RE VALUE POLICIES

Policy Instruments to Support Renewable Energy Industrial Value Chain Development

IEA Implementing Agreement on Renewable Energy Technology Deployment (IEA-RETD)

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ACKNOWLEDGEMENTS

The authors would like to extend their gratitude to the members of the RE Value Policy Project Steering Group: Martha Ekkert (Federal Ministry for the Environment, Nature Protection and Nuclear Safety, Germany), Michael Paunescu (Natural Resources Canada), Kaoru Yamaguchi (Institute for Energy Economics, Japan), Rabia Ferroukhi (IRENA) and Kristian Petrick (All Green Energies). Our special thanks goes to Sascha van Rooijen (Ecofys) for her continued support as operating agent.

The authors would also like to thank the following reviewers Julian Blohmke (DII), Laura Williamson and Christine Lins (REN21), Thomas Fink (Wuppertal Institute), Steffen Erdle (UfM), Roberto Lacal Arántegui (IEA-Wind/JRC-Institute for Energy and Transport), Anita Richter and Jan-Christoph Kuntze (GIZ), Sofia Martinez (IDAE), Marius Backhaus Federal Ministry for the Environment, Nature Protection and Nuclear Safety, Germany) and Foppe de Haan (NL Ministry of Economic Affairs). Further, we would like to thank Tom Prugh from World Watch Institute who edited the final report. All errors remain our own.

ABOUT IEA-RETD

The International Energy Agency's Implementing Agreement on Renewable Energy Technology Deployment (IEA-RETD) provides a platform for enhancing international cooperation on policies, measures and market instruments to accelerate the global deployment of renewable energy technologies. IEA-RETD operates under the legal framework of the International Energy Agency. IEA-RETD aims to empower policy makers and energy market actors to make informed decisions by: (1) providing innovative policy options; (2) disseminating best practices related to policy measures and market instruments to increase deployment of renewable energy, and (3) increasing awareness of the short-, medium- and long-term impacts of renewable energy action and inaction. IEA-RETD member countries are Canada, Denmark, France, Germany, Ireland, Japan, Norway, and United Kingdom. For further information please visit: http://iea-retd.org or contact iea_retd@ecofys.com.

ABOUT THE CONSORTIUM

GWS, the Gesellschaft für Wirtschaftliche Strukturforschung is based in Osnabrück, Germany. The activities of GWS are based upon economic modelling and policy analysis in a wide range of economic questions. This study has been led by the renewable energy and climate group in GWS. For more www.gws-os.com

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This publication should be cited as:

IEA-RETD (2014), *Policy Instruments to Support Renewable Energy Industrial Value Chain Development (RE-ValuePolicies)*, [Lehr, U., B. Breitschopf & G. Vidican; GWS/Fraunhofer ISI/German Development Institute] IEA Implementing Agreement for Renewable Energy Technology Deployment (IEA-RETD), Utrecht, 2014

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LIST OF ACRONYMS

CEEW	Council on Energy, Environment and Water
CEM	Clean Energy Ministerial
CENER	Centro Nacional de Energías Renovables - National Renewable Energy Centre
CENIFER	Centro Nacional Integrado de Formación en Energías Renovables - Training Centre for Renewable Energy
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas – The Spanish Research Centre for Energy, Environment and Technology
CHP	Combined Heat and Power
CSP	Concentrated Solar Power
DFAIT	Department of Foreign Affairs and International Trade
DLR	Deutsches Zentrum für Luft- und Raumfahrt - German Aerospace Centre
EAF	Electric Arc Furnaces
EC	European Commission
EPIA	European Photovoltaic Industry Association
E[r]	Energy [r]evolution scenario
EU	European Union
EU ETS	EU Emission Trading System
FDI	Foreign Direct Investment
FIT	Feed-in Tariffs
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GW	Gigawatt
IEA	International Energy Agency
IEA – RETD	IEA Implementing Agreement on Renewable Energy Technology Deployment
ILO	International Labour Organization
IOT	Input-Output Tables
IRENA	International Renewable Energy Agency
LCR	Local Content Requirements

LIUP	Local Industry Upgrading Program
MENA	Middle East and North Africa
MSP	Mediterranean Solar Master Plan
NDRC	National Development Reform Commission
OECD	Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
PSDC	Penang Skills Development Centre
PSA	Plataforma Solar de Almería – Solar Platform of Almeria
PV	Photovoltaic
RE	Renewable Energy, if not mentioned otherwise excluding large hydro and traditional biomass
RET	Renewable Energy Technology
RETI	Renewable Energy Transmission Initiative
R&D	Research and Development
SCM	Subsidies and Countervailing Measures
SME	Small and Medium Enterprises
TAC	Technical Advisory Committee
TGC	Tradable Green Certificates
TNC	Transnational Corporations
TRIM	Trade Related Investment Measures
UfM	Union for the Mediterranean
UNB	University of New Brunswick
VPAP	Visiting Professors and Academics Program
WTO	World Trade Organization

RE VALUE POLICIES - HEADLINES

- Industries spin off industries. Successful industrial players come from already existing adjacent industries. New industries can build on existing competitive industries. For example, the semiconductor industry has been an important starting point for a successful PV production in Japan. Analysing strengths and weaknesses of the already existing industrial structure should be a starting point for the design of any support instrument. Comparative advantages should be identified.
- Create an "industrial environment". Isolated approaches do not work. A successful industry needs partners along the value chain, partners in the financing sector who understand its needs, etc. Upstream and downstream integration benefit from the respective environment and enhance value creation. Policies should be designed taking all major aspects of the industrial environment into account.
- Infrastructure matters. Therefore, infrastructure bottlenecks should be eradicated before they become an impediment to industrial development.
- Local Content Requirements (LCR) can only be a start. The potential value of LCR goes hand in hand with creating an industrial environment. The success of LCR critically depends on the expected market size, domestically as well as regionally or internationally. The expected market size should be carefully analysed and the respective support instruments, such as demand side policies or reliable strategic plans, should be developed.
- Enhancing innovation capabilities matters. Demand oriented policies are important, but should be combined with the measures to increase innovation efforts in the respective industries. In the automotive industry, GM and Chrysler seem to have been on the verge of large innovation steps just when the crisis hit. The federal rescue gave them the time they needed to follow through.
- Downstream integration should be considered. It could provide a solution to coping with the current (financial/economic) crisis because it allows for recouping investment in specialized products by securing demand.
- Finding the appropriate policy mix is critical. To find the appropriate policy mix decision-makers need to closely assess several issues, such as: what are the domestic RET deployment status, RET industry and knowledge, and R&D intensity? What is the expected local, regional, and global market development? How strong is global competition? High RET deployment and an existing industry structure call for measures to better position the industry in international markets. High deployment but undeveloped industry structure requires complementary policies to capture value from deployment. Developed industries can help to spin off industries for inputs to the RE value chain. Diversification can create market niches for domestic products.

- Governmental commitment impresses investors. High level government commitment to strategic plans and a clear government choice of sectors or regions give investors security and confidence to develop an area.
- Involve all citizens/stakeholders from the start. Bringing all citizens/stakeholders along with you is a proven approach for successful implementation of policies. It works in two directions. Public support can be ensured by the respective discursive elements in policy design and policy makers can tremendously benefit from stakeholders input. Strict interventions can be ameliorated by round tables, public participation, and discussion platforms.
- Quality matters. Producers and investors are attracted by the ability to produce and design high quality products, and to develop answers to frontier research questions. Governments should introduce guidelines and training for quality standards to enhance comparative advantages.
- Policy consistency, reliability, and coherence are important. Negative interactions between instruments or strategies as well as incoherence between policy planning and implementation signal poor reliability. Although learning and adaptation of policy instruments to changes in the market conditions (domestically and internationally) is important, drastic and sudden policy changes are detrimental to investment, and hence to value creation.

EXECUTIVE SUMMARY

A. BACKGROUND, OBJECTIVES AND CENTRAL FINDINGS

Background

Renewable energy deployment remains an important issue. Generation of electricity and heat from renewable energy (RE) sources reduces the emission of greenhouse gases, provides energy access in remote areas, and diversifies fossil-fuel reliant energy supply, increasing energy security. As such RE deployment creates environmental and social value.

Increasingly, RE deployment also contributes to employment and the emergence of an economic sector which is participating in global competition. The question for decision makers in industrialized countries as well as in emerging economies and developing countries is: How can economic value be generated from RE and how can this process be supported by value enabling policies?

Objectives

This study is set out to:

- Offer/develop an analytic framework oriented toward identifying opportunities for value creation along the entire RE value chain;
- Identify and define RE value creation policies and discuss possibilities for strategic policy interventions to enhance RE value creation; and
- Deepen the analysis with lessons learnt from the development of RE and other sectors.

Central findings

Value creation is supported not by a single policy but by a policy mix. Important lessons can be learnt from the RE industry itself, which has developed rapidly although not as homogeneously as RE deployment. Further insights can be gained from established industries, whose development can be observed over a longer time in response to different policy interventions.

The main lessons learnt are the following:

a. An adequate policy mix (policy targets, instruments, and implementation) is important to enable value creation.
b. Promotion of demand for goods in the initial phase helps to boost the industry, but in the end competitiveness determines how much an industry is able to sell.
c. The existing industry structure and know-how in related industries matter as well as the potential spin-offs of new industries and spill-overs into other sectors.
d. Supporting industrial development is necessary through measures such as investment promotion, industrial clusters, centres of excellence, and education and training.
e. Adequate infrastructure is important.

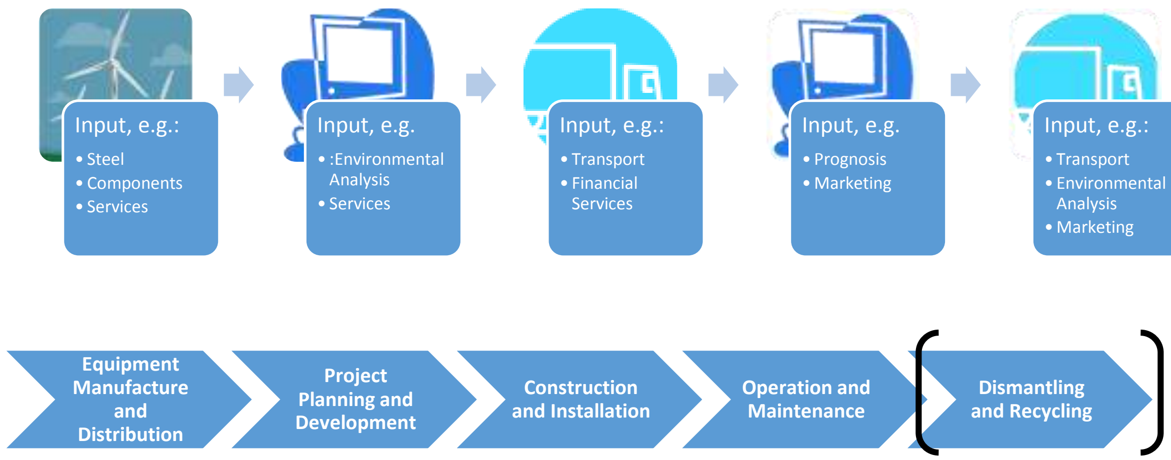
We use three criteria to cluster our findings into four types of economies and suggest a focus on the respective policy mix to enhance value creation. The country types differ by their state of RE deployment (high or low), their RE industry, and the existence of (other) R&D intensive industries. For each cluster, a policy mix is suggested which focuses on extending strengths and building upon opportunities.

B. From value chain to value policies

Context and scope

The analysis starts with the value chain concept. The renewable energy technology (RET) value chain includes four phases: manufacturing and distribution, project planning and development, construction and installation, and operation and maintenance (decommissioning / dismantling and recycling is important but so far there exist no experience or data) (see Figure ES1).

Figure ES1: Value chain in Renewable Energy Technologies



Source: ILO, 2012.

In each phase inputs from different economic sectors are needed. Deployment triggers additional demand for equipment, planning, installation, and operation and maintenance, as well as additional demand in the input sectors. Consequently, value creation happens throughout the economy in all economic sectors.

With this, we extend the scope of value creation beyond the very narrow focus point of RET production. To this end, the study sets out to define a framework for the analysis of value creation in sectors which may be hidden in the value chain. Upstream activities, such as the provision of raw materials or other intermediate inputs to production, or downstream activities such as installation, monitoring, or operation and maintenance contribute to value creation often more than the main production activity. Moreover, the former may offer more opportunities than the latter to find the right niche for developing a competitive industry.

The geographical scope of the analysis focuses primarily on IEA-RETD and OECD member countries. Recommendations and lessons learnt are also particularly interesting for emerging economies and developing countries, because they can try to avoid known fallacies and repeat successes. In terms of technologies considered, this report focuses on wind and solar electricity generation. Other technologies are considered in more general terms.

C. SEIZING OPPORTUNITIES – IDENTIFYING RELEVANT POLICIES FOR VALUE CREATION

Which policies are important?

RE Value policies

... aim at increasing the domestic share from RE value creation such that overall societal welfare is maintained or increased. This can be most efficiently achieved by:

- Improving competitiveness and the regulatory and economic framework for economic sectors and technologies related to RE, based on allocative efficiency;
- Improving the availability, accessibility, and quality of resources (capital, natural resources, human capital) used for RE deployment;
- Stimulating demand for RE(T); and
- Directly addressing support to selected RET producers or service providers.

To understand which policies are crucial to capturing a large share of RE value creation, bottlenecks for RET use and value creation need to be analysed. Therefore, the analysis is based on the value chain approach for RET, following two main steps.

First, the policy analysis looks at the key factors in RE value creation. Three factors have been defined along the value chain:

- demand for RET (e.g., for PV plants)

- suppliers of RET and its components, e.g., of PV cells, modules, converters, and systems)
- inputs for RET (e.g., inputs for operation and maintenance, manufacturing, construction, planning, etc.)

Second, the policy areas with a potential impact on inputs, demand, or suppliers are identified. These policies can comprise clearly delineated or very broad policies, such as energy or climate policies, R&D, financing, fiscal, and trade, policies. All financial instruments deal with financing issues, while regulatory instruments address rules, regulations, property rights, etc.; education instruments address skills and know-how, knowledge generation, capacities, and capabilities; and, finally, infrastructure refers to public goods or networks that are needed by selected suppliers, consumers, or both. Policies addressing inputs are called complementary policies as they could improve not only the quality or quantity but also availability or access to these inputs for all sectors.

Policies addressing these issues are then called supply related, demand or input related (complementary) policies, reflecting the focus of the policy. Furthermore, there are barriers in different areas such as infrastructure, human capital, financing, regulation, etc. Policies addressing these areas are referred to as policy types. This approach is depicted in Table ES1. The type of policy shows which area or level is addressed by the instrument.

Table ES1: Examples of RE value creation policies

focus type	Demand	Supply	Complementary
Financial	e.g., FIT	Grants, soft loans	R&D grants
Regulatory	e.g., ISO	Labels, IPR	Mandatory education
Educational, research, learning	Information platform	e.g., Training	R&D networking
Infrastructure	Financing infrastructure	Power grid	Finance of rails

RET demand related policies are often understood or translated as policy instruments that create demand for RET. But additional policies, such as having a vision and strategy for RET deployment as well as policy making and implementation, are also very crucial. Examples for these policy activities are given below:

RE demand policies should comprise:

- Vision and strategy: e.g., action plan, roadmap 2050;
- Objectives: e.g., 20% RE electricity generation in 2020;
- Instruments: e.g., FIT, TGC and quotas, subsidies, grants, regulation, financing;
- Policy making: suggestions and decisions on targets and measures, changes (proactive) and announcements, lobbying opportunities, reporting; and
- Implementation: institutional set-up for generation, controlling, installation, procedures for evaluation, adjustments and announcements, and societal participation.

In contrast to demand policies, supplier focused policies are very specific and target either a sector or firm. They can include selected measures regarding investment support, establishing discussion platforms, selective educational curriculums, and mandatory training in a special technology or activity.

Supplier focused policies:

- are selective, focusing on the producing and service sector – at the firm and / or sector level;
- range from protective instruments and interventions addressing market failures to creating a stimulating economic framework for selected firms or sectors/technologies; and
- comprise parts of complementary policies that address special needs of selected sectors or technologies.

The understanding of supplier focused policies is broad: from instruments to a process oriented policy engaging in collaboration with the private sector to find the right policy focus and instruments.

Examples: process oriented policies could include stakeholder involvement for policy target formulation; policies for selected technologies could include technology parks, selective R&D; selective policy might be grants for investments, tax relief for certain production processes or inputs, etc.

Input related, or complementary, polices refer to all measures that somehow affect the quality, quantity, or availability of inputs, such as human capital, infrastructure, etc. They are called complementary policies as they do not target a special technology, firm, or sector but contribute to a general improvement of the factor conditions, i.e., the competitiveness of the economy.

Complementary RE policies:

- are not selective and do not target specific industries;
- focus on enhancing and strengthening competitiveness of all industries or sectors; and
- affect the use of human and natural resources and capital.

Examples: training programs, R&D grants, centers of excellence, rail or road infrastructure

Finally, we must choose not only the "right combination" of different policy focuses (demand, supplier, complementary) and policy types (financial, fiscal, education, infrastructure) but also ensure consistency and coherence among the planning, instruments, implementation, and so on; i.e., choose the right mix of policy activities. Therefore, RE value creation policy is a policy mix, understood here as the mix of:

- Policy types
- Policy focus
- Policy consistency and coherence

Case studies: From RET deployment to industrial development

Drawing on the current international discussion on industrial development and employment creation as well as on international best-practice policies, the analysis suggests a number of practical policies for RET value creation. The implementation of these policies needs to take into consideration: (a) the specific challenges to promoting RE industries; (b) the specific country level framework conditions; and (c) the level of domestic capabilities in different parts in the RE value chain, relative to other countries/regions (i.e., comparative advantage). Table ES2 illustrates the policy interventions discussed in the study, aimed at enhancing capabilities in the private sector and boosting knowledge creation.

Table ES2: Policy interventions and opportunities for value creation along the RE value chain

	Equipment Manufacture and Distribution	Project Planning and Development	Construction and Installation	Operation and Maintenance
Strategic investment promotion	X	X		X
Linking investment to employment creation and capacity building:				
- Local content requirements	X	X	X	X
- Supplier development programs	X	X	X	
Developing industrial clusters	X	X	X	X
Cooperation between public research organisations and the private sector	X	X		
Enhancing know-how through education and training	X	X	X	X

These policy interventions will generate various opportunities for value creation along different parts of the value chain. For example, while advanced skills development programs are expected to create value along the entire value chain, some policies, such as investment promotion, tend to support value creation especially in manufacturing, project development, and operation and maintenance.

Strategic investment promotion

Once the vision and objectives for RE development have been set, investment is critical for enabling industrial development (and hence value creation). While restrictive policies on investment promotion can discourage the private sector from making investments, a wide set of incentives might also fail to guarantee that investors will be able to maintain their regional competitiveness for a long time, leading to a potential waste of state resources.

Therefore, a strategic approach to targeting specific firms and segments of the value chain, based on a long-term vision for the RE sector (and its dynamics relative to other sectors), is necessary to guide the actions of foreign investors towards higher value creation at the local level. The following messages emerge:

- Strategic targeting of specific firms and segments of the value chain based on a long-term vision for the RE sector is necessary.
- Restrictive policies can discourage private sector investment.
- A wide set of incentives, without targeting, does not ensure higher competitiveness.

Linking foreign investment to local job creation and capacity building

Closer linkages between foreign investors and the local economy can be made mandatory via local content requirements (LCRs) or by supporting supplier development programs that enable local companies to upgrade and enter partnerships with foreign suppliers.

There is considerable controversy over the use of LCRs (see the case of Ontario, Canada). If judiciously applied, they may increase the local share in projects and may in some cases help technology transfer and learning. But if they are too ambitious and force project developers to source local products that are inferior in terms of international market prices or product quality, LCRs may undermine the competitiveness of the entire value chain and potentially deter investment. The study leads to three guidelines for policy makers seeking to implement LCRs:

- First, LCR policies should be limited in duration and incorporate planned evaluation phases.
- Second, they should be technology-neutral and consistent with other industry promotion policies.
- Third, on their own, LCRs are unlikely to enable local firms to fully develop the capabilities needed to be globally competitive in the long-run.

Further, several determinants are important for LCRs to be effective in creating value from RE deployment: market size and stability, policy design, cooperation among the government and the private sector, financial incentives, industry sophistication, and innovative potential.

Supplier development programs targeted especially at upgrading capabilities of SMEs (small and medium enterprises) are needed to enable local companies to capture value from RE investments and to foster closer linkages with foreign investors. For supplier development programs to be effective, best-practice examples suggest that instead of being mandated by the host country, such policies work best when they are driven by the private sector (especially by lead firms with experience in global markets). Examples of best practices for supplier development programs in various sectors can be found in Singapore, Ireland, and Mexico. While these examples are not RET specific and go beyond the focus on OECD countries, supplier development programs tend to be more generic and, hence, more easily adapted to the needs of different sectors, technologies, or countries. Evidence from various countries and sectors suggests that the following measures have been among the most effective for supplier development support:

- Coordination of and information on promotion measures
- Matching between potential customers and suppliers
- Economic incentives to intensify supplier relations and technology transfer

Developing industrial clusters

Industrial clusters are important to promote economic competitiveness, to enhance the innovation capacity of SMEs, and promote research and innovation collaboration projects. Policy principles in the development of industrial clusters include:

- Mechanisms to promote a mix of competition and cooperation between firms;
- Policies that emphasize the linking of firms to the (local/regional) technological infrastructure of education and R&D institutions;
- Balanced input of resources from government and industry;
- "Nudging" private companies and inviting them to collaborate and network among themselves;
- Trust-building and enhanced dialogue to create spillovers; and
- Joint marketing and regional branding.

The best-known examples of cluster development initiatives in the RE sector can be found in the US and in Germany. In light of changes in global market conditions for RET, a key challenge for most RE industrial clusters is how to become more resilient so that they can adapt to global competitive pressures.

Improving cooperation between public research organizations and the private sector

Improving linkages between public research organizations (i.e., universities and research institutes) and the private sector as a channel for creating a more favourable environment for innovation, entrepreneurship, and technology development should have a high priority for enabling value creation in the RE sector, with a strong impact especially on the manufacturing and project planning and development phases of the value chain. Ways of improving such links include:

- Supporting the creation of centers of excellence;
- Joint funding from the private sector and the government for technology oriented research; and
- Involving universities (faculty and students) in applied research through various channels (e.g., joint appointments, internships).

In the field of RET, examples for policy makers include the Canadian CanmetENERGY (a research centre for clean energy technologies), WEICan (a research institute for wind energy technologies), and TechnoCentreÉolien (a research and support centre for wind energy technology); the Plataforma Solar de Almería in Spain; and the Fraunhofer Institute for Solar Energy in Germany. These organisations thrive on close coordination between research and the needs of the private sector. The research and testing facilities create an excellent environment for cooperating with the private sector and public research organizations, driving R&D and innovation for RET.

Enhancing know-how through education and training

Skills development interventions must be implemented hand-in-hand with efforts toward industrial upgrading and technology development (e.g., R&D and innovation activities), thus increasing the demand for higher skills. Hence, interventions to enhance know-how through education and training can vary depending on the existing level of capabilities as well as on the industrial structure and the development pathway. Such measures could include:

- Integrating training programs into public sector vocational training systems;
- Promoting and coordinating local apprenticeships;
- Improving basic and strategic management education in universities and training centers;
- Establishing training centers based on public-private partnerships;
- Developing "training the trainer" programs on RETs; and
- Encouraging training that complies with international standards.

Examples of successful skills development initiatives that can be used as reference points for decision-makers are the Penang Skills Development Centre in Malaysia, RE training programs in the Navarra region in Spain, and vocational training programs for RE in Germany.

D. Lessons learnt from other sectors

Policies to enable or support value creation can be observed in most industrial sectors. The purest economic motivation for this is the existence of market failures. Further motivations for policy interventions are securing national interests and avoiding socially undesired results. Target categories of policy interventions in economic practice are the following:

- Keeping a minimum amount of domestic production in certain sectors (to hedge against quantity and price shocks). Typically this goal is driven by security considerations, whether military or in terms of resource access and provision of certain goods (such as refineries, steel, and trains). Pursuing this goal includes interventionist measures.
- Ensuring a soft transition from "old" to "new" sectors, e.g., compensation measures for loss of jobs, re-training programs, and support of shrinking sectors (for example, in coal mining in Spain).
- Strengthening of future-oriented, promising sectors to be ready for a leading role in innovative markets (picking winners); the automotive sector is an example.

From observations of the development of selected sectors, the following lessons can be learnt:

Support demand temporarily

In the commercial aircraft sector, initially, most airlines were state owned, which led to the "comfy duopoly" (Boeing and Airbus) that characterized the sector for a long time. Demand was guaranteed and developed with the market size. Recently, pressure from Asian companies has emerged. Clearly a sizeable market with guaranteed returns does attract competitors.

Demand side measures help to establish the market in its initial phase. Even in established markets, such as the automotive sector, they are used to overcome temporary distortions. The rebate system for used cars (cash for clunkers, scrap bonuses) helped the automotive industry out of the 2009 crisis. However, in established markets, these systems are temporary and aimed at supporting the self-healing forces of the industry.

Infrastructure matters

Industries and products can only be successful when adequate infrastructure is provided (the role of complementary policies). The most obvious example is the automobile industry, which literally could not have gotten anywhere without roads. The same holds true for the aircraft industry: without airports, airport security, and air traffic security, the development of large aircraft would have been impossible. In electricity generation, as in any grid-bound technology, the existence of infrastructure is also crucial for the distribution of the product. The lack of grid connections has caused a severe bottleneck for wind energy development in China.

RETS have the capability of addressing off-grid power supply challenges. Long-term infrastructure planning helps prevent sunk costs from off-grid solutions followed by the grid connection arriving shortly thereafter. This, of course is more important in developing countries. In industrial countries, the grid needs to be made fit for increasing shares of RET.

Closely related to the infrastructure motive is proximity to customers. From the steel industry one can learn that large coke-fired steel plants were located near either means of transport (ships or railroads) for the raw materials and the product, or near the resources and the customers themselves. For RET production, which involves heavy parts such as wind turbines, this means that producing near an emerging large market may pay off. For politicians this points to securing the market with demand-supporting policies that enables the development of a large market and attracts production – and thus domestic value creation.

The infrastructure consideration can be taken one step further, a lesson from the large players in the automotive industry. Infrastructure can be defined more broadly to include qualification- and capacity building. Countries with a successful automotive sector also provide education and training in terms of vocational training and study courses. RET has taken a similar route. In Germany, for instance, 148 study courses focusing on renewable energy are currently offered. This sort of effort falls under the category of complementary policies.

Industries spin off industries

Today's successful industrial players were born out of existing strengths. The backbone of the Asian PV industry, for example, is the pre-existing strong industrial base in semiconductors. The German wind industry likewise relies on a strong background in machinery and engineering, and Austria established a competitive and successful industry for automotive parts based on its own machinery and engineering foundation. These facts argue for a strategy of first analysing a country's strengths and existing knowledge, matching these with the value chain phase where they can make a contribution, and then deriving policies.

E. Recommendations for Policy Actions

While not a new message, the results of this study stress that there is no one-size-fits-all solution regarding policy interventions for RE value creation. To successfully design policies that capture a large share from RE value creation, a detailed analysis is necessary. The steps necessary for such an analysis are highlighted below.

Identifying opportunities for value creation and effective enabling policies

- Identify where in the RE value chain can value most efficiently be captured

Value creation takes place and can be captured:

a. In the industry that is directly involved in RET deployment including services as well as products (first order effects) (i.e., in industries in which the country has a comparative advantage, such as the manufacturing, construction, installation, and operating and maintaining sectors); and
b. In the upstream industry (second order effects) that provides services and goods for the supplying industry, such as IT, steel, glass, electronic, cement, fibre, and so on.

The relative share of the first and second order effects as well as the share of industries depends on the specific comparative advantages and domestic capabilities.

- Identify and implement the most effective policies for RE value creation

Many interacting factors and dependencies among industries, politics, consumers, and framework conditions determine value creation. Therefore, the policy mix must be customized for local framework conditions.

However, to understand which policies are important one has to know what is needed for value creation. A country seeking to enable value creation from RET deployment should be endowed with three main factors:

a. Qualified suppliers of RET (industries and services)
b. Strong demand for RET
c. Qualified inputs for RET (e.g., financial and human capital, infrastructure, etc.)

The challenge is to identify policies that support the formation of qualified suppliers, creation of strong demand, and provision of qualified inputs for production. The first step, therefore, is to analyse where the bottlenecks are. Are there any RET suppliers? If not, why not? If so, which barriers do suppliers of RET or upstream goods face? Is there a demand of RET? If not, how to promote strong domestic demand or export markets for RET? Are there sufficient inputs for RET production? If not, what are the constraining input factors (human capital, infrastructure, skills, know-how, financing, property rights) that inhibit the development of a strong competitive RET industry, and where are competitive advantages?

In addition, value enabling policies will always be cross-cutting and comprise a mix of policies addressing RET demand (market), suppliers (firm or sectors), and main input factors. The mix will differ by country or region, by development state, by the resources available, and by a country's taste or culture for certain policy approaches.

Identifying the policy mix for RE value creation

Based on the above insights, the approach to identifying the appropriate RE value creation policy mix can be structured by gaining insight into the following aspects:

- domestic RET deployment
- RET industry structure
- knowledge and R&D intensity

Having identified the RE deployment status, RET industry structure, and R&D intensity, the development potential and respective bottlenecks need to be evaluated. This also includes an analysis of expected local, regional, and global market development as well as of the degree of regional and global competition. Based on these steps, value creation policies can be prioritized.

Depending on the degree of RET deployment, industry strength, and knowledge and R&D intensity, countries can be roughly grouped into four cases (drawing on the solar PV and wind energy sectors) (see Figure ES2):

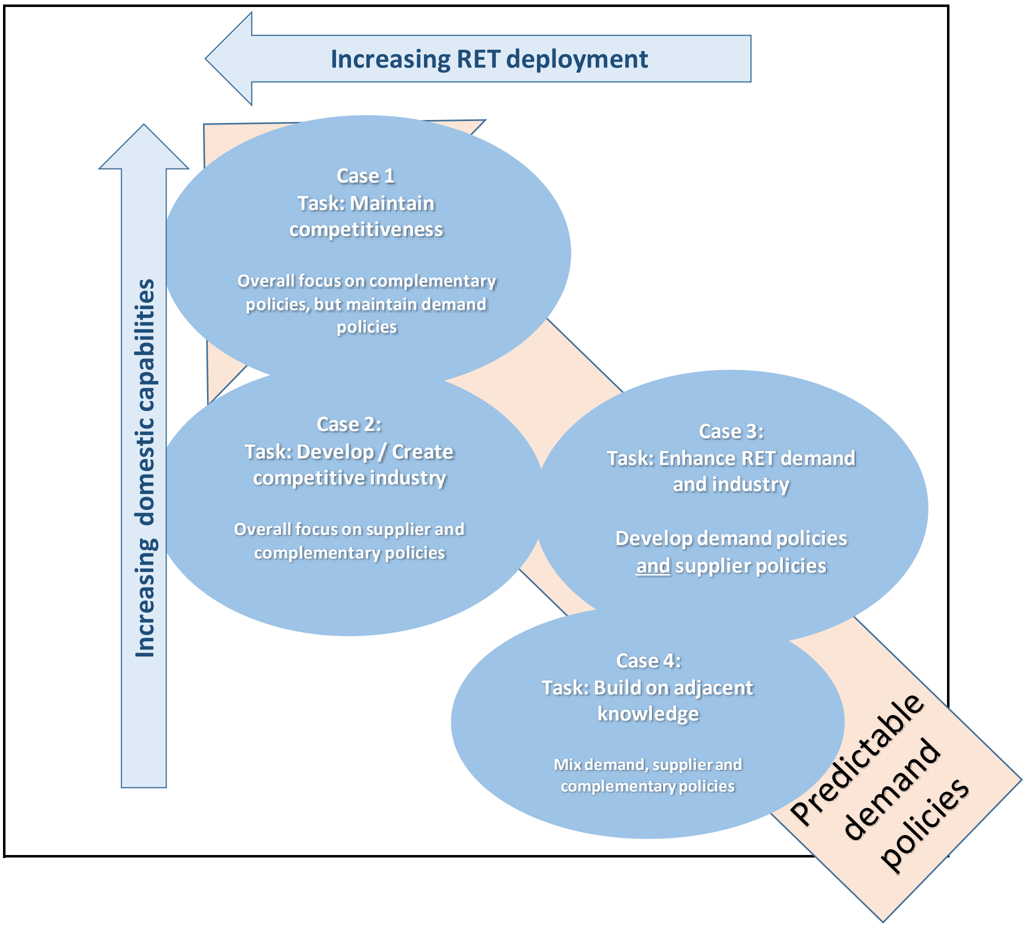
Case 1: Countries that have extensive RET deployment, a strong RET industry, and R&D intensive industries (e.g., Germany, Spain, Denmark, Japan, China, and the US, and to a lesser extent Italy and Brazil).

Case 2: Countries that have some degree of RET deployment but weak RET industries and little R&D intensive industry, such as Morocco, Tunisia, India, Turkey, South Africa, and Mexico.

Case 3: Countries with neither extensive (new) RET deployment nor a strong (new) RET industry but do have strong knowledge- and R&D intensive industries (e.g., Netherlands, Russia, Canada, and France).

Case 4: Countries that have no (or very low) RET deployment, no RET industry, and no R&D intensive industries (e.g., most sub-Saharan Africa countries, Gulf Cooperation Countries, Middle East).

Figure ES2: Country case clusters



The appropriate policy mix will vary according to the characteristics of the countries in each case grouping:

Case 1: The challenges for these countries seem the least daunting, but new ones have arisen recently. New market players have entered, competition has increased, and demand policies are being reviewed in the light of stretched budgets and increasing RET deployment. To maintain domestic value creation, it is important to seize the opportunity in international markets by means of competitive prices and competitive products. Policies can support R&D in markets that call for innovative products. Demand policies applied in a commensurate way, however, are not obsolete, because domestic markets serve as showcases for international buyers. Also, specialization and diversification can create new market niches. Special applications can be supported by demand increasing policies.

Case 2: Within these countries, demand policies have been successful in enhancing deployment but have failed to induce domestic value creation. This may be explained by the fact that the international competition is so strong that the domestic industry cannot catch up, and hence building an RET industry is not profitable. Complementary policies strengthen the knowledge base across the economy, and supplier focused policies enhance competitiveness in the private sector.

Case 3: Countries that already have knowledge-intensive and competitive industries can develop them toward the RE value chain. Intermediary goods and services can spin off existing industries to the RE sector and thereby capture value. This includes export of inputs to RET production and value creation thereof. The respective instruments to support this process are mainly complementary and sector/firm-specific policies.

Case 4: When RET deployment is low and the industrial structure as well as R&D intensity is weak, RE can provide a starting point for industrial development. Once the niche market is identified, RE demand policies, supplier focused policies targeting specific economic actors that produce goods and services, and complementary policies should be deployed simultaneously.

For most, if not all, of the policies aimed at industrial development (and value creation more generally), the presence of a large and predictable demand for RET is critical. Therefore, for RE value creation policies to be effective, robust (i.e., ambitious and consistent) policies for market creation (RE demand policies) are a precondition. If the local market is small or saturated, emphasis should be put on strengthening export opportunities. For value creation to emerge, demand oriented policies need to be complemented with policies aimed at strengthening competitiveness (e.g., education, training, R&D, infrastructure, supplier development, industrial clusters). In this process, investment promotion and facilitation is critical. In practice, the strength of these policies varies among countries, implying that policy makers need to carefully assess the necessary interventions at multiple levels in order to achieve the desired results. Hence, monitoring and evaluation should accompany the implementation of the policy mix, while constantly taking note of changing market conditions.

1 Objectives and Background

The RE Value Policies analysis aims at "assessing a basket of cross-cutting policy instruments (innovation, labor, industrial, finance, export, etc.) which could complement the currently used set of renewable energy (RE) policies to enable countries to get the most economic benefits from RE deployment and RE related industries" (ToR 2012). For this, the scope of the analysis takes the whole RE value chain into consideration.

The discussion on renewable energy technology (RET) deployment has recently shifted from "why" to "how". Investment in RET around the world has increased steadily over the last 10 years, driven by a growing understanding of the pressing issues of global warming, energy security and energy access, and the role renewables can play in addressing these issues. Worldwide, 118 countries have set renewable energy targets and total new investment in renewable energy has risen from US$40 billion in 2004 to $244 billion in 2012. Renewables accounted for an estimated 22% of global electricity production and more than half of net total additions to global electricity capacity in 2012 (REN21, 2013).

Economists contributed cost estimates and suggestions of different financing mechanisms and how to allocate the additional costs of RET. Although the cost debate is important, other economic aspects need to be addressed, especially since RET prices are falling rapidly. More and more governments are interested in capturing additional economic benefits of RET deployment by establishing competitive industries, creating value added and stimulating employment.

Against this background, IEA-RETD commissioned the present study by a consortium consisting of the German Development Institute (Bonn, Germany) and Fraunhofer-ISI (Karlsruhe, Germany) under the lead of the Institute of Economic Structures Research (Osnabrück, Germany).

The challenges of turning RET *deployment successes* (measured in terms of capacity installed, electricity produced, etc.) into *socio-economic successes* (measured in terms of jobs or value added) are manifold. The initial experience in industrialized countries was that RET industries developed in parallel with deployment, and thus deployment success equalled economic success. However, recent market development seems to indicate that this strong tie might be severed. New competitive players in the field, notably from China, have entered the market and had some economic success before strong domestic deployment plans were put in place. Moreover, developing countries such as the Middle East and North African (MENA) countries with large wind and solar natural resources have developed ambitious deployment plans without yet garnering their share of economic value creation from RET deployment.

The first goal of this study, therefore, is to provide a framework for the analysis of the impact of RET deployment and the RET industries throughout the economy. An analysis of the complete value chain can help all players, be it individual companies or whole sectors. Specifically, it can identify value creation opportunities along the RE value chain, determine country-specific niches and assist policy makers in targeting policies for capturing value in all economic sectors concerned.

Today's RET markets are highly regulated and various policy instruments have been used to promote RETs. Yet, given the cross-cutting approach needed to foster value creation from RETs, a new definition of RE value creation policies is needed. Thus, the second goal of this study is to focus aspects of industrial economics and renewable energy policies on RE value creation. The definition of RE value creation policies complements the analytic framework from step one. The framework is illustrated with examples from the RE sector and from other sectors.

The third goal of the analysis is to draw on lessons learnt from all sectors, either as best-practice examples or as examples of failures to be avoided.

In pursuing these goals, this report aims to explore two key questions:

1. How can RET investments be turned into drivers and catalysts for sustainable development and value creation with the best result for local populations?
2. What policy instruments are most effective for achieving these outcomes?

The analysis focuses primarily on IEA-RETD and OECD member countries. Recommendations and lessons learnt will also be particularly interesting for emerging economies and developing countries. To this extent, the project feeds into the larger initiative of the Clean Energy Ministerial (CEM) working group on solar and wind energy technologies, econValue, lead and coordinated by International Renewable Energy Agency (IRENA) in partnership with key organizations and research institutes. Some numerical examples in RET are taken from the case of Germany since it has been a large player in the field in terms of capacities installed, weight of t support policies for RE deployment and industrial development and amount of analyses or policy evaluations published. However, data on value creation can be easily transferred to other OECD members, because the RE industry is fairly new and production processes in these countries are similar to each other. In terms of technologies considered, this report focuses on wind and solar electricity generation. Other technologies are considered only in more general terms.

The report is organized as follows: After this introduction, Chapter 2 provides the definitions of economic value added and the value chain, and gives an overview of existing opportunities along the value chain, which have been explored in the past or might open in the future. Chapter 3 offers a detailed discussion of RE value creation policies, defining value policies in both bottom-up and top- down approaches. Chapter 4 addresses the most pressing question for newcomers: How can they find the right niche? Chapter 5 turns to other sectors for an understanding of the development process in mature industries. Chapter 6 highlights the main conclusions and offers key recommendations for policy makers.

2 FROM THE RE VALUE CHAIN TO VALUE POLICIES

This chapter sets the framework for the subsequent analysis, which is important given that aspects such as system boundaries, inclusion of second-round effects, and geographical scope have an impact on value creation from RETs. It starts with the central value definitions and shows where value is created along the RE value chain (Section 2.1). In Section 2.2, opportunities for value creation along the value chain are identified for both the solar PV and wind energy sectors. Section 2.3 addresses the question of how countries can find the right niche in RE sectors. Using examples from more mature markets, factors that contribute to achieving these objectives are analyzed, and the process by which promising economic niches can be identified is described.

2.1 CAPTURING VALUE

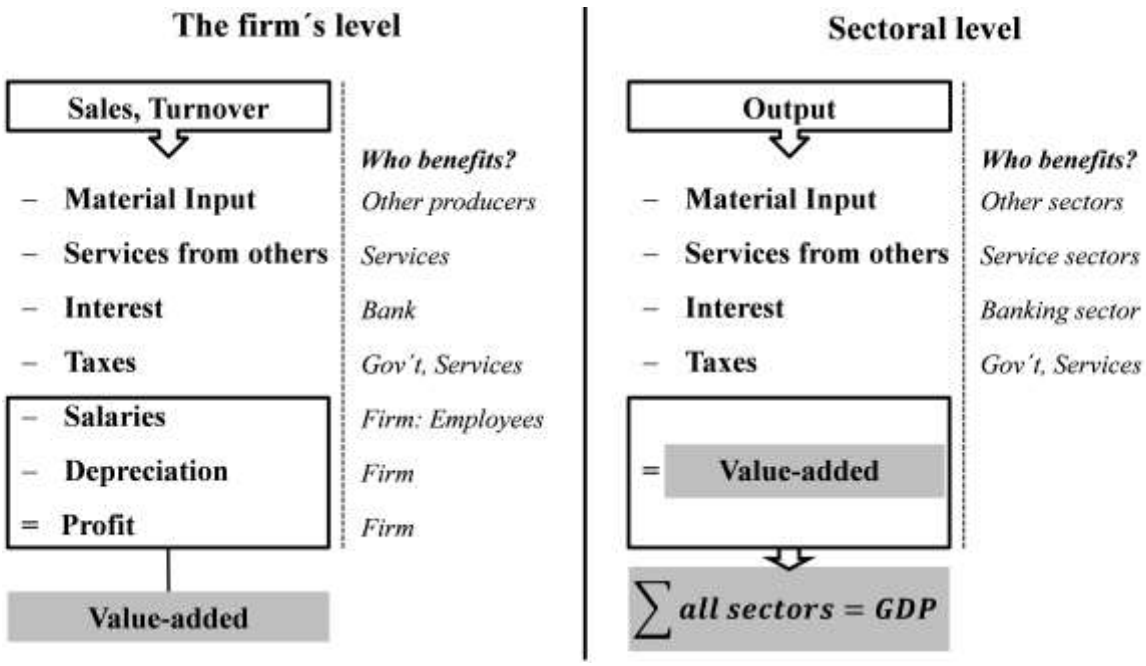
2.1.1 Value creation and value added

Value creation is at the center of economic activity, whether of firms, sectors, or countries. From the point of view of a firm or any private enterprise, value creation is the source of the firm owner's profit and wages or salaries for the employees. At the micro-economic level, value added is defined as the amount of money, which remains in the firm after all payments for material inputs, services from others, interest on loans, and taxes are settled.

At the more aggregated meso-level of an economic sector, the definition is similar: Value added is defined as the production value of the sector minus all purchases of inputs (at basic prices) from domestic providers or from imports. Value added in an economic sector is always domestic. If the geographical boundary of the data used for the analysis is a region and not a single country, then domestic refers to the region. In terms of wages it increases incomes of the workforce in the country, while in terms of profit it adds to the wealth of company owners. Both wages and profits can be spent within the country and thus create additional value in other sectors, such as consumption of goods or services, which themselves create further value added (induced effects). In addition, the demand of one sector for material inputs from another sector creates value added; this is called a second-round effect. The more production steps along the value chain are successfully and efficiently integrated domestically, the larger is the contribution of a sector to overall value creation in the economy. Summing up all value added over economic sectors (net of subsidies plus taxes) yields the highest level of aggregation.

This sum (plus taxes, minus subsidies) is called gross domestic product (GDP) at the macroeconomic level. GDP is the most popular and widespread measure of economic performance[1].

Figure 3: Value added on the firm's level, the sectoral level, and the macroeconomic level



Source: The authors.

According to the OECD, "value added reflects the contribution of labour and capital to production. It can be shown by: type of enterprise/establishment (activity, size, market/nonmarket, age, etc.); type of product, and institutional sector and combinations of these, and is a key variable in economic analyses such as productivity and structural analysis" (OECD, 2010). This definition emphasizes the sectoral level and the meso-scale effects. This report also focuses on this level by analyzing value creation in the RE sector and all other sectors contributing to RE deployment.

2.1.2 Sectoral value added and GDP in OECD countries

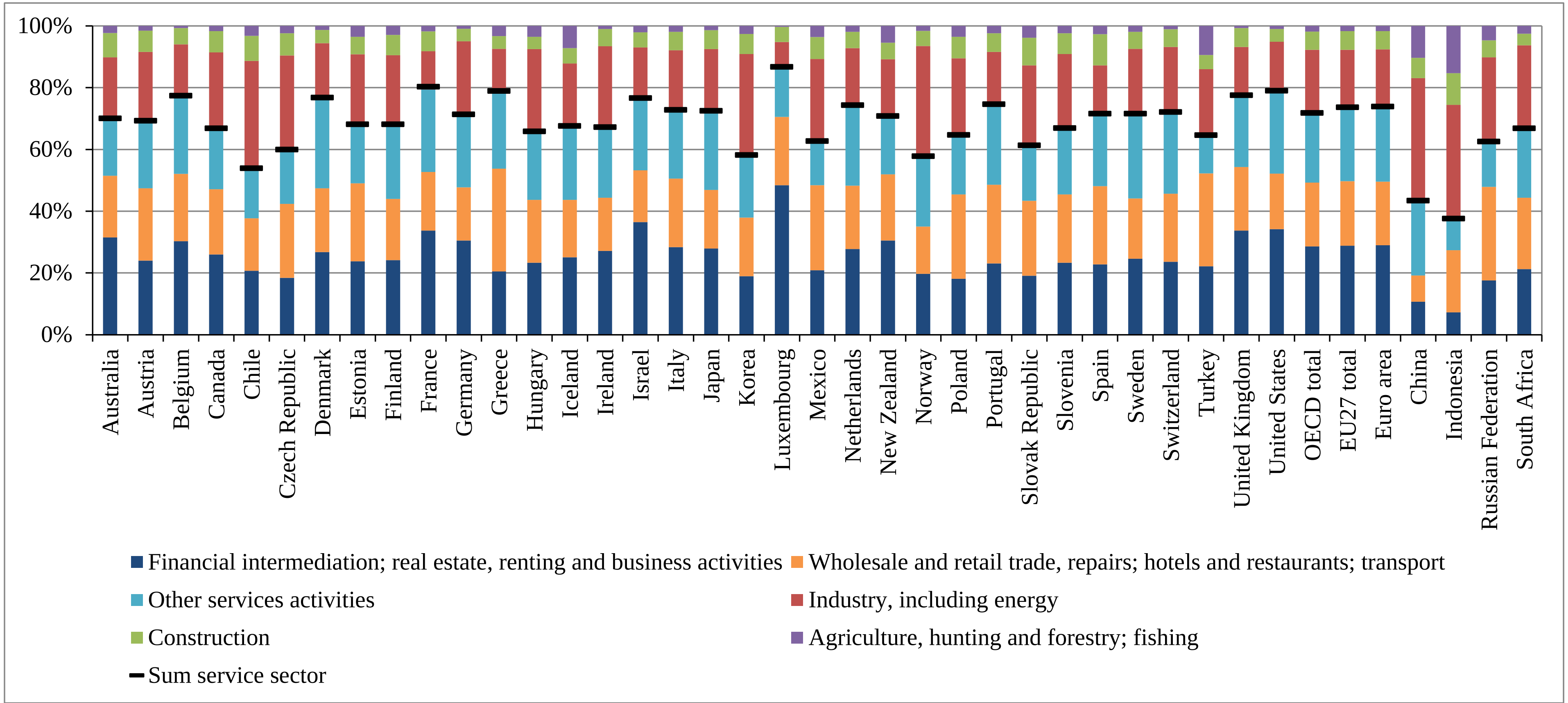
Why talk about value added? At the micro-level, the success of a firm is measured in terms of its value added from a given material input and at a given output. Moreover, that success typically is measured by looking at the potential profit, i.e., also at a given level of employment. At the meso-scale, the analysis of value added sheds light on potential employment and potential profits of a sector. The success criterion is similar to that for firms: the performance of sectors is compared across countries. The more that can be produced from material inputs (i.e., the greater the output per unit of input), the more efficient and more successful a sector is considered.

[1] Widespread does not mean undisputed. Other measures for people's well-being have been suggested, but currently they are neither established nor documented with time series data.

While the comparison of firms might be interesting for investors or the stock market, the development of a sector in international comparison is of interest for policy makers. Why are some sectors less successful in some countries? Shaping factors include access to resources, infrastructure, finance, domestic price levels, and a qualified workforce, among others (see Chapter 4). Even non-interventionist economists generally see providing the framework conditions for nurturing these factors as a government role. Chapter 4 discusses support policies for selected established economic sectors and explores what can be learned from these sectors for RE value policies.

The macro perspective leads to an estimate of the relevance of sectors to overall GDP. Figure 4 compares the contribution of the main sectoral aggregates to GDP for OECD countries as well as China and India. In most OECD countries agriculture accounts for a rather small share of GDP. This is in line with the conclusions of Barry Eichengreen and Poonam Gupta (2009). They point out that "the pioneers of the literature on structural change, such as Fisher (1939) and Clark (1940), who emphasized the shift from agriculture to industry in the course of economic growth, have observed the fundamentals of the sectoral contribution to GDP". Yet, stark differences between countries exist with respect to economic structure. For instance, Luxembourg, but also Belgium and France exhibit rather small contributions of this sector to GDP. Construction features more strongly in the emerging economies such as China and Indonesia. The tertiary sector (services in trade, financial intermediation as well as other services) contributes 70% or more in 50% of all countries (median value). Within the OECD, the average contribution of the tertiary sector is 71.8%. Germany's tertiary share is 71.3%, slightly below average. The median country is Australia.

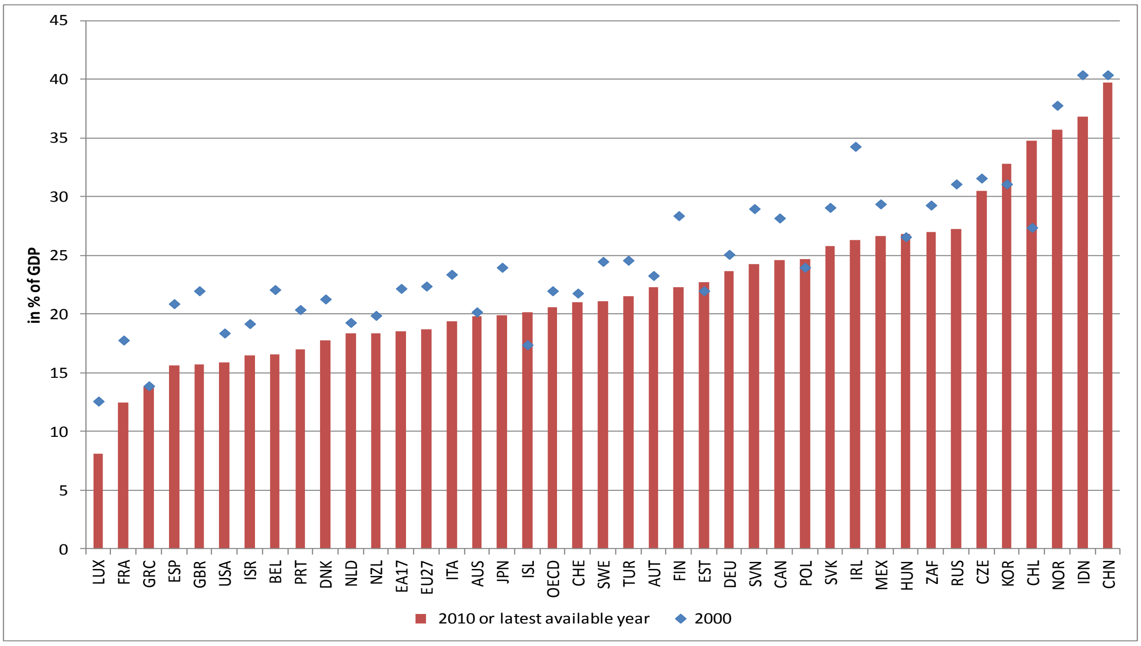
Figure 4: Contribution of main aggregates to GDP (in % of total GDP) in 2010 or year of latest available data



Source: OECD, 2011, author compilation.

The share of industry has evolved in OECD countries over time, as shown in Figure 5. Some European countries such as Ireland have shifted in their main contributing sector away from industry and towards services.

Figure 5: Contribution of the industrial sector to GDP in OECD countries, China and India



Source: OECD 2011, Author compilation..

Only few OECD countries increased the share of industry in GDP between 2000 and 2010, notably Chile, Estonia, Hungary, Korea, Poland, and Iceland. In Chile, Norway, and partly for Poland the mining sector is largely driving the comparatively high shares. The shift toward service sectors in the OECD countries' structure is partly caused by outsourcing. Less productive parts of the respective industries, such as cleaning staff, catering, and logistics, have been outsourced and the personnel moved to the service sector.

The share of value added in GDP translates into a share of employment of the respective sector in overall employment. Employment is used as an indicator of the success and the necessity of industrial policies.

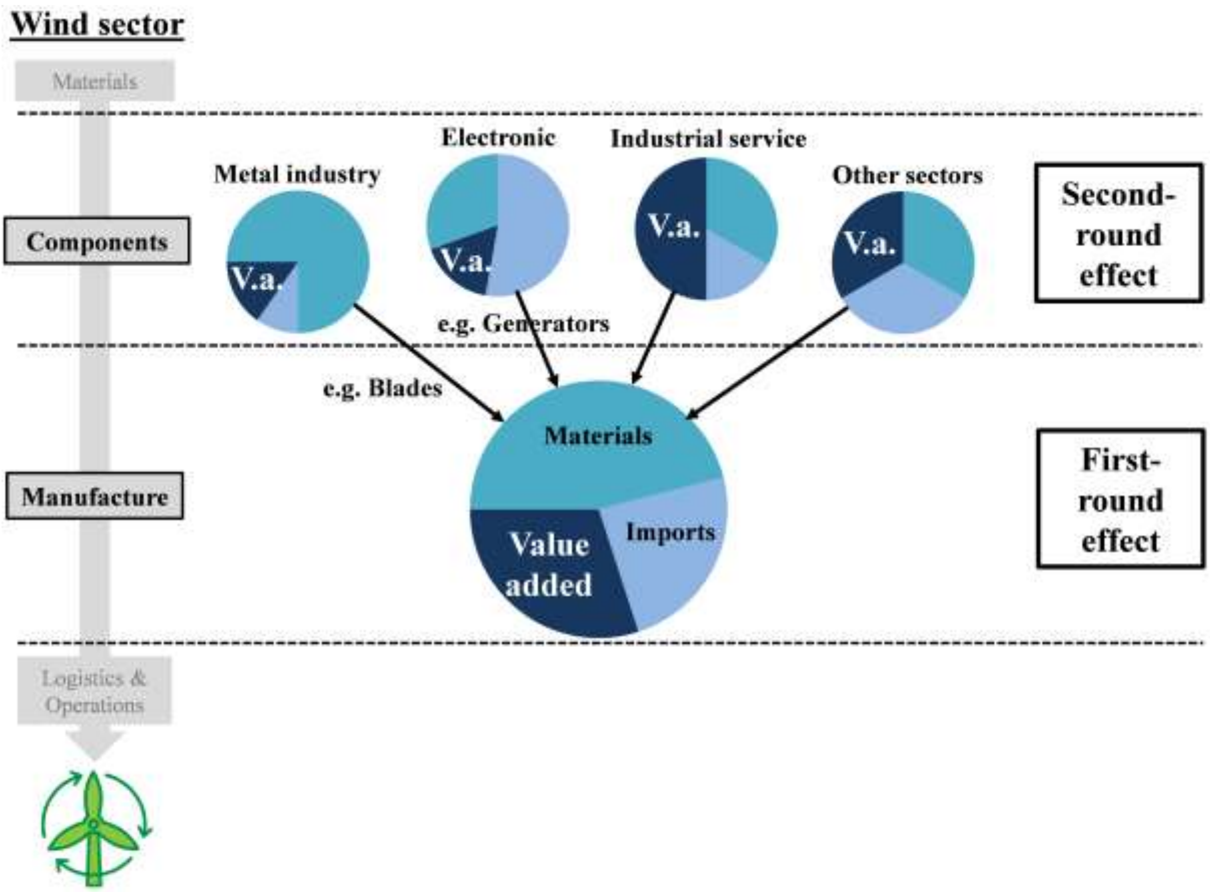
Data on value added, available in most country-level economic statistics, provide a useful tool for impact analysis of individual industries and for the design of industrial policies. However, the analysis described thus far only provides a first estimate. Additional activity in one sector also translates, via additional material inputs, into impacts in other sectors. The next section discusses how the activity of one sector affects other sectors along the value chain.

2.1.3 Second round effects

The analysis of first round effects focuses on value added in a certain industrial sector or a service sector. Since sectoral value added is used to pay workers' wages, this analysis leads also to an estimate of employment impacts of an economic sector. When looking for the impacts of second round effects, the focus turns to the expenditures on material inputs, because they reflect the impacts of one sector on other sectors. They can therefore be used to evaluate the economic impacts and employment effects of a sector's activity on the upstream chain of activities[2] which yield final output.

The following example aims to illustrate these second round effects further, through the lens of the wind energy industry in Germany (Figure 6 in the middle).

Figure 6: Second-round effect from production and services of inputs – the example of the wind sector (Germany)



Source: Author graph.

[2] Up-stream refers to all activities which yield inputs to the production of any RET, down-stream refers to operation and maintenance, etc.

For an output of €1 million, the wind energy industry in Germany has a value added of approximately €300 million (Lehr et al., 2011)[3], which goes to wages and profits (dark blue parts in Figure 6). As noted above, at least some part of the wages and profits remains in the country and pays for consumption goods. For production, a firm in the wind industry also needs domestic material inputs (shaded blue) of €460 million and imports from the rest of the world light blue) inputs for €240 million.

The €460 million spent on material inputs domestically creates demand for goods in those industries, which produce the materials needed. In this example, the main sectors producing the inputs are metals (€73 million), electrical devices (€86 million), and industrial services (€60 million). They themselves have a value added quota and need materials (again shaded green) to produce goods for the wind industry from other sectors. Thus, the demand for material inputs creates second round effects in upstream industries.

From the employment standpoint, it is important not only where the (wind) industry is based, but also if intermediate inputs can be domestically produced. Moreover, even when there is no industry producing the final outputs, the production of intermediate inputs can lead to domestic employment. A good example is the Austrian automotive industry. Although Austria produces very few complete automobiles, it still has a fairly large automotive sector specializing in car parts and components.

However, the value added at different points in the international production chain is not easily derived from the databases currently available. The OECD together with the WTO last year launched a new database in which the value added incorporated in trade receives special attention. It shows that, taking value creation into consideration, the US-China trade balance for instance "in 2008 would be about 40 per cent lower and the Japan-China trade balance switching from a surplus in gross terms to a deficit if estimated in value-added terms" (OECD/WTO, 2012). The most prominent example in the literature is Apple's iPad (Linden et al., 2011). The authors argue that the value captured from assembling a $275 iPad by China is $10. The new database allows looking at value incorporated in trade and thus responds to the fact that "[p]olicymakers are increasingly aware of the necessity of complementing existing statistics with new indicators better tuned to the reality of global manufacturing, where products are 'Made in the World'" (OECD/WTO, 2012).

This section aimed to convey the idea that data on value added, be it from domestic production or from trade, help policy makers' decisions on industrial development. This is useful for industries which are captured by the conventional statistical classification. Applying the same approach to the RE sector, however, is profoundly complicated by the lack of official statistical data, and any analysis of value creation policies needs to first define the boundaries of the sector under scrutiny. The next section describes the different approaches found in the literature for dealing with the boundary problem and tries to develop a harmonized definition for the remainder of the analysis.

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[3] The split is similar for other established wind energy industries in other countries. Note that the split follows the Input-Output-Systematic, which is described in a later chapter of this text.

2.1.4 Value creation from Renewable Energy Technologies

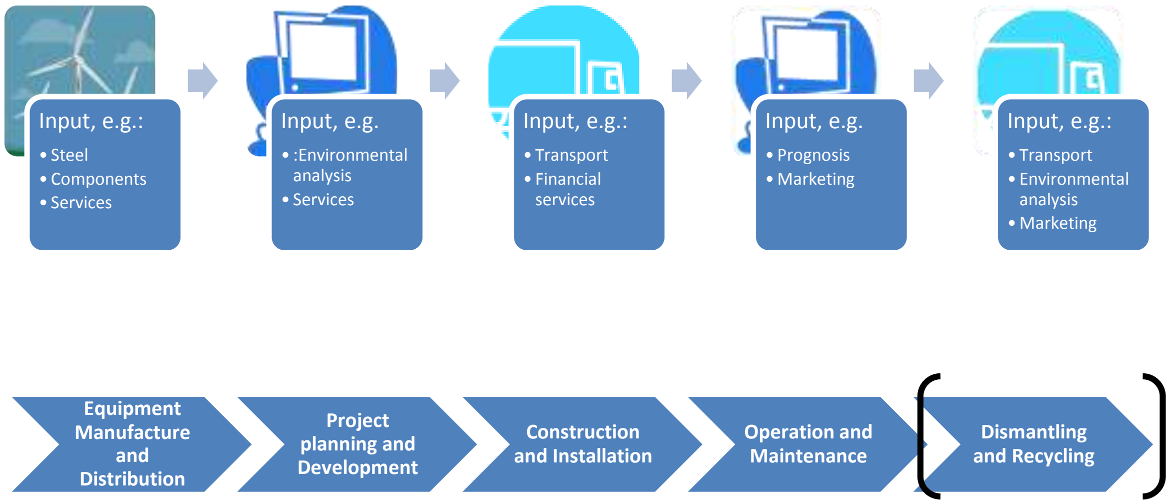
How much value does the RE sector create? To answer this question a definition of the RE sector is needed. OECD statistics as well as most national statistics currently do not address RE as an economic sector of its own. Rather, activities such as the development, project planning, construction, producing, maintaining, and operating RE systems are attributed to several economic sectors. Thus, at least two definitions can be found in the literature:

- A "life cycle" analysis starts from raw materials and ends at the dismantling or recycling of a product (RE-Supply, IEA-RETD, 2011). The analysis then looks at components, manufacturing, and integration, including transport and distribution to the installation site, the installation itself, and on-site integration. The operation phase of the site is analyzed and finally the disposal and recycling as a last phase. This approach embodies the idea of environmental life-cycle analysis and enables analysis of environmental impacts and material inputs. It has often been used to assign employment factors to the various life-cycle stages.
- The value chain or supply chain analysis (e.g., ILO and EC, 2011) combines the impacts along the value chain from manufacturing to operation and maintenance with an impact analysis of economic sectors as they are categorized by international or national economic statistics. Material input is part of the respective stages of the value chain and thus included in the production of RET, in construction by way of construction material, and so on. The very comprehensive analysis of "Middle East and North Africa Region Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects" (World Bank, 2011) follows this approach as well as the MED-Impacts Study (2011).

In this report the latter approach is used as a framework for the analysis of policies that increase value creation, because it brings the analysis more in synchrony with industrial policy analysis in other sectors and is more comprehensive, as the example in Figure 5 shows. One goal of this study is to mainstream the analysis of RE impacts and to facilitate the comparison with other sectors' experiences. Moreover, meaningful economic policy analysis is data-based and the suggested approach combines technology specific expert-based knowledge from the RE literature with economic indicators from statistical data.

Figure 7, describing the RET value chain, includes dismantling as the last phase of the chain, though most studies focus on the first four steps and leave out dismantling and recycling. There are few data about dismantling as renewable energy technologies are still "too young".

Figure 7: Value chain in RET



Source: ILO, 2011.

Combining the approach of Figure 6 and Figure 7 yields a comprehensive framework for the analysis of value creation from RET and the policies which enable and support value creation. To apply this framework, information is needed on value added at each stage of the value chain, on the material inputs at each stage, and on the economic sectors involved in the production of these inputs.

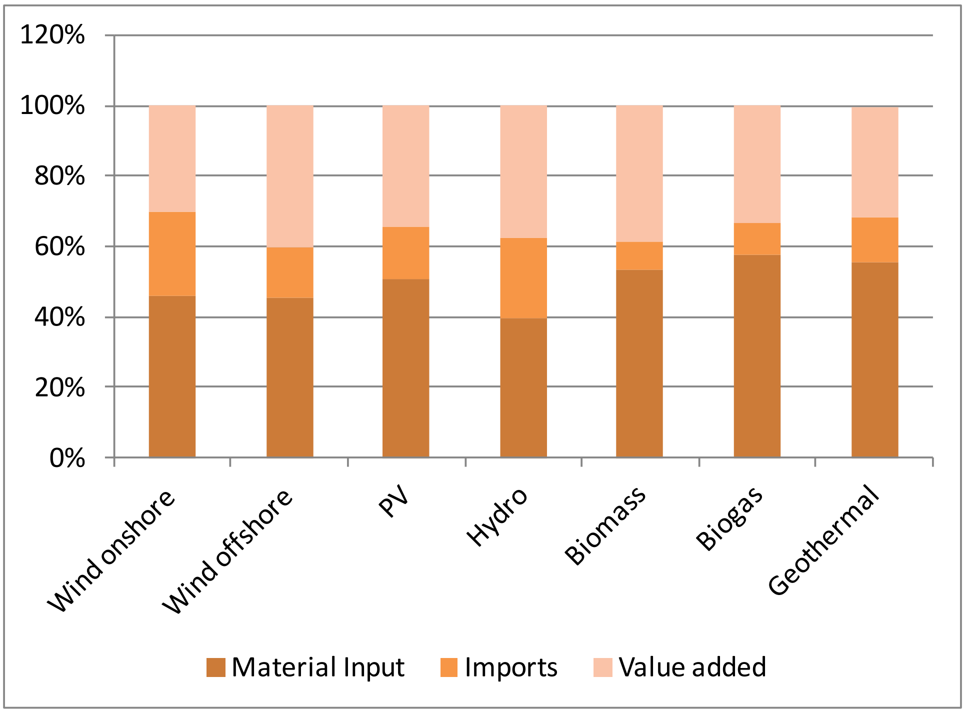
Fortunately, economic theory already has developed tools to analyze the effects of the second round of value creation. Once economic sectors are assigned to the technical components of RET, an established economic analysis tool—input-output tables (IOT)—can be applied. IOT depict the input flows (measured in monetary terms) from each economic sector to any other economic sector (and within the sector itself). Typically these inputs are broken down into inputs from domestic production and inputs from imports. Additional production activity creates additional demand for inputs and thus additional value added in all intermediate input-producing sectors.

For the policy maker the approach is helpful in the analysis of strengths of already existing sectors (see Chapter 4). Once the inputs in production, planning, installation, and operation and maintenance are known, the analysis of the strengths of all sectors involved helps to reveal more opportunities for value creation than the mere analysis of a narrowly defined industry.

The analysis of value creation from RET deployment is not as straightforward as in sectors which fall into the usual classifications, such as the automotive sector or the steel industry. RET is not an economic sector in most national statistics. Activities in RET are therefore cross-cutting, i.e., they take place in the machinery sector, in the production of electrical appliances, or in the electricity sector. Although there exist different approaches for addressing this issue, here we discuss the development of special extensions to the classical IOT for RET[4].

To illustrate this approach, we turn to the very comprehensive studies on the German RE industry that have been carried out since 2004. For the German RE industry a survey based extension of the IOT has been developed, based on input structures as described by German RET manufacturers. Components, services, and materials are allocated to the respective economic sectors and the survey results yield a production cost structure for each of 10 RETs. Value added, material inputs, and imports are also obtained from the survey and are integrated into the analytic framework.

Figure 8: Production structure of RET in Germany (2008)



Source: Lehr et al. , 2011.

The first step is defining the different sectors. For each technology (offshore and onshore wind, PV, solar thermal heat, heat pumps, biogas generation, biomass applications for heat and electricity generation, hydro, and geothermal power generation) an IO-vector is constructed. (Solar thermal power generation is not part of the set, since there are no applications in Germany.)

[4] For an overview, see the IEA-RETD EMPLOY (2012). In the literature, the most recent applications of this approach can be found in EMPLOY-RES (2009), the annual gross employment reports of the German Federal Ministry (for the latest results see O'Sullivan et al. 2013) and in the IfW/Dii Study on Economic Impacts of Desert Power (2013).

For instance, the vector for wind energy reflects all inputs from up-stream industries for the production of the several components of a wind turbine as well as the planning and construction of the wind farm in its material input coefficients. A second set of vectors gives the input structure by technology for operation and maintenance. One reason for this, among others, is that operation and maintenance involves more small trades than the production.

Thus, it is more labor intensive and value added is higher and these effects stay visible with a separate treatment of production and O&M. Value added for the electricity generating technologies in German RET industries is shown in Figure 8 (the values are from the 2008 survey and are being updated). The main point is that more than half of the production value goes into buying inputs from domestic production and from abroad. This translates into second round effects of the same order of magnitude. On average, 35% of the total production value is value added.

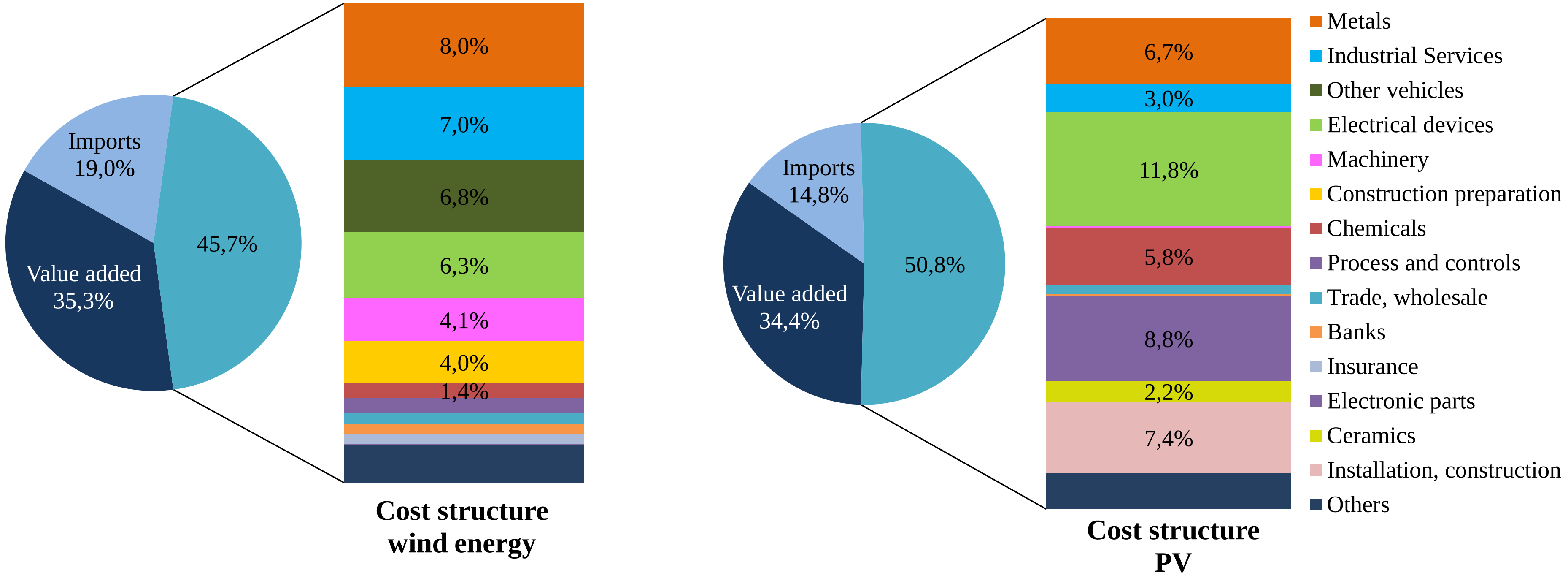
To analyze second round effects, the structure of material inputs is relevant. Figure 9 illustrates in detail the input structure for the German wind[5] and PV industries. The database is the same as in the previous figure. The production processes for each exhibit similarities and differences.

The largest single cost components in wind energy are the tower and the blades, but the hardware for transforming wind energy into electrical energy (generator, connection to grid) makes for the third largest component. PV needs inverters and also all the grid connection components. Thus "electrical devices" and "metal production" are the sectors which experience the largest impact from additional demand for wind and PV technology. The metal industry itself needs inputs from other industries (second round effects for the metal industry) and creates additional demand on these industries. In the case of the metal industry, 19.6% of the additional demanded production value feeds back into the metal industry. To give another example, close to 6% goes into the vehicle sector; the costs for cranes used in installation are the main input in this category.

Production of electrical devices, on the other hand, is not as diverse in its input structure; it demands most of its intermediates from other companies within the same sector. Still, the impact from additional demand affects sectors which deliver inputs to the electrical devices and the metals sectors. If these sectors are weak or not competitive in a region or in a country, their products have to be imported and the related value creation takes place elsewhere.

[5] Note: the structure is a weighted average of onshore and offshore.

Figure 9: Input structure of wind and PV industry in Germany (2008)



Source: Author graph.

Table 1: Sectoral value added shares

Main input sectors	Value added
Chemicals	3,89%
Ceramics	33,28%
Metals	39,70%
Machinery	35,05%
Electrical devices	35,06%
Electronic parts	25,54%
Process and controls	45,76%
Other vehicles	27,18%
Construction preparation	44,68%
Installation, construction	38,02%
Trade, wholesale	63,91%
Banks	44,93%
Insurance	17,27%
Industrial services	55,84%

Source: Destatis, 2013.

Table 1 shows the value-added shares of the respective industries from the German database (IOT, cf. Destatis, 2013). To better understand the monetary flows and the mechanism, the example from the wind industry from Chapter 2.1.3 is continued here. That example of second round effects yielded €460 million for inputs. Of that, €88 million goes to the electrical devices sector, €57 million to machinery, €74 million to metals, and €61 million to industrial services, just to name a few. Given the respective shares of value added in output from Table 1, this leads to value added in all input sectors of €114 million. Given that the first round impact described in the example in Chapter 2.1.3 was €300 million, neglecting second round effects means neglecting more than one third of the value creation possibilities in the analysis.

There have been a few other attempts in the literature to develop an RE-IO vector. Similar work has been done by Dii (2013), among others, and an approach to transferring the results has been suggested in IEA-RETD EMPLOY (2012). The basic idea of transferring RE-sector results from one country to another consists of the following steps:

- analyze the production structure of the target country;
- compare with production structure of the source country, with a special focus on the share of imports vs. domestic production;
- compare especially the relevant sectors where parts and components of RET are produced, e.g., semi-conductors, machinery, and electrical devices;
- adjust accordingly.

Data on the economic structure of countries can be found for most countries. IO databases have tables for up to 130 countries in the world (EORA, WIOD, GTAP-MRIO, GRAM, IDE-Jetro, all described and quoted in Tukker and Dietzenbacher, 2013).

The suggested approach is in line with the literature, for instance the IEA-RETD FINANCE-RE (2012) study, in which mainstreaming of support for capturing value creation from RET deployment is strongly suggested:

Countries must look to and support that entire value chain of players in the clean energy space—to strengthen the roles of universities, manufacturers, supply chains, financing entities, developers, installers, local governments, and customers in clean energy market development. …A key way to rapidly bring down the costs and scale up clean energy technologies will be to increase innovation all along the technology development value chain—from lab to product development, and to business and finance models. Innovation is needed at all of these stages to increase performance and decrease costs of technologies." (FINANCE-RE/Clean Energy Group, 2011)

By mainstreaming RE analysis, the set of policy options can be broadened, as the example for the PV industry and the wind energy industry in the following sections show.

2.2 OPPORTUNITIES ALONG THE VALUE CHAIN

2.2.1 The case of PV

How can the suggested approach be used to find opportunities for capturing value along the value chain? Applying the systematic approach from above, this section starts with first round effects. How can the 50% value added from PV be captured? As outlined, value creation occurs in the three steps of the value chain: projecting and planning, production, and installation. In recent years, much attention has focused on production, so we begin our discussion there.

Currently, industries in the RE sector fear overcapacities rather than shortages. This first became evident in the PV industry. Especially in Asia, production capacities expanded rapidly and led to huge global overcapacity in PV production facilities, which in turn led to large price decreases[6]. Today, it is estimated that PV modules are often sold below their production costs. February 2013 was the first time since May 2009 when module prices did not drop (pvexchange, 2013)[7]. Worldwide, there is an overcapacity of nearly 100%.

In 2011, module production firms were concentrated in Asia, notably China. Of 370 module production firms worldwide, 131 were located in China, 121 in Europe, 21 in the US and Canada, and the others in India, Malaysia, Australia, etc. China also dominates in terms of ("nameplate") capacity of the modules produced, with 45 GW/year.

[6] Of course, as has been pointed out in the REN21 *Global Status Report 2013*, retroactive policies also played a role.

[7] The slowdown in price declines may be also an effect of the trade barriers imposed by the US and the EU. Because of these barriers (tariff or quota) it follows that Asian cells and modules take smaller market shares in the respective markets and that price decreases from Asian products cannot translate into overall price decreases as rapidly as before.

Europe has a nameplate production capacity of only 8.3 GW (a figure established before the closing down of several European players in 2013). Thus the average company in Europe is much smaller than the large Chinese and other Asian players. Chinese manufacturing capacity is more than 1.5 times that needed to produce all the modules installed in the world in 2012 (data on production capacity from SWW, 2012). The picture for cell production looks very similar.

From these numbers it seems that value creation from module and cell production has been distributed among the global players and there is no possibility for new players to emerge. However, one might ask: how does the existing production capacity match the more ambitious global deployment scenarios – and is it in the right regions?

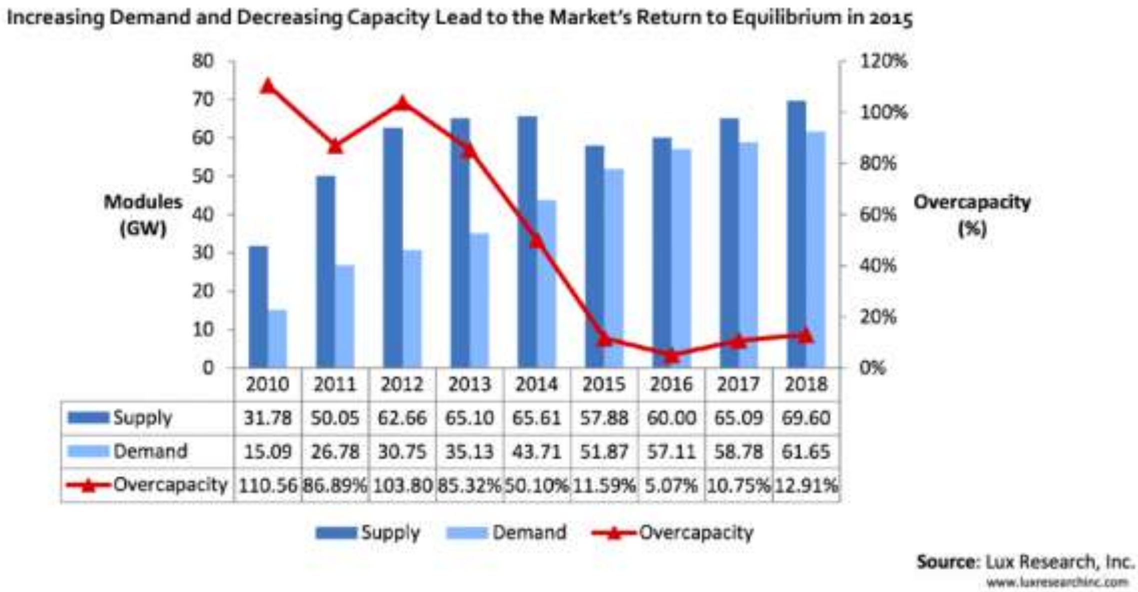
Installation of new capacity has moved from the developed countries to emerging economies and the developing world (Bloomberg, 2012). The more ambitious scenarios for RET deployment also have a strong focus on the latter, such as the annually updated Energy [r]evolution scenario (E[r]) (Greenpeace, 2012). The IEA *World Energy Outlook*, on the other hand, sees Europe still as an important market for renewables until 2035, followed by China and the US (IEA, 2012). Other mid-term scenarios (up to five years) for RET deployment also still see Europe as an important market, but of decreasing relevance.

The Energy [r]evolution scenario sees an average annual market of 34 GW until 2030 and is very close to what has been observed in the last two years. To achieve the E[r] long perspective, annual additions of 50–60 GW will be necessary. The main market in the long perspective is North America. However, these projections pre-date the unconventional gas boom in the US, which significantly increases the generation cost gap for renewables. Thus, E[r] seems overly optimistic from today's perspective on the opportunities for renewables, at least in the US market. The *World Energy Outlook* (2012) projects an annual increase of 22 GW/year on average until 2035. In the short term (until 2015), the 100 GW milestone will not be reached, the result of fewer installations per year than have been observed in the recent past.

In its "policy-driven" projection scenario of PV deployment through 2016, the European Photovoltaic Industry Association (EPIA) projects more than 350 GW PV capacity by 2014 (EPIA, 2011). After then, the largest increases are projected for the Americas, predominantly in North America. Annual markets evolve from 20 GW to 40 GW in 2016. Given these numbers, it seems that today's production capacities are sufficient for years to come. However some analysts are much more optimistic for the future opportunities in PV production (Box 1).

Turnover among PV producers affects producers of intermediaries (inputs to final PV production) and also impacts second round effects. Currently, news and discussion focus on bankruptcies and closures. At the end of 2012, Michael Hall at *PV Magazine* argued that "maybe half of the polysilicon suppliers will still be around when the price of polysilicon picks up" (Hall, 2012). The situation obviously is easier for inverter manufacturers, because they sell directly to the markets where the capacities are installed and are not tied to individual producers.

Box 1: "The return to equilibrium"



	2010	2011	2012	2013	2014	2015	2016	2017	2018
Supply	31.78	50.05	62.66	65.10	65.61	57.88	60.00	65.09	69.60
Demand	15.09	26.78	30.75	35.13	43.71	51.87	57.11	58.78	61.65
Overcapacity	110.56	86.89%	103.80	85.32%	50.10%	11.59%	5.07%	10.75%	12.91%

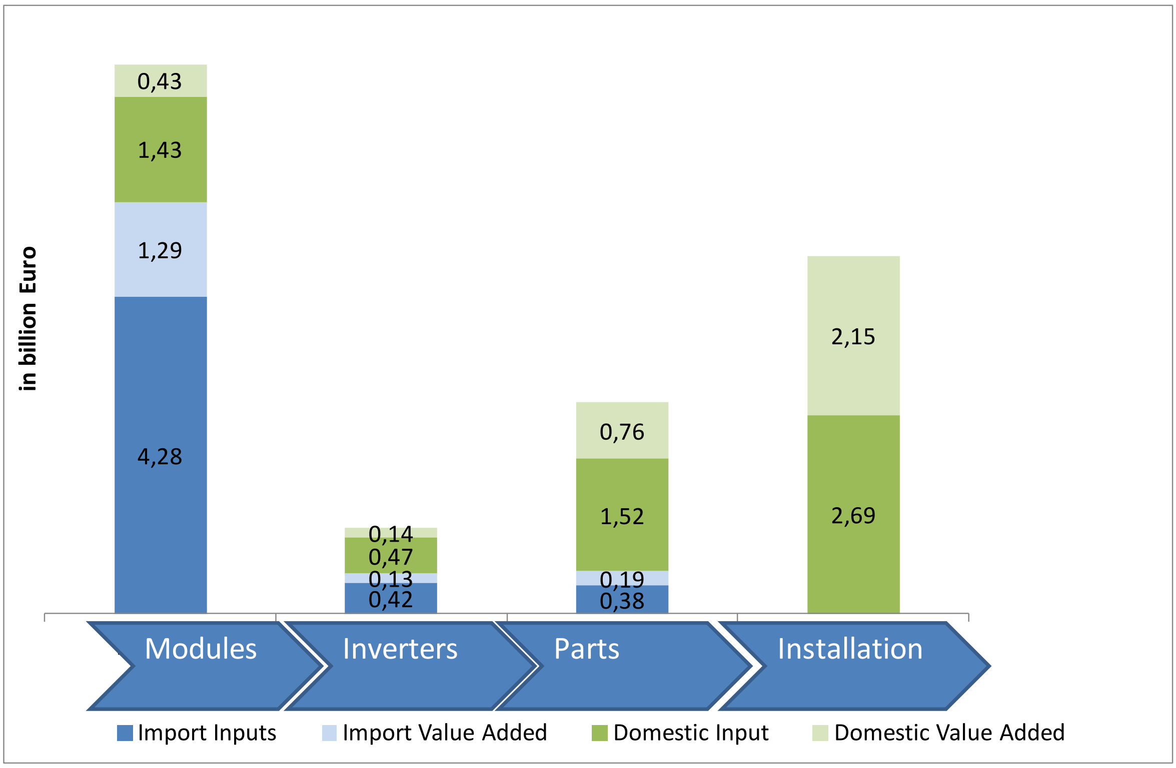
Lux research, an analyst specializing in energy questions, stated in May 2013: "Due to the extreme price pressure experienced by manufacturers today, many will not survive the next two years. ... Some tier-1 manufacturers, like Suntech, either will dissolve or be acquired. As a result, global module capacity will decrease from 65 GW in 2013 and 2014 to 58 GW in 2015. With demand increasing to 52 GW in 2015, overcapacity is reduced to 12%. ... Moreover, with the US, China, Japan, and India taking over where Germany and Italy left off, companies looking for growth need to look no further than the PV global demand doubling from 31 GW in 2012 to 62 GW in 2018."

From Figure 9 it can be seen that the largest single contribution in the PV cost structure is "production of electrical devices". Inverter production, one segment of this sector, had only a 10% decrease in turnover 2102. However, some of the European players are comparatively small and one may ask whether they will be able to keep up if the market picks up speed (Photon, 2013).

Taking the other steps of the value chain into consideration changes the picture. EPIA (2012) claims that 25% of the value of PV modules installed in Europe is created in Europe. Including second round effects, the European share increases to 53% of inverters, worth €2.2 billion. Installation of PV modules has led to turnover of €14.3 billion in the respective sectors, with a value added share of up to 56% (see Figure 10). A closer look at these numbers reveals that installation is closely connected to the domestic deployment of PV modules. Thus, the policy recommendations of EPIA have a strong focus on deployment policies.

Eighty-five percent of the costs of a PV system[8] are input costs for modules, inverters, cables, and small parts. The largest single cost item is the modules, followed by the installation of the inverters and other parts (Figure 10). Out of total investment of €9 billion in 2012 in Germany, €2.86 billion went into domestically produced modules. Value added in this sector accounts for roughly 50%; thus almost €1.5 billion went to create additional demand impact in the input sectors of this industry. However, in the second round, most of this is spent on imported cells. Inverters, which account for 8% of total cost of the installation, are produced largely in Europe. The value added share is the same as in module production. Installation is assumed to be 100% domestic, with a rather high share of value added. Most input goods (second-round effect) are also from domestic production.

Figure 10: Value added from PV installations in Europe (2012)



Source: EPIA, 2012.

In installation, as well as in operation and maintenance, domestic value creation opportunities are larger. Though they differ in terms of value shares, even greater differences become evident when employment is considered instead of value. Downstream, installation has high domestic value added shares – and high domestic employment. Installation is done by electrical fitters; the parts needed to wire the system, the services from scaffolding companies for larger systems, and performance testing and approval are also done by local companies. Thus, value added (e.g., paying for the fitters) stays local. The demand for these parts and services creates value in the second round among the service and part providing sectors. As long as the domestic market exists, this value creation opportunity stays in the region.

[8] Note that this calculation refers to the end-user cost of a PV system. Above we consider cost shares in the PV industry.

With PV installations, however, a single installation usually does not take more than a couple of days. Thus, a steady stream of installations is required to create permanent employment.

The provision of parts for installations can create more continuous employment, particularly if the parts are multiple-use parts that can also be sold outside of the RE industry. A screw factory, for instance, can have a variety of customers and might not even know that some of their product goes into renewables.

A similar argument holds for the upstream sectors. The more specialized the product, the more opportunities the sector has to participate in RET deployment successes – and risks. The permanency of employment depends on the stability of demand: if, on the one hand, an upstream industry is tied to the local manufacturers and to domestic demand, downswings in local demand translate to the upstream industry. If, on the other hand, it also caters to the global market, it can even out the cyclic behavior of local markets.

What are the opportunities along the PV value chain? The current market situation suggests focusing on keeping the existing industry alive as opposed to setting up new PV clusters around the world. For industrialized countries with an existing (and struggling) PV industry, the opportunities lie in new and innovative products. As Lux research (Lux 2013) points out, "Companies need to invest in their future now to develop products for the next generation of solar – the generation in which differentiated products such as back contact modules, passivated emitters, kerfless wafers, copper zinc tin sulfide modules, and numerous other technologies can earn large margins in a $155 billion market". These products will impact producers of intermediaries. But the analysis also shows that large shares of value added are found in installation, operation, and maintenance. This segment should not be left out when trying to capture value from PV or from renewables as such, as the wind energy example below will show.

2.2.2 The wind energy case

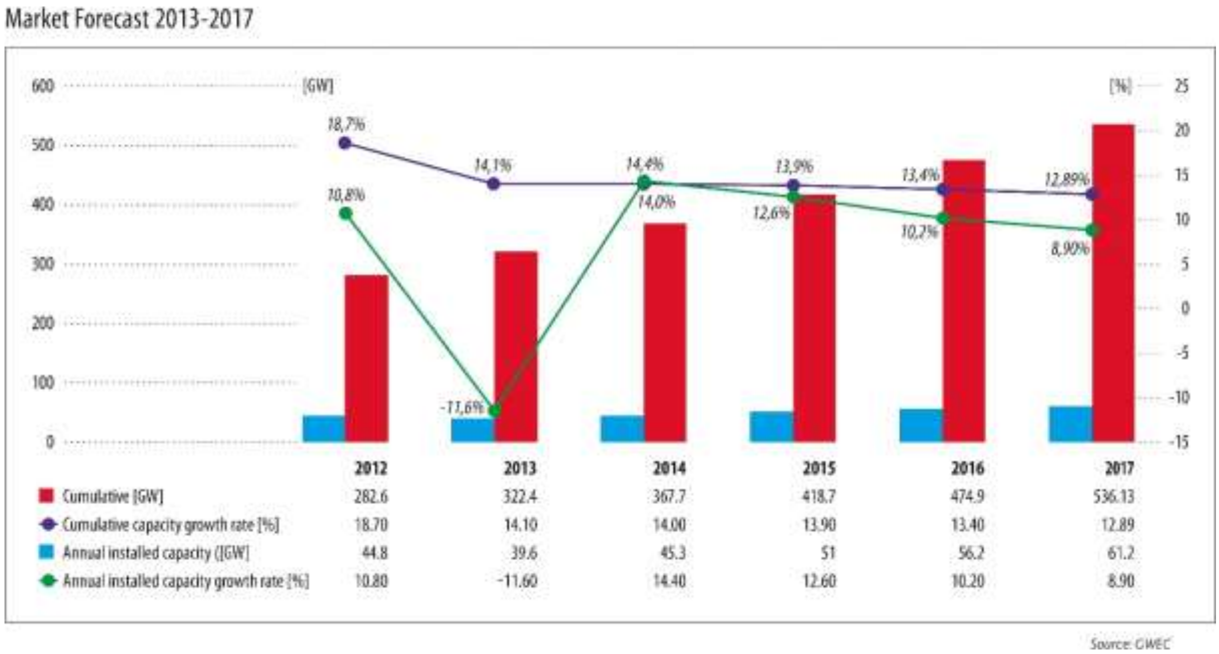
Although there are few similarities between the wind energy market and the PV market, the basic steps for analyzing opportunities along the value chain, taking first round and second round effects into consideration on a more abstract level, are the same:

1. Focus on first round:
    a. Production: Global market situation (overcapacity, undercapacity, price development, competition), regional market situation (size, long-term perspective, infrastructure)
    b. Installation: Deployment strategy, operation and maintenance
2. Focus on second round:
    a. Input industry strength and weakness
    b. Service sector strengths and weakness

The wind energy market is more stable than the PV market. The number of players in the market has been more constant, although wind energy also faces competition from Asian production, and supply capacity exceeded demand in 2012.

Wind turbines especially have faced downward pressure on prices from overcapacities and from austerity programs, such as reducing feed-in tariffs, in several countries. Still, 2012 was an exceptionally successful year for the wind industry. The industry's outlook for 2013 is less optimistic, but in the long term (by 2017) capacity installation growth rate is expected to be around 10%.

Figure 11: Market forecast for PV until 2017



Source: GWEC, 2013.

As Figure 9 shows, transport costs and vehicles at the construction site are a large share of the input costs ("other vehicles" and a part of "industrial services)." These costs can be reduced by decentralized production (i.e., by bringing the production site closer to the wind farm) and thus creating local value. This is an example of how second round effects feed back into the analysis of the market potential for first round effects. "The size of the equipment means that at a certain stage and size of market, local manufacture makes sense in purely economic terms" (Global Wind Energy Council, 2012). One important aspect is the expected market size that can be served from a new production location. As GWEC (2013) points out, "The more difficult issues arise in smaller markets which probably do not warrant a fully-fledged manufacturing industry. Every politician wants to bring a factory to town, but it's just not practical to do it in each case". Thus market size and industrial capacity are the main limits to establishing a new production site.

Generation of electricity from wind energy requires a rather high service input, in the installation phase as well as in the operation and maintenance phase (second highest input in Figure 9). These services comprise site evaluation, environmental approval, legal approval, and contracting and wind-yield prognosis. The prognosis of electricity generated becomes increasingly important in the debate on integration of large shares of renewables into the grid.

Service sectors in industrialized countries are gaining importance, as seen from the analysis in the above chapter. But the development of services is also attractive for developing countries, because it needs less capital and more well-trained labor forces as an input (see the policy discussion in Chapter 3).

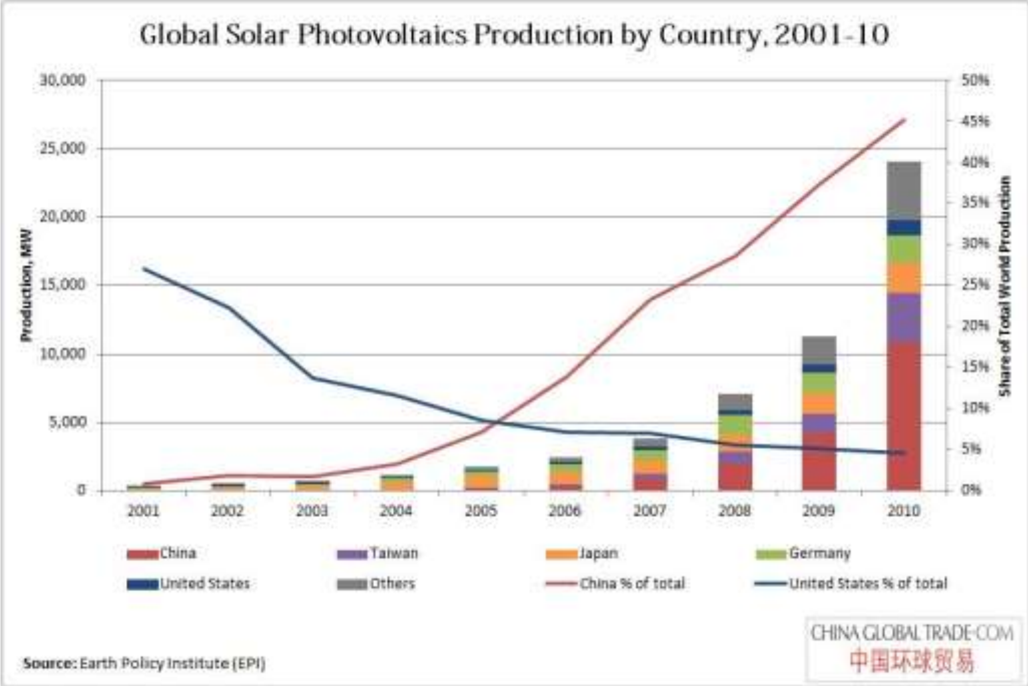
2.3 HOW TO JOIN? – FINDING THE RIGHT NICHE

Using the value chain approach, one may ask how can the right niche be found for countries still on the verge of entering new RE markets or considering whether (and especially how) to do so. Using examples from more mature markets, we analyze the potential for value creation and highlight important factors that contribute to achieving this objective. We also describe a process by which promising economic niches could be identified.

Looking at the major players in the PV industry, for example, different drivers for developing an industry can be observed. Japan and the US have been dominating the market at the turn of the millennium with a combined market share of 73% (see Figure 10) Both countries had existing strengths in the semi-conductor industry. Both countries had a sufficient amount of natural resource (solar radiation) and had experienced uncomfortable pressure from increasing fossil fuel prices in the past. While global installation has increased almost by a factor of 10 since 2001 and global production has increased 20-fold, other Asian countries (led by China) entered the market and gained more and more market share. This development in Asia was not triggered by the attempt to meet local market needs but rather was directly targeted at world markets.

Driving the German PV industry, in addition to existing strengths in the semi-conductor industry and in research, was the interest in developing the former East Germany, which was in danger of de-industrializing and also qualified for EU funds. In the first half of the 2000s large German PV producers, led by Q-Cells, managed to overtake all other producing countries except for Japan in terms of market share (Figure 10).

Figure 12: World's Five Largest Single Producers of Solar PV, % of Total World Production 2001 – 2010



Source: [www.futureofUSChinaTrade.com,](http://www.futureofUSChinaTrade.com) 2013.

Today, China accounts for about two thirds of global production of PV modules. The driving forces behind China's production structure were the expected size of the international market and its low competitiveness in the mid- 2000s. The market allowed for new entries because demand was increasing rapidly and production capacities seemed to lag behind. The decisive factors for market entry were at different points in time: individual strengths (semi-conductor), market competitiveness (low in mid-2000s, availability of qualified workforce (high in Germany early 2000s). By 2012 Chinese companies accounted for nine of the top fifteen producers of solar PV modules.

Entry or even survival in the meanwhile highly competitive and China-dominated market environment is difficult (see section above). Integration along the value chain is currently one strategy of PV companies. Su (2013) states that "currently, companies that employ vertical integration and cross-border cooperation have the most competitive advantages." Examples are the joint venture of Q-Cells (Germany) with LDK Solar Company (China) to establish downstream systems, or the joint venture of E-Ton Solar Company (Taiwan) with US Spire Corporation (Su, 2013).

The Mediterranean Solar Plan (MSP) (UfM, 2013), in its Annex, sees additional opportunities in developing countries/emerging economies in assembly and metal frame construction. These medium to low-tech capabilities can be developed without major investment. But the bottom line is that in PV, the right niche in production is hard to find.

For the wind energy sector, global production sites are distributed according to the "hotspots" of installation – with the exception of China, which tackled domestic installation and exports. But the number of players in the wind industry, being a more mature and consolidated industry, is much smaller than the number of PV players. Large companies such as Gamesa, GE, Vestas, and Enercon have production sites in Europe (Spain, Germany, Denmark, and Italy), the US, India, and China. India also has Suzlon and China recently added new players such as Sinovel, Goldwind, and Dongfang (SWW, 2009). Along the value chain, however, production is more locally distributed. Local content regulation in tenders, as well as cost inefficiency of transporting heavy parts, has led to the emergence of local producers of intermediary goods in Portugal and South Africa (see the discussion on local content in Chapter 3).

The easiest entry into the value chain for wind as well as for other RET is in construction, operation and maintenance, and in the service sectors. (e.g., forecasting, site planning, wind measurement) Though the market barriers in terms of knowledge to the latter are rather high, the investment barriers are low (as compared to setting up manufacturing facilities). Capturing value from such activities is easier (e.g., only limited facilities are needed), although quite knowledge intensive.

The difficulties and cost to transport large components make the creation of local wind manufacturers feasible, if there is a reasonable market size. It may be worthwhile for countries to cooperate and coordinate RET deployment efforts and industrial build-up. The approach taken in the MSP might serve as an example. In the UfM report (2013), towers and several components (blades, civil works, cabling, and assembly) are suggested as opportunities for regional value creation. Application of the analytic framework suggested above reveals that almost all of these activities belong to the installation phase of the value chain, meaning that the entries take place at a rather late stage.

With respect to second order effects, a number of factors, shown in Table 2, can be identified as important. The metals industry produces specialized inputs for the wind industry and less specialized products for PV frames. A skilled workforce is essential for the specialized products. Also, for the more complex products, proximity to existing production sites is important. Morocco, for example, already has a metals industry and has low barriers to developing specialized production. However, the metals industry is globally under pressure, leading to fierce competition and possibly downward pressure on prices that cannot be faced by newcomers.

Wind turbines, generators for biomass and for CSP power plants, and other components are part of the machinery sector. This sector depends strongly on a skilled workforce and innovation capabilities benefiting from cluster environments and close interaction with research institutes and universities. The emerging RE sector (i.e., manufacture of parts and components for RET) can, therefore, gain from spillover effects from existing machinery industries.

Electronic parts and industrial services also play an important role in the value chains of all RET. They require high workforce competency and, in the case of electronic parts, can only be established when there is some experience—an educated workforce and strong manufacturing skills—already in the field. Otherwise, international competition will be too fierce, especially because electronic parts are easily transported and can be produced at some distance from the point of demand.

Construction and trade have lower prerequisites. Typically these sectors already exist in a country and only specialization in RET is needed. For RET installations special training is needed for the workforce in the construction sector, which can best be provided by the producer of the technology. If the technology is imported, special seminars or other training opportunities offered by the producer abroad, i.e., in the country from which the technology is imported have proved a success factor. (Table 2 identifies sections later in this report where these success factors are discussed in more detail.)

Table 2: Success factors along the value chain

Relevant factors:	Domestic industry structure		Sectoral structure	Human resources
	Proximity to existing production	Cluster quality	Integration along the value chain	Skilled workforce
Metals	++	+ (cf. Section 5.2)	+ (cf. Section 5.2)	++
Machinery	+++ (cf. Section 5.1)	+++ (cf. Box 8)	+	+++ (cf. Box 13)
Electrical devices	++	+	++ (cf. Box 6)	++
Electronic parts	+++ (cf. Section 5.1)	++ (cf. Box 9)	++ (cf. Box 7)	+++ (cf. Box 11)
Process and controls	++	++	+	++ (cf. Box 12)
Construction preparation	+			+
Installation, construction	++		+++ (cf. Box 7)	+
Trade, wholesale		+	++	+
Banks			++	+
Insurance			+	+
Industrial services	++	++	+++	+++ (cf. Box 6)

+++ high importance, ++ medium importance, + low importance, blank: not relevant. Source: Author compilation.

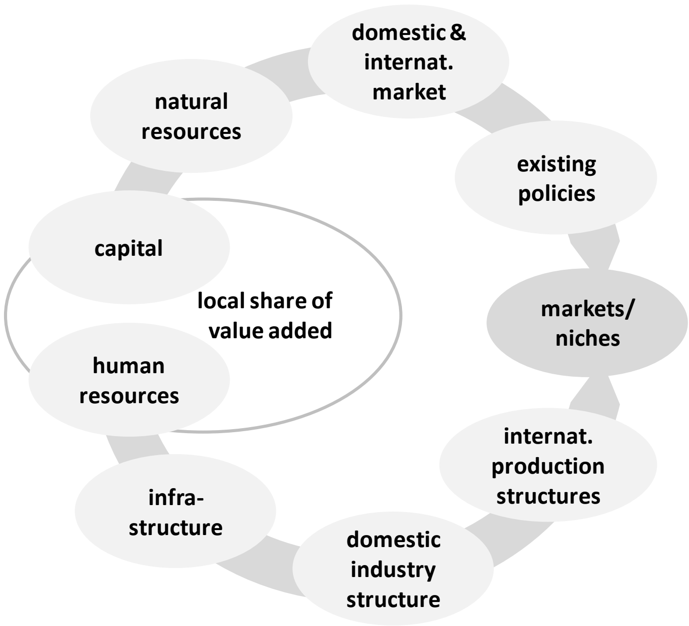
If capabilities exist in intermediary or final production in the machinery sector, this creates opportunities for the development of production capabilities for RET. Further, if skills for manufacturing parts and components are available, this could present an opportunity to enter or extend RE manufacturing. An additional factor is the regional/global dimension; policy-induced demand for PV at the international level, for example, creates new markets for domestic producers or exporters.

To come up with concrete suggestions for RE value creation policies, the existing manufacturing structure and resources that could be used for RE value creation must be analyzed to disclose the potential "input" for RE value creation. The analysis is again based on the value chain phases, the required inputs, related industries, and available resources.

The main idea is to identify in each value chain phase the direct (first round effect) and indirect (second round effect) value added that arises from local labor and capital input, the activity areas, and the resources needed to increase the time horizon and local share. In order to identify niches, this structure has to be compared to and mirrored by the existing industrial structures and endowments to see where unused potentials are available.

The concept and specific sequence of assessments illustrated in Figure 13 helps identify existing strengths:

Figure 13: Concept to identify existing strengths



Source: Author design.

1. Identify the required capital in each value chain phase. Determine who is able to provide capital and what the barriers are, such as high project risks in combination with low returns, missing legal framework for enforcements in case of default, missing information about financing needs of projects, etc. Policies improving the legal framework, supporting financing conditions, providing information, reducing risks for creditors or investors, and so on might be necessary (see Section 3.1.2.3).

2. Identify the required natural resources, such as land or surfaces (e.g., rooftops) and assess the wind and/or solar potential for each project. Are the resources accessible and property rights clear? Is transfer of ownership possible? Are there any constraints? Policies should be designed in a way that facilitate the efficient use of natural sources (see Section 3.1.2.3).

3. Evaluate the domestic and international market to assess the demand potential. Domestic demand depends on societal awareness and acceptance of RET, the economic situation, and returns of RET use as well as on demand policies. What are potential demand barriers and are there policies to overcome them? International markets open a window for exports; what do these international markets depend on? Are there trade restrictions or quality standards? What are promising policies affecting these markets? (See Section 3.1.2.1.)

4. Check existing policies that could constrain RE value creation.

5. At the RE sectoral level, identify the required qualifications for human resources at each value chain phase, e.g., in manufacturing (welding, plumbing, production engineering, etc.) or in financing (credit officers, technical assistance for RE projects). If there are bottlenecks, assess why. For example, if there is a lack of sufficient and qualified vocational training programs or centers, policies should aim at establishing or improving them by building on existing structures (see Section 3.1.2.3).

6. Identify infrastructural needs for operating a manufacturing or generation facility, for providing services, and so on. Are there bottlenecks (such as production zones or long transport distances) between technology providers or research institutes, missing networks or IT infrastructure, etc.? How could they be overcome? (see Sections 3.1.2.3 and 3.1.2.2.)

7. Assess the domestic production structures. Are there appropriate sectoral capabilities in finance, technology and research, project development, and upstream industries such as steel or glass manufacturing? If not, what has constrained development (e.g., human resources or capital)? Is the existing production potential sufficient for the targeted RET deployment? (See Section 3.1.2.2.)

8. Assess the international production structures. How competitive is the domestic industry? Which markets feature strong competition? Are there any small markets (product niches) left, or could new markets be created that domestic suppliers could serve more rapidly than the international industry? Adopt policies that focus on actors and input factors to enable domestic industries to adjust or react quickly (see Sections 3.1.2.2 and 3.1.2.3).

9. Identify the niche product: What is the technological development potential of the product? Are radical or incremental product or process innovations feasible? Which country or countries could realize or benefit from this potential?

3 SEIZING OPPORTUNITIES – IDENTIFYING RELEVANT POLICIES FOR VALUE CREATION

To examine how various policies support value creation in RE, this chapter chooses two approaches (Section 3.1): (1) it identifies potential action or service points for policies along the value chain; and (2) it provides examples of policies and potential policy mixes to generate and capture value creation. Section 3.2 then briefly summarizes key aspects of the current international discussion on policies to promote development and employment creation, extracting the most important practical lessons for implementation. In doing so, the analysis suggests a number of practical policies for RET industrial development drawing on international best practice policies.

A key message from this chapter is that a mix of policies from different policy areas is necessary to successfully generate value creation from RET deployment. This mix should be country-specific, as framework conditions vary widely.

3.1 FROM RE VALUE CHAIN TO RE VALUE CREATION POLICIES

To achieve the key objective of this report – identifying the most efficient policies for turning investments into drivers and catalysts for value creation – this chapter presents various types of policies available to decision-makers and analyses where along the value chain policies can be supportive.

Industrial policies are widely discussed in the literature as means to increase value added and thus the contribution of certain sectors to GDP and growth[9]. However, in this context, referring only to conventional industrial policies as they have been observed in the last 50 years in the development of conventional economic sectors (see examples concerning the steel, automotive, and aircraft industries in Chapter 4) would ignore other relevant policy areas beyond industrial policies, such as RE demand promoting policies and coherence among policy instruments, strategies, and implementation. The intentions of this study are to identify policies that help to capture a large share of RE value creation and to make clear that the range of policies is much broader than those seen by looking only at industrial instruments. This means that RE value creation policies do not necessarily stand for one type of policy but rather a bundle of policies and their interactions; they can even have a meta-policy character. The identified policies are described in more detail by highlighting possible instruments, fields of activities, and interfaces with other areas.

Then a systematic overview of different RE policies and their general effects is provided, covering the following aspects:

- an outline of the understanding of RE value creation policy (Section 3.1.1)
- policies currently applied to support RE deployment (Section 3.1.2.1),
- policies that directly affect RET (e.g., via promoting the manufacturing sector)(Section 3.1.2.2), and
- policies that have a potential impact on the intermediate production of RET (indirect effects) along the value chain (Sections 3.1.2.2 and 3.1.2.3).)

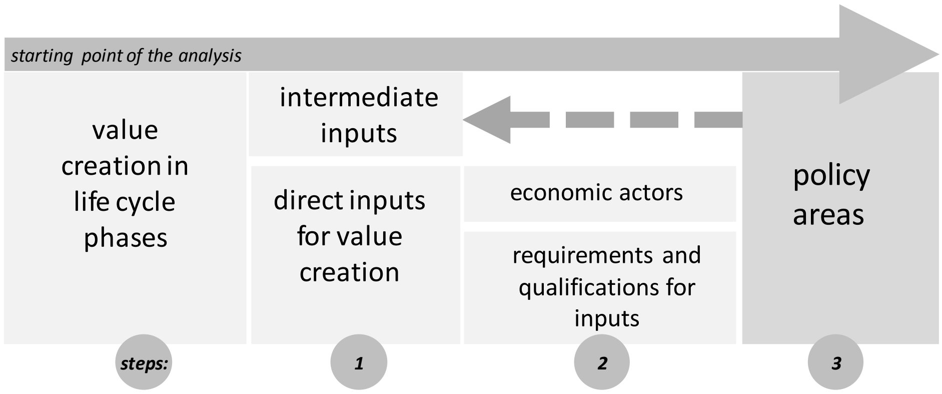
3.1.1 Value creation along the value chain – which policies matter?

To identify relevant policy areas, the value chain approach from Chapter 2 is applied. Along the value chain, economic activities (first round effects) arise from the investment in an RE plant. Inputs –intermediate inputs and direct inputs such as capital and human resources – are required to manufacture machinery and components and to construct, install, and operate and maintain the plant and, hence, to create value. To contribute to value creation, inputs have to meet certain criteria; for example, human resources need specific skills and know-how and capital requires a good investment climate. To capture a large share of value creation, situation- or country-specific policies are necessary. A process for identifying such policies should address the following aspects, described also in Figure 12:

[9] An anonymous reviewer pointed out that there are additional growth-limiting and enabling factors: See Collier, P. and Venables, A., "Greening Africa? Technologies, endowments and the latecomer effect", *Energy Economics* Vol. 34, Nov. 2012, pp. S75–S84. They outline that land, labour, capital are the main growth drivers. Reallocation of resources from one sector to another also affects growth. However, in the following, we are assuming an unrestricted labour force and will not discuss policies to increase access to resources such as land.

1. Which are the relevant inputs, i.e., what are direct inputs in each phase of the project/plant?
2. What are the requirements or qualifications that ensure efficient use of the input factors? Which actors or groups are involved in each value chain step and, hence, upon which actors could policies focus?
3. Which policy areas help to shape the specific requirements regarding input factors?

Figure 14: Approach to identifying policy areas and policies for value creation



Source: Author graph.

We draw a distinction here between policy areas and policy focus. The term policy area refers to policies addressing certain economic, political, or societal issues such as education, research, infrastructure, environment, and energy. Policy focus refers to inputs or actors (of supply or demand) such as firms, households or other final consumers. In this context "policies" includes any potential governmental actions in any area that is supposed to positively contribute to value creation. The dotted arrow between "policy areas" and "intermediate inputs" in Figure 12 indicates that policies also have an impact on upstream suppliers and service providers, and hence, on the provision of intermediate inputs (second round effects). However, the main focus here is on direct inputs.

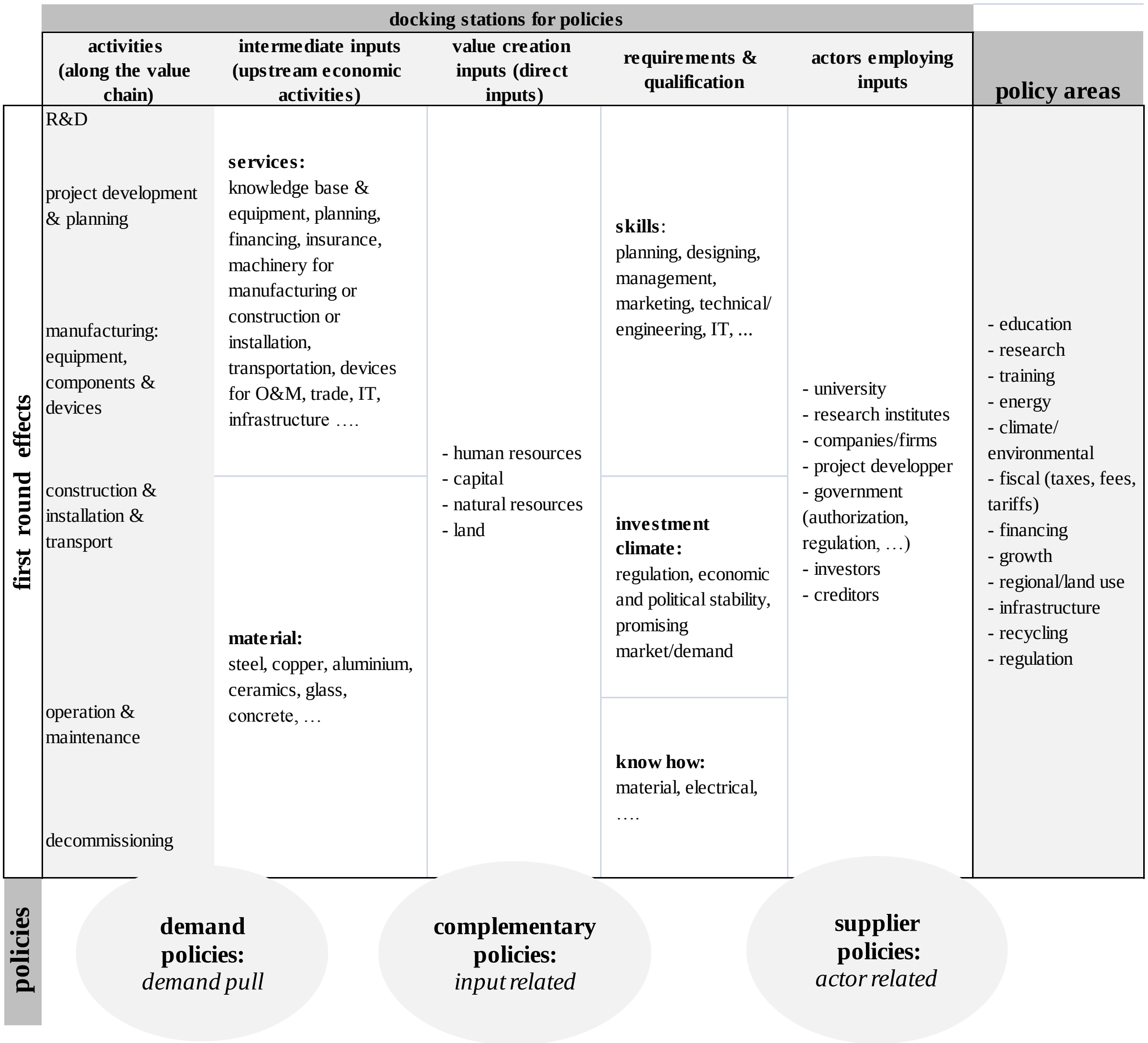
Applying this approach, exemplified for wind and PV, leads to a detailed list of inputs, requirements, qualifications, and actors, where policies could or should be applied to contribute to value creation. A summary of this list is given in Table 3 (a more detailed presentation can be found in Figure 20 in Annex 7). The results show different policy areas (the last column of Table 3), such as education, research, and regulation, as well as the following starting points for policies to induce and/or increase domestic value creation:

- Demand for economic activities—basically, value creation relies on economic activities that are induced or stimulated by demand for RET. However, to be able to meet this demand for RET, other drivers are important.
- Input factors—the main direct inputs for value creation are human resources and capital, followed by natural resources (such as solar radiation, wind and biomass potential, but also raw materials) and land. The latter are prerequisites for RE generation, but not further discussed in this analysis. However, unclear property rights or insufficient technological know-how for the efficient exploitation and allocation of natural resources are important, as they can constitute a major barrier for value creation.

- Infrastructure, specific requirements and qualifications—the main specific requirements encompass skills, know-how, and the investment climate. The latter is a rather broad term and encompasses many fields, such as the financial, legal, and regulatory framework (including property rights and standards), as well as political and economic stability, all ensuring the efficient allocation and use of inputs.
- Actors—when looking at the actors involved in these economic activities and which of them should provide skills or know-how as well as ensure a stimulating investment climate, it becomes clear that besides actors from the private sector (e.g., manufacturers, installers, or project developers), public or semi-public actors such as research institutes, universities, creditors, and governments are deeply involved in value creation as well. Overall, in the first round firms produce equipment and machinery, then actors in the RE upstream sectors (in the second and third, or x- round effect) produce materials and equipment for manufacturing, etc.

Table 3: Overview of identified policies for value creation by type of activities, inputs, requirements/qualifications, and actors

	docking stations for policies					
	activities (along the value chain)	**intermediate inputs (upstream economic activities)**	**value creation inputs (direct inputs)**	**requirements & qualification**	**actors employing inputs**	**policy areas**
first round effects	R&D project development & planning manufacturing: equipment, components & devices construction & installation & transport operation & maintenance decommissioning	**services:** knowledge base & equipment, planning, financing, insurance, machinery for manufacturing or construction or installation, transportation, devices for O&M, trade, IT, infrastructure .... **material:** steel, copper, aluminium, ceramics, glass, concrete, …	- human resources - capital - natural resources - land	**skills**: planning, designing, management, marketing, technical/ engineering, IT, ... **investment climate:** regulation, economic and political stability, promising market/demand **know how:** material, electrical, ...	- university - research institutes - companies/firms - project developper - government (authorization, regulation, …) - investors - creditors	- education - research - training - energy - climate/ environmental - fiscal (taxes, fees, tariffs) - financing - growth - regional/land use - infrastructure - recycling - regulation
policies	**demand policies:** *demand pull*		**complementary policies:** *input related*		**supplier policies:** *actor related*	



Source: Author graph.

The overview given in Table 3 spans a matrix with relevant policy areas (see last column) and policy focuses (see last row) to shape the environment for value creation. Policies are derived based on their impact on, and relationship with, demand, inputs, and actors:

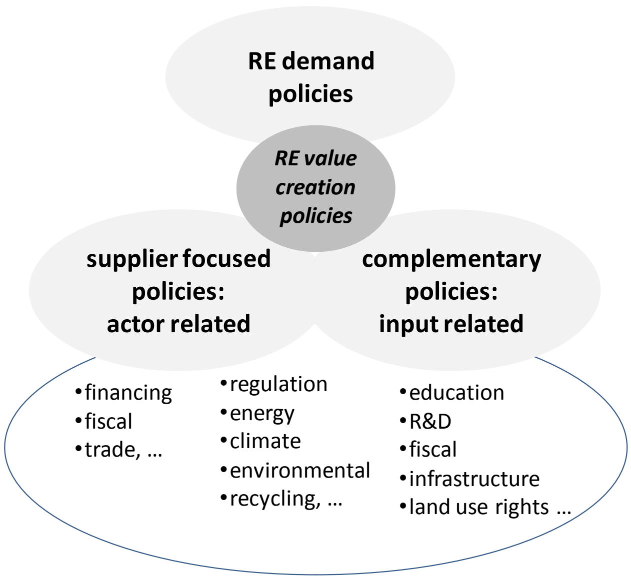
- Policies that affect the demand for RET are classified as RE demand policies[10]. An increase in demand leads to increased economic activities along the value chain of an RET. Examples of such policies are feed-in tariffs (FIT) or premiums, RE quotas based on installed capacities or actual generation, price or quantity tenders, production tax breaks, and investment subsidies.
- Policies targeting specific economic actors that produce goods, i.e., service providers or manufacturers, are labeled supplier focused policies. They address single actors (firms) or sectors that produce any kind of intermediate or final good or service for RET use. Policies could comprise specific fiscal measures, financial support, or trade rules that address firms with selected features such as affiliation with an industry sector, or technology or region.

[10] They are not discussed in detail here as other studies address this in more depth.

- Complementary policies are aimed at strengthening competitiveness by improving the quality of an input factor, such as human capital, natural capital, or monetary capital. They are input-related and comprise, for example, general measures in the fiscal area, administrative quality, financing, education, training, R&D, and infrastructure. Their effect is economy-wide but directed towards industries and services to improve their business environment.

All three types of policies have an impact on value creation or create benefits from RE deployment; they just differ in the focus of the policy measures and the target (specific or more general and cross-cutting). This understanding of RE value creation policies is depicted in Figure 15. It illustrates that RE value creation policies comprise three policy focuses (the bright grey bubbles): on actors in the supplier sector (selective), on the market (demand side), and on inputs (cross-cutting or general). Further, it shows that policy areas (in the blue circle) such as financing or fiscal could be used in a general as well as in a specific sense, that is, for complementary as well as for supply focused policies. The blue circle around the policy areas should emphasize that a clear delineation of policy areas to policy focuses (especially actor and input related) is not possible.

Figure 15: RE value creation policy focuses and areas



Source: Author graph.

3.1.1.1 *Why RE value creation policies?*

There are many justifications for industrial or RE value creation policies. Regarding RE deployment, specific motivations include climate targets, protection of scarce fossil resources, energy supply security, and RE technological development. From a broader economic and social perspective, RE use should also contribute to value creation and employment. The rationale of RE value creation policies (as well as of industrial policies) is that the market fails to meet these targets, i.e., fails to enable market entry of new technologies (see Box 2).

Box 2: Market failures justify RE policies

Environmental externalities. The external effects of RET deployment are not sufficiently accounted for in private investments. Policies therefore need to incentivize the choice of technologies with low emissions, such that we move along a sustainable development path.

Informational externalities or spillovers. Developing new business ideas entails costs and the risk of failure. When pioneering investors take the risk to test, for example, new types of PV cells or wind off-shore technologies, others may rapidly copy their ideas once they have proven successful. This is good for society but bad for the pioneer, who incurs the risk and cannot appropriate the full benefit. Thus experimentation will be undersupplied in market economies if there is no full compensation for taking risks.

Security of supply externalities: Geopolitical issues as well as natural factors may cause bottlenecks in the supply of fossil fuels. Although actual and expected bottlenecks are reflected in prices for fossil energy sources, policies addressing potential future bottlenecks could reduce risks and hence costs for individual consumers.

Coordination failure. Refers to the hen and egg problem; for example, to successfully participate in a tender a bidder needs to prove its qualifications, but to acquire recognized qualifications the bidder should have already successfully contributed to RE installations or provide guarantees which are difficult to get without such experience. Governments may then have an important role as a coordinator and guarantor.

Dynamic costs and knowledge spillovers. Price signals help entrepreneurs identify where they can currently exploit comparative advantages, but they do not help to identify future production possibilities if substantial learning-by-doing economies are involved. Thus there can be a case for supporting new activities such as PV if they have the potential to create manifold linkages and spillovers in the future.

Source: Altenburg, 2011: 13f, supplemented by the authors.

The case for RE value creation policies is clear, although there are on-going discussions on how such policies should be implemented. Regarding industrial policies, several caveats or criticisms, however, should be kept in mind (Altenburg, 2011; Hausmann et al., 2007; Rodrik, 2008), which could also be applied to RE value creation policies:

1. They both have, or could have, a normative component. This is particularly true for environmental technology policies which deliberately favor non-polluting over polluting energy technologies; likewise, governments may favor a specific technology such as RET or a specific sector such as the automotive sector that are particularly promising for job creation.

2. There may be different degrees of selectivity. For example, countries may decide to support solar instead of wind energy technology, but they may leave it to market actors to decide whether CSP or PV technology is used, or they may decide to support PV instead of CSP but leave it to the market whether to invest in thin-film or crystalline PV technology.

3. Industrial as well as RE value creation policies are justified by the existence of market failures (cf. Box 2). Although there is broad agreement on the existence of market failures, governments may fail to identify and remedy them.[11] The government focus implies several challenges; governments must actually know the potentials and the problems or barriers to growth and select the appropriate measures or instruments (information problem). Further, the incentives for government officials to meet these challenges are sometimes weak, and governments often face resource constraints.
4. Finally, empirically and statistically it has been very difficult to give evidence of a successful industrial and RE value creation policy. For example, the special economic zones and development zone policies in Guangdong, China, are listed as a success story of industrial policies (Barbieri et al., 2012), but it is difficult to determine precisely the contribution of industrial policies to economic growth, since it is unknown what would have happened without them, or what would have been the dynamics of development under different time horizons or measures used.

3.1.1.2 *What is the difference between RE value creation policy and industrial policy?*

When talking about RE value creation, the term RE value creation policies is used to emphasize the specific focus and coverage of policies, in order to avoid ambiguity or confusion with more traditional industrial policy instruments.

The term "industrial policy" is widely but not uniformly used and defined. In the past the focus was on protective government interventions and government subsidies to strengthen domestic industries' development. The objective was to protect infant industries and to maintain growth or promote a selected industry that is perceived as beneficial for the country. Industrial policy is still understood by some proponents in this sense, but its scope has broadened from protective to growth stimulating measures and now is seen as a governmental strategy to pursue economic growth and development in the manufacturing sector. Hence, industrial policies imply attempts by governments "to encourage resources to move into particular sectors that the government views as important for future growth" (Krugman and Obstfeld, 1991). Over time the focus has shifted from selective measures to increasing competitiveness, removing barriers to growth, and strengthening the economy across all sectors. Nowadays, promoting innovations and technological competitiveness have become central objectives, and flexibility of policies as well as the institutional setting matter. "The how rather than the why of industry policy*"* has become much more important (Warwick, 2013). In addition, emphasis is placed on improving the general policy and economic conditions to foster the dynamic development of businesses. Some authors enlarge this perspective by including the private sector in the policy process. Industrial policy "… facilitates learning and self-discovery of private sector actors.

[11] Government failures are to some extent perceived as even worse than market failures. Liberalization, privatization, foreign investment, macroeconomic stability, and a minimum of government interference are seen as fundamental for economic growth (Warwick, 2013).

Organizational innovation – a new way of doing things in a given context – is at center of the proposed approach" (World Bank, 2013; Rodrik, 2008). This understanding of industrial policy stresses learning by doing and collaborating with the private sector to determine the right direction and overcome obstacles to growth (Hausmann et al., 2007).

According to Warwick (2013) industrial policy can be defined as

"any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity towards sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention." (Warwick, 2013).

Applying this definition of industrial policy, it can target all economic sectors and technologies individually as well as the entire business environment and it can influence structural change. Industrial policy is seen as part of a broader strategy with the clear objective of also promoting societal welfare. However, it does not include the "how and which", i.e., the process by which the focus of policies is determined. In line with this definition of industrial policy, RE value creation policies are defined as follows:

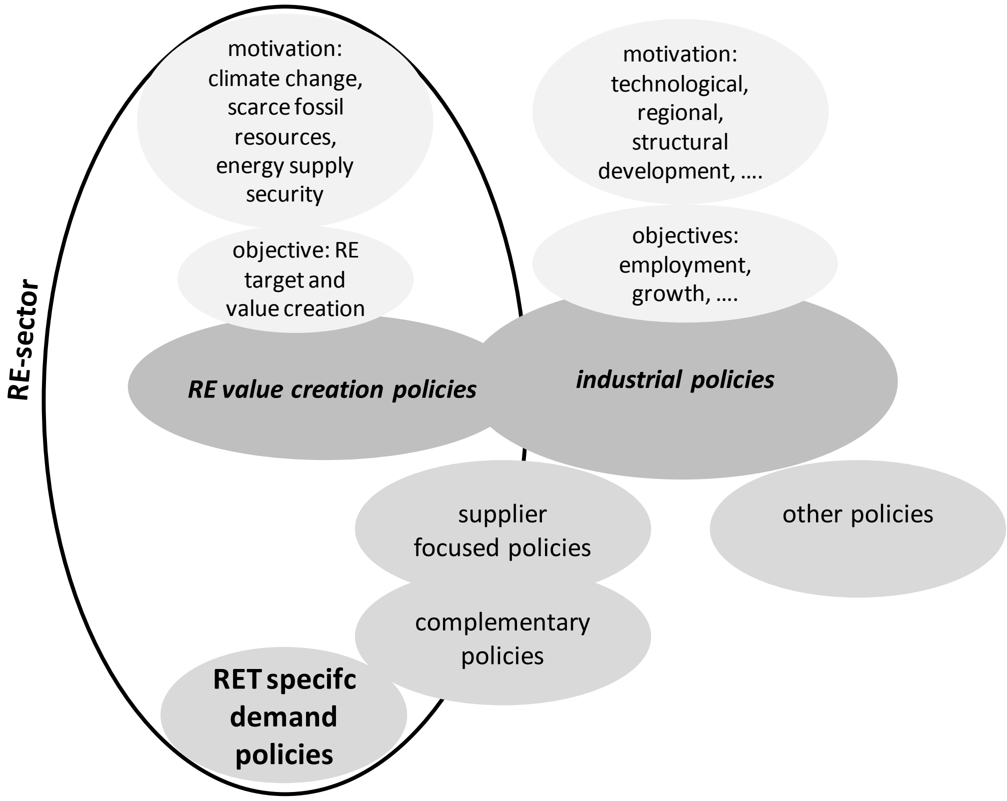
RE Value policies

... aim to increase the domestic share of RE value creation such that overall societal welfare is maintained or increased. This is done by

- *improving competitiveness and the regulatory and economic framework for economic sectors and technologies related to RE;*
- *improving the availability, accessibility, and quality of resources (capital, natural resources, human capital) used for RE deployment;*
- *stimulating demand for RE(T); and*
- *directly addressing support to selected RET producers or service providers.*

The definition of RE value creation policies in this report covers parts of the concepts of industrial policy shown above, as it comprises policies addressing producers, service providers, technologies, and the business environment. It should be clear that RE value creation policies are very specific regarding the objective, target group, and measures. The motivations, as mentioned earlier, are mitigation of climate change, protection of scarce fossil resources, and ensuring security of energy supply. The objective is to capture a large part of domestic value creation from RET deployment. In addition (and contrary to industrial policies), RE value creation policies strongly rely on the demand side while the focus of industrial policies is very often on industries and the access to, and quality of, natural, monetary, and human resources. This is illustrated in Figure 16.

Figure 16: Delineation of RE value policies



Source: Author graph.

3.1.1.3 Policies, policy instruments, and the policy mix

To explain what we mean by "policies", here we offer a brief outline of the terminology based on Hall (1993). Policies include strategic goals, address specific problems, and use specific instruments which may interact with each other. They have a content-related dimension and include a broad range of activities. Therefore, policies comprise more activities than establishing instruments or programs to achieve a certain target. Policies include the total process from definition of an issue or problem, through the selection and implementation of measures, to the final evaluation, including the following activities:

- Formulating a vision and setting general and specific objectives as well as the definition of the time horizon and geographic scope. For example: reduce emissions by 20%, increase share of RE in electricity to 20% in the EU by 2020.
- Participating in discussions on goals, ways to proceed (e.g., whether to involve the parliament via legislation, hearing procedures for stakeholders, and/or EU consultation paper).
- Elaboration of a program, plan, or strategy (for example: RE action plan).
- Selection of instruments to achieve the objectives, for example feed-in tariffs (FIT), EU emission trading system (EU ETS), tax credits, and/or investment subsidies.
- Establishing and implementing procedures, controlling implementation, evaluating and reporting achievements, such as by establishment of a national network agency and/or evaluation processes anchored in legislation.

The combination of goals, instruments, and their interactions has been defined as the policy mix. Rogge and Reichardt (2013) have expanded the definition of the policy mix by including policy making and implementation, strategies, and the dimension of policies (policy field, time, sector, geography, etc.), as well as the element of consistency between instruments and strategies and coherence between processes and policy elements.

Due to the multifaceted nature of the policies listed above, their interactions—especially among instruments—and the consistency and coherence among objectives, targets or goals, policy making, and implementation are important. For example, the announcement of the German Government (in 2013) to retrospectively change the FIT for PV electricity has created uncertainty about the reliability of policy makers, not only among PV investors but also those interested in wind, such that their readiness to invest in large and high-risk wind off-shore projects has changed. An example of non-coherence between policy targets and policy making is the retroactive change of the PV FIT in Spain, in which policy making counteracted the policy targets, leading to a strong decrease in PV installations and a perception of policy instability. A good RE value creation policy includes a policy mix that incorporates not only an appropriate design but also a detailed analysis of ante-impact evaluation and monitoring as well as ex-post evaluation of policy effects, coordination of different measures, and continuous checks for consistency and coherence. This calls for qualified human capital in politics and industry, in areas ranging from policy strategy and implementation to installation, RE power generation, and decommissioning of the plant.

RE value creation policy includes a policy mix.

It requires detailed planning, selection and implementation of policies, ante-and ex-post evaluation of effects, monitoring, and checks for consistency and coherence among strategies, targets, instruments, policy making, and implementation.

It calls for qualified human resources from the public and private sector.

Instruments are a subset of policies and are designed to meet a clearly formulated goal or target, like the installation of x MW, or generation of x MWh, support by x €, reduction of GHG emissions by x%, etc. They represent tools, techniques, or methods to address a policy problem and to contribute to the overall policy objective. More than one instrument may be applied to address a specific policy objective.

3.1.1.4 Summary of RE value creation policies

The answer to the question "Value creation along the value chain – which policies matter?*"* is depicted in Figure 17. It illustrates a matrix of policy focuses (horizontal) and areas (vertical) along the value chain and shows the third dimension, namely the policy mix (visions, strategies, plans and targets, instruments, policy making and implementation) in the last row.

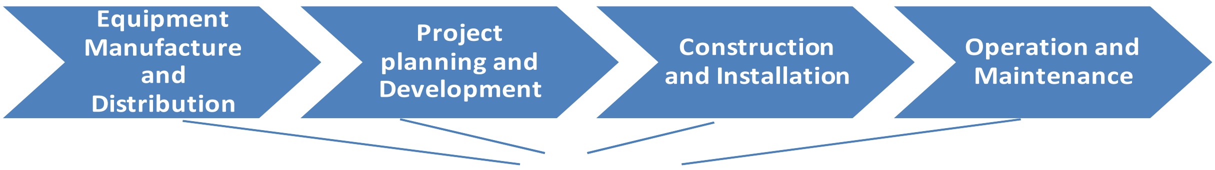
The grey shaded areas show whether policy measures from the respective policy area can address:

- RE demand,
- RE suppliers (single firms or selected sectors that provide services or products for RET deployment), or
- RE inputs (complementary RE policies addressing the availability and quality of natural, monetary, or human resources necessary to deploy RET).

In contrast to industrial policies, the objective, focus and motivation of RE value creation policies is more specific: it is RE focused and encompasses not only complementary, firm and sector focused policies but relies also on demand for RET.

In addition, the analysis shows that the RE value creation policies is a policy mix for which identification, elaboration and implementation requires qualified inputs from private as well as public sector. So: human resources are key not only for industrial production & services but also for identifying, designing and implementing the policy mix (needs) for RE value creation.

Figure 17: Supportive policies for RE value creation



	Policies focus		
Policy area	**RE demand**	**RE suppliers**	**RE complementary activities**
education, training			e.g. RET trainig program
research, development			e.g. public R&D spending
infrastructure		e.g. transportation network	
regional and structural		e.g. technology park	
fiscal, trade	e.g. local content	e.g. tax reliefs	
financing	e.g. FIT		
recycling			
environment			
energy			
legal framework			
....			
Policy mix: **setting targets, elaborating plans, selecting instruments and implementing and policy making**			

Source: Author depiction. Note: Grey areas show which policy area can be combined with which policy focus (demand, supply, complementary).

3.1.2 Three types of RE value creation policies

3.1.2.1 RE demand policies

Demand policies need vision and objectives, a strategy and action plan, and effective instruments that are deployed in an on-going process. Many countries apply a portfolio of instruments to promote RE use and RET deployment but neglect the accompanying policy measures, such as developing a strategy based on barrier and impact analysis, coherent policy making, and implementation.

RE demand policies should comprise:

- *vision and strategy: e.g., action plan, roadmap 2050*
- *objectives: e.g., 20% RE electricity generation in 2020*
- *instruments: e.g., FIT, TGC and quotas, subsidies, grants, regulation, financing*
- *policy making: suggestions and decisions concerning targets and measures, changes (proactive) and announcements, lobbying opportunities, reporting*
- *implementation: institutional set-up for generation, controlling, installation, procedures for evaluation and amendments, adjustments and announcements, societal participation*

Instruments mainly address the deployment of RET. These "demand pull" instruments are aimed at increasing the demand for RE fuels and technologies. Their rationale is the existence of external effects or market barriers that might prevent RET deployment. An overview is given in Box 2).

Market-pull instruments can be market-based, regulatory, or voluntary and can stem from fiscal, financing and trade, energy, climate, or environmental policies. Market-based instruments provide incentives via prices or quantities and can be technology specific or neutral. Price-driven instruments (e.g., FIT) have so far proved to be more efficient and effective with respect to RET deployment than quantity-driven instruments such as tradable green certificates (TGC) and quotas. Technology specific instruments often entail higher support costs but may better stimulate technological development and learning-by-doing than technology-neutral instruments and, hence, could be more efficient from a dynamic perspective (i.e. including time effects as well as multiplier and feedback effects). Voluntary instruments like participation in voluntary programs, agreements, or voluntary restrictions or labels are based on the idea that agreements create additional utility or value for consumers or producers, such as by improving reputations or the quality of goods. Regulatory instruments set standards and point towards one or more fundamental requirements, including emission regulations, fuel quality standards, obligation to add biofuels, and RE obligations in heating. Their introduction requires an input of resources to meet and enforce the standards. An example of a regulatory instrument is provided by Israel's program for solar water heaters. There, the requirement for the use of solar thermal appliances for water heating was introduced for new buildings more than 30 years ago. The rationale has been to boost the security of energy supply. Nowadays almost every household in Israel uses a solar thermal technology for water heating, and solar water heaters have become a mainstream technology, with significantly declining system prices since their introduction (Winter, 2011).

Examples of bundles of market-based, voluntary, or regulatory instruments from different policy areas that support, stimulate, or increase demand for RET are given in Table 4.

Table 4: Examples of demand stimulating policies

	Market based	Voluntary	Regulatory
Fiscal	Production tax credits, Investment tax credits		
Access to finance	Interest subsidy, repayment grants for RE investments		
Trade	Tariffs	Voluntary agreements on materials, technology	Minimum standards of products, local shares
Regional/ structural		Labels with regional provenance	Detailed specification in the land development plan e.g. for energy use
Recycling	Refunds	Collecting points	Standards, quotas
Environment / climate	TGC, Energy tax, Carbon tax	Emission agreements, bio-labels	Insulation standards, emission caps
Energy	FIT, FIP, certificates and quota, tender	Agreements on energy use, efficiency.	Standards on efficiency or technology, RE obligations

To date, the benefits of RE deployment have been measured in numbers of jobs, investment amounts, or turnover of the RE industries. Value creation through operation is a consequence of past activities and is on-going, while value creation from production and installation can be temporary. However, the increasing deployment and use of RE in association with the promotion of RET entails further benefits which could contribute to value creation, such as:

- Technological development (invention/innovation)
- Increasing competitiveness of domestic firms in international markets
- Energy supply security
- Improved energy access or enhancement
- Learning by doing / technology cost reductions
- Emission reduction

The different RE instruments listed in Table 4 exert a certain influence on these benefits. Technological development or avoided emissions, for example, will be different under a technology-neutral scheme than under a technology-specific policy. While RE obligations set a quantity target that has to be met, market-based instruments such as certificates or FIT provide incentives but no guarantee that the RE quantity target will be reached.

3.1.2.2 Supplier focused policies

Supplier focused policies are here defined as selective policies that directly address the actors in RE manufacturing, construction, and installation as well as service providers such as project developers or operators of generation plants. The focus could be on a company, a sector/technology, or both. These supplier focused policies can have a market distorting effect if they discriminate between firms or sectors or technologies.

Very common and widespread instruments for direct interventions include tax credits, soft loans, special tariffs, subsidies, grants, or state-supported establishment of industrial zones. But broadening the focus from these interventions to addressing specific market failures in knowledge generation, training, exchange of information, and credit allocation regarding RE actors opens the scope of activities to areas such as public support for R&D, education, training, and networking for actors involved in RE component, technology, and service provisions.

Although supplier focused policies could be based on complementary policies, they are considered selective as long as they address only the specific needs of selected actors – RE technology or service providing firms.

A new understanding of policies at the industry (supplier) level, however, is more oriented towards processes and procedures for selecting the respective economic activities and instruments. As Hausmann et al. (2007) argue, the term policy refers to "putting mechanisms in place to ensure that roadblocks facing these activities can be identified and removed.". This process "is based on improving the provision of public inputs to existing activities" with the expectation that it "will lead to higher productivity and quality for existing activities" (ibid). Further, Hausmann et al. go on to suggest that these policies should involve the following elements:

- Mechanisms to promote systematic discussion with business representatives to identify and propose solutions for coordination failures or externality problems
- Budgetary procedures (e.g., via bidding processes) for the allocation of money to different public entities to increase their responsiveness to specific needs of businesses
- Monitoring, evaluation, and feedback procedures to identify the successes and failures of industrial policies and allow for adjustment and improvement
- Basic principles and operation rules (transparency, open structure, inclusiveness, clear and sound criteria for participation and success).

This understanding of supplier focused policies includes processes and procedures that help to identify barriers to business development and design tools to overcome them. Identifying barriers and designing policy tools is supposed to be done in collaboration with the business sector and not by policy makers only.

Rodrik (2008) emphasizes that each country should be able to address a broad range of economic activities and not pursue only the activities which it can do best at a given time (static view). He suggests that a nation should identify which economic activities have competitive potential in the long run. However, such a process of discovery is costly and the private sector alone cannot bear these costs. Meso-level structures, such as clusters or regional value chains are of central concern in this new style of (industrial) policy.

This implies pursuit, not of a targeted and single instrument policy, but of a mix of instruments offering a framework for the development of various competitive industries. How targeted or selective a policy should be is discussed in the next chapter.

Supplier focused policies:

- *are selective, focusing on the producing and service sector – at the level of firms and / or sectors;*
- *range from protective instruments and interventions addressing market failures to creating a stimulating economic framework for selected firms or sectors/technologies; and*
- *also include horizontal policies that address special needs of selected sectors or technologies.*

The understanding of supplier focused policies is broad: from instrument to a process oriented policy engaging in collaboration with the private sector to find the right policy focus and instruments.

It follows from this broad view that supplier focused policy is a multi-faceted task, as it encompasses a policy mix covering policy areas such as legal, educational, research, financing, infrastructure, energy, fiscal, and regional economic development. The interests and concerns of industries should be fed into the political discussion and decision making process as well. Relevant supplier focused policies are depicted in Table 5. They comprise areas that are usually counted as complementary policies but when they are applied with a strong focus on the actor – firm or sector/technology –they acquire a targeted or selective character.

Table 5: Supplier focused policies – targeted at firms or sector/technology

Area	Instruments/activities (examples)	Private sector participation (examples)	Procedures (examples)
Regional / structural policies	- Industrial zones - Development zones - Local content requirements	- Joint public-private participation in planning and investment, in support of cluster development	- Working groups at community and ministry level - - Setting up regional cluster management bodies
R&D	- Support for networking/ cooperation - Public R&D funding for specific topics aimed at supporting cooperation between public research organizations and enterprises	- Workshop for defining strengths and weaknesses in existing knowledge - Technology foresight studies - Elaborating programs and calls for projects - Requiring co-funding from the private sector	- Establishment of (high level) discussion and consultation group (with private and public representatives) to develop an R&D strategy and to monitor implementation
Access to finance	- Public investment supports - Grants - Soft loans - Export support (financial) - State/public banks	- Private investments - Creation of private loan funds - Public private partnership in financing institutions	- Establishment of a private-public body that approves and monitors these activities (budgetary and control competences)
Fiscal (targeted)	- Tax privileges - Import tariffs or quotas - Export support (fiscal).		- Establishment of a private - public implementation body
Training/ education (targeted)	- Financial and organizational support for training activities in the	Private sector involvement (financial or know-how) in specialized education centers,	- Definition of training and education needs based on thorough analysis of

Area	Instruments/activities (examples)	Private sector participation (examples)	Procedures (examples)
	private sector - Establishment of specialized education centers - Support for RET curriculum development activities in education institutions	e.g., provision of technical teaching staff, buildings, institutional set-up	existing gaps - Establishment of a competence body (of public and private actors to implement and monitor training and education related measures)
Small/ medium enterprise upgrading	- Financial support (e.g., grants, loans) and technical advice for improving quality (and consistency in quality) in products and services - Support for enhancing managerial and design and engineering capabilities	- Encouraging lead firms to engage in supplier development programs for SMEs (including training, quality standards and monitoring)	- Establishment of industry forums to exchange knowledge and various practices - Benchmarking studies for existing programs

3.1.2.3 Complementary policies

As described in the previous chapter, complementary policies can be used in selective ways. But in general they are not explicitly targeted at a specific sector or actor but have a cross-sector or cross-industry impact. Complementary policies such as education, training, regulation (e.g., exploitation and property rights, standards, and risk provisions), financing, and R&D are focused on enhancing and strengthening competitiveness in all sectors. They are input related, i.e., they address the availability, quality and potential of human, monetary, and natural resources.

Looking at the requirements for value creation, such as skills and knowledge and a supportive investment climate, it becomes clear that a very broad knowledge base (legal, technical, etc.) and many diverse skills ranging from management to technical areas are crucial for value creation.

Complementary RE policies:

- *are not selective and not targeting specific industries;*
- *focus on enhancing and strengthening competitiveness of all industries or sectors; and*
- *affect the use of human and natural resources and capital.*

Education and training play a key role in building up capabilities and skills and in transferring know-how. Hence, policies promoting education and training are central for economic growth and well-being. Because of the positive external effects of education, governments usually finance the general educational system to varying extents, while secondary or tertiary education is in some nations increasingly financed by private institutions. Specific policies affecting human resources along the RE value chain mainly appeal to technical universities and colleges but should also address financial, vocational, and managerial training while broadening the focus at tertiary level and strengthening links with other disciplines.

Depending on the autonomy of the educational institutions, governments can apply a bundle of instruments that should not only focus on know-how transfer but also on technical/organizational support, evaluation, and design of the system:

- Capacity needs diagnostics for RE[12]
- Establishment or (co)financing of technical departments or research centers (college, university)
- Introduction or (co)financing of lecturers or chairs (college, university)
- Introduction of new technical certificates or training programs (vocational training centre, vocational school, college, university)
- Establishment and (co)financing (investment, working expenditures) of training centers (for companies)
- (Co)financing of research activities at the college or university level or by special research centers and think tanks
- Stakeholder processes for curricula development with business associations, R&D, and state institutions
- Promotion of (international) co-operation
- Tax relief or subsidies for participation in research and training programs
- Transparency and provision of information on RE education and training opportunities

Since education and training cover a broad field of activities and topics, there are many interactions with other policy areas. Hence, close coordination with selective and other complementary policy areas is necessary.

In this context, research policies in a broad sense include technological development and innovation policies. They aim at enhancing or disseminating knowledge as well as developing or improving technologies. The focus of research policies has changed from a heavily technology- and thematic-focused support to promoting (international) co-operation and addressing global challenges and multifaceted-problems that could be solved by technological advances. The research policies apply to a broad range of policy areas; in the EU (EU, 2013), for example, they affect agriculture and forestry, energy, environment, fisheries and aquaculture, food, health, industrial technologies, IT (or ICT), marine and maritime research, and nanotechnology as well as innovation, international cooperation, and training. In these areas support can be given through a bundle of instruments:

- Financial or institutional support of research institutes (grants, special allowances, tax exemption for private research institutions)
- Project (co) financing (subsidies or grants) in selected technology fields such as research in thin film materials and converters
- Financial support of technical cooperation projects, e.g., among research institutes, universities, and firms
- Support for exchange platforms and networking, e. g., workshops, electronic platforms for research results and discussions, fairs and exhibitions, and conferences

[12] GIZ, IDEA, IRENA, NREL (2012): Capacity Development Needs Diagnostics for Renewable Energy CADRE, Volume I: The Handbook, Volume II: The Toolbox. Download: http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=225.

- Financial support for scientific training and knowledge exchange
- Setting of (technical) standards

Research policy, in a broad sense, can apply instruments from many different policy areas, such as financial or fiscal policies. Furthermore, research and innovation have developed from predominantly national to increasingly globalised activities that play not only a key role in domestic economic and social development but are also prerequisites to solve a priori transnational challenges such as combating climate change and environmental degradation or securing a continuous supply of energy and food for a growing population. The increasing "internationalization" of research and innovation becomes obvious by the number of internationally co-authored publications and the international mobility of researchers. I addition, companies are investing in R&D beyond their national borders, including in the emerging economies (EU, 2013). Since participation in research and innovation activities becomes increasingly vital for national value creation and economic growth, research policies that include the international perspective are gaining in significance.

Fiscal policy with respect to RE value creation policies can be understood as the use of money or targeted spending by governments to capture value creation and promote a nation's social and economic development. The monetary policy with which a central bank manages the money supply is the respective "sister" policy. These two policies are used in many combinations to achieve the economic goals of growth and stability. Fiscal policy represents a horizontal policy that exerts an influence on different economic activities or selective policy areas. Their main instruments are taxation and selective subsidies.

In the context of energy policies, the following range of instruments is applied:

- Tax exemptions; tax relief; or holidays from sales, production, corporate, or income taxes (including VAT); and special accounting rules (for example, depreciation rules reducing tax burdens)
- Special taxes or levies on the use of natural resources, e.g., eco-taxes on fossil fuels, taxes on ground-water use, or transmission grid levies
- Subsidies for investments in RE facilities or generation of RE energy
- Tariffs (especially for exports and imports of fossil fuels)

Financing is per se not an explicit policy area. However, in the context of RE value creation financing—the provision of capital to support RE deployment—plays a crucial role. Financing includes any activities that directly affect the volume and cost of money provided by investors or creditors for RE investments. As a result, policies affecting financing encompass monetary policies to maintain stability, regulation to ensure a functioning financial market, and financing activities such as lending or investing by governmental organizations if market imperfections lead to undesired results.[13]

[13] Technical assistance and capacity building for financial market reform and modernization should be provided by training and education policies.

Relevant policy activities in the area of financing include:

- Creating access to international public funding (climate finance, international financing institutions)
- Regulation of risk provisions (e.g., minimum capital ratio and leverage ratio)
- Regulation of risk assessments and risk exposure from project financing and corporate financing, risk mitigation institutions such as bad banks or insurances
- Financing of project or investments with loans from a governmental or state owned organization
- Taxation, deposit, and investment guarantees to support domestic capital formation

Although monetary or central bank policy (lending rate and money supply) has a significant impact on the availability and cost of capital, this policy is independently handled and determined by politics or governmental decisions in many nations.

Regional and land use policies are important for the selection of generation and production facilities. Regional polices refer to spatial planning and regional structures – incentives for industries, clusters, and development centers - and are closely related to infrastructure polices, while land use focuses on the natural, societal, and legal aspects of land use. Excessive restrictions inhibiting access, acquisition, or use of land for RE generation and manufacturing represent barriers to RE value creation. Policies in this area include:

- Policies concerning spatial planning, land use, and land use rights
- Establishment of industrial zones
- Infrastructure planning (e.g., construction of roads and availability of ITC systems)
- Regional development (e.g., establishment of technology parks, special industrial zones, and training centers)

Infrastructure policy focuses on the available infrastructure necessary to set up and operate a manufacturing or generation facility. Grid, road, shipping, and railway systems are crucial for provision of supply and transport of outputs. Infrastructure policies go hand in hand with regional development.

An example of integrating regional policies and infrastructure planning is the special economic zone program in China. The Chinese policy established three special economic zones close to foreign capital sources. The policy targeted the attraction of foreign capital, acquisition of foreign technology and managerial skills, and promotion of exports. However, these infrastructure and regional policies were combined with fiscal measures, R&D support, and adaptation of the legal framework to allow the creation of small autonomous economic areas, etc. Additional "zone - programs policies" accompanied this program, all supporting an agglomeration of specific firms to develop lagging areas and to promote competitiveness, technological upgrading, and innovation. This region, Guangdong, has developed into an important economic growth region in China.

Recycling policy is closely related to environmental policies but refers here more to the rules and implementation systems for RE facilities. Recycling policy addresses such questions such as which technical parts need to be recycled, which institutions or organizations collect the material, and who bears the costs. Although this area is the last along the value chain of an RE facility, it might produce some revenues or other benefits from recycling of rare materials.

Regulation policy is not a stand-alone policy area, but rather a part or even an instrument of many other policy areas (such as financing, environment, regional planning, and consumption) used to achieve policy goals. Regulation encompasses any kind of activity that constrains, guides, and/or administers economic activities, supply or access to resources, technical and security standards, utilization of resources (e.g. land, mining), etc. Governments establish regulations if market forces fail to regulate or to provide a certain (security) standard or procedure. Typical examples of areas subject to regulation are natural monopolies (electricity grids, broadband cable, railways) and the exploitation or use of public goods (pollutant emissions, biodiversity). It makes a difference in implementation or deployment how standards are anchored (e.g., in national law or directives), who participates in adaptation, and who is enforcing standards. Besides setting and controlling quantities, prices, or standards, regulations also include the authorization and use of property rights. With respect to RE regulations, the following aspects are important:

- Access to grids
- Grid stability criteria to ensure energy supply
- Technical standards to ensure deployment of efficient technologies
- Establishment of regulation institutions (e.g., Network Agency)
- Property rights (intellectual, land, real estate)

Overall, policies in financing, education, and R&D can be used in a very selective way as well. Table 6 shows the types of instruments and their focuses. The type of instrument shows which area or level is addressed. For example, all financial instruments deal with financing issues; while regulatory instruments address rules, regulations, and property rights; education instruments address skills and know-how, knowledge generation, capacities, and capabilities; and, finally, infrastructure refers to public goods or networks that are needed by selected suppliers, consumers, or both.

Finally, in line with Collier and Venables (2012), who conclude that although natural resources are widely available, the scarcity of capital, government capacity, and skills limits growth in some countries and that bottlenecks in the supply of input factors such as land, labor, and capital could constrain sectoral growth and hence RE value creation as well. On the other hand, a shift of input factors to RE deployment and value creation could limit the availability of input factors in other sectors and could constrain growth. Therefore, we should be aware of the negative impacts that RE value creation policies could have on other sectors.

Table 6: Overview of RE value creation policies

focus / type	Supplier	Demand	Complementary
Financial	• Investment grants • Interest subsidies • Tax credits	• FIT • TGC • Tax credits • Investment subsidies	• R&D grants • Financial programs for schools, universities • Research awards
Regulatory	• Standards (TÜV, …), • Labels • IPR • R&D spending obligation • Land use rules • Intellectual property	• Product norms/ standards (ISO) • Quotas • Product information standards or requirements • Financing and land use rules	• Mandatory education/training • Educational standards (curriculum) • Reporting standards • Legal framework/rights • Banking rules • Recycling rules
Educational, research, learning	• Scientific, management, … training on the job • Building of capacities and skills	• Information activities (platforms, discussion rounds, presentations, talks, speeches, …) to increase awareness of selected issues	• R&D networking • Education programs • Establishment of platforms, WS
Infrastructural	• Infrastructure road, rail, ship, IT, power, water, finance, ….	• Infrastructure finance, road, power, IT, water, …	• Infrastructure finance, road, rail, ship, IT, power, education, etc.

3.2 CASE STUDIES: FROM RET DEPLOYMENT TO POLICY[14]

Having highlighted various instruments that constitute the RE value creation policies, this section focuses on strategic policy interventions for enhancing value creation by turning RET *deployment successes* into *socio-economic successes*, a critical objective in supporting RET industrial development with respect to manufacturing, service development, and R&D. This section, therefore, aims to highlight how policy instruments (specifically, supplier focused policies and complementary support policies) can be combined and targeted to generate both first round effects and second round effects, as described in Chapter 2. In light of the discussion in Section 3.1, here we provide an overview of lessons from conventional industrial policies (highly relevant as guiding principles for the implementation of RE value creation policies) and discuss challenges for RE industrial development. We then analyze in greater depth the specific RE value creation policy mixes while drawing on relevant examples.

[14] This section (especially sub-section 3.2.1 and 3.2.2) builds on the contribution that DIE made to the Union for the Mediterranean's (UfM) report "The Mediterranean Solar Plan: A Flagship Initiative for a Sustainable Mediterranean Region," to be published in 2013. Some parts, cited as UfM (2013), are reproduced here with the permission of the Secretariat of the UfM.

In this assessment we are concerned with countries that already have a market for RE or plan for future deployment, and that seek to optimize the social and economic benefits (i.e., value creation) from large-scale deployment of these technologies. For most (if not all) of the policies aimed at industrial development (and value creation more generally), the presence of a large and predictable demand for RET is critical. Hence for RE value creation policies to be effective, robust (i.e., ambitious and consistent) policies for market creation (RE demand policies) are a precondition. The reality, however, is that the strength of these policies varies among countries (as is the case with other framework conditions), which implies that policy makers need to carefully assess the necessary interventions at multiple levels in order to achieve the desired results.

Given that RET should increase in the coming years to fulfil the roadmaps set for climate change mitigation and for affordable domestic clean energy, we should see more and more countries with large RET deployment efforts in the next decade. Moreover, these countries will extend the current focus on industrialized countries in Europe and North America to more regions globally.

To achieve optimal results in terms of economic efficiency, environmental sustainability, and social equity, implementing RE value creation policies requires a careful balancing of market forces and state intervention. Further, an important aspect to emphasize is that in the process of value creation, different policy priorities may be chosen depending on country- level framework conditions. Inevitably, these choices imply certain trade-offs (e.g., emphasis on deploying labor intensive vs. technology intensive RE, or unconditional support for all investors vs. local content requirements) that must be carefully identified and the effects of which must be clearly understood. Effective policy design should carefully consider such trade-offs between different policy alternatives. In addition, the choice and implementation of policies should reflect the country's "latent comparative advantage" (Lin and Monga 2010) by supporting the private sector to "grow in sync with the dynamic change in the economy's comparative advantage" (ibid.).

3.2.1 Lessons from conventional industrial policies

To improve policy effectiveness, good design practices are crucial. Before delving in more detail into specific policy areas for enhancing value creation through industrial development (see Section 3.2.3), policy makers may find it relevant to reflect on lessons from conventional industrial policies. These lessons are critical for policy design with respect to implementation and monitoring of outcomes, as they aim at integrating learning and inducing more flexibility in adjusting to market changes.

Based on a review of the industrial policy literature and practical guidelines for policy makers (CDASED, 2001; Bullock et al., 2001), the following lessons for efficient industrial promotion can be identified (UfM, 2013):

1. Industrial policy, like other types of policies, should balance economic with social and environmental objectives.

2. A wide range of public and private stakeholders should be invited to contribute to the policy design from the very beginning. This helps to identify good compromises and increases policy certainty, as it reduces the risks of policy makers having to abandon or change certain policies during the implementation phase in response to unexpected opposition.
3. A balanced and coherent policy entails cooperation among government agencies, which in turn requires that mandates, competences, and responsibilities are clearly defined.
4. Technological objectives should be defined in such a way that they can be achieved without long-term subsidies.
5. Industrial policies should build on private sector-led experimentation rather than top-down planning. In particular, "nudging" private companies and inviting them to collaborate is often more effective than "command and control", especially when the government's capacity for enforcement is weak.
6. Whenever pilot projects are supported, it is paramount to incorporate, from the very start, mechanisms to ensure scaling up if the pilots are successful.
7. All policies should be subject to continuous monitoring and independent third-party evaluation. Monitoring and evaluation systems should measure outputs and outcomes rather than inputs. Hence, expected outcomes need to be defined in measurable terms.
8. Different policy functions – such as target-setting, implementation, funding, and evaluation – should be institutionally unbundled to create clear lines of accountability.
9. Service agencies should have strong incentives to act in a customer-oriented and business-like manner. Competitive tenders and results-based management are ways to ensure these behaviors.

3.2.1.1 Challenges to promoting RE industries

In the case of RE sectors, the need for selective government intervention becomes more prominent. Four specific challenges for promoting RE industries can be identified (Altenburg and Pegels, 2012; also reflected in UfM, 2013).

First, policies need to provide incentives for internalizing environmental costs (along with social and health costs) in private investment decisions. Typically, the social costs of resource depletion are borne by the larger society rather than by the current resource users. Once environmental costs are internalized in market prices, which can be achieved through a variety of instruments as discussed in Section 3.1, investors will redirect resources towards RET.

Second, market failures, such as information and coordination failures, tend to be particularly severe in RE industries. To address such failures simultaneous investments in various activities, closely coordinated by one or more public agencies/players, are necessary.[15] Another challenge is to increase the attractiveness of RET vis-à-vis the competition from conventional energy systems that benefit from sunk costs and path-dependent consumer habits.

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[15] For this reason the issue of high-level coordination becomes more important for the RE sector compared with other sectors (e.g., semiconductors or the automotive sector). However, it should be mentioned that up to a certain point, objectives can also be achieved with a lower level of coordination (see the example of large amount of distributed RE installations in Germany).

Third, systemic changes need to be accelerated at an unprecedented pace. Systemic changes have not been uncommon in the past, such as the introduction of the steam engine, the rise of the automotive industry, or the IT revolution. However, it took several decades until the new technologies were mainstreamed. In the case of environmental industries, innovations are urgently required in the next 10-15 years if tipping points in global ecosystems are to be avoided.

Fourth, the uncertainty related to policy measures and technology costs is particularly pronounced for RETs, given the relatively large upfront investments required and the long-payback periods involved, all of which are affected by the political and institutional framework conditions in a particular country context. All of this requires corrective action by governments, or else the necessary investments will not be made in the years ahead.

In light of these challenges, policies aimed at industrial development in the RE sector call for different, in some cases additional, interventions and an accelerated speed of implementation; this, in turn, *entails higher policy risks* (Altenburg and Pegels, 2012). These policy risks could result in RET not becoming cost-competitive or socially accepted in spite of large investments, or could be reflected in complex dynamics between different stakeholders (some who might lose and some who might gain from such policies) (ibid.). The ultimate goal is to manage the risks and trade-offs in a socially and politically acceptable way and such that value creation is maximized.

3.2.2 Practical policies for RE industrial development

Single policies are not sufficient to expand value creation. Rather, as discussed in Section 3.1, integration of policy measures is necessary to achieve competitiveness in the face of global market dynamics and climate change concerns. Below we offer a "bird´s-eye perspective" of several complementary policies and supplier-focused policies that are geared toward value creation in the RE sector and that need to accompany the demand oriented policies briefly presented in Section 3.1 (a more extensive assessment of policies for supporting RET deployment can be found in other reports, such as OECD, 2013). A combination of these policies contributes to value creation locally (in the form of first- and second-round effects). While other sets of policies may be important, here we are specifically concerned with five categories: attracting investment, targeting that investment toward building domestic capabilities and stimulating employment (including local content requirements and supplier development programs), developing industrial clusters, enhancing R&D capabilities aligned with firms' needs, and improving skills.

These policy interventions are likely to generate various opportunities for value creation along different parts of the value chain. For example, while advanced skills development programs can be expected to create value along the entire value chain, some policies, such as investment promotion, tend to support value creation especially in manufacturing, project development, and R&D.

Table 7: Policy interventions and opportunities for value creation along the RE value chain

	OPPORTUNITIES FOR VALUE CREATION ALONG THE VALUE CHAIN				
POLICIES	**R&D**	**Manufacturing**	**Project Development**	**Installation**	**O&M**
Investment promotion	←	—	→		
Linking investment to employment creation and capacity building:		←	—	—	→
- Local content requirements		←	—	—	→
- Supplier development programs		←	—	→	
Developing industrial clusters	←	—	—	—	→
Cooperation between public research organizations and the private sector	←	—	→		
Enhancing know-how through education and training	←	—	—	—	→

For each of these policy areas we draw on specific country (and sector) case studies, summarized in Table 8, to provide more concrete insights into specific policy design options for maximizing value creation.

Table 8: Best practice examples for different policy areas

Policy areas	Best practice examples
Investment promotion	Costa Rica, Canada
Linking investment to employment creation and capacity building	
- Local content requirements	Canada
- Supplier development programs	Ireland, Singapore, Mexico
Developing industrial clusters	California, Germany
Cooperation between public research organizations and private sector	Germany, Canada, Spain
Enhancing know-how through education and training	Malaysia, Spain

3.2.2.1 *Strategic investment promotion*

In the transition to a low-carbon economy worldwide, technology and finance have emerged as critical factors (Hanni et al., 2011). A major source of both finance and technology is foreign direct investment (FDI) channeled through transnational corporations (TNCs).[16] In the RE sector Germany and Spain are the main sources of FDI[17]. Given that reliance on technology transfer is critical in the early stages of RET development, a strategic investment promotion approach is important for developing countries in particular. Yet, when global competition for capital investment is high, as is the case for RET, developed countries also need to attract FDI to regions with comparative advantages. Hence, identifying effective strategies for attracting FDI becomes a core concern for developed and developing countries alike.

Statistical evidence shows that developed economies remain the main destination for RE electricity generation FDI, although developing and transition economies are becoming more important hosts for these projects (Hanni et al., 2011: 32). When it comes to specific RET, more than half of FDI for manufacturing solar and wind energy hardware and installations has been targeted towards developed economies (Hanni et al., 2011).[18]

The long-term impact of FDI on the host economy varies from country to country, depending on domestic capabilities to absorb know-how and on the existing industrial base, but also on the implicit goals of the investors and the strategic government approach to targeting investment. The effects on the economy can be both positive (e.g., creating additional employment and know-how that spills over to the larger economy) and negative (e.g., crowding out existing jobs by improving productivity as a result of superior technology and know-how or by replying on imported products and services).

Thus, the extent to which the host economy benefits depends on the *type of investment* and its *"fit" with the local productive structure* (UfM, 2013). In this process the role of the government is critical with respect to having a clear vision of what type of benefits it wishes to target and the roadmap for achieving them.

Table 9 provides a typology of strategic approaches to attracting FDI, illustrating a range of interventions. While open-door policies have been successful in the past, mainly in late-industrializing countries in East Asia, nowadays they have been largely deemed incompatible with international trade requirements. Strategic targeting policies have, however, been proved quite effective in guiding the actions of foreign investors towards higher value creation at the local level. Restrictive policies can discourage the private sector from making investments.

[16] However, as Marcias et al. (2011) argue, “the way in which FDI affects development remains obscure, hidden within a ‘black box’”.

[17] FDI from developing countries (mainly to other developing countries) is also increasing in this sector, especially from China, Brazil, Malaysia, the Russian Federation, and India (Hanni et al., 2011).

[18] For solar manufacturing, the top five destinations were the United States, China, Germany, Spain, and Canada, while for wind manufacturing the top five top destinations were the United States, China, Spain, India and the United Kingdom.

At the same time, even a wide set of incentives might not guarantee that investors will be able to maintain their regional competitiveness for a long time, leading to a potential "waste" of state resources. One such example is the costly and unsuccessful struggle of the state of Massachusetts in the US to convince Evergreen Solar Inc. to maintain their local manufacturing facilities (using "strategic targeting policy", as illustrated in Table 9).[19]

Table 9: Four approaches to FDI policy

Type 1 Passive open-door policy	Type 2 Open-door policy	Type 3 Strategic targeting policy	Type 4 Strategic restrictive policy
• Limited and only horizontal inteventions to improve supply conditions	• Active and sometimes selective support measures to improve supply conditions	• Target and guide policy with selective interventions to develop advanced factors	• Restrict and exploit policy with strong selective interventions

Source: Adapted from Lall, 1995, pp. 7 (ff).

Strategic targeting of investors is essential. Such targeting requires a holistic approach that takes into consideration the general policy framework (e.g., demand oriented policies, supplier oriented policies), economic determinants, and promotion and facilitation aimed at attracting FDI (UNCTAD, 2010). Examples of how such strategic targeting works in practice can be found in various sectors.

Box 3 shows how Costa Rica's government proactively engaged in attracting a large INTEL plant, which then triggered other knowledge-intensive investments. The main factors that contributed to this positive experience were the government´s actions in attracting investors, not necessarily with large financial concessions but rather by showing a visionary approach and providing auxiliary services necessary to increase the long-term competitiveness of investments (a case of "open-door policy" illustrated in Table 9).

This example shows how an integration of policy instruments (outside of the "standard" policy toolbox) can contribute to value creation (both in terms of first- and second-round effects).

[19] In 2008, Massachusetts convinced Evergreen Solar to locate there, in an effort to boost the state´s reputation as a hub for green industry (Smith, 2011). More than US$50 million in incentives (in the form of fringe benefits, tax breaks, free rent, and cash grants) have been paid achieve this goal (Brickley, 2012). Three years later, due to competition from China, the company was forced to shut its doors and lay off its 800 employees (Smith, 2011); in 2012 it had to walk away from the factory facilities having been unsuccessful in selling it due to changing market conditions (Brickley, 2012).

Box 3: Strategic investment policy in Costa Rica

Costa Rica's government realized quite early that it was necessary to stop competing in world markets on the strength of low wages and instead search for knowledge-based competitive advantages. Owing to high levels of education, conditions were favorable. As early as the 1990s, the government made efforts to build dynamic competitive advantages and to attract foreign investments in knowledge-based areas: a National Strategy for Investment Promotion focusing on technology policy was formulated; improvement of the telecommunication infrastructure received high priority; education was focused on information technologies; and technological pilot projects with international corporations were encouraged.

Former President Figueres held regular meetings in order to discuss business experiences with a dozen managers from foreign high-tech firms with branches in Costa Rica. Accompanied by a team of investment experts, he paid visits to firms like Microsoft, Hewlett Packard, and Boeing and invited them to make investments in Costa Rica. This eventually led to an investment by INTEL of US$500 million in a production site for the assembly and testing of Pentium-II processors.

INTEL had originally studied several possible sites for construction of its assembly plant, including Brazil, Chile, Mexico, the Philippines, and Thailand. Costa Rica won the competition without offering major firm-specific concessions. Instead, what impressed INTEL's management was the country's focus on an electronics strategy, its willingness to invest in training, and the strong commitment to the INTEL project. The facilitation work undertaken by Costa Rica's investment promotion agency CINDE and the President's personal support for the project were decisive.

The INTEL production site triggered follow-up investments by suppliers. Also, other large corporations, including Hewlett Packard, followed INTEL's example and opened a regional service centre for Latin America in Costa Rica.

Source: Spar, 1998; and press reports.

Canada provides another example of how to best maximize value creation from FDI, in the form of employment creation and industrial development. Between 2003 and 2011, 126 foreign companies established greenfield FDI projects in the RE sector in Canada, which, relative to size, is more than any other major economy during this period (Invest in Canada, 2012). FDI has been attracted for both electricity generation and manufacturing projects. In particular, Ontario has attracted 79% of Canada´s investment in manufacturing projects, due to a set of policies for investment promotion (Hanni et al., 2011: 59). These measures included market creation policies such as FIT, business facilitation, and local content requirements (LCR) (although these are controversial, as we will discuss in Section 3.2.3.2) asking developers to ensure that a certain percentage of their products´ materials were sourced from Ontario.[20]

[20] As we will discuss in Section 3.2.3.2, the LCRs in Ontario have become very controversial in light of World Trade Organisation (WTO) rules for free trade, which might demand a re-assessment of Ontario´s success with the creation of a local industry and might limit opportunities for other countries to use this measure.

Box 4 highlights how the Department of Foreign Affairs and International Trade´s (DFAIT) Invest in Canada Bureau is systematically targeting investors who could increase the value added locally through employment creation and industrial upgrading (using a combination of "open-door" and "strategic targeting" policy approaches to investment promotion.

Box 4: Strategic investment promotion in Canada

Aside from conventional marketing approaches, the Department of Foreign Affairs, Trade and Development´s (DFATD) Invest in Canada Bureau operates a more targeted program focusing on specific foreign TNCs. This program identifies targets through three successive levels of analysis: at sectoral or industry level, at country level, and at firm level. Recently the Bureau identified 15 industry sub-sectors characterized by high productivity and high growth within these broader sectors: aerospace and defense manufacturing, pharmaceuticals and biotechnology, business and financial services, environmental technologies, and information and communication technologies. It then selected 20 target countries in the Americas, Europe, and the Asia-Pacific region. Within the targeted sectors and countries, specific firms with potential to establish and expand their operations in Canada were identified and pursued. Firms attracted in these sectors are more skill-oriented than others and thus have the potential to both take advantage of and add to Canada´s pool of skilled labor.

Within Canada, Ontario is by far the most active in attracting investment. Its approach has become increasingly sophisticated and data-driven. Within the Ministry of Economic Development and Trade, a strategic intelligence unit works with sector-specific industry groups to develop proactive promotional approaches. These focus on specific industries; within them, individual firms are identified with the help of banks, Ontario´s international trade secretariats, corporate lawyers, and industry insiders. Contact with the firms is established via human resource departments, senior executives, and legal counsels. Every aspect of a potential investment is examined so the Ministry can formulate a compelling case for FDI to be attracted to Ontario, including infrastructure requirements (for the role of infrastructure also see Section 4), industry linkages, personnel requirements, transport needs, training opportunities with universities, and so forth.

In terms of investment incentives, Canada generally does not have fiscal or other concessions specifically targeted at FDI. However, FDI often utilizes general investment incentives. For example, specific tax subsidies, which receive both federal and provincial support, apply to R&D. In some cases, however, subsidies negotiated at the provincial level are used to attract and increase the local impact of certain large-scale projects. For example, Pratt & Whitney recently obtained a US$142 million supplement from Quebec to build a new plant there, involving some 7,000 jobs. The grant is tied to local hiring and training, creating a direct link between FDI promotion and local skill development.

A core element of success for FDI attraction in Canada has been the presence of strong human capabilities. An emphasis on local skills upgrading, where universities and research institutes play a critical role, and on the close cooperation with the private sector, have been an essential part of the investment promotion strategy of Canada.

Source: UNCTAD, 2011.

In these examples (and in others), the key message is that because investment is critical for enabling industrial development (and hence value creation), a strategic approach to targeting specific firms and segments of the value chain based on a long-term vision for the RE sector (and its dynamics relative to other sectors) is critical.

3.2.2.2 Linking foreign investment to local job creation and capacity building

When attracting FDI a key challenge for policy makers is to ensure that sufficient linkages are built with the host economy (e.g., the private sector, training institutions) to maximize value creation. This is important because in many cases such linkages are weak, especially where the technological gap between the foreign and local firms is large. Benefits from closer linkages can materialize for both the foreign investors and the host economy. On the one hand, the local supply of competitive inputs and services can reduce production and operation costs for foreign investors. On the other hand, proactive effort in upgrading the value chain for different inputs and services is likely to lead to higher investments in the future, which in turn can contribute to job creation. Close collaboration among foreign investors (which tend to be technology lead firms) enables economy-wide knowledge spillovers, thereby creating second-round effects from RET investments. In general, however, the more locally embedded investments are, the less likely they are to shift locations when costs increase, which is crucial in light of the global market dynamics in RETs.

Closer linkages between the foreign investors and the local economy can be made mandatory, via local content requirements or by supporting supplier development programs that enable local companies to upgrade and enter partnerships with foreign suppliers. Below we discuss these two policy instruments in more detail.

Local content requirements

LCRs act as performance requirements that determine the extent to which projects must use locally manufactured products. LCRs are usually tied to government concessions, such as preferential tariffs, tax exemptions, low-interest loans, infrastructure support, and/or land acquisition support (Tomsik and Kubicek, 2006: 1). The promise of value creation through employment generation and local economic development makes LCRs an important tool to get buy-in for RET deployment strategies from powerful interest groups, increasingly being made part of government support for RETs. Yet, currently only a few countries have mandatory LCRs in place (see Table 10).

Table 10: Selected countries with LCRs for RET

Region	Period	Industry	Local content requirements
China	1996-2008	Wind	Wind turbines were required to source at least 70% content from local manufacturers; bids with larger amounts of local content are scored higher.
Brazil	2005-2009	Wind	At least 60 to 90% local content for wind development.
India	2009-	Solar	National Solar Mission-approved solar PV projects must use locally manufactured cells and modules. Solar thermal projects must have 30% local content.
Canada			
- *Quebec*	2006-	Wind	A minimum of 40% to 60% regional local content for each wind farm.
- *Ontario*	2009-2012	Wind	At least 50% local content for wind development.
	2013-	Wind	At least 20% for on-shore wind facilities.
		Solar	A minimum of 19% to 28% for solar photovoltaics facilities (depending on technology type).

Sources: Rivers and Wigle, 2011; CEEW and NRDC, 2012: 22; Hao et al., 2010; UNEP and Bloomberg New Energy Finance, 2011: 29; HydroQuebec (2014); Ontario Power Authority (2013).

However, there is considerable controversy over the use of LCRs. If judiciously applied, they may increase the local share in projects and may in some cases help technology transfer and learning. But if they are too ambitious and force project developers to source local products that are inferior in price or quality to those available in international markets, LCRs may undermine the competitiveness of the entire value chain, potentially deter investment, and thus also backfire for the respective jurisdiction.

The World Trade Organization considers LCRs inconsistent with rules governing free and fair international trade (except when they are used for public procurement). In a recent ruling, the WTO's Appellate Body held that Ontario's Feed-in Tariff regime with attached LCRs violated provisions in the General Agreement on Tariffs and Trade (GATT) and the Agreement on Trade Related Investment Measures (TRIMs). It did not reach a conclusion on the question whether Ontario's law also breached provisions of the Agreement on Subsidies and Countervailing Measures (SCM Agreement; see Box 5). The ruling on Ontario's law is the first interpretation of RE promotion schemes with LCRs by the WTO's Appellate Body. It will likely serve as a precedent for future decisions on RE promotion schemes with LCRs from other countries. Contrary to laws for RE promotion, procurement tenders for single RE projects are hardly disciplined by WTO law (Kuntze and Moerenhout, 2013: 35-40).

Given the growing tensions around LCRs, countries looking to use them to develop local solar PV and other renewable energy manufacturing industries must carefully consider their design. Drawing insights from India's experience with LCRs, Johnson (2013) proposes three recommendations for policy makers seeking to implement LCRs:

- LCR policies should be limited in duration and incorporate planned evaluation phases.
- LCRs should be technology-neutral and consistent with other industry promotion policies.
- LCRs on their own are unlikely to help local firms fully develop the capabilities needed to be globally competitive in the long term.

There is a need for additional mechanisms to support development of long-term capabilities. Doing so requires focusing on all stages of the value chain (once the infant industry achieves a certain level of maturity) and putting in place measures to support the services that are integral to the success of RE industries (related to O&M, such as legal and financial services, energy economics, forecasting, and resource assessment).

Further, drawing on Kuntze and Moerenhout (2013), Johnson (2013) argues that four determinants are important for LCRs to be effective in creating value from RE developments, the effects of which are summarized in Figure 16: market size and stability, policy design, cooperation and financial incentives, and industry sophistication and innovation potential. Hence, the debate on whether LCRs are effective for creating value from RE investments needs to move beyond whether LCRs are legitimate policy tools to understand under which conditions LCRs might be effective tools for building a competitive local RE industry (Johnson, 2013; Cosbey, 2011). Other aspects that should be explored relate to the process of implementing LCRs so that they avoid creating additional administrative burdens for project developers and investors (e.g., with respect to measuring LCRs and value creation).

Box 5: LCRs in Ontario

The issue of LCRs for RETs has been climbing the agenda of WTO for a number of years. The most high-profile example is the recent case brought by Japan against Ontario in 2010 (and then by the EU in 2012), which is likely to have far-reaching consequences.

In 2009, the Canadian province of Ontario put in place a Feed-in Tariff (FIT) for wind power projects. The LCR is linked to the FIT. Specifically, in order to qualify for the FIT, projects had to source 50% of project costs locally. If the required LCR was not respected, RE developers were not eligible to receive the FIT. The LCRs determined the percentages of total project value that have to be sourced in Ontario. For wind projects the LCR was 25% while for solar projects it was 60% (Sheargold, 2013). The legislation also specified the percentages that could be claimed for a number of designated activities to meet those overall targets. By using these instruments policy makers can prioritize certain policy targets such as employment or green innovation. It is estimated that the Green Energy and Green Economy Act has created 20,000 new jobs in Ontario, although it is not clear how many of these jobs were due to the LCRs and how many to the FIT. For more detail on this case and how the LCR scheme has worked in Ontario, see Kuntze and Moerenhout (2013).

In response to the restrictiveness of the LCR and FIT policy, in September 2010 Japan filed a complaint against the Ontario FIT. By mid-2011 the case remained unresolved, so Japan, with support from the EU, requested that the WTO Dispute Settlement Body establish a panel to review the case. Specific agreements that needed to be analyzed to evaluate the LCRs were the GATT, the TRIMs Agreement, and the SCM Agreement. The decisions of the panel (handed down in December 2012) were then reviewed by the WTO Appellate Body.

Following a ruling on 6 May 2012, the WTO's Appellate Body found that Ontario's Feed-in Tariff regime with attached LCRs violated provisions in the GATT and the TRIMs. It did not reach a conclusion on the question whether Ontario's law also breached provisions of the SCM Agreement, as it had inadequate evidence before it to draw the necessary conclusions (Sheargold, 2013). Ultimately, the Minister of Energy issued a directive on 16 August 2013 to lower local content requirements for on-shore wind facilities and solar photovoltaic facilities, in compliance with the 24 May 2013 WTO rulling (Ontario Power Authority 2013).

This ruling sets a clear precedent that will have important ramifications for other countries with, or seeking to establish, LCRs, particularly those such as India which have previously viewed their LCR policies as permitted under WTO rules because they are associated with publicly procured electricity. Even those countries that are not members of the WTO may be affected by this ruling, as international financial institutions from which they borrow may align themselves with the WTO position.

For example, in February 2013, the US filed a complaint against the Indian government regarding the Jawaharlal Nehru National Solar Mission, claiming that its LCR violates the SCM Agreement (along with the GATT and TRIMs Agreement) (Sheargold, 2013). Further, although it has not yet made a formal complaint, in April 2013 India raised concerns about US support for RE producers; in particular it questioned whether LCRs adopted by Connecticut, Delaware, Massachusetts, and Minnesota are consistent with SCM and TRIMs Agreements (ibid.).

Sources: WTO, 2013c; ICTSD, 2012; Kuntze and Moerenhout, 2013; Sheargold, 2013.

Figure 16: Evaluation framework for LCRs effectiveness

Potential welfare loss (limited jobs and protection of uncompetitive industry)	⟷	**Potential welfare benefit** (increased jobs and long-term competitiveness)
small	Market size and stability	*large*
too restrictive / too relaxed	Policy design	*clear, enforceable and adaptable*
non-existent / weak	Cooperation and financial incentives	*existing / strong*
low	Industry sophistication and innovation potential	*high*

Source: Johnson, 2013, adapted from Kuntze and Moerenhout, 2013.

Supplier development programs

Supplier development programs targeted especially at upgrading capabilities of small and medium enterprises (SMEs) are necessary to enable local companies to capture value from RE investments and foster closer linkages with foreign investors. Upgrading capabilities of local firms is necessary to ensure that value creation opportunities stay in the region, by increasing the feasibility of sourcing components and services locally. Sourcing locally creates second round value-creation effects among the service sectors and the suppliers of parts and components. However, as mentioned in Chapter 2, the steadiness of demand is critical, a reason why the demand oriented policies are necessary.

For supplier development programs to be effective, best-practice examples suggest that instead of being mandated by the host country such policies work best when they are driven by the private sector (especially by lead firms with experience in global markets). These firms are better able to customize upgrading programs to their specific needs. They can also better assess which companies and organizations can best support them as partners in this process. Instead of mandating certain programs and approaches, the government (typically the Ministry of Industry and its agencies) can encourage, facilitate, and guide foreign companies to engage in such programs by providing different but well-coordinated services and benefits, such as organizing supplier fairs or other formats to provide information to local suppliers, capacity-building programs for those joining the supplier development programs, or more generic support in the form of management training or quality assurance systems to complement the more technology specific know-how provided by lead firms (UNCTAD, 2010).

Examples of best practices for supplier development programs in various sectors can be seen in Singapore, Ireland, and Malaysia. While these examples are not RET specific and go beyond the focus on OECD countries, supplier development programs tend to be more generic and therefore more easily adapted to the needs of different sectors, technologies, or countries.

The success of Ireland´s Enterprise Ireland agency (see Box 6) is the result of a strategically targeted approach by the Irish Government to enhance the competitiveness of domestic enterprises through firm-level policy measures, i.e., targeted support programs for SMEs to foster R&D capabilities and entrepreneurship, and business linkages with technology leaders nationally and internationally.

Box 6: The industrial upgrading program Enterprise Ireland

Enterprise Ireland is the Irish leading state economic development agency, focused on helping companies to upgrade their capabilities, creating innovative companies that can compete on international markets, and generating export-led jobs. As Richard Bruton, Minister for Jobs, Enterprise & Innovation, recently argued, the goal is not only to deepen the impact of world-leading multinational companies present in Ireland, but also to support the development of a powerful engine of indigenous business.

Enterprise Ireland has been created as part of the highly interventionist industrial policy of Ireland, along with other Operational Programmes for Industry (co-financed by the European Commission). Ireland`s industrial policy has recognized the importance of developing a long-term business relationship with TNCs, its experience suggesting that it takes time for TNCs to acquire local suppliers. Hence, active policy is necessary to reduce the "learning phase" about local supply and increase the speed at which linkages occur and SME upgrading takes place.

Through a network of 13 Irish offices, 34 international offices, and a network of business development advisors, the agency works with Irish companies to enter and grow in international markets. The services offered are:

- Funding support, for start-up, expansion plans, and R&D business plans
- Export assistance, including the provision of in-market services, local market information, and the facilities of their international office network
- Support to develop competitiveness, i.e., helping companies to become leaner to make them more competitive in international markets
- Incentives to stimulate in-company R&D, aimed at new product, service and process development
- Assistance with R&D collaboration
- Connections and introductions to customers overseas

With the support of such programs Ireland has built an internationally successful software industry, recognized abroad as being highly innovative, technically expert, and commercially adept. The sector comprises over 500 companies employing over 10,000 people, and being driven by a dynamic start-up entrepreneurial culture.

In 2012 a target was set for Ireland to become, by 2016, the best small country in the world in which to do business. To achieve this goal, a consultation process has been initiated to reform the National Micro and Small Business Support Infrastructure. Enterprise Ireland will play a key role in this process. In line with this vision, the Government has decided to establish a Centre of Excellence to develop new thinking and best practice with regard to supporting measures for SMEs and ensuring their delivery, and to set up a first-stop-shop at local levels for SMEs. More importantly, recognizing that the existing schemes of support for SMEs upgrading are not very transparent or well coordinated, a systematic reassessment of existing programs has been proposed, in close consultation with the private sector and the local authorities.

Source: Enterprise Ireland, 2013.

The Singaporean experience with industrial upgrading (see Box 7) has been primarily focused on maximizing value creation from business partnerships between TNCs and local companies that are geared toward fostering innovation. The positive results from engaging in the local upgrading program stemmed primarily from its emphasis on identifying win-win opportunities for both the TNCs and the SMEs.

Box 7: The Local Industry Upgrading Programme in Singapore

The Singaporean Local Industry Upgrading Programme (LIUP) brings TNCs together with local suppliers of parts and services in mutually beneficial innovation collaborations. For the TNCs the incentive is that they are better able to secure the needed quality and quantity of supplies, while local companies can tap the technical and managerial expertise of the multinationals and thus upgrade their business operations and become more competitive internationally. The typical pattern of collaboration has three main phases:

(1) The improvement of overall operational efficiency, such as production planning and inventory control, plant layout, financial and management control techniques
(2) The introduction and transfer of new products or processes to the local enterprises
(3) Joint product and process research and development

As part of the scheme TNCs partners are also encouraged to organise seminars and information workshops for local enterprises on issues such as quality control, packaging design and requirements, quick-die-change, and general industrial engineering practices.

The Singapore Government does not oblige TNCs to participate in the programme, but there seems to be some "nudging", and corporate leaders usually feel obliged to participate in order to maintain good relationships with the Government.

Source: UNCTAD, 2006.

Evidence from various countries and sectors suggests that the following measures have been among the most effective for supplier development support (Altenburg, 2000 and UfM, 2013): coordination of and information on promotion measures, matching between potential customers and suppliers, and economic incentives to intensify supplier relations and technology transfer.

Coordination of and information on promotion measures are important because lack of coordination between different instruments is often one of the most prevalent problems. Hence, it is advisable to establish a coordination unit that: (a) works towards the coherence and packaging of existing instruments by seeking to integrate all relevant institutions into the formulation of a joint promotion strategy, and (b) works as a one-stop agency providing information on promotion instruments and specific advisory services (e.g., via information booklets) and establishing contacts with appropriate institutions.

Matching between potential customers and suppliers aims to bridge the gap in information between potential customers and suppliers. Instruments to promote this matching are: subcontracting exchange schemes, supplier fairs and exhibitions, and information and promotions events for suppliers. Such instruments can help to identify potential bottlenecks of suppliers and find specific promotion instruments to overcome these problems, such as training and education, advice on manufacturing and logistics, financing, and other services.

Economic incentives are meant to encourage firms to engage in subcontracting and are aimed at both customers (such as tax relief, subsidies, and advisory services) and suppliers (such as credit guarantees, soft credit lines, and exemption from duties). Incentives are beneficial only if: (a) potential customers have an interest in local suppliers; (b) the competitiveness of potential suppliers with respect to prices, quality, and terms of delivery does not lag too far behind alternative sources (e.g., imports) or the option of supply via vertical integration within the customer´s own plant; and (c) such supplier relations do not develop without these incentives.

Another way to increase the value added from foreign investment is maximizing spillover effects (i.e., second order effects) through information exchange on process related aspects of production. As most TNCs are ahead of SMEs in fields such as human resource management, quality management, statistical process control, plant layout, and logistics, disseminating this type of information could be extremely beneficial for supplier upgrading programs (Altenburg, 2000). Business associations, international donors, or other intermediaries may promote this process. An example of such a process, initiated by the International Labor Organization (ILO), is going on in Toluca, Mexico (see Box 8).

Box 8: The *Comité de Empresas Trabajando en Calidad* in Toluca, Mexico

The Comité de Empresas Trabajando en Calidad is a loose association of firms in the Mexican town of Toluca whose management and personnel directors meet once a month for an exchange of experience regarding the introduction of quality management and related measures. Meeting places rotate among the firms involved. Management members report on their concrete experience with the implementation of new programs, which is illustrated during a tour of the firm. The focus is on problems and solutions in the fields of human resources and total quality management, e.g., new requirements for qualification and training measures, more responsibility for the workers, introduction of innovations such as: group work, suggestion schemes and statistical process control or the reorganization of wages and incentives.

The ILO initiated the first meeting and helped to coordinate the meeting, work out a model scheme for the firms´ presentations, and generated minutes and comparative analyses. Since 1997 the meetings have been organized by the Consejo Estatal de Productividad in close cooperation with the firms.

The meeting, as a rule, is attended by 20-30 firms from differing branches of industry. These include SMEs, large Mexican firms, and subsidiaries of TNCs. In most cases it is the large (foreign or national) firms that host the meeting and present their human resources and quality management concepts, while the majority of the other participants are representatives of local SMEs, which thus profit from an intense and free transfer of knowledge.

Source: Altenburg, 2000, based on author´s observations and minutes of the ILO office in Mexico.

3.2.2.3 Developing industrial clusters

Industrial clusters are important to revitalize (or start up) local industries, promote competitiveness and cooperation across a range of stakeholders, and stimulate spillovers (UfM, 2013), and hence are relevant to the emerging RE sectors. In addition, clusters can be effective in enhancing the innovation capacity of SMEs and promoting research and innovation collaboration projects. At the core of this process is the need for close cooperation among various stakeholders and among government agencies.

Policy options in the development of productive clusters can include the following: mechanisms to promote a mix of competition and cooperation between firms; policies that emphasize the linking of firms to the (local/regional) technological infrastructure of education and R&D institutions; a balanced input of resources from government and industry; "nudging" private companies and inviting them to collaborate and network among themselves; trust-building and enhanced dialogue to create spillovers; and joint marketing and regional branding. In this process, business associations for RET technologies that promote representation across the entire value chain are essential for creating legitimacy for the sector and for linking the interests of firms to government policy.

Examples abound of successful industrial clusters in various countries and sectors. In light of recent global market changes, a key challenge for most RE industrial clusters is how to become more resilient so that they can adapt to global competitive pressures. The example of California, the first largest and most dynamic solar cluster, illustrates the challenges that policy makers need to address to maintain regional competitiveness (see Box 9). In spite of the presence of unique entrepreneurial resources offered by Silicon Valley, which contributed to the development of the solar energy cluster in California, this example shows that fast changes in global market conditions for RET require renewed flexibility and a strong ability to learn and adapt to a volatile environment. In this process, cluster management capabilities, often developed with public-private funding, are critical to boosting cluster resilience.

Box 9: California´s solar energy cluster

California´s 40-year old solar energy cluster had a global first-mover advantage and strong incentive plan to boost local demand and drive cluster innovation. Though it has dedicated solar energy research and universities, strong support from related clusters, and a foothold in the new thin-film market, the cluster is currently facing challenges due to increased global manufacturing competition and losing edge relative to Germany and China. As a result, the solar cluster in California will have to transition to different types of products in order to survive.

The development of the solar cluster benefited from various demand-pull and supply-push policies, which enabled companies to locate in the cluster and take advantage of its manufacturing and entrepreneurial resources. Aside from demand oriented policies that enabled the formation of a local solar industry, a government funded initiative, GoSolar, was set up to act as a "one-stop-shop" for solar companies and consumers. GoSolar aimed to reduce the lack of coordination among firms performing different activities in the cluster. The agency coordinates governments, financing partners, contractors, new-home builders, and real estate professionals.

California´s Silicon Valley and venture capital clusters have played an important role in the growth of California´s solar energy cluster. The Silicon Valley cluster continues to be the leading hub for high-tech innovation in the US and worldwide. At the same time, a dynamic interaction between Silicon Valley´s interest in solar technology and venture capital support created unique conditions for industrial development in the region.

The solar cluster has also benefited from the California Renewable Energy Transmission Initiative , which identifies transmission projects needed for energy goals, supports energy policy, and facilitates permitting. The Intersolar, the largest and most prestigious North American solar conference, held in San Francisco, has been very successful in enabling shared research and innovations across the sector.

Several factors have been identified that challenge the relative competitiveness of the solar energy cluster in California: reduced competitiveness in PV manufacturing, fragmentation of solar technology start-ups, incentive program instability and company relocation, and lack of infrastructure (transmission and installation permitting). The way in which California´s authorities and other actors in the innovation ecosystem respond to these challenges, by potentially redirecting the focus of the solar energy cluster towards boosting innovation capabilities, is likely to influence the future of the solar energy sector in the United States.

Source: Gibson et al., 2011.

Germany, on the other hand, shows how the effective push of RE into the market has also resulted in the development of a local industry, including manufacturing of PV cells and modules, as well as a range of specialized upstream and downstream industries. Germany's industry thus reaped an early-mover advantage triggered by the particularly generous national FIT, thereby stimulating employment creation and the formation of an industrial cluster (see Box 10).

Yet, this early mover advantage has eroded in the last two to three years, mainly due to the expansion of low-cost PV cell and module manufacturing in China. The loss of manufacturing capabilities and jobs was substantial (Gosselin, 2013). Some authors argue that Germany has not reached its full potential with respect to integrating market development with innovation and competitiveness. Specifically, as Luetkenhorst (2013 forthcoming: 61) argues, "[market] expansion was put above upgrading" by not paying sufficient attention to forming an innovative industry pushing the technological frontier. It is estimated that the solar energy sector in Germany invests only 2–3% of its revenues in R&D, much less than the machine-building sector, for example (Spiegel Online, 2011).

These developments suggest that industrial clusters must continually adapt their strategies to maintain their competitive edge. While Germany has lost a large share of the manufacturing of solar cells and modules to China, strong capabilities in the design and manufacturing of other parts and components, as well as associated services (such as selling turnkey solutions for the setup of PV plants globally), contribute to maintaining Germany as an industrial leader in some knowledge-intensive parts of the solar energy sector.

Box 10: Germany´s solar PV cluster

Germany has been the most dynamic market for solar energy worldwide, driven by generous demand-oriented policies and a strong focus on innovation and technology development. Due to extensive incentive programs provided by the German government, the German PV cluster is concentrated in the former East Germany states of Saxony, Thuringia, Saxony-Anhalt, and Berlin-Brandenburg (also called the Solar Valley). Over 90% of PV manufacturers are located in this region. Several PV equipment and machinery suppliers are spread further south into Bavaria, due to the well-established heavy machinery and equipment cluster located in that region. In fact, the historical emphasis of German industrial development on manufacturing, engineering, and innovation enabled the solar energy sector to benefit from extensive spillover effects. In the heyday of the Solar Valley, as many as 10,000 people were employed in the sector (Spiegel Online, 2011).

The solar energy cluster has developed successfully because of several factors: supportive government policies and incentives, the availability of a skilled labour force and high-quality infrastructure, significant investment in R&D, the presence of highly developed supporting industries, and the depth and breadth of enabling industry associations. The focus on a tightly knit innovation system has been critical for the dynamic solar energy cluster in Germany. In particular, the close cooperation and collaboration between among institutes, universities, and PV manufacturers and equipment suppliers has helped make the adoption of new PV technologies more cost effective and seamless.

Industry associations have played an important role in coordinating the sharing and exchange of information between different stakeholders (i.e., the private sector, government, advocacy groups, and research and academia). At the same time, cluster management organisations have contributed to bringing in flexibility in the development of the sector.

More recently, however, the competitiveness of the solar cluster in East Germany has been severely challenged due to changes in global market conditions, especially as a result of the expansion of low-cost PV cell and module manufacturing in China. In 2011 two major solar companies slid into bankruptcy (Solon and Solar Millennium). The next year, Q-Cells, a large solar cell manufacturer that has been the core of Solar Valley cluster, filed for bankruptcy in 2012. A string of other bankruptcies followed among German solar energy firms (Spiegel Online, 2012). Large companies such as Bosch and Siemens have shut their solar divisions. Anecdotal evidence suggests that one third of all companies disappeared from the market within a year, leaving only about 6,000 jobs in Germany (Gosselin, 2013).

Some authors argue that the weak performance of the cluster lies in its strong dependence on demand generated by state subsidy programmes; when the FIT was reduced many companies were not able to maintain their competitiveness. In addition, the limited internationalisation of companies in East Germany reduced their flexibility in adapting to new market dynamics.

Under these conditions a reassessment of Germany´s cluster development strategy is needed in order to renew its competitiveness. Currently efforts are being made to keep manufacturing jobs in the region (e.g. Q-Cells has been bought by Hanwha, a Chinese company, which pledged to keep manufacturing and research in the Solar Valley) (Nicola 2012). Yet, companies need to develop more competitive business models, invest more in innovation and R&D, and explore new business areas.

Source: Brachert and Hornych, 2009; El-Beyrouty et al., 2009; Spiegel Online, 2011; Gosselin, 2013.

The experience of various countries and sectors suggests that in order to be successful and effective clusters should:

- Be managed jointly by the public and the private sector;
- Rely on cooperation between different stakeholders, i.e., regional financial institutions, private sector, entrepreneurial associations, and chambers of commerce;
- Develop centers of specialized services targeted to the needs of SMEs, and develop and rely on strong formal and informal networks between SMEs;
- Focus on employment and value creation in the region;
- Emphasize identifying R&D cooperation activities between companies and universities and research institutions; and
- Promote information sharing, communication, and marketing of the activities of the cluster.

These elements of policy design ensure a balanced and coherent policy that creates synergy between the needs of different actors and ultimately contributes to increasing the competitiveness of firms. In effect, a strategic approach results in inviting companies to collaborate rather than using top-down command-and-control policies. The case of cluster development is, therefore, a good example of the importance of integrating different policies in order to achieve value creation.

3.2.2.4 *Improving cooperation between public research organizations and the private sector*

Improving linkages between public research organizations (i.e., universities and research institutes) and the private sector as a channel for creating a more favorable environment for innovation, entrepreneurship, and technology development should have a high priority for policy makers. Aside from universities (which have a clear mandate for creating new knowledge through basic research and disseminating knowledge through education and training), research institutes and centers of excellence that can convert more theoretical knowledge into applied and commercialized results are crucial for increasing RE value creation. Examples of such organizations that have made major contributions to the development of renewable energy technology and policy are the Fraunhofer Institutes in Germany (see Box 11) and the National Renewable Energy Laboratory in the US. Another good practice is exemplified by the Mexican initiative Clínicas Empresariales, a linkage and training program involving students, teachers, and enterprises in projects (e.g., SME diagnostics) that arise from the needs of the enterprises. As a result, companies benefit by increasing their competitiveness (i.e., improving products and processes), having external innovative and creative observers, supporting the training of new professionals, and strengthening the practical experience of teachers.

These organizations are positioned at the intersection between academia and the private sector, with researchers who move easily between these spheres, can understand each other´s professional needs, and can easily communicate them to policy makers. Other key features that have contributed to fostering linkages between public research organizations and enterprises have included: funding mechanisms that rely on several types of sources (i.e., industry, non-industry, and government; a balance between application-oriented research and basic research; a focus on practical application to the technical and organizational problems of firms; emphasis on entrepreneurship and spin-off creation; and the intent to achieve a high reputation for quality research and problem-solving skills.

Box 11: The Fraunhofer Institutes in Germany

The Fraunhofer Institutes are part of the Fraunhofer Society, Europe's largest application-oriented research organization. At present, the Fraunhofer Society maintains 66 institutes and independent research units. The majority of the more than 22,000 staff are qualified scientists and engineers, whose work balances application-oriented fundamental research and innovative development projects. The Society has a research budget of 1.9 billion euros, of which more than 1.6 billion euros is generated through contract research (Fraunhofer, 2012).

More than 70% of the Fraunhofer Society's contract research revenue is generated through contractual research with industry and publicly financed research projects, and the rest is institutional funding from the central government and the *Länder* (the states within the German federal republic). The joint public-private approach to funding, which became known as the "Fraunhofer Model", entails that "for every euro Fraunhofer earns from contract research, the federal government will match with a euro of base funding. This ensures that government support ends up where it works most effectively – in commercially relevant projects" (Fraunhofer, 2012).

The Fraunhofer Institutes offer an important source of innovative know-how for SMEs that do not maintain their own R&D departments. Funding from the German Federal Ministry of Education and Research enables the Fraunhofer Institutes to also conduct non-contract advanced research into technological fields with great promise for the future.

Energy is one of the main areas of research. Eleven Fraunhofer Institutes join their expertise in energy technologies and energy research under the framework of the Fraunhofer Energy Alliance. The Alliance´s work is chiefly focused on: renewable energy sources (solar energy, biomass, wind energy); energy efficiency technologies (fuel cells, combined heat and power systems and gas delivery, building-service technologies, power electronics); buildings and components (low-energy houses, building energy technology); intelligent energy networks; and electrical energy storage and micro-energy systems (lithium battery technology, fuel-cell systems).

The Fraunhofer Society acts as an umbrella institution that links the research institutes with each other as well as with the private sector and supports technology transfer as a core element of its innovation system. At present, more than 400 spin-offs have been created that have registered thousands of patents from their research results. Technology transfer at the institutes also occurs through graduate students' on-the-job training.

The main principles behind the success of the Fraunhofer model in Germany are a focus on national economic strengths, networking of its institutes, excellent reputation and name recognition, commercial focus and autonomy, and especially joint research funding between public and private sources, its positioning between basic and applied research, and proximity to universities institutionalized through Fraunhofer directors' appointments as university professors.

Source: Abramson, 1997; Fraunhofer, 2012 ; Reid et al., 2010; Fraunhofer Energy Alliance, 2013.

In the field of RET, the Canadian CanmetENERGY (research centre for clean energy technology), WEICan (research institute for wind energy technologies; see Box 12), and TechnoCentreÉolien (research and support centre for wind energy technology) are examples that should be emphasized. They thrive on a close cooperation between research and the needs of the private sector. Such research and testing facilities create an excellent environment for cooperation between the private sector and public research organizations, driving R&D and innovation for RET.

Box 12: The Wind Energy Institute of Canada (WEICan)

WEICan was set up in 1981 to advance the development of wind energy through research, testing, training, and close collaboration with the private sector and academia. WEICan has been positioned to assist the wind industry in meeting the increasing technical demands on the wind industry by developers, grid owners and operators, and electricity regulators. The Institute has also created a Technical Advisory Committee (TAC) to provide technical advice for their general activities. The TAC consists primarily of engineers and researchers from industry, research institutions, universities and colleges, and government.

The Board of the Institute includes representation from the energy industry, academia, and major funding partners: Natural Resources Canada and the PEI Energy Corporation. WEICan has established the Visiting Professors and Academics Program (VPAP) in order to enhance and recognize the contribution of scholars in the field of wind energy. VPAP participants enhance their scholarship through intellectual interactions with other visiting academics, connections to the wider Canadian and global wind energy network, discourse with WEICan Board, management and staff, and access to state-of-the-art small and large wind test facilities, supported by modern, fully furnished accommodation on the WEICan site.

Cooperation with academia is integrated into the core activities of the Institute. For example, the University of New Brunswick´s Renewable Energy Technology Research Facility, located within WEICan, offers a test bed that allows generators, inverters, and energy storage devices to be tested in a controlled environment. This joint research platform brings together researchers, academics, and business enterprises on a regular basis for studying technical problems in the real world with operational wind turbines.

Source: WEICan, 2013.

Another relevant research organization is the Plataforma Solar de Almería (PSA)[21], an R&D division of the CIEMAT (*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas* – The Spanish Research Centre for Energy, Environment and Technology) in Spain, reporting to the Ministry of Science and Innovation. PSA is currently the largest concentrating solar technology R&D and testing center in Europe.

[21] Information on PSA-CIEMAT comes from http://www.psa.es/webeng/gen/index.php (accessed on 25 September 2013).

The goal of the PSA, created in 1981, is to conduct R&D on potential industrial applications of concentrating solar thermal energy and solar photochemistry; it strives on close cooperation with the private sector (SMEs and large companies from Spain and abroad). One of CIEMAT's core goals (and hence of PSA too) is to facilitate technology transfer; towards this end it signs conventions, cooperation agreements, and contracts with companies aimed at transferring technology into the market place. PSA also collaborates with a wide range of international institutions and programs, such as DLR, The German Aerospace Centre (as part of a larger Spanish-German agreement between DLR and CIEMAT signed in 1987); Solar-PACES of the International Energy Agency (where information is exchanged and costs are shared with similar centers in other countries, including the US, Mexico, Italy, Germany, France, Switzerland, South Africa, Israel, Algeria, and Egypt)[22], SolLAB (Alliance of European Laboratories on Solar Thermal Concentrating Systems), and with various Spanish and international universities and research centers. The PSA also has a training program open to international students. The PSA operates with an annual budget of approximately €9 million, of which 30% come from earned income. Another example in the north of Spain is the Cartif Technology Centre, whose latest research focuses on using solar and geothermal energy for home and office climate control.[23]

3.2.2.5 Enhancing know-how through education and training

Evidence suggests that many of the RET related capacity building programs have focused too much on training activities that are not well integrated into actual project development and implementation (Sabbagh et al., 2012; UNIDO, 2008). Yet more practical knowledge is critical for large scale deployment of these technologies. Hence, skills development interventions "must be implemented hand-in-hand with efforts towards product and process upgrading, thus increasing the demand for higher skills (e.g., by promoting linkages with quality markets)" (ILO and EC, 2011). Table 11, based on a survey conducted by REN Alliance, illustrates a set of occupations that are difficult to fill in various country contexts. Existing studies point to a shortage of engineers and technicians, non-technical skills, and qualified trainers (ILO, 2012).

[22] Information from: http://www.renovablesmadeinspain.com/ficha/pagid/47/letra/P/titulo/Plataforma%20Solar%20de%20Almer%C3%ADa/len/en/ (accessed on 1 October 2013).

[23] Information from: http://www.renovablesmadeinspain.com/ficha/pagid/83/letra/C/titulo/CARTIF/ (accessed on 1 October 2013).

Table 11: Occupations difficult to fill in the RE sector

Sub-sector	Occupations
Wind energy	Project developers; service technicians; data analysis; electrical, computer, mechanical and construction engineers
Solar energy	Photovoltaic and solar thermal system installers and maintainers; building inspectors
Hydropower	Electrical and operation and maintenance engineers; technicians; tradespersons; sustainability specialists
Geothermal	Trainers; geothermal engineers
Bioenergy	R&D and design engineers; service technicians; trainers

Source: ILO, 2012: 94.

Interventions to enhance know-how through education and training can vary depending on the existing level of capabilities as well as on the industrial structure and the development pathway. Such measures could range from integrating training programs into the public sector vocational training system, promoting and coordinating local apprenticeships, improving basic and strategic management education in universities and training centers, establishing training centers based on public-private partnerships, developing "training the trainer" programs on RETs, and encouraging training to comply with international standards (ILO and EC, 2011; Marchese and Sakamoto, 2008; UfM, 2013). To this end various programs to assess gaps in skills and knowledge have been implemented in various countries. One such example is the GIZ assessment of training and skills needs for the wind energy industry in South Africa, aimed at achieving the optimum economic, employment, and industrial benefits (GIZ, 2012).

In achieving these objectives with respect to value creation from education and training, the report emphasizes the importance of addressing the risks stemming from uncertainty about to market conditions. Such risks can be mitigated through strong policy leadership.

Successful skills development initiatives exist that could be used as benchmarks for other countries. For instance, the Penang Skills Development Centre in Malaysia is currently considered a role model of demand-oriented skills development; it has been widely replicated worldwide and could also be relevant for the RE sector (see Box 13). The main aspects that made this centre effective have been: close cooperation among the private sector, education institutions, and government entities; training and education programs closely aligned with the market needs; and shared funding from the private sector.

Box 13: Best practice exemplified through the Penang Skills Development Centre

The Penang Skills Development Centre (PSDC) was created in 1989 in order to resolve the mismatch between the skills industry needed and those the labor force possessed. While Malaysia was turning out an educated labor force and many engineers, it was not providing its workers with the skills they needed to function on the factory floor. There was a technology gap between industry standards and academic/commercial training. PSDC also resolved a second problem, namely that each TNC could not train all its many vendors and so collective efforts made sense.

The government supported the effort by providing land and buildings for the skill centers and modest grants for initial operational costs. It also gave incentives to the private sector to send workers for retraining. Since its inception, the PSDC has grown to become the premier learning institution in the country, dedicated to meeting the immediate human resource needs of the business community and to supporting and strengthening business requirements. It has received both national and international recognition as a truly successful example of shared learning and a model institution for human resource development to be emulated within and beyond Malaysia.

PSDC is structured as a non-profit society with 775 member enterprises employing more than 170,000 workers. The Centre is exempt from income tax and is financially independent in terms of daily operations. It is governed by a management council composed of representatives from industry, government, and academia; the council meets quarterly and through its chairman guides the PSDC executive director and staff. PSDC relies on industry partnerships to share experts and training programs and to contribute the machinery necessary to conduct practical courses.

The PSDC has been considered successful not only because it trains shop-floor workers as technicians and engineers, but also because competing companies pool resources to fund it. Over a period of 20 years, the Centre has trained over 150,000 participants through more than 7,000 courses, pioneered local industry development initiatives, assisted in the input and formulation of national policies pertaining to human capital development, and contributed directly to the Malaysian workforce transformation initiatives.

PSDC also offers degrees in engineering. Several universities have been affiliated with the PSDC, where students can further pursue their studies to obtain a Bachelor Degree Honours Degree or a Master Degree. The positive impact that PSDC has had on the Malaysian regional and national economy has led to similar models being implemented in China, Thailand, Indonesia, and India.

Sources: PSDC, 2013; UNDP, 2006: 24-25.

Other skills development systems, which rely strongly on close cooperation among government, private sector, business associations, and academia and are specifically geared for RET can be found in the apprenticeship programs in Spain, Germany, and Denmark. In Spain, for example, such approaches to skills development have been implemented at national as well as regional level. Box 14 highlights the example of capabilities building programs in the Navarra region, successful in supporting the development of RE sector by creating necessary skills at different levels (from engineering to technical skills) customized to the needs of the private sector. In Germany, such programs are based on the Dual Vocational Training System, which entails practical vocational training given at work and backed up by theoretical and general education provided in vocational training schools. The core feature of this system is that the provision of knowledge and skills is linked to acquiring the necessary job experience, focused on learning by doing to stimulate motivation, and ensuring that there is a direct link between training capacity and the demand for skilled labour. Several sectors, including the RE sector, have benefited from this practical training system.

Box 14: Renewable energy capabilities development in Navarra, Spain

Spain´s Navarra region, with a population of 620,000, has seen the share of RE in local electricity generation grow to around 20% (ILO, 2012: 103). Following an economic downturn in the 1980s, a tripartite agreement was struck between the provincial government, businesses, and unions to promote an active industrial policy, with RE development as a key element. The regional government first identified skills shortages and resolved to build the local skills base needed for the expansion of the RE sector (ibid.).

Several organizations have been set up to support the creation of capabilities in this new sector. The National Renewable Energy Centre (CENER), for example, is a technology centre specializing in applied research and in the development and promotion of RE. CENER is incorporated as a non-profit foundation, called CENER-CIEMAT Foundation. CENER offers a wide set of services to companies, public administrations, or institutions both nationally and internationally, including: research, development and innovation; knowledge and technology transfer (through training professionals and defining the rights whereby that knowledge may be exploited); certification; technical assistance; and studies on various issues. Their activities address wind energy, photovoltaic solar energy, solar thermal energy, biomass energy, energy in buildings, and renewable energy grid integration. CENER has also developed various collaborations with other centres and organisations, especially in the area of wind turbines. CENER is also developing a pilot plant for the production of second generation biofuels.

To support the development of the RE sector in the Navarra region the Training Centre for Renewable Energy (CENIFER) has also been created, promoted by the regional government to meet training requirements in this sector.

CENIFER offers a wide range of training courses, from engineering to maintenance, in close communication and coordination with the private sector. Beyond Navarra, CENIFER was designated as a National Renewable Energy Training Centre, training workers and students from all over Spain (ILO, 2012: 103).

The Navarra region's overall industrial policy, which included RE promotion, was instrumental in bringing unemployment down from a peak of 11.7% in 1990 to 5.7% in 2008.[24] More recently the unemployment rate in the region has increased to approximately 15% (due to the larger economic crisis) but still remains lower than the national level (EC, 2013). In the region there are currently more than 100 companies and 5,000 jobs related to RE, accounting for an estimated 5% of regional GDP and 1.6% of the working population.[25]

Sources: For CENER - http://www.cener.com/en/que_es/index.asp (accessed on 25 September 2013) and http://www.renovablesmadeinspain.com/ficha/pagid/86/letra/C/titulo/CENER/ (accessed on 1 October 2013); For CENIFER - http://www.cenifer.com/pages/nivel1.asp?idAp=1&idm=eng (accessed on 25 September 2013).

Most countries, however, have not adopted a strategic approach to advanced skill development, in which skills development programs are based on a thorough assessment of existing gaps in knowledge and capabilities (such as the one conducted for the wind energy sector in South Africa) and on the evolving needs of the private sector. In Turkey, for example, while several policies to support RET deployment are in place, no government policies have been identified to increase employment in the RET sector and no assessment of the size of employment in this sector has been made (Ercan, 2013).

Such programs should be combined with upgrading programs for SMEs (as discussed earlier), so that newly trained workers can be integrated into the labour market. Moreover, these programs should follow a close monitoring of the demand creation policies (and subsequent market development), in order to avoid a misalignment between supply and demand of skilled labour. Close contact and cooperation with the private sector should also serve to help monitor changes in the market conditions. To stimulate the private sector to participate in the design and delivery of education and training programs, various incentives could be considered, such as tax breaks, priority considerations in the procurement of government projects and services, or direct subsidies; or mandates that dictate businesses and state enterprises to cooperate with the education system (Sabbagh et al., 2012; UfM, 2013) although the latter type tend to be less effective.

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[24] Data from http://www.navarra.es/home_en/Navarra/Asi+es+Navarra/Economia+y+servicios/Economia.htm, accessed on September 25, 2013.

[25] Data from http://www.solarrok.org/index.php/regions/navarra, accessed on 25 September 2013.

4 WHAT CAN BE LEARNT FROM OTHER SECTORS?

This chapter turns to the experience of selected economic sectors with industrial policy support, beginning with the automotive industry. Today's automotive industry is highly consolidated, competitive, and specialized in each phase of the value chain. Industrial policy has supported the automotive industry and still does. The second example is the steel industry. Steel production has shaped regions of Europe. Today, a high share of global output of the steel industry is produced in Asia. For a third example we look at the large commercial aircraft industry, which is highly regulated and concentrated. The "comfy duopoly"—Boeing and Airbus—of aircraft producers has recently been challenged by new market entries.

RE deployment and technology development at a large industrial scale are still relatively new phenomena. Yet industrial policy instruments have been tried and tested in other economic sectors, and successes and failures in the history of industrial policies can serve as examples, benchmarks, or cautionary counter-examples for the identification of policy recommendations for value creation in RE. While Chapter 3 analyzed case studies for specific policy instruments and policy mixes, in this chapter we take a sectoral approach.

Since this section is analyzing traditional sectors, it assesses more conventional approaches from industrial policy. As defined in economic textbooks and discussed in Section 3.1., industrial policy is targeted at the sectoral production structure and attempts to influence the productive outcome of a sector (Gabler, 2013). Economic theory makes a distinction between structural planning processes and policies which compensate for market failures. Economic practice often exhibits a mix of different measures, more or less in sync. Three objectives for these measures can be identified:

- Keeping a minimum amount of domestic production in certain sectors; typically this goal is driven by security considerations, whether military or concerns for resource access and provision of certain goods (e.g., aircraft, refineries, steel, trains)
- Prolongation of sectoral change due to social considerations, such as providing a soft transition or support of shrinking sectors (e.g., coal mining in Spain)
- Strengthening future oriented sectors to be ready for a leading role in innovative markets (picking winners) (e.g., automotive sector)

While various policy instruments are typically applied, they are mostly targeted at either improving the domestic framework (i.e., production conditions) or decreasing competition with foreign producers by making imports more difficult. In general, favoring one sector means disfavoring others. In the case of domestic protection, certain sectors are either supported or subsidized (by tax money); in the case of competition shielding, usually with import tariffs, exchange rates are affected and lead to additional costs for consumers and buyers.

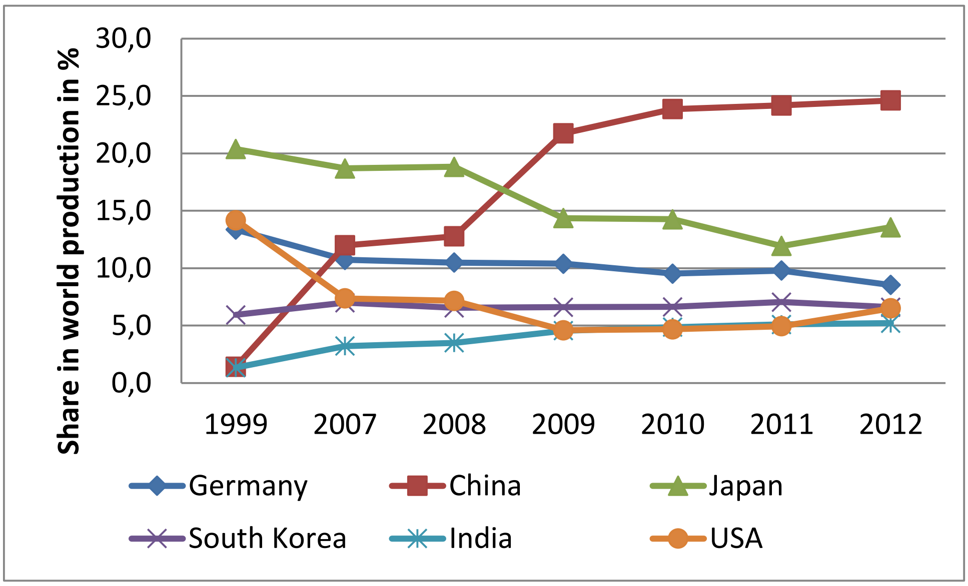
In this chapter the development of the automotive sector, the steel sector, and the aircraft sector is analyzed in selected OECD countries. The sectors have been selected as examples of at least one of the objectives outlined above. The automotive sector illustrates a conventional sector that holds large innovation potential, apart from its economic relevance. The steel industry is also highly relevant because steel is an important resource for the production processes in several sectors. The aircraft industry is the number one example of a sector considered as strategic.

4.1 AUTOMOTIVE INDUSTRY

4.1.1 World production of cars

The automotive industry is an important sector in more than 50 countries worldwide (despite concentration into a few major companies). Automobile production and the production of parts, components, and material inputs strongly contributes to economic capacity worldwide. However, as in other sectors (e.g., steel, aircraft) and as has been discussed in the case of solar PV above, automotive production also shows a regional shift over the last 15 years (Figure 16). Before the turn of the century, most cars came from Japan, followed by the US, Germany, and South Korea. China first overtook Germany in 2007, then Japan in 2009, and is today the leading global producer of automobiles. Overall turnover of the industry was $1.8 trillion and the industry claims more than 50 million automotive related jobs (OICA, 2013).

Figure 18: Regional distribution of car production in shares of world production



Source: Organisation Internationale des Constructeurs d'Automobiles, 2013.

The industrial consolidation that is now ongoing in the RE industries (described in Chapter 2) took place in the automotive industry years ago. The number of original equipment manufacturers (OEM) went from 500 in the early years (turn of the last century) of the industry to 13 today (Telekom, 2012). The largest players today are Toyota, General Motors, Volkswagen, Hyundai, Ford, Nissan, Honda, and the Peugeot Group, which together claim more than 75% of the market (including trucks).

4.1.2 Value chain and innovation

Most industrial players emerged from already existing industries, such as machinery or bicycle manufacturing (Hawlitschek, 2011; Flik, 2001). Thus, the sector benefited from strong existing industrial capabilities (see Section 2.3, "finding the right niche"). The automotive value chain reaches deep into almost all sectors of the economy: metal producing industries for the body and most parts; machinery to supply the production equipment and the movable parts; plastics and rubber industry for tires, interior covers, and mats; electronics and electrical devices; the textile industry for the seats; and the glass industry for windows and mirrors.

Along the value chain, often co-operative arrangements have been established over several years—a structure that proves to be a barrier for the development of electrical vehicles, since the value chain of the latter differs greatly from the historically built chains in major car producing countries.

Complementary policies have been identified in the preceding chapters as supportive for innovation. One example is R&D funding at the university level. University courses and study fields have been established to contribute to R&D in the automotive sector. Each country with a significant automotive industry also offers study courses in engineering, planning, etc. Germany, for instance, offers courses in automotive engineering at 105 locations (Studieren-Studium, 2013). Direct transfers, loans, and governmental part-ownership (e.g., Lower Saxony and the Federal Government of Germany hold 20% of Volkswagen and no other single investor may ever hold more than a 20% share) also serve as complementary policies. During the recent economic crisis the US government spent $85 billion on GM and Chrysler, in part because the firms were at a point in their innovation cycle where they could not survive without support, but exhibited signs pointing toward market success in the very near future. From the total, $60 billion is likely to be recovered (Timmerhoff, 2012).

4.1.3 Demand and supply

Early automotive industries have been supported by several policies; the most basic is the build-up of the infrastructure through public investment. In most countries, streets are built with public funds and are the most important precondition for a domestic market for cars to develop. The early automotive industry is one of the more compelling cases for infrastructure investment.

Today, policies are targeted at enhancing the demand for automobiles. Scrap bonuses[26] were put in place in the most car producing countries during the automotive crisis of 2008/2009 (Schweinfurth, 2009). Absent crises, the demand for cars is supported by tax breaks for company cars, special loans at low rates, and changes in technology and shifts in environmental and safety standards. Europe emphasizes new opportunities from new environmental standards as discussed on the European platform CARS21. The transition to electro-mobility will most likely change the picture of winners and losers tremendously.

China's huge demand increases in recent years, a consequence of economic development and the rise of the middle class, attracted international car producers. China aims at technological spillovers from automotive production by enforcing high local content requirements (see Section 3.2 on LCRs).

4.2 STEEL INDUSTRY

Although the steel sector converts raw material and might seem unrelated at the first glance to RE industries, it still offers lessons relevant to the latter. For example, while special steels are created for special applications, most of the world's steel products are rather homogeneous. Unlike the automotive industry's product, where different classes, features, and technologies can be used to distinguish a product from its competitors, competition in the steel market is largely works over price. Here, the parallel to PV is obvious. As will be seen below, the instruments applied in the steel sector parallel instruments suggested in the PV sector.

Steel is produced in 62 countries around the world. It has been in production since the 1900s and during that time the steel industry has undergone massive transitions in terms of regional concentration, regional importance, technologies applied, and economic relevance. A wide set of industrial policies has been applied during the course of the industry's development, and in fact the instruments currently discussed sound surprisingly similar to some of those discussed in the PV sector in North America and Europe, such as import tariffs and R&D support. Some of the drivers of the current situation in the steel market also remind of PV: large overcapacities around the world drive prices down and lead to closing production sites, and demand (and supply) shift from Europe and North America to Asia and the emerging economies in Africa. Thus, it may be fruitful to give a short overview of the development, its drivers, and the related industrial policies in the past and today.

Among the *drivers* of the observable change were changes in integration along the value chain starting 50 years ago and privatization/liberalization of the industry starting more than 30 years ago. More recent changes concern mergers and acquisitions, the evolution into multinational companies, and the rising demand in Asia. Most of these aspects also matter for the RE industries.

[26] Abwrackprämie in Germany, CARS (car allowance rebate system) in the US, often called "cash for clunkers". The system pays a rebate for cars of a certain age to be sent to the wrecker.

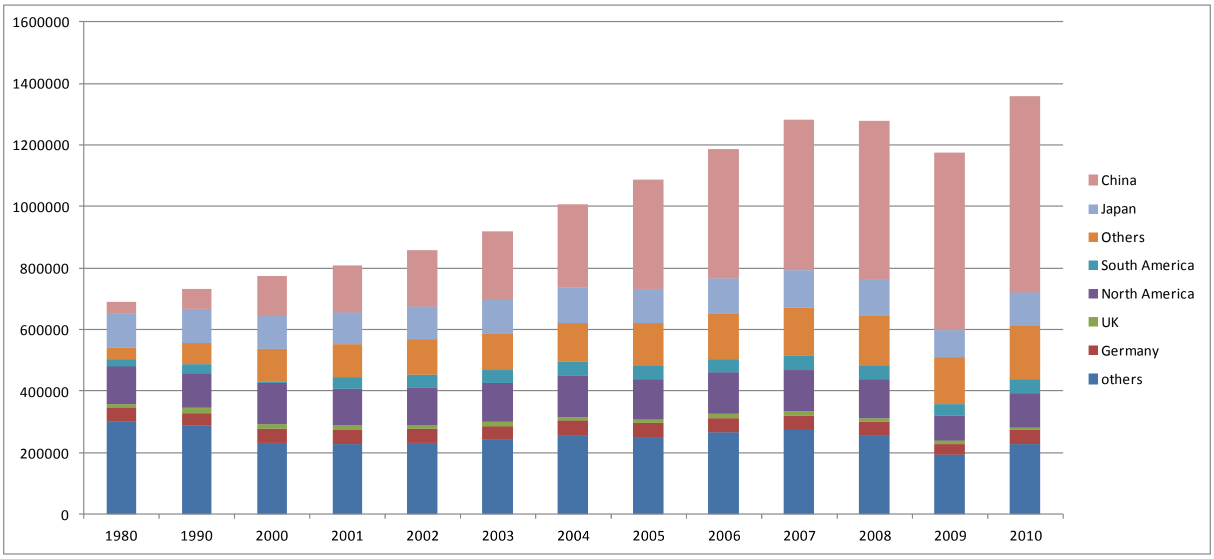
Industrial policies targeted at the steel sector pursue all targets of industrial policies generally, as described above:

- First, since the steel sector is considered strategic – also given its historical contribution to industrialization as such - a minimum amount of domestic production should be kept.
- Second, the steel sector contributed considerably to an organized workforce with strong unions. Delaying sectoral change is still a sub-target of steel policies, to delay workers' protests.
- Third, there are vast potentials for the steel industry in terms of innovation and contributions to the greening of the economy and to climate-friendly production. Thus, the strengthening of the steel sector can improve the opportunities in innovative markets.

4.2.1 World production of steel

Steel production has almost doubled since 1990 (Figure 19). However, the most striking insight is the regional shift in production; Asia increased its world market share from 26.1% in the 1980s to 52.3% today. Japan dominated Asian production until 2000, when China became the largest producer in Asia. Since then China has become the largest steel producer worldwide, with a production capacity about four times that of Europe (Worldsteel, 2013).

Figure 19: Steel production in 1000 tons



Source: Worldsteel, 2013.

4.2.2 VALUE CHAIN AND INNOVATION

The dominance of Chinese steel production shifted the relative shares of production technologies back to blast furnace technology. This technology calls for access to iron ore, coke coal, waterways, or all three, especially large amounts of coke and iron ore. The proximity to either one of these natural resources determined the location of early steel mills, as evidenced by examples in the US or Europe. North American steel mills were adjacent to coal mines and waterways, by which iron ore was transported to the mill. As electric arc furnace (EAF) technology—which uses scrap metal as an input and smelts it in the electric arc—the geographical distribution of steel mills became independent of the resource locations.

Initially thought of as a technology to produce low-quality steel, it has evolved significantly, to the point where today all quality steels can be produced from EAF processes.

In the US this led to a shift in the location of steel mills and strong development of the EAF production (DR Market trends, 2011). EAF needs reliable, inexpensive electricity, which is not available in China in all regions., and hence the continuing reliance in China on blast furnace technology. Although globally less than 30% of steel production is from EAF, it is stronger in certain regions: more than 60% of North American steel production and 44% of European production are based on EAF-smelted scrap metal. Moreover, cheap natural gas has contributed to a rise in a third technology, in which coke is not necessary but the steel-making process goes through an additional step of directly reducing the iron ore with the help of natural gas. This process has gained ground in the US and predictions of continued growth range up to 70% over the next five years (DR Market trends, 2011).

Thinking in terms of changing value chains, this leads to the following conclusions:

- Integration of the value chain for blast furnace technologies in the 1970s has led to inflexibility of the large steel producers and finally to abandonment of traditional steel production locations.
- Infrastructure (here, access to the electricity grid) determines the choice of production technology.
- Changes in the input structure and innovations have led to the dominance of the new technology.
- Changes in input prices support this change.
- Natural gas prices have fallen in recent years due to massive support of unconventional gas in the US, support which was not explicitly aimed at the steel sector but primarily at energy security. Recent analyses show that the benefits thus far have reached American heavy industry and all production sectors as well as households. However, the gas industry itself has yet to see large profits from unconventional gas (Edinburgh conference).

Downstream integration is considered as a means of coping with the current (financial/economic) crisis because it allows for recouping investment in specialized products by securing demand.

4.2.3 Privatization, nationalization, and other direct measures

In Europe, steel production has been nationalized, privatized, re-nationalized, and re-privatized. Historically, one success story is the restructuring of the Italian steel industry (Grabas and Nützenadel, 2012). After WWII, a large new state-owned steel plant was set up, funded by Marshall Plan loans, which dominated the Italian market by size, capacity, and technological advantage. With a second state-owned steel plant, Italy became a net steel exporter by 1960. While Italy succeeded with this strategy, state-owned steel mills in the UK have proven very expensive in the post-war period (Grabas and Nützenadel, 2012). The UK underwent a brief period of re-privatization in 1953; it sold United Steel shares for a total of £394 million. In 1947, nationalization had cost the government £402 million. The UK contribution to worldwide steel production fell to less than 1 percent and also fell in absolute terms.

Belgium looked into nationalizing the Lüttich mill. The European Union continues to follow its philosophy of strengthening private ownership and competitive forces (Steel Action Plan) (COM, 2013).

Other suggested measures are import tariffs on Chinese steel, on the grounds that the Chinese government has been subsidizing its steel production. The flip side of the coin would be a tariff on scrap exports, as suggested by the Italian government to keep the scrap material within Italy) and thus decrease scrap costs for Italian EAF steel production.

Environmental policies have affected the steel industry in many ways. There is a school of economic thought which claims that strict environmental regulation might benefit heavy industry, because it forces innovation and yields new products and new market opportunities (for examples see Klemmer et al.. 1999; Jänicke, 1997 and Rexhäuser and Rammer, 2011). In the steel industry efficiency measures are required to claim the CO_2 certificates allocation, and high emission reduction targets are set. This and the pressure from high European energy prices has led to large efficiency gains.

On the other hand, the steel industry is exempt from the German EEG surcharge, the refinancing mechanism of RET deployment. Although this exemption has recently been challenged by the European Commission for other sectors, it is still approved for the steel industry. This policy reflects the strategic role that is attributed to the industry.

4.2.4 Demand and supply

Additionally, programs are developed to support the demand side, i.e., the construction and automotive sectors. In Europe, the financial crisis and the Euro crisis have led to decreasing demand from construction, automotive manufacturing, and infrastructure build-up in general. China and other emerging countries, on the other hand, have experienced a booming housing and non-residential building sector as well as high demand for infrastructure in roads and rails. This led to overcapacities in both regions, while traditional customers were weak in Europe and exports could have filled the books. China had built its own production with its typical exuberance, leading to sufficient or even excess capacities in that region. Japan, typically strong in steel, also had a period of slow economic growth in the aftermath of the Fukushima events.

4.3 AIRCRAFT /SPACECRAFT INDUSTRY

The aircraft/spacecraft industry is one of the most concentrated of any. The sector is considered to be strategic, and development and procurement of aircraft and spacecraft are significantly supported by military spending. (However, to some extent the development of the transnational consortium EADS is an exception; see below.)

The US aircraft industry has been subject to industrial policy since its beginning (Tyson and Chin, 1995). Building aircraft is a highly risky business, as developing new models requires tremendous upfront investment. The risk has partly been covered by the US government through securing demand and financing R&D in the military airplane sector (which spilled over to the civilian aircraft sector) and through airline regulation, which let airlines strongly compete via comfort and service (ibid). New aircraft were one of the few options to attract new customers.

The European EADS (European Aeronautic Defence and Space Company), a consortium, has always emphasized the civilian use of their products. The Europeans used direct financial support as the main mechanism in the Airbus program; the city of Hamburg, for example, holds a share. Upstream industries, as well as EADS itself, have also benefitted from R&D programs, tax credits, and loans. For years all economic textbooks characterized the aircraft industry as the "comfy duopoly" of Boeing and Airbus (FAZ, 2010), especially after the merger of McDonnell Douglas with Boeing.

The Brazilian firm Embraer, the third largest player in the sector, turned from an inefficient, military-oriented, state-owned company into a major (43%) owner of the market for small regional planes. The industry was started after WWII with US army support, with the setting up of an industrial center complemented by a technical university. The military government after 1964 switched the focus of this ensemble to civilian use and continued R&D support. Although successful with propeller planes, the switch to jets almost failed. After privatization of the company (in 1993) and of the airline markets in several countries, a new class of smaller passenger planes was invented in anticipation of the need for new and low-cost private carriers (FAZ 2010). This niche has expanded and other new entrants into the market such as China, Japan, and Russia are emerging.

Infrastructure is important for the aircraft industry as well, at least for large passenger airplanes. The provision of airports and personnel, the training of airport staff, and the participation of governments in airport security can be seen as demand-supporting policies throughout the history of the aircraft industry.

4.4 POLICIES AND SUCCESSES ALONG THE VALUE CHAIN

Policies aimed at value creation (demand side policies, firm level policies, complementary policies) are found in almost all countries and all industrial sectors at least at some point in their development. They include (cf. table 12)):

- Direct demand enhancing measures ;
- Fiscal measures, direct transfers, budgetary measures;
- Regulatory measures;
- Labor force improvement, capacity building;
- Infrastructure, innovation, R&D support; and
- Market entry and market share expansion measures.

Table 12: Selective measures – examples from automotive, aircraft, and steel sectors

	Automotive	Aircraft	Steel
Direct demand enhancing measures	Car scrap bonus	Military demand	Construction, procurement
Fiscal measures, direct transfers, budgetary measures	Federal rescue, tax exemption for company cars	Federal rescue	Subsidies, tax exemptions, energy price lowering, Federal rescue/ nationalization
Regulatory measures	CAFE standard (US)	Regulation of airlines	
Labor force improvement, capacity building	Advanced skills development, short-term compensation	Advanced skills development vocational training, specialized	Advanced skills development, short-term compensation
Infrastructure, Innovation, R&D support	Roads, R&D support, E-mobility platforms, supplier development programs, cluster policies	Innovation programs, R&D support, university programs focused on (military) aircraft development, airports	Innovation programs
Market entry and market expansion measures	Local content, tariffs, anti-tariff policies		Export tariff on scrap, import tariff on steel

Measuring the success of the sectoral policies is very difficult, in the conventional sectors as well as in the three under review here. Earlier in this report we have tried to give a definition of successful policies (see Section 3). The case studies of the steel sector, the automotive sector, and the aircraft industry show that each industry has needed support policies at times (Table 12).

The history of the steel sector shows that its development has gone through several up-turns and downs-swings. Currently, the steel industry is globally again under pressure. In the short run, sectoral policies served the purpose of securing employment, which fulfils the second objective of keeping the workforce. Whether the industry has been strengthened in the long run remains an open question.

The most successful policy support measures seem to be the provision of infrastructure and securing demand. Demand enhancing measures in domestic markets, paralleled with innovation requirements, can lead to periods of growth, as is seen in the automotive industry. This, however, implies that the domestic market is sufficiently large. This is an important lesson to be learned for RE industries and support policies. Demand enhancing measures are valuable for an existing industry, especially when it is under pressure.

Overcapacities can be put to good use by demand enhancing measures. Infrastructure measures, such as grid capacity enhancement or grid modernization, are a sine qua non for demand enhancing measures on the one hand, but on the other hand infrastructure also is an important backbone for an infant industry. Without infrastructure industrial development cannot take place. In particular, for renewables roads are needed to get to the construction site of large wind farms or large CSP or PV plants, grids are needed to deliver electricity and get the returns from a RE installation, and educational infrastructure is needed to provide properly qualified domestic employees.

It can be learned from the example of the steel industry that markets for homogeneous products can be radically changed when a large player enters. The same holds to some extend for the RE industry, especially for PV. Overcapacities in markets with rather homogeneous products have led to price drops in steel as well as in PV. Again, our analysis suggests that one solution seems to be demand enhancing measures.

The main reason for the selection of example sectors was, as said initially, that they were subject to industrial policies in the past and that something can be learned that is applicable beyond the sectoral border. But the main reason for these sectors to be targeted by policies was that each of them has been considered "strategic". What characterizes a sector as strategic?

Next to military considerations (see aircraft industry), strategic sectors are all sectors whose failure would cause significant disruptions in a country's development. In Germany, for instance, the automotive sector and the machinery sector are both considered strategic. Possible measures of impact would be the sector's contribution to GDP, its share of total employment, or the depth of the value chain within the economy. The German machinery sector yields crosscutting demand in the German economy. If it failed, plenty of other industries would fail as well.

The steel industry has been considered strategic because its products are necessary for the other strategic industries. Shortages in this input can lead to production bottlenecks. From the standpoint of input necessity the electricity sector is also strategic, and one can discuss if the RE sector should be considered a strategic sector. Currently, it is not significant in terms of contribution to employment and GDP. In terms of RE electricity and heat generation needed in the future, it may develop into one of the most important strategic sectors.

5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter gives a brief summary of the central steps of this study before it presents key conclusions and recommendations. Specifically, this study:

- Offers and develops an analytic framework for identifying opportunities for value creation along the entire RE value chain;
- Identifies and defines RE value creation policies and discusses possibilities for strategic policy interventions to enhance RE value creation; and
- Deepens the analysis with lessons learnt from the development of RE and other sectors.

The analytic framework is based on the idea of analyzing first- and second-round effects at each stage of the RE value chain. Applying this framework not only ensures compatibility with economic sector analyses (i.e., I-O analysis as discussed in Chapter 2), it also allows for identifying value creation effects from RE development that reach deeply into the economy. Figure 5 in Chapter 2 depicts the main steps of the value chain and the main economic sectors that are influenced by the RE sector. Hence, this analytical framework can be used to:

- Determine the impact of successes and failures of sectors along the value chain on the economy;
- Identify opportunities for economic sectors from participating in first round and second round effects; and
- Provide the framework for knowledge-based policy choices and policy decisions.

To identify promising niches for future activities, such an analysis has to be complemented by an analysis of the respective markets. In Chapter 3, after we defined different sets of policies for stimulating value creation in the economy, we highlighted the following steps:

I. Analysis of domestic and international market size and competitiveness. PV module production, for instance, is already marked by overcapacities and does not offer an attractive business climate for an infant sector (Section 3.1.2.1).
II. Analysis of domestic endowment: natural resources and land (Section 3.1.2.3).
III. Analysis of domestic strength along the value chain of RET in terms of human resources, adjacent existing industry, and infrastructure (Sections 3.1.2.2 and 3.1.2.3).
IV. Strategic policy interventions and comparison with other countries that are similar in economic level and structure but more advanced in RE industry development and RET deployment (Section 3.2).

Identification of niches is an important step for the policy maker to be able to develop target oriented policies. Of course, policy support for industrial development is not new to economics and the political debate. In addition, policy support for RET deployment has been applied globally in the last decade. However, given the specific challenges for promoting RE industries (see Section 3.2.2), we argue that a new definition is needed for RE value creation policies, to highlight the need for integrating industrial development with market creation and building of capabilities.

In this report RE value creation policies (Chapter 3) aim at increasing the domestic share from RE value creation such that overall societal welfare is maintained or increased. This is done by: improving competitiveness and the regulatory and economic framework for economic sectors and technologies related to RE; improving the availability, accessibility, and quality of resources (capital, natural resources, human capital) used for RE deployment; stimulating demand for RET; and directly addressing support to selected RET producers and service providers. We stress that a good RE value creation policy is a policy mix that requires not only an appropriate design but also a detailed analysis or ante-impact evaluation as well as monitoring and ex-post evaluation of policy effects, coordination of different measures, and continuous check for consistency and coherence.

To allow policy makers to draw on earlier experiences with value creation, we also draw on lessons that could be learnt from other sectors and from more conventional industrial policy studies. The following key lessons emerge for value creation in the RE sector (Chapter 3):

- As with any policy, RE value policy should balance economic with social and environmental objectives. To achieve this, a wide range of public and private stakeholders should be invited to contribute to the policy design from the very beginning. This helps to find good compromises and increases policy certainty, as it reduces the risks of policy makers having to abandon or change certain policies during the implementation phase in response to unexpected opposition. However, any stakeholder process entails the risk of being dominated by incumbent sectors or actors that have established a strong network with policy makers. How to deal with this issue requires a detailed analysis which is beyond this study.
- To be in accordance with international competition standards, sector policies should be based on private sector-led experimentation rather than top-down planning. Private investors should share some of the costs and risks. In order to compensate investors for high risks, the expected returns must increase. In some cases expected returns of RET exceed actual realizable returns. In such cases some (not all) risks can be shifted from the private investor to the public sector. If the private sector is not willing to bear a certain share of risks, it is a clear signal that investors do not believe in the likelihood of commercial success. In general, "nudging" private companies and inviting them to collaborate is often more effective than "command and control", especially when the government's capacities to enforce implementation are weak.
- RE demand enhancing policies should build on technological objectives that can be achieved without long-term subsidies. Policy consistency and coherence is important.

- The analysis of more mature sectors yields mixed lessons concerning policies along the value chain. Some industries strive to integrate more steps along the value chain, to ensure steady supply and mitigate input price risks. The downside is the risk of technology lock-in, because technology lines can be altered less easily within highly integrated production processes. Other producers focus on key activities and outsource or integrate downstream to bind customers to them.
- The automotive and steel industries both illustrate that infrastructure matters. Obviously, it is necessary in the form of roads for vehicles, but also in a less trivial sense in terms of transport possibilities or, again from the steel sector, as electricity for electrical furnaces, which dominate in countries with reliable electricity grids.
- Demand stabilizing measures temporarily support weakening industries, but should be combined with the requirement of increased innovative efforts in the respective industries. In the automotive industry, GM and Chrysler seem to have been on the verge of major innovation steps just when the crisis hit. The federal rescue gave them the time they needed to follow through.
- Downstream integration is considered as a solution to coping with the current (financial/economic) crisis because it allows for recouping investment in specialized products by securing demand.

One central lesson that emerges from this study is that a mix of policies from different policy areas (financing, fiscal, education, R&D policy)that address RET demand (market), suppliers (firm or sectors) as well as main input factors, in particular human resources and capital, is necessary to successfully generate value creation from RET deployment. This mix will be very country-specific and no general applicable "one size fits all" policy set" can be recommended. However, the lessons learnt for the appropriate RE value creation policy mix can be structured with the following questions:

- What is the domestic RET deployment status, RET industry structure, the knowledge- and R&D intensity?
- What is the expected local, regional, and global market development?
- How strong is global competition?

The questions can guide policy makers to localize their current status and to prioritize value creation policies. Depending on 1) the status of RET deployment (solar and wind) and 2) industry, knowledge. and R&D intensity, countries can be roughly grouped into four cases:

Case 1: Countries which have extensive levels of RET deployment, strong RET industries, and R&D intensive industries (e.g., Germany, Spain, Denmark, Japan, China, and the US, to a lesser extent Italy and Brazil).

Case 2: Countries which have some levels of RET deployment but weak RET industry and little R&D intensive industry (e.g., Morocco, Tunisia, India, Turkey, South Africa, and Mexico).

Case 3: Countries which have neither large RET deployment nor RET (PV or wind) industry but strong knowledge and R&D intensive industries (e.g., Netherlands, UK, Russia, Canada, France[27]).

Case 4: Countries which have no (or very low) RET deployment, no RET industry, and no R&D intensive industries (e.g., most sub-Saharan Africa countries, Gulf Cooperation Countries, Middle East).

Some countries with significant natural resources, such as Norway and Iceland, have a high share of RE (through hydro or thermal power) and knowledge-intensive economic sectors, but a less developed RET industry. They capture RE value creation by supplying electricity at low (variable) costs and, hence, put their energy intensive industry in a competitive position, enabling consumers to use a relatively large share of their available income (budget) for the consumption of other goods.

Case 1 seems the least difficult, but there have been new challenges recently. Even countries with a more or less thriving RE industry and a strong support from RE demand policies are facing a changing market environment and have to adapt to new market players.

The crucial and challenging factors for capturing value creation from RET deployment are the following:

- How are international RET markets developing? Is demand for RET decreasing? If economic opportunities are rare, new technologies with higher expected returns are necessary. Policies that strengthen R&D should complement the existing demand- and supply-side policies.
- Is the domestic industry competitive enough to persist in the market? The challenge is to remain competitive in a quickly changing environment where process or product innovations can make previously proven RE technologies or processes obsolete. Specialization and diversification can create new market niches. Special applications can be supported by demand-increasing policies. Strong private sector-led development and continuing evaluation and revision of existing policies are recommended. To maintain competitiveness, continuing adjustments in industry and politics are required, which can be best achieved by complementary policies (focusing on human capital).

Case 2: Demand policies have been successful in enhancing deployment but they have failed to induce growth in the RET industry, for any or all of three reasons: (1) international competition is so strong that the domestic industry cannot catch up, (2) there is no domestic and in particular no international market due to weak international demand policies, and/or (3) building an RET industry is not profitable.

The selection of policies depends on the reasons why building up an industry has so far not delivered expected results. If the industry is not sufficiently advanced to compete internationally, via prices or quality, the following policies could contribute to enhancing value creation:

[27] Ignoring here hydro power or biomass.

- Complementary policies to strengthen the knowledge base across the economy by building up technical, managerial, planning, and engineering skills, capacities, and capabilities. This entails, for example, incentives for the setting up of educational and training programs in engineering and materials science; developing joint research centers involving public and private institutions or companies; and providing platforms for communication and exchange. Further, institutional set-up of state banks providing guarantees or special loans can facilitate access to finance (leverage effect).
- Supplier focused policies to enhance competitiveness in the private sector, motivating businesses to invest in RET and to overcome market failures such as missing information and/or coordination. This can be achieved by meeting the needs of the industry, for example, through applied research centers that provide services to small firms, supplier development programs (grants or soft loans for start-ups, SME, etc.), investment promotion (e.g., soft loans or guarantees for manufacturing investments) and facilitation, and cluster development programs.

As discussed earlier in the report, the integration of these policies is crucial, as is the adaptation of this policy mix to local framework conditions.

Case 3: Countries that already have knowledge-intensive and competitive industries can use their existing strengths for securing value from RE deployment by developing links to the RE value chain. Intermediary goods and services can spin off to the RE sector and capture value. The respective instruments to support this process are mainly complementary and sector/firm-specific policies. Further, the analysis tool suggested in Chapter 4 can be applied to identify the economic niche sectors. However, RE demand policies are critical for ensuring a large market for RET. If the local market is small, policy makers should strategically seek export markets.

Case 4: When RET deployment is low and the industrial structure as well as R&D intensity is weak, RE can provide a starting point for industrial development. After having identified the niche market and barriers, the corresponding policy mix must be elaborated and implemented. Overall, RE demand policies (as discussed for Case 3 countries), supplier focused policies (targeting specific economic actors that produce goods and services), and complementary policies are simultaneously needed to stimulate markets, provide qualified and sufficient inputs, and enhance competitiveness, and thereby provide incentives for actors to do business in this new sector. For example, infrastructure has to be established, in terms of institutions, networks (e.g. information technology and telecommunication, transportation, energy), industrial zones and facilities. Further, qualifications and skills should be developed and an investment climate should be created that offers attractive and trustworthy framework conditions for both FDI and domestic investment.

Table 13 illustrates the above by mapping policy options for the different country cases along two main dimensions: domestic RET deployment status and domestic capabilities in terms of industrial development, knowledge, and R&D intensity.

Table 13: An illustration of possible policy mix by country cases

		Domestic RET Deployment Status /Market size	
		High	Low or none
Domestic Capabilities	Strong RET industry; knowledge and R&D intensive industry	Case 1 Maintain competitiveness of the industry: - Remove any barriers for export opportunities, maintain local market growth and enhance service provision. -Adopt a participatory approach to bring all actors along in developing large shares of RE. -Strengthen innovation and R&D capabilities, keep quality high. → Overall, focus on complementary policies (especially human capital).	-
	Weak RET industry; knowledge and R&D intensive industry	Case 2 Develop/Create a competitive industry: - Implement complementary policies to strengthen competitiveness: - Support education, training, R&D policies to increase quality. - Improve infrastructure (physical as well as institutional) and create an industrial environment. - Apply supplier oriented policies (sector-level policies) to strengthen manufacturing and upstream industries: - Address trade barriers, financing constraints, and fiscal issues along the whole value chain. - Include the services sector in activities related to construction, operation, and maintenance to capture value creation in this field. - Adopt LCRs but only as one	Case 4 Build up RET demand and a competitive RET industry - Set up and implement consistent and reliable RET demand policies signaling government commitment, to stimulate domestic demand. - Identify bottlenecks for input or production factors in industry, such as human capital and infrastructure, and chose complementary policies to strengthen competitiveness through education, training, and R&D policies. - Identify bottlenecks for suppliers and implement supplier oriented policies to support manufacturing, services, and upstream industries. For instance, investment support, land access/rights, promotion of SME or start-ups, and FDI promotion and facilitation programs play an important role. → Start from scratch and elaborate an appropriate policy mix

		among several other policies. - Strengthen existing RET demand policies: - Ensure access to power in remote areas. →Overall, identify needs in the area of supplier and complementary policies	(including strategies, instruments, implementation as well as the supplier, inputs and demand focused policies and includes various policy areas (financing, education, infrastructure, etc.).
	Weak RET industry but strong knowledge and R&D intensive industry	-	Case 3 Start from successful existing industries to build on relevant knowledge. - Implement RET demand policies to stimulate domestic demand. - Supplement education and training programs, standards, and infrastructure policies to encourage FDI or inclusion of local production in RET deployment. - Check the needs for supplier oriented policies (sector-level policies) to initiate investments in manufacturing and operation and maintenance of RET. → Overall, identify potential bottleneck areas and apply a mix of demand, supplier, and complementary policies.

Source: Author illustration.

The allocation of countries to these categories can be debated in detail but the authors hope to have contributed to a fruitful debate. The analysis in this report and the illustration with case studies helps decision makers to find their location in this landscape. Moreover, it may also help to identify what development pathway to follow and what policies could support this process. The above categorization in Table 13 is thought to provide decision makers with a starting point for developing action-oriented roadmaps. However, this study does not elaborate a detailed roadmap on how to proceed to capture RET value creation, as this process is very case/country specific.

For most (if not all) of the policies aimed at industrial development (and value creation more generally), the presence of a large and predictable demand for RET is critical. For RE value creation policies to be effective, therefore, robust (i.e., ambitious and consistent) policies for market creation (RE demand policies) are a precondition. If the local market is small (or saturated), emphasis should be placed on strengthening export opportunities and on maintaining competitiveness. For value creation to emerge, demand oriented policies need to be complemented with policies aimed at strengthening/building up competitiveness (e.g., education, training, R&D, infrastructure, supplier development, industrial clusters). In this process, investment promotion and facilitation is also critical (supplier support). In practice, the strength of these policies will vary among countries. This implies that policy makers need to carefully identify bottlenecks at input, supplier, and demand levels and assess the impact of the necessary interventions at multiple levels in order to achieve the desired results. Hence, monitoring and evaluation should accompany the implementation of the policy mix, while constantly reflecting on changing market conditions.

6 REFERENCES

- Abramson, N. H. (1997): Technology transfer systems in the United States and Germany: Lessons and perspectives, Washington D.C.: National Academy Press.
- Altenburg, T. (2000): Linkages and Spill-Overs Between Transnational Corporations and Small and Medium-Sized Enterprises in Developing Countries: Opportunities and Policies, in: UNCTAD, TNC-SME Linkages for Development, Issues – Experiences – Best Practices, New York and Geneva, 3-61.
- Altenburg, T. (2011): Industrial policy in developing countries: overview and lessons from seven country cases, Bonn: Deutsches Institut für Entwicklungspolitik / German Development Institute (Discussion Paper 4/2011).
- Altenburg, T. and Pegels, A. (2012): Sustainability-oriented innovation systems – Managing the green transformation, in: Innovation and Development, 2 (1), 5–22.
- Barbieri, E., Di Tommaso, R. R., Bonnini, S. (2012): Industrial development policies and performances in Southern China: Beyond the specialised industrial cluster program, China Economic Review 23, 613-625.
- Bloomberg (2012): The Great Renewable Energy Race, http://go.bloomberg.com/multimedia/the-great-renewable-energy-race/.
- BMW (2013): Federal Ministry of Economics and Technology, Industrial Policy.
- Brachert, M., Hornych C. (2009): Die Formierung von Photovoltaik-Clustern in Ostdeutschland, in: Wirtschaft im Wandel 15 (2), 81-90. online: http://www.iwh-halle.de/d/publik/wiwa/2-09-5.pdf (accessed 15 Jan. 2013).
- Brickley, P. (2012): Evergreen Solar to Abandon Massachusetts Factory, Wall Street Journal, March 12, 2012, http://online.wsj.com/article/SB10001424052702304450004577277632600824356.html (Accessed on April 7, 2013).
- Bullock, H., Mountford, J., Stanley, R. (2001): Better Policy-Making, Centre for Management and Policy Studies, London.
- CDASED (2001): Business Development Services for Small Enterprises: Guiding Principles for Donor Intervention, Washington DC: Committee of Donor Agencies for Small Enterprise Development.
- CEEW (Council on Energy, Environment and Water) and NRDC (Natural Resources Defense Council) (2012): Laying the Foundation for a Bright Future: Assessing Progress under Phase 1 of India's National Solar Mission. Interim Report, New Delhi.
- Collier, P., Venables, A. J. (2012): Greening Africa? Technologies, endowments and the latecomer effect in Energy Economics Vol. 34, Nov. 2012.
- COM (2013); COMMUNICATION FROM THE COMMISSION TO THE PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF REGIONS, 407, Action Plan for a competitive and sustainable steel industry in Europe

- Commission on Growth and Development (2008): The Growth Report: Strategies for Sustained Growth and Inclusive Development, Washington, D.C. Council on Energy, Environment and Water (CEEW)/Natural Resources Defense Council (NRDC) (2012), Laying the Foundation for a Bright Future: Assessing Progress Under Phase 1 of India's National Solar Mission, Interim Report, New York; New Delhi, Natural Resources Defense Council; Council on Energy, Environment and Water.
- Cosbey, A. (2011): Renewable Energy Subsidies and the WTO: The Wrong Law and the Wrong Venue; online http://www.iisd.org/gsi/news/renewable-energy-subsidies-and-wto-wrong-law-and-wrong-venue (accessed 06 June 2013).
- Destatis (2013), Input-Output-Tabelle der inländischen Produktion und Importe zu Herstellungspreisen 2010 in Milliarden Euro, https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/VGR/InputOutputRechnung/Tabellen/InputOuptRechnung.html;jsessionid=B02451E52A12BA9F236CAFAE9F8344A0.cae4.
- Dii (2013), Desert Power 2050: Regional and sectoral impacts of renewable electricity production in Europe, the Middle East and North Africa; Kieler Working Paper No. 1891, January 2014.
- DR Market Trends (2011):Thomas Scarnati, Metal Bulletin 15th Middle East Iron & Steel Conference, Dubai, UAE, 12-14 December 2011.
- EC (2013): EURES The European Job Mobility Portal. Labor Market Information. Pail – Comunidad Foral de Navarra. https://ec.europa.eu/eures/main.jsp?countryId=ES&acro=lmi&showRegion=true&lang=en&mode=text&regionId=ES0&nuts2Code=%20&nuts3Code=null&catId=445 (accessed on 21 May 2014).
- Eichengreen, B. and Gupta, P. (2009): The Two Waves of Service Sector Growth NBER Working Papers 14968, National Bureau of Economic Research, Inc.
- El-Beyrouty, K., Meimanaliev, A., Petrosyan, L., Singh, D. (2009): Germany´s Photovoltaics Cluster, Institute for Strategy and Competitiveness, http://www.isc.hbs.edu/pdf/Student_Projects/Germany_Photovoltaic_Energy_2009.pdf (Accessed on April 8, 2013).
- EMPLOY-RES (2009): The impact of renewable energy policy on economic
- Enterprise Ireland (2013): Enterprise Ireland –Reports and Publications, http://www,enterprise-ireland,com (Accessed on April 7, 2013).
- Enterprise Ireland (2013): Enterprise Ireland –Reports and Publications, http://www.enterprise-ireland.com (Accessed on April 7, 2013).
- EPIA (2011), Global Market Outlook for Photovoltaics 2011-2015.
- Ercan (2013): Promoting Green Jobs Throughout the Crisis: Turkey. European Employment Observatory Review. Available at: http://www.eu-employment-observatory.net/resources/reviews/Turkey-EEO-GJH-2013.pdf (accessed on 21 May 2013).
- EU (2013): Research and Innovation, http://ec,europa,eu/research/iscp/index,cfm?lg=en&pg=policy.
- EU (2013a) The EU's Industrial Policy.
- FAZ (2010): Das Ende der gemütlichen Luftfahrt, Frankfurter Allgemeine Zeitung, 7.02.2011.
- FINANCE-RE/Clean Energy Group (2011): Strategies to Finance Large-Scale Deployment of Renewable Energy Projects: Study commissioned by IEA-RETD.

- Flik (2001): Flik, R. (2001). *Von Ford lernen?: Automobilbau und Motorisierung in Deutschland bis 1933* (Vol. 11). Böhlau.
- Fraunhofer (2012): Annual Report 2012 - Research for Greater Efficiency. Available online at http://www.fraunhofer.de/content/dam/zv/en/Publications/Annual-Report/Fraunhofer-Annual-Report_2012.pdf (accessed on 22 May 2014).
- Fraunhofer Energy Alliance (2013): Fraunhofer Energy Alliance: Business Areas. Online at http://www.energie.fraunhofer.de/en (accessed on 21 May 2014).
- Gabler (2013), Gablers Wirtschaftslexikon.
- GEWC (2012), Global Wind Report 2012.
- GEWC (2013), Global Wind Report 2013.
- Gibson, B., Moles, K., Sanger-Katz, M., Salghini, C., Taylor, J. (2011): The California Solar Energy Cluster, Harvard Business School & Harvard Kennedy School, Cambridge U,S, http://www,isc,hbs,edu/pdf/Student_Projects/USA_(CA)_Solar_Energy_2011,pdf (Accessed on April 8, 2013).
- Global Solar Photovoltaic Production by country (2013): www.futureofUSChinaTrade.com
- Gosselin, P. (2013): Germany's $20-million Solar Jobs – Die Welt Finally Realizes: Expensive Green Energy Subsidies Useless. http://notrickszone.com/2013/05/02/germanys-20-million-solar-jobs-Grdie-welt-finally-realizes-expensive-green-energy-subsidies-useless/ (Accessed on 25 September 2013).
- Gosselin, P. (2013): Germany's $20-million Solar Jobs – Die Welt Finally Realizes: Expensive Green Energy Subsidies Useless. http://notrickszone.com/2013/05/02/germanys-20-million-solar-jobs-die-welt-finally-realizes-expensive-green-energy-subsidies-useless/ (Accessed on 25 September 2013).
- Grabas, C. and Nützenadel, A. (2012): Industrial Policies in Europe in Historical Perspective (No. 15). WWWforEurope.
- Greenpeace (2012), The Energy [R]evolution 2012.
- Groba. F. and Breitschopf, B. (2013): Impact of renewable energy policy and use on innovation - a literature review, Working Paper, forthcoming 2013.
- Hall, P. A. (1993): Policy Paradigms, Social Learning, and the State, in: Comparative Politics 25 (3), 275 – 296.
- Hanni, M. S., van Giffen, T., Krüger, R., Mirza, H. (2011): Foreign direct investment in renewable energy: Trends, drivers and determinants, In UNCTAD, Transnational Corporations, 20(2): 29-66.
- Hao, M., Mackenzie, M., Pomerant, A., Strachran, K. (2010): Local Content Requirements in British Columbia's Wind Power Industry, Victoria, British Columbia, Pacific Institute for Climate Solutions.
- Hausmann, R., Rodrik, D., Sabel, C. F. (2007): Reconfiguring industrial policy: A framework with an application to South Africa, revised August 31, 2007.
- HydroQuébec (2014). Wind Power: Ensuring Québec's electricity supply. Available at: http://www.hydroquebec.com/publications/en/others/pdf/depliant_eolienne_distribution.pdf (Accessed on 01 July 2014).
- ICTSD (2012): Renewable Energy WTO Dispute Moves into Home Stretch, Dispute Settlement and Understanding Programme 16(19), Available at http://ictsd,org/i/news/bridgesweekly/133592/ (Accessed on 11 July 2012).
- IEA (2012): World Energy Outlook 2012, Paris.

- IEA-RETD RE-Employ (2012): Employment Effects of Renewable Energy Deployment – The Policy Makers View, Sevilla.
- IEA-RETD RE-Finance (2011): Strategies to Finance Large-Scale Deployment of Renewable Energy Projects: An Economic Development and Infrastructure Approach.
- IEA-RETD RE-Supply (2011): Securing the Supply Chain for Wind and Solar Energy.
- IfW/Dii Study on Economic Impacts of Desert Power (2013).
- ILO and EC (2011): Skills and occupational needs in renewable energy, Geneva: International Labor Office and European Commission.
- Invest in Canada (2012): Renewable energy: wind and solar, Canada´s competitive advantages.
- Isaksen, A., Hauge, E. (2002): Regional clusters in Europe, Brussels: European Commission.
- Jänicke (1997): Nationale Umweltpläne in ausgewählten Industrieländern / [Enquete-Kommission Schutz des Menschen und der Umwelt des 13. Deutschen Bundestages (Hrsg.)].
- Johnson, O. (2013): Promoting solar PV manufacturing in India: exploring effectiveness of local content requirements, DIE Discussion Paper, Bonn, German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE).
- Klemmer et al. (1999):Environmental innovation, Metropolis.
- Krugman, P. R., & Obstfeld, M. (1991). International economics (2d ed.) HarperCollins. New York.
- Kuntze, J. C., & Moerenhout, T. (2013). Local Content Requirements and the Renewable Energy Industry: A Good Match?. *Geneva: International Centre for Trade and Sustainable Development*.
- Lall, S. (1995): Industrial Strategy and Policies on Foreign Direct Investment in East Asia, in: Transnational Corporations, 4 (3), 1 – 26.
- Lehr, U., O'Sullivan, M., Edler, D, Lutz C, Ulrich, P, Bickel P, (2011): Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt. Study commissioned by German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.
- Lin, J. and Chang, H.-J. (2009): Should Industrial Policy in Developing Countries Conform to Comparative Advantage or Defy it? A Debate Between Justin Lin and Ha-Joon Chang, in: Development Policy Review, 27 (5): 483-502.
- Lin, J. and Monga, C. (2010): Growth identification and facilitation: the role of the state in the dynamics of structural change, Washington, DC: WB (Policy Research Working Paper 5313).
- Linden, G., Dedrick, J., Kraemer, K.L. (2011). Innovation and Job Creation in a Global Economy: The Case of Apple's iPod. *Journal of International Commerce and Economics*, 3(1), 223-239.
- Luetkenhorst, W. and Pegels, A. (2013): Stable Policies, Turbulent Markets – Germany's Green Industrial Policy: The Costs and Benefits of Promoting Solar PV and Wind Energy. International Institute for Sustainable Development, Geneva.
- Lux research (2013): http://www,luxresearchinc,com/blog/2013/05/the-photovoltaic-markets-return-to-equilibrium-in-2015-drives-tomorrows-growth-for-todays-innovators/
- Marchese, M. and Sakamoto, A. (2008): Skills development for industrial clusters: A preliminary review, Geneva: International Labour Office.

- Nicola, S. (2012): China price war drains jobs in Germany's Solar Valley. Bloomberg News. http://www.bloomberg.com/news/2012-09-06/china-price-war-draining-jobs-in-germany-s-solar-valley-energy.html (Accessed on 11 October 2013).
- OECD (2010): Value Added, in *National Accounts at a Glance 2009*, OECD Publishing.
- OECD (2013): Renewable energies in the Middle East and North Africa: Policies to support private investment, Organisation for Economic Cooperation and Development (OECD), Competitiveness and Private Sector Development.
- OECD/WTO (2012), Trade in value-added: concepts, methodologies and challenges, joint OECD -WTONote, www.wto.org/.../res.../oecd_wto_mar2012_e.doc.
- Ontario Power Authority (2013). Changes to Domestic Content and New FIT/micro FIT Schedule. August 16. http://fit.powerauthority.on.ca/newsroom/august-16-2013-program-update (Accessed on 1 July 2014).
- Sheargold, E., and Walavalkar, S. (2013). NEPA and Downstream Greenhouse Gas Emissions of US Coal Exports. Columbia Center for Climate Change Law (CCCL) White Paper.
- Pack, H. and Saggi, K. (2006): Is There a Case for Industrial Policy? A Critical Survey, in: The World Bank Research Observer 21, (2), 267-297.
- Photon (2013); Aus der Traum, Photon Januar 2013, p. 16 – 23.
- PSDC (2013): Penang Skills Development Centre (PSDC), http://www,psdc,org,my/ (Accessed on April 8, 2013).
- PV Magazin;e http://www.pv-magazine.com/news/details/beitrag/industry-analysis--half-of-tier-3-polysilicon-suppliers-face-bankruptcy_100009224/#ixzz32H7OTnks.
- pvexchange 2013, Price Index for solar modules, http://www.pvxchange.com/default.aspx?langTag=en-GB.
- Reid, B. et al. (2010): Technology Innovation Centers: Applying the Fraunhofer model to create an effective innovation ecosystem in the UK, The Work Foundation, REN21.
- REN21 (2013), Global Renewable Energy Status Report 2012.
- Rexhäuser, S., & Rammer, C. (2011). Unmasking the Porter hypothesis: Environmental innovations and firm-profitability, ZEW Discussion Papers 11-036, ZEW - Zentrum für Europäische Wirtschaftsforschung / Center for European Economic Research.
- Rivers, N., & Wigle, R. (2011). Domestic content requirements and renewable energy legislation. *Available at SSRN 2129808*.
- Rivers, N., & Wigle, R. (2011). Local content requirements in renewable energy policies: Ontario's feed-in tariff. *Stockholm, Sweden*, 19-23.
- Rodrik, D. (2008): Commission on Growth and Development, Working Paper No, 3, Normalizing Industrial Policy, The World Bank.
- Rogge, K. S., & Reichardt, K. (2013). Towards a more comprehensive policy mix conceptualization for environmental technological change: a literature synthesis (No. S3/2013). Working Paper Sustainability and Innovation.
- Sabbagh, K. M., Mouajes, C. N., Hoteit, L., Hiltunen, J., Samman, H. (2012): Education for employment - Committing enterprises to education development in the Middle East and North Africa, in: Addressing the 100 million youth challenge - Perspectives on youth employment in the Arab world in 2012: World Economic Forum, 25-29.
- Schweinfurth, A. (2009). Car-scrapping schemes: An effective economic rescue policy?, Policy brief of the Global Subsidy Initiative, November 2009 | Page 2.

- Sheargold, E., & Walavalkar, S. (2013). NEPA and Downstream Greenhouse Gas Emissions of US Coal Exports. Columbia Center for Climate Change Law (CCCL) White Paper.
- Smith, T. (2011): Loss of Solar Jobs has Massachusetts Rethinking State Aid, New Public Radio, (Accessed on April 7, 2013).
- Spar, D. (1998): Attracting High Technology Investment, Intel's Costa Rican Plant, Foreign Investment Advisory Service, Occasional Paper 11, World Bank: Washington, D.C.
- Spiegel Online (2011): The sun rises in the East: German solar firms eclipsed by Chinese rivals. http://www.spiegel.de/international/business/the-sun-rises-in-the-east-german-solar-firms-eclipsed-by-chinese-rivals-a-784653.html (Accessed on 10 October 2013).
- Spiegel Online (2012): Twilight in an Industry: Bankruptcies have German solar on the ropes. http://www.spiegel.de/international/business/q-cells-bankruptcy-heralds-end-of-german-solar-cell-industry-a-825490.html (Accessed on 10 October 2013).
- Studieren-Studium (2013): http://www.studieren-studium.com/.
- Su (2013): International Journal of Photoenergy, Volume 2013 (2013), Article ID 794367, 11 pages, Studieren-Studium (2013): http://www,studieren-studium,com/.
- SWW (2009), Weltkarte der Windenergiehersteller.
- SWW (2012), Sonne, Wind und Wärme, Weltkarte der Hersteller von Photovoltaikmodulen, Heft 9/2012.
- Telekom (2012), White Paper, Vernetzte Wertschöpfung.,Die Automobilbranche im Wandel – von der produzierenden zur Dienstleistungsindustrie, T-Systems Enterprise Services GmbH.
- The World Bank 2013, Knowledge for Development, http://web,worldbank,org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/0,,contentMDK:20753860~pagePK:64156158~piPK:64152884~theSitePK:461198~isCURL:Y,00,html.
- Timmerhoff, L. (2012): The-auto-industry-rescue-by-the-numbers http://www.americanprogress.org/issues/economy/news/2012/10/09/40834/the-auto-industry-rescue-by-the-numbers/.
- Tomsik, V. and Kubicek, J. (2006): Can Local Content Requirements in International Investment Agreements Be Justified, NCCR Trade Regulation Working Paper No, 2006/20, Available at SSRN: http://ssrn,com/abstract=1092840 or http://dx,doi,org/10,2139/ssrn,1092840.
- ToR (2012), Policy Instruments to Support RE Industrial Value Chain Development, (RE-ValuePolicies), Terms of Reference as of 6th December 2012.
- Tukker, A. and Dietzenbacher, E. (2013): Global multiregional Input-Output Frameworks: an introduction and outlook, *Economic Systems Research 25*(1), 1–19.
- Tyson. L. and Chin, P-H. (1995): Industrial Policy and Trade Management in the Commercial Aircraft Industry.
- UfM (2013): The Mediterranean Solar Plan: A Flagship Initiative for a Sustainable Mediterranean Region – MSP Master Plan. Secretariat of the Union for the Mediterranean (UfM), Barcelona.
- UNCTAD (2006): Deepening Development through Business Linkages, United Nations Conference on Trade and Development (UNCTAD), New York and Geneva.
- UNCTAD (2011): Best Practices in Investment for Development: How to Integrate FDI ad Skill Development - Lessons from Canada and Singapore, United National Conference on Trade and Development (UNCTAD), Investment Advisory Series, Series B, Number 5.

- UNDP (2006): Deepening Development Through Business Linkages. United Nations Conference on Trade and Development (UNDP). Available at: http://unctad.org/en/Docs/iteteb20067_en.pdf (accessed on 21 May 2014).
- UNEP/Bloomberg New Energy Finance (2011): Global Trends in Renewable Energy Investment: Analysis of Trends and Issues in the Financing of Renewable Energy, Frankfurt, UNEP/Bloomberg New Energy Finance.
- UNIDO (2008): Action plan adopted by the International Conference on Renewable Energy in Africa - Scaling up renewable energy in Africa, Dakar, Senegal, 16-18 April 2008: United National Industrial Development Organisation.
- Warwick, K. (2013): Beyond Industrial Policy: Emerging Issues and New Trends, OECD Science, Technology and Industry Policy Papers, No 2, OECD Publishing.
- WBGU (2011): World in Transition: A Social Contract for Sustainability, Berlin, German Advisory Council on Global Change.
- WEICan (2013): Wind Energy Institute of Canada (WEICan), http://www.weican.ca/ (Accessed on April 8, 2013).
- Winter, R. (2011): Israel's Special Relationship with the Solar Water Heater; Reuters: http://www.reuters.com/article/2011/03/18/idUS311612153620110318.
- World Bank (2011): Middle East and North Africa Region Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects.
- World Bank 2013, Knowledge for Development, http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/0..contentMDK:20753860~pagePK:64156158~piPK:64152884~theSitePK:461198~isCURL:Y.00.html.
- Worldsteel (2013): Annual steel production 1980 – 2012.
- WTO (2013): Dispute Settlement DS412: Canada – Certain Measures Affecting the Renewable Energy Generation Sector, http://www,wto,org/english/tratop_e/dispu_e/cases_e/ds412_e,htm (Accessed on 20 March 2013).

7 ANNEX

Figure 20: Policy areas, actors, inputs by value chain phases

value chain	intermediate inputs	value creation inputs/direct inputs	requirements	actors	policy area
R&D	services: financing, IT, equipment & knowledge base, ... material in small amounts	- human resources - capital	know-how	- university - research institutes - firms	- education - research - industrial/regional
project development	services: insurance, financing, planning, IT, ...	- human resources - capital - natural resources	skills: planning, management investment climate: regulation, economic and political stability, market	- project developper - regulation body (authorization) - investors - creditors	- education - training - fiscal - financing - regional/land use - infrastructure - energy/climate/environmental
manufacturing: equipment, components & devices	services: planning, financing, insurance, machinery for manufacturing, transportation, trade, IT, ... material: steel, copper, aluminium, ceramics, glass, ...	- human resources - capital - land - natural resources	skills: planning, management, technical/engineering investment climate: regulation, economic and political stability, promising	- companies - investors - creditors - regulation body (standards, authorization)	- education - applied research - training - fiscal - industrial - regional/land use - infrastructure
construction	services: infrastructure, planning, financing, insurance, machinery for construction, transportation, trade, IT, ... material: concrete, steel, ...	- human resources - capital - land	skills: planning, management, technical/engineering investment climate: regulation, economic and political stability, promising	- companies - regulation body (standards)	- education - applied research - training - regional/land use - infrastructure
installation	services: insurance, machinery for installation, transportation, trade, IT, ... material: copper, steel, aluminium, ...	- human resources - capital - land	skills: planning, management, technical/engineering investment climate: regulation, economic and political stability, promising	- companies - regulation body (standards)	- education - applied research - training - regional/land use - infrastructure
operation	services: IT, devices	- human resources	skills: planning, management/marketing, technical/engineering, IT,	- companies - regulation body (standards)	- energy/climate/environmental - fiscal - education - applied research - training - regional/land use - infrastructure - regulation
maintenance	services: planning, devices for repair/replacement material in small amounts	- human resources	skills: technical/engineering, IT	- companies - regulation body	- education - training
demolition	services: planning, infrastructure	- human resources	skills: management, technical/engineering, IT	- companies - regulation body (standards)	- education - training - recycling - regulation (standards, controlling)

Table 14: Delineation of RE value policies

	RE value policies	Industrial policies
Objective	Domestic RE value creation (finally contributing to societal welfare) and finding RE market niches	Economic growth and societal welfare
Target group	- Manufacturers, service providers and actors of the upstream industry of the RE sector, … - Input factors land, human resources, capital, … - Power generator, investors (demand), …	- Industries (not specified) - Input factors land, human resources, capital, … - Not focused on[28]
Policy components	- RE Supplier focused: incentives for manufacturing (RE sector), … → selective policies - Input related: Promotion of immature technologies, research center, pilot projects, support of educational programs, provision of infrastructure and land, … → complementary/horizontal policies - Demand related: RE deployment targets and their implementation (e.g., FIT, tax credits), power system regulation, … → demand policy	- Selective policies - Horizontal policies
Policy process	- Supplier side: comprises discussions and decisions with public, private sector and scientific representatives on selective support → support programs, … - Input factors: ranges from private and public initiatives to improve quality and availability of required input factors, based on an (scientific) analysis and identification of growth barriers → institutional settings, investments in infrastructure, R&D programs, ,,, - Demand side: comprises discussions and decisions with involvement of public and private sector and scientific representatives on RE targets, RE financing → RET strategy and deployment targets, support programs, directives (acts), …	- Country, policy and industry specific - Country, policy and industry specific

[28] Recently, the German politic launched a program to induce demand in the automotive sector and to overcome the financial crisis. This program purely aimed at increasing the sales number of cars, without explicitly targeting an increase in competitiveness or technological development or being put into a broader context of industrial policy. The program was limited in time.