the renewable energy market should at least be adapted, consistent and continuous signals should be given as to where it is that we want to go, and how we plan to get there.

(19) Green certificates can be used to facilitate trade in electricity generated by renewable sources. The certificates are used to accredit and monitor the production, sales and 'consumption' of the 'green quality' of electricity produced by renewable sources (see also section 4.1.2).

4.3.2 Security for investors

4.3.2.1 Providing security for investors in a long term perspective

The realisation of the growth of the renewable energy market is, finally, in the hands of individual investors who make investment decisions on individual projects. Typically, these investors make a feasibility analysis of the investment in which risks are assessed. Of course, every investment entails certain risks. For renewable energy these risks may be higher than for conventional energy investments. There are extra technological risks related to the innovative nature of the technology, market risks related to the price and demand for the energy product, but there are also policy risks related to the financial support that may or may not be available. Whereas most policy instruments are aimed at (partial) compensation for the technology and market risks, they often form a risk in themselves due to policy uncertainty.

Maximum security against technology and market risks is not necessarily the objective of policies aimed at the stimulation of the renewable energy sector, but unnecessary policy risks should be avoided. The nature of policy risks is first discussed in general below. A more detailed analysis is then developed about what kind of risks can be covered by different types of policy instruments and which risks cannot.

Policy uncertainty

Before an investment decision is made, investors need to assess with a reasonable degree of certainty how much financial support will be available for the project on hand for its entire duration. Risks created by policies are related to insecurity of project implementation that follows from inconsistency between policy fields or authorities, or to insecurity about the continuity of policy. Insecurity follows directly from inconsistency, as inconsistency causes decision making about projects to be highly dependent on local and project-specific circumstances ([20]). Risks concerning continuity of policies follow from a lack of *foresight* by investors into policy changes.

The adaptation of policy instruments or policy support levels alone does not create a policy risk, although it will impact technology and market risks. Policy support is by definition prone to adaptations over time- because it follows technology and sector development, and also because government support is a political issue. A certain level of continuity of policy, however, with sufficient insight into changes, is necessary to reduce risks for investors and to stimulate the development of the sector as a whole.

For the development of the sector avoiding policy uncertainty is even more important than for individual investment projects. The development of the sector is more than the sum of individual investment projects, namely: establishment of strong market players, improvement of technology and project organisation and legal embedding. Therefore, for sector development security on individual projects is not sufficient, but insight into future developments on a long term is necessary.

(20) Issues related to inconsistency of policies at national level are discussed in more detail in section 4.3.3.

How much security do different policy instruments offer?

Strategies to enhance the development of the renewable energy sector generally involve a gradual imposing of risks on the investors as technologies develop from innovative niche products into mature energy production facilities. We assume that in twenty years time, the market for renewable energy will be demand driven (except for a number of innovative technologies), and independent from direct financial support from governments. This assumption means that all financial support instruments are transitional.

How much security do different policy instruments offer?

Taking a closer look at the range of different policy instruments that have been used and are being used to stimulate the implementation of renewable energy technologies we can see that they target different sectors of the RE 'value chain'. The level of security that an instrument can provide depends partially on the targeted stage in the value chain and partially on the characteristics of the instrument itself. In general, of course, the higher the level of support, the higher the security against technical and market risks, but the higher the risks associated with policy continuity and the available budgets.

Financial support on *investment* delivers maximum security at the project level. The financial support (in the form of grants, subsidies, tax reductions) is granted at the beginning of operation, and it is independent of the operation itself. This means that both technical risks and market risks are covered. So are policy risks, once a project has received the support. However, these support schemes are typically very vulnerable to (annual) adaptations. Regular reviews of supported technologies and levels of support are common, partly to adapt to changed insights, market and technical developments, but also often due to budget limitations or changed political priorities. Precisely because financial support on investment reduces market risks, this instrument category is usually targeted at new technologies with high technical risks that need maximum shelter from market conditions (such as PV).

Support instruments on *operation* reduce the market risks of operation, but do not cover technical risks. Examples are feed-in tariffs, or quota on production with green certificates. These instruments are very different in nature. Feed-in tariffs can be established and designed in many different manners. Tariffs established by government decision provide more security in the project development phase than tariffs established through tenders in a bidding procedure. The design of instruments also largely impacts security of return on investments. The tariffs can be set at a fixed level, or the support can be a fixed premium on top of grey electricity prices. The most popular among investors is the fixed feed-in tariff, as this offers the most security against changing market conditions. An essential aspect of the impact of this kind of support measure is the duration of the income level. Long term certainty, for at least the project economic lifetime, which is commonly 10 years, is necessary. In Germany, the feed-in tariff is fixed for a 20 year period.

Support instruments targeting the *demand* for green energy reduce only part of the market risks and do not provide security against technical risks. The demand for green energy can be stimulated in several ways: decreasing the price difference with grey electricity, increasing the (perceived) value of the green energy product, or setting a target that may or may not be obligatory. Examples of instruments that target demand in these ways are respectively:

- a 'greening of the energy taxation' making non-renewable energy more expensive. 'Green energy taxes' are commonly used in Europe. Depending on the level of the taxes, they stimulate the market for renewable energy, especially of technologies that are close to competitive production, or as an additional instrument. Green taxation generally offers a long term improvement in the market framework, as taxes are only very rarely abolished or reduced.
- decreasing the price of energy from renewable sources.
- awareness and information campaigns that advertise the value of renewable energy, Awareness campaigns have the lowest impact on security of income for renewable energy technology operators. However, this type of instrument does impact the framework within which the renewable energy market develops. Awareness and public support also provide political arguments for policy support, and are therefore beneficial to continuity of policy. Awareness and information also form a basis for the demand-driven renewable energy market which is the expected future.
- agreements or quota on the consumption of renewable energy. Agreements or quota provide more security on market size depending on enforcement However, security on a certain level of *consumption* does not imply either a certain demand or a certain price for individual *producers* of renewable energy. Quota systems with tradable obligations introduce competition between technologies and between plants with lowest production costs. In order to meet demand, green electricity (or its green quality in the form of certificates) may be imported if this is allowed under the policy design. Therefore the security for investors in renewable energy technologies is highest for technologies with lowest production costs, and at the most attractive locations (especially for wind energy) within the market area. Concerning the continuity of the implementation of policy instruments, stimulation of demand is the ideal instrument, as the roles of actors do not change during the process of decreasing the influence of the obligatory demand. The 'supported market' can gradually dissolve into the competitive general electricity market.

4.3.2.2 Actions to create security in a long term perspective

As clarified above, security of investments is impacted by technical, market and policy risks. Different policy instruments offer different levels of security to hedge against these types of risks. There is no such thing as one optimal instrument, because policy instruments and combinations of instruments have to be designed for a specific situation of technology development, market structure, and national political framework. For technologies at different stages of maturity, different policy instruments or conditions are needed to create adequate levels of security.

Considering the fact that support will not be infinite, the highest possible level of security will be provided by a gradually developing set of policies that achieve a balance between security for investors and stimulation to learn to cope with competitive market conditions. Of course such developments should be communicated well in advance.

Such communication is important to maximise foresight into policy developments for individual investors and for the sector as a whole. To ensure a constructive trajectory of policy development, a stable framework with clear long term targets should be established. Such a stable framework consists of regulations and people, the stakeholders with an interest in continuity.

Examples of essential regulations are those for building and operating permits, and conditions for access to the grid. However, the only type of regulation that can really prevent large shifts in strategy or targets within a country is an international agreement. Targets such as set in the EC Directive on Renewable Energy (2001/77/EC) place a pressure on national governments to develop renewable energy policy. However, if such targets were to become obligatory at European level, this would induce a definitive common long term perspective. Whatever the (changing) political priorities of national governments, obligatory targets ensure a minimum level of security for the renewable energy sector.

To optimise security, it is important to cover at the very minimum, the common project lead times plus the economic project duration. Continuity of policy, or even sufficient insight into policy changes, on such a term would generate confidence and reduce anticipation of policy risks for all stakeholders, thereby creating a large impetus for a solid growth towards a mature renewable energy market. For sector development a foresight period of at least 15 to 20 years is necessary.

Besides regulations and targets, a factor of importance in increased stability of policy are stakeholders. Stakeholders are the industrial parties, branch organisations and NGO's who can form a lobby against undesirable policy shifts, but also the general public. In countries with a large public support for renewable energy, it is less likely that governments, at any level, will remove supporting policies.

Based on the above discussion, four main actions can be suggested to improve security aspects of policy instruments.

<u>Action III.1</u>:

Tailor policies to offer an adequate level of security

<u>Policy makers, public authorities and public agencies</u> should design and implement policies tailored to the (developing) state of technology and market so as to ensure the intended level of security to investors. This is an ongoing process. Large technology and market developments require adaptation of instruments. All levels of policy design and execution should be involved to guarantee sufficient contact with implementation and political feasibility. Access to knowledge on current technology and market situation, and insight into future development can be achieved through co-operation with market parties and NGO's.

Example: Tailor quota systems to create markets for different technologies

If renewable energy is stimulated through renewable energy quota which are traded on a competitive basis, higher cost technology options will not be selected for implementation. The definition of technology bands with specific quota ensures a diversification of technologies.

Action III.2:

Communicate policy developments well in advance

Policy makers should set out a clear direction in which policies will develop over time. Anticipating this, public authorities and agencies executing policy developments should communicate plans on policy change well before they come into effect. In order for project developers to be able to anticipate changes, both for new project development and contract adaptations that may be required, a 3 year period is desirable for large changes in eligibility or financial support levels. For sector development, the strategy over a 20 year period should be clear.

Example: Announcing policy changes in advance in Belgium

In Flanders, Belgium, the new support system for renewable energy introduced in 2002 was announced 3 years in advance, so that project developers could anticipate this and make use of the enhanced support as soon as the system came into force.

Action III.3:

Establish supportive international agreements with clear mandatory targets

Policy makers at national and international level should work to establish supportive international agreements with clear mandatory targets for the mid and long term. Taking into account an economic project lifetime of 10 years, and a project lead time of 2-5 years for most technologies, the project development within the coming 10 years will depend on a perspective of developments over two decades. As the total project lifetime is commonly 20 years, a longer foresight period will be beneficial.

Example: New directives at EU level

EU member states should establish a new directive with mandatory targets (with clear sanctions) for renewable energy for 2020 and 2030. Clear uniform definitions are necessary to impose such targets.

Action III.4:

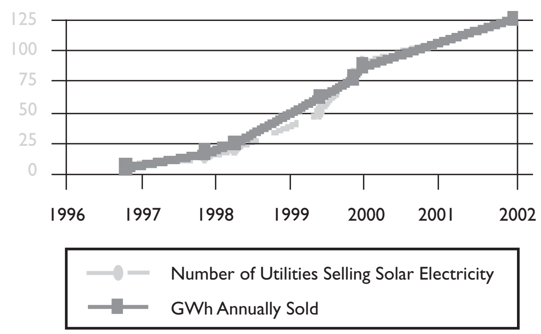
Build a strong stakeholders framework

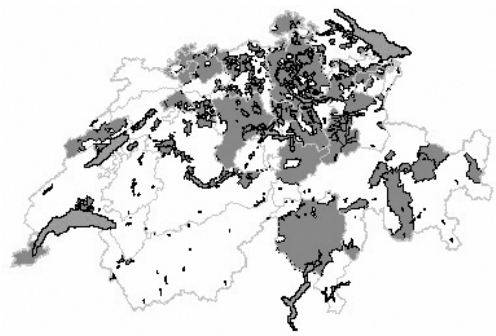
Shaping policy is not a matter of politics or government alone, all stakeholders, ranging from manufacturers of RE technology, to installers, and from research institutes to marketing organisations, should take an active role to promote their common interest in renewable energy. Creation of public awareness, and forming a co-ordinated lobby will help improve consistency and continuity of policies for the stimulation of renewable energy.

Example: Initiative 'Solar Electricity from the Utility' in Switzerland

In the 1990s, different Swiss utilities took up the idea to act as a "solar broker" and to sell solar electricity to their customers. Given the success of this approach, it was subsequently extended towards a national initiative called "Solar Electricity from the Utility" within the National Action Programme *Energy 2000*, and supported by the Swiss Federal Office of Energy and the Swiss Electricity Supply Association (460 members providing 90% of the Swiss electricity supply).

The national initiative "Solar Electricity from the Utility" is a marketing approach, both towards the utilities and their customers. The purpose is to provide utilities with information on a variety of possible financing models (the so-called solar stock exchange being the most famous one) which serve their customers with solar PV electricity. Today's prices per PV solar kWh are between 60 and 90 €¢. The overall goal is to make solar electricity available to all customers in the service territories (electricity market not liberalised) of the (more than 1000) Swiss utilities. The initiative has achieved the following results so far: The number of participating utilities grew from 7 to over 100 between 1997 and 2002, more than half of the population has access to solar electricity from the grid and some 27000 customers have subscribed so far to a total amount of solar electricity of about 5 GWh per year. This "initiative" (still ongoing) can be considered a successful contribution to strengthening and continuing part of the policy actions – many of them focus voluntary measures agreed among the relevant market stakeholders. In this sense, the market also contributes to policy continuity.





Figures: Evolution in time of the solar electricity subscribed within the action "Solar Electricity from the Utility" and the number of utilities providing solar electricity to their customers on the left. On the right, areas in Switzerland where customers can buy solar electricity from their utility. Source: Data compiled through NET Ltd. Switzerland, last update figures per end of 2001 by AEE (http://www.erneuerbar.ch), map from SwissEnergy and Swiss Federal Office of Topography.

Example: Electricity suppliers take the lead in the Netherlands

In the Netherlands, electricity suppliers were given a strong incentive to create public awareness and interest in renewable energy by the design of the liberalisation process. Because the market for renewable energy was opened up before that of grey electricity, renewables now form the main distinguishing element between utilities, and the only product of new suppliers. The electricity suppliers made a great effort to raise customer awareness on renewable energy and affinity with the product. The raised public awareness on renewable energy is expected to support an enhanced level of activities in the field of renewables by electricity suppliers.

4.3.3 Consistency of policy

4.3.3.1 Areas of inconsistency in current policies and policy framework

Inconsistency of policy exists in two forms, namely between policy fields and between authority levels. Both forms inhibit the optimal implementation of renewable energy and sometimes even block renewable energy investments completely.

Lack of consistency between policy fields is related to the nature of renewable energy itself which requires the involvement of several policy fields, and to the fact that renewable energy is a young sector. Therefore, where the implementation of a technology may be stimulated through one particular policy field, it can be involuntarily hampered by another. Examples of this type of inconsistency are commonly observed between energy and environmental policies (see the example under action 2).

The generation of energy through renewable technologies can be regarded as production activity as any other. It is therefore commonly required to comply with the environmental standards that regulate industrial activities. Hence, deployment of renewable energy projects is often hampered by rules and constraints created to protect the environment and landscape from industrial pollution, especially when these rules do not take into account the specific features of renewable technologies. Contradictory signals to the renewable energy sector cause confusion both at the project and sector levels. At the project level, the weighing of contradictory indications takes place at local level, where the interpretation of an individual public official and local public consultation is decisive. This creates high risks for project developers, which can only be partly reduced by an intensive communication effort with local authorities and local inhabitants. At the sector level, the consistency of policy is needed to guarantee long term security. Hence some of the regulatory constraints that currently create obstacles to RE projects should be reconsidered in an integrated environmental and planning assessment scheme, which takes specifically into account the peculiarities of renewable energy technologies.

Policy makers and planners are commonly not aware of the specific aspects of the renewable energy sector outside their own professional competence area. Because of the innovative nature of the sector, many actors responsible for energy and renewable energy planning are not fully aware of the contradictions existing between policy fields. Communication between policy fields and different areas of competence should at least lead to consensus, so as to render the framework in which project implementation takes place clearer and more consistent. This would decrease the risks of project development for each individual renewable energy project, and also lead to a clearer view of the future perspectives for technology and sector developments.

In a similar manner, the lack of consistency between authority levels hinders the implementation of renewable energy. Because different authority levels often have different responsibilities, priorities and mandates, lack of consistency here also causes confusion, and greatly increases risks of investing in RE projects.

4.3.3.2 Actions to improve consistency of policy

Communication and consensus are the keywords to improve consistency. Communication must take place between policy fields, between policy makers and planners, between authorities at the municipal, regional and national level. It would be beneficial to include the experiences of the sector in the communication, to identify the areas where conflicts between policy fields and levels of authority cause the largest problems for implementation of renewable energy. Ad-hoc decisions focused on individual projects will not play a decisive role to improve security, either at project level or at the sector level. Even though in some cases the search for consensus may produce less favourable conditions for implementation, the security provided will ultimately lead to shorter project lead times, lower project development costs, and better insight into future opportunities.

Hence, two major actions can be envisaged to increase the consistency of policies:

Action III.5:

Set up a consultation structure between authority levels, policy fields and renewable energy sector

Such a consultation structure should be established by policy makers at high level, while all relevant policy makers, authorities, agencies, sector representatives, specialists and relevant NGO's should be represented.

Example: Interprovincial Consultation in the Netherlands

In the Netherlands, the IPO (Interprovincial Consultation) discusses planning and environmental issues across authority levels and policy fields. Such a structure allows identification of inconsistencies.

Action III.6:

Remove inconsistencies from regulations, planning and permit procedures

Executing agencies and authorities need to translate identified inconsistencies into concrete adaptations of regulations and procedures.

Example: PV in the built environment

Adapt building regulations to allow integration of PV in the built environment, and facilitate project development for PV.

Example: Small scale electricity generation

In the Netherlands, a farmer investigating the feasibility for electricity generation from farm waste in a digestor on his farm could count on support from the demonstration funds available through Novem: the Netherlands Agency for Energy and Environment. The municipality agreed in principle to give a permit for a small scale biomass digestor. However, the project was stopped at Provincial level, because the Province did not allow a power plant (whatever scale or fuel) to be built in a designated rural area.

Such risks for investors in project preparation could have been avoided if conditions at municipal and provincial level were in line with one another.

4.3.4 Trade and developments in trade

4.3.4.1 Current issues with international green electricity trade

As renewable energy develops from innovative technologies operating in small local markets towards an international industrial sector, international interactions increase. This is true for trade in hardware, but also for trade in electricity and green certificates. For international optimisation of a renewable energy market pulled by demand, the supply should come from the most economically viable technologies operating at the most economically viable locations. Such economic optimisation is generally considered to be the final goal for a mature renewable energy market. We are not there yet.

The main barriers to the functioning of such a market are differences between regulations and market conditions in each country, and national policies. The EC Directive on Renewable Energy foresees measures to improve regulations and market conditions, such as access to electricity distribution networks, and streamlining procedures. National policies for the stimulation of renewable energy are foreseen to co-exist during a transitional period, after which a stronger focus on trade of renewable energy should be in place. These national policies allow an emphasis on other aspects of renewable energy implementation than cost efficiency. Governments generally have national priorities such as regional development, employment in a national renewable energy sector, or national environmental targets that may outweigh the priority for cost optimisation. The large differences between country policies currently disrupts the market for renewable energy trade wherever this is allowed by national policy. These distortions are expected to increase in coming years, not only causing problems for policy makers, but also bringing large uncertainty for investors, and therefore hindering stable market development.

The markets for renewable energy are already dependent on one another, and will become increasingly so in the near future. According to the EC Directive on renewable energy, all member states are required to have implemented a system of guarantees of origin for all renewable energy production in 2003. The Directive does not state that these guarantees of origin have to be tradable, neither need they be accepted by other EU countries for national support schemes. However, it is expected that the guarantee system will merge with a green certificate system to facilitate trade wherever this is not forbidden by national law. The existence of uniform Guarantees of Origin will also provide an additional argument for advocates of an open EU market. The EC Treaty may be used to force EU member states to adapt their national measures to open their market to all Green Certificates in an equal manner. Article 81 (1) of the EC Treaty prohibits agreements which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market.

Several EU member states (Denmark, Italy, Sweden, UK) have already indicated that they may open their renewable energy markets to imports from other member states on the basis of reciprocal trade arrangements. As countries open their renewable energy markets to foreign production, these markets will become more directly linked. As a consequence, the success of domestic renewable energy policies will be strongly influenced by policies in other countries. For instance, if a strategy to achieve national targets for renewable energy is partially based on imports from other countries, the level and price of imports depends on the value of renewable energy in all competing markets.

Even if a market for renewable energy is not completely open for trade, it may still be affected by policies implemented in other countries. For instance, an operator of a renewable energy plant may choose to apply for green certificates outside the country of production to get the highest value for the certificate.

A situation where trade is allowed, but where the conditions differ largely across countries, leads to an increase of sales to the country with the most favourable conditions. This makes it very difficult for the national government to decide on the absolute magnitude of the support to allocate in the longer term, as the balance between achieving targets and acceptable costs will be unstable. Such difficulties in predictability will lead to regular adjustments and adaptations of government policies, which in their turn will lead to adaptations of polices in other countries. Such frequent adaptations cause a great deal of uncertainty for the renewable energy sector as a whole and for individual projects as well, not only because the value of a project may keep changing, but also because investors will constantly reassess which national market to target. Ultimately, this uncertainty leads to a lower willingness to invest in renewable energy projects.

Eventually, market fluctuations and policy adaptations will decrease and will reach an equilibrium in a more or less stable international market. However, by simply co-ordinating their national renewable policies, governments can significantly accelerate this process of convergence towards a well functioning RE market.

4.3.4.2 Actions to coordinate between countries for international trade

Although the development towards market-oriented policy instruments can be expected to continue, different policy instruments will need to be selected for different technologies and different national contexts for at least the near future. Given that a range of national policies will continue to co-exist, it is clear that within such a context, the policies of a country should not undermine the effectiveness of other countries' policies. Similarly, they should not cause large market distortions that may affect international trade in renewable energy. However legitimate national priorities such as creating employment or strengthening national industry may be, it is essential that some co-ordination of national policies takes place in the short term. Governments need to take into account developments in other countries for the selection of a set of policy instruments and the design of these instruments. This involves several aspects.

First, countries that allow trade of renewable energy must broaden their perspective beyond their national border when designing RE policies. Adjusting national policy instruments and support levels to those of other countries that also allow trade is necessary to avoid erratic trade movements and large uncertainties for the renewable energy market. Second, after that, countries that do not yet allow trade should be guided into the renewable energy market, as locking out RE trade indefinitely is not an option.

The role of the EC would be to co-ordinate the establishment of a common framework for the issuing, the registration and the consumption of guarantees of origin in relation to the targets set in the Renewable Energy Directive.

With a common framework in place for a trading system for renewable energy, and no large differences in market conditions, policy support levels or conditions for support eligibility, market distortions will be minimised. This will contribute to increased continuity of policies and security for investors, allowing stable development of the renewable energy sector. Hence, the main intervention suggested to foster RE trade is the following:

Action III.7:

Design and implement policies to minimise undesired interactions between RE markets

Communication between policy makers is essential to identify possible mismatches of policies and regulations. The acquired knowledge must of course be translated in practical terms into policy instruments and regulations, at national or international level.

Example: Creating insight into related markets

In countries in which renewable energy imports from other countries are eligible for national support schemes, national government should analyse possible interactions with all markets that could access the support scheme. They should use the knowledge to ensure that differences with related markets are minimised in order to avoid market distortions.

Example: The Dutch Green Certificate System (21)

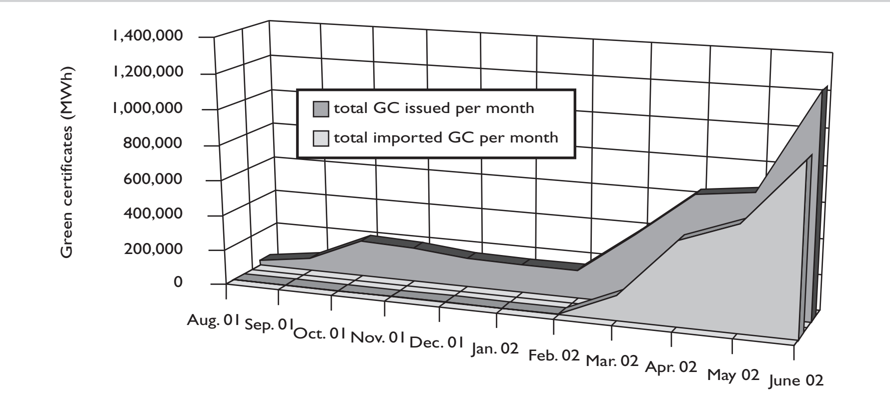
The Netherlands chose to ‘green’ its tax system in the mid-nineties. This was implemented through an increasing ecotax or regulatory energy tax (REB) on final energy consumption. Renewable electricity consumption was exempt from the ecotax. Moreover, producers of renewable electricity received a production incentive from the ecotax funds collected from non-renewable electricity consumers. Since 1996 this fiscal stimulation has become the dominant policy instrument to promote renewable electricity.

Initially only domestic renewable electricity production was eligible for green certificates. As a consequence, only Dutch renewable electricity generation was able to claim the tax benefits associated with the ecotax regulations. However, it was clear from the beginning that such a discriminatory arrangement could not be upheld in view of European regulations. As of January 2002 foreign renewable electricity became eligible for Dutch green certificates, under certain conditions such as avoidance of double subsidisation and certification by an authorised body.

The ecotax exemption has been very effective in stimulating the *consumption* of renewable electricity in the Netherlands. Because of the high level of the ecotax, renewable electricity was offered to retail customers at around the same rate as grey electricity. Combined with strong marketing efforts by suppliers, the number of renewable electricity customers increased from

(21) From: Sambeek, E.J.W. van; *The European dimension of national renewable electricity policy. An analysis of the Dutch experience,* ECN 2002.

some 250,000 at the beginning of 2001 to approximately 1.2 million in mid 2002. Because domestic renewable electricity production was able to supply approximately 500,000 households, a large proportion of demand was met through imports of renewable electricity (approximately 800,000 MWh of imported green certificates by June 2002, see figure below). These imports of renewable electricity have lead to a vast cost in terms of avoidance of tax revenues to the Dutch government- amounting to almost 250 million Euro from January till October 2002. Although the impact on increasing demand is obvious, the effect in creating additional investments in renewable energy projects, stimulating the total capacity for *supply* of renewable electricity has been small. The imports come from existing plants that have been realised in the absence of the Dutch renewable electricity policy and that would have continued to operate under their national support schemes if the Dutch market had not been more attractive. A new policy system is currently being developed. On the one hand, the envisaged system will make use of a feed-in system for the stimulation of national production of renewable energy, and on the other it will involve a continued but smaller tax reduction on the consumption of energy from renewable sources. It is expected that the volume of imports will be reduced. New investment in the national market is envisaged as a response to allowing for the sometimes higher costs of RE production within the national boundaries, and decreasing policy uncertainty.



4.4 INTERVENTION AREA IV: MODIFY CALCULATION MODELS

by Andrea Masini

4.4.1 The current dominance of the cost minimization approach

Under current market conditions, characterized by increasing liberalization and fierce competition among different energy generation systems, the decision criteria used for evaluating energy options may – by themselves – play an important role in accelerating or hampering the diffusion of a particular technology.

The criteria recommended by energy regulators often go beyond the mere achievement of a minimum cost solution, and tend to incorporate – at least in principle – much broader issues such as the security of energy supply and the environmental impact of energy generation. However, the lack of appropriate instruments for the correct assessment of issues not strictly "economic" render the latter much more difficult to incorporate in decision making processes. As a result, the financing of energy projects, as well as the design of energy policies, are based on mere cost minimization rationales.

This particularly penalizes RES because most of the cost assessment models that are commonly used to evaluate energy technology options exhibit three major shortcomings, which neglect or overlook the advantages of RES, namely:

- They often fail to reflect the true cost of energy technologies over their entire life cycle (e.g. in the case of nuclear energy, the decommissioning of plants is seldom considered when assessing the cost of the kWh);
- They do not include the cost of environmental externalities (e.g. the additional cost of curing health problems caused by air pollutants typically generated by fossil fuel combustion or the cost of damage to the eco-sphere caused by the very same substances);
- They do not fully account for some of the potential advantages that renewable energies generate when included into an energy system. For instance, existing models do not consider that the inclusion of given amounts of renewable electricity into an energy portfolio may actually increase the value of the system as a whole because of its increasing ability to hedge against risks and against the fluctuations of fossil fuel prices ([22]).

4.4.2 Concerted actions to promote new cost assessment models

The development and effective use of alternative instruments and cost assessment models that overcome the limitations cited above is a fundamental milestone towards a sharp acceleration of RE diffusion and the reinforcement of RE presence in the world energy market in a *sustainable* manner.

The limited role that this strategy for RE support has played so far is not solely due to a shortage of potential solutions (i.e. alternative cost assessment models). It is also – if not primarily – caused by the lack of consensus around the methodologies already at hand, by their reduced applicability and, ultimately, by the limited acceptance that they have received by the very same actors who were supposed to adopt and use them.

(22) Further information on alternative methodologies to assess the value of energy portfolios can be found – for instance, in Shimon Awerbuch and Martin Berger: Energy diversification and security in the EU: Mean-Variance Portfolio Analysis of electricity generating mixes and its implications for renewables, IEA technical report, Paris, August 2002.

As a result, in order to effectively promote RE diffusion through a radical rethinking of the methodologies for energy system assessment, it is fundamental to promote a series of *concerted efforts* that will involve all potentially concerned actors, either individually or jointly. These include not only those institutions and agencies that are expected to be directly involved in the development activities (i.e. research centres and statistical offices, national governments and international agencies), but also all the business organizations that will adopt and use the methodologies (i.e. energy companies and investors in the energy sectors).

Accordingly, the development of the coordinated set of actions (see also Fig. 13 in chapter 5) is envisaged, each of which will be promoted or coordinated by a specific "champion", as summarized below:

<u>Action IV.1:</u>

Promote round tables to identify needs for new models and generate consensus

International agencies and government bodies should promote a *preliminary round table* with all the concerned actors, where the expected users highlight their needs vis à vis the new cost assessment methodologies and confront them with the methodological issues that may constrain their development. An overall agreement with respect to overall objectives and applicability of the methods is sought at this stage of the process.

Example: EU Commission conferences

The EU commission organizes a series of conferences on energy assessment models with representatives from research centres, energy industries, the financial community and statistical offices to identify shortcomings of existing methodologies and compare them to industry needs. Based on results of this preliminary work, a restricted workgroup with representatives from the above bodies is formed, with the objective to identify suitable characteristics for the new methodologies and sign a binding agreement with main partners.

<u>Action IV.2:</u>

Support and implement research projects to develop new models

Research centres, academic communities and international agencies should sponsor and implement research programs to develop/refine new cost assessment models that take into account the above requirements. Particular emphasis must be dedicated to the practical *applicability* of the methods proposed especially with respect to the availability of the data necessary to their application.

Example: Calls for proposals

Those responsible for research budgets at national and international level reserve a budget quota (e.g. in the next framework programme) for projects that aim at developing new cost assessment methodologies using analytical tools such as Life Cycle Assessment and Technology Portfolio evaluation models. Calls for proposals must be explicitly designed by taking into account the methodological requirements discussed and agreed during the round table. These are also used as evaluation criteria during the project selection and financing phase.

Action IV.3:

Validate models and promote use through appropriate legislation

Statistical agencies at national and international level should validate the proposed models by verifying that reliable databases are widely available, so as to render implementation possible in the short term. Moreover, they should improve and refine processes for collecting data that are purposeful to the application of the proposed models.

Example: EUROSTAT involvement

EUROSTAT and national statistical offices are invited to participate (either directly or as member of the steering committee) in research projects on new assessment methodologies and are asked to provide active feedback. In parallel, they are asked to activate new data collection processes that may emerge as necessary for the support of the new methodologies under development.

National governments and energy regulators will contribute to the validation of the new methodologies by explicitly requiring their application in some particular cases and by promoting them among potential users.

Example: Model utilisation

National governments require the use of the newly developed methodologies by firms that participate in bids for the realization of energy systems. Certifying organizations require the use of the same methodologies as a necessary condition for obtaining quality labels.

Action IV.4:

Use new models and provide feedback for improvement

The energy industry, investors and other operators in the sector should provide feedback during the research phase as well as adopt and extensively use the methodologies once validated by national governments.

CONCLUSIONS AND RECOMMENDATIONS

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF ROAD MAP ACTIONS

We have identified 4 main areas of intervention within the Road Map for RE market acceleration:

- Increase market transparency and awareness of stakeholders;
- Improve RE techno-economic performance;
- Improve the impact of policies;
- Modify cost calculation models.

These areas of intervention imply several more targeted actions. In this section, we summarise the whole set of 23 proposed actions, relate them to relevant stakeholders and propose an agenda for implementation.

5.1.1 Increase market transparency and awareness of stakeholders

REMAC envisages achieving a significant and self-sustained diffusion of RES-E in 2020, driven primarily by demand and consumer choice in a single and liberalised European market. To reach this objective, consumers need to be empowered and to make independent decisions. In turn, this requires that they are provided with transparent, reliable and easily available information on renewable electricity. Consumers must be able to perceive the benefits of RES-E with respect to conventional electricity and must be aware of the possibility they actually have to buy green electricity. Awareness of the value of RE is crucial also for other stakeholders, e.g. business clients and local authorities. Moreover, RES-E demand can be fostered in an indirect manner through the increase of consumption of sustainable products, produced using RES-E during manufacturing processes.

In order to reach these objectives aiming at raising RE demand, we envisage 3 main interventions:

- Increasing **market transparency**;
- Increasing **awareness** of consumers and other stakeholders;
- Increasing RE demand through the link with other policy instruments and **sustainable consumption**.

These interventions can be further split into a set of coordinated actions. The first three are related to the increase of **market transparency**.

First, we recommend developing common standards for voluntary green electricity excellence labels to provide reliable and easily understandable information to that portion of consumers potentially interested and willing to buy RES-E, in a format easily recognised all over Europe.

In addition, we suggest introducing a mandatory fuel mix disclosure to increase overall market transparency and to give all consumers the right to know what they actually buy.

Finally, it is crucial to support and accelerate the development and use of RE certificates of origin as a basic guarantee mechanism for green electricity tariffs and labels and to foster RES-E trade.

However, transparency alone is not enough. In order for these actions to become really effective, **awareness of consumers** and stakeholders has to be raised, particularly in some countries. We therefore envisage two actions; namely awareness-raising campaigns on green electricity labels at national and international level, and awareness-raising campaigns on RE at local level. More specifically, the latter are crucial to removal of current obstacles in local administrations. These obstacles are mainly due to limited knowledge and awareness of the added value and possible benefits of RE. Moreover, action at local level is essential to increase social acceptance of RE, another major present barrier against RE diffusion.

Finally, we highlight that the use of RES-E instead of conventional electricity during manufacturing processes can substantially lower the life-cycle impacts of many products. This means that the use of RES-E is a tool toward production of more **sustainable products**. Looking at this the other way round, we conclude that the increase of sustainable consumption is an **indirect way to foster RES-E demand**. In the medium-long term, this might potentially become a very significant accelerator for the RE market. In order to initiate this process, we recommend increasing the link with Integrated Product Policy tools. In particular, we envisage the development of specific business-to-business product information schemes, such as Environmental Product Declarations or other specific labels to be used by industry and business to communicate that they use RES-E. Another important IPP tool is green public procurement, i.e. public administrations buying green electricity and sustainable products. This might play an important triggering role to expand the RE market in the initial expansion phase.

Figure 10 summarises the expected benefits of the proposed actions. The direct expected effects are an increase in transparency, trust and perceived value of RE among investors, authorities at local level, and obviously consumers. In its turn, this is expected to increase RES-E demand, as well as to facilitate investments, and development and implementation of RET installation at local level.

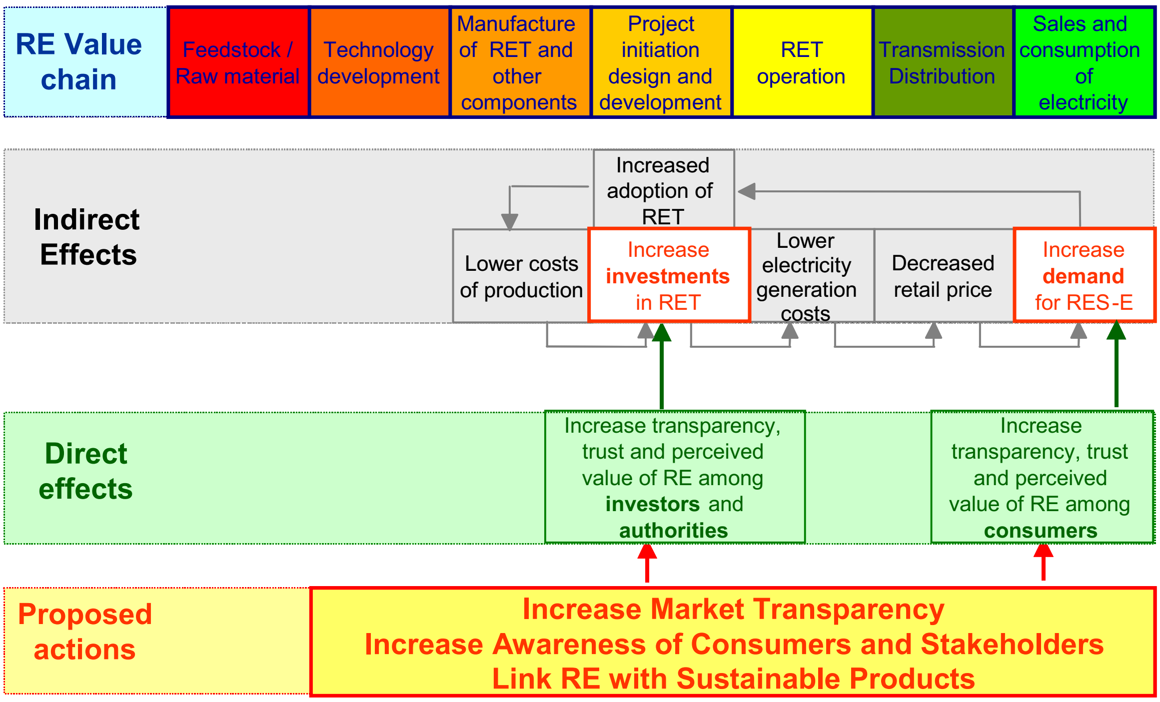


Figure 10: Expected benefits of actions aiming at increasing market transparency and awareness of consumers and stakeholders.

Different **stakeholders** are involved at various level for promotion and implementation of the proposed actions. We recommend a close multi-stakeholder collaboration between policy-makers at national and international level, environmental NGO's, market operators (producers, traders, distributors) and grid operators for the development of effective measures to increase market transparency. Consumer associations should also be involved in this specific respect, in particular as for the development of common standards for voluntary, EU-wide excellence green electricity labels. As far as RE certificates of origin are concerned, market players are expected to be the main promoters, while the presence of public actors in issuing bodies must ensure the credibility and independency of the latter.

NGO's, local market operators and consumer associations should be the main promoters of awareness-raising campaigns on green electricity labels, while local public administrations might play a major role together with environmental and consumer NGO's to raise local awareness and acceptance of RE.

Finally, linking RE with sustainable products involves a much broader set of actors, mostly connected with the area of Integrated Product Policy. Of course, consumer associations might play a crucial role in pushing consumers to buy more sustainable products. Green electricity producers and distributors will be involved in business-to-business communication with other industry clients, who will buy RES-E and will communicate this to their own customers.

5.1.2 Improve RE techno-economic performance

Technology development means improving the techno-economic performance of RES by targeting costs, performance and applicability so that RE systems a) cost less, b) perform better and c) can be used for more and newer applications. Five key issues are identified as being particularly important from a technology development perspective.

Three vertical issues – **Research & Development (R&D)**, **Grid** and **Markets** – highlight three crucial areas and *sequences within the technology development chain*. They each have their specific potential for improving techno-economic performance on the way from the lab to the market and are strongly interrelated and interdependent. The two horizontal issues – **System** and **Synergy** – highlight these potentially beneficial links *all along the value chain* by focusing on improving process and approach for technology development.

The importance of **R&D** both in the public and private sector is widely recognised - the challenge, however, is to find the best ways to improve the techno-economic performance of RE systems by means of appropriate activities, investments and policy framework. Continuity and long-term strategy, as well as market and system orientation are key features of efficient and sustained R&D. By allocating R&D resources towards technologies resulting in competitive products for niche **markets** and then gradually gaining larger segments, the private sector seizes business opportunities, and provides learning investments, spurring further technological and commercial progress within the "self-reinforcing" virtuous cycle of technology development and market deployment.

On the way to large-scale use, RES-E and the **grid** face performance challenges. Enhanced grid integration, management tools and storage capabilities help remove this potential bottleneck and offer at the same time opportunities for RES-E related products with great functionality.

The **system** orientation is of prime importance all along the value chain in order to spot and enhance technical solutions providing best value for grid integration and customers' needs and choice. Appropriate **synergies** bring different skills, competence and infrastructure together and can induce considerably higher innovation and productivity rates all along the technology development chain.

According to the two basic types of key issues – vertical and horizontal –, different groups of **stakeholders** are involved in different ways when improving techno-economic performance.

R&D, grid issues and market segment-oriented strategies involve stakeholder groups specific to their strength and interest in the different phases of technology development steps in the value chain. Policy makers and financial institutions (public funds and learning investments) are strongly involved in the *promotion* of *R&D,* whereas the research community and industry are active in the *application of R&D*, the former especially involved in basic R&D and the latter more likely in applied R&D. The same stakeholders together with the electricity sector (both supply and demand side) can be found for developing and applying *market segment-oriented strategies*. With respect to *grid issues* utilities, electro-technical committees and their (inter-) national associations play a paramount role.

The two horizontal issues (*synergy* and *system orientation*) emphasise the fact that a wide range of different stakeholders and groups from R&D programme managers to global market players – with some focus on the research community and the industry sector – should exploit the *synergies* and focus on functionality and *system* value. This results in higher efficiency, coherence and coordination all along the value chain from R&D to products and services for final users as well as within appropriate intra- and inter-sectorial networks and clustering – to make technology development successful.

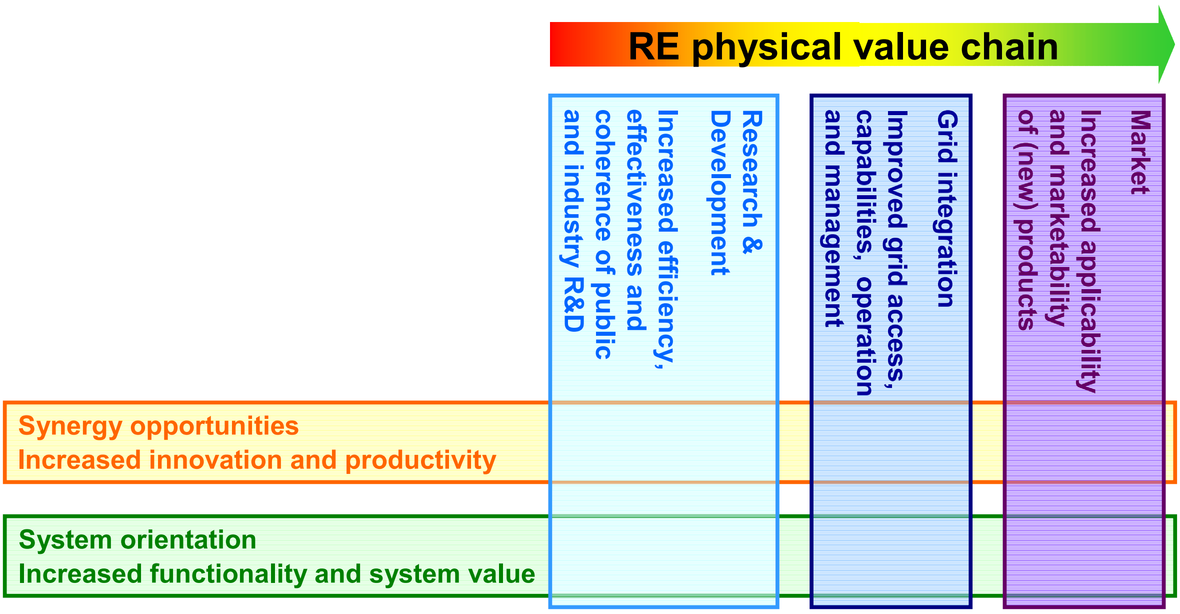


Figure 11: The five key issues subdivided into two basic perspectives related to technology development and to techno-economic performance improvement.

5.1.3 Improve the impact of policies

On the road towards a completely demand driven market for renewable energy, many different policy instruments will be used to stimulate development and implementation of these technologies and the development of the sector as a whole. Different instruments can be chosen to meet priorities at national or local level or to diversify technologies. However, policies and policy fields should be aligned towards the same long term goal: the demand driven market. In order to achieve solid growth of a renewable energy sector, the current perspective of all involved in design and execution of policy needs to be broadened in three different ways.

Firstly, a longer time perspective is necessary to provide (developing) technologies and markets the level of security that is necessary. An appropriate level of security will take into account that support (especially from government budgets) is not indefinite. A longer time perspective will also allow communication of planned policy developments well in advance- avoiding market disruptions by sudden changes in policy and unnecessary risks for investors. Of course, political changes can lead to shifting priorities and thereby to sudden changes in policies. The establishment of international agreements with mandatory targets is the only real means to eliminate the largest of such policy changes. However, a strong stakeholders network can also help strengthen political support for continuity of policies.

Secondly, the perspective of policy makers, public agencies and authorities in the field of renewable energy should be broadened to all related policy fields and authorities involved. Inconsistencies currently form a major barrier to renewable energy implementation. Such inconsistencies can be removed through consultation structures between authority levels, policy fields and the renewable energy sector, and by removing inconsistencies from regulations, planning and permit procedures.

Finally, policy makers should have an orientation that looks further than national borders. As trade (of green electricity or green certificates) will play an increasing role in the renewable energy sector, international co-ordination between countries is necessary to prepare the market and to minimise undesirable interaction between national renewable energy markets.

These three groups of actions will impact the full value chain, from manufacture of RETs to the consumption of 'green' electricity. Figure 12 illustrates the different benefits for different stakeholders along the RE value chain.

In order to realise the desired improvement in policy security and consistency, policy makers should take the lead. Other public actors involved in policy execution, such as public agencies and authorities, are essential to creating coherency and communication with the market. However, the market itself needs to take on some responsibility for this issue as well, as only market parties, from NGO's to project developers, can provide the public sector the information and insight into technology and market developments that it needs.

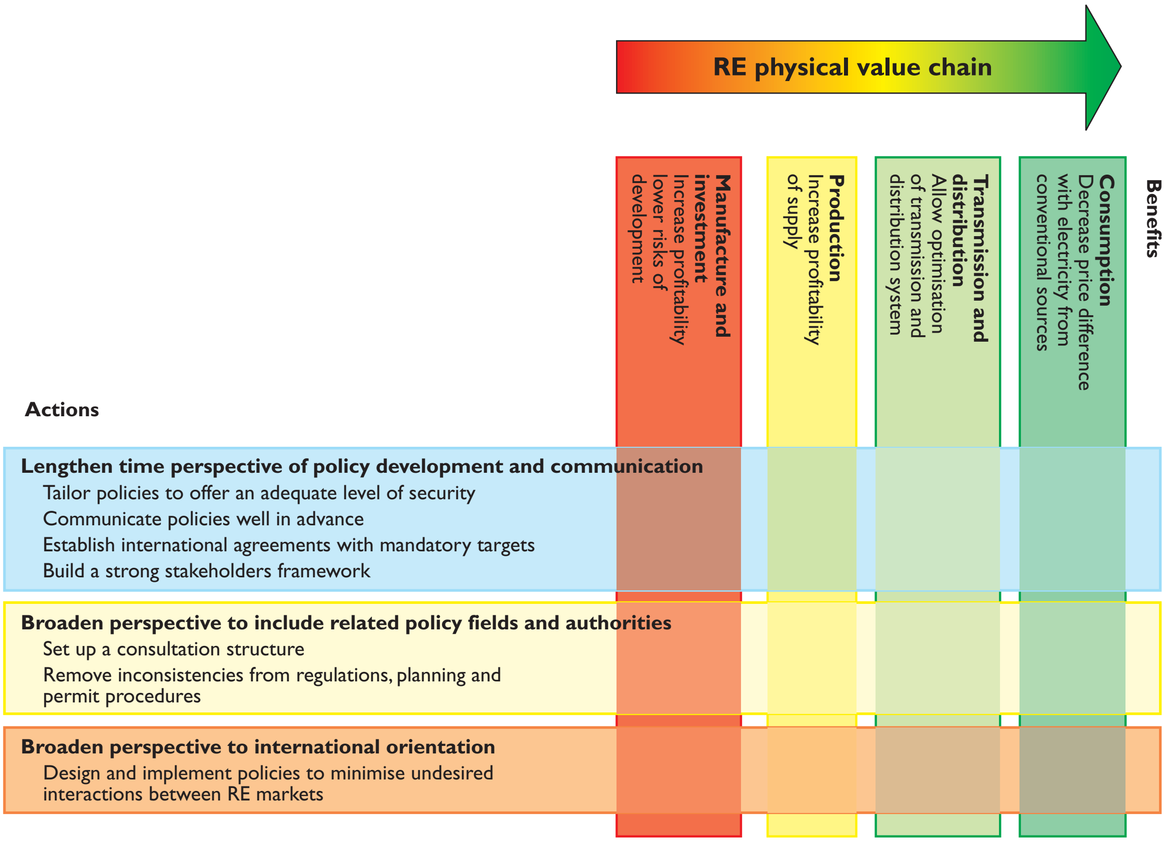


Figure 12: Expected benefits of actions aimed at improving the impact of policies for different stakeholders along the RE value chain.

5.1.4 Modify cost calculation models

Under current market conditions, the decision criteria used for evaluating energy options may – by themselves – play an important role in accelerating or hampering the diffusion of a particular technology. However, because of the lack of appropriate instruments for correct assessment of issues not strictly "economic", the financing of energy projects as well as the design of energy policies are still largely based on mere cost minimization.

Unfortunately most of the cost assessment models currently available have important shortcomings that penalize RE technologies. For instance, they fail to reflect the true cost of energy technologies over their entire life cycle, they do not include the cost of environmental externalities and they do not fully account for the potential advantages that renewable energies may generate to increase the security of energy supply.

Accordingly, there is ample evidence that RE diffusion can be significantly and actively supported through a radical rethinking of methodologies for energy system assessment. This is therefore one of the primary milestones of the REMAC Road Map.

The limited availability of alternative models is not solely due to a shortage of potential solutions. It is also due to the lack of consensus around methodologies already at hand, by their reduced applicability and, ultimately, by the limited acceptance that they have received by the very same actors who were supposed to adopt and use them. Hence, we recognize that the above objective can be achieved only through a series of *concerted efforts*. These will involve all actors potentially affected by the problem, i.e. both those directly involved in the development of the model (research centres and statistical offices, national governments and international agencies) and those who will ultimately use them (energy companies and investors).

To this end, we suggest the implementation of an action plan subdivided into four steps: i) the promotion of a preliminary round table, where all the concerned actors agree upon the desired properties of the new models; ii) the financing of dedicated research programs to develop models in accordance with the desired specifications and a parallel data collection effort to prime the models with updated and reliable information, iii) the promotion of dedicated legislation that favours or enforces use of the new tools and – finally – iv) the development of efforts to provide accurate and reliable feedback during the actual use of the models, so as to improve their characteristics and increase their applicability.

A possible action plan to promote new models for assessing the true cost of energy technologies is schematically summarised in Figure 13.

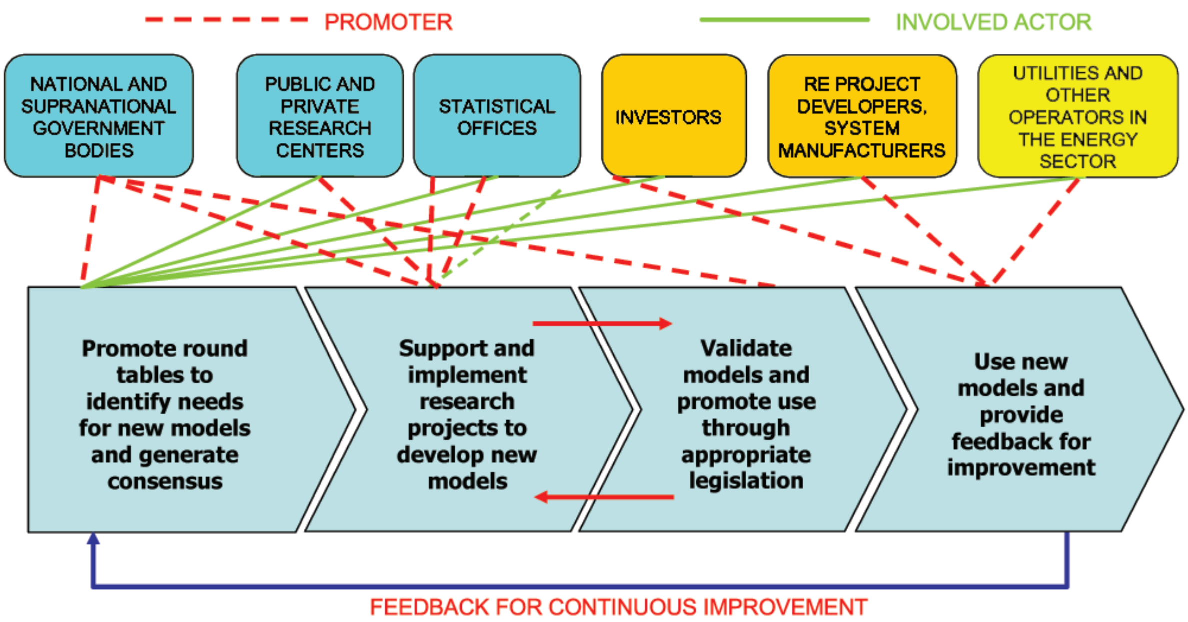


Figure 13: An action plan to promote new models for assessing the true cost of energy technologies.

5.2 CONCLUSIONS AND RECOMMENDATIONS FOR STAKEHOLDERS

Table 2 summarises the whole list of proposed actions within the 4 main areas of intervention, addressing the 12 identified key diffusion factors for RE market acceleration.

The table also shows which stakeholder is mainly involved in the promotion and implementation of which specific action. We have distinguished two main categories of stakeholders:

- Stakeholders who have a generic role in promoting RE diffusion (e.g. policy-makers, NGO's, etc.);
- Stakeholders who are directly involved in the physical RE value chain (from suppliers of feedstock and raw materials to end-users).

As shown in the table, policy makers, public authorities and public agencies are involved in all proposed actions, at least to some extent. This is not surprising, and reflects the fact that strong policy actions are needed to ensure a significant RE market acceleration.

However, these actions must be well co-ordinated, at least at two levels:

- Within stakeholder groups: policy actions promoted by different policy-makers, public authorities and public agencies at different levels (e.g. national vs. local) must be coherent and consistent across each other;
- Between stakeholder groups: in order to be effective, the actions promoted by policy-makers must be fully co-ordinated with those promoted by other stakeholders.

This strong need for co-ordination is actually one of the guiding principles of the REMAC Road Map. As shown in table 2, this is reflected by the fact that most of the actions proposed imply strong involvement of several stakeholders, who play different and yet complementary roles.

More specifically, a major responsibility for **policy makers** is to set up a policy framework capable of guaranteeing more security for investors, ensuring consistency of policy actions at different level and facilitating trade of RES-E. The latter action is also connected with an increase in market transparency. The role of policy makers in this area is to increase credibility of the system (e.g. by participating in certificate and label issuing bodies). Policy makers, public authorities and public agencies also play a major role in increasing awareness and fostering sustainable consumption. Besides, they should trigger and promote the development of new cost assessment models. Last but not least, the public actors play a crucial role in providing continuity and long term strategies for R&D.

Environmental NGO's and **consumer associations** are mostly involved in actions aimed at increasing RE demand (e.g. by increasing market transparency and the awareness of consumers and other stakeholders), as well as at stimulating RE demand in an indirect manner through increased consumption of more sustainable products.

Financial institutions play a major role in the intervention area of improvement of RE techno-economic performance, in particular with respect to R&D and to the development of market-segment oriented deployment strategies. Quite obviously, they are also actively involved in development of new cost assessment models. Similarly, research institutes are also concerned with the same areas of intervention.

Companies involved in the **supply chain of RET** (from raw material suppliers, to project developers and investors) logically have a leading role in all actions related to the improvement of techno-economic performances of RET.

Utilities, **producers** and **distributors of RES-E** are also involved in this area; in particular, to assure a system orientation and to address critical issues in grid integration. Moreover, market operators in production and sale of RES-E play a central role in actions aimed at increasing market transparency and awareness of stakeholders.

Finally, **all actors** over the whole value chain should take their responsibility in urging the renewable energy sector forward. The establishment of a strong stakeholders framework would contribute to strengthening political support for continuity of policies. Further, the role of all market parties is essential to providing insight for policy development and for the development of new cost assessment models.

Main Intervention areas	Key issues and/or diffusion factors	Actions	Expected impact on RE growth	Policy makers, public authorities and public agencies	NGO's	Financial Institutions	Research institutes, statistical offices	Suppliers of feedstock and raw materials	Manufacturers of RE systems	Manufacturers of complementary products and systems	Project developers, investors	Utilities, independent producers and auto-producers	Grid operators and retailers	End-Users (small and large consumers)
I - Increase market transparency and awareness of stakeholders	Market transparency	I.1) Develop common standards for voluntary excellence green electricity labels	XXX	★	★		✉		✉			★	✉	★
		I.2) Introduce mandatory fuel mix disclosure	X	★	✉		✉					★	★	✉
		I.3) Support and accelerate the development and use of RE certificates of origin	XXX	★	✉							★	★	✉
	Awareness of stakeholders	I.4) Organise awareness-raising campaigns on green electricity labels	XX	✉	★							★	★	★
		I.5) Organise awareness-raising campaigns on RE at local level	XXX	★	★							✉	✉	★
	Sustainable products	I.6) Link the use of RE with Integrated Product Policy tools and sustainable consumption	XX	★	★	✉						✉	✉	★
II - Improve RE techno-economic performance	Research & Development	II.1) Provide continuity and long term strategy for R&D	XXX	★		★	✉	✉	✉	✉				
		II.2) Orient R&D towards markets	XX	★		★	★	✉	★	✉				
	System orientation	II.3) Assure energy system orientation in techno-economic development	X	✉		✉	★	✉	★	✉	✉	★	★	
	Grid integration	II.4) Address critical issues in grid integration	X	✉		✉	✉		✉	✉	✉	★	★	
	Products and applications	II.5) Develop segment-oriented deployment strategies	XX	✉		★	✉		★	✉	✉	✉	✉	
	Synergy opportunities	II.6) Explore benefits from synergy opportunities between different stakeholders	XX	★		✉	★	★	★	✉	✉	✉	✉	
III - Improve the impact of policies	Security for investors	III.1) Tailor policies to offer an adequate level of security	XXX	★										
		III.2) Communicate policy developments well in advance	XXX	★										
		III.3) Establish supportive international agreements with clear mandatory targets	XXX	★										
		III.4) Build a strong stakeholders framework	X	✉	★		★	★	★	★	★	★	★	★
	Consistency of policy	III.5) Set up a consultation structure between authority levels, policy fields and renewable energy sector	X	★	✉		✉	✉	✉	✉	★	✉	✉	
		III.6) Remove inconsistencies from regulations, planning and permit procedures	XXX	★										
	Trade	III.7) Design and implement policies to minimise undesired interactions between RE markets	XX	★										
IV - Modify cost calculation models	New cost assessment models	IV.1) Promote round tables to identify needs for new models and generate consensus	X	★		★	★		★		★	★	★	✉
		IV.2) Support and implement research projects to develop new models	X	✉		✉	★							
		IV.3) Validate models and promote use through appropriate legislation	X	★			★							
		IV.4) Use new models and provide feedback for improvement	XXX	✉		★					★	★	★	✉

Table 2: Main stakeholders involved in the promotion and implementation of the Road Map actions (★: major involvement, ✉: secondary involvement)

5.3 AN AGENDA FOR IMPLEMENTATION

The measures discussed in the previous paragraphs cover a broad range of areas and envisage the active contribution of several groups of stakeholders and sponsors. They are the individual building blocks of a coherent structure aimed at accelerating RE diffusion, which exploits synergistic interaction across the different actions proposed. To maximise this synergistic effect and increase effectiveness of the roadmap, the proposed initiatives should be carefully coordinated and implemented according to a logical sequence, which sets the pace at which the efforts should be allocated over time.

The need for a well conceived schedule for implementing the actions derives from two main reasons. First, it stems from the fact that some measures cannot be fully effective unless a fertile ground for supporting their development is put into place ahead of their implementation. In these settings, the measures aimed at building the appropriate framework for hosting future diffusion support strategies must obviously be given priority. This is typically the case – for instance – for those actions that leverage market mechanisms, which can obviously be promoted only after other measures aimed at designing and improving these mechanisms have already exerted (or are in the process of exerting) their effect.

Second, this need derives from the necessity to coordinate among each other a broad set of actions that have different "incubation" times (i.e. different delays between the time at which efforts are initiated and that at which their effects become visible). Accordingly, the development of efforts should be phased in such a way that synergistic actions (i.e. actions that are most effective when implemented together) with different incubation times become effective at similar points in time.

To take into account the fact that the transition between the initiation of an effort and the visibility of its effect is never sharp, we have subdivided the "life cycle" of the actions proposed into three general epochs (see Figure 14) the initial incubation or infancy (where efforts are needed just to set the system in motion, although no visible effects are observed), the adolescence (where the efforts produced start displaying the first visible effects and must be continued) and the maturity (where the action fully displays its expected contribution towards accelerating RE diffusion).

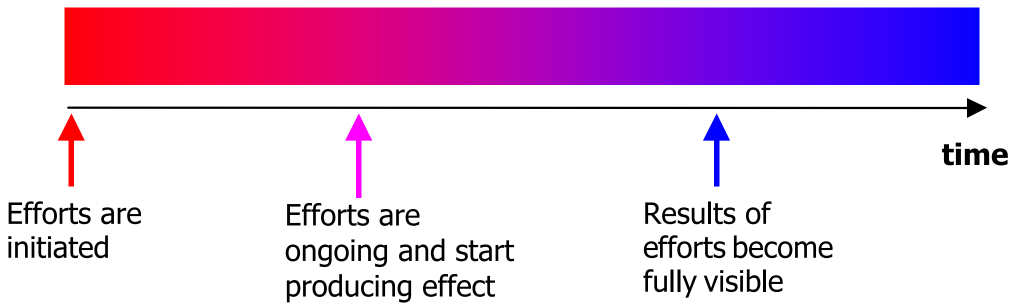


Figure 14: The life cycle of a RE supporting action: from initial efforts to full visibility of effects.

Figure 15 provides some useful indications to prioritise the implementation of the actions described in this roadmap, on the basis of the considerations developed above. The proposed prioritisation follows the overall logic put forth by REMAC, which consists in favouring a smoothed transition from the current policy-pushed system to a fully demand-driven RE market (see Figure 15). Accordingly, actions aimed at leveraging market mechanisms to stimulate demand are naturally placed after those aimed at setting the necessary regulatory and technical conditions that will make the achievement of this objective possible.

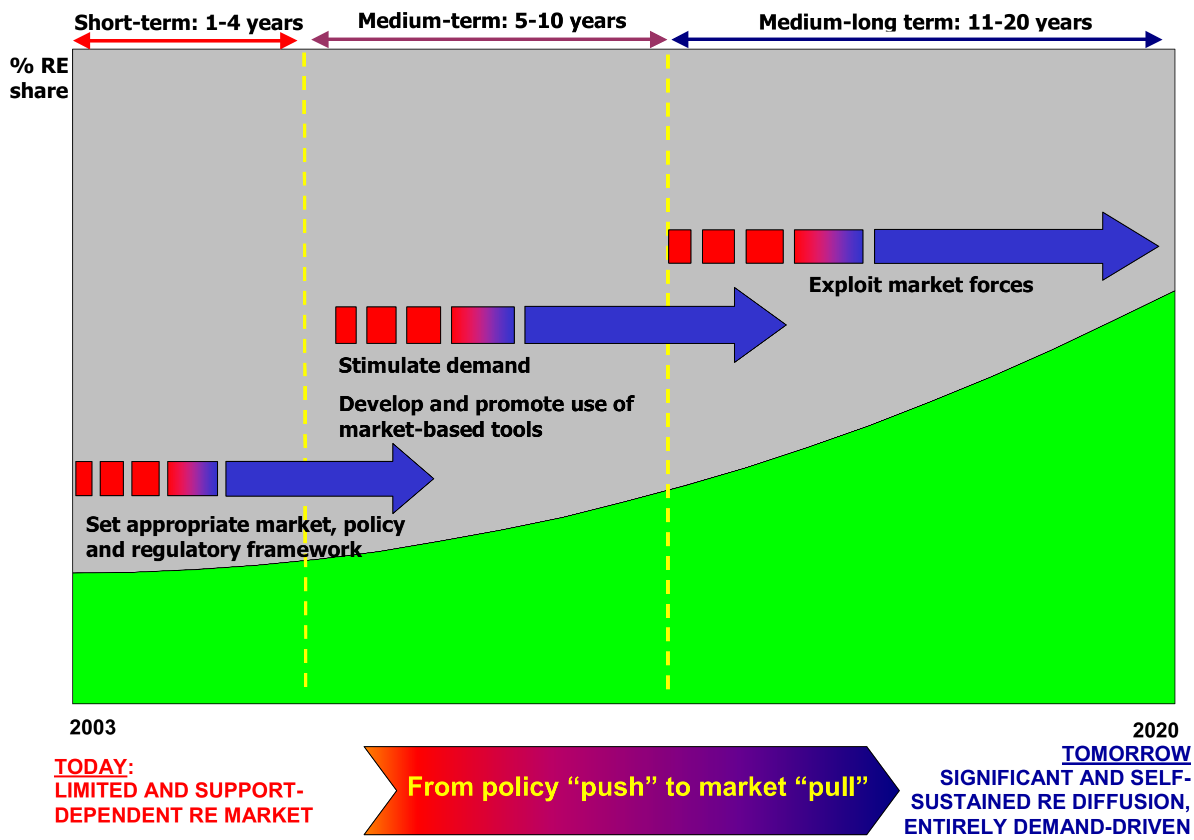


Figure 15: Proposed prioritisation of intervention

Table 2 summarises the 23 specific actions discussed in the previous paragraphs and provides the following concise information:

- A qualitative assessment of the expected contribution of each action towards the acceleration of RE market penetration;
- A suggested schedule for the implementation of the measures proposed. As discussed above, each action is characterized by means of three main milestones, namely:
  - An estimate of the time at which the efforts should be initiated;
  - An estimate of the time at which the efforts start becoming visible;
  - An estimate of the time at which the action exerts its full potential.

It is worth emphasizing that the proposed prioritisation is necessarily an educated guess and that it contains several elements of uncertainty. As such, it should be used to propose general guidelines – as opposed to precise deadlines – for the implementation of the actions discussed in this document.

To facilitate the positioning of each action, the horizon retained for the analysis has been subdivided into three main windows:

– Short-term (1-4 years);
– Medium-term (5-10 years);
– Medium-long term (11-20 years).

5.3.1 Short-term

The short-term horizon of the Road Map foresees the initiation of efforts in a number of areas that concern both the demand and the supply side and – especially – the market mechanisms. The main objective of this phase is twofold: *i*) **to set the framework** necessary for the occurrence of a demand-driven RE diffusion; *ii*) to **stimulate** and **assist technical development** and to **attract investments**, which would otherwise suffer from the current demand level. Accordingly, actions that can or should be implemented in the short-term include four types of measures:

- Actions focused on the **demand-side**. These are necessary prerequisites to prepare the ground for future efforts, such as those aimed at simplifying and improving transactional mechanisms and at developing the instruments that will be used later on to trade renewable energy in a fully liberalised market. These actions include, for instance, the development of common standards for green labels and certificates of origin, and promotion of the RE system among stakeholders at the local level. These actions must be initiated as soon as possible, because failing to do so will further delay the implementation of other and more important measures.
- Actions aimed at preparing the policy **framework** and the **operational environment** for future demand-driven RE diffusion. These measures are especially meant to provide the necessary level of policy security and continuity so as to attract investments and, also, to remove inconsistencies between different policies or policy fields that currently hamper RE diffusion. This group of actions must also be implemented as soon as possible; both because it is a prerequisite to a guarantee of the effectiveness of future efforts, and also, because it reinforces the effectiveness of other short-term measures.

- Actions that necessitate **long incubation times** and whose effect will not be visible in the medium or long run, unless efforts are undertaken in the very near future. Typical examples are the measures dedicated to support R&D – which may have a potentially large impact on RE diffusion, but whose "pay-back" time cannot be estimated with certainty.
- Actions that can make a contribution to **increasing the value of RE today** and that do not require the preliminary development of efforts in other areas (e.g. the orientation of R&D towards market and the use of segment-oriented strategies to promote RE systems in specific niches where they are already profitable).

5.3.2 Medium-term

In the medium-term the first effects of the actions previously implemented start becoming visible. However, significant efforts are still dedicated to maintain the momentum achieved and to further leverage the effect of the policies implemented in the previous years. Additional efforts in new areas are also developed in parallel.

In accordance with the above rationale, actions that can or should be implemented in the medium term include either measures that are dependent on the effective actuation of efforts in other areas or measures meant to address issues that will become truly relevant only after RE penetration overcomes a given threshold (like – for instance – the solution of grid-connection problems) ([23]).

It is worth stressing that – although scheduled later – these measures are by no means less important than the ones discussed in the previous section. They simply need to benefit from previous efforts to fully develop their potential. Indeed, their net contribution to RE diffusion may be even more significant, because they are meant to exploit market-mechanisms with longer and more important leverages.

New actions that have to be initiated in the medium-term horizon include:

- Actions focused on the **demand-side**, which **leverage "green consumerism"** by promoting the use of improved green labels and establishing a link between RE and integrated product policy tools. It seems appropriate to undertake a massive effort to promote green labels only at this stage (i.e. when a reliable and trustworthy certification system is already in place).
- Actions focused on the **supply side** – such as the development of **synergies** across different industries and industry sectors, which aim at further reinforcing the market-orientation of R&D and at capitalising on the actions already initiated in the previous period.
- Policy actions that favour the **transfer of experiences** developed at the local level to a broader scale, such as the establishment of international agreements with mandatory quota.
- Actions aimed at **preparing the ground** for the development of new instruments that facilitate the assessment of energy systems in a fully liberalised market. Again – although the full benefits will only be visible in the long run, efforts in this area have to begin at least in the medium term.

(23) The only exception is represented by wind generators, for which grid-connection is already becoming an important issue today.

Once again, it is worth stressing that the initiation of a new set of actions does not have to occur at the expenses of the ongoing efforts in areas previously cited. These must be continued and possibly improved.

5.3.3 Medium-long term

The long-term horizon sees the final consolidation of previous efforts, which now **deploy their full potential** and **exert all their benefits**. In this setting, the existence of a consistent policy framework, the improved RE techno-economic performances and the availability of a new sets of reliable instruments to fully assess the benefit of renewables enable RE to compete against other technologies in fully liberalised markets.

Although most of the actions described in this Road Map should have been already initiated in the previous epochs, the magnitude of the efforts *must remain important* in the medium-long term. Energies are dedicated to consolidating results obtained and further improving the effectiveness and reliability of initiatives already begun.

For instance, policy efforts are dedicated to maintaining and improving consistency of the framework put in place, at the local, at the national and at the international levels. R&D efforts are also maintained and further oriented towards market applications, possibly including new and potentially interesting niches that may have been emerged. Also – while fundamental research is continued – additional efforts are dedicated to the development phase. The occurrence of economies of scale can also bring new opportunities for increasing RE competitiveness and must be managed appropriately. Similarly, demand-oriented initiatives are still in place, and fully benefit from the new set of dedicated tools now available (green certificates, new models to assess the “true” RE cost, etc).

			impact on RE growth	short-term 1-4 years	medium-term 5-10 years	long-term 11-20
I - Increase market transparency and awareness of stakeholders	Market Transparency	I.1) Develop common standards for voluntary excellence green electricity labels	xxx			
		I.2) Introduce mandatory fuel mix disclosure	x			
		I.3) Support and accelerate the development and use of RE certificates of origin	xxx			
	Awareness of stakeholders	I.4) Organise awareness-raising campaigns on green electricity labels	xx			
		I.5) Organise awareness-raising campaigns on RE at local level	xxx			
	Sustainable Products	I.6) Link the use of RE with Integrated Product Policy tools and sustainable consumption	xx			
II - Improve RE techno-economic performance	Research and Development	II.1) Provide continuity and long term strategy for R&D	xxx			
		II.2) Orient R&D towards markets	xx			
	System Orientation	II.3) Assure energy system orientation in techno-economic development	x			
	Grid Integration	II.4) Address critical issues in grid integration	x			
	Products and Applications	II.5) Develop segment-oriented deployment strategies	xx			
	Synergy Opportunities	II.6) Explore benefits from synergy opportunities between different stakeholders	xx			

			impact on RE growth	short-term 1-4 years	medium-term 5-10 years	long-term 11-20
III - Improve the impact of policies	Security for Investors	III.1) Tailor policies to offer an adequate level of security.	xxx			
		III.2) Communicate policy developments well in advance.	xxx			
		III.3) Establish supportive international agreements with clear mandatory targets	xxx			
		III.4)Build a strong stakeholders framework.	x			
	Consistency of Policies	III.5) Set up a consultation structure between authority levels, policy fields and renewable energy sector	x			
		III.6) Remove inconsistencies from regulations, planning and permit procedures.	xxx			
	Trade	III.7) Design and implement policies to minimise undesired interactions between RE markets	xx			
IV - Modify cost calculation models	New cost assessment models	IV.1) Promote round tables to identify needs for new models and generate consensus	x			
		IV.2) Support and implement research projecs to develop new models	x			
		IV.3) Validate models and promote use through appropriate legislation	x			
		IV.4) Use new models and provide feedback for improvement	xxx			

Table 3: Agenda for Road Map implementation.

Initiation of effort.

Ongoing effort, effects already present.

Effect of effort fully visible.

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