Quantitative Effectiveness Analysis of Solar Photovoltaic Policies, Introduction of Socio-Feed-in Tariff Mechanism (SocioFIT) and its Implementation in Turkey

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Abstract

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Some of the main energy issues in developing countries are high dependence on non-renewable energy sources, low energy efficiency levels and as a result of this high amount of CO_2 emissions. Besides, a common problem of many countries including developing countries is economic inequality problem. In the study, solar photovoltaic policies of Germany, Japan and the USA is analyzed through a quantitative analysis and a new renewable energy support mechanism called Socio Feed-in Tariff Mechanism (SocioFIT) is formed based on the analysis results to address the mentioned issues of developing countries as well as economic inequality problem by using energy savings as a funding source for renewable energy systems. The applicability of the mechanism is solidified by the calculations in case of an implementation of the mechanism in Turkey.

This thesis is dedicated to “The One” who taught me everything I know …

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I. Introduction

A. Subject

The objective of the thesis was to create a quantitative evaluation tool for solar PV policies, and based on the analysis to form an effective renewable energy policy for developing countries In order to form a successful renewable support mechanism in developing countries, solar photovoltaic deployment policies of Germany, Japan and the USA was analyzed through a quantitative analysis. In the quantitative analysis, five different index tables were formed: "Relative Installation Index", "Relative Growth Index", "Relative Solar Potential Index", "Relative Installation and Solar Potential Usage Index", and "Relative Growth and Solar Potential Usage Index" to be used as a comparison tool for evaluating policies. Based on the results, the Socio Feed-in Tariff Mechanism (SocioFIT) was introduced with exemplary calculations in case of an implementation in Turkey.

B. Importance of Problem

Some of the important problems of developing countries are growing energy demands and low energy efficiency levels. Many of the developing countries meet their energy needs with non-renewable energy sources that emit considerable CO_2 into the atmosphere. Besides, some of these countries import their energy with a considerable economic burden on a country economy. Such issues becomes particularly important in emerging economies due to their rapidly growing energy demands.

Many of the developing countries have lower financial resources to fund their energy policies in comparison with developed countries. As a result, the renewable energy production potentials of developing countries cannot be utilized as much as it should have been. Although, the renewable energy markets in such countries are also expanding, the growth can be accelerated through implementation of the right policy.

Economic inequality is a common problem for many countries. The unequally distribution of wealth causes many problems such as: health issues, social cohesion, increased crime and corruption levels, decreased social, cultural, and civic participation, low happiness and productivity levels.

On the other hand, developing countries have considerable energy saving potentials through energy efficiency measures. If an appropriate renewable energy support mechanism can be established, energy saving potential of a country can be used for creating a budget to enhance energy efficiency, increase the number of renewable energy installations, support domestic market, raise energy efficiency and renewable energy awareness, create environmental consciousness, and increase economic equality level of a country.

C. Methodology

The thesis includes two main parts:

- ❖ Quantitative analysis of Germany, Japan, and USA
- ❖ SocioFIT Mechanism for developing countries based on the quantitative analysis conducted.

1. Data

For the historical data, multiple sources are used for collecting solar renewable energy related policies of Germany, Japan and the USA. These countries are selected for analysis due to their long history in solar PV industry. Solar energy industry policy data is collected and grouped based on the implementation years for each of the selected countries (see appendix section A). The solar cumulative photovoltaic installation data of International Energy Association (IEA) member countries are used for creating an index table.

2. Quantitative Analysis

The policies of selected countries are evaluated through a quantitative analysis. The implemented policies of selected countries are grouped under the policy types and the policy types are matched with the index numbers for evaluating their success levels.

3. Forming the New Mechanism

Based on the quantitative analysis conducted, the most successful policies as well as other implemented policies in Japan, Germany and the USA are used as a baseline to form an appropriate renewable energy deployment mechanism for developing countries.

II. Literature Review And Background

A. Introduction

International Energy Agency (IEA) has published reports on renewable energy policies such as "Deploying Renewables (2011)", "Policy Considerations for Deploying Renewables (2011)", and "Technology Roadmap: Solar Photovoltaic Energy (2010)". Similarly, International Renewable Energy Agency (IRENA) has published some articles such as "Financial Mechanism and Investment Frameworks for Renewables in Developing Countries (2012)", "Capacity Building Strategic Framework for IRENA (2012)" and "Evaluating Policies in Support of the Development of Renewable Power (2012)". In USA the Department of Energy (DOE) has also published some reports: "Solar Photovoltaic Financing: Residential Sector Deployment (2009)" and "Solar Powering Your Community: A Guide for Local Governments (2011)". A report of The European Photovoltaic Industry Association (EPIA) named "Connecting the Sun (2012)" was found to be useful.

For the quantitative analysis the "Trends in Photovoltaic Applications: Survey Report of Selected Countries Between 1992 and 2011" report of IEA is used as a data source (IEA 2012).

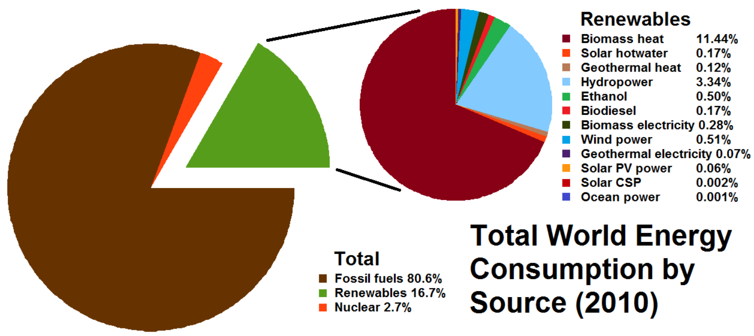
In addition, a study was conducted to evaluate the efficiency levels, which is the indicator that shows the renewable installations achieved for economic resources spent, of renewable energy policies. One of them was (Avril, et al. 2012). In the study, the budgets allocated to renewables are compared with the capacity of installations in France, Germany, Japan, Spain and the US. The results showed that Germany and Japan were two of the most successful countries in terms of the efficiency of their solar energy policies.

The main information source for the Turkish Energy Industry was from the published reports of Energy Market Regulatory Authority (EMRA) such as "Electricity Market Report (2010)".

B. World Renewable Energy Outlook

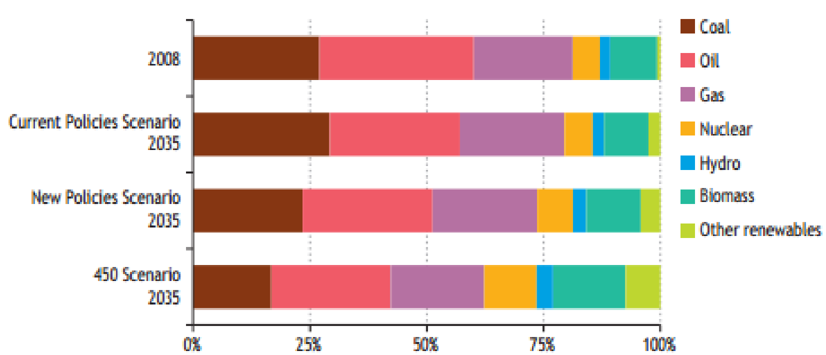
In 2010, renewable energy has supplied 16.7% of world's energy needs (REN2012). The distribution of energy sources is presented in the figure below.

Figure 1 - Total World Energy Consumption by Source (2010) *(Karpthy 2013)*



As it can be seen from the figure, the main source of energy production is from fossil fuels. Renewables still have a small share in total energy production. According to IEA Report, the share of renewable energy sources will not change considerably if the current policies are maintained (IEA 2010). The figure below presents the shares of energy demands under different scenarios.

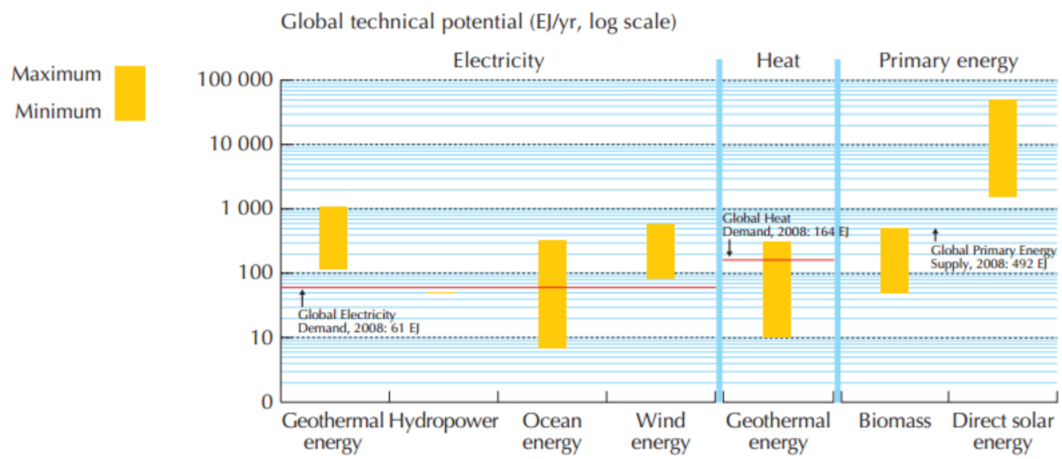
Figure 2 - Shares of Energy Sources in World Primary Demand by Scenario *(IEA 2010)*



C. World Solar Energy Outlook

As an energy source, solar energy has the highest potential for humans to produce electricity. The figure below presents the technical potential of solar energy in comparison with other sources.

Figure 3 - Global Technical Potentials of Energy Sources *(IEA 2011)*



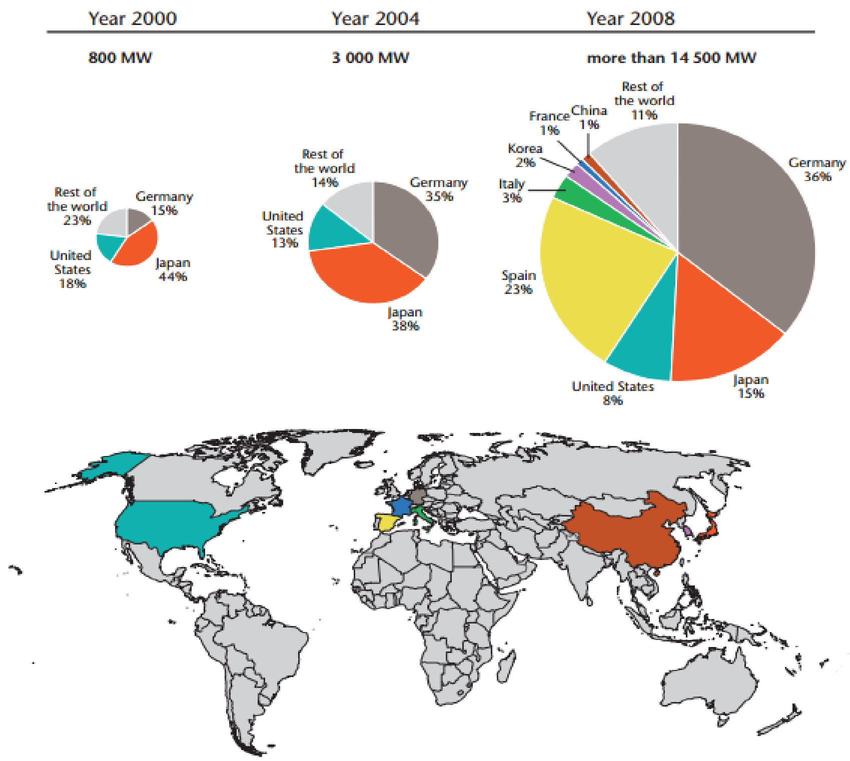
Notes: Biomass and solar are shown as primary energy due to their multiple uses; the figure is presented in logarithmic scale due to the wide range of assessed data. Technical potentials reported here represent total worldwide potentials for annual RE supply and do not deduct any potential that is already being utilised. 1 exajoule (EJ) ≈ 278 terawatt hours (TWh).

Although solar energy has such a great potential the solar market has not grown remarkably until the last decade. As a consequence of developing technology and reducing solar module prices, the solar energy industry has expanded considerably between 2000 and 2012.

There are two main types of solar systems: the solar photovoltaic (PV) systems that convert solar radiation into direct current electricity, and concentrated solar power (CSP) systems that use mirrors or lenses to concentrate a large area of sunlight to produce electricity (Wikipedia 2013). Among two these two types of solar systems, solar PV systems was leading in the market by far. At the end of 2011, the total installed capacity of CSP and PV systems was 1.6 (Wikipedia 2013) GW and 65 GW (EPIA 2012) respectively.

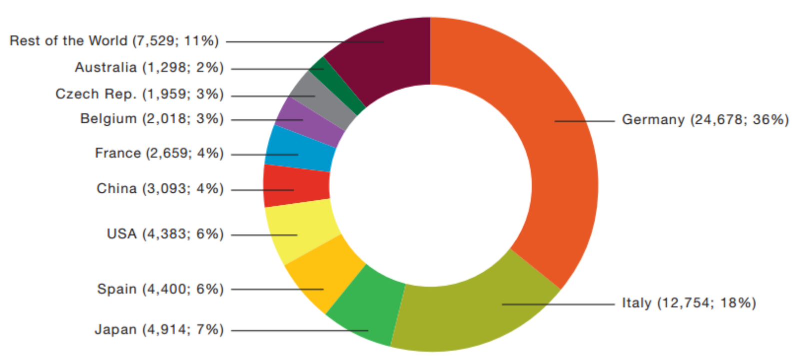
Solar photovoltaic technology has grown rapidly in the last decade. The PV installations and shares among countries in the years 2000, 2004, and 2008 are presented below.

Figure 4 - Cumulative Solar PV Capacities *(IEA 2010)*



In 2011 more than 29.5 GW of solar PV systems were installed globally (EPIA 2012). Germany has installed more than one third of total solar installations in 2011. The share of installations for the year 2011 are presented below.

Figure 5 - Global Cumulative Installed Capacity Share 2011 (MW, %), *(EPIA 2012)*



D. Renewable Energy Support Policies

1. Renewable Support Policies in the World

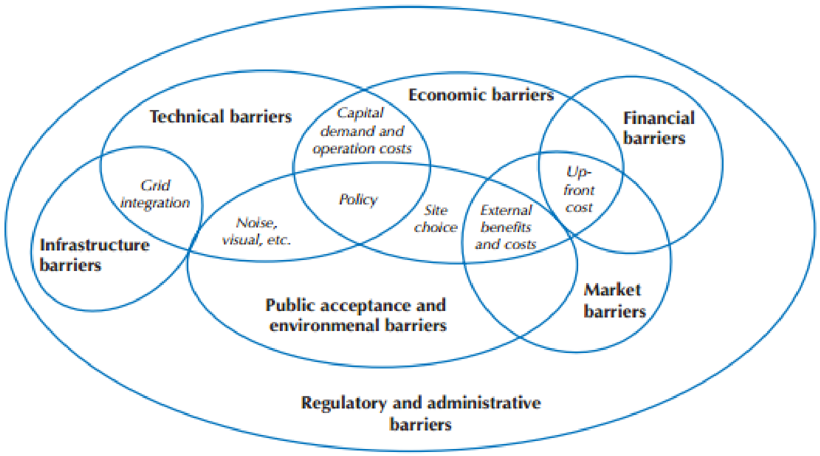
Government support renewable energy for many different reasons. According to IEA, some of the reasons are as follows (IEA 2011):

- Improving energy security
- Encouraging economic development
- Protecting climate

Although there are considerable benefits of renewable energy systems, many barriers were needed to be resolved for deployment of these systems. In the same report, these barriers are explained as follows (IEA 2011):

- Techno-economic barriers (direct cost of renewable systems)
- Non-economic barriers
  - Regulatory and policy uncertainty barriers
  - Institutional and administrative barriers
  - Market barriers
  - Financial barriers
  - Infrastructure barriers
  - Lack of awareness and skilled personnel
  - Public acceptance and environmental barriers

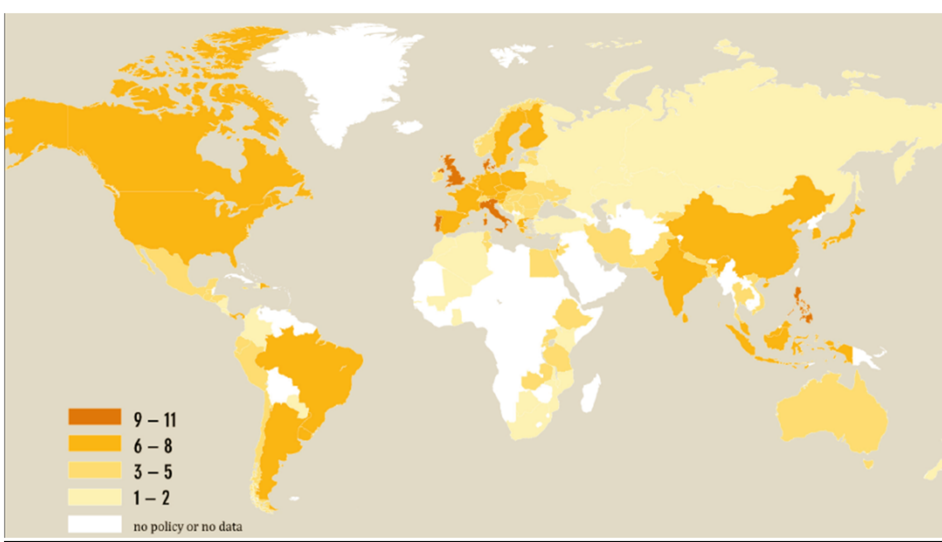
Figure 6 - Barriers to Renewable Energy Technology Deployment *(IEA 2011)*



As the figure above shows, among all of these barriers "Policy Barrier" is at the center of all barriers, which means it has an effect on other barriers. Besides "Regulatory and Administrative Barriers" comprises all the other barriers which also means that this barrier has a comprehensive effect on other barriers. Therefore, it can be said that it is required overcome these barriers first for a successful renewable energy deployment.

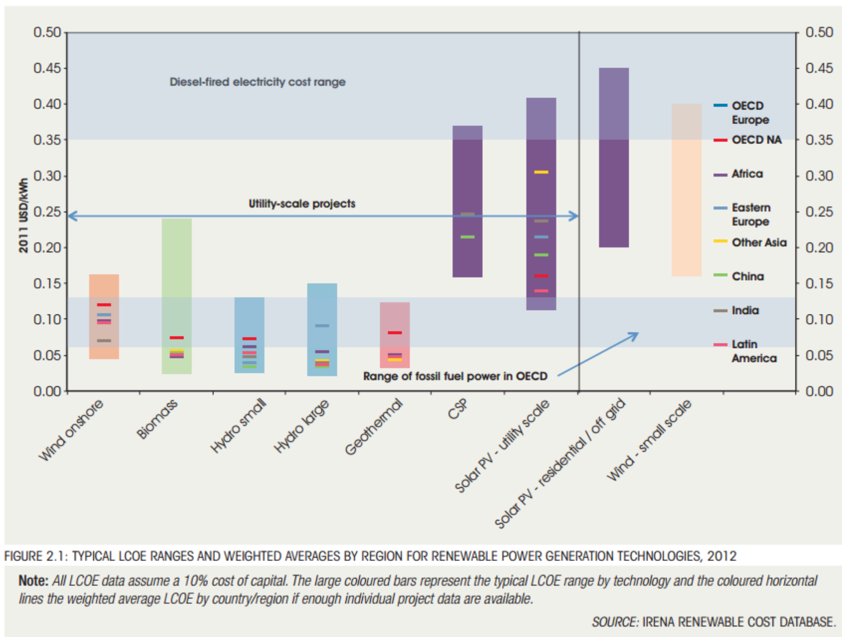
All around the world countries have implemented different types of policies for overcoming these barriers. The map below presents the countries with the number of implemented policies.

Figure 7 - Countries with Policies, Early 2012 *(REN21 2012)*



The costs or renewable systems have reduced quickly as a result of learning process (IEA 2011). The levelized cost of renewable systems and the fossil fuel range for the year 2012 are presented in the figure below.

Figure 8 - Typical LCOE Ranges and Weighted Averages by Region for Renewable Power Generation Technologies, 2012 *(IRENA 2013)*



The costs of renewable systems are expected to decrease further in the future. The figure below presents the generating costs of systems between 2010 and 2035.

Figure 9 - Generating Costs of Renewable-Based Electricity Generation by Technology and Learning Rates in the New Policies Scenario *(IEA 2010)*

	Generating costs						Learning rates
	2010-2020 ($2009 per MWh)			2021-2035 ($2009 per MWh)			
	Min	Max	Avg	Min	Max	Avg	(%)
Hydro - large	51	137	94	52	136	95	1%
Hydro - small	71	247	143	70	245	143	1%
Biomass	119	148	131	112	142	126	5%
Wind - onshore	63	126	85	57	88	65	7%
Wind - offshore	78	141	101	59	94	74	9%
Geothermal	31	83	52	31	85	46	5%
Solar PV - large scale	195	527	280	99	271	157	17%
Solar PV - buildings	273	681	406	132	356	217	17%
CSP	153	320	207	107	225	156	10%
Marine	235	325	281	139	254	187	14%

Note: MWh = megawatt-hour.

As it can be seen from the figures, almost all of the renewable system types have become cost competitive with the conventional energy systems and they are expected to become more feasible in the future.

Since the energy production costs from renewable sources dropped lower than the conventional systems, governments have implemented many different support mechanisms for increasing the renewable energy production.

2. Renewable Support Mechanisms

The support mechanisms play an important role on making renewable systems more feasible. For example, a payback period of a solar PV system can be reduced from more than 60 years to a range of 5-10 years by providing incentives (NREL 2012).

In the IRENA report, support mechanisms are categorized as follows (IRENA 2012):

i. **Fiscal Incentives**

- **Grant:** Monetary support that does not have to be repaid.
- **Energy Production Payment:** Direct payment per unit of renewable energy production.
- **Rebate:** One time direct payment for covering a specific percentage of a renewable energy system
- **Tax Credit (Production of investment):** Allowing the investment amounts in renewable energy systems to be deducted from tax obligations or income. It is also known as investment credit.
- **Tax reduction/ Exemption:** Tax reductions for purchasing / producing renewable energy and renewable energy technologies.

- **Permitting Incentives:** Permitting fees such as building permit fees, plan check fees, design review fees, or other charges are reduced or waived. Expedited permitting procedures are provided for customers (DSIRE Solar 2012).

ii. **Public Finance**

- **Investment:** Financing provided for individuals who are interested in getting a share in a renewable energy company.
- **Guarantee:** Risk-sharing mechanism aimed at mobilizing domestic lending from commercial banks for renewable energy companies and projects that have high risk (usually between 50-80% of principal loan)
- **Loan:** Financing for renewable energy projects usually with lower interest rates and lower security requirements.
- **Public procurement:** Public entities preferentially purchase renewable energy services/ equipment such as renewable electricity.

iii. **Regulations**

Regulations are grouped into four categories.

- ❖ **Quantity Driven Regulations**
  - **Renewable Portfolio Standard/Quota obligation or mandate:** Generators, suppliers and/or consumers are obliged to meet a minimum renewable energy target such as a specific amount of total supply or consumption. The costs are borne by consumers.
  - **Tendering/ Bidding:** Tenders are organized by public authorities. A quota is specified for the tender and the winner is remunerated.

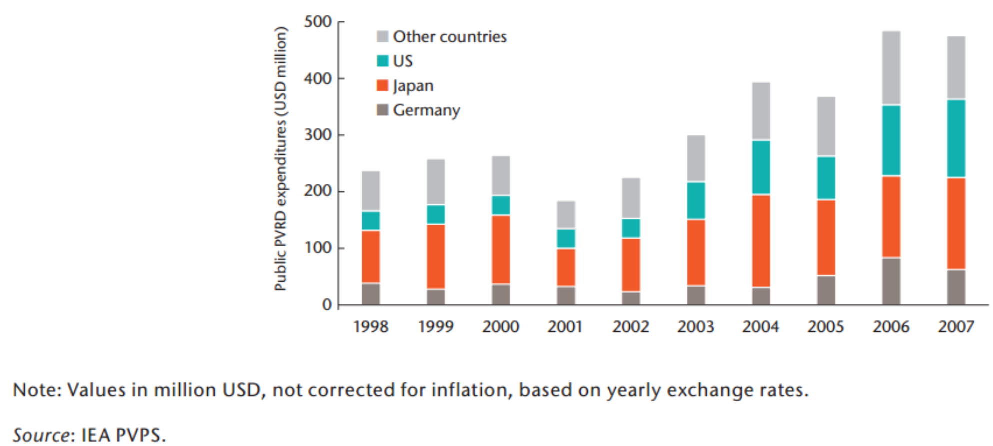
- **Price-Driven Regulations**
  - **Fixed payment feed-in tariff (FIT):** Renewable energy systems are guaranteed with priority access and dispatch. A fixed price per unit delivered is set for a specified number of years. For example, a fixed price, above the retail electricity price, is provided by a government per kWh of electricity production from a renewable source. FITs typically include the benefits as follows (Wikipedia 2013):
    - ✓ Guaranteed grid access
    - ✓ Long-term contracts for the electricity produced
    - ✓ Purchase prices based on the cost of generation
  - **Premium payment FIT:** Renewable energy systems are guaranteed with additional payment in top of their energy market price.
- **Quality Driven Regulations**
  - **Green energy purchasing:** Voluntary renewable energy purchases are regulated.
  - **Green labelling:** Energy products are labelled for meeting sustainability criteria. For example, some governments require labelling on consumer bills that present the renewable energy share.
- **Access Regulations**
  - **Net metering (also net billing):** The system allows two-way flow of electricity between the grid and customers who are generating their electricity. For example, in case a customer produces electricity more than he consumes, the electricity is sent to the grid.

- **Priority or guaranteed access to network:** Renewable energy systems are provided with unhindered access to energy networks.
- **Priority dispatch:** Renewable systems are prioritized in terms of integration into energy systems rather that other energy sources.

Governments allocate considerable budgets for the support of renewable energy systems including financial support mechanisms mentioned above as well as research and development investments.

In addition to mentioned support mechanisms, many countries has increased their R&D budgets for renewable energy and specifically solar PV systems. The figure below presents the R&D budgets of Germany, Japan, USA and other countries between 1998 and 2007.

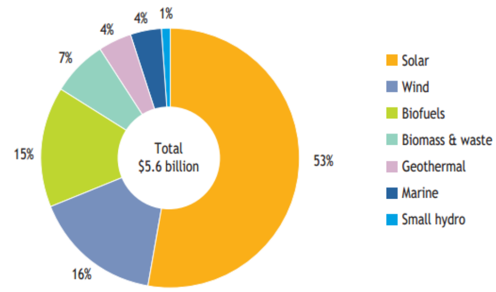
Figure 10 - Public PV and R&D Spending in Selected Countries *(IEA 2010)*



As shown in the figure, Germany, Japan and USA were the main investors of solar PV technology before 2007.

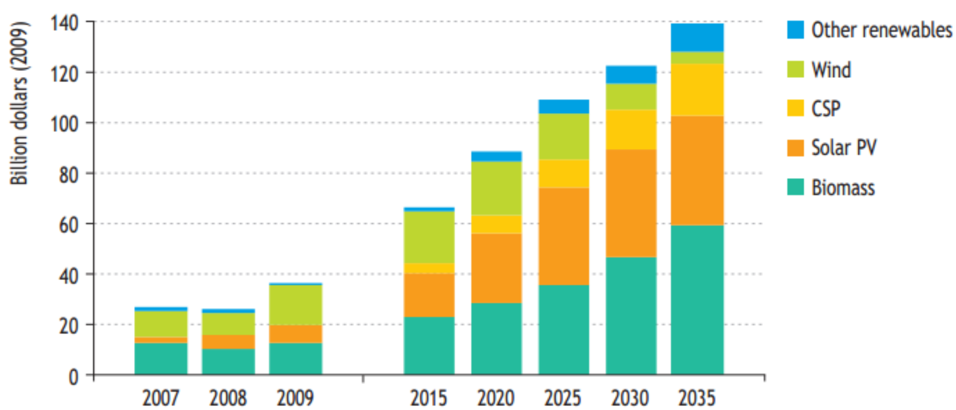
Among all different types of renewable systems, solar technologies had the most share of R&D budgets globally in the year 2009 as it can be seen from the figure below.

Figure 11 - Global Spending on Research and Development in Renewable Energy by Technology, 2009, *(IEA 2010)*



According to the IEA report, the government supports on renewable energy systems are expected to continue with a growing support for solar PV and biomass technologies as it can be seen from the figure below.

Figure 12 - Global Government Support for Renewable-Based Electricity Generation by Technology *(IEA 2010)*



Note: Other renewables include small hydro, geothermal and marine power.

III. Quantitative Analysis of Solar Energy Policies

A. Introduction

In this chapter, quantitative analysis were conducted for evaluating the success of solar PV deployment policies.

Historical data was used for categorizing the policies of Germany, Japan, and the USA.

The solar PV installation capacities of International Energy Agency (IEA) member countries were used as a numeric data. The cumulative installation capacities were collected from an IEA report and index charts were formed to compare the success levels of countries in terms of solar PV installations. Two additional index tables were formed to take into consideration the solar potentials of the countries.

The index table and historical policy data are matched and the success of implemented policies in the selected countries are evaluated.

B. Historical Data

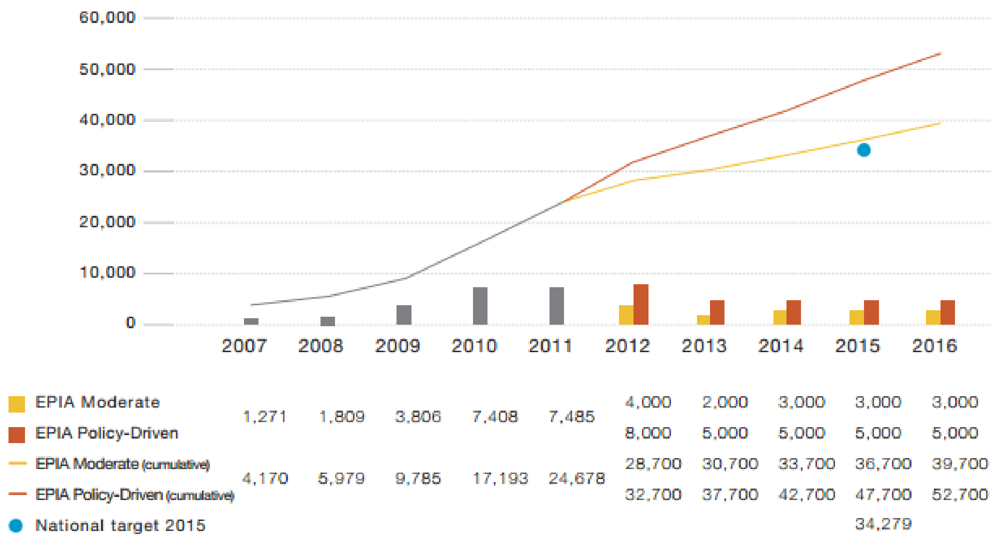
In this section, the solar energy policies and relative policies of Germany, Japan and the USA are analyzed and grouped under policy types.

1. Germany

1.1. Country Overview

Germany is the leader in the solar PV industry in the world as of 2012 (Wikipedia 2013). The solar market of Germany is expected to grow. The figure below presents the current market circumstance and the projections until 2016.

Figure 13 - Yearly and Cumulative Solar PV Installation Capacities of Germany (MW), *(EPIA 2012)*



1.2. Implemented Policies Throughout the History

The implemented policies and alternative approaches of Germany is explained in detail in the Appendix chapter. The implemented solar energy and relevant policies, and types of these policies are presented in the table below.

Table 1 - Solar Energy Related Policies of Germany

Solar Energy Related Policies of Germany			
Name of the Policy	**Imp. Year**	**Type of the Policy**	**Target of the Policy**
Federal States (Lander) Support For Renewable Energy	1985	Incentives/Subsidies	Multiple RE
1000 Solar Roof Program	1989	Rebates	Solar PV
Environment and Energy Saving Program (ERP)	1990	Loans	Multiple RE
Electricity Feed-in Law (StrEG)	1991	Feed-in Tariffs	Multiple RE

Full Cost Rates	1993	Feed-in Tariffs	Solar PV
100 Million Programme	1995	Promotions/ Incentives/Subsidies	Multiple RE
Home Eco Grant	1995	Grants	Solar Thermal
Ordinance on the Fee Schedule For Architect and Engineers	1995	Incentives/Subsidies	Energy Efficiency
Green Power	1996	Monitoring/ Regulatory Reform	Multiple RE
Federal Building Codes For Renewable Energy Production	1997	Mandates/Standards	Multiple RE
Electricity Market and the Energy Industry Law (EnWG)	1998	Monitoring/ Regulatory Reform	Multiple RE
100,000 Roofs Solar Power Program	1999	Loans	Solar PV
Preferential Loan Programmes (KFW Loans)	1999	Loans	Multiple RE
Market Incentive Programme	1999	Grants/Loans	Multiple RE
German Renewable Energy (EEG)	2000	Feed-in Tariffs/Monitoring/ Quota/Standards	Multiple RE
CO_2 Building Restructuring Program	2001	Grants/Loans	Multiple RE
Law to Amend the Mineral Oil Tax Law and Renewable Energy Law	2002	Quota Change	Solar PV
EEG Amendment	2004	Removal of Cap/ Change of Feed-in Tariff Rates	Multiple RE
KFW-Programme For Producing Solar Power	2005	Loans	Solar PV
Energy Industry Act	2005	Monitoring/ Comparison Labelling	Multiple RE
5th Energy Research Programme	2005	R&D	Multiple RE
Funding for Solar Power Development Center	2006	R&D/ Private Sector-Government Agreement	Solar PV/Solar Thermal

Integrated Climate Change and Energy Programme	2007	Strategic Planning/ Policy Enhancement	Multiple RE
EEG Amendment	2008	Decrease of Feed-in Tariff Rates	Multiple RE
Climate Legislation	2008	Strategic Planning/ Policy Enhancement	Multiple RE
Climate Protection Investment	2008	R&D	Multiple RE
EEG Amendment	2009	Degression of Feed-in Rates	Multiple RE
KFW Renewable Energies Programme	2009	Grants/Loans	Multiple RE
EEG Amendment	2010	Decreased Feed-in Tariff Rates	Multiple RE
Law on Energy and Climate Fund	2011	Promotions	Multiple RE
6th Energy Research Programme	2011	R&D	Multiple RE
EEG Amendment	2012	Degression of Feed-in Rates / Capacity Threshold	Multiple RE

1.3. Implemented Policy Types

Based on the data presented in the table above, the policies between 1990 and 2011 is taken for further analysis. This data will be used in the quantitative analysis section for evaluating policy performances. It is assumed that the effect of R&D policies could be observed in long term. Therefore, the stimulative effect of such policies are not taken into account for the analysis. The implemented policy types (other than R&D policies) between 1990 and 2011 are presented in the table below.

Table 2 - Implemented Policy Types in Germany between 1990 and 2011

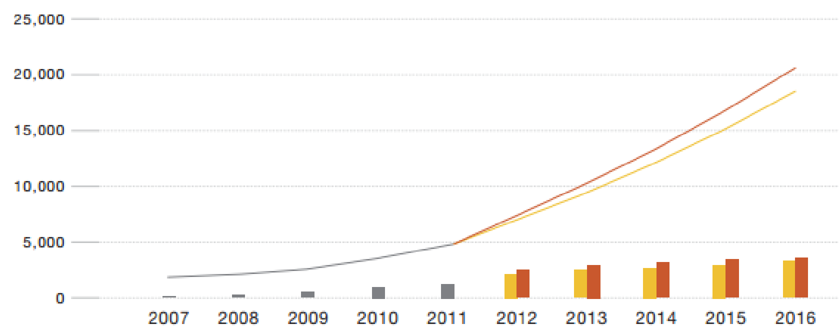
Policy Types Between 1990 - 2011		
Year	**Implemented Policy Types**	**Policy Targets**
1990	Loans	Multiple RE
1991	Feed-in Tariffs	Multiple RE
1992	-	-
1993	Feed-in Tariffs	Solar PV
1994	-	-
1995	Grants / Promotions / Incentives / Subsidies	Multiple RE
1996	Monitoring / Regulatory Reform	Multiple RE
1997	Mandates / Standards	Multiple RE
1998	Monitoring/ Regulatory Reform	Multiple RE
1999	Grants /Loans	Multiple RE
2000	Feed-in Tariffs/Monitoring/ Quota/Standards	Multiple RE
2001	Grants/Loans	Multiple RE
2002	Quota Change	Solar PV
2003	-	-
2004	Removal of Cap/ Change of Feed-in Tariff Rates	Multiple RE
2005	Loans, Monitoring/ Comparison Labelling	Multiple RE
2006	Private Sector-Government Agreement	Solar PV/Solar Thermal
2007	Strategic Planning/ Policy Enhancement	Multiple RE
2008	Decrease of Feed-in Tariff Rates, Strategic Planning/ Policy Enhancement	Multiple RE
2009	Degression of Feed-in Rates, Grants/Loans	Multiple RE
2010	Decreased Feed-in Tariff Rates	Multiple RE
2011	Promotions	Multiple RE

2. Japan

2.1. Country Overview

Japan is the fifth largest solar PV installer in the world as of 2012 (Wikipedia 2013). The solar market of Japan is also is expected to grow. The figure below presents the current market circumstance of solar PV systems and the projections until 2016.

Figure 14 - Yearly and Cumulative Solar PV Installation Capacities of Japan (MW), *(EPIA 2012)*



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EPIA Moderate	210	230	480	991	1,296	2,200	2,500	2,750	3,000	3,250
EPIA Policy-Driven						2,500	3,000	3,200	3,400	3,600
EPIA Moderate (cumulative)	1,917	2,147	2,627	3,618	4,914	7,100	9,600	12,400	15,400	18,600
EPIA Policy-Driven (cumulative)						7,400	10,400	13,600	17,000	20,600

2.2. Implemented Policies Throughout the History

The implemented policies and alternative approaches of Japan is explained in detail in the Appendix chapter. The implemented solar energy and relevant policies, and types of these policies are presented in the table below.

Table 3 - Solar Energy Related Policies of Japan

Solar Energy Related Policies of Japan			
Name of the Policy	**Imp. Year**	**Type of the Policy**	**Target of the Policy**
Sunshine Project	1974	R&D/Demonstration	Solar Thermal/ Solar PV
Moonlight Project	1978	R&D	Energy Conservation
Energy Conservation Law	1979	Strategic Planning	Energy Efficiency
Alternative Energy Act / Establishment of NEDO	1980	R&D/Tax-Levy/Demonstration	Multiple RE
Voluntary Net Metering	1992	Net-Metering	Multiple RE
Field Test Project on PV Power Generation for Public Facilities	1992	Demonstration	Solar PV
New Sunshine Project	1993	Grants/ R&D/Demonstration	Multiple RE
Subsidy Program for Residential PV Systems	1994	Grants	Solar PV
New Renewable Energy Target	1996	Quota	Multiple RE
New Energy Law	1997	Regulatory Reform	Multiple RE
Subsidy for R&D for New and Renewable Energy	1997	R&D	Multiple RE
Promotion for Development and Dissemination of PV Systems	1997	R&D/Demonstration/ Subsidies	Solar PV
Support for Deployment of New and Renewable Energy	1997	Grants	Multiple RE
Promotion for the Local Introduction of New Energy	1998	Subsidies	Multiple RE
Introduction of Solar Power in Government Office Buildings	2001	Promotion	Solar Energy
New Energy Indicator	2001	Strategic Planning	Multiple RE

Basic Law of Energy Policy Enacted	2002	Strategic Planning/ Policy Enhancement	Multiple RE
Green Power: Renewable Portfolio Standards (RPS)	2003	Quota/Green Certificate Trading	Multiple RE
International Joint Research Grant Program (NEDO Grant)	2004	R&D	Multiple RE
Comprehensive Review of Japanese Energy Policy	2007	Strategic Planning	Multiple RE
Cool Earth Energy Innovative Technology Plan	2008	R&D	Multiple RE
Renewable Energy Targets	2008	Strategic Planning	Multiple RE
New Purchase System for Solar Power Generated Electricity	2009	Feed-in Tariffs/Mandates	Solar PV
Subsidy for Residential PV Systems	2009	Grants	Solar PV
Strategic Energy Plan	2010	Strategic Planning	Multiple RE
New Feed in Tariffs	2012	Change in Feed-in Tariff Rates and Mandates	Multiple RE

2.3. Implemented Policy Types

Similarly, the implemented policy types (other than R&D policies) between 1990 and 2011 are presented in the table below.

Table 4 - Implemented Policy Types in Japan between 1990 and 2011

Policy Types Between 1990 - 2011		
Year	**Implemented Policy Types**	**Policy Targets**
1990	-	-
1991	-	-

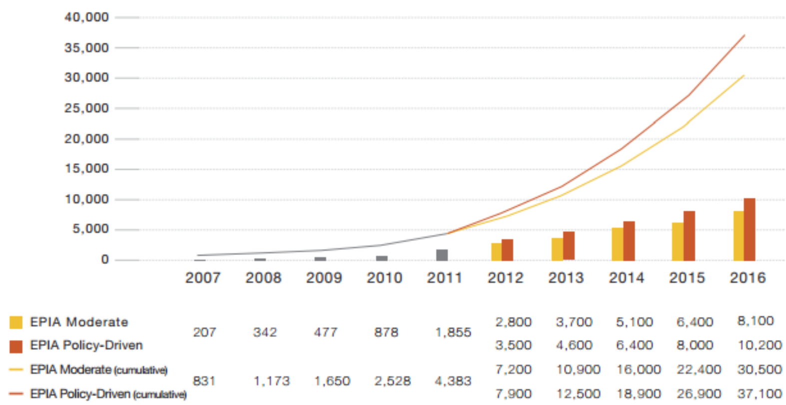
1992	Net-Metering/ Demonstration	Multiple RE/Solar PV
1993	Grants/ Demonstration	Multiple RE
1994	Grants	Solar PV
1995	-	-
1996	Quota	Multiple RE
1997	Regulatory Reform/ Demonstration/Subsidies/Grants	Multiple RE/Solar PV
1998	Subsidies	Multiple RE
1999	-	-
2000	-	-
2001	Promotion	Solar Energy
2002	Strategic Planning/ Policy Enhancement	Multiple RE
2003	Quota/Green Certificate Trading	Multiple RE
2004	-	-
2005	-	-
2006	-	-
2007	Strategic Planning	Multiple RE
2008	Strategic Planning	Multiple RE
2009	Feed-in Tariffs/Mandates	Solar PV
2010	Strategic Planning	Multiple RE
2011	-	-

3. The United States of America

3.1. Country Overview

Although USA has started its R&D investments many years ago, country has become 4th in terms of solar PV installations in 2012 (Wikipedia 2013).The solar market of USA is expected to expand. The figure below presents the current market circumstance of solar PV systems and the projections until 2016.

Figure 15 - Yearly and Cumulative Solar PV Installation Capacities of the USA (MW), *(EPIA 2012)*



3.2. Implemented Policies Throughout the History

The implemented policies and alternative approaches of the USA is explained in detail in the Appendix chapter. The implemented solar energy and relevant policies, and types of these policies are presented in the table below.

Table 5 - Solar Energy Related Policies of the USA

Solar Energy Related Policies of the USA			
Name of the Policy	**Imp. Yea**	**Type of the Policy**	**Target of the Policy**
Solar Energy Research Act & Office of Solar Energy Research	1974	R&D	Solar Energy
Solar Heating and Cooling Demonstration Act	1974	Demonstration	Solar Heating
Energy Tax Act	1978	Tax Credit	Multiple RE
Solar Photovoltaic Energy Research, Development and Demonstration Act	1978	R&D	Solar PV
Public Utility Regulatory Policies Act (PURPA)	1978	Mandates	Multiple RE
Economic Recovery Act	1981	Tax Reduction	Multiple RE
State-Level Renewable Portfolio Standards (RPS)	1983	Mandates/Quota	Multiple RE
Tax Reform Act	1986	Tax Credit/Tax Reduction	Solar/ Geothermal
Modified Accelerated Cost Recovery System (MACRS)	1986	Tax Reduction	Multiple RE
State and Local Climate and Energy Program	1990	Education and Outreach/ Strategic Planning/ Voluntary Agreement	Multiple RE
Mortgages for Energy Efficiency	1992	Third Party Financing	Multiple RE
Energy Policy Act: Incentives for Renewable Energy	1992	Investment Credit/ Tax Credit/ Incentive Payment	Multiple RE
Federal Business Investment Tax Credit (ITC)	1992	Tax Credit	Multiple RE
Environmentally Preferable Purchasing (EPP)	1993	Education and Outreach/ Public Investment	Multiple RE
The Federal Utility Partnership Working Group (FUPWG)	1994	Education and Outreach	Multiple RE
Tribal Energy Program	1994	Education and Outreach/ Funding/ Grants	Solar PV/Wind
State Energy Program	1996	Education and Outreach/ Funding/ Grants	Multiple RE

Building Energy Software Tools Directory	1996	Education and Outreach	Efficiency/ Multiple RE
Renewable Portfolio Standard (RPS) – Massachusetts	1997	Mandates/Quota	Multiple RE
Workforce Investment Act	1998	Grants	Multiple RE
Energy Efficiency and Renewable Energy (EERE) International Activities	1999	Education and Outreach/ R&D/Voluntary Agreement	Efficiency/ Multiple RE
Greening of the National Park Service	1999	Education and Outreach/ Infrastructure Investment	Multiple RE
Tax Relief Extension Act	1999	Tax Credit	Multiple RE
Green Power Partnership	2001	Education and Outreach/ Voluntary Agreement	Multiple RE
San Francisco Solar Energy Incentive Program	2001	Grants	Solar PV
Economic Security and Recovery Act	2001	Tax Credit	Multiple RE
Renewable Portfolio Standard (RPS) – California	2002	Mandates/Quota	Multiple RE
Renewable Energy and Energy Efficiency Partnership (REEEP)	2002	Strategic Planning/ Project-Based Programmes	Multiple RE
Rural Energy for America Program Grants (REAP/RES/EEI Grants)	2002	Grants/Loans	Multiple RE
Solar Decathlon	2002	Education and Outreach/ R&D/Demonstration	Multiple RE
New York State Energy Plan	2002	Strategic Planning	Multiple RE
Production Tax Credit – Extension	2004	Tax Credit/ Incentives/Subsidies	Multiple RE
Renewable Portfolio Standard (RPS) – Colorado	2004	Mandates/Quota	Multiple RE
Energy Policy Act (Energy Bill)	2005	Incentives/Subsidies/ Strategic Planning/ R&D/Regulatory Reform	Multiple RE
Interconnection Standards for Small Generators	2005	Regulatory Standards	Multiple RE
Clean Energy – Environment State Partnership Program	2005	Education and Outreach/ Policy Enhancement/ Strategic Planning	Multiple RE

Renewable Portfolio Standard (RPS) - Nevada	2005	Mandates/Quota	Multiple RE
State Climate and Energy Program	2005	Education and Outreach/ Policy Enhancement/ Strategic Planning	Multiple RE
State Utility Commission Assistance	2005	Education and Outreach/ Voluntary Agreement	Multiple RE
Solar America	2006	Education and Outreach/ R&D/ Strategic Planning	Solar Energy
Credit for Holders of Clean Renewable Energy Bonds (CREBS)	2006	Taxes/Tax Incentives	Multiple RE
Residential Renewable Energy Tax Credit	2006	Tax Credit	Multiple RE
Maryland Clean Energy Production Tax Credit	2006	Tax Credit	Multiple RE
California Solar Initiative	2007	Rebates	Solar Energy
DOE Loan Guarantee Program	2007	Loans	Multiple RE
Executive Order 13423: Strengthening Federal Environmental, Energy, and Transp. Management	2007	Institutional Creation/ Government Procurement Programme	Multiple RE
Renewable and Energy Efficiency Portfolio Standard (RPS) – Illinois	2007	Mandates/Quota	Multiple RE
Solar America Board for Codes and Standards	2007	Education and Outreach/ Government Procurement Programme	Solar Energy
Solar America Cities	2007	Education and Outreach/ Funding/ Strategic Planning/ Regulatory Change/ Voluntary Agreement	Solar Energy
Solar America Showcases	2007	Education and Outreach	Solar Energy
Energy Improvement and Extension Act – Tax Incentives	2008	Tax Credit	Multiple RE
Energy Independence and Security Act	2008	Regulatory Change	Efficiency/ Multiple RE
Energy Provisions – National Defense Authorization Act	2008	Government Procurement Programme/ R&D/ Mandates/Monitoring	Multiple RE

Federal Fleet Fueling Centers	2008	Infrastructure Investment/ Mandates	Multiple RE
Food, Conservation, and Energy Act	2008	Tax Credit/ Grants/ R&D	Multiple RE
Regional Greenhouse Gas Initiative (RGGI)	2008	GHG Emissions Trading	Multiple RE
Technology Commercialization Fund	2008	R&D	Multiple RE
Western Renewable Energy Zones (WREZ) Project	2008	Project-Based Programmes/ Strategic Planning	Multiple RE
American Recovery and Reinvestment Act (ARRA): Appropriations for Clean Energy	2009	Tax Credit/ Grants/ Government Procurement Programme/ R&D	Multiple RE
American Recovery and Reinvestment Act (ARRA): Tax-Based Provisions	2009	Tax Credit/ Funding/ Grants/	Multiple RE
Climate Showcase Communities Grants	2009	Education and Outreach/ Funding/ Grants	Multiple RE
Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance	2009	Institutional Creation/ Government Procurement Programme	Multiple RE

3.3. Implemented Policy Types

The implemented policy types (other than R&D policies) in the USA between 1990 and 2011 are presented in the table below.

Table 6 - Implemented Policy Types in the USA between 1990 and 2011

Policy Types Between 1990 - 2011		
Year	**Implemented Policy Types**	**Policy Targets**
1990	Education and Outreach/ Strategic Planning/ Voluntary Agreement	Multiple RE
1991	-	-
1992	Third Party Financing/ Investment Credit/ Tax Credit/ Incentive Payment	Multiple RE

1993	Education and Outreach/ Public Investment	Multiple RE
1994	Education and Outreach/ Funding/ Grants	Multiple RE (Solar PV/Wind)
1995	-	-
1996	Education and Outreach/ Funding/ Grants	Efficiency/ Multiple RE
1997	Mandates/Quota	Multiple RE
1998	Grants	Multiple RE
1999	Education and Outreach/ Voluntary Agreement/ Infrastructure Investment/ Tax Credit	Efficiency/ Multiple RE
2000	-	-
2001	Education and Outreach/ Voluntary Agreement/ Grants/ Tax Credit	Multiple RE (Solar PV)
2002	Mandates/Quota/ Strategic Planning/ Project-Based Programmes/ Grants/Loans/ Education and Outreach/ Demonstration	Multiple RE
2003	-	-
2004	Tax Credit/ Incentives/Subsidies/ Mandates/Quota	Multiple RE
2005	Incentives/Subsidies/ Strategic Planning/ Regulatory Reform/ Education and Outreach/ Policy Enhancement/ Mandates/Quota/ Voluntary Agreement	Multiple RE
2006	Education and Outreach/ Strategic Planning/ Taxes/Tax Incentives	Multiple RE (Solar Energy)
2007	Rebates/ Loans/ Institutional Creation/ Government Procurement Programme/ Mandates/Quota/ Education and Outreach/ Funding/ Strategic Planning/ Regulatory Change/ Voluntary Agreement	Multiple RE (Solar Energy)
2008	Tax Credit/ Regulatory Change/ Government Procurement Programme/ Mandates/Monitoring/ Infrastructure Investment/ Grants/ GHG Emissions Trading/ Project-Based Programmes/ Strategic Planning	Efficiency/ Multiple RE
2009	Tax Credit/ Funding/ Grants/ Government Procurement Programme/ Education and Outreach/ Institutional Creation	Multiple RE
2010	-	-
2011	-	-

C. Numeric Data

The cumulative installation capacities of the IEA countries are collected from the "Trends in Photovoltaic Applications" survey report (IEA 2012). The data includes both on-grid and off-grid solar PV systems.

The cumulative installed solar PV capacities of the IEA countries are presented in the Table 7.

A table that presents yearly solar PV installation capacities is created by using the cumulative installation data (Table 8).

The yearly solar PV capacity growth percentages is calculated and presented in the Table 9. Note that the "-"sign in the table represents the incomputable values such as a year with no installations or the first solar installations of a country.

Table 7 – Cumulative Solar PV Installation Capacities (MW), *(IEA 2012)*

Cumulative Capacity (MW)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia (AUS)	7.3	8.9	10.7	12.7	15.7	18.7	22.5	25.3	29.2	33.6	39.1	45.6	52.3	60.6	70.3	82.5	104.5	187.6	570.9	1407.9
Austria (AUT)	0.6	0.8	1.1	1.4	1.7	2.2	2.9	3.7	4.9	6.1	10.3	16.8	21.1	24	25.6	27.7	32.4	52.6	95.5	187.2
Belgium (BEL)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000
Canada (CAN)	1	1.2	1.5	1.9	2.6	3.4	4.5	5.8	7.2	8.8	10	11.8	13.9	16.8	20.5	25.8	32.7	94.6	281.1	558.7
Switzerland(CHE)	4.7	5.8	6.7	7.5	8.4	9.7	11.5	13.4	15.3	17.6	19.5	21	23.1	27.1	29.7	36.2	47.9	73.6	110.9	211.1
China (CHN)	0	0	0	0	0	0	0	0	19	23.5	42	52	62	70	80	100	140	300	800	3300
Germany (DEU)	3	5	6	8	11	18	23	32	76	186	296	435	1105	2056	2899	4170	6120	9914	17320	24820
Denmark (DNK)	0	0.1	0.1	0.1	0.2	0.4	0.5	1.1	1.5	1.5	1.6	1.9	2.3	2.7	2.9	3.1	3.3	4.6	7.1	16.7
Spain (ESP)	0	0	1	1	1	1	1	2	2	4	7	12	24	49	148	705	3463	3523	3915	4260
France (FRA)	1.8	2.1	2.4	2.9	4.4	6.1	7.6	9.1	11.3	13.9	17.2	21.1	26	33	43.9	75.2	179.7	380.2	1197.3	2831.4
UK (GBR)	0.2	0.3	0.3	0.4	0.4	0.6	0.7	1.1	1.9	2.7	4.1	5.9	8.2	10.9	14.3	18.1	22.5	26	69.8	976
Israel (ISR)	0	0	0	0	0	0	0	0	0	0	0	0	0.9	1.0	1.3	1.8	3	24.5	69.9	189.7
Italy (ITA)	8.5	12.1	14.1	15.8	16	16.7	17.7	18.5	19	20	22	26	30.7	37.5	50	120.2	458.3	1181.3	3502.3	12802.9
Japan (JPN)	19	24.3	31.2	43.4	59.6	91.3	133.4	208.6	330.2	452.8	636.8	859.6	1132	1421.9	1708.5	1918.9	2144.2	2627.2	3618.1	4913.9
Korea (KOR)	1.5	1.6	1.7	1.8	2.1	2.5	3	3.5	4.0	4.7	5.4	6.0	8.5	13.5	35.9	81.2	357.6	524.2	655.6	812.3
Mexico (MEX)	5.4	7.1	8.8	9.2	10	11	12	12.9	13.9	15	16.2	17.1	18.2	18.7	19.7	20.8	21.8	25	30.6	37.1
Malaysia (MYS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.5	7	8.8	11.1	12.6	13.5
Netherlands(NLD)	1.3	1.6	2	2.4	3.3	4	6.5	9.2	12.8	20.5	26.3	45.7	49.2	50.7	52.2	52.8	56.8	67.5	88	131.4
Norway (NOR)	3.8	4.1	4.4	4.7	4.9	5.2	5.4	5.7	6	6.2	6.4	6.6	6.9	7.3	7.7	8	8.3	8.7	9.1	9
Portugal (PRT)	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.9	1.1	1.3	1.7	2.1	2.7	3	3.4	17.9	68	102.2	130.8	143.6
Sweden (SWE)	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.8	3	3.3	3.6	3.9	4.2	4.8	6.2	7.9	8.8	11.4	15.8
Turkey (TUR)	0	0	0	0	0	0	0.2	0.3	0.4	0.6	0.9	1.3	1.8	2.3	2.8	3.3	4	5	6	7
US America (USA)	43.5	50.3	57.8	66.8	76.5	88.2	100.1	117.3	138.8	167.8	212.2	275.2	376	479	624	830.5	1168.5	1616	2534	3966
IEA AVERAGE	**4.5**	**5.5**	**6.6**	**7.9**	**9.6**	**12.2**	**15.5**	**20.6**	**30.3**	**43**	**59.9**	**81.1**	**129.1**	**190.8**	**254.3**	**361.4**	**628.4**	**902.5**	**1523.3**	**2765.7**

Table 8 - Yearly Solar PV Installation Capacities (MW)

Yearly Installations (MW)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia (AUS)	1.6	1.8	2.0	3.0	3.0	3.8	2.8	3.9	4.4	5.5	6.5	6.7	8.3	9.7	12.2	22.0	83.1	383.3	837.0
Austria (AUT)	0.2	0.3	0.3	0.3	0.5	0.7	0.8	1.2	1.2	4.2	6.5	4.3	2.9	1.6	2.1	4.7	20.2	42.9	91.7
Belgium (BEL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2000.0
Canada (CAN)	0.2	0.3	0.4	0.7	0.8	1.1	1.3	1.4	1.6	1.2	1.8	2.1	2.9	3.7	5.3	6.9	61.9	186.5	277.6
Switzerland (CHE)	1.1	0.9	0.8	0.9	1.3	1.8	1.9	1.9	2.3	1.9	1.5	2.1	4.0	2.6	6.5	11.7	25.7	37.3	100.2
China (CHN)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	4.5	18.5	10.0	10.0	8.0	10.0	20.0	40.0	160.0	500.0	2500.0
Germany (DEU)	2.0	1.0	2.0	3.0	7.0	5.0	9.0	44.0	110.0	110.0	139.0	670.0	951.0	843.0	1271.0	1950.0	3794.0	7406.0	7500.0
Denmark (DNK)	0.1	0.0	0.0	0.1	0.2	0.1	0.6	0.4	0.0	0.1	0.3	0.4	0.4	0.2	0.2	0.2	1.3	2.5	9.6
Spain (ESP)	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	2.0	3.0	5.0	12.0	25.0	99.0	557.0	2758.0	60.0	392.0	345.0
France (FRA)	0.3	0.3	0.5	1.5	1.7	1.5	1.5	2.2	2.6	3.3	3.9	4.9	7.0	10.9	31.3	104.5	200.5	817.1	1634.1
UK (GBR)	0.1	0.0	0.1	0.0	0.2	0.1	0.4	0.8	0.8	1.4	1.8	2.3	2.7	3.4	3.8	4.4	3.5	43.8	906.2
Israel (ISR)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.3	0.5	1.2	21.5	45.4	119.8
Italy (ITA)	3.6	2.0	1.7	0.2	0.7	1.0	0.8	0.5	1.0	2.0	4.0	4.7	6.8	12.5	70.2	338.1	723.0	2321.0	9300.6
Japan (JPN)	5.3	6.9	12.2	16.2	31.7	42.1	75.2	121.6	122.6	184.0	222.8	272.4	289.9	286.6	210.4	225.3	483.0	990.9	1295.8
Korea (KOR)	0.1	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.7	0.7	0.6	2.5	5.0	22.4	45.3	276.4	166.6	131.4	156.7
Mexico (MEX)	1.7	1.7	0.4	0.8	1.0	1.0	0.9	1.0	1.1	1.2	0.9	1.1	0.5	1.0	1.1	1.0	3.2	5.6	6.5
Malaysia (MYS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	1.5	1.8	2.3	1.5	0.9
Netherlands (NLD)	0.3	0.4	0.4	0.9	0.7	2.5	2.7	3.6	7.7	5.8	19.4	3.5	1.5	1.5	0.6	4.0	10.7	20.5	43.4
Norway (NOR)	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.4	0.4	0.3	0.3	0.4	0.4	-0.1
Portugal (PRT)	0.0	0.1	0.0	0.1	0.1	0.1	0.3	0.2	0.2	0.4	0.4	0.6	0.3	0.4	14.5	50.1	34.2	28.6	12.8
Sweden (SWE)	0.2	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.6	1.4	1.7	0.9	2.6	4.4
Turkey (TUR)	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.7	1.0	1.0	1.0
US America (USA)	6.8	7.5	9.0	9.7	11.7	11.9	17.2	21.5	29.0	44.4	63.0	100.8	103.0	145.0	206.5	338.0	447.5	918.0	1432.0
IEA AVERAGE	**1.0**	**1.1**	**1.3**	**1.7**	**2.7**	**3.2**	**5.1**	**9.8**	**13**	**16.9**	**21.2**	**47.9**	**61.8**	**63.5**	**107.1**	**267.0**	**274.1**	**620.8**	**1242.4**

Table 9 - Yearly Solar PV Capacity Growth Percentages

Cap. Growth Percentages (%)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia (AUS)	21.9%	20.2%	18.7%	23.6%	19.1%	20.3%	12.4%	15.4%	15.1%	16.4%	16.6%	14.7%	15.9%	16.0%	17.4%	26.7%	79.5%	204.3	146.6
Austria (AUT)	33.3%	37.5%	27.3%	21.4%	29.4%	31.8%	27.6%	32.4%	24.5%	68.9%	63.1%	25.6%	13.7%	6.7%	8.2%	17.0%	62.3%	81.6%	96.0%
Belgium (BEL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada (CAN)	20.0%	25.0%	26.7%	36.8%	30.8%	32.4%	28.9%	24.1%	22.2%	13.6%	18.0%	17.8%	20.9%	22.0%	25.9%	26.7%	189.3	197.1	98.8%
Switzerland	23.4%	15.5%	11.9%	12.0%	15.5%	18.6%	16.5%	14.2%	15.0%	10.8%	7.7%	10.0%	17.3%	9.6%	21.9%	32.3%	53.7%	50.7%	90.4%
China (CHN)	-	-	-	-	-	-	-	-	23.7%	78.7%	23.8%	19.2%	12.9%	14.3%	25.0%	40.0%	114.3	166.7	312.5
Germany	66.7%	20.0%	33.3%	37.5%	63.6%	27.8%	39.1%	137.5	144.7	59.1%	47.0%	154.0	86.1%	41.0%	43.8%	46.8%	62.0%	74.7%	43.3%
Denmark	-	0.0%	0.0%	100.0	100.0	25.0%	120.0	36.4%	0.0%	6.7%	18.8%	21.1%	17.4%	7.4%	6.9%	6.5%	39.4%	54.3%	135.2
Spain (ESP)	-	-	0.0%	0.0%	0.0%	0.0%	100.0	0.0%	100.0	75.0%	71.4%	100.0	104.2	202.0	376.4	391.2	1.7%	11.1%	8.8%
France (FRA)	16.7%	14.3%	20.8%	51.7%	38.6%	24.6%	19.7%	24.2%	23.0%	23.7%	22.7%	23.2%	26.9%	33.0%	71.3%	139.0	111.6	214.9	136.5
UK (GBR)	50.0%	0.0%	33.3%	0.0%	50.0%	16.7%	57.1%	72.7%	42.1%	51.9%	43.9%	39.0%	32.9%	31.2%	26.6%	24.3%	15.6%	168.5	1298.3
Israel (ISR)	-	-	-	-	-	-	-	-	-	-	-	-	11.1%	30.0%	38.5%	66.7%	716.7	185.3	171.4
Italy (ITA)	42.4%	16.5%	12.1%	1.3%	4.4%	6.0%	4.5%	2.7%	5.3%	10.0%	18.2%	18.1%	22.1%	33.3%	140.4	281.3	157.8	196.5	265.6
Japan (JPN)	27.9%	28.4%	39.1%	37.3%	53.2%	46.1%	56.4%	58.3%	37.1%	40.6%	35.0%	31.7%	25.6%	20.2%	12.3%	11.7%	22.5%	37.7%	35.8%
Korea (KOR)	6.7%	6.2%	5.9%	16.7%	19.0%	20.0%	16.7%	14.3%	17.5%	14.9%	11.1%	41.7%	58.8%	165.9	126.2	340.4	46.6%	25.1%	23.9%
Mexico (MEX)	31.5%	23.9%	4.5%	8.7%	10.0%	9.1%	7.5%	7.8%	7.9%	8.0%	5.6%	6.4%	2.7%	5.3%	5.6%	4.8%	14.7%	22.4%	21.2%
Malaysia (MYS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.3%	25.7%	26.1%	13.5%	7.1%
Nederlands	23.1%	25.0%	20.0%	37.5%	21.2%	62.5%	41.5%	39.1%	60.2%	28.3%	73.8%	7.7%	3.0%	3.0%	1.1%	7.6%	18.8%	30.4%	49.3%
Norway (NOR)	7.9%	7.3%	6.8%	4.3%	6.1%	3.8%	5.6%	5.3%	3.3%	3.2%	3.1%	4.5%	5.8%	5.5%	3.9%	3.8%	4.8%	4.6%	-1.1%
Portugal (PRT)	0.0%	50.0%	0.0%	33.3%	25.0%	20.0%	50.0%	22.2%	18.2%	30.8%	23.5%	28.6%	11.1%	13.3%	426.5	279.9	50.3%	28.0%	9.8%
Sweden (SWE)	25.0%	30.0%	23.1%	12.5%	16.7%	14.3%	8.3%	7.7%	7.1%	10.0%	9.1%	8.3%	7.7%	14.3%	29.2%	27.4%	11.4%	29.5%	38.6%
Turkey (TUR)	-	-	-	-	-	-	50.0%	33.3%	50.0%	50.0%	44.4%	38.5%	27.8%	21.7%	17.9%	21.2%	25.0%	20.0%	16.7%
US America	15.6%	14.9%	15.6%	14.5%	15.3%	13.5%	17.2%	18.3%	20.9%	26.5%	29.7%	36.6%	27.4%	30.3%	33.1%	40.7%	38.3%	56.8%	56.5%
IEA AVERAGE	**25.7%**	**19.7%**	**16.6%**	**25.0%**	**28.8%**	**21.8%**	**35.7%**	**29.8%**	**31.9%**	**31.4%**	**29.3%**	**32.3%**	**26.3%**	**34.6%**	**67.5%**	**84.6%**	**84.7%**	**85.2%**	**139.1**

D. Quantitative Analysis

In order to observe the success in each year, the "Yearly Installations" and "Capacity Growth Percentages" tables were presented in the previous chapter.

Based on these tables, a quantitative analysis was conducted through an index table formation. The "Relative Installation Index" and "Relative Growth Index" tables were formed to have a comparison table for policy performance comparison among the IEA countries.

Additionally, solar irradiation average data was used to consider the solar irradiation potential of the countries. The index tables "Relative Solar Irradiation Potential Index", "Relative Installation and Solar Potential Usage Index" and "Relative Growth and Solar Potential Usage Index" were formed.

In order to have a better understanding, the definitions of "irradiance" and "irradiation" are given below.

- **Irradiance:** Irradiance is the power of electromagnetic radiation per unit area (radiative flux) incident on a surface. The unit for irradiance is watts per square meter (W/m2), (Wikipedia 2013).
- **Irradiation:** Solar irradiance is also called as ''insolation'' is a measure of solar radiation energy received on a given surface area and recorded during a given time. The unit of irradiation is watt-hours per square meter (Wh/m2) (Wikipedia 2013).

"Insolation figures are used as an input to worksheets to size solar power systems for the location where they will be installed (Wikipedia 2013)". In short, insolation (solar irradiation) is the input of solar energy (Watkins n.d.).

Therefore, in this section in order to take into account the effect of solar irradiation potential on a country's performance in terms of solar installations, the "Relative Solar Potential Index" table is formed by using the same methodology.

As the effect of solar irradiance is integrated to the index table, the positive or negative effect of solar irradiation can be ignored. Therefore, the reason of success in terms of number of solar PV installations can be related to factors other than solar irradiation. This way, the countries can be evaluated at the same level in terms of solar irradiance.

It is assumed that the economic level of a country is factor on the solar PV installations. Therefore, in order to group the countries based on their economic levels, the IEA countries are sorted based on their average "GDP per Capita" between the years 1993 and 2011 based on IMF data (US Dollars per Person, Current Prices), (IMF 2011). The countries listed from the lowest average GDP per Capita to Highest GDP per Capita.

The index tables were colored to present the high and low values such that:

- **Green Color** represents the **High** values
- **Yellow Color** represents the **Average** values
- **Red Color** represents the **Low** values.

The analysis method and usage of the index table are explained in the sections below.

1. Index 1 : "Relative Installation Index"

In this chapter, the "Yearly Solar PV Installation" table was used to analyze the solar installation success among the IEA countries.

Each yearly installation data was divided by the "IEA Average" for the selected year. Every number in the table is divided by the IEA average number in that specific year. In order to clarify the analyze method three examples are shown below.

Example 1: Germany – 1995	
The PV installation capacity in 1995 in Germany	2.0 MW
The average PV installations in 1995 among all IEA Countries	1.326 MW
Index Number For Germany for 1995	**1.508**

The index number can be evaluated as Germany had a capacity of installations 50.8% more than the average installation capacity among all IEA countries in 1995.

Example 2: Japan – 2003	
The average PV installation capacity in 2003 in Japan	222.8 MW
The average PV installations in 2003 among all IEA countries	21.23 MW
Index number for Japan for the year 2003	**10.494**

Similarly, the index number can be evaluated as Japan had a capacity of installations 949.4% more than the average installation capacity among all IEA countries in 2003. The country performed exceptionally better than the other countries in that year.

Example 3: USA – 2010	
The average PV installation capacity in 2010 in the USA	918.0 MW
The <u>average</u> PV installations in 2010 among all IEA countries	620.8 MW
Index number for the USA for the year 2010	**1.479**

The index number can be evaluated as the USA had a capacity of installations 47.9% more than the average installation capacity among all IEA countries in 2010.

The index tables will be used for evaluating country performances in terms of solar PV installations.

The Difference of Using the Index Tables

The cost of solar PV panels have dropped significantly from approximately 9 $\$/W_p$ in 1990s to about 2 $\$/ W_p$ in 2010 (Gorton and Bedell 2013). This decrease in prices naturally affected the annual solar PV installations. As can be seen from the Table 7 the average cumulative solar PV installations has increased from 4.5 MW in 1990 to 2765 MW in 2011 in listed countries. Under these circumstances, in order to compare success level of a country, the installation capacities should be leveled. For example, a 100 MW solar PV installation in 2000 should be more appreciated than the same capacity of installations in 2011. Therefore, using the index tables instead of yearly installation numbers allows us to make a comparison between past years and recent years.

The “Relative Installation Index” table is presented below.

Index 1 - Relative Installation Index

Relative Installation Index	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Country Average
China (CHN)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.948	0.354	1.096	0.471	0.209	0.130	0.157	0.187	0.150	0.584	0.805	2.012	0.426
Malaysia MYS)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.087	0.014	0.007	0.008	0.002	0.001	0.006
Turkey (TUR)	0.000	0.000	0.000	0.000	0.000	0.062	0.020	0.010	0.016	0.018	0.019	0.010	0.008	0.008	0.005	0.003	0.004	0.002	0.001	0.010
Mexico (MEX)	1.636	1.570	0.302	0.483	0.373	0.311	0.176	0.103	0.087	0.071	0.042	0.023	0.008	0.016	0.010	0.004	0.012	0.009	0.005	0.276
Korea (KOR)	0.096	0.092	0.075	0.181	0.149	0.156	0.098	0.051	0.055	0.041	0.028	0.052	0.081	0.353	0.423	1.035	0.608	0.212	0.126	0.206
Portugal (PRT)	0.000	0.092	0.000	0.060	0.037	0.031	0.059	0.021	0.016	0.024	0.019	0.013	0.005	0.006	0.135	0.188	0.125	0.046	0.010	0.047
Israel (ISR)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.002	0.005	0.005	0.004	0.078	0.073	0.096	0.015
Spain (ESP)	0.000	0.924	0.000	0.000	0.000	0.000	0.196	0.000	0.157	0.178	0.236	0.250	0.405	1.559	5.203	10.330	0.219	0.631	0.278	1.082
Italy (ITA)	3.464	1.847	1.282	0.121	0.261	0.311	0.157	0.051	0.079	0.118	0.188	0.098	0.110	0.197	0.656	1.266	2.638	3.739	7.486	1.267
Canada (CAN)	0.192	0.277	0.302	0.423	0.299	0.342	0.254	0.144	0.126	0.071	0.085	0.044	0.047	0.058	0.050	0.026	0.226	0.300	0.223	0.184
UK (GBR)	0.096	0.000	0.075	0.000	0.075	0.031	0.078	0.082	0.063	0.083	0.085	0.048	0.044	0.054	0.035	0.016	0.013	0.071	0.729	0.088
France (FRA)	0.289	0.277	0.377	0.906	0.635	0.467	0.294	0.226	0.205	0.195	0.184	0.102	0.113	0.172	0.292	0.391	0.731	1.316	1.315	0.447
Australia (AUS)	1.540	1.663	1.508	1.811	1.120	1.183	0.548	0.400	0.346	0.326	0.306	0.140	0.134	0.153	0.114	0.082	0.303	0.617	0.674	0.683
Germany DEU)	1.925	0.924	1.508	1.811	2.614	1.556	1.762	4.512	8.655	6.514	6.547	13.979	15.398	13.273	11.873	7.303	13.841	11.930	6.037	6.945
Belgium (BEL)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.610	0.085
Austria (AUT)	0.192	0.277	0.226	0.181	0.187	0.218	0.157	0.123	0.094	0.249	0.306	0.090	0.047	0.025	0.020	0.018	0.074	0.069	0.074	0.138
Ned. (NLD)	0.289	0.369	0.302	0.543	0.261	0.778	0.529	0.369	0.606	0.343	0.914	0.073	0.024	0.024	0.006	0.015	0.039	0.033	0.035	0.292
Japan (JPN)	5.100	6.373	9.200	9.780	11.836	13.103	14.720	12.469	9.647	10.896	10.494	5.683	4.694	4.512	1.965	0.844	1.762	1.596	1.043	7.143
Sweden (SWE)	0.192	0.277	0.226	0.121	0.112	0.093	0.039	0.021	0.016	0.018	0.014	0.006	0.005	0.009	0.013	0.006	0.003	0.004	0.004	0.062
USA (USA)	6.544	6.928	6.787	5.856	4.369	3.704	3.367	2.205	2.282	2.629	2.967	2.103	1.668	2.283	1.929	1.266	1.633	1.479	1.153	3.218
Denmark(DNK)	0.096	0.000	0.000	0.060	0.075	0.031	0.117	0.041	0.000	0.006	0.014	0.008	0.006	0.003	0.002	0.001	0.005	0.004	0.008	0.025
Switz. (CHE)	1.059	0.831	0.603	0.543	0.485	0.560	0.372	0.195	0.181	0.113	0.071	0.044	0.065	0.041	0.061	0.044	0.094	0.060	0.081	0.290
Norway (NOR)	0.289	0.277	0.226	0.121	0.112	0.062	0.059	0.031	0.016	0.012	0.009	0.006	0.006	0.006	0.003	0.001	0.001	0.001	0.000	0.065

An index number shows the ratio of country's installations in a particular year to the IEA average installations in the same year.

Assumptions and Evaluation of Index Table

The assumptions and evaluation of the "Relative Installation Index" table can be explained as follows.

Assumptions

- Since each data is divided by the same year average for the selected year, global solar photovoltaic prices and the development of solar PV technology were not considered in this index.
- The solar irradiation potential are not taken into consideration at this chapter
- The renewable energy deployment barriers, mentioned in the chapter II.D.1, such as population, technology level, economic level, and renewable energy awareness level were not considered in this index.

Evaluation of the Index Table

- A high index number can be evaluated as,
    - That country has installed more solar systems in comparison with other countries and the IEA average in the selected year.
    - The success of the country can be related to the solar energy policies of the country. If the country has more installations than other countries in the selected year, this might be evaluated as:
        - ✓ The country's policies and their implementations were successful.
        - ✓ The renewable energy awareness was higher in that country

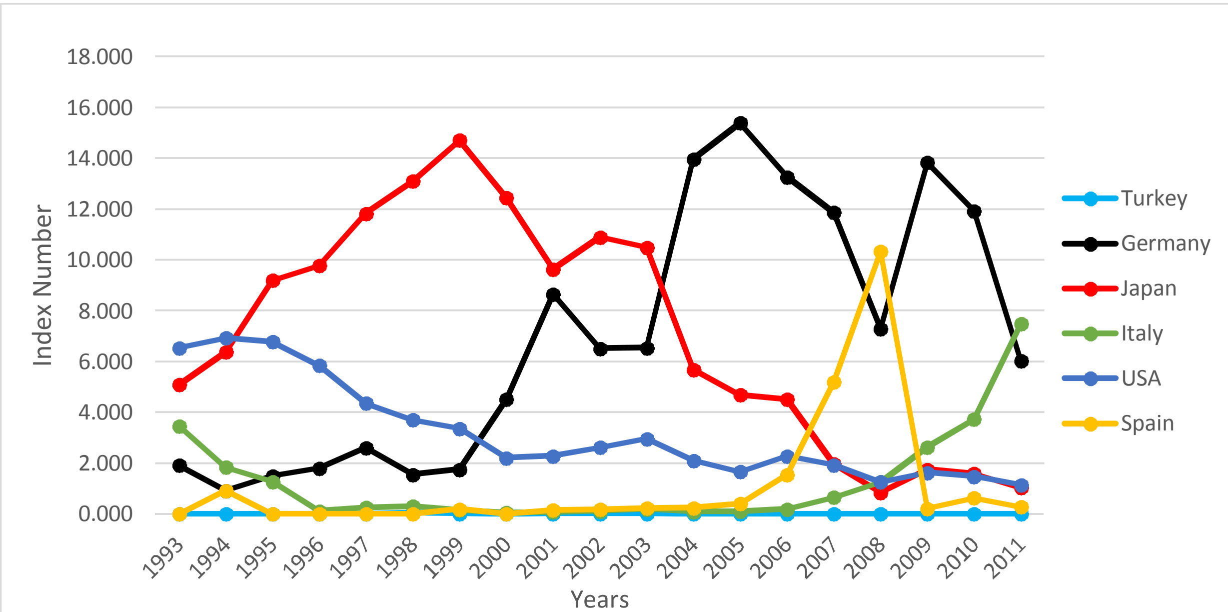
        As a whole, the solar energy policies of the country can be accepted as relatively better.
- A low index number can be evaluated as,

- The country was incapable of installing PV systems as much as the other countries in the selected year.
- There was either no solar energy policy, or it was not as successful as other countries' policies in the selected year or in the previous years.

Relative Installation Graph

Below, the index values of some countries are presented in a graph.

Figure 16 - Relative Installation Graph



Evaluation of the Graph

The relative installation index numbers can give an idea about historical success of the selected countries. The trend of the graph would allow us to see how the country was performing in comparison with other countries in terms of solar PV installations.

Based on this assumption, the success of the country and the reasons of this success can be evaluated. For example, as can be seen from the graph Japan was relatively successful than other countries until 2003, however as the other countries increased their installations, the relative success level of Japan in terms of solar PV installations was decreased. There might be many reasons for this trend including saturation of solar PV market, electricity retail prices, solar irradiation and solar PV policies. As explained in the chapter II-D.1, policies and regulations have the most comprehensive effect on deployment of renewable energy systems. Therefore, the relative success or failure of the country can be related to the effectiveness of the implemented policy.

2. Index 2 : "Relative Growth Index"

It is likely to expect higher amount of solar PV installations from a country that already has a developed solar PV market. On the other hand, the market growth in such a country might not be as much as a country that has recently started its investments.

For example;

- ❖ In 2011, Germany installed 7500 MWs of solar PV systems, and the solar market growth percentage was 43.3%
- ❖ In 2011, the United Kingdom installed 906.2 MWs of solar PV systems, however the solar

The obvious success of the United Kingdom can be observed from the increased percentage. This success might be related to many factors. However, a significant growth in a period of one year can be associated with particularly the policy and regulations of the country due to its comprehensive effect (see chapter II.D.1). Therefore, the growth percentage of the solar market can be used as an indicator for observing the success of a policy.

The same method was used to form the index table. However, instead of using the Yearly Solar PV Installation Capacities (Table 8), Yearly Solar PV Capacity Growth Percentages (Table 9) was used to form the index table. The Relative Growth Index table is presented below.

Index 2 - Relative Growth Index

Relative Growth Index	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Country Average
China (CHN)	-	-	-	-	-	-	-	-	0.743	2.511	0.812	0.595	0.491	0.413	0.370	0.473	1.350	1.957	2.246	1.087
Malaysia (MYS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.404	0.304	0.309	0.159	0.051	0.245
Turkey (TUR)	-	-	-	-	-	-	1.399	1.119	1.568	1.595	1.516	1.190	1.058	0.629	0.265	0.251	0.295	0.235	0.120	0.864
Mexico (MEX)	1.223	1.216	0.274	0.348	0.348	0.417	0.210	0.260	0.248	0.255	0.189	0.199	0.105	0.155	0.083	0.057	0.173	0.263	0.153	0.325
Korea (KOR)	0.259	0.317	0.354	0.668	0.662	0.917	0.466	0.480	0.549	0.475	0.379	1.289	2.240	4.799	1.869	4.023	0.550	0.294	0.172	1.093
Portugal (PRT)	0.000	2.538	0.000	1.336	0.869	0.917	1.399	0.746	0.570	0.981	0.802	0.884	0.423	0.386	6.318	3.308	0.594	0.329	0.070	1.183
Israel (ISR)	-	-	-	-	-	-	-	-	-	-	-	-	0.423	0.868	0.570	0.788	8.466	2.176	1.232	2.075
Spain (ESP)	-	-	0.000	0.000	0.000	0.000	2.798	0.000	3.135	2.392	2.436	3.093	3.967	5.844	5.575	4.623	0.020	0.131	0.063	2.005
Italy (ITA)	1.645	0.839	0.726	0.051	0.152	0.275	0.126	0.091	0.165	0.319	0.620	0.559	0.844	0.964	2.080	3.324	1.864	2.307	1.909	0.993
Canada (CAN)	0.777	1.269	1.605	1.476	1.069	1.484	0.808	0.810	0.697	0.435	0.614	0.550	0.795	0.637	0.383	0.316	2.236	2.315	0.710	0.999
UK (GBR)	1.942	0.000	2.006	0.000	1.738	0.765	1.599	2.442	1.320	1.654	1.497	1.206	1.254	0.902	0.394	0.287	0.184	1.978	9.331	1.605
France (FRA)	0.647	0.725	1.254	2.073	1.343	1.128	0.552	0.812	0.721	0.757	0.773	0.718	1.025	0.955	1.056	1.642	1.318	2.523	0.981	1.106
Australia (AUS)	0.851	1.027	1.125	0.947	0.664	0.932	0.348	0.518	0.472	0.522	0.567	0.454	0.604	0.463	0.257	0.315	0.939	2.399	1.054	0.761
Germany (DEU)	2.589	1.015	2.006	1.503	2.212	1.274	1.095	4.616	4.538	1.886	1.602	4.764	3.278	1.186	0.649	0.553	0.732	0.877	0.311	1.931
Belgium (BEL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Austria (AUT)	1.295	1.904	1.641	0.859	1.022	1.460	0.772	1.089	0.768	2.196	2.152	0.792	0.523	0.193	0.122	0.201	0.736	0.958	0.690	1.020
The Ned. (NLD)	0.896	1.269	1.204	1.503	0.737	2.867	1.162	1.314	1.886	0.902	2.516	0.237	0.116	0.086	0.017	0.090	0.223	0.357	0.354	0.933
Japan (JPN)	1.083	1.441	2.353	1.496	1.848	2.115	1.577	1.957	1.164	1.296	1.193	0.980	0.975	0.583	0.182	0.139	0.266	0.443	0.257	1.124
Sweden (SWE)	0.971	1.523	1.389	0.501	0.579	0.655	0.233	0.258	0.224	0.319	0.310	0.258	0.293	0.413	0.432	0.324	0.135	0.347	0.277	0.497
US America (USA)	0.607	0.757	0.937	0.582	0.532	0.619	0.481	0.615	0.655	0.844	1.013	1.133	1.043	0.876	0.490	0.481	0.452	0.667	0.406	0.694
Denmark (DNK)	-	0.000	0.000	4.007	3.475	1.147	3.357	1.221	0.000	0.213	0.639	0.651	0.662	0.214	0.102	0.076	0.465	0.638	0.972	0.991
Switzerland (CHE)	0.909	0.788	0.719	0.481	0.538	0.851	0.462	0.476	0.471	0.344	0.262	0.309	0.659	0.277	0.324	0.382	0.634	0.595	0.649	0.533
Norway (NOR)	0.307	0.371	0.410	0.171	0.213	0.176	0.155	0.177	0.105	0.103	0.107	0.141	0.221	0.158	0.058	0.044	0.057	0.054	-0.008	0.159

An index number shows the ratio of country’s installation growth percentage in a particular year to the IEA average installation growth percentage in the same year.

Assumptions and Evaluation of Index Table

The assumptions and evaluation of the "Relative Growth Index" table can be explained as follows.

Assumptions

- Since each data is divided by the same year average for the selected year, global solar photovoltaic prices and the development of solar PV technology were not considered in this index.
- The solar irradiation potential are not taken into consideration at this chapter
- The renewable energy deployment barriers, mentioned in the chapter II.D.1, such as population, technology level, economic level, and renewable energy awareness level were not considered in this index.

Evaluation of the Index Table

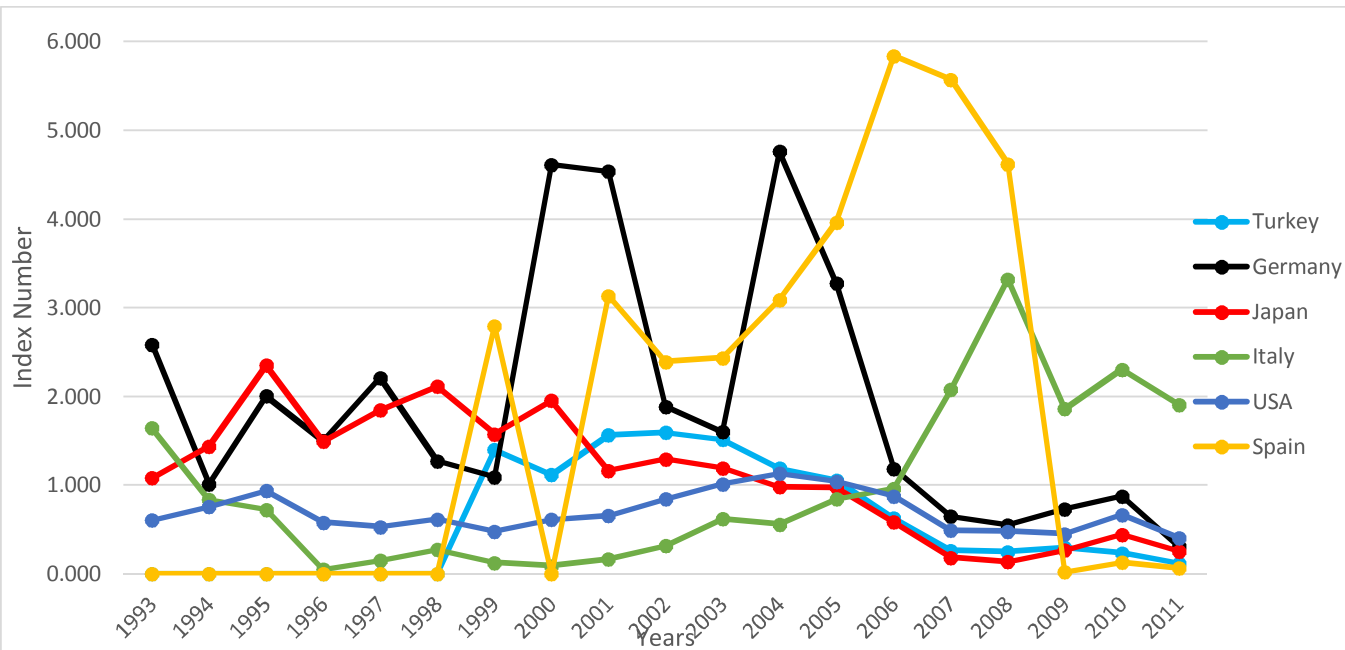
- A high index number can evaluated as,
  - The country has experienced a considerable growth in the selected year compared to other countries
  - The growth of the market can be related to a new implemented policy. A rising renewable energy awareness and available incentives can be one of the main effects of this growth.
- A low index number can evaluated as,
  - The country did not experience a considerable growth in the solar energy installations for the selected year in comparison with other countries. The low growth rate can be evaluated as;

- ✓ The total capacity of already installed systems were too high to have a considerable increase in the installations
- ✓ The solar energy market in that country has reached its saturation point
- ✓ The implemented policies were not as successful as the other countries' policies

Relative Growth Graph

Below, the index values of the same countries are presented in a graph.

Figure 17 - Relative Growth Graph



Evaluation of the Graph

This graph can be used for observing significant changes in terms of growth in the number of PV system installations. The usage of the graph can be summarized as follows:

- ❖ If the curve in the graph is having a positive trend for a particular country, then there is a strong reason to believe that the country have good policy and is successfully implementing this policy.

- The policy successes can be compared between two countries by observing the trends in the graph.
- The country trend can be compared with the IEA average (1.0) for evaluating the country success.

For example, it can be asserted that Germany had a rise in the number of solar PV installations by the end of 2000 in comparison with other countries. This remarkable growth can interpreted as an effect of an implementation of a new policy.

Similarly, Italy has experienced a relatively bigger growth in the number of installations in 2007 and 2008. Although, Japan has not seen relatively higher growth in the number of installations in the recent years, the success of the country in 1995 can be seen from the graph. The table also presents the plummeting trend of Spain, which can be related to many reasons including reaching to a saturation point in the market or implementing a new policy that was not successful.

3. Index 3 : "Relative Solar Potential Index"

The global average solar irradiations of the IEA countries are presented in the table below (see appendix section B for sources).

Table 10 - Yearly Average Solar Irradiation (kWh/m2/year)

Yearly Average Solar Irradiation (kWh/m2/year)			
Australia (AUS)	2200	Italy (ITA)	1600
Austria (AUT)	1100	Japan (JPN)	1427
Belgium (BEL)	1125	Korea (KOR)	1304
Canada (CAN)	1240	Mexico (MEX)	1825
Switzerland (CHE)	1350	Malaysia (MYS)	1789
China (CHN)	1460	The Netherlands (NLD)	1000
Germany (DEU)	1050	Norway (NOR)	875
Denmark (DNK)	963	Portugal (PRT)	1550
Spain (ESP)	1600	Sweden (SWE)	850
France (FRA)	1200	Turkey (TUR)	1311
United Kingdom (GBR)	1000	US America (USA)	1825
Israel (ISR)	2000	IEA AVERAGE	1376

An index table is formed by using the same approach. Each country's average solar irradiation is divided by the IEA average solar irradiation value. The "Relative Solar Potential Index is presented below.

Index 3 - Relative Solar Potential Index

Relative Solar Potential Index			
Australia (AUS)	1.599	Italy (ITA)	1.163
Austria (AUT)	0.800	Japan (JPN)	1.037
Belgium (BEL)	0.818	Korea (KOR)	0.948
Canada (CAN)	0.901	Mexico (MEX)	1.326
Switzerland (CHE)	0.981	Malaysia (MYS)	1.300
China (CHN)	1.061	The Netherlands (NLD)	0.727
Germany (DEU)	0.763	Norway (NOR)	0.636
Denmark (DNK)	0.700	Portugal (PRT)	1.127
Spain (ESP)	1.163	Sweden (SWE)	0.618
France (FRA)	0.872	Turkey (TUR)	0.953
United Kingdom (GBR)	0.727	US America (USA)	1.326
Israel (ISR)	1.454		

Assumptions and Evaluation of Index Table

The assumptions and evaluation of the "Relative Solar Potential Index" table can be explained as follows.

Assumptions

- The average solar irradiations are in the table.
- Regional solar irradiance differences are not taken into consideration.

Evaluation of the Index Table

- The numbers present the solar potential of the countries.
  - A high number (green) shows that the selected country is above the average among all IEA countries
  - A low number (red) shows that the selected country is below the average.

4. Index 4 : "Relative Installation and Solar Potential Usage Index"

As mentioned in the previous chapter solar irradiation is the input of solar energy. Therefore, it is likely to expect higher return from solar energy systems in locations with high-solar irradiations. A higher return would be reducing economic barriers of solar energy deployment.

Therefore, the solar irradiation potentials of countries should also be considered. For example, as it can be seen from the Table-6 Germany has lower solar irradiance in comparison with the other countries. On the other hand, Australia's solar irradiation average is more than twice of Germany's solar irradiation average. Therefore, the expectations from Australia can be higher in terms of solar installations, whereas Germany would be expected to have fewer installations due to low solar irradiation levels.

In this chapter, the solar irradiation potentials are integrated into the "Relative Installation Index". In order to form the "Relative Installation and Solar Potential Usage Index", Index 1 (Relative Installation Index) values were divided by the Index 3 (Relative Solar Potential Index) values. The ratio of two index numbers can be explained as:

- The index numbers of countries with low solar irradiations are increased
- The index numbers of countries with high solar irradiations are decreased

As a result, the solar irradiation of the countries are taken into consideration. An example is presented below for the year 1994 for further clarification.

Germany, Australia, and Spain – 1994			
Country Name	**Relative Installation Index Number (Index 1)**	**Relative Solar Potential Index Number (Index 3)**	**Relative Installation and Solar Potential Usage Index Number (Index 4 below)**
Germany	0.924	0.763	**1.210**
Australia	1.663	1.599	**1.040**
Spain	0.924	1.163	**0.794**

As can be seen from the example, Germany's relative installation index number increased whereas, the index numbers of Australia and Spain decreased as a result of dividing relative installation index numbers with their solar potential index numbers.

The index table will provide us a set of numbers in which the solar energy potentials are taken into consideration. "The Index4: Relative Installation and Solar Potential Usage Index" is presented below.

Index 4 - Relative Installation and Solar Potential Usage Index

Relative Inst. and Solar Pot. Usage Index	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Country Average
China (CHN)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.836	0.334	1.032	0.444	0.197	0.122	0.148	0.176	0.141	0.550	0.759	1.896	0.402
Malaysia(MYS)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.011	0.005	0.006	0.002	0.001	0.005
Turkey (TUR)	0.000	0.000	0.000	0.000	0.000	0.065	0.021	0.011	0.017	0.019	0.020	0.011	0.008	0.008	0.005	0.003	0.004	0.002	0.001	0.010
Mexico (MEX)	1.233	1.184	0.227	0.364	0.281	0.235	0.133	0.077	0.065	0.054	0.032	0.017	0.006	0.012	0.008	0.003	0.009	0.007	0.004	0.208
Korea (KOR)	0.102	0.097	0.080	0.191	0.158	0.164	0.103	0.054	0.058	0.044	0.030	0.055	0.085	0.372	0.446	1.092	0.641	0.223	0.133	0.217
Portugal (PRT)	0.000	0.082	0.000	0.054	0.033	0.028	0.052	0.018	0.014	0.021	0.017	0.011	0.004	0.006	0.120	0.167	0.111	0.041	0.009	0.041
Israel (ISR)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.001	0.003	0.003	0.003	0.054	0.050	0.066	0.010
Spain (ESP)	0.000	0.794	0.000	0.000	0.000	0.000	0.168	0.000	0.135	0.153	0.203	0.215	0.348	1.340	4.474	8.882	0.188	0.543	0.239	0.931
Italy (ITA)	2.979	1.589	1.102	0.104	0.225	0.268	0.135	0.044	0.068	0.102	0.162	0.084	0.095	0.169	0.564	1.089	2.268	3.215	6.437	1.089
Canada (CAN)	0.214	0.307	0.335	0.469	0.331	0.380	0.282	0.159	0.140	0.079	0.094	0.049	0.052	0.065	0.055	0.029	0.251	0.333	0.248	0.204
UK (GBR)	0.132	0.000	0.104	0.000	0.103	0.043	0.108	0.113	0.087	0.114	0.117	0.066	0.060	0.074	0.049	0.023	0.018	0.097	1.004	0.122
France (FRA)	0.331	0.318	0.432	1.038	0.728	0.535	0.337	0.259	0.235	0.224	0.211	0.117	0.130	0.197	0.335	0.449	0.839	1.509	1.508	0.512
Australia(AUS)	0.963	1.040	0.943	1.133	0.700	0.740	0.343	0.250	0.217	0.204	0.191	0.087	0.084	0.096	0.071	0.052	0.190	0.386	0.421	0.427
Germany(DEU)	2.522	1.210	1.976	2.373	3.425	2.039	2.308	5.912	11.341	8.535	8.579	18.316	20.176	17.391	15.557	9.570	18.136	15.632	7.910	9.100
Belgium (BEL)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.969	0.104
Austria (AUT)	0.241	0.347	0.283	0.227	0.233	0.272	0.196	0.154	0.118	0.311	0.383	0.112	0.059	0.032	0.025	0.022	0.092	0.086	0.092	0.173
Ned. (NLD)	0.397	0.508	0.415	0.747	0.360	1.070	0.727	0.508	0.834	0.473	1.257	0.100	0.033	0.032	0.008	0.021	0.054	0.045	0.048	0.402
Japan (JPN)	4.917	6.145	8.870	9.429	11.411	12.633	14.192	12.022	9.301	10.505	10.118	5.479	4.526	4.351	1.895	0.814	1.699	1.539	1.006	6.887
Sweden (SWE)	0.312	0.449	0.366	0.195	0.181	0.151	0.063	0.033	0.025	0.029	0.023	0.010	0.008	0.015	0.021	0.010	0.005	0.007	0.006	0.101
USA (USA)	4.933	5.223	5.116	4.414	3.293	2.792	2.538	1.662	1.720	1.982	2.237	1.585	1.257	1.721	1.454	0.954	1.231	1.115	0.869	2.426
Denmark	0.138	0.000	0.000	0.086	0.107	0.044	0.168	0.059	0.000	0.008	0.020	0.012	0.009	0.005	0.003	0.001	0.007	0.006	0.011	0.036
Switz. (CHE)	1.079	0.847	0.615	0.554	0.495	0.571	0.379	0.199	0.184	0.115	0.072	0.045	0.066	0.042	0.062	0.045	0.096	0.061	0.082	0.295
Norway (NOR)	0.454	0.436	0.356	0.190	0.176	0.098	0.092	0.048	0.025	0.019	0.015	0.010	0.010	0.010	0.004	0.002	0.002	0.001	0.000	0.102

An index number shows the ratio of country's relative installations in a particular year to its solar potential (Index 1 values are divided by Index 3 values).

Assumptions and Evaluation of Index Table

The assumptions and evaluation of the "Relative Installation and Solar Potential Usage Index" table can be explained as follows.

Assumptions

- Same assumptions of "Index 1: Relative Installation Index" and "Index 3: Relative Solar Potential Index" are made.

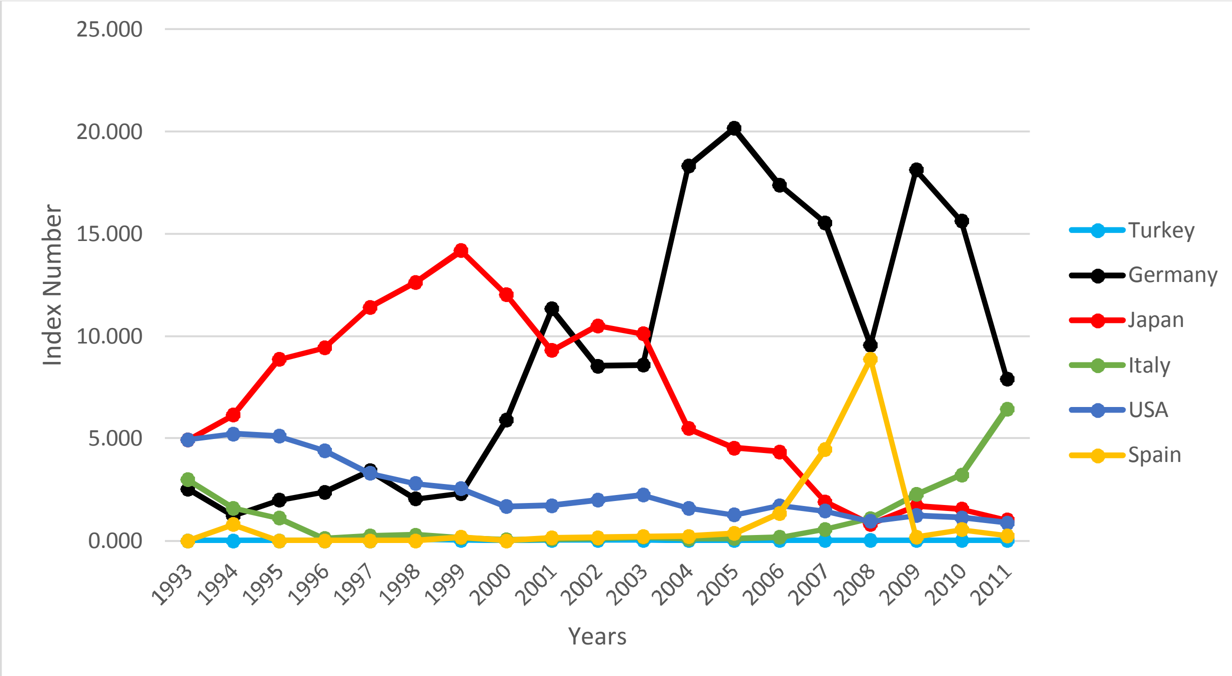
Evaluation of the Index Table

- Countries can be evaluated in terms of the usage of their solar irradiation potentials. For example, when comparing Germany to Australia, it is possible to conclude that Germany is making a very good use of its solar potential even though the average solar irradiation of the country is significantly less than Australia's. One can conclude that:
  - Australia is not making a good use of its solar irradiation potential,
  - Australia does not promote the usage of PV systems,
  - Australia lacks PV policies,
  - Australia's policies are not enforced or implemented quite well,
  - Australia's market for PV systems production is not yet matured.

Relative Installation and Solar Potential Usage Graph

Below, the index values of the same countries are presented in a graph.

Figure 18 - Relative Installation and Solar Potential Graph



<u>Evaluation of the Graph</u>

As can be seen from the graph, after the integration of solar irradiances, the index numbers of Germany has increased considerably, whereas the index numbers of other countries have decreased. The success of low-solar irradiation countries such as Germany becomes more prominent in this graph.

5. Index 5 : "Relative Growth and Solar Potential Usage Index"

A similar approach was followed to form the "Relative Growth and Solar Potential Usage Index". Index 2 (Relative Growth Index) values are divided by Index 3 (Relative Solar Potential Index) values.

The "Index 5: Relative Growth and Solar Potential Usage Index" is presented below.

Index 5 - Relative Growth and Solar Potential Usage Index

Relative Growth and Solar Pot. Usage Index	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Country Average
China (CHN)	-	-	-	-	-	-	-	-	0.700	2.366	0.765	0.560	0.463	0.389	0.349	0.445	1.272	1.844	2.116	1.025
Malaysia (MYS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.311	0.234	0.237	0.122	0.039	0.189
Turkey (TUR)	-	-	-	-	-	-	1.468	1.174	1.645	1.674	1.591	1.248	1.110	0.660	0.278	0.263	0.310	0.246	0.126	0.907
Mexico (MEX)	0.922	0.916	0.206	0.263	0.262	0.314	0.158	0.196	0.187	0.192	0.143	0.150	0.079	0.117	0.062	0.043	0.131	0.198	0.115	0.245
Korea (KOR)	0.273	0.335	0.373	0.705	0.698	0.968	0.492	0.506	0.579	0.501	0.400	1.360	2.364	5.063	1.972	4.244	0.581	0.311	0.181	1.153
Portugal (PRT)	0.000	2.253	0.000	1.186	0.771	0.814	1.242	0.662	0.506	0.871	0.712	0.784	0.376	0.342	5.608	2.936	0.527	0.292	0.062	1.050
Israel (ISR)	-	-	-	-	-	-	-	-	-	-	-	-	0.291	0.597	0.392	0.542	5.824	1.497	0.847	1.427
Spain (ESP)	-	-	0.000	0.000	0.000	0.000	2.406	0.000	2.696	2.057	2.095	2.659	3.411	5.025	4.794	3.976	0.018	0.112	0.054	1.724
Italy (ITA)	1.414	0.722	0.624	0.044	0.131	0.236	0.109	0.078	0.142	0.274	0.533	0.481	0.725	0.829	1.788	2.858	1.602	1.984	1.641	0.853
Canada (CAN)	0.862	1.408	1.780	1.638	1.186	1.647	0.897	0.899	0.773	0.483	0.681	0.611	0.882	0.707	0.425	0.351	2.481	2.568	0.787	1.109
UK (GBR)	2.672	0.000	2.760	0.000	2.391	1.052	2.200	3.359	1.816	2.275	2.060	1.659	1.725	1.241	0.542	0.395	0.253	2.721	12.837	2.208
France (FRA)	0.742	0.831	1.437	2.376	1.539	1.293	0.633	0.931	0.827	0.868	0.887	0.823	1.176	1.095	1.211	1.883	1.511	2.893	1.125	1.267
Australia (AUS)	0.532	0.642	0.703	0.592	0.415	0.583	0.218	0.324	0.295	0.326	0.355	0.284	0.378	0.290	0.161	0.197	0.587	1.500	0.659	0.476
Germany (DEU)	3.392	1.330	2.628	1.969	2.898	1.670	1.434	6.049	5.946	2.472	2.098	6.242	4.295	1.554	0.851	0.724	0.960	1.149	0.408	2.530
Belgium (BEL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Austria (AUT)	1.619	2.381	2.053	1.074	1.278	1.826	0.965	1.362	0.960	2.747	2.692	0.990	0.655	0.241	0.152	0.251	0.921	1.198	0.863	1.275
Netherlands (NLD)	1.233	1.746	1.656	2.067	1.014	3.944	1.599	1.807	2.595	1.242	3.461	0.326	0.160	0.118	0.023	0.123	0.306	0.491	0.488	1.284
Japan (JPN)	1.044	1.390	2.269	1.442	1.782	2.039	1.521	1.887	1.122	1.250	1.150	0.945	0.940	0.562	0.176	0.134	0.257	0.427	0.248	1.083
Sweden (SWE)	1.571	2.465	2.248	0.811	0.938	1.061	0.377	0.418	0.363	0.516	0.502	0.417	0.474	0.669	0.699	0.524	0.218	0.561	0.449	0.804
US America (USA)	0.458	0.571	0.706	0.439	0.401	0.467	0.362	0.464	0.494	0.636	0.763	0.854	0.786	0.660	0.370	0.363	0.341	0.503	0.306	0.523
Denmark (DNK)	-	0.000	0.000	5.728	4.968	1.639	4.799	1.745	0.000	0.304	0.914	0.931	0.947	0.306	0.146	0.109	0.665	0.912	1.389	1.417
Switzerland (CHE)	0.926	0.803	0.732	0.490	0.548	0.868	0.471	0.485	0.480	0.351	0.267	0.315	0.672	0.283	0.330	0.389	0.646	0.606	0.662	0.543
Norway (NOR)	0.482	0.584	0.645	0.268	0.335	0.277	0.244	0.278	0.164	0.162	0.168	0.221	0.347	0.249	0.091	0.070	0.090	0.085	-0.012	0.250

An index number shows the ratio of country's relative installation growth in a particular year to its solar potential (Index 2 values are divided by Index 3 values).

Assumptions and Evaluation of Index Table

The assumptions and evaluation of the "Relative Growth and Solar Potential Usage Index" table can be explained as follows.

Assumptions

- Same assumptions of Index 1: "Relative Installation Index" and Index 3: "Relative Solar Potential Index" are made.

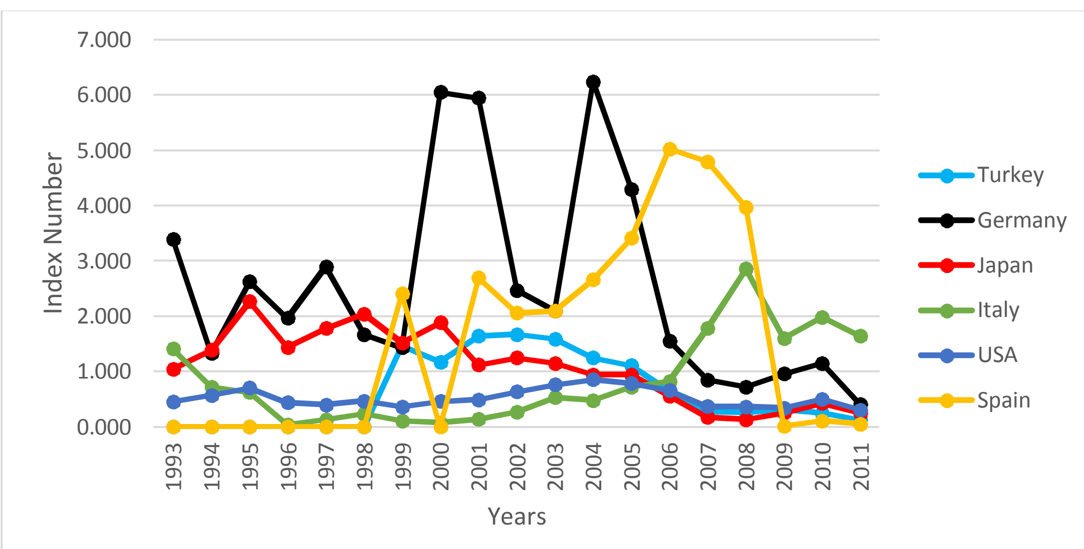
Evaluation of the Index Table

- Since the effect of solar irradiation is taken into account, its effect on country success in terms of growth in the capacity of solar PV installations can be ignored. Therefore, the index numbers can provide us a more realistic indicator of policy success. The index numbers can be used for comparing success levels of policies between selected countries.

Relative Growth and Solar Potential Usage Graph

Below, the index values of the same countries are presented in a graph.

Figure 19 - Relative Growth and Solar Potential Graph



Evaluation of the Graph

As the solar potentials of countries included in the index table, the growth in the number of solar PV installations in Germany increased considerably. In the Figure-17, some of the index numbers of Spain was higher than Germany. On the other hand, in this graph the growth in Germany raised to a higher level.

E. Evaluation of the Quantitative Analysis Results

In this chapter, the quantitative analysis results are evaluated for assessing the policies of Germany, Japan, and the USA. The index tables 2 and 5 were used for evaluating the policy effects in order to observe considerable changes between the years 1993 and 2011.

The index tables will be named as follows for convenience.

- "Index 2: Relative Growth Index": RGI
- "Index 5: Relative Growth and Solar Potential Usage Index": GSPI

1. Policy Analysis

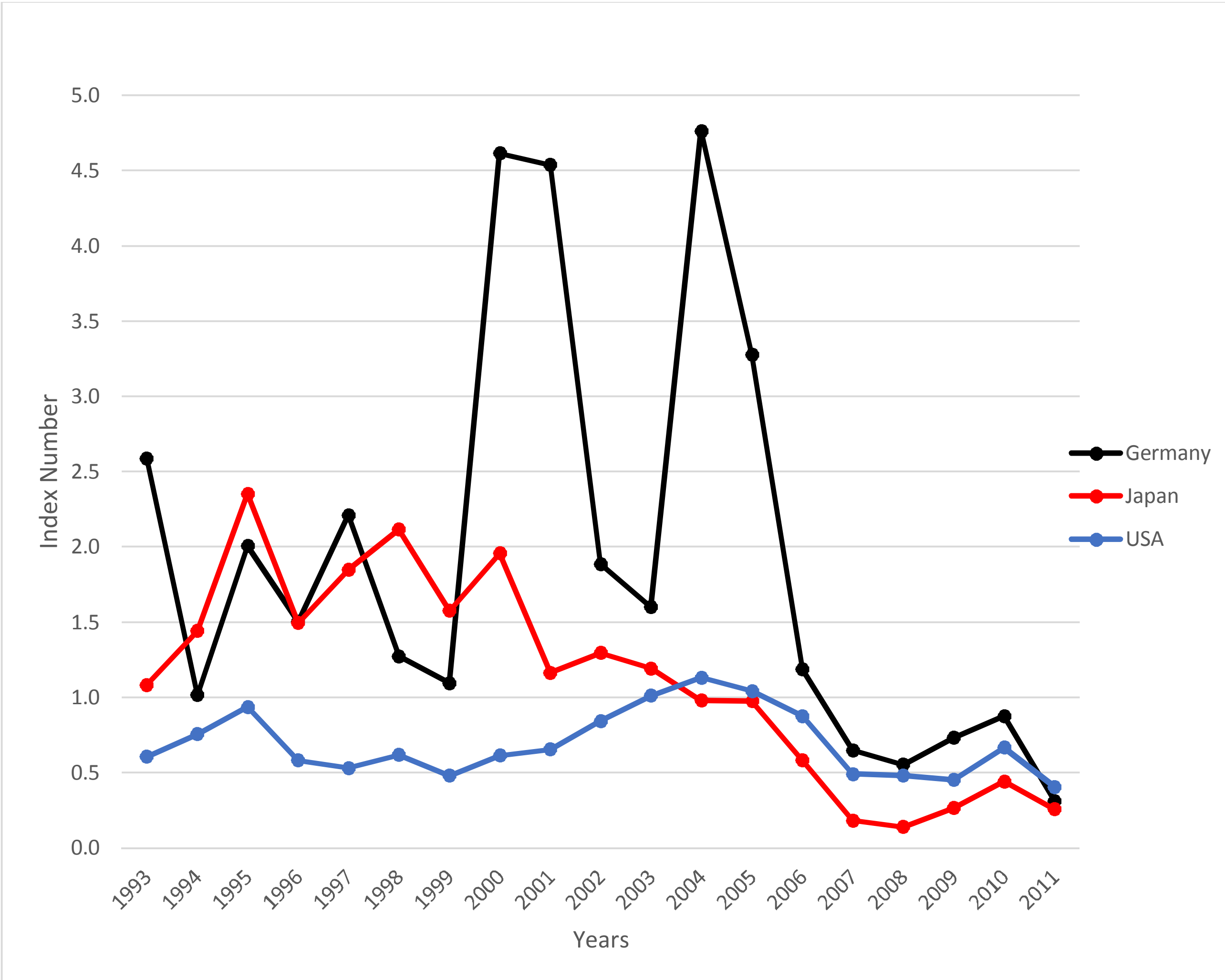
The index numbers are relative numbers, which present the success of the selected country in terms of solar PV installations among the IEA member countries. Therefore, a higher number would indicate that that country has performed better in that specific year compared to the other IEA countries.

As presented in section II.D.1, policies and regulations have the most comprehensive effect on renewable energy deployment (see Figure 6). Therefore, it is assumed that a change in a policy and regulations would have the most powerful impact on renewable energy deployment. Based on this assumption, implemented policies are associated with the index numbers of the selected countries to evaluate the success of the policies.

In order to present the usage of both RGI and GSPI indexes, the policies of selected countries Germany, Japan and USA were analyzed by using the RGI (Relative Growth Index) index, and the years with highest index numbers are selected for comparison between countries by using GSPI (Relative Growth and Solar Potential Usage) index.

The RGI Graph for the selected countries are presented below.

Figure 20 - Relative Growth Graph for the Selected Countries



As can be seen from the graphs the upsurges can be observed in some years. Especially in Germany, an obvious increase in the index number gives an idea about the relative growth in the number of installations. Similarly, the trend of Japan's index numbers show the success of the country in terms of solar PV installations in the mid-90s. On the other hand, there was not a considerable growth in the number of installations in the USA neither in the recent years nor in previous years.

Based on the graph, the years with notable changes in the selected countries are as follows:

- **Germany:** 1995, 1997, 2000,2004
- **Japan:** 1994, 1995, 1997, 1998 ,2000
- **USA:** 1994, 1995, 2002, 2003, 2004, 2010

Since the renewable energy deployment barriers (section II.D.2) such as technology levels, income levels, global solar PV prices, renewable energy awareness levels are assumed to be the same for each country, the index numbers were solely associated with the country policy. Based on this assumption, the policies were matched with the index numbers of the selected year and the preceding years, and the effect and success level of the policies were analyzed. The years with notable changes based on the RGI and GSPI graphs will be referred as "the most successful years" in the next chapters.

1.1. Germany

The implemented policy types and index numbers of Germany are presented in the table below.

Table 11 - Policy Types and RGI Numbers for Germany

Year	RGI	Implemented Policy Types
1990	-	Loans
1991	-	Feed-in Tariffs
1992	-	-
1993	2.589	Feed-in Tariffs
1994	1.015	-
1995	2.006	Grants / Promotions / Incentives / Subsidies
1996	1.503	Monitoring / Regulatory Reform
1997	2.212	Mandates / Standards
1998	1.274	Monitoring/ Regulatory Reform

1999	1.095	Grants /Loans
2000	4.616	Feed-in Tariffs/Monitoring/ Quota/Standards
2001	4.538	Grants/Loans
2002	1.886	Quota Change
2003	1.602	-
2004	4.764	Removal of Cap/ Change of Feed-in Tariff Rates
2005	3.278	Loans, Monitoring/ Comparison Labelling
2006	1.186	Private Sector-Government Agreement
2007	0.649	Strategic Planning/ Policy Enhancement
2008	0.553	Decrease of Feed-in Tariff Rates, Strategic Planning/
2009	0.732	Degression of Feed-in Rates, Grants/Loans
2010	0.877	Decreased Feed-in Tariff Rates
2011	0.311	Promotions
Average	1.931	

As explained in the previous chapter, the years 1995, 1997, 2000, and 2004 were selected for analysis due to significant changes in these years based on the RGI and GSPI Graphs.

In 1995, capital subsidies were offered under the 100 Million program and in 1997, building power plants in undeveloped outskirts were allowed under the Federal Building Codes for Energy Production. However, for the years 1995 and 1997, the previously implemented Electricity Feed-in Law in 1991 (see Appendix A.1.1) should also/ be considered. Therefore, the common policy in all of the successful years was feed in tariffs. Additionally the effect of continuing 100,000-rooftop program (from 1999 to 2004) should be included in the success in 2000 and 2004 (see Appendix A.1.1). Under this program, low-interest loans were offered. Therefore, the most remarkable change was experienced in 2000 and 2004 where loans were being offered and a feed-in tariff mechanism was implemented.

Based on the information above, the implemented policy types and the RGI numbers of these years are presented in the table below.

Table 12 - The Most Successful Years and Implemented Policies in Germany

Year	RGI	Implemented Policy Types
1995	2.006	Feed-in Tariffs/Capital Subsidies
1997	2.212	Feed-in Tariffs
2000	4.616	Feed-in Tariffs/Low-Interest Loans
2004	4.764	Feed-in Tariffs/Low-Interest Loans

1.2. Japan

The implemented policy types and index numbers of Japan are presented in the table below.

Table 13 - Policy Types and RGI Numbers for Japan

Year	RGI	Implemented Policy Types
1990	-	-
1991	-	-
1992	-	Net-Metering/ Demonstration
1993	1.083	Grants/ Demonstration
1994	1.441	Grants
1995	2.353	-
1996	1.496	Quota
1997	1.848	Regulatory Reform/ Demonstration/Subsidies/Grants
1998	2.115	Subsidies
1999	1.577	-
2000	1.957	-
2001	1.164	Promotion
2002	1.296	Strategic Planning/ Policy Enhancement
2003	1.193	Quota/Green Certificate Trading
2004	0.980	-
2005	0.975	-
2006	0.583	-
2007	0.182	Strategic Planning
2008	0.139	Strategic Planning
2009	0.266	Feed-in Tariffs/Mandates
2010	0.443	Strategic Planning
2011	0.257	-
Average	1.124	

The most successful years were selected as 1994, 1995, 1997, 1998 and 2000 for Japan. The table shows that the main drivers was grants and subsidies in the most successful years. The success level of the year 1995 can be associated with the implemented policy in the previous year. In 1994, grants, covering 50% of total systems costs, were offered for the new residential PV systems (see Appendix A.2.1). Likewise, in 1997 and 1998, subsidies (1/3 of total cost) were offered along with demonstration programs. Starting from 1997, the demonstration programs were also continued in 2000. Therefore, the growing number of solar PV installations in 2000 can be linked to such programs.

The implemented policy types and the RGI index numbers of these years are presented in the table below.

Table 14 - The Most Successful Years and Implemented Policies in Japan

Year	RGI	Implemented Policy Types
1994	1.441	Grants (high level)
1995	2.353	Grants (high level)
1997	1.848	Subsidies/ Demonstration
1998	2.115	Subsidies /Demonstration
2000	1.957	Demonstration

1.3. USA

The implemented policy types and index numbers of the USA are presented in the table below.

Table 15 - Policy Types and RGI Numbers for the USA

Year	RGI	Implemented Policy Types
1990	-	Education and Outreach/ Strategic Planning/ Voluntary Agreement
1991	-	-
1992	-	Third Party Financing/ Investment Credit/ Tax Credit/ Incentive Payment
1993	0.607	Education and Outreach/ Public Investment
1994	0.757	Education and Outreach/ Funding/ Grants
1995	0.937	-
1996	0.582	Education and Outreach/ Funding/ Grants
1997	0.532	Mandates/Quota
1998	0.619	Grants
1999	0.481	Education and Outreach/ Voluntary Agreement/ Infrastructure Investment/ Tax Credit
2000	0.615	-
2001	0.655	Education and Outreach/ Voluntary Agreement/ Grants/ Tax Credit
2002	0.844	Mandates/Quota/ Strategic Planning/ Project-Based Programmes/ Grants/Loans/ Education and Outreach/ Demonstration
2003	1.013	-
2004	1.133	Tax Credit/ Incentives/Subsidies/ Mandates/Quota
2005	1.043	Incentives/Subsidies/ Strategic Planning/ Regulatory Reform/ Education and Outreach/ Policy Enhancement/ Mandates/Quota/ Voluntary Agreement
2006	0.876	Education and Outreach/ Strategic Planning/ Taxes/Tax Incentives
2007	0.490	Rebates/ Loans/ Institutional Creation/ Government Procurement Programme/ Mandates/Quota/ Education and Outreach/ Funding/ Strategic Planning/ Regulatory Change/ Voluntary Agreement
2008	0.481	Tax Credit/ Regulatory Change/ Government Procurement Programme/ Mandates/Monitoring/ Infrastructure Investment/ Grants/ GHG Emissions Trading/ Project-Based Programmes/ Strategic Planning
2009	0.452	Tax Credit/ Funding/ Grants/ Government Procurement Programme/ Education and Outreach/ Institutional Creation
2010	0.667	-
2011	0.406	-
Average	0.694	

The most successful years were selected as 1994, 1995, 2002, 2003, 2004 and 2010 for the USA. The success in the years 1994 and 1995 can be associated with the financial and technical support, education and training of the US government under the Tribal Energy Program (See Appendix A.3.1). It is assumed that the success level in 2003 was linked to the implemented policies in 2002. The main implemented policy types were renewable portfolio standards and grants in 2002. In 2004, tax-credits and again renewable portfolio standards were implemented. The success of 2010 is also linked to the year 2009. Tax credits and grants were the main policies implemented in these years.

The RGI numbers are linked with the implemented policies presented in the table below.

Table 16 - The Most Successful Years and Implemented Policies in the USA

Year	RGI	Implemented Policy Types
1994	0.757	Education/Technical Support/ Grants
1995	0.937	Education/Technical Support/ Grants
2002	0.844	Renewable Portfolio Standards / Grants
2003	1.013	Renewable Portfolio Standards / Grants
2004	1.133	Renewable Portfolio Standards/ Tax Credit
2010	0.667	Tax Credits / Grants

2. Comparison of Policy Types

In the previous chapter, the most successful policy types were listed for Germany, Japan and the USA. In this section, best three policy type from each country are listed and sorted according to GSPI index numbers in order to ignore the effect of average solar irradiation of the countries.

Table 17 - Policy Comparison of Selected Countries

Implemented Policy Types	GSPI	RGI	Implemented Country/Year
Feed-in Tariffs/Low-Interest Loans	6.242	4.764	Germany, 2004
Feed-in Tariffs/Low-Interest Loans	6.049	4.616	Germany, 2000
Feed-in Tariffs	2.898	2.212	Germany, 1997
Grants (high level)	2.269	2.353	Japan, 1995
Subsidies /Demonstration	2.039	2.115	Japan, 1998
Demonstration	1.887	1.957	Japan, 2000
Renewable Portfolio Standards/ Tax Credit	0.854	1.133	USA, 2004
Renewable Portfolio Standards / Grants	0.763	1.013	USA, 2003
Education/Technical Support/ Grants	0.706	0.937	USA, 1995

If the similar policy types are grouped, the table shows that the most successful policies according to the quantitative analysis were as follows:

1. Feed-in tariffs with low interest loans
2. Grants (high level)
3. Subsidies / Demonstration Programs
4. Renewable Portfolio Standard (RPS) / Tax Credits

For the SocioFIT Mechanism, these policies were used as a baseline along with other implemented policies in the selected countries.

IV. The Need for a New Policy in Emerging Economies

In order to understand the implementation of this policy in developing countries the "Developing Country" and "Newly Industrialized County" terminologies should be clarified.

Developing Countries

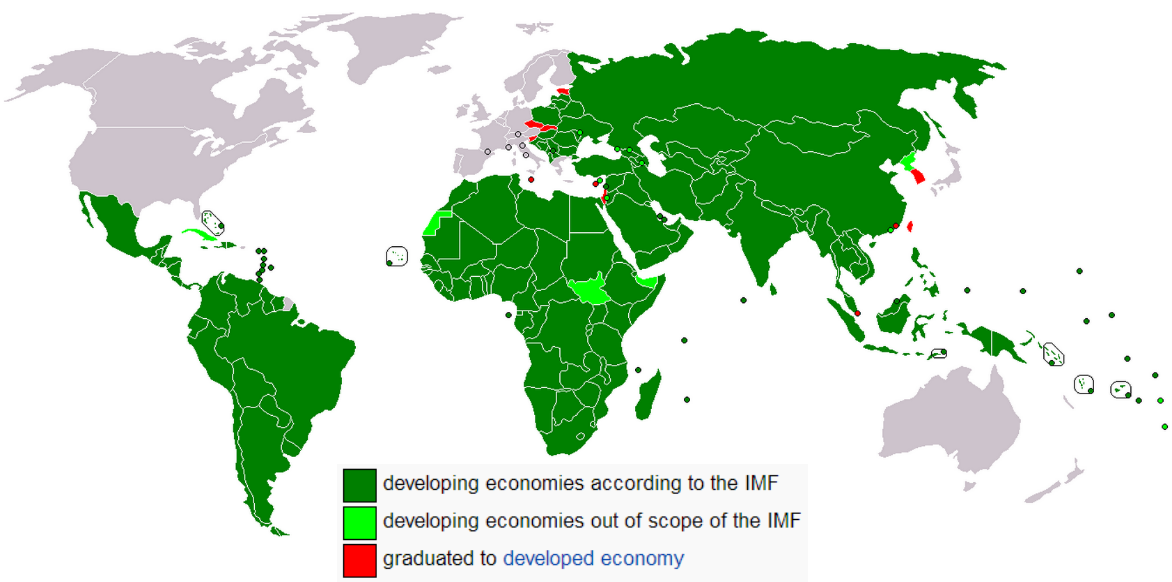
The definition of "Developing Country" is:

> "A developing country, also called a less-developed country (LDC), is a nation with a low living standard, undeveloped industrial base, and low Human Development Index (HDI) (a composite statistic of life expectancy, education, and income indices to rank countries) relative to other countries. (Wikipedia 2013)".

IMF has classified the countries into four income groups based on their GNI (gross national income) levels. Based on this classification low income and lower middle income countries are called as developing countries (Wikipedia 2013).

The map below represents the developing countries in the world

Figure 21 - Developing Countries in the World *(Wikipedia 2013)*



Newly Industrialized Countries

The definition of the Newly Industrialized Countries is:

> "The Newly Industrialized Countries (NICs) are countries whose economies have not yet reached Developed Country status but have, in a macroeconomic sense, outpaced their developing counterparts" (Wikipedia 2013).

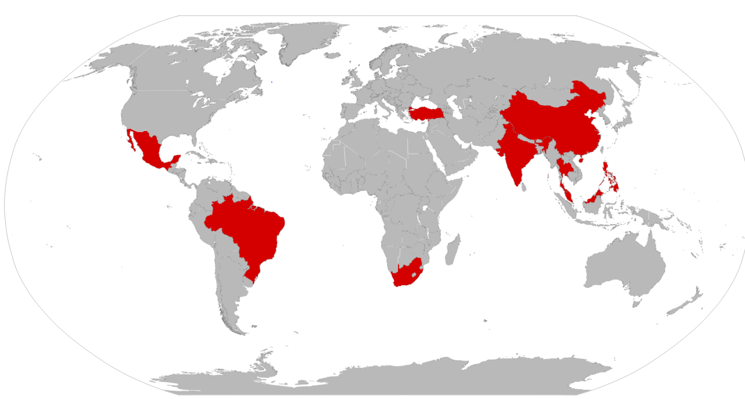
NICs are the emerging markets of the world in which social and business activities are in a process of rapid growth (Wikipedia 2013).

Newly Industrialized countries are presented in the table and the world map below (Wikipedia 2013).

Table 18 - Facts about Newly Industrialized Countries *(Wikipedia 2013)*

Region	Country	GDP (PPP) (Billions of USD, 2011 World Bank)[7]	GDP per capita (PPP) (international dollars, 2011 World Bank)[8]	Income inequality (GINI) 2008-09[9][10]	Human Development Index (HDI, 2011)[11]	GDP (real) growth rate as of 2010	GDP (real) growth rate per capita as of 2008
Africa	South Africa	555,340	10,977	**63.1**	0.619 (medium)	**2.78**	1.29
North America	Mexico	1,659,016	15,121	48.3	**0.770** (high)	5.52	0.75
South America	Brazil	2,309,138	11,845	54.7	0.718 (high)	7.49	4.06
Asia	China	**11,316,224**	8,394	45.3	0.687 (medium)	10.3	**10.4**
	India	4,469,763	**3,703**	**32.5**	**0.547** (medium)	**11.1**	8.5
	Malaysia	447,595	15,578	46.2	0.761 (high)	7.16	2.86
	Philippines	**393,987**	4,111	43	0.644 (medium)	7.6	1.97
	Thailand	622,914	9,693	40	0.682 (medium)	7.8	1.84
Europe	Turkey[a]	1,288.638	**17,499**	39	0.699 (high)	9.0	**-0.34**

Figure 22 - Newly Industrialized Countries in the World *(Wikipedia 2013)*

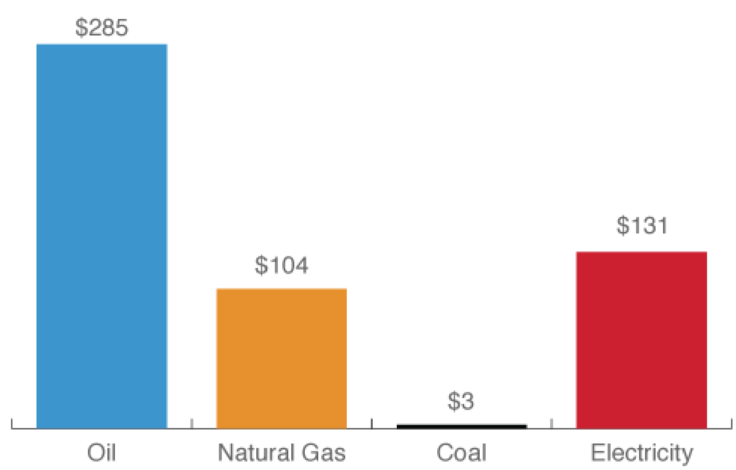


There are some differences between emerging economies and developed countries. Therefore, the specific needs of these countries should be addressed by a new mechanism for supporting renewable energy systems. The need for a new mechanism is explained in the further paragraphs.

A. Renewable Energy vs. Non-Renewable Energy

According to the IEA report, global fossil fuel subsidies were almost six times higher than global renewable subsidies in 2011. Moreover, the fossil fuel subsidies have increased by 27% between 2010 and 2011 (IEA 2012). The global fossil fuel subsidies for 2011 is presented below.

Figure 23 - Fossil-Fuel Consumption Subsidies, by Fuels Type, 2011 (Billion Dollars), *(Institute for Energy Research 2013)*



As it can be seen from the figure, electricity subsidies stand for about 25% of total fossil fuel subsidies.

The Organization for Economic Cooperation and Development (OECD)

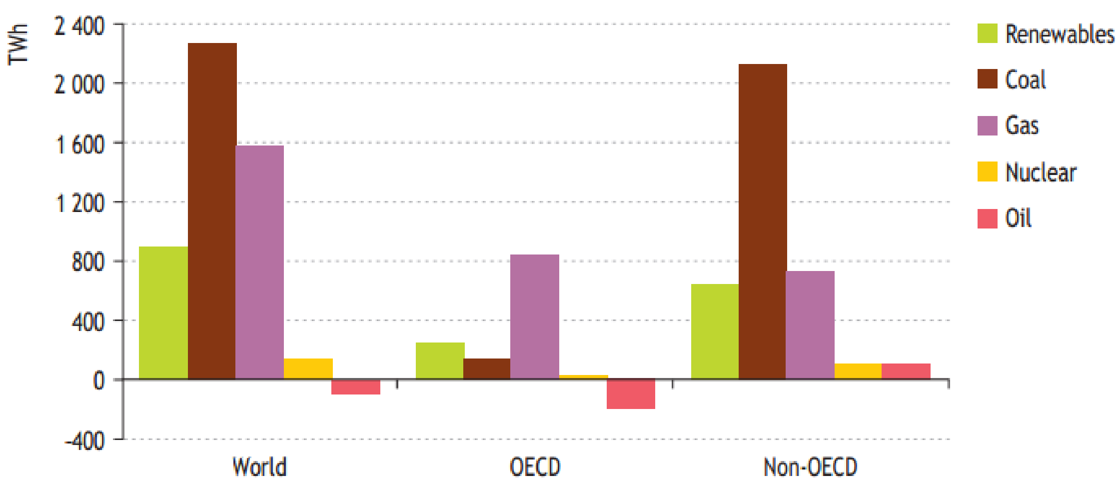
The developed countries and developing countries should be distinguished in order to address the specific needs of developing countries. Therefore, the differences between OECD countries and Non-OECD countries are presented.

For further clarification, it is important to introduce OECD Countries.

> "The Organization for Economic Cooperation and Development (OECD) is a unique forum where the governments of 34 democracies with market economies work with each other, as well as with more than 70 non-member economies to promote economic growth, prosperity, and sustainable development (OECD n.d.)."
> "OECD member countries account for 59 percent of world GDP, three-quarters of world trade, 95 percent of world official development assistance, over half of the world's energy consumption, and 18 percent of the world's population (OECD n.d.)."

It is accepted that OECD represents the developed nations of the world (Institute for Energy Research 2013). Among the emerging economies, Turkey and Mexico are member countries of OECD (Wikipedia 2013). The figure below show the electricity generation sources among OECD and Non-OECD countries.

Figure 24 - World Incremental Electricity Generation by Fuel, 2000-2008 *(IEA 2010)*



As can be seen from the figure, gas and especially coal are the main sources of electricity generation in Non-OECD countries.

B. Environmental Concerns

The climate change is considered as a major problem worldwide. It is asserted that some of the results of climate change might be:

- ❖ Increased frequency of hot extremes, heat waves and heavy precipitation which pose a direct risk to the health and safety of people (European Commission 2012)
- ❖ Increase in tropical cyclone intensity, which might imposes heavy costs on society and the economy (NASA 2007)
- ❖ Decreased water resources in many semi-arid areas, including western U.S. and Mediterranean basin (NASA 2007)
- ❖ Increased risk of extinction for 20-30% of plant and animal species (European Commission 2012)

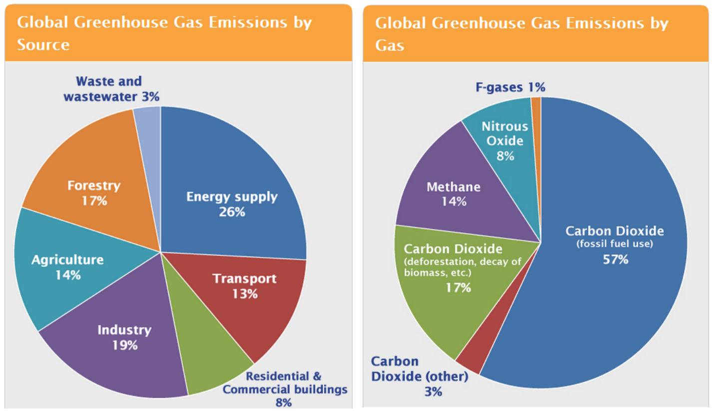
The KYOTO Protocol was established with the purpose of reducing greenhouse gas emissions through setting binding obligations on industrialized countries (Wikipedia 2013). The participant countries can be divided into three categories:

- ❖ Countries with binding targets
- ❖ Developing countries without binding targets
- ❖ Non-participant countries

Among the emerging economies, all the countries were under the "Developing Countries without binding targets" except Turkey, which was in "Countries with binding targets" category. However, Turkey does not have a binding target yet (Wikipedia 2013).

The charts below present the global GHG emissions and the share of energy supply in it.

Figure 25 - Global Greenhouse Gas Emissions by Gas and by Source *(EPA 2012)*



As it can be seen from the figures energy supply, including electricity and heat, stands for more than one fourth of total greenhouse gas emissions.

GHG Emissions

As the climate change awareness advanced in the world, reducing the Greenhouse Gas (GHG) emissions became more prominent.

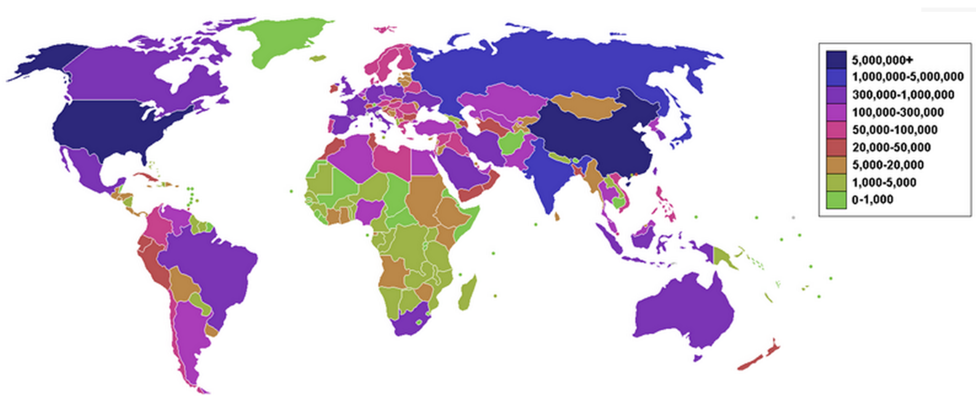
In the IPCC report, the lifecycle GHG emissions of different types of electricity sources were calculated.

Table 19 - Lifecycle Greenhouse Gas Emissions by Electricity Source *(Wikipedia 2013)*

Technology	Description	50th percentile (g CO2/kWh$_e$)
Coal	various generator types without scrubbing	1001
Natural gas	various combined cycle turbines without scrubbing	469
Solar PV	Polycrystaline silicon	46
Geothermal	hot dry rock	45
Solar thermal	parabolic trough	22
Biomass	various	18
Nuclear	various generation II reactor types	16
Wind	onshore	12
Hydroelectric	reservoir	4

As it can be seen from the table, fossil fuels are causing more CO2 emissions by far. Therefore, a considerable amount of CO2 emissions can be reduced by replacing fossil fuel energy systems with renewable energy systems. Therefore, using the full potential of renewable sources is important for each country in the world. The CO2 emissions of the countries are presented in the map below.

Figure 26 - Countries by CO2 Emissions (thousands of tons per annum) via the Burning of Fossil Fuels
(Wikipedia 2013)



As it can be seen from the figure, the CO_2 emissions of the emerging economies are above the world average. Turkey, Mexico, South Africa, Malaysia, Philippines and Thailand are above the average whereas India and China are two of the highest CO_2 emitters in the world.

C. Energy Efficiency

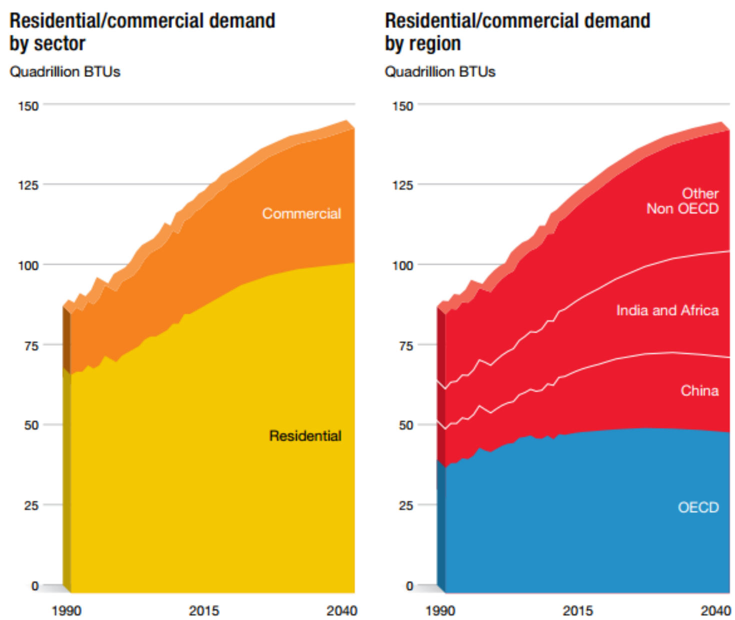
The annual energy consumption in the world is increasing; however, the main increase of the consumption will be caused by the developing countries (Exxon Mobil 2012).

Although OECD countries have the half of the world's energy consumption, the increment of the energy demand in these countries is lower than the non-OECD countries. According to a report published by Exxon Mobil, this situation is explained:

"Residential/commercial demand for energy, including electricity, is expected to rise by about 25 percent from 2010 to 2040. Virtually all of this increase will come from Non OECD countries, and almost all of it will be met by two forms of energy: electricity and natural gas (Exxon Mobil 2012)".

The projection of the rise of the residential demand is presented in the figure below:

Figure 27 - Residential / Commercial Demand Projections *(Exxon Mobil 2012)*



According to the report,

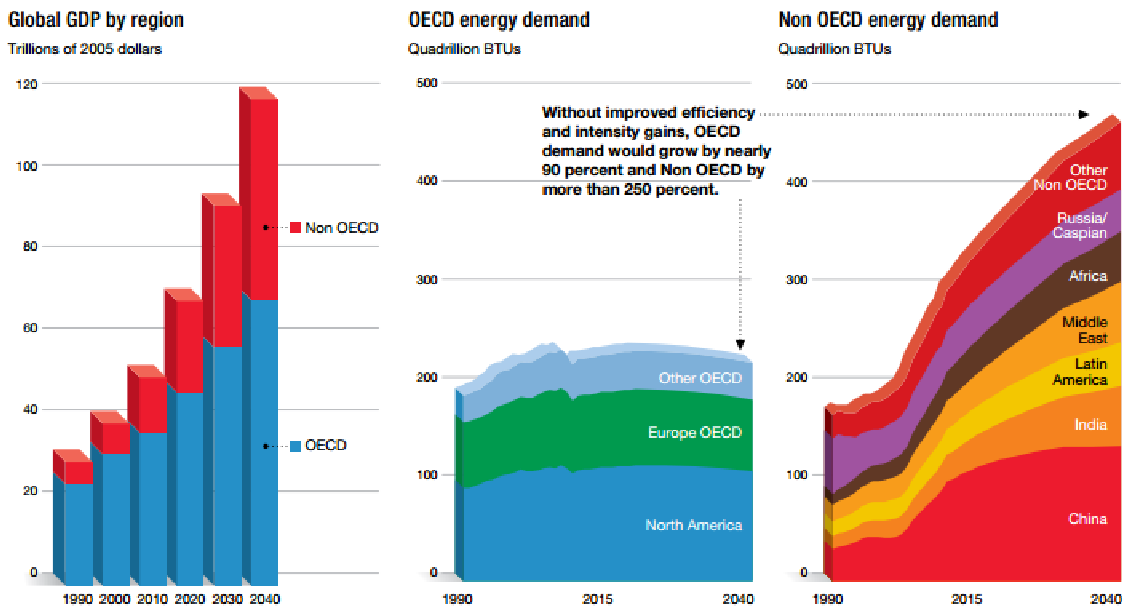
"The residential energy demand is expected to rise through 2030, then flatten as global growth in households and population begins to slow around that time. On the other hand, commercial demand for energy will continue to grow on a global basis through 2040, as economic advancement in Non OECD countries will require more energy, particularly electricity, for stores, hospitals, schools and businesses (Exxon Mobil 2012)".

The Exxon Mobil report has also pointed the importance of efficiency:

"The Efficiency will have a big impact in Non OECD countries" and added "But these gains will not be enough to offset the rise in energy demand associated with having five-sixths of the world's population accelerating its progress toward better living standards and greater prosperity (Exxon Mobil 2012)".

ExxonMobil foresee the Non OECD energy demand rise by nearly 60 percent, and if the energy efficiency will not be improved, the energy demand would grow 90 % in OECD counties and by more than 250 % in Non-OECD countries by the year 2040 as it is presented in the figure below (Exxon Mobil 2012).

Figure 28 - GDP and Energy Demand in OECD and Non-OECD Countries *(Exxon Mobil 2012)*



It is stated in the McKinsey Global Institute (MGI) report that there is a big potential in energy productivity in developing countries (McKinsey Global Institute 2009). A research conducted by the MGI showed that developing countries could slow the growth of their energy demand by more than half over the next 12 years and this reduction potential is larger than total energy consumption in China (McKinsey Global Institute 2009).

When compared to developed countries, the developing countries has different drivers for energy efficiency measures (World Energy Council 2013). In developing countries, energy efficiency is an important issue with the driving forces such as alleviating the financial burden of oil imports, reducing energy investment requirements, and making the best use of existing supply capacities to improve the access to energy rather than reducing greenhouse gas emissions and local pollution (World Energy Council 2013).

According to World Energy Council, improving the energy efficiency in developing countries would benefit the country in many ways such as:

- "Supply more consumers with the same electricity production capacity, which is often the main constraint in many countries of Africa and Asia (World Energy Council 2013)."
- "Slow down the electricity demand growth, and reduce the investment needed for the expansion of the electricity sector; this is especially important in countries with high growth of the electricity demand, such as China and many South East Asian countries (World Energy Council 2013)."

The second benefit seems to be more important for emerging economies because of their growing demand for electricity.

As it can be understood, energy efficiency is both an issue and an opportunity for developing countries to utilize their full potential. Therefore, a policy should also be addressing energy efficiency issues.

D. Economic Inequality

Economic inequality, also known as income inequality, is the common problem of many countries notwithstanding the economic level of the country. The effects of economic inequality has been researched for years. The consequences of economic inequality can be summarized as:

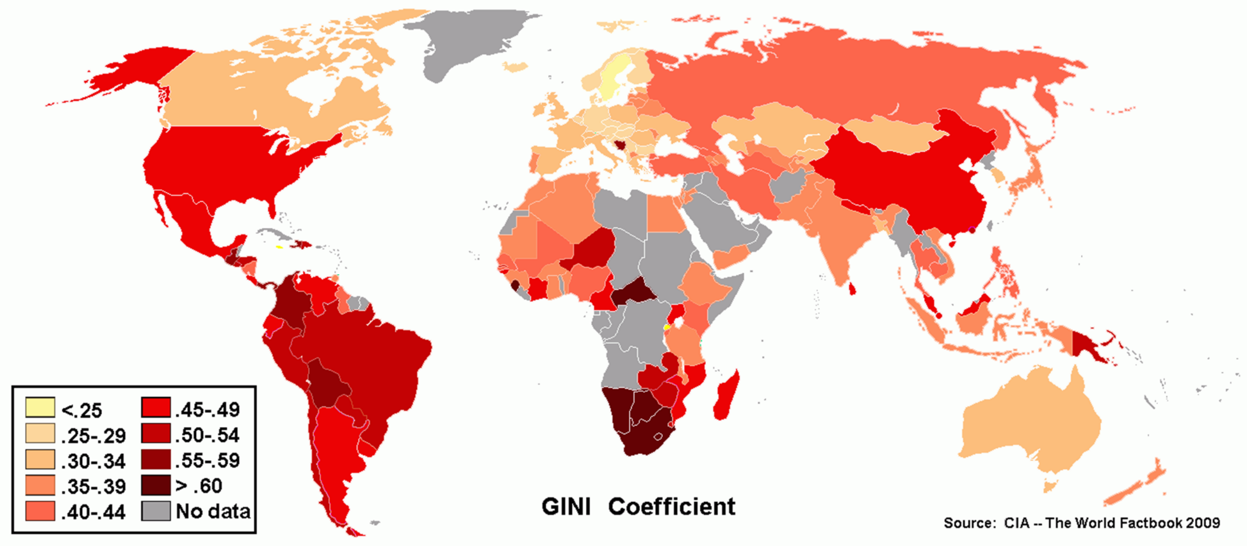
- **Health: "**Higher rates of health and social problems (obesity, mental illness, homicides, teenage births, incarceration, child conflict, drug use), and lower rates of social goods (life expectancy, educational performance, trust among strangers, women's status, social mobility, even numbers of patents issued) in countries and states with higher inequality (Wikipedia 2013)."

- ❖ **Social Cohesion: "**In more equal societies, people are much more likely to trust each other, measures of social capital (the benefits of goodwill, fellowship, mutual sympathy and social connectedness among groups who make up a social units) suggest greater community involvement, and homicide rates are consistently lower (Wikipedia 2013)".
- ❖ **Crime: "**Economic inequality is found to be positively and significantly related to rates of homicide (Wikipedia 2013)."
- ❖ **Social, Cultural, and Civic Participation:** "Higher income inequality led to less of all forms of social, cultural, and civic participation among the less wealthy (Wikipedia 2013).
- ❖ **Happiness Level: "**Societies where inequality is lower, population-wide satisfaction and happiness tend to be higher (Wikipedia 2013)".
- ❖ **Corruption:** It is found that income inequality breeds corruption (Bernasek 2006).
- ❖ **Productivity:** Psychological effect that may lower productivity and reduce efficiency in a system (workplace, country, etc.), (Bernasek 2006).

When all the consequences of economic inequality are considered, it can be said that it is not only the problem of low-income individuals, but it has an extensive effect on a nation as whole. The "Gini Coefficient" is a coefficient used for measuring inequality among any set of values such as income levels (Wikipedia 2013). The coefficient ranges between 0 and 100.

When considering income distribution, a Gini coefficient of "0" shows a perfect equality where everyone has the exactly same income, and "100" represents the maximal inequality where only one person has all the income of the nation (Wikipedia 2013). The Gini Coefficients of countries are presented in the map below.

Figure 29 - GINI Coefficients of Countries *(Wikipedia 2013)*



As it can be seen from the figure the countries with emerging economies has the economic inequality problem. Especially in a country where the annual income is growing rapidly, the opportunity for curing the economic inequality problem through appropriate allocation of sources rises.

As mentioned in the previous chapters, developing countries are highly dependent on fossil fuels that cause high amount of CO_2 emissions. Moreover, such countries have considerable energy saving potentials. As a common problem of many countries in the world, economic inequality is also a problem of many developing countries. The aim of the SocioFIT Mechanism is to address mentioned issues while implementing a successful renewable energy policy.

V. Introduction of the Socio Feed-in Tariff Mechanism (SocioFIT)

As is mentioned in the previous chapters, one of the constraining problems of developing countries is limited financial resources. Although a country might have excellent renewable sources, the financial limitations would not allow the country to use its full potential.

The developed countries have sufficient resources for strong policies. However, funding is still a significant problem for developing countries (European Union 2006). Moreover, many of these countries has low energy efficiency levels.

On the other hand, energy efficiency saving potentials can be used as a driver for deploying renewable energy systems if an appropriate mechanism can be established. The Socio Feed-in Tariff Mechanism is introduced for such a purpose.

The SocioFIT can be implemented until a country reaches its energy saving goals and installs adequate renewable energy systems. Therefore, the mechanism can be defined as a transitional renewable energy support mechanism for countries with lower economic, income equality and energy efficiency levels. The mechanism targets residential energy efficiency and renewable energy systems for addressing some of the shortcomings found in the analysis of the previous chapter.

The policies of three developed countries were evaluated in the previous chapters. In this chapter, a new mechanism is introduced based on the conducted analysis.

Since economic inequality problem, one of the social problems in many countries is addressed while increasing renewable energy deployment of a country, the new policy is named as “Socio Feed-in Tariff Mechanism” or “SocioFIT” in short.

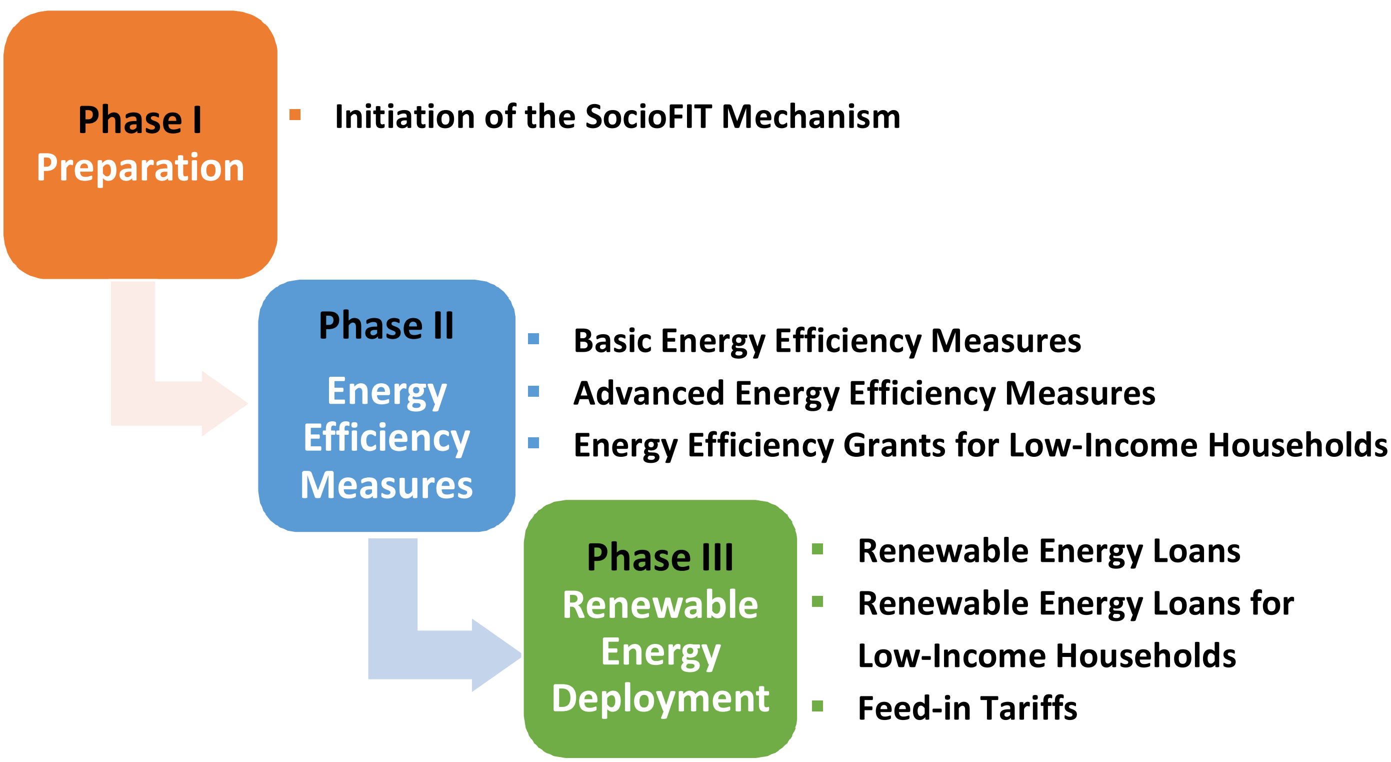
The SocioFIT Mechanism is formed by combining implemented policies of Germany, Japan and the USA. The mechanism can be implemented in many countries with different economic levels.

The objective of the SocioFIT Mechanism can be explained as:

- Establishing a self-sufficient mechanism that does not need external financial support
- Enhance the energy efficiency of a country as whole
- Using energy savings as a resource for renewable energy deployment
- Increasing the number of renewable energy installations
- Supporting the domestic market
- Raising energy efficiency, renewable energy awareness, and environmental consciousness
- Supporting the economy of every household and country as whole
- Supporting the income equality in a country

The phases of the SocioFIT Mechanism is presented in the figure below.

Figure 30 - Phases of the Socio Feed-in Tariff Mechanism



The following regulations and mechanisms are used as a baseline for the SocioFIT Mechanism:

- EEG, Germany, 2004(see Appendix A.1.1)
- KFW-Programme for Producing Solar Power, Germany, 2005(see Appendix A.1.1)
- Alternative Energy Act, Japan, 1980 (see Appendix A.2.1)
- Energy in My Yard Japan (see Appendix A.2.2)
- Mortgages for Energy Efficiency, USA,1992 (see Appendix A.3.1)
- REAP/RES/EEI Grants Program, USA 2002 (see Appendix A.3.1)
- Energy Independence and Security Act, USA, 2007 (see Appendix A.3.1)
- ARRA: Tax-Based Provisions, USA, 2009 (see Appendix A.3.1)
- California Solar for Affordable Housing Programs, USA (see Appendix A.3.2)
- Solar Photovoltaic Systems for Low-income Housing Developments, USA (see Appendix A.3.2)

A. Phase I: SocioFIT Preparation Phase

1.1. Introduction

The quantitative analysis results showed (see chapter III) that German EEG law of 2004 was the most effective solar energy policy among the selected countries. In the SocioFIT Mechanism, the 2004 German EEG law was taken as an example and modified for implementing in a developing country.

Instead of limiting the policy only for solar PV systems, the mechanism is designed to support all kinds of small renewable systems.

Some of the noticeable features of this policy was:

- High-level feed-in tariffs
- Low-interest loans
- Tax Credits
- EEG Tax-levy

In Germany, electricity buyers pay an additional price for the electricity (tax-levy), which is used as a funding source of the feed-in tariff incentives for supporting renewable energy systems.

It is asserted that one of the reasons for the success of the EEG law was that the policy concerned every individual in the country (Peter Sinclair 2013). This example shows that people would be more interested in a renewable energy support mechanism where citizens pay the renewable tax-levy whether they install a renewable system or not. It is also claimed that the EEG law caused the public to become more interested in, and informed about, energy politics and more motivated to save energy (Peter Sinclair 2013). The same approach can be used in developing countries to raise awareness about economic and environmental impacts of energy efficiency and renewable energy systems.

The electricity consumption per capita is found to be related to the income level of a household (IEA 2008, 76), (Kamogawa and Shirota n.d.) . That means high-income households tend to spend more electricity than low-income households do. Therefore, high-income households pay more than low-income households for the electricity. Since the tax-levy is charged as an additional amount on top of the electricity retail prices per kWh consumption, and electricity consumptions of households increase as the income levels rise it can be said that high-income household would be paying more for the tax-levy, whereas low income households would be paying less. Therefore, it can be asserted that collecting money through a tax-levy can support economic equality in a country.

On the other hand, this system can cause the redistribution of the wealth from the poorer parts of the country to middle and high-income class (IEA 2011). If everyone had the capability to install a renewable system, a tax-levy system could be considered as a just policy. However, since the most of the low-income households might not afford to install a renewable system, but still pay the tax-levy, in fact they become grantors of renewable energy systems to higher-income citizens without any return.

In Germany, the electricity retail price was 0.253€/kWh for the households (EuroStat 2012) and the EEG levy amount was at 0.035 €/kWh in 2011 (PVTech 2011). The tax-levy represented nearly 14 % of the residential electricity retail price in that year. Since the levy amount was considerably high, it caused many reactions from the German citizens. The tax-levy was collected from households and the industrial buildings were set apart from the mechanism in Germany.

1.2. Nominal Tax-Levy

It is suggested in the SocioFIT Mechanism that a tax-levy should be charged from all households as in Germany. However, instead of using tax-levy as a funding source, at this phase the tax-levy should be kept at a nominal level to increase the public interest on energy efficiency and renewable energy systems, and prepare the public for next phases of the mechanism.
The tax-levy amount is increased gradually as more people install energy efficiency measures and renewable energy systems in the next phases of the SocioFIT Mechanism. Moreover, the collected money is allocated with a different approach.

1.3. Promotions

Since this phase is a preparation stage, it is important to promote the mechanism effectively to inform the public about the benefits of the mechanism to get the public support at this phase.

1.4. Domestic Market Support

Additionally, energy efficiency and renewable energy industries should be supported by the government to be able to use domestic products at the next phases of SocioFIT Mechanism. The details of the mechanism are explained in the next sections.

Summary Framework of Phase I: SocioFIT Preparation Phase

- A nominal tax-levy is charged from all households.
- The SocioFIT Mechanism is promoted through mass media sources.
- Domestic energy efficiency market and renewable energy market should be supported by the government.

Benefits of Phase I: SocioFIT Preparation Phase

The benefits of this phase can be summarized as follows:

- Since the tax-levy is nominal, the reaction of the public will likely be considerably lower than the reaction in Germany.
- Early start of promotions would create the desired environment for the next phases of the mechanism.
- If an effective domestic supply-chain can be established for energy efficiency products and renewable energy systems, such products can be used in the next phases of the mechanism to support the country economy.

B. Phase II: Energy Efficiency Measures

In Phase I: Budget Creation, the implementation of a nominal tax levy was introduced. Since the SocioFIT Mechanism aims to use the energy savings as a financial source for renewable energy deployment policies, the energy efficiency measures are presented in this chapter.

Before installing a renewable system in a house, its energy efficiency should be maximized. If the consumed electricity can be reduced, a smaller renewable system would be sufficient to meet the needs of a building.

As it is explained in the chapter IV-C, the energy efficiency is an important issue for developing countries and specifically emerging economies because of their growing energy demand. On the other hand, this means there is a great potential for energy savings in such countries. Therefore, this phase of the SocioFIT Mechanism introduces energy efficiency measures for households.

"The Phase II: Energy Efficiency Measures" involves three stages as presented in the figure 30.

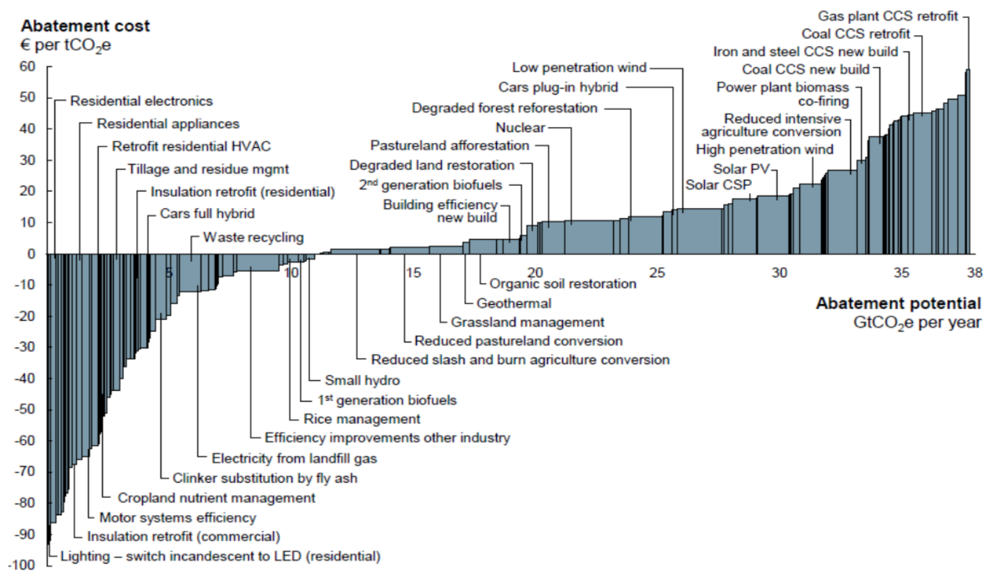
1. Basic Energy Efficiency Measures

1.1. Introduction

The allocation of the collected tax levy budget starts with basic energy efficiency measures for residences. According to UN Foundation “Energy efficiency is the cheapest, fastest, and smartest strategy available for saving money and resources and reducing greenhouse gas emissions (UN Foundation 2012)”.

The figure below presents the GHG abatement potential and energy efficiency measures sorted according to their costs.

Figure 31 - Global Greenhouse Gas Abatement Cost Curve *(Sarkar and Singh 2009)*



As it can be seen from the figure, there are many economical ways of reducing CO_2 emissions including energy efficiency measures and renewable energy systems. The figure shows that the cheapest method for reducing CO2 emissions is switching the lighting from incandescent to LED bulbs. One of the most effective bulbs is Compact Fluorescent Lamps (CFLs). CFL bulbs consume 60% less than conventional light bulbs and pay for themselves in about 6 months (European Commission 2013), (Energy Star n.d.).

1.2. Energy Efficiency Packages

In addition to the government level incentives, there are some utility companies offering incentives for energy efficiency measures. One of these companies is Puget Sound Energy of Washington State, USA. The Puget Sound Energy company can be introduced as:

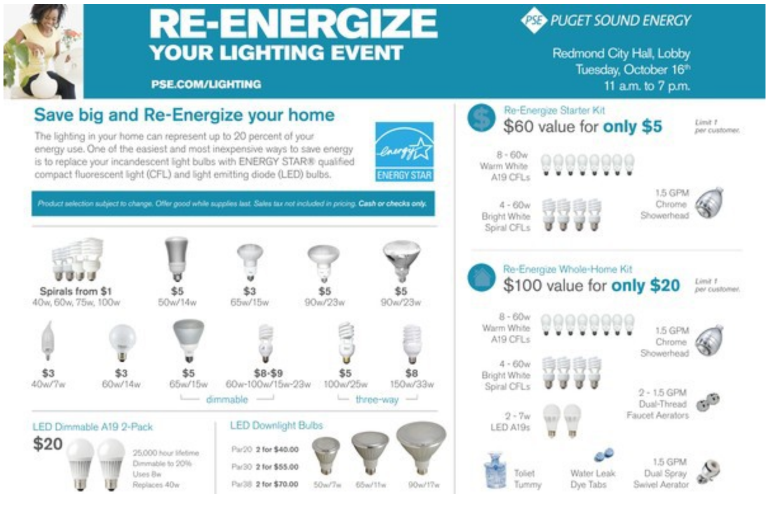
> "Washington State's oldest local energy utility providing electrical power and natural gas primarily in the Puget Sound region of the northwest United States (Wikipedia 2013)."

The company offers many services for saving energy. One of these offerings is a program called, "Re-Energize". Under the program, PSE Company offers (Pudget Sound Energy 2012):

- ❖ Rebates for homeowners on energy-efficient furnaces and appliances
- ❖ Engineering consultation for commercial and industrial projects,
- ❖ Tailored grants for retrofits and upgrades in energy-intensive buildings.

Within the scope of the Re-Energize program, the company offers packages called the "Re-Energize Kits" for different needs of Washington residents. A flyer of the product is presented below.

Figure 32 - Puget Sound Energy Re-Energize Kit Brochure *(Chapman 2012)*



The figure shows the different energy efficiency products offered by the company comprising not only electricity but also water saving products. The products were offered in small boxes for specific periods in selected locations such as a city hall or a shopping mall for a cost that is below the market retail price.

For the Phase II: "Energy Efficiency Measures," this program is taken as an example to be implemented in a larger scale.

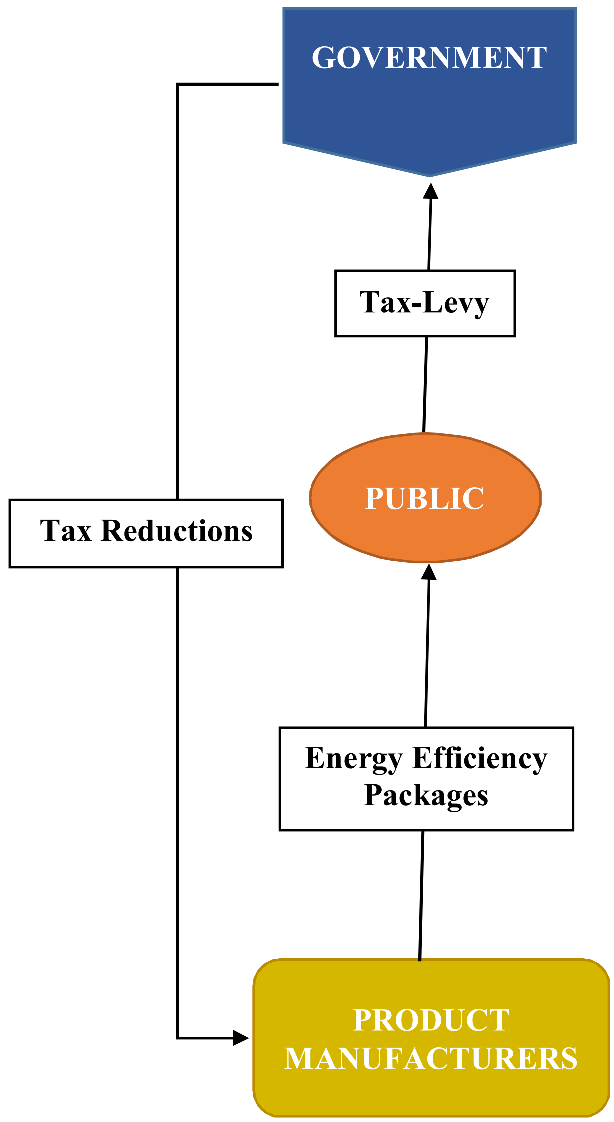
Such energy efficiency packages can be offered countywide in developing countries. The costs can be reduced through mass production by making deal with domestic manufacturers to support the country economy.

Along with CFL bulbs, some educational materials can be included in the energy efficiency packages such that the residents could be informed about energy efficiency, the benefits of the products and the program, and its contributions to both household and country economy. That way public can be informed about and engaged to energy efficiency measures.

Additionally, promotions can be used to increase the interest of the public to energy efficiency products. The educational materials, along with advertisements, demonstration projects and other media sources, can be designed to effect the consumer behavior to obtain a powerful result.

The diagram of the basic energy efficiency stage is presented below.

Figure 33 – Phase II: Basic Energy Efficiency Measures Diagram



1.3. Gradual Phase-Out of Incandescent Bulbs

The European Union countries started phasing out the incandescent bulbs in 2009, and in September 2012, sale of these bulbs is completely banned in the European Union (Wikipedia 2013).

It is assumed that the energy savings through this phase-out policy would bring energy savings of 39 TWh of electricity across the EU by 2020. The UK government stated that the average annual net benefit of the phase-out is expected to be £108 million between 2010 and 2020 just in the UK (Hickman 2012).

Similarly, in the Basic Energy Efficiency Measures Phase, such a gradual phase-out policy can be implemented. Especially by offering energy efficiency packages, the reaction for such a phase-out could be minimized.

Summary Framework of Phase II: Basic Energy Efficiency Measures

- The government makes agreements with local energy efficient bulb manufacturers
- Energy efficiency packages are created including energy efficient bulbs and educational materials.
- The cost of the energy efficiency packages are met with the nominal tax-levy income and energy efficiency savings.
- Energy efficiency packages are sent to each household.
- Gradual phase-out of incandescent bulbs is initiated.
- The public is constantly informed about the usage of the collected tax-levy by explaining the benefits of energy efficiency packages and their contribution to both national and

household economy through promotions, demonstrations, advertisements and efficient usage of media sources.

Benefits of Phase II: Basic Energy Efficiency Measures

The benefits of this phase can be summarized as follows:

- The energy efficiency packages will be sent to each household, therefore every tax-levy payer will be able to benefit from the mechanism as they make their payments.
- If the supply chain can be established successfully, the delivery time of the products would be considerably lower. This would increase the confidence of residents to the mechanism as they see a real product and energy savings in a short time in return of their payments.
- Both the country and household economy is benefited through the usage of national products and the low prices caused by the bulk purchases.
- The country economy is benefited through energy efficiency measures such that reduced electricity consumption would lower both the imported energy costs and required investments for energy transmission lines.
- As the mechanism succeeds, increasing support from the public would establish the necessary environment for the next phases of the SocioFIT Mechanism.

2. Advanced Energy Efficiency Measures

2.1. Introduction

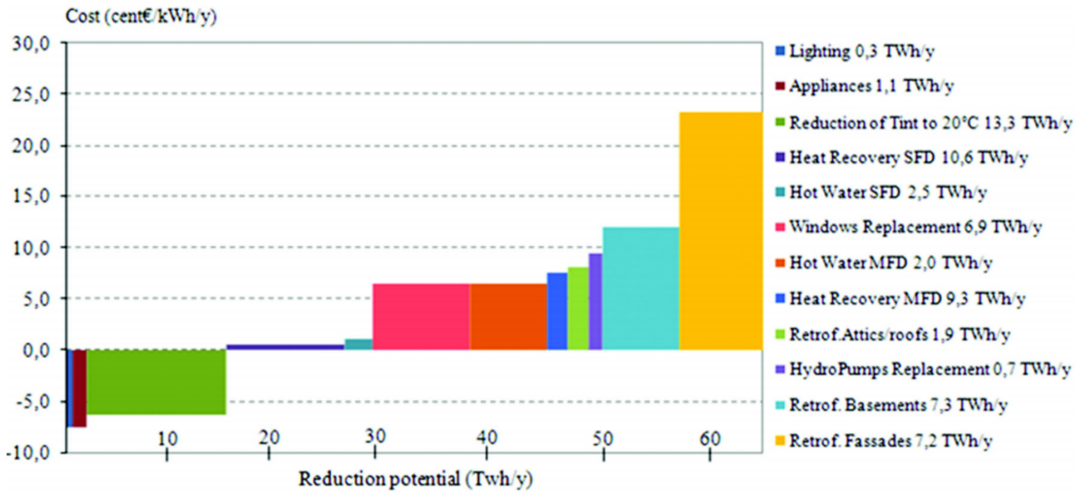
At the first stage of Phase II: Basic Energy Efficiency Measures the public awareness and confidence is ensured through the reduction of the electricity consumptions of the households. A country can proceed to Advanced Energy Efficiency Phase as the energy efficiency awareness increases in the public.

At this stage, demonstration programs, advertisements, usage of media sources, and educational programs are expanded by using the increased budget. In addition to energy efficiency awareness environmental issues such as climate change, GHG emissions can be introduced at this phase for preparing the public for the next phases of the mechanism. Most importantly, to create the appropriate environment for the next phase of SocioFIT Mechanism, the environmental and economic effects of renewable energy systems should be introduced to the public.

The incandescent bulbs can be completely phased out for further energy efficient bulb sales as it is done in European Countries as the usage of energy efficient bulbs increase.

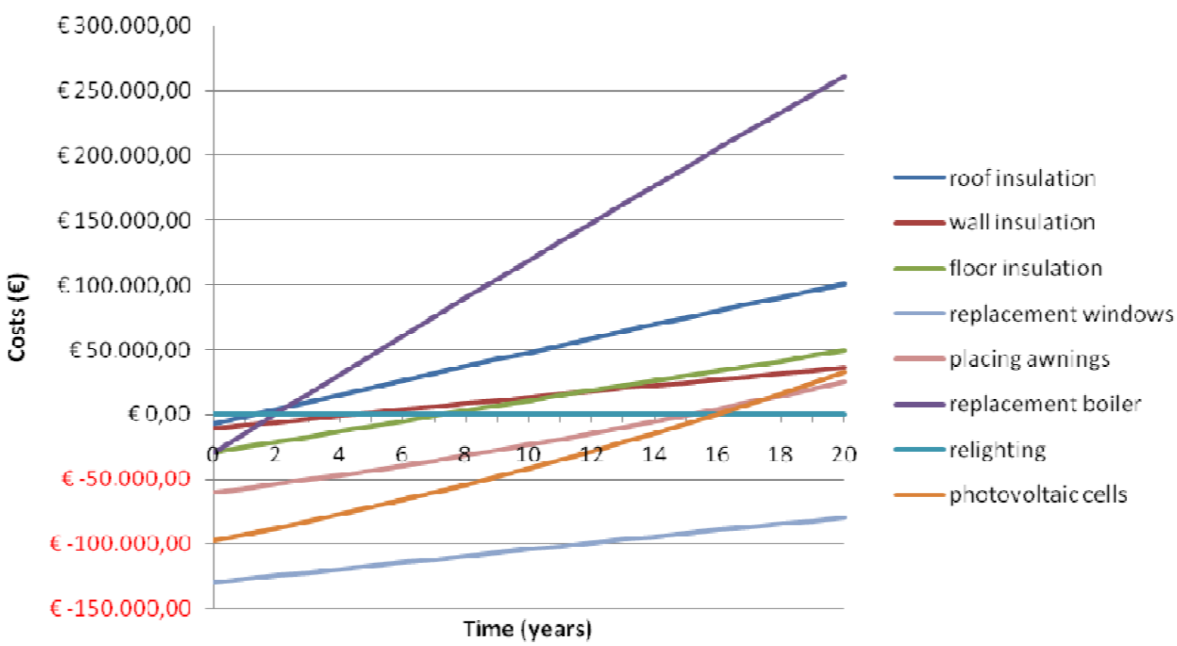
The one of the energy efficiency measures with the least payback period was implemented in the previous phase. However, the costs and energy savings of energy efficiency systems vary as the measures change. Costs for different energy efficiency measures are presented in the figure below.

Figure 34 - Average Costs per Type of Energy Efficiency Measure *(Mata, Kalagasidis and Johnsson 2010)*



In another research, a residential building was analyzed to determine the payback periods of energy efficiency measures. The study showed the payback periods of different energy efficiency measures were as presented in the graph below.

Figure 35 - Payback Period Measures for a District House *(Audenaert 2000)*



As can be seen from the figure, the relighting costs almost no money. Roof insulation and wall insulation costs around €5,000, whereas floor insulations can be as high as €25,000. Therefore, at this stage supporting the low-cost energy efficiency materials are targeted.

2.2. Tax-Levy and Direct Rebound Effect

Although energy efficiency measures improve energy efficiency, many efficiency improvements do not reduce energy consumption by the amount predicted by simple engineering models (Wikipedia 2013).

This situation is explained in the UK Energy Research Center report:

> "This is because they make energy services cheaper and so consumption of those services increases. For example, since fuel efficient vehicles make travel cheaper, consumers may choose to drive farther and/or faster, thereby offsetting some of the potential energy savings. This is an example of the direct rebound effect. (UK Energy Research Centre 2007)"

Therefore, at this stage, tax levy is increased from a nominal level to a medium level for both supporting further energy efficiency measures and avoiding the direct rebound effect.

Although the money saved through the energy savings of the country might provide a sufficient budget at this stage, the tax levy is maintained for continuing energy efficiency levels, awareness of the issue and the next phase of the SocioFIT Mechanism.

2.3. Energy Efficiency Loans

At this phase, loans are offered for energy efficiency products such as building insulations. As USA's "Mortgages for Energy Efficiency" program in 1992, the government should involve as a warrantor in the system such that every individual will have the opportunity to get a credit from a financial institution. The financial institutions should be secured by the government warranty.

The payments are ensured through financial institution-government collaboration. For example, if an individual do not pay the required loan payments to the financial institution, the financial institution should inform the government. The government should pay the required amount from the tax-levy budget and charge that individual with an additional tax on the electricity bill on a monthly basis. Additionally, a credit score database should be created as a deterrent factor for such defaults and for using for the next phase of SocioFIT Mechanism in which loans will be offered for renewable energy systems. For example, a citizen with a higher credit score should benefit more from the mechanism, whereas a person with a low credit score should be provided with a limited support.

2.4. Tax Reductions

At this phase, tax reductions should be offered to the manufacturers of energy efficiency products. This would reduce the prices of energy efficiency products and therefore would allow the households to install such products for lower prices.

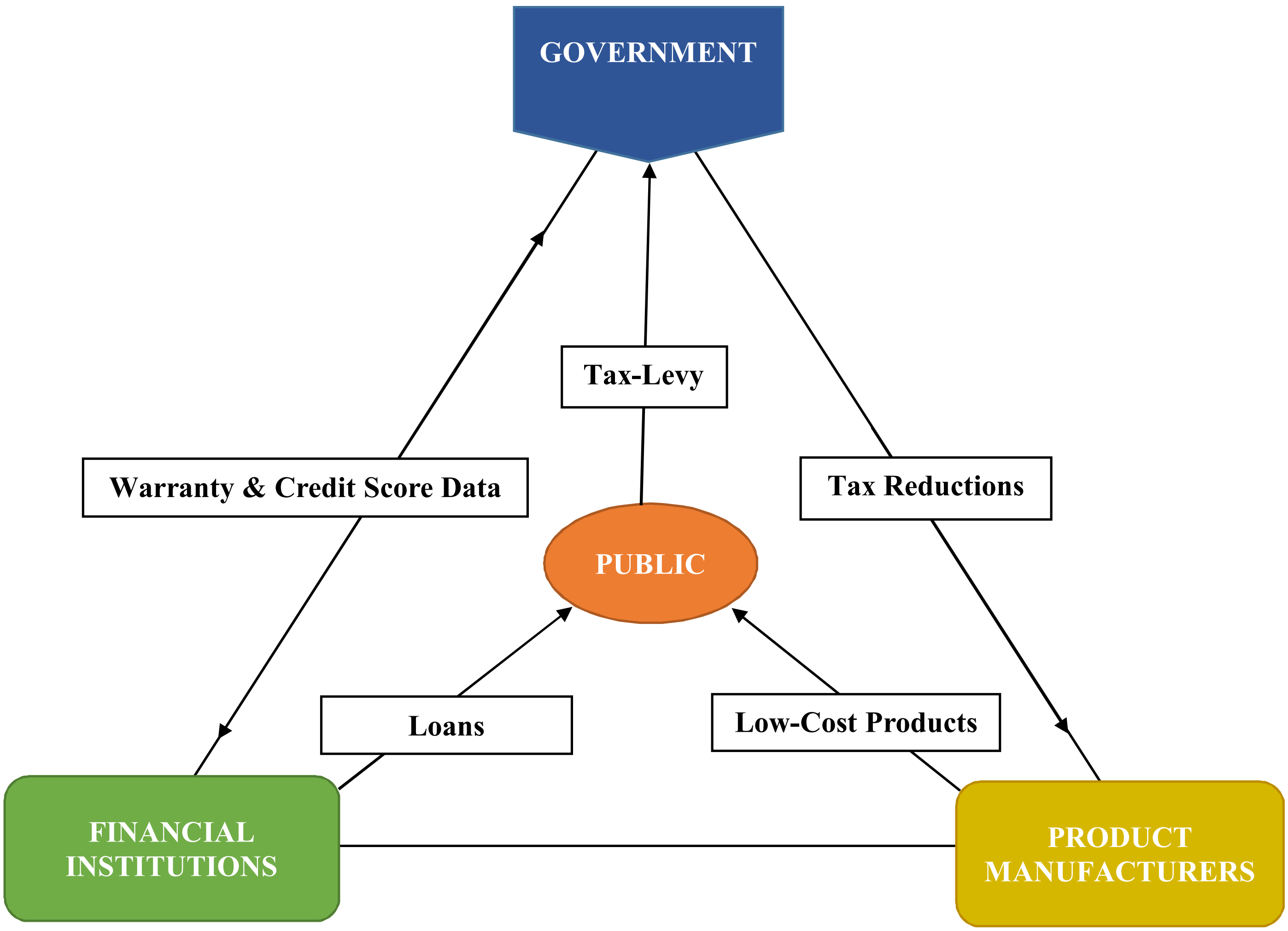
2.5. Energy Efficiency Certification

It is likely to expect that homeowners would be willing to install energy efficiency products in their houses due to the decreasing costs of these materials. On the other hand, a tenant might not have the authority to install such products. In that case, even though a resident would be willing to install energy efficiency products to decrease their energy expenditures, they would not be able to install such systems. Therefore, at this stage a certification mechanism can be initiated to solve this problem.

Energy Star is an international standard for energy efficient consumer products, and the Energy Star certificates are provided for many products including new homes that meet guidelines for energy efficiency (Wikipedia 2013). Likewise, during the implementation of phase II, homeowners that install energy efficiency products can be awarded with similar certificates. Government can start promoting the certificates by emphasizing the energy consumption difference of an energy efficient house and a regular house. As the energy efficiency awareness of the public increases, the interest level on energy efficient houses would rise.

Another certification system called LEED certification is a standard for evaluating building sustainability (NRDC 2013). According to Dakowicz, "the average rent for a LEED certified building is 20 percent higher compared to buildings with no certification (Dakowicz 2012)". A similar trend can be observed in case of an implementation of a certification mechanism. Similarly, increasing demand on the energy efficiency houses could increase the rent levels of such houses. As a result, homeowners would be encouraged to install energy efficiency products. The same mechanism will be used for both "Advanced Energy Efficiency Measures" and "Renewable Energy Loans" (next phase) stages of the SocioFIT Mechanism. The diagram below presents these stages of the mechanism.

Figure 36 – Phase II: Advanced Energy Efficiency Measures Diagram



Summary Framework of Phase II: Advanced Energy Efficiency Measures

- The tax-levy is increased to a medium level.
- The government offers tax rebates to local manufacturers of energy efficiency products.
- Manufacturers offer energy efficiency products for a lower price.
- The government warrants the financial institutions for the loans for energy efficiency products.
- Financial institutions offer loans for energy efficiency products.
- Financial institutions provide credit score data to the government for creating a nationwide credit score database.
- Energy efficiency certificates are provided to product installers.
- More comprehensive and effective demonstrations, advertisements, and education materials are supported through the mechanism for promoting energy efficiency measures as well as renewable energy awareness.

Benefits of Phase II: Advanced Energy Efficiency Measures

- The increased budget of the program would allow the government to improve energy efficiency measures.
- The "Direct Rebound Effect" problem is solved through the increment of the tax-levy.
- Energy savings support the economy of both the public and the government.
- The awareness of energy efficiency, environmental issues and residential renewable energy systems are risen through the comprehensive demonstrations and advertisements.

- ❖ The increased awareness of residential renewable energy systems prepares the desired awareness level for successful implementation of "Phase III: Residential Renewable Energy Deployment".
- ❖ Increased employment number in energy efficiency industry.

3. Energy Efficiency Grants For Low Income Households

3.1. Introduction

As it is explained in the section IV.D, one of the main problems in developing countries is inequality in the distribution of wealth. The German tax-levy is a taxation system based on the electricity consumption. The created budget is used for supporting renewable energy systems through a feed in tariff (FIT) mechanism. The customers are charged whether or not they can install a renewable energy system. As mentioned in the previous chapters, this system can cause the redistribution of the wealth from the poorer parts of the country to middle and high-income class (IEA 2011).

Although the wealthier households have higher electricity consumptions and pay more share of the tax-levy, it can be argued that such a mechanism is still supporting inequality in the distribution of wealth.

The high up-front costs of energy efficiency products can be met with loans that are introduces in the previous stage. Although such loans would be favorable for households with many income levels, the households with the lowest income level might not even be able to afford such loans. Since the majority of the population in developing countries is low-income citizens, the mechanism is not appropriate for every individual unless an additional supportive mechanism is established. At this point, the SocioFIT Mechanism might complete the missing part for this problem.

3.2. Low-Interest Loans & Grants

The SocioFIT Mechanism was supplied by the tax levy incomes thus far. Loans were offered by financial institutions in the previous phase. The government involvement was limited a as warrantor.

At this stage, the return from the energy savings should be used for creating a budget for low-interest loans and grants to be provided for low-income households. The grants should be dedicated to low-income households in order to create a mechanism that supports the equality in the distribution of wealth.

The government can provide low-interest loans and grants to low-income households where the grant coverage would vary based on the income level of the household. For instance, the households below a specific income level can be provided with 75% of the energy efficiency product costs, whereas a household with a higher income can benefit less from the grants. The middle and high-level income families can still be provided with loans that are offered by the financial institutions.

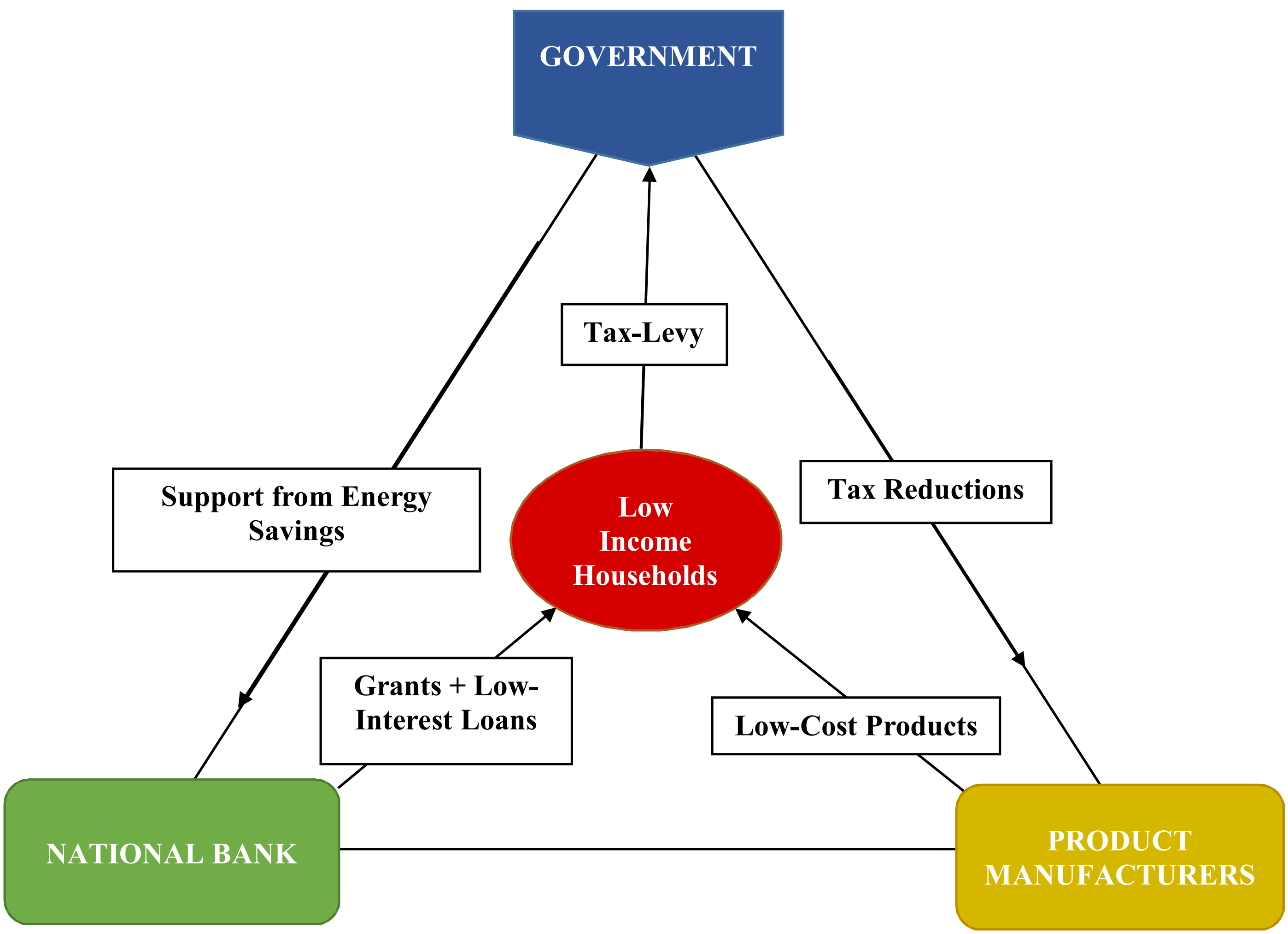
An exemplary loan and grant distribution is presented in the table below;

Income Level of the Household	Incentive Type
Lowest %25	75% Grant + Low-Interest Loans by Government
Lower %25-50	25% Grant + Low-Interest Loans by Government
Upper %50	Loans by Financial Institutions

The government grants and low-interest loans can be offered by a national bank. The poor management of high volume of applications by the government would become a restraining factor for a rapid implementation of the mechanism. Therefore, it is important for a country to establish a well-functioning system at this stage.

The same mechanism will be used for both “Energy Efficiency Grants for Low Income Households” and “Renewable Energy Loans for Low Income Households” (next phase) stages of the SocioFIT Mechanism. The diagram below presents these stages of the mechanism.

Figure 37 - Phase II: Energy Efficiency Grants for Low Income Households Diagram



As the grants and low-interest loans are offered at this stage, the loans that are offered by financial institutions should be continued for higher-income households.

Summary Framework of Phase II: Energy Efficiency Grants

- The government starts offering low-interest loans and grants for low-income households provided by a national bank.
- The budget is supported through the energy savings.
- Previously offered loans by financial institutions are continued.
- The benefits of the mechanism is promoted through mass media.

Benefits of Phase II: Energy Efficiency Grants

- Tax-levy payers from every income level are benefited through the mechanism.
- Low-income families are provided with energy efficiency measures.
- Both the economy of low-income households and government is supported through the energy savings.

C. Phase III: Renewable Energy Deployment

The energy efficiency measures are implemented in the previous phase of the SocioFIT Mechanism. At the "Phase III: Residential Renewable Energy Deployment" the deployment of residential renewable systems is aimed to be achieved. The same approach implemented in the energy efficiency phase is followed at this stage for supporting small renewable energy systems. If domestic manufacturers can establish an operative supply chain for renewable energy systems by this stage, such products can be used in the mechanism and therefore country economy can benefit from it. Therefore, as mentioned in the previous chapters it is important for the government to support such manufacturers at the earlier stages of the mechanism.

1. Renewable Energy Loans

1.1. Introduction

The high upfront costs of renewable systems are quite an important problem in most developing countries as the majority of the population is at lower income levels. Since the low-income households represent the majority in many developing countries, engagement of such households play an important role on nationwide renewable energy deployment.

As a result of the energy savings, a considerable budget is expected to be created at the end of "Phase II: Energy Efficiency Measures". It is likely to expect that as a result of energy efficiency measures, the energy efficiency, energy security and environmental awareness should be raised in the country. In such an environment, this would be an appropriate time for guiding the public interest to renewable energy systems. If the previous phase can be implemented successfully, the confidence of public on the mechanism can be a significant source for implementation of this phase.

1.2. Tax-Levy

The payback periods of some renewable energy systems are not as high as energy saving measures (see Figure 35). In order to meet the increased costs of the mechanism the tax-levy should be increased to an adequate level at this stage. Since it is likely to expect that many of the households should have installed energy efficiency products until this point, the effect of the increased tax-levy would be much lower on households, and especially on low-income households due to their low energy consumption in comparison with high-income households. Moreover, increasing retail prices though the tax-levy would be an additional motivator for renewable installations.

1.3. Small Renewable Energy Systems (Micro-Generation)

After the nationwide implementation of energy efficiency measures, the country can allocate the energy savings budget to renewable energy systems.

Small renewable energy systems (micro-generation systems) can be supported with the same mechanism. Some of these renewable energy systems are:

- Solar photovoltaic systems
- Small wind power plants
- Small Hydropower plants
- Geothermal heat pumps

United Kingdom Example

In the United Kingdom, under the program called "Low Income Carbon Buildings Programme (LCBP)", the government offers grants for micro-generation systems. The offered incentives are presented in the table below.

Figure 38 - Domestic Microgeneration Grants in the UK *(Bergman and Jardine 2009)*

Technology	***Grants – First Year***	***Grants – Second Year***
Solar photovoltaics (PV)	Maximum **£3,000** per kW Overall maximum **£15,000** or 50% (lower of the two)	Maximum of **£2,000** per kW Overall maximum **£2,500** or 50% (lower of the two)
Micro-wind and Small hydro	Maximum of £1,000 per kW Overall maximum **£5,000** or 30%	Maximum of £1,000 per kW Overall maximum **£2,500** or 30%
Solar thermal	Maximum of £400 or 30%	Maximum of £400 or 30%
Ground source heat pumps	Maximum of £1,200 or 30%	Maximum of £1,200 or 30%
Wood pellet fed heaters/stoves	Maximum of £600 or 20%	Maximum of £600 or 20%
Wood-fuelled boiler systems	Maximum of £1,500 or 30%	Maximum of £1,500 or 30%

1.4. Community Renewable Systems

A community solar farm is "a solar power installation that accepts capital from and provides credit for the output and tax benefits to individual and other investors (Wikipedia 2013)". Such systems are built and shares are offered for individuals who are interested in having a regular renewable energy income.

The concept of "community solar farm" can be used for increasing the engagement of the public. In some cases, a household might not have an appropriate location for installing a renewable energy system. For example for installing PV systems,

- The roof of the house might not be large enough
- In a multi-story building, the produced electricity might be minimal when divided among the residents
- The solar irradiation might not be sufficient in that location

In that case, community renewable systems can be installed in any designated location. The government can determine specific locations for such systems and the households can have the opportunity to buy a share from a community renewable system with the provided loans.

1.5. Renewable Energy Campaign

At this stage of the mechanism, a campaign can be started by using the mass-media communication. A campaign called 100% Renewable Energy that started in Australia is a good example of such a promotion. The logo of the camping is presented below.

Figure 39 - 100% Renewable Energy Campaign Logo *(100% Renewable n.d.)*

In this case, for example a campaign called “Renewable Energy for Every House” can be initiated for further installations.

1.6. Merit-Order-Effect

Installing renewable energy systems would benefit a country in many ways. One of the benefits of installing renewable energy systems is an effect called “Merit-Order-Effect”. The “Merit-Order” is a way of ranking available energy sources based on their cost levels, and the “Merit-Order-Effect” is the cost reduction effect that is caused by using the available cheap electricity produced by renewable energy systems (Wikipedia 2013).

The Fraunhofer Institute asserted that the retail price of peak electricity could be lowered by as much as 40% during the sunny hours of the day. The study of the institute showed that the price of the electricity was reduced by 0.78 €cent/kWh in Germany during the sunny afternoons (Kraemer 2012).

In his book, Mendoça stated, "the German Ministry for the Environment has calculated their FIT cost electricity customers €3.2 billion in 2007, but saved them more than €5 billion through the merit-order-effect (Mendonça, Jacobs and Sovaco 2010). Therefore, the benefits through merit-order-effect should not be ignored.

1.7. Credit-Scores

In the energy efficiency phase a credit score database was created. Since the costs of renewable energy systems are higher than many energy efficiency measures, it is important for both the financial institutions and government to take the minimum risks while providing loans. At this stage, the credit score database can be used for evaluating the loan borrowers. The database can be provided to the participant financial institutions that will provide loans for renewable energy systems.

The Figure 36 presented in the advanced energy efficiency section also presents the implementation of this phase.

Summary Framework of Phase III: Renewable Energy Deployment

- Tax-levy is raised to an adequate level
- The government offers tax rebates to local manufacturers of renewable energy systems.
- Manufacturers offer small renewable energy systems for a lower price.
- Financial institutions offer loans for small renewable energy systems
- The credit score database is used for evaluating the loan borrowers.
- Community renewable energy locations are designated by the government.

- The benefits of the mechanism is promoted through mass media.
- A campaign is started for further public engagement.

Benefits of Phase III: Renewable Energy Deployment

- The program involves many renewable energy options for the needs of public and the characteristics of the location. Therefore, the mechanism addresses different needs of individuals.
- The effect of tax-levy on households are minimized due to the previously installed energy efficiency measures.
- As households install renewable energy systems, the tax-levy costs can be met by the produced electricity.
- The usage of non-renewable energy sources and export electricity can be reduced through renewable energy deployment.
- The renewable energy production benefit the economy of households and serves the country's economy as whole.
- The on-grid applications create the "Merit-Order Effect". As a result, the retail prices are reduced.
- The renewable energy awareness is increased through both education and promotions.
- Increased employment number in renewable energy industry.

2. Renewable Energy Loans For Low Income Households

2.1. Introduction

As mentioned in the previous chapters, most of the energy efficiency products are relatively cheaper than renewable energy systems. Therefore, in case of offering grants countrywide, it does not seem possible for the government to meet the costs of grants by the energy savings. On the other hand, renewable energy systems provide permanent income to the owner of a system. Therefore, at this stage, the grants are lowered and an alternative payback mechanism is offered.

2.2. Low-Interest Loans & Grants

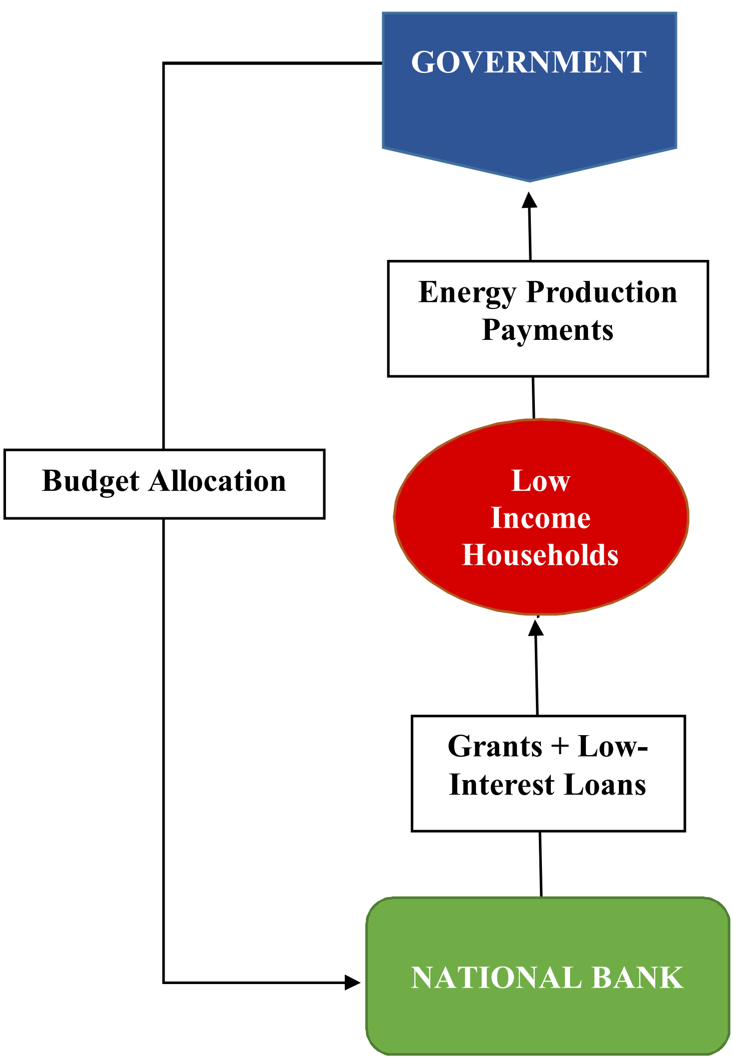
Similarly, at this stage government can provide grants and low-interest loans for low-income households who are willing to install a renewable energy system. Since the upfront costs of renewable systems are considerably high, the offered grant amounts can be reduced for renewable energy systems. For instance, 30% of the total system costs can be granted as it is done in the UK, and the rest of the costs can be met with low-interest loans. The incentives can be offered by a national bank. An exemplary loan and grant distribution is presented in the table below:

Income Level of the Household	Incentive Type
Lowest %25	30% Grant + Low-Interest Loans by Government
Lower %25-50	15% Grant + Low-Interest Loans by Government
Upper %50	15% Grant + Loans by Financial Institutions

2.3. Payback Mechanism

Although the costs of renewable energy systems are high, such systems produce electricity and as a result provide income for the installed household. The loan amount can be paid by the produced energy until the renewable energy system pays for itself as it is done by Northeast Denver Housing Center in the USA (see appendix A.3.2). The money can be collected through electricity bills of households. After the loans are paid back to the government, the household can start getting the income from the produced electricity. The payback mechanism is presented in the figure below.

Figure 40 - Payback Mechanism for Renewable Energy Loans for Low Income Households



Summary Framework of Phase III: Renewable Energy Deployment

- Government offer grants and low-interest loans for low-income households.
- As households install renewable systems, the income from the systems are paid to the government until renewable system pays for the loan amount.

Benefits of Phase III: Renewable Energy Deployment

- Low-income households are provided with the opportunity of installing renewable energy systems.
- Low-income households are provided with a regular income through renewable energy production after the debt is paid back to the government.
- The greenhouse gas (GHG) emissions would be reduced through the reduced consumption of fossil fuels.
- Further renewable system installations would reduce the electricity retail price (Merit-order-effect)

3. Feed-in Tariffs

3.1. Introduction

Feed-in tariffs were found to be the most successful supportive mechanism as a result of the quantitative analysis. In addition, there are many other examples that show the success if feed-in tariffs. For instance, in the UK the micro generation capacity has grew by 400% between 2010 and 2011 after the implementation of a feed-in tariff schedule in 2010 (AEA 2011).

Therefore, in order to benefit from such a successful and proven mechanism, the incentives should eventually be transformed to a feed-in tariff schedule as the developing country reaches to a desired level of renewable energy installations.

The SocioFIT Mechanism benefits households from every income level, and mainly contributes to low-income households as it can be seen from the previous chapters. Although such a system would contribute household economies, the increasing tax-levy would be a burden on the public households, especially high-income households. When this situation is considered from the high-income household's perspective, in such a mechanism they would be paying most share of the tax-levy but receiving benefits much less than a low-income family.

The energy savings are not used directly for the feed-in tariffs because of the reasons listed below:

- Allowing low-income households to install renewable energy systems
- Preventing the wealth redistribution effect of the tax-levy
- Increasing economic equality level of the country
- Increasing the number of renewable energy installations by households with every income level
- Benefit more from the merit-order effect

3.2. Feed-in Tariffs

After the renewable energy systems are installed by the majority of the households, the grant amounts can be reduced and the energy savings budget used for grants can be transferred to feed-in tariff incentives for residential renewable systems. Since the most effective policy is found feed-in tariffs with low-interest loans in the quantitative analysis, the government can continue offering low-interest loans at this stage.

Since it is likely to expect that many of the households should have installed renewable energy systems until this point, almost every household would benefit from the feed-in tariffs. Since low-income families are likely to consume less electricity, in some cases the produced electricity would be sufficient for the needs of a low-income household. Therefore, households with such a low level of electricity consumption would not be affected by any change on the electricity retail rate anymore.

3.3. Public Support

The introduced mechanism requires a high engagement and support from the public. The reactions caused by the tax-levy amounts should not be underestimated. Therefore, it is very important to explain the benefits of the program through promotions, effective usage of media and educating the public. Moreover, the support level of the public can be obtained by conducting a referendum. Using referendums for such reasons is not a new practice. In Bellingham USA, a tax-levy for low-income housing has passed by a referendum (Relyea 2012). Moreover, In Bulgaria a referendum is conducted for building a nuclear energy power plant (Fox News 2013).

Summary Framework of Phase IV: Feed-in Tariff Regulations

- The offered grant percentages are lowered.
- The mechanism budget is allocated to increased feed-in tariff rates for residential renewable energy systems.

Benefits of Phase IV: Feed-in Tariff Regulations

- Increased renewable energy system installations.

- Reduced electric retail prices due to merit-order-effect.
- Increased prosperity of the people of every income level.
- Increasing the economic equality level of the country.
- Reduced fossil fuel consumption and imported energy.
- Reduced GHG emissions

VI. Implementation of Socio Feed-in Tariff Mechanism (SocioFIT) in Turkey

Although the SocioFIT Mechanism can be implemented in any country, the developing countries and specifically "Newly Industrialized Countries" were focused in this paper. In order to solidify the implementation of the mechanism, Turkey was selected as a potential implementer of this policy due to its increasing energy demands, low energy efficiency levels, high GHG emissions, and economic inequality problem.

A. Country Background

According to CIA Turkey is considered as a developed country (Wikipedia 2013). Turkey's GDP has increased more than three-fold in the last ten years (Invest in Turkey 2012).The GDP of Turkey has increased from $231 billion in 2002 to $772 billion in 2011 (Invest in Turkey 2012). As a result of this growth in the economy, the electricity demand also raised. In the "2012 Performance Program" report of "Turkish Ministry of Energy and Natural Resources" the energy goals of the country is explained. Some of the goals can be summarized as follows (The Ministry of Energy and Natural Resources 2012):

- Energy Security
    - Prioritizing national resources
    - Increasing renewable energy production
    - Increasing energy efficiency level
    - Creating a better market for investments
    - Decreasing the risks associated with the oil and natural gas imports
- Environment

- Minimizing the impacts caused by energy production activities

❖ Natural Resources

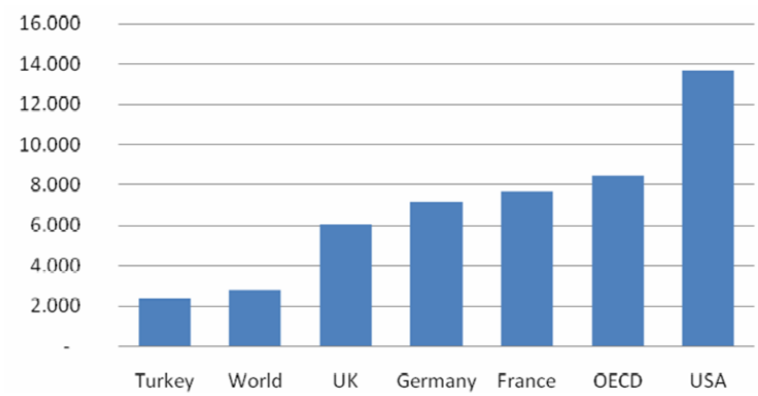
- Using the full potential of natural resources

1. Energy Demand

1.1. Energy Consumption

The energy demand of Turkey is relatively lower than other developed countries such as Germany or UK. This situation can be seen from the figure below.

Figure 41 - Electricity Consumption per Capita for 2009 (MWh/person, *(EMRA 2010, 4)*



On the other hand, Turkey has one of the fastest growing economies in the world and as a result, the electricity demand is growing rapidly. Turkey's electricity demand has risen by 70% between 2001 and 2010 (EIA 2013).

In a report of Deloitte, the growth rate of electricity consumption and the electricity consumption per capita are presented among the European countries.

Figure 42 - Electricity Consumption Growth Rates (2010-2015) *(Deloitte 2010)*

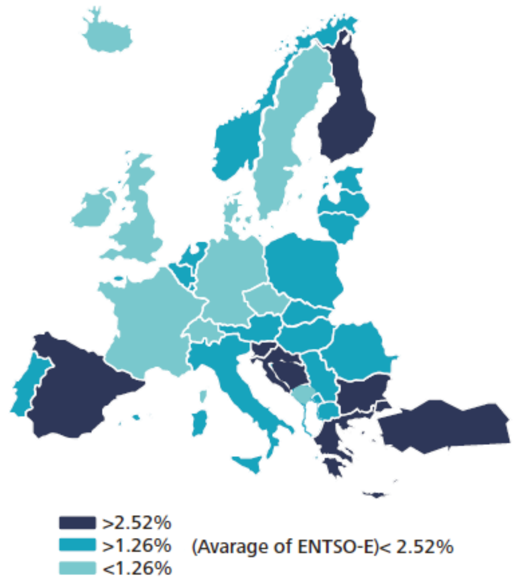
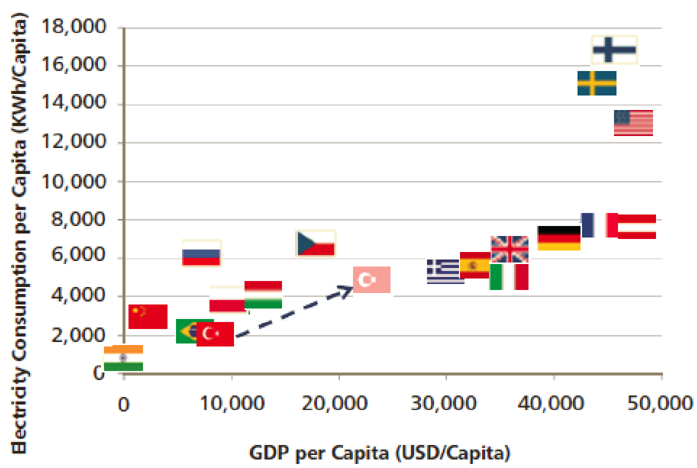


Figure 43 - GDP per Capita and Electricity Consumption per Capita *(Deloitte 2010)*



Energy Market Regulatory Authority (EMRA) has published a report Electricity Market Report in 2010. In that report, a high demand and low demand scenarios were analyzed. The Projections of the report is presented below.

Table 20 - Estimated Peak Demand and Energy Demand According to High and Low Scenarios *(EMRA 2010)*

YEAR	High Demand				Low Demand			
	Peak Demand		Energy Demand		Peak Demand		Energy Demand	
	MW	Increase (%)	GWh	Increase (%)	MW	Increase (%)	GWh	Increase (%)
2010	32170	7,7	209000	7,7	32170	7,7	209000	7,7
2011	33780	5,0	219478	5,0	33780	5,0	219478	5,0
2012	36314	7,5	235939	7,5	36043	6,7	234183	6,7
2013	39037	7,5	253634	7,5	38458	6,7	249873	6,7
2014	41965	7,5	272657	7,5	41035	6,7	266615	6,7
2015	45112	7,5	293106	7,5	43784	6,7	284478	6,7
2016	48450	7,4	314796	7,4	46674	6,6	303254	6,6
2017	52036	7,4	338091	7,4	49754	6,6	323268	6,6
2018	55886	7,4	363110	7,4	53038	6,6	344604	6,6
2019	60022	7,4	389980	7,4	56539	6,6	367348	6,6

According to Energy Market Regulatory Authority (EMRA), if the high projection case scenario comes true, the county will not be able to meet its electricity demands by 2017 (Energy Market Regulatory Authority 2012).

There are many reasons to believe that high case scenario would occur. For example electric car industry. The electric cars are started being popular worldwide. Thousands of electric cars are being sold every year (Wikipedia 2013). Turkey has world's second highest gasoline prices. The average costs and its share on citizen's budget is presented in the table below.

Figure 44 - Ten Most Expensive Countries for Unleaded Gas (2012), *(Lee Boyce 2012)*

Country	Average monthly disposable income after tax (£)	Average monthly petrol expenditure (£)	Percentage of monthly income spent on petrol
1. Norway	£2,681.07	£198.06	7.4%
2. Turkey	£572.57	£195.65	34.2%
3. Netherlands	£1,784	£178.74	10%
4. Italy	£1,134.53	£176.32	15.5%
5. Greece	£688.60	£175.12	25.4%
6. Denmark	£2,124.18	£172.70	8.1%
7. Britain	£1,660.52	£171.49	10.3%
8. Sweden	£2,197.54	£170.29	7.7%
9. Eritrea	£278.71	£170.29	61.1%
10. Belgium	£1,935.65	£169.08	8.7%

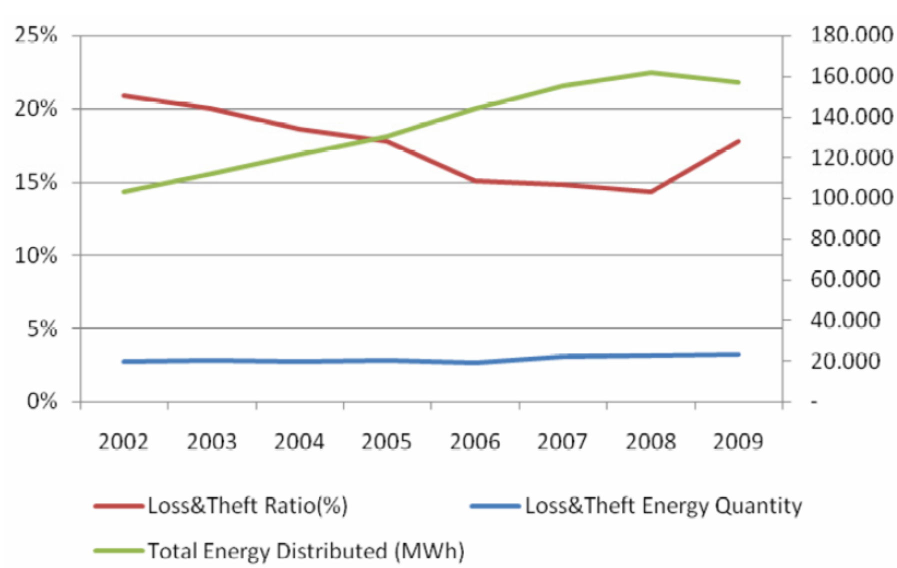
As it can be seen from the table, Turkey is a suitable market for electric car industry.

The Scientific and Technological Research Council of Turkey is planning to support R&D projects for electric cars starting from 2013 (Energy Institute 2013). Moreover, Turkish Ministry of Finance is considering excising additional taxes from motor vehicles that pollute the air (Energy Institute 2013). In the future, it is likely to expect increasing number of electric cars in Turkey. Such an increase in the number of electric cars would increase the electric demand in the country.

1.2. Distribution of Electricity

In Turkey, a considerable amount of return that comes from the electricity production cannot be collected due to grid losses and theft of the electricity. The loss & theft ratio was 17.7% in 2009 (EMRA 2010). According to the report the costs caused by losses and thefts was approximately 3 billion Turkish Liras (€1.28[1] Billion) in 2010. The loss and theft ratios between 2002 and 2009 are presented in the table below.

Figure 45 – Loss & Theft Quantity (MWh) and Ration at Distribution Level across Turkey *(EMRA 2010)*



[1] March 2013 Exchange Rate

As it can be seen from the graph, the loss & theft ratio has increased in 2009. This can be associated to the rising price of electricity.

Turkish Government continue their efforts on the privatization of The Electricity Distribution Company of Turkey (TEDAS). With the latest privatizations, the distribution of the electricity will be provided by private companies in every region of Turkey (Milliyet 2011).

By the latest privatizations, the loss and theft ratios are expected to decrease (EMRA 2010).

1.3. Residential Electricity Consumption

The electricity consumption share of the residential buildings has been constantly rising for more than 20 years. The residential electricity consumptions and their shares in total consumption can be seen from the table below.

Table 21- Annual Development of Turkey's Net Electricity Consumption by Sector *(Turkish Electricity Distribution Co. 2009)*

Birim / *Unit* : GWh

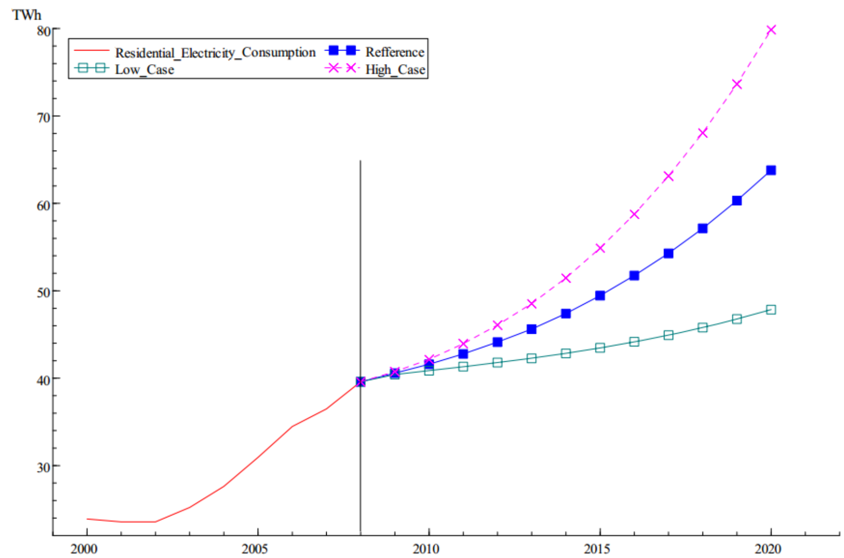
Yıllar *Years*	Mesken *Resident.*	%	Ticaret *Commercial*	%	R.Daire *G.Offices*	%	Sanayi *Industry*	%	G.Aydınlat . *P.Lighting*	%	Diğer *Others*	%	Toplam *Total*
1990	9 059,8	19,4	2 557,8	5,5	1 463,3	3,1	29 211,8	62,4	1 231,4	2,6	3 295,9	7,0	**46 820,0**
1991	10 833,3	22,0	3 054,1	6,2	1 864,3	3,8	28 511,8	57,9	1 417,9	2,9	3 601,5	7,3	**49 282,9**
1992	11 481,7	21,3	3 270,3	6,1	2 008,6	3,7	31 535,6	58,4	1 859,7	3,4	3 828,8	7,1	**53 984,7**
1993	12 559,0	21,2	3 605,4	6,1	2 266,4	3,8	34 247,1	57,8	2 270,3	3,8	4 288,8	7,2	**59 237,0**
1994	13 449,7	21,9	3 704,7	6,0	3 315,1	5,4	34 138,1	55,6	2 502,1	4,1	4 291,2	7,0	**61 401,0**
1995	14 492,5	21,5	4 195,2	6,2	3 011,6	4,5	38 007,4	56,4	3 105,9	4,6	4 581,2	6,8	**67 393,9**
1996	16 394,2	22,1	5 740,9	7,7	3 002,5	4,0	40 638,3	54,8	3 084,9	4,2	5 295,9	7,1	**74 156,7**
1997	18 514,4	22,6	6 852,4	8,4	3 803,4	4,7	43 491,3	53,1	3 310,2	4,0	5 913,2	7,2	**81 884,9**
1998	20 034,1	22,8	7 733,8	8,8	4 271,6	4,9	46 139,0	52,6	3 691,2	4,2	5 835,0	6,7	**87 704,6**
1999	22 584,3	24,8	8 208,0	9,0	3 775,1	4,1	46 480,3	51,0	4 185,3	4,6	5 968,9	6,5	**91 201,9**
2000	23 887,6	24,3	9 339,4	9,5	4 107,9	4,2	48 841,7	49,7	4 557,7	4,6	7 561,4	7,7	**98 295,7**
2001	23 557,3	24,3	9 907,8	9,7	4 370,0	5,0	46 989,0	48,4	4 888,2	5,0	7 357,7	7,6	**97 070,0**
2002	23 559,4	22,9	10 867,3	10,6	4 580,5	4,4	50 489,4	49,0	5 103,9	5,0	8 347,3	8,1	**102 947,9**
2003	25 194,9	22,5	12 871,9	11,5	4 554,0	4,1	55 099,2	49,3	4 974,8	4,5	9 071,2	8,1	**111 766,1**
2004	27 619,0	22,8	15 656,2	12,9	4 530,7	3,7	59 565,9	49,2	4 432,5	3,7	9 337,5	7,7	**121 141,9**
2005	30 935,0	23,7	18 543,8	14,2	4 662,7	3,6	62 294,2	47,8	4 143,0	3,2	9 684,1	7,4	**130 262,8**
2006	34 466,0	24,1	20 256,4	14,2	6 044,8	4,2	68 026,7	47,5	3 950,4	2,8	10 326,2	7,2	**143 070,5**
2007	36 475,8	23,5	23 141,2	14,9	6 933,2	4,5	73 794,5	47,6	4 052,6	2,6	10 737,9	6,9	**155 135,3**
2008	39 583,6	24,4	23 903,3	14,8	7 344,3	4,5	74 850,3	46,2	3 970,2	2,5	12 295,9	7,6	**161 947,6**
2009*	39 147,5	25,0	23 157,4	14,8	7 115,1	4,5	72 514,6	46,2	3 843,3	2,4	11 116,2	7,1	**156 894,1**

* Yaklaşık değerler / *Approximate data*

In 2010, the number of the electricity purchasers has risen from 26,596,875 to 27,400,382; and the total consumption has reached to 41,393,175 GWh (Göker 2013).

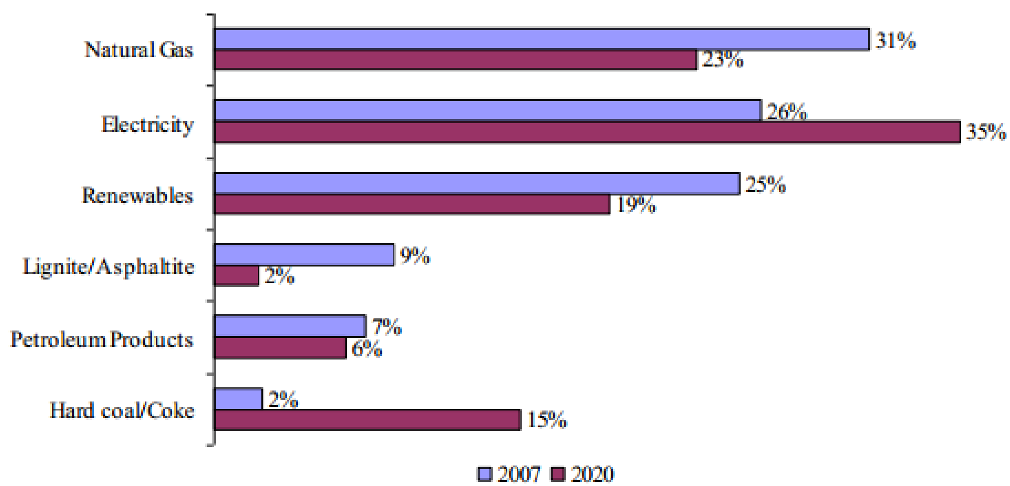
The residential electricity demand projection is presented in the graph below.

Table 22 - Turkey's Residential Electricity Demand Forecast over the Period 2009-2020 *(Dilaver and Hunt 2010)*



The share of electricity in the total energy consumption of buildings is expected to increase in the coming years. The figure shows the building energy consumptions in 2007 and the 2020 projections.

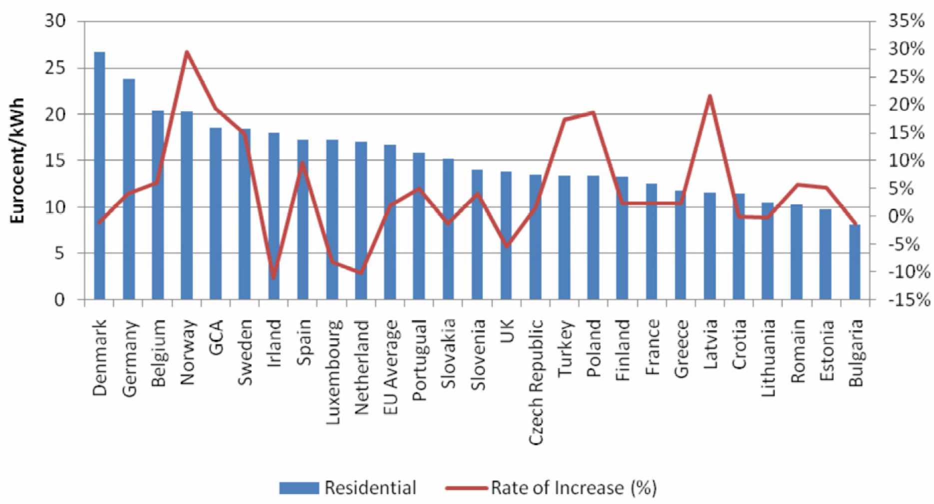
Figure 46 - Building Energy Consumption by Fuel *(World Bank 2011)*



Electricity Prices

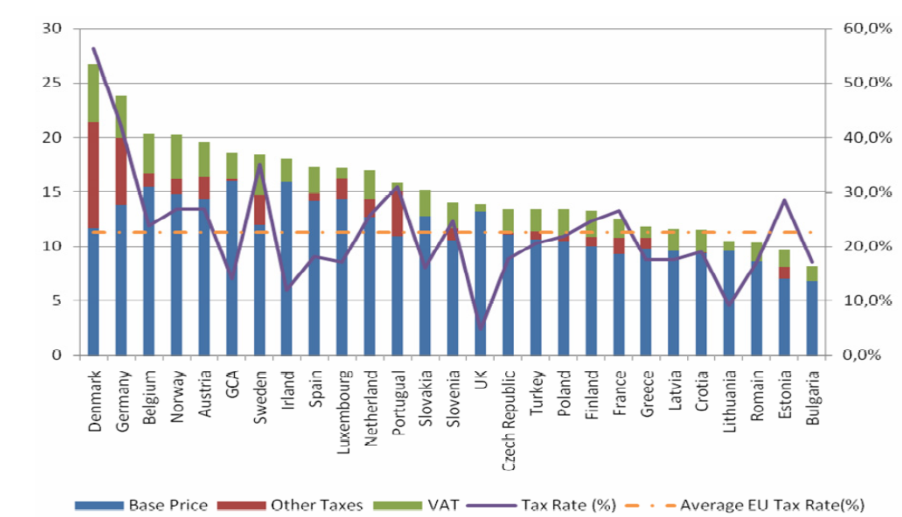
The electricity prices are relatively lower when compared to EU countries, whereas the rate of increase is higher than many of the countries due to the increasing demand. The electricity prices and the price increase rate is presented in the figure below.

Figure 47 - Electricity Prices for Residential Consumers in EU (€cent/kWh), *(EMRA 2010)*



The tax rate distribution among the European countries are presented in the figure below.

Figure 48 - Electricity Prices and Tax Rates for Residential Consumers in EU (€cent/kWh), *(EMRA 2010)*



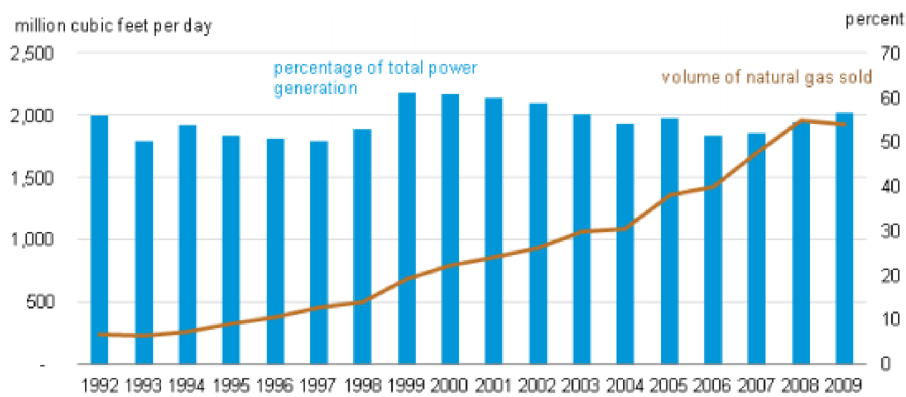
As it can be seen from the figure, the tax rates are relatively lower than other European countries.

2. Energy Production

2.1. Non-Renewable Sources

Turkey is a major natural gas importer. The imports represented 98.3% of total natural gas consumption in 2011 and 7% of imported natural gas is used for energy production (EMRA 2011). The increasing demand of natural gas and its share in the power generation is presented in the figure below.

Figure 49 - Natural Gas Sales to Electric Power Generators and Percentage of Total Power Generation, 1991-2009 *(EIA 2013)*



As can be seen, the demand for natural gas has increased significantly in the last 20 years. It can be perceived that more than half of the imports were due to meet the growing energy demand of Turkey. The table below shows the electricity generations by sources in 2009.

Table 23 - Breakdown of Generation and Capacity by Energy Source (2009), *(IEA 2009)*

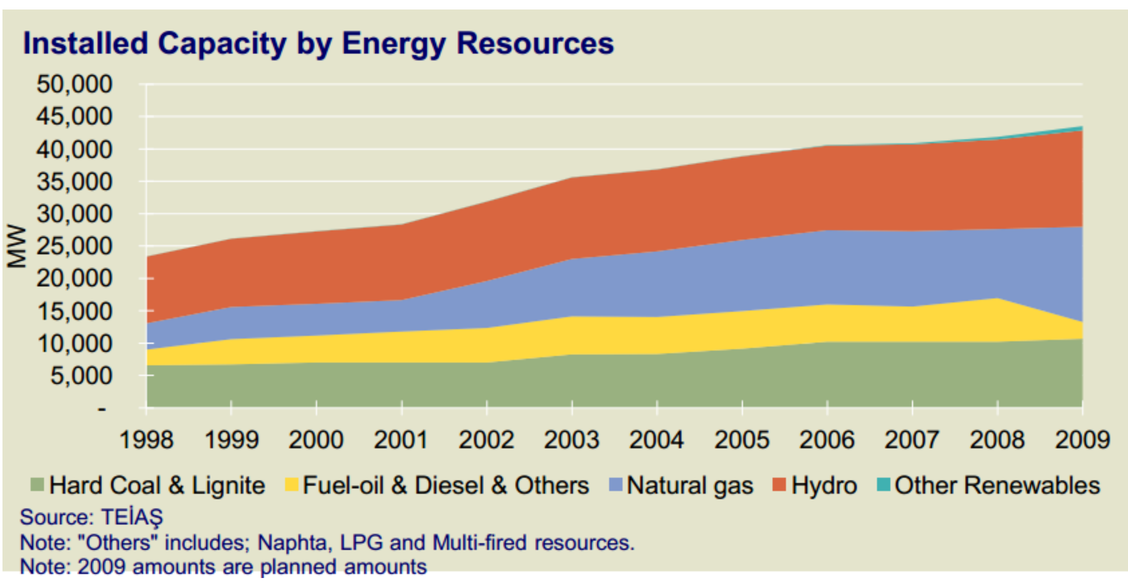
Energy source	Generation. TWh	Share, %	Capacity, MW	Share, %
Natural gas	94.4	48.6	16 345.2	36.5
Domestic coal	42.2	21.7	8 691.3	19.4
Imported coal	12.8	6.6	1 921.0	4.3
Hydropower	35.9	18.5	14 553.4	32.5
Liquid fuels (oil)	6.6	3.4	2309.7	5.2
Wind, geothermal, biogas	2.2	1.1	961.2	2.1
Total	**194.1**	**100**	**44 782**	**100**

As presented in the table, coal, natural gas and oil, which are the major imports of Turkey, represented almost half of Turkey's energy generation.

2.2. Renewable Sources

Turkey has been using its hydroelectric potential for many years. On the other hand, renewable systems other than hydroelectric was not utilized notably until the implementation of renewable energy law in 2005. The installed capacity by energy sources between 1998 and 2009 is presented in the figure below.

Figure 50 - Installed Capacity by Primary Energy Sources *(Deloitte and Invest Turkey 2010)*



Turkey is planning to decrease its fossil fuel dependence. The 2010 status of the market and 2020 projections are presented below.

Figure 52 - Capacity in Operation as Licensed by EMRA by Types of Fuels
(EMRA 2010)

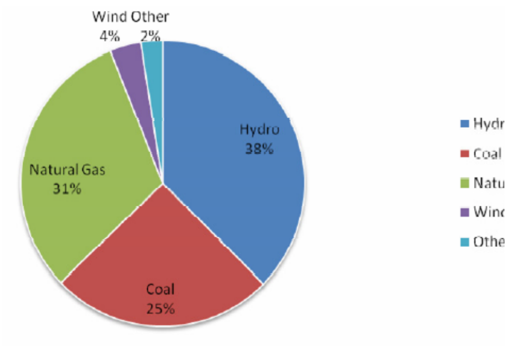
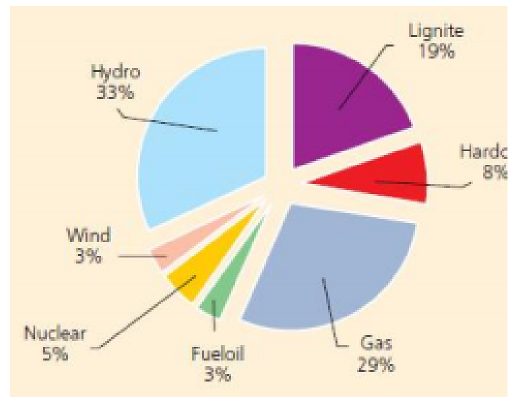


Figure 51 - Installed Capacity by Resources, 2020 Projections (MW),
(McBDC 2013)



Turkey's first nuclear power plant, with its 4800 MW capacity, will be commissioned between 2019 and 2022 (Akkuyu NPP JSC 2011). It is expected for the power plant to supply 8% of Turkey's energy demand (ElektrikPort 2011).

3. Energy Efficiency

Turkey has been reinforcing its energy efficiency policy through the implementation of Energy Efficiency Law (2007). The promotion of energy efficiency is created through the support of service companies, transport sector, building efficiencies (IEA 2009).

According to IEA report, "Turkey should examine possibilities for economic incentives to accelerate energy efficiency gains and continue to increase public awareness of energy efficiency as a means to improve energy security, save money and mitigate climate change (IEA 2009).

In the IEA report, the energy efficiency policies of countries were analyzed among IEA countries in many ways including: buildings, appliances, lighting, transport, industry and utilities. In the report, the energy saving recommendations for buildings was explained as follows (IEA 2009):

- Establishing stronger energy efficiency requirements for buildings

- Strengthening support for passive energy houses (PEH) and zero energy buildings(ZEB)
- Increasing the efforts to promote energy efficient windows and glazing.

Moreover, it is stated in the IEA report that "government and industry actions must be coordinated internationally to ensure a sufficient supply of good quality higher efficiency alternative lamps (IEA 2009)".

Based on the recommendations made by IEA, the association has created a table for comparing the country performances. The table is presented below.

Figure 53 - Comparison of Country Progress with Implementing Applicable Buildings Recommendations *(IEA 2009)*

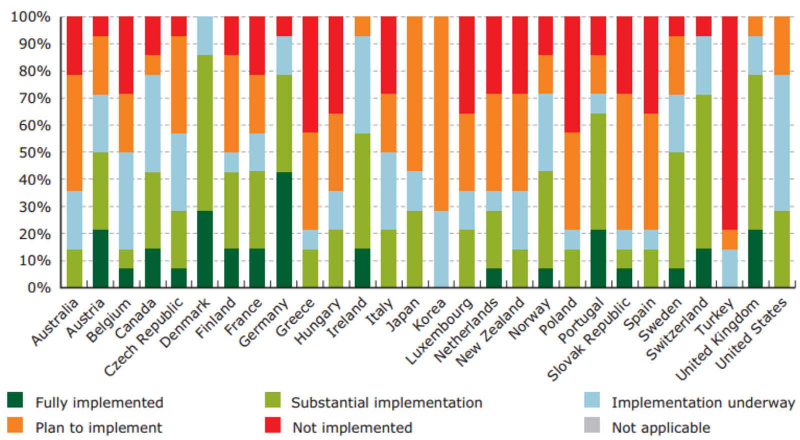
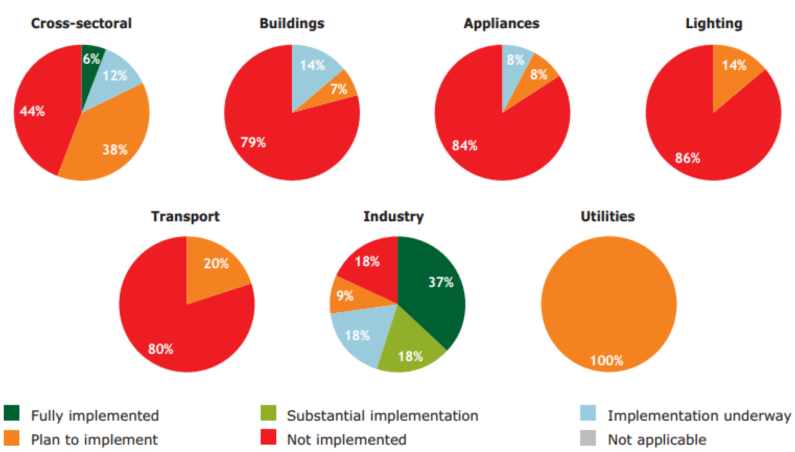


Figure 54 - Turkey's Progress with Implementing IEA Energy Efficiency Recommendations *(IEA 2009)*



The figures show that Turkey still has many policies to implement for energy efficiency and energy efficiency in buildings is one of the most important issues.

According to the World Bank report, the energy saving potentials in residential buildings can be listed as follows.

Table 24 - Energy Efficiency Saving Potential for Buildings *(World Bank 2011)*

Parameter	**Residential**	**Commercial and Public**	**Total**
Non-Electricity Energy Consumption ('000 toe 2007)	14,774	3,451	18,225
% Saving Potential	29	29	29
Consumption after EE Potential is Realized ('000 toe 2007)	10,553	2,465	13,018
Electricity Energy Consumption ('000 toe 2007)*	3,144	2,593	5,737
% Saving Potential	46	20	34
Consumption after EE Potential is Realized ('000 toe 2007)	1,710	2,074	3,785
Total Energy Consumption ('000 toe 2007)	**17,918**	**6,044**	**23,962**
% Saving Potential	**32**	**25**	**30**
Consumption after EE Potential is Realized ('000 toe 2007)	**12,263**	**4,539**	**16,802**
Saving Potential ('000 toe 2007)	**5,655**	**1,505**	**7,160**

As shown in the table, the energy saving potential for electricity was calculated 46% and non-electricity energy, such as natural gas or other energy sources, as 29%. The Energy Efficiency Report of Turkish Chamber of Electrical engineers confirms this potential by pointing 47.5% of energy savings (Chamber of Electrical Engineers 2012, 36).

There are some energy efficiency measures are being developed in collaboration with United Nations Development Program (UNDP) such as: improving the energy efficiency regulations, improving energy efficiency measurement methods, and developing financial mechanisms for energy efficiency (Chamber of Electrical Engineers 2012).

4. Economic Equality

The Result of Income Level and Living Standards Research for the year 2011 can be summarized as follows (Turkish Statistical Institute 2011):

- Gini coefficient has increased by 0.002 points and reached to 0.404
  - Gini coefficient for urban areas : 0.394
  - Gini coefficient for rural areas : 0.385
- Average annual income was 24,343 TL (~€10,500[2])
- The lowest 20% income level represents 46.4% of the population
- 16.1% of the population is under the poverty level
- 18.5% of the population is under the risk of poverty

Although it cannot be claimed that the economic equality level is reducing, it can be said that the economic equality level is not rising. Although the county economy is growing, the GINI index number is progressing at the same level.

5. Energy Security

According to IEA, : "Energy security involves the provision of sufficient and reliable energy supplies to satisfy demand at all times and at affordable prices, while also avoiding environmental impacts (IEA 2011)". This requires the ability to supply energy at all times. Leon E. Panetta, The defense secretary of USA, stated, "the need for clean energy and energy efficiency has an enduring security angle, and added "it's the only way to break out of the

[2] March 2013 exchange rates

paradigm of foreign energy dependence and its associated instability (US Department of Defense 2013)".

Turkey had $237 billion of imports in 2012 and $60.1 billion, approximately one fourth of total imports, was for paid for only energy, and natural gas and coal represented $23.2 billion and $4.6 billion of these imports respectively (Energy Institute 2013). According to IMF, the energy imports will reach to 70 billion dollars by 2017 (Energy Institute 2013).

The Turkish Electricity Transmission Company (TEIAS) warned "unless the necessary steps are taken, electricity supply will not meet the demand in 2016 (Colak and Cubukcu 2011)". The public awareness for renewable energy has risen in the recent years. On the other hand, it can be said that transformation of renewable energy production is not as fast as it should be. If necessary precautions are not taken, the electricity imports will have a considerable burden on the country economy in the near future.

6. Environmental Concerns

There are many environmental issues in Turkey including water pollution, air pollution, and deforestation (US EIA 2000).

The environmental performance index of Yale University, which evaluates environmental performances of 132 countries, presents the current level of the country.

Figure 55 - Environmental Performance Index Numbers of Turkey *(Yale University n.d.)*

Level of Aggregation	Performance Score	Performance Rank	Pilot Trend Results Score (-50 to 50)	Pilot Trend Results Rank
Environmental Performance Index	**44.8**	**109**	**11.1**	**17**
Environmental Health	**69.8**	**67**	**35.7**	**2**
Air (Effects on Human Health)	64.8	71	11.6	30
Environmental Burden of Disease	74.1	63	48.5	8
Water (Effects on Human Health)	66.1	56	34.1	7
Ecosystem Vitality	**34.1**	**118**	**-9.0**	**112**
Agriculture	42.8	93	-3.8	115
Air (Ecosystem Effects)	30.6	90	15.2	40
Biodiversity and Habitat	20.2	121	0.0	88
Climate Change	42.7	71	-21.4	114
Fisheries	25.0	60	8.4	21
Forests	91.5	42	-4.2	42
Water Resources (Ecosystem Effects)	10.0	114	-45.0	114

As it can be seen from the table, climate change is one of the main problems along with water resources. The detailed table of the same index shows the country profile in terms of climate change.

Figure 56 - Climate Change Index Numbers of Turkey *(Yale University n.d.)*

Climate Change	42.7	71	-21.4	114
CO2 per Capita	61.9	66	-50.0	107
CO2 per GDP	47.8	66	2.9	91
CO2 per KWH	9.2	74	-3.9	91
Renewable Electricity	19.6	64	-28.8	108

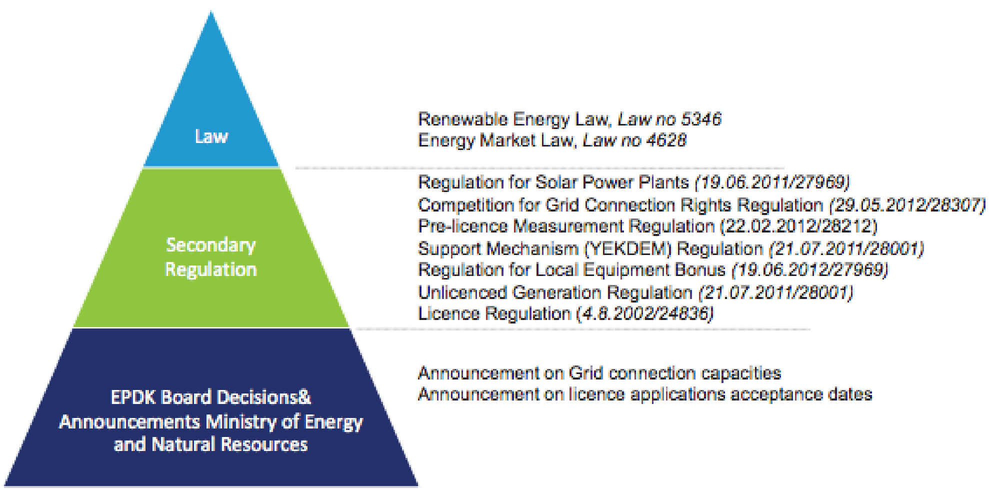
Although Turkey has many environmental issues, the country is considered as an improving country in terms of environmental performance (Yale University n.d.).

B. Renewable Law and Regulations in Turkey

1. Implemented Policies Through the History

In Turkey, the regulatory system is based on the Renewable Energy Law, Energy Market Law, secondary regulations and EMRA (Energy Market Regulatory Authority) Decisions. (Deloitte 2013). The regulatory framework is presented in the picture below:

Figure 57 - Regulatory Framework of Turkey *(Deloitte 2013)*



When compared to selected countries, Turkey has started promoting renewable energy systems lately. The implemented regulations are presented below.

2001

- **Electricity Market Licensing Regulation**

The Electricity Market License Regulations is the first legislation that promotes power generation from renewables (Topkaya 2012). Under this regulation, different types of procedures were offered.

i. Connection Priority

The Turkish Electricity Transmission Company (TEIAS) and/or distribution companies are obliged to give priority to renewable energy projects (Topkaya 2012).

ii. Purchase Obligation

Electricity sale companies were obliged to give priority to renewable energy productions for supplying their customer's energy demands in case the renewable production price was lower than/ equal to the Turkish Electricity Trade and Contracting Corporation (TETAS) tariffs (Topkaya 2012).

iii. Unlicensed Power Generation Regulation

The "Regulation Concerning Unlicensed Generation of Electricity in the Electric Market" was published in December 2010. The regulation allows generation of electricity to real and legal persons without obtaining a license under the following conditions (EMRA 2010). However, this regulation was not found sufficient for the unlicensed applications. There were still legal barriers and uncertainty about the procedures (SABAH 2011). Therefore, on March 2012 EMRA has published the "Communique about the Application of the By-Law Concerning the Unlicensed Generation of Electrical Power in the Energy Market" (EMRA 2012). The regulations cover the renewable energy and co-generation plants under 500kW. After the implementation of 2012 regulation, 647 applications were made for unlicensed power plants as of February 2013.

iv. License Fees

The main regulations offered under The Electricity Market Licensing Regulation of the Electricity Market Law was as follows (IEA 2009):

- The renewable energy facility constructers were required to pay only1% of the total license fee

- Renewable energy generation facilities were exempted from annual license fees for the first eight years, and given priority for grid connection

2005

- **Law on Utilization of Renewable Energy Resources For the Purpose of Generating Electrical Energy**

  "This law aims to expand the use of renewable energy sources for generating electrical energy by establishing the necessary legal and regulatory framework while ensuring increase in the use of renewable energy sources without disturbing free market conditions. The Law encompasses the procedures and principles for conservation of renewable energy resource areas, utilization of these sources, and certification of the energy generated from these sources. (IEA 2009)"

2007

- **Energy Efficiency Law**

  "The Energy Efficiency Law (EE Law) aims to increase the efficient use of energy and energy resources for reducing the burden of energy costs on the economy and protecting the environment. This law comprises the organization, principals and procedures for increasing energy efficiency in industry, electrical power plants, transmission and distribution systems, buildings, and service and transport sectors (IEA 2009). "

  The Law also amended the 2005 Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy. After the implementation of the amendment, renewable energy producers were provided with a fixed purchase price of 5-5.5 €cents/kWh for 10 years (IEA 2009).

2010

- **Strategic Plan 2010**

“The 2010-2014 Strategic Plan is a first step in reaching Turkish national renewable energy target of 30% of the total electricity generated from renewable source by 2030 (IEA 2009).”

“The 2010-2014 Strategic Plan aims to increase Turkish energy security by diversifying its energy supply, make greater use of domestic resources, protect the environment by relying on clean, renewable and low carbon technologies and foster energy market efficiency by fostering private sector’s investment and integration. The strategy also targets energy efficiency improvements and seeks to save 10% of national energy bill by 2015 and 20% by 2023 (IEA 2009).”

2011

- **Renewable Energy Law**

In December 2010 the old renewable energy law, which was enacted in 2005, was amended by new renewable energy law (Topkaya 2012). In this law, different types of incentives were introduced.

The renewable energy producers were provided with 85% discount on transmission costs for 10 years (IEA 2009). The fixed feed-in tariffs were adjusted according to the renewable energy type as follows (IEA 2009):

- Wind and hydropower $0.073/kWh
- Geothermal $0.105/kWh
- Biomass and biogas from organic waste $ 0.133/kWh
- Solar $ 0.133/kWh (with a cap of 600 MW by 2013)

Turkey also implemented a premium payment feed-in tariff system that provides extra compensation if the components of a solar PV system are domestic. Local equipment was entitled for local equipment bonuses for a period of 5 years. The rates are as follows (IEA 2009):

- PV panel integration: $0.008/kWh
- Modules: $0.013/kWh
- Cells which constitute modules: $0.035/kWh
- Invertors: $0.006/kWh
- Tracking system: $0.005/kWh

If all the conditions are met, the maximum feed in tariff can reach up to 20 USDcent/kWh for 5 years and, 13.3 USDcent/kWh for the remaining 5 years.

On the other hand, there are some oppositions to the premium feed-in tariffs. Some argue that instead of supporting domestic products through premium FITs, research projects can be provided with grants or local solar panel manufacturers can be ensured with tax exemptions (Tekin 2013).

One another problem is about the premium payment feed-in tariffs is the domestic support is provided for national products and the incentive is added on the electricity price per kWh. This approach blocks the residential usage in some ways. For example if a household buys a domestic solar product and use it just for its electric need, they cannot be contributed by the premium feed-in tariff. The law for the unlicensed production is mainly for people who will produce electricity for their own use, but the domestic product FIT support cannot be used for these cases.

2. Recent Developments in Turkey

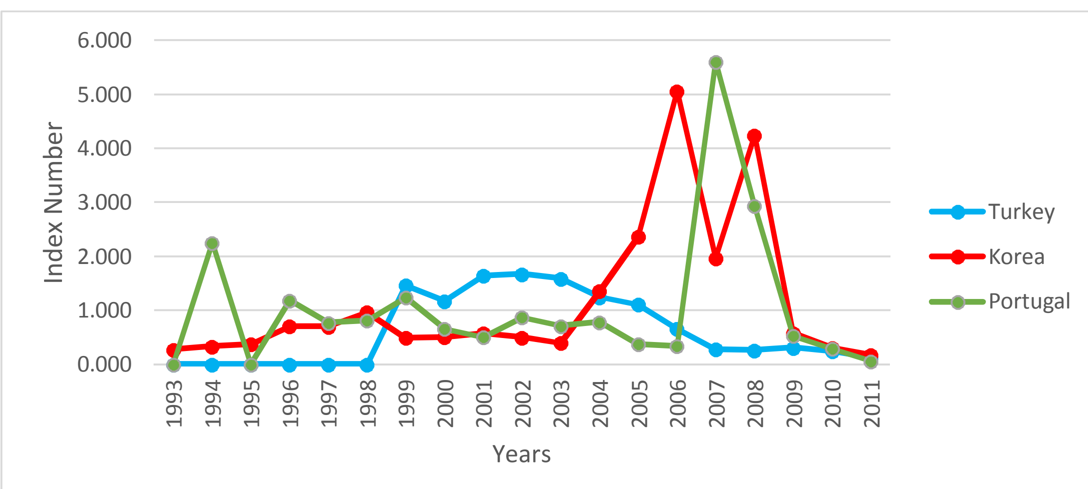
EMRA has announced the lowering of the independent electricity consumer limit to 5,000 kWh (Star Ekonomi 2013). This means the consumers who has an annual consumption of 5,000 kWh or more will be eligible to purchase electricity from any electricity sale company.

The government is also working on a new regulation for increasing the unlicensed power generation limit from 500 kW to 1 MW and even up to 2.5 MW with special permissions (Enerji Dergisi 2012).

3. Policy Evaluation For Turkey

The Relative Installation and Solar Potential Index and Relative Growth and Solar Potential Indexes are presented below for Turkey, Korea and Portugal. Korea and Portugal is selected due to their low GDP per Capita values.

Figure 58 - Relative Growth and Solar Potential Index for Turkey, Korea, and Portugal



As can be seen from the graphs Turkey started installing solar PV systems in 1998. It can be seen that 2001 regulations had a positive impact on solar PV installations. On the other hand, Turkey could not maintain this success level after 2003. As can be understood from the graph although Korea and Portugal has lower GDP per capita levels when compared to other IEA countries, both countries have implemented relatively successful policies after 2003 and 2006 respectively. It can be seen that Turkey has never implemented a policy that caused a considerable growth in the solar PV installations in comparison with other countries. It is likely that if an appropriate policy can be implemented in Turkey, such a growth can be achieved.

C. Implementation of Socio Feed-in Tariff Mechanism (SocioFIT) in Turkey

As mentioned in the previous chapters, Turkey is importing more than half of its energy, and a huge potential of energy savings is waiting to be utilized. Additionally, 40% of the population represents the lowest income level in Turkey. Because of such reasons, Turkey was selected for an analysis of a potential implementation of the SocioFIT Mechanism. The implementation of the SocioFIT mechanism in Turkey is solidified with calculations in further chapters.

1. Phase I: Preparation Phase

The economy of Turkey is growing rapidly, however it can be said that Turkey does not have the sufficient resources to meet its growing demand. The rising imports of energy and the retail price of electricity can be shown as evidence.

The amount of the tax-levy can be determined in compliance with the country's retail electricity price. In Germany, the EEG tax-levy amount was 0.035 €/kWh (PVTech 2011), and the residential end-user electricity price was 0.2495 €/kWh in 2011 (Vaasa ETT 2012). The tax-levy was 14 % of the retail price in that year.

In Turkey the retail price for households was 0.115 €/kWh (EuroStat 2012) in 2011. As is presented in the chapter VI.A.1.3, the total residential electricity consumption was 41,393 GWh in 2010 and the number of electricity buyers was 27,400,382.

As introduced in the previous chapter, a nominal tax-levy is charged from residential buildings at this stage. For example, 1.5% of the retail price can be charged. This amount should not be considered as a high amount since the electricity price has risen by 9.8% (Energy Institute 2013) in 2012 in Turkey.

The calculations of the created budget are presented below.

NOMINAL TAX –LEVY BUDGET CALCULATIONS	
Tax-levy Rate	▪ 1.5% of retail price 0.115 €/kWh x 0.015 = 0.001725 €/kWh
Budget	▪ The total residential consumption of 41,393,000,000 kWh is multiplied with 0.001725 €/kWh 41,393,000,000 x 0.001725 = € 71,402,925
Tax-Levy budget per buyer	▪ If we divide the total budget with 27,400,382 electricity buyers. 71,402,925 / 27,400,382 = € 2.61

The calculations show that a budget of €71.5 million can be created with an annual average payment of €2.61 from each household.

2. Phase II: Energy Efficiency Measures

2.1. Basic Energy Efficiency Measures

In the study conducted by Bayrak and Sezer, the electricity consumption of an average house was investigated and it is found that the lighting costs were representing 28.4% of the electricity consumption of a household (Bayrak and Akturk Sezer n.d.). In the same study, the monthly energy consumption of the house was reduced by 57.6 kWh by using only four energy efficient CFL bulbs (Bayrak and Akturk Sezer n.d.). The cost of one CFL bulb were assumed as TL 6 (Approximately €2.5[3]) in this study.

Two different calculations are presented in the tables below. First table shows the cost and return of the energy efficiency packages from the household's perspective, and the second one presents the benefits of the energy efficiency measures from government's perspective.

Although it is likely to have a lower price for energy efficient bulbs in case of a bulk purchase, the costs of CFL bulbs were assumed as €2.5 and the energy savings as 40 kWh per month (480 kWh per year).

The packaging, delivery, instructional and promotional documents, and miscellaneous costs were assumed as 20% of the product cost. Therefore, the total cost of an energy efficiency package is calculated as €12 (four bulbs + other costs).

The 2011 electricity retail price of 0.115 €/kWh is used for calculating the energy savings from the household perspective.

For calculating the energy savings on national scale, the production costs of electricity from natural gas is used. The reason of using electric production cost from natural gas is its high cost

[3] 2013 March exchange rates.

and extensive usage in Turkey. According to a local magazine, the cost of electricity production from natural gas is 7.5 $cent/kWh (€0.0577/kWh[4]) in Turkey (Para Dergi 2013).

Based on this information the calculations are presented below.

Energy Efficiency Packages – Household's Perspective	
Annual Tax Levy Burden of a purchaser	▪ The program cost per consumer € 2.61
Energy Savings	▪ 480 kWh savings is multiplied with electricity retail price per kWh 480 kWh * 0.115 € /kWh = € 55.2
Annual net saving of an average household	€55.2 – €2.61 = **€52.59**

The government's perspective is presented in the table below.

Energy Efficiency Packages – Government's Perspective	
Cost of an energy efficiency package	▪ 4 CFL Bulbs at the price of €3 4 x € 3 = 12 €
Total Program Cost	▪ 27,400,382 households will be provided with the energy efficiency packages. 27,400,382 x 12 € = € 328,804,584
Income from the tax-levy	▪ As calculated in the budget creation chapter; € 71,402,925

[4] 2013 March exchange rates.

Energy Savings	▪ 480 kWh savings from 27,400,382 electric subscribers. 480 x 27,400,382 = 13,152,183,360 kWh
Return From the Energy Savings	▪ 13,152 GWh energy savings is multiplied with electricity production price from natural gas 13,152,183,360 kWh x €0.0577/kWh = €758,880,980
Net Benefit of the Program	▪ Program costs are subtracted from tax levy income and energy savings. €71,402,925 + €758,880,980 - €328,804,584 = **€501,479,321**

As it can be seen from the tables, approximately €50 can be saved in each household and €500 million nationwide by saving the wasted electricity.

CFL Bulbs can be produced in Turkey. Therefore the "Phase II: Basic Energy Efficiency Measures" can be implemented by using domestic products to support the domestic energy efficiency products.

It should be noticed that the costs of CFL bulbs were the retail prices of such bulbs. In case of a mass purchase by the government, this price would be minimized. However, the calculations show that even in a worst-case scenario the mechanism could be implemented in Turkey.

As it can be seen from the calculations, the program budget would be sufficient for supplying the mechanism. In addition to that, a considerable amount of savings can be achieved by the end of the Basic Energy Efficiency Measures. Although the tax-levy does not contribute the mechanism noticeably at this phase, it should be collected for the engagement of public and the subsequent phases of the SocioFIT Mechanism.

2.2. Advanced Energy Efficiency Measures

Turkey can move to “Advanced Energy Efficiency Measures” phase as the energy efficiency awareness increases in the public. As is explained above, the tax-levy is increased to a moderate level in order to support further investments.

For example, a tax-levy rate of 4% of the 2011 retail electricity rate can be charged in Turkey for increasing the program budget and maintaining the engagement of the public with the program. The calculations are presented in the table below.

MEDIUM LEVEL TAX – LEVY BUDGET CALCULATIONS	
Tax-levy Rate	▪ Four percent of retail price 0.115 €/kWh x 0.04 = 0.0046 €/kWh
Budget	▪ If the total consumption of 41,393,000,000 kWh is multiplied with 0.0046 €/kWh 41,393,000,000 x 0.0046 = € 190,407,800
Annual Cost per purchaser	▪ If we divide the total budget with 27,400,382 electricity purchasers. € 190,407,800 / 27,400,382 = € 6.95

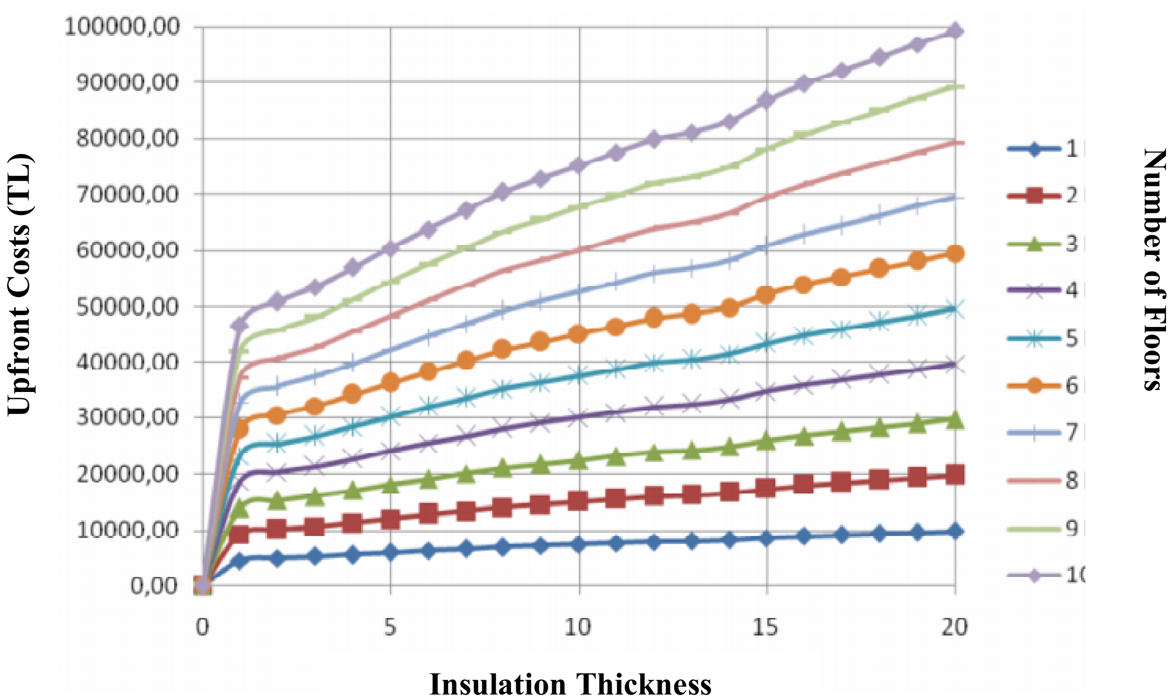
Building insulations are taken as an example for implementation of this phase. According to a report by Energy Institute, 90 % of the buildings in Turkey do not have insulations (Energy Institute 2013).

Since two of the energy efficiency measures with the least payback period were wall and roof insulations (see Figure 35) the budget can be used primarily for such energy savings.

The costs and savings of installing such insulation systems are calculated below. Although coal is also used for heating purposes, the calculations are made only for natural gas savings to have a better understanding of the return.

Based on the study of Turkish Chamber of Mechanical Engineers, the change of insulation upfront costs in accordance with insulation material thickness and number of floors is presented in the graph below (Gulluce, Karsli and Sarac n.d.).

Figure 59 - Upfront Costs of Insulation According to Number of Floors and Insulation Thickness *(Gulluce, Karsli and Sarac n.d.)*



In the study, insulation material thickness with the lowest payback period was found to be 4cm and 5cm for a five-story building. Therefore, 5 cm insulation material is selected for calculations. As it can be seen from the graph 5 cm, insulation would cost approximately 30,000 TL (~€13,000[5]).

In another study of Turkish Chamber of Mechanical Engineers, the annual potential natural gas savings through installing insulations of a building is found as 13,420 m^3 (Ince n.d.).

[5] March 2013 Exchange rate.

The natural gas retail price per m^3 in Turkey was 1.06 TL (€0.45[6]) in March 2013 (Baskent Dogalgaz 2013). This number is used for household savings.

Based on this data, the calculations for program costs and savings are presented from electricity buyer and government perspective.

The calculations for a 5-story 10-resident building is presented as an example.

FIVE-STORY BUILDING CUSTOMER'S PERSPECTIVE	
Cost of Building Insulation	€13,000
Tax Levy Cost	▪ 10 Residents charged for €6.95 10*6.95 = € 69.5
Total cost	▪ The cost of insulations is added to the tax-levy cost 13,000+69.5= € 13,070
Cost for each Household	▪ The total cost is divided by the number of households. €13,070/10 = **€1307**
Natural Gas Savings	13,420 m^3
Annual Return From the Natural Gas Savings	13,420 m^3 x 0.45 €/ m^3 = € 6309
Annual Savings for each household	▪ The savings is divided by the number of households. €6309/10 = **€631**

[6] March 2013 Exchange rate

As can be seen from the calculations a cost of €1307 and an annual saving amount of €631 would be the result of implementing the mechanism. The payback period of such investments would be approximately 2 years. It should be noticed that the reduction in the material prices is not taken into account. Therefore, it can be said that the cost of the program can be reduced further.

For calculating nationwide savings, the number of natural gas subscribers is used.

According to EMRA Natural Gas Report, the number of residential natural gas subscribers was approximately 8 million at the end of 2011 (EMRA 2011). It is assumed that all the buildings were identical with 10 residents. Therefore, the number of buildings that install insulations will be accepted as 800,000.

As mentioned in the chapter VI.A.2.1, Turkey is importing almost all of its natural gas. The country is buying most of the product from Russia for $0.45 (€0.35[19]) per m^3 (Gurcanli 2012). Based on this information the calculations are presented below.

Savings from imported natural gas	▪ The import rate is multiplied with the natural gas savings and the number buildings. €0.35/m^3 x 13,420 x 800,000 = **€ 3,757,600,000**

The table shows that € 3.75 billion can be saved every year through installation of insulation materials in households. The savings from coal is not included in the calculations. Therefore, it is likely to expect higher saving amounts as a result of energy efficiency measures and increased consciousness for energy efficiency. Moreover, the calculations were only for insulations for the buildings. Therefore is can be said that the savings can be enhanced through the implementation of other energy efficiency measures.

2.3. Energy Efficiency Grants For Low Income Households

In Turkey, 46.4% of the households represent the lowest 20% income level, and 21.9% of the households represent lower 20-40% (Turkish Statistical Institute 2011). The mentioned grants and low-interest loans can be offered for such households in Turkey.

The last building census was conducted in 2000 in Turkey. According to the census, the number of buildings was 16,235,830 in that year (State Institute of Statistics Prime Ministry 2000). In order to have a more realistic number and have an appropriate calculation this number will be assumed as 25,000,000 for the year 2013. Based on this information, the number of low-income households are calculated as follows.

Number of Low-Income Households	
Lowest 20%	▪ 46.4% of 25,000,000 buildings 0.464 x 25,000,000 = 11,600,000 households
Lower 20-40%	▪ 21.9% of 25,000,000 households 0.219 x 25,000,000 = 5,475,000 households

In the previous chapter, an insulation cost of €1307 was calculated for each household, and the national annual natural gas savings was calculated as €3.75 billion. This means a total of €3.75 billion can be saved every year if the mentioned insulations can be installed by every natural gas using household.

It is assumed that none of the low-income households has participated in the mechanism so far. Therefore, real energy savings would be lower unless low-income households are participated in the mechanism.

The amount of potential savings is used for the calculations of low-income household grants and low-interest loans. The program costs are calculated as follows:

Cost of Government Grants	
Support for each household of the Lowest 20%	▪ 75% of total insulation costs are provided by the government €1307 x 0.75 = €980
Total Support for the Lowest 20%	▪ 11,600,000 households are provided with €980 11,600,000 x €980 = €11,368,000,000
Support for each household of the Lower 20-40%	▪ 25% of total insulation costs are provided by the government €1307 x 0.25= €327
Total Support for the Lower 20-40%	▪ 5,475,000 households are provided with €327 5,475,000 x €327 = €1,790,325,000
TOTAL GRANT COSTS	€11,368,000,000 + €1,790,325,000 = **€13,158,325,000**

As it can be seen from the calculations, €13.2 billion is required for providing such grants in Turkey. As mentioned in the previous paragraphs an annual saving amount of €3.75 billion is expected as a return. That means theoretically in four years €15 billion can be saved just from natural gas savings if every household can be included in the mechanism. The government can assure participation through offering grants as explained above. Under this circumstance, €13.2 billion grant costs can be provided from the energy savings and the cost of low-interest loans can be met with the remaining budget.

It is important to remember that the possible reduction of the insulation material price as a result of government tax-reduction and bulk purchase is not taken into account. Moreover, the calculations are made only for natural gas savings through installation of building insulations. It is likely to expect considerable energy savings from coal savings and other energy efficiency measures as a consequence of increased energy efficiency consciousness and energy efficient product installations.

3. Phase III: Renewable Energy Deployment

Turkey has increased its renewable energy capacity in the last decade. On the other hand, the country has not started using its solar energy potential yet. Turkey has a good solar irradiation when compared to many other countries as can be seen from the Table 10. Therefore, it can be said that solar PV installations can be increased by implementing the appropriate mechanism. The calculations for this phase are presented below. The increased tax-levy amount selected as 12% of 2011 retail prices as an adequate level tax-levy.

ADEQUATE LEVEL TAX – LEVY BUDGET CALCULATIONS	
Tax-levy Rate	▪ 12 % of retail price 0.115 €/kWh x 0.12 = 0.0138 €/kWh
Budget	▪ If the total consumption of 41,393,000,000 kWh is multiplied with 0.0138 €/kWh 41,393,000,000 x 0.0046 = € 571,223,400
Annual Cost per purchaser	▪ If we divide the total budget with 27,400,382 electricity purchasers. € 571,223,400 / 27,400,382 = € 20.85

As can be seen €500 million can be collected for supporting the mechanism by collecting an average amount of €20.85 annually from every household. Similarly, it is assumed that this budget is supported with the energy savings from previous phase (€3.75 billion annually). It is assumed that a budget of €4 billion is provided every year for this mechanism.

In this chapter, the costs of small renewable energy systems and calculations are presented for a better understanding.

According to an informative website from UK, the installed price ranges of small renewable systems can be listed as follows (Electricity Guide 2013):

- ❖ Residential Solar PV: £4,000 – £9,000/kW
- ❖ Small wind turbines: £3,000/kW
- ❖ Geothermal : £800-1,200/kW
- ❖ Micro-hydro power plants: €1,500-6,000/kW (Energypedia 2011)

For the calculations, the average prices are selected as follows:

- ❖ Residential Solar PV: £6,500 kW (~€7500[7])
- ❖ Small wind turbines: £3,000/kW (~€3500[7])
- ❖ Geothermal : £1000/kW (~€1150[7])
- ❖ Micro-hydro power plants: €3750/kW

Based on this data the collected tax levy amount would be sufficient for considerable renewable energy installations. As mentioned in the previous chapter the government can provide 30% of the renewable energy system costs for low-income households and 15% for the rest of the households. Since approximately half of the population presents the lowest 20% of the households in Turkey, an average grant amount of 23% is selected for the calculations for all households.

The grant costs are presented in the table below.

[7] March 2013 Exchange rate

Grant Cost Per kW of Installed Capacity	
Residential Solar	▪ 23 % of system installation costs 0.23 x €7500/kW = €1725/kW
Small Wind Turbines	0.23 x €3500/kW = €805/kW
Geothermal	0.23 x €1150/kW = €265/kW
Micro Hydropower	0.23 x €1150/kW = €863/kW

It is assumed that a budget of €20 billion will be allocated to the mechanism budget by the end of fifth year. The €20 billion budget is divided by the grant costs of renewable systems to present the possible installation capacities of small renewable energy systems.

POSSIBLE SMALL RENEWABLE ENERGY INSTALLATION CAPACITIES	
Residential Solar	20,000,000,000 € / 1725 €/kW = 11,594,203 kW = 11,594 MW
Small Wind Turbines	20,000,000,000 € / 805 €/kW = 24,844,720 kW = 24,845 MW
Geothermal	20,000,000,000 € / 265 €/kW = 75,471,698 kW = 75,472 MW
Micro Hydropower	20,000,000,000 € / 863 €/kW = 23,174,971 kW = 23,175 MW

The grants would be sufficient for considerable amount of installations by the end of fifth year. As can be seen from the table, a grant budget of €20 billion is equal to 11.5 GW of solar PV, 24.8 GW of wind turbine, 75.5 GW of geothermal and 23.2 GW of micro-hydropower system capacities. This is equal to an average of 33.8 GW of installed capacity.

As mentioned in the previous chapters the number of electricity purchasers was 27,400,382 in 2010. Under these circumstances, it can be seen that the mechanism can provide 33.8 GW of renewable systems for 27,400,382 households. This number is equal to 1.23 kW of renewable system per household. Therefore, it can be seen that a 1kW renewable system can be installed by every household if the mechanism can be implemented successfully. The remaining budget can be used for low-interest loans.

When the benefits of installing renewable systems are taken into account, the government might consider supporting the budget with allocating additional resources.

In chapter VI.A.1.2, the loss of electricity due to theft and grid losses are mentioned. Although the illegal usage of electricity cannot be advocated, it should be accepted that if the government would be able to provide cheaper electricity, or even free electricity in cases that the renewable production exceeds the consumption, these numbers would decrease significantly.

After the successful deployment of renewable energy systems, the budget for grants can be allocated to feed-in tariff incentives as mentioned in the previous chapter for the benefit of all households from every income level.

Such a system would benefit the whole country in terms of economy, environment and social welfare.

VII. Results & Recommendations

A. Results

In the study, five index tables were formed as a tool for evaluating country performances in terms of solar PV installations. The country performances are related to implemented solar energy policies and the policies of Germany, Japan, and the USA were evaluated through a quantitative analysis. The quantitative analysis results showed that the most successful policies in mentioned countries were as follows:

1. Feed-in tariffs with low interest loans
2. Grants (high level)
3. Subsidies / Demonstration Programs
4. Renewable Portfolio Standard (RPS) / Tax Credits

Based on the result a new mechanism called "Socio Feed-in Tariff Mechanism (SocioFIT)" was formed for developing countries. Some of the main energy related problems of developing countries were found as follows:

1. High dependence on non-renewable energy sources
2. High CO_2 emissions
3. Low energy efficiency levels

In addition to these problems economic inequality problem of such countries were presented and the new mechanism is formed to address these issues.

The study showed that energy savings through energy efficiency measures can be used as a funding source for renewable energy systems. Moreover, it is explained that economic equality level of a country can be increased by implementing the SocioFIT Mechanism. The phases of the mechanism are explained and solidified with calculations in case of an implementation in Turkey.

It is found that The SocioFIT Mechanism is applicable in Turkey. The mechanism can be implemented, and billions of dollars spent for energy imports can be transferred to the country's economy and used for energy efficiency, renewable energy systems and improving economic equality of the country.

B. Recommendations

1. Quantitative Analysis

The "Relative Installation Index" and "Relative Growth Index" were introduced. Additionally, "Relative Installation and Solar Potential Usage Index" and "Relative Growth and Solar Potential Usage Index" were formed by integrating "Relative Solar Potential Index" into the first two indexes. Similarly, other factors that might affect the solar PV installations can be integrated with an appropriate ratio into the indexes and therefore such factors can be ignored. As a result, a more practical index table can be formed and more realistic policy evaluations can be conducted.

2. Socio Feed-in Tariff Mechanism

Developing countries were analyzed for an implementation of SocioFIT Mechanism. On the other hand, there is no reason to limit the mechanism for implementing only in developing countries. Especially economic inequality problem is a common problem of many developed countries. Therefore, developed countries can also be analyzed for implementation of the SocioFIT Mechanism.

In this paper, rough calculations are presented for illustrating the costs and returns of the SocioFIT Mechanism. The calculations can be made with more accurate and current data for a better understanding of the feasibility of the mechanism.

Instead of implementing the SocioFIT Mechanism countrywide, one of many of the introduced phases of the mechanism can be implemented by municipalities in a smaller scale. A feasibility study for such an implementation of SocioFIT Mechanism can be conducted.

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IX. Appendix

A. Solar PV Related Policies of Selected Countries

The solar photovoltaic policies and alternative approaches in Germany, Japan, and USA is presented below. The solar energy related laws and regulations are sorted according to the implementation dates.

1. Germany

1.1. Implemented Policies Through the History

During the energy crises of 1973-1974 and 1979-1980, German economy has severely damaged and as a result of this in order to reduce the fossil fuel dependence renewable energy sources have become more important (Avril, et al. 2012, 249). A historical trend can be explained as follows:

1985

- **Federal States (Lander) Support For Renewable Energy**

In Germany, the renewable support level was differing in different regions. Regional findings were supporting technologies such as heating, cooling, agricultural sector, photovoltaic and biogas. The Federal States law mainly supported renewable electricity generation at that time (IEA 2009).

1989

- **1000 Solar Roof Program**

Germany has announced world's first major solar installation initiative (rebates) in 1989: 1000 Solar Roof Program (Avril, et al. 2012). The program requested feedback from the participants of the program such that they had to send quarterly statistics on the electricity generation. The feedback mechanism contributed the technologic development of the small grid-connected solar systems. (IEA 2011).

1990

- **ERP – Environment and Energy Saving Program**

Under the program, The Reconstruction Loan Corporation (KFW) of Germany has offered low interest loans to both public-private companies, private companies and freelancers for energy saving and renewable energy measures. A total volume of €10.7 billion has been extended between 1990 and 2005 through the program (IEA 2009).

1991

- **The Stromeinseisungsgesetz (StrEG – Electricity Feed-in Law)**

The Stromeinseisungsgesetz (StrEG) was Germany's first feed-in tariff law. Under this program, solar PV systems were provided with feed-in tariff payments, which were ranging between 8.45 – 8.84€cent/kWh, and rebates equal to 70% of the system cost (DBCCA 2011). Under the law, grid access for renewable energy was ensured (IEA 2009). The difference of this feed-in tariff from current law was that it was set at 90% of the electricity retail rate (DBCCA 2011).

When the 1000 Solar Roof Program ended in 1995, the German PV market has experienced a regression period because of the insufficiency of the feed-in tariffs (IEA 2011). The StrEG feed-in tariff were not able to cover the costs of the solar systems except some few German towns (IEA 2011). This program ended in 2000 as the new feed-in tariff schedules were offered (IEA 2009).

1993

- **Full Cost Rates (Kostendeckende Vergutung)**

Under the Full Cost Rates legislation, the electricity production from photovoltaic installations were supported by a tariff for the production per kWh (IEA 2009).

1995

- **100 Million Programme**

The programme offered capital subsidies particularly for solar collectors, heat pumps, small hydropower, large wind and solar PV systems, and biomass installations (IEA 2009).

- **Home Eco Grant (Eigenheim – Ozkozulage)**

Additional federal grants were offered for homebuyers who would install solar thermal collectors or heat pumps. The grants are paid as deductions from personal tax amounts (IEA 2009).

- **Ordinance on the Fee Schedule For Architect and Engineers**

Incentives are provided for architects and engineers who include renewable energy systems in their work for dwellings (IEA 2009).

1996

- **Green Power**

The renewable energy generators that are not compensated under the Feed-in tariffs are given the opportunity to sell their electricity on the market. Most utilities provided their customers the option to purchase green power (IEA 2009).

1997

- **Federal Building Codes For Renewable Energy Production**

In 1997, the Federal Building Codes for Energy Production was amended. Under the amendment, hydropower, wind power, and biogas power plants (with some regulations) were permitted for building in the undeveloped outskirts (IEA 2011).

1998

- **Electricity Market and the Energy Industry Law (EnWG)**

In 1998 the Electricity Market and the Energy Industry Law (EnWG) was implemented which guaranteed grid access to individual power producers (IEA 2011).

1999

- **100,000 Roofs Solar Power Program**

In 1999, 100,000-rooftop program was implemented with the goal of mass demonstration (IEA 2011) and installing 300 MW of solar generators by 2004 (Avril, et al. 2012). In this program, low-interest loans were offered for a period of 10 years with no money down and no interest payments (Avril, et al. 2012).

- **Preferential Loan Programmes (KFW Loans)**

The Reconstruction Loan Corporation (KFW) offered soft loans for private buildings, private companies, municipalities, public institutions, and non-profit organizations. KFW offered financing options such as financing for usage of renewable energy sources and conversion of heating systems, investment credits for PV systems, environmentally friendly construction and modernization of houses. Additionally, public financing was offered for modernization of public buildings such as schools or kindergartens. The offered loan interest rates were 1-2% under the market level and the credit terms were 10 to 20 years (IEA 2009).

- **Market Incentive Programme (Marktanreiz Programm)**

The eco-tax sources are allocated to renewable energy technology development. Under the programme, biomass, solar power and geothermal energy systems were supported with grants and low-interest loans (IEA 2009).

2000

- **Erneuerbare-Energien-Gesetz (EEG) - German Renewable Energy**

In 2000, Germany has passed the Erneuerbare-Energien-Gesetz (EEG) - German Renewable Energy Act (DBCCA 2011). The feed-in tariff rate was approximately 51€cent/kWh guaranteed for a period of 20 years (Avril, et al. 2012).

The law obliged electricity suppliers to give priority to renewable energy systems such that all the suppliers had to have the same share of electricity from renewable energy. In this system not only the additional costs caused by renewable systems but also the benefits from the generated electricity was shared equally among the electricity suppliers (IEA 2009).

The financing of the feed-in tariffs were provided by a mechanism called EEG Umlage (EEG Apportionment - EEG Levy) which was the distribution of the costs of this support scheme to the electricity consumers (Bode and Groscurth 2006). As the EEG Apportionment was implemented, all the electricity consumers had to pay the EEG Levy notwithstanding with the fact that they own a renewable energy system or not. The tax-levy is charged as an additional amount on top of the electricity retail prices per kWh. This system was criticized because of its inequitable mechanism such that since all consumers pay the EEG surcharge per kWh, the less wealthy parts of the society, who could not afford to install a PV system, in fact were subsidizing the revenues of PV plant owners (IEA 2011).

In order to control the policy costs an installation cap of 300 MW was fixed in the EEG of 2000 (DBCCA 2011).

After the implementation of EEG along with the 100,000-rooftop program, the remuneration for solar energy was barely covering the cost of solar systems (IEA 2011).

In the same year (2000), the Federal Clearing Centre was founded in order to clear the technical and economical differences concerning EEG (IEA 2011). Federal Clearing Centre had a considerable impact on the 2004 EEG Amendment (IEA 2011).

2001

- **CO_2 Building Restructuring Program (CO_2 Gebaude Sanierungsprogramm)**

Non-repayable grants and low-interest loans were provided by The Reconstruction Loan Corporation (KFW) for energy saving measures in residential sector (IEA 2009).

2002

- **Law to Amend the Mineral Oil Tax Law and Renewable Energy Law**

Under the law, solar photovoltaic cap was risen to 1,000MW (IEA 2009).

2004

- **EEG Amendment**

In 2003 the 100,000 Roofs Program ended and in order to prevent the possible market decline the EEG law was amended in 2004 (IEA 2011). The amended law was offering new rates ranging between 46-62€cent/kWh that were differentiated according to the application type (Façade mounted, roof-mounted, or freestanding) (DBCCA 2011). The tariffs were set to be declined by 5% each year (Avril, et al. 2012).

The 2004 EEG law has removed the 1000 MW program cap and created the first uncapped PV market in the world (DBCCA 2011).

2005

- **KFW-Programme For Producing Solar Power**

Under this program, low-interest loans were offered for small solar PV systems for up to 100% of the system costs (IEA 2009).

- **Energy Industry Act (Energiewirtschaftsgesetz)**

Germany's Energy Industry Act required electricity labelling according to type of energy source (IEA 2009).

- **5th Energy Research Programme**

The development of renewable energy systems was funded with the research programme (IEA 2009).

2006

- **Funding for Solar Power Development Center**

The center provided testing facilities and equipment for solar cell and solar system manufacturers interested in testing their new products (IEA 2009).

2007

In 2007 the government has exempted the large electricity consumers from the EEG Apportionment by setting a minimal fixed amount of 0.0005€/kWh (IEA 2011).

- **Integrated Climate Change and Energy Programme**

The renewable energy and energy efficiency targets of the country was expanded under the programme for energy security of supply, economic efficiency and environmental protection (IEA 2009).

2008

- **EEG Amendment**

The EEG was amended twice in the years 2008 and 2009. The tariffs were reduced moderately in 2008 (IEA 2011). In 2008 a registry system for feed-in tariff applicants, which was managed by the Federal Network Agency (Bundesnetzagentur), was established in order to track the installed and pending capacity easily (DBCCA 2011).

- **Climate Legislation Package Enacted Under the Integrated Climate Change and Energy Programme**

The increased energy efficiency and renewable energy production on the building sector was focused in the package. Some of the main elements of the package was increasing electricity generation from renewable systems and combined heat and power (CHP), using renewable heating systems in buildings, and using smart meters for net-metering (IEA 2009).

- **Climate Protection Investment From Sale of Carbon Allowances**

"Under the program €400 million obtained from the sales of carbon allowances were planned to be allocated to low-carbon projects such as refrigeration technology and biomass researches (IEA 2009).

2009

- **EEG Amendment**

In 2009, EEG was amended for the third time. The 2009 amendment was offering a bonus payment on top of the retail electricity rate for PV electricity consumed <u>on site</u> (DBCCA 2011). Under this new amendment, in order to control the costs of the policy instead of a setting a cap, the government has introduced a new method. With this amendment, a new degression system called "Corridor" or "Flexible" was implemented. The system was arranged such that the feed-in tariff rate was going to decrease each year based on the capacity of installed PV systems in the previous year (DBCCA 2011). The installation scenarios and degression rates of the 2009 amendment are presented in the table below.

Figure 60 Degression Rates of EEG 2009 Amendment *(DBCCA 2011)*

Scenario	2009 (MW)	2010 (MW)	2011 (MW)	Degression
Low case	< 1000	< 1100	< 1200	5.5%
Base case	1500	1700	1900	6.5%
High case	> 1500	>1700	> 1900	7.5%

As it can be seen from the table, if the projected installations were matched the degression rate would be 6.5%. If the installations were to stay below or exceed the projections, the rate would be 5.5% or 7.5% respectively.

- **KFW Renewable Energies Programme**

The KFW programs: Producing Solar Power, ERP-Environment and Energy Saving Programme, KFW Environment Programme, KFW-Programme Renewable Energy were combined under one single program. Under the program, standard loans were offered for electricity and heat generation from renewable and combined heat and power (CHP) sources; and premium loans were provided for producing heat from renewable energies in large plants (IEA 2009).

2010

- **EEG Amendment**

The German Government has amended the EEG in 2010 again. Further decreases in the feed in tariff rate was implemented changing according to the MW installed capacity of the previous year. The rates decreased by 7.5% since the installed capacity exceeded the 2009 projection (DBCCA 2011).

The 2010 adjustments are presented in the tale below.

Figure 61 Degression Rates of EEG 2010 Amendment *(DBCCA 2011)*

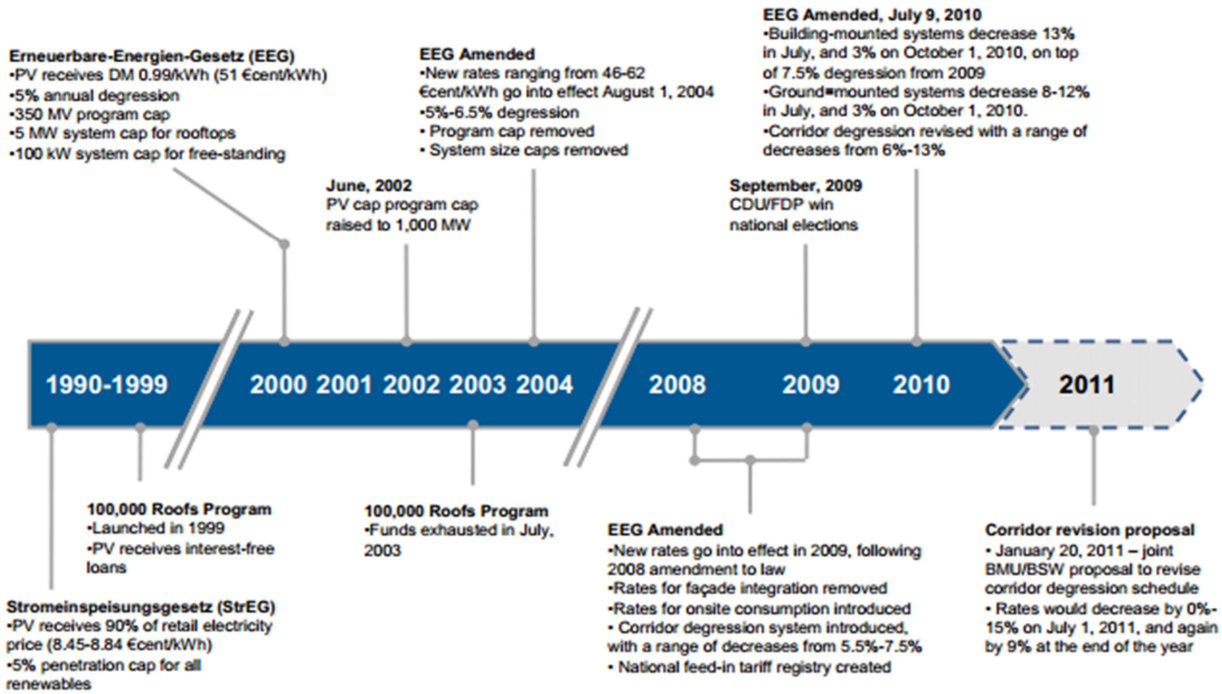
Scenario	MW installed	Degression (2010)	Degression (2011)
< -2 GW	< 1500	6%	1.5%
-2 GW	1500	7%	4%
-1 GW	2500	8%	6.5%
Base case	3500	9%	9%
+1 GW	4500	10%	12%
+2 GW	5500	11%	15%
+3 GW	6500	12%	18%
> +3 GW	> 6500	13%	21%

A base case were set at 3500 MW with a degression rate of 9% as a result of the 2010 EEG Amendment.

Between 2008 and 2011, the tariffs were reduced by 40% due to the degression caused by high amount of renewable energy system installations and the rising problem of grid integration (IEA 2011).

Since producing energy from renewable sources such as solar and wind energy is relatively cheaper than fossil fuel sources such as coal and gas, the average price per unit of electricity went down as a result of the increased installations of renewables. One of the main advantages of increased PV installations was this effect called “Merit Order Effect” (Sensfuß, Ragwitz and Genoese 2007) (Blyth, Yang and Bradley 2007).

Figure 62 - History of German Solar PV Policy (DBCCA 2011)



2011

- **Law on Energy and Climate Fund**

Under the law, a special purpose energy and climate fund is created and dedicated to the promotion of environmentally friendly, reliable and affordable energy supply (IEA 2009).

- **6th Energy Research Programme**

German government has enhanced its support for research and development of energy technologies by starting 6th Energy Research Programme (IEA 2009)."

2012

- **EEG Amendment**

Germany had approximately 24,700 MW of PV installations as of the end of 2011 (DBCCA 2012). As the installation capacity of PV systems increased rapidly, the volume of FIT contracts has grew and as a result, the EEG tax-levy has risen. The previous policies were obviously successful. On the other hand, the EEG tax-levy became an economic burden on the citizens as the rates increased (GWPF 2012). In order to control this growth the government established another amendment on the EEG law in 2012. The important changes under this amendment are explained below.

Capacity Threshold

One of the most remarkable changes was the "Capacity Threshold". The solar projects that are going to benefit from the financial support under the EEG were limited with a capacity threshold of 52 GW (DBCCA 2012). Once the installation limit is passed, the government is going to introduce a different policy regarding the solar PV installations. In any case, the PV electricity will have the priority access to the grid (DBCCA 2012).

New FIT Rates

The new amendment introduced new feed-in tariff payments. The PV FIT payments are presented in the table below.

Table 25 - Feed-in Tariff Rates of EEG 2012 Amendment *(DBCCA 2012)*

Installation Type	EEG 2012	EEG 2012	PV Amendment	PV Amendment
Roof-mounted PV	<30 kW	28.74 € ct/kWh	<10 kW	19.5 € ct/kWh
	30 kW – 100 kW	27.33 € ct/kWh	10 - 40 kW	18.5 € ct/kWh
	100 kW – 1 MW	25.86 € ct/kWh	40 - 1000 kW	16.5 € ct/kWh
	>1 MW	21.56 € ct/kWh	1-10 MW	13.5 € ct/kWh
Freestanding PV		21.11 € ct/kWh - 22.07 € ct/kWh		

Degression (Corridor) System

Under the 2012 amendment the corridor system, which is the degression mechanism on the FIT rates, is maintained with further adjustments. The target corridor was set to be between 2,500 to 3,500 MW. The corridor system under 2012 Amendment is presented in the table below.

Table 26 - Volume-Based, Monthly Degression Schedule *(DBCCA 2012)*

Installed capacity during prior 12-month period	Monthly degression
7,500 MW	2.8%
6.500 MW	2.5%
5,500 MW	2.2%
4,500 MW	1.8%
3,500 MW	1.4%
2,500 – 3,500 MW (target corridor)	1%
Less than 2,500 MW	0.75%
Less than 2,000 MW	0.5%
Less than 1,500 MW	0%
Less than 1,000 MW	-0.5%

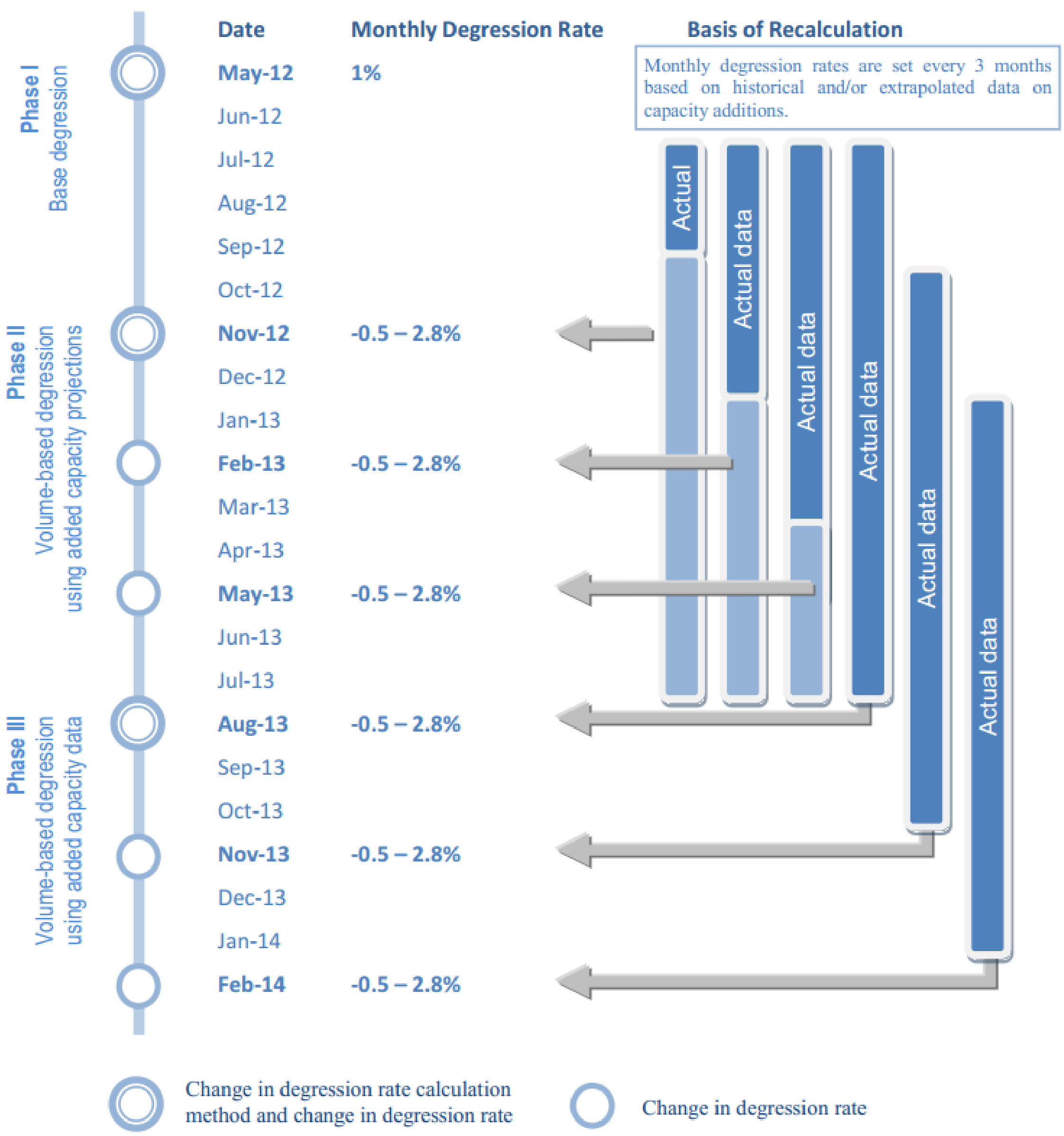
The degression system was planned to not to be implemented immediately. The degression system included three phases as follows (DBCCA 2012):

- Phase I – Flat monthly degression: A degression rate of 1% was applied to the FIT payments at the end of each month for a period of 6 months.
- Phase II – Volume Based Degression (Extrapolated): Starting from November 2012 to July 2013 the volume-based degression presented on the table above will be implemented. Since the degression rates are based on the previous year's cumulative PV installations, the data from July 2012 to September 2012 was used and extrapolated. As the actual PV installation data is collected, the degression rate will be recalculated on a three-month basis.

- Phase III – Volume Based Degression (Actual Data): Starting from the August 2013 actual data will be used for calculating the degression rate. The calculation of degression rate will be continued on every three months.

The figure below represents the proposed phases and the degression mechanism.

Figure 63 - 2012 Solar PV FIT Degression Timeline of Germany *(DBCCA 2012)*



PV Output Limit

The government has limited the compensations under FIT regulations of PV systems to 90% of the PV system output. In other words, only 90% of the electricity produced will be compensated under the EEG law (DBCCA 2012). This regulation affects the solar systems that are between 10kW to 1 MW. This means small PV systems will continue being compensated for 100% of their electricity productions.

The remaining 10% can be consumed on site, sold in the wholesale market or compensated at the average market price, which is approximately 3-5€cent/kWh. Since this average market price is higher than the retail electricity rate, using the 10% of produced electricity on-site becomes more feasible with this regulation (DBCCA 2012).

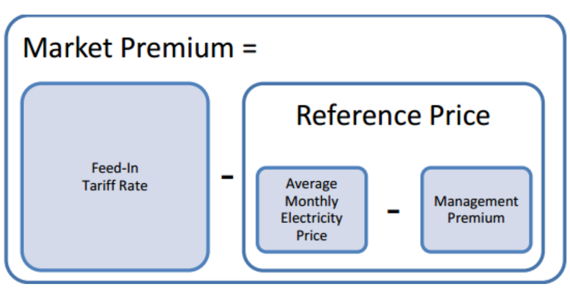
Market Premium Payments

In the past, power was purchased from the producers by the distribution companies and then it was sold on the market. The amended law introduced a new model called "Market Premium" the direct sale of the renewable electricity to the market. The new model offerings are explained below (DBCCA 2012).

1. Power producers can sell their electricity directly to wholesale market.
2. Electricity generators will receive an additional payment on the wholesale price. This bonus payment is called "market premium payment".

   The calculation of this payment is presented in the figure below:

Figure 64 - Calculation of Market Premium Payment *(DBCCA 2012)*



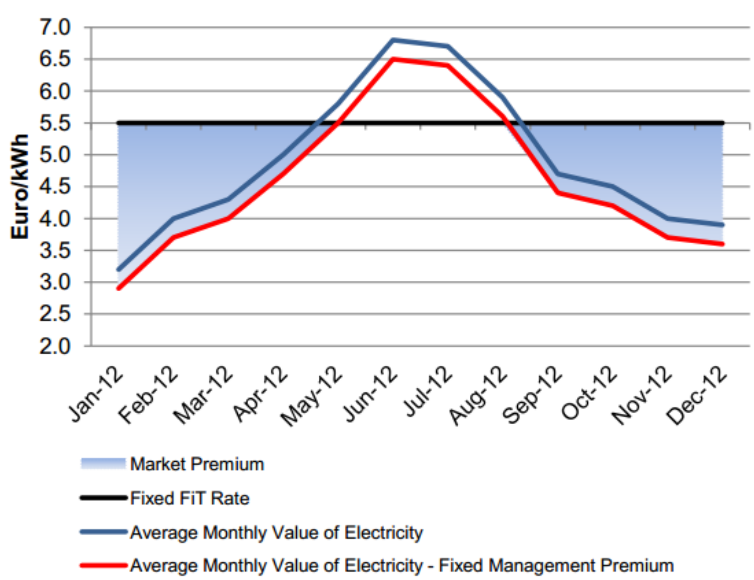
Here the reference price is the difference between "Average Monthly Electricity Price" and a premium amount called "Management Premium". The management premium is the additional cost that electricity generators, who sell the electricity to the wholesale market, absorb because of actively managing their electricity sales (DBCCA 2012). The EEG law has specified the management premiums for different types of energy sources that is shown in the figure below.

Table 27 - Management Premiums for Renewable Energy Sources *(DBCCA 2012)*

Year	Onshore Wind	Offshore[15] Wind	Solar	Other[16]
2012	1.20	0.00	1.20	0.30
2013	1.00	1.00	1.00	0.275
2014	0.85	0.85	0.85	0.25
2015-on	0.70	0.70	0.70	0.225

3. FIT rates will be reducing based on the degression schedule. Since the FIT rates reduce, the market premium rate will be decreasing by time. In the DBCCA study, the possibility of lowering of the market premium rate is shown.

Figure 65 - Forecast Payments to Generators under the Market Premium System over Time *(DBCCA 2012)*



As it can be seen from the figure above, the market wholesale prices exceed the level of FIT rates during June, July and August, which means the market premium rate will be "0" for this period. Since the FIT rates will be decreasing due to the degression rates, this scenario seems to occur more often in the future (DBCCA 2012).

4. The renewable energy producers will have the opportunity to change their compensation methods by switching between the fixed FIT rates and Market Premium Model on a monthly basis (DBCCA 2012).
5. Older generators can switch to the market premium. For example, the generators that have a contract under the EEG 2004 has a locked FIT rate, which became disadvantageous by time. The Market premium model gives the flexibility to switch between market and fixed FIT rates (DBCCA 2012).

Other Changes

- **Project size cap for freestanding systems:** Since the FIT rates are higher for smaller PV systems, the amendment has introduced a project size cap (with some exceptions) of 10 MW. Under this amendment, freestanding installations built within 24 months and located in a distance of 2 kilometer of each other will be considered as one installation. That way the artificially separated systems for higher FIT rates will be prevented (DBCCA 2012).
- **Removal of Self-Consumption Bonus:** The bonus payment for on-site consumption of produced electricity, which was introduced in the 2009 amendment, was eliminated (DBCCA 2012).
- **Rate "lock-in"**: In order to lock-in the FIT rate, the systems must be firmly mounted to the rooftop, have a power inverter, and should have started producing electricity. The grid

interconnection is not a condition for the FIT rate lock-in in order to protect customers from the delays caused by the distribution companies (DBCCA 2012).

- **Curtailment Capability:** The new law require curtailment capability for the PV systems in order to be able to shut the systems to prevent grid instability or to control the expansion need of the grid. The existing systems will have to pay the half of the curtailment system cost and the half will be paid through the EEG levy.
  In case the produced energy is curtailed, the generator owner will still be compensated for the produced energy amount. However, the curtailed energy will be compensated by 95% of FIT rate. The remaining 5% will be used to create a budget as an incentive for the generators that are located in less congested areas (DBCCA 2012).

The latest EEG Amendment was criticized in some aspects. It is asserted that the degression rates and the 90% production limit create uncertainties. Additionally, it is mentioned that 52 GW threshold causes a reduction in the longevity and the transparency of the policy (DBCCA 2012).

1.2. Alternative Approaches

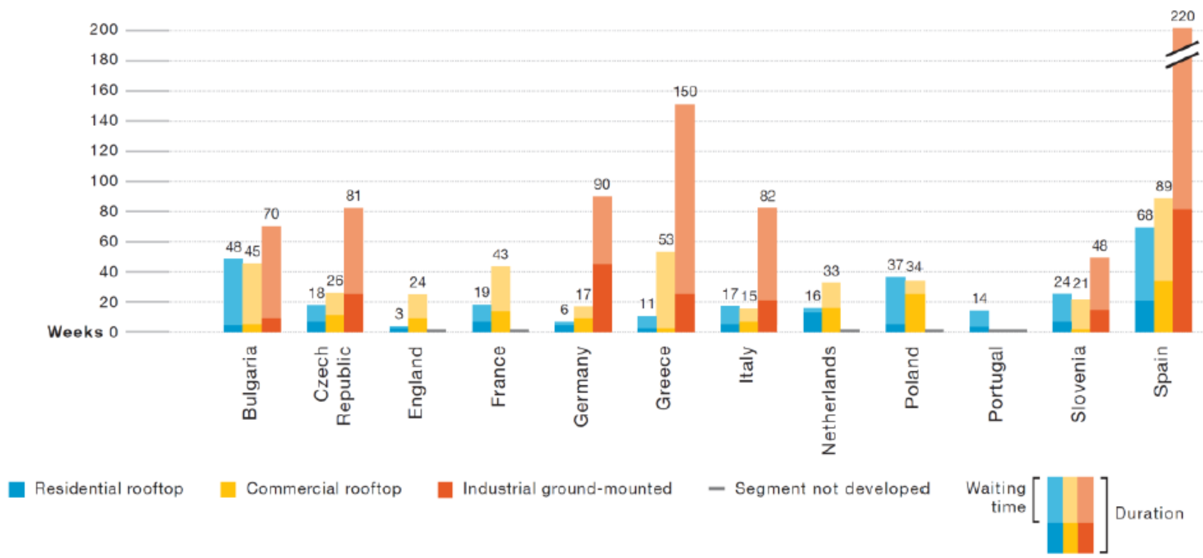
1. Permitting Procedures

Germany has implemented basic design and installation procedures to reduce the cost and waiting times of residential solar systems. There is not a permitting fee in Germany for standard residential solar systems (Jackson 2012). Moreover, only a simple one page online registration is the requirement for installing a solar PV system (Rauber 2013).

According to renewable energy world, “Standardizing permitting and installation procedures to streamline these processes has helped make Germany a world leader in solar energy (Jackson 2012)”.

The EPIA report presents the success of Germany in terms of total durations for developing a solar PV system among the European Countries.

Figure 66 - PV Project Development Process: Total Duration Including Waiting Time (Weeks) *(EPIA 2012)*



2. Japan

2.1. Implemented Policies Through the History

Japan has no natural gas or oil but just a small amount of coal as national energy resource. Therefore, the country was dependent on imported fuels to meet its energy demand. After the oil crises in 1970 and 1980, energy efficiency became the one of the top issues of the country and therefore the country started making investments on energy efficiency and renewable resources in order to have energy security (Kimura and Suzuki 2006).

The R&D studies has started after the invention of silicon solar cells in 1953 in Japan. In 1960s and 1970s, a small number of photovoltaic systems were used in some industries such as spacecrafts, telecommunication stations in isolation places and off-grid lighthouses (Kimura and Suzuki 2006). A historical trend of Japan's solar PV related policies can be explained as follows:

1974

- **Sunshine Project**

In 1974, the Sunshine Program was established with the goal of supplying 1.6% of energy demand from solar, coal liquefaction, geothermal and hydrogen sources by 1990. The focus of the program was solar thermal power generation due to the experimented performance of these systems in US and Spain. PV systems were considerably expensive at that time.

For demonstration purposes, two 1-MW solar thermal power generation were constructed in late 70s. However, the performance was below the expectations, therefore the focus and the budget was shifted to PV solar (Kimura and Suzuki 2006).

1978

- **Moonlight Project**

The project was established in 1978 to support energy conservation efforts (IEA 2009). The goal of the program was increasing the efficiency of MHD (magneto hydrodynamic) generators, gas turbines, heat pumps and power storage (O. Kimura 2007).

1979

- **Energy Conservation Law**

In 1979, second oil crisis urged and the government increased the Sunshine project budget and raised the target from 1.6% to 5% by 1990, and 7% by 1995 (Kimura and Suzuki 2006). The law was the pillar of Japanese energy conservation policies. The law was covering the energy issues of all sectors including energy management in manufacturing, commercial and transportation sectors, energy efficiency standards for vehicles and appliances, energy efficiency standards for houses and buildings (REEGLE 2012).

1980

- **Alternative Energy Act / Establishment of NEDO**

In 1980, "Alternative Energy Act" was enacted. Under this law, three main policies were introduced (Kimura and Suzuki 2006):

1. New Energy Development Organization (NEDO) was established for organizing new energy developments.
2. Electricity tax were raised for securing the revenue for the policies

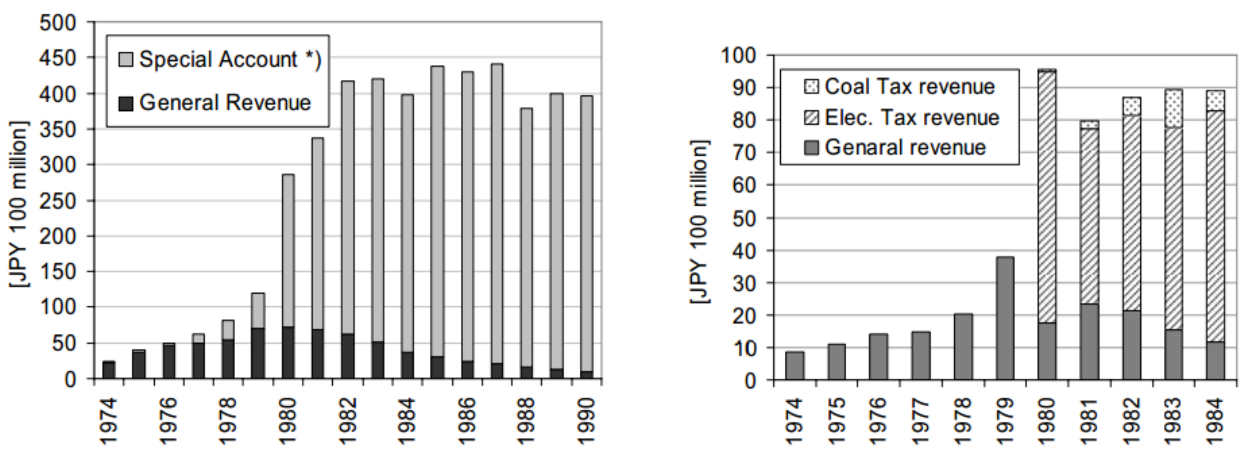
3. “Special Account for Alternative Energy Development” was established. This account was funded by an electricity tax and a tax on coal use that were dedicated exclusively for alternative energy development.

   The establishment of “Special Account for Alternative Energy Development” was remarkably important because most of the budget of the Sunshine Program was coming from this account.

   Since this account was funded by the tax revenues, the income of the account was stable and sufficient for the R&D subsidies.

   The allocation of the budget of the Sunshine program and the budget for the PV development are shown in the figure below.

Figure 67 - Budgets by Revenue Sources of the Sunshine Program, 1974-1994 *(Kimura and Suzuki 2006)*

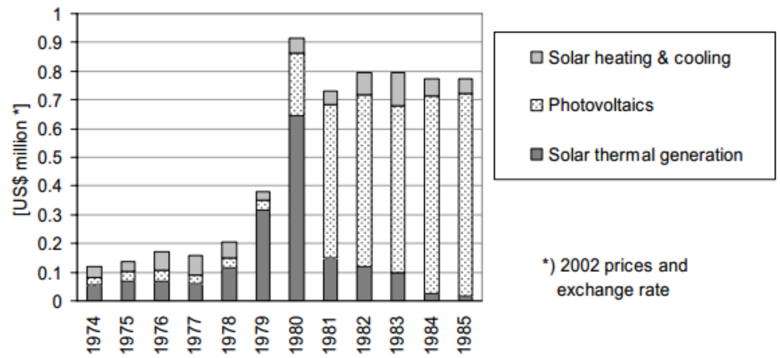


a) Budgets of the Sunshine Program **b) Budgets of the PV development**

*) Special Account includes revenues from the coal use tax and the electricity tax.

In 1981, the PV budget was suddenly expanded due to the allocation of Solar Thermal budget (Kimura and Suzuki 2006). The budget allocation among the solar energy technologies is shown in the figure below.

Figure 68 - Budgets for Solar Energy Technologies, 1974-1985 *(Kimura and Suzuki 2006)*

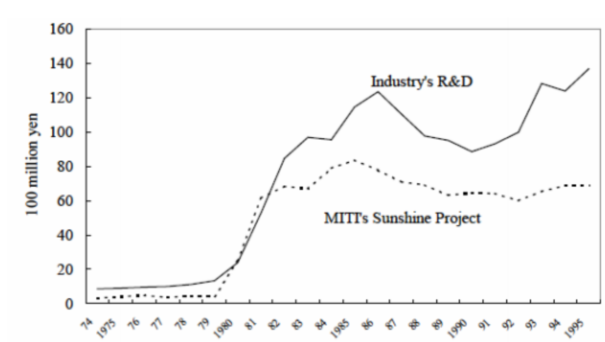


The Sunshine program was being supported by a large and stable budget through the "Special Account for Alternative Energy Development". This system has created a healthy R&D environment for researchers (Kimura and Suzuki 2006). According to Horigome, the reason for this was "they did not have to worry about financial problems and could pursue their mission with abundant budget, which seems to be an important background of Japan having the top level in PV technology" (Horigome, 2003).

Most of the major solar PV producers such as Sharp, Matsushita, Hitachi, Toshiba, and NEC (Nippon Electronics Company), Kyocera, Sanyo and more others had already been conducting R&D in the 1960s. After the introduction of Sunshine Program, these companies accelerated their efforts and increased their investments on PV solar (Kimura and Suzuki 2006).

The R&D budgets of the Sunshine project and the industry is presented in the figure below.

Figure 69 - R&D Budgets of Sunshine Project and Industry
(Kimura and Suzuki 2006)



This was the result of government's clear intention to develop the PV solar through R&D subsidies and national targets. The government had a clear intention to develop and adopt PV technologies therefore; firms could have an expectation that there might be a large market of the technology in the future (Suzuki, 2004).

In addition to small PV applications in 1985 (OSTI 2008), New Energy Development Organization (NEDO) has established a 1-MW solar PV plant for demonstration purposes. These demonstration projects provided the only market for the PV industry at that time in which the producers had the chance to improve their products by learning by doing (Kimura and Suzuki 2006).

In addition to that, NEDO set annual targets of cost reduction for PV systems. NEDO established a system such that if the companies could not meet the cost reduction targets, the organization would not buy solar cells from that company (Kimura and Suzuki 2006).

This resulted with a considerable improvement on the efficiency and of PV systems and remarkable reduction of the cost of the systems. The efficiency and costs of the systems in Japan before 1993 is shown in the figures below.

Figure 70 - Trend of Solar Cell Efficiency 1981-1993 *(Kimura and Suzuki 2006)*

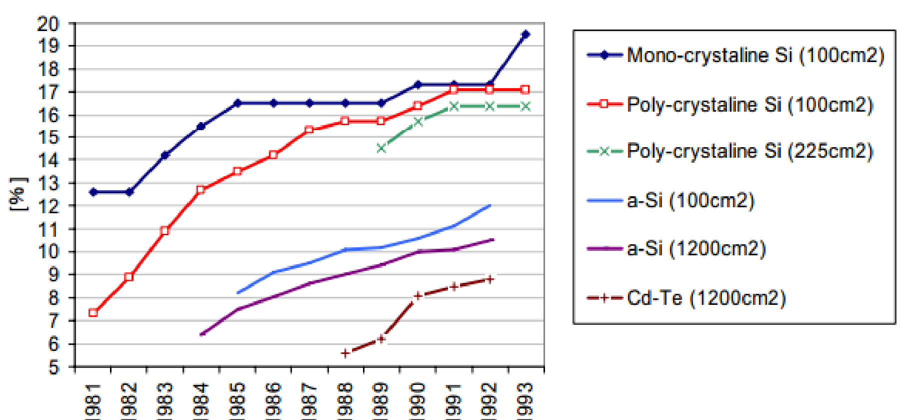
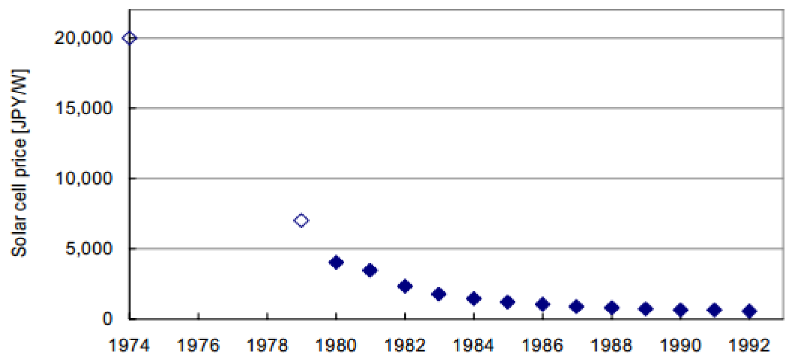


Figure 71 - Cost Reduction of Solar Cells from 1974-1992 *(Kimura and Suzuki 2006)*



At that time, it was very difficult to reach to the laboratory efficiency levels on site for the PV systems. Therefore, by the help of the Sunshine program, companies had the chance to have experience on site (PVTEC, 1998) which brought constant improvement and cost reductions. Between the years 1986 to 1990, NEDO started a large demonstration project. Under the program 100 buildings were installed with 2 kW PV systems to examine the effect of grid connection. As a result of the demonstration program, the reliability, safety and grid connectivity of the PV systems were accepted by the electric power industry (Kimura and Suzuki 2006).

1987

- **Japan Photovoltaic Energy Association**

Many of the policies mentioned above were established by the request of PV producers since the early 1980's. In 1987 the Japan Photovoltaic Energy Association (JPEA), an industry coalition group was established. Through JPEA, the industry members intensified their lobbying activities against the government around the period of 1990 (Suzuki, 2004).

In 1989, the international oil prices decreased and Japan's economy grew, MITI's energy R&D efforts were shifted to a Global Environmental Technology Program. Under this program, environmental technologies were focused (The National Academies Press 2013).

As the interest for PV systems grew, some regulations became a barrier for the PV industry. For example until 1990 a regulation was requesting an Electrical Chief Engineer in case of a PV installation of over 30W (Kimura and Suzuki 2006).

In response to rising momentum in mass media and the governmental committee,

MITI and electric power companies established simplified procedures of PV installation in 1990. The subsequent actions by MITI were very quick. In a few years after 1990, MITI established a series of technical guidelines for PV grid-connection (The National Academies Press 2013).

1992

- **Voluntary Net Metering**

As the government set targets for renewables, the industry also started taking necessary measures to enhance renewable energy introduction. The Federation of Electric Power Companies announced the start of a net-metering system such that the power companies were to purchase produced electricity from the residential PV generators at a price of residential electricity rate (22JPY/kW) (FEPCO, 1990).

Since the produced electricity were being sold to electricity companies, a considerable return was gained by the PV generator owners (Kimura and Suzuki 2006).

- **Field Test Project on PV Power Generation for Public Facilities**

  PV Field Test Project for Public Facilities by NEDO (New Energy and Industrial Technology Development Organization) started in the year 1992 (Ikki 1999).

1993

- **New Sunshine Project**

The “New Sunshine Project” integrated the Sunshine Project (1974), Moonlight Project (1978) and Global Environmental Technology Program (1989) mentioned above.

The target of the program was to develop the PV technology through R&D for competing with conventional systems in terms of electricity production costs. R&D works was focusing on solar cells, PV power generation. Development of low energy consumption manufacturing and high-efficiency multi-crystalline silicon solar cells (IEA 2009).

Under the “New Sunshine Project”, most support was given to solar electricity researches. The aim was to reduce the production cost of PV systems from 600 JP¥/W_p to 100-200 JP¥/W_p by 2000.

1994

- **Residential PV Subsidy Program**

The industry needed the first stimulus to start up a ‘virtuous cycle’ of increased demand, investments in new production facilities and further cost reduction by economies of scale, which in turn create further increase of demand.

In 1994 MITI (Ministry of International Trade and Industry) established a subsidy program known as 700 Roofs Program, with a 2 Billion JPY budget. The full name of the program was “Residential Monitoring Photovoltaic Power Generating Systems” (EIA 2005). Under the program government provided subsidies for residential PV installations with the condition of collecting data about user needs and efficiency. The subsidy was covering 50% of the costs of a PV system between 1994 and 1996, and 1/3 of the costs between 1997 and 1999 (IEA 2009).

The subsidy was given to newly installed systems only, which met the technical specifications established by NEF (New Energy Foundation), (IEA 2009).

The goal of both the program was to reduce the cost of installing PV systems by subsidizing the installation costs of residential systems. As a result of the program, PV producers quickly organized mass-production lines for residential PV systems.

The effect of the program was higher than the expected. In the first year of the program under the 700 Roofs Program 1,000 applicants requested the subsidy. Next year the program was expanded and supported with a larger budget and the 1,000 Roofs program started. More than 5,000 electricity consumers applied for this program.

As a result of the increasing demand, MITI has expanded the subsidy program in the subsequent years by reducing the subsidy amount due to the decreasing cost of solar PV systems.

More than 60,000 installations were made by the program by the year 2004 (Kimura and Suzuki 2006). The program ended in 2006 (IEA 2009).

1996

- **New Renewable Energy Target**

Japanese government set a target of providing 3.1% of the total primary energy supply from new energies (excluding hydroelectric and geothermal energy) by 2010 (IEA 2009).

1997

After the new renewable energy targets were set in 1996, which was providing 3.1% of energy from renewables, new programs were offered by the government.

- **New Energy Law**

The full name of the law was “Law Concerning Special Measures for Promotion of New Energy Use”. The aim of enacting this law was to accelerate the advancement of the introduction of New Energy types (small hydro, modern biomass, wind, solar, geothermal and biofuels (Wikipedia 2013)).

By the implementation of this law, financial support measures were provided for utilities for the use of new energy sources. Additionally. The role of each area for the overall advancement of new energy usage was clarified (IEA 2009).

- **R&D Subsidy for New and Renewable Energy**

  Along with New Energy Law, METI provided subsidies for R&D projects to contribute diffusion of new and renewable energy for a variety of sectors such as electricity, heat and transport (IEA 2009).

- **Promotion for Development and Dissemination of PV Systems**

  The “Residential Monitoring Photovoltaic Power Generating Systems (1994)” program was renewed in 1997 and renamed as “Residential PV System Dissemination Program” (EIA 2005). This program was offering subsidies that are covering 1/3 of the total system costs (IEA 2009).

  The main objectives under this program was technology development of PV for mass deployment, demonstrative researches, and introduction & promotion of PV systems for residences, enterprises, and local governments (IEA 2009).

  Over the course of the program, the subsidies decreased as the economics of PV systems became more favorable.

- **Support for Deployment of New and Renewable Energy**

The New Energy Promotion Council (NEPC) offered incentives for PV systems, wind power, solar heat, differential temperature energy, natural gas-cogeneration, fuel cell biomass generation, biomass thermal, biofuel manufacturer, snow and ice heat energy, hydro generation (up to 1MW),geothermal generation, and micro grid (IEA 2009).

1998

- **Promotion for the Local Introduction of New Energy**

Under this program, NEDO (New Energy and Industrial Technology Development Organization) has subsidized local renewable energy projects. The subsidies were available for public entities as well as Non-governmental Organizations (NGO) for many types of renewable technologies including PV systems. Not only the costs for installation, but also deployment, promotion of public awareness and related activities were covered by the subsidies for up to 50% of the total cost (Kimura and Suzuki 2006).

2000

- **New Sunshine Project Ended**

After conducting 26 years of comprehensive and systematic R&D, the Sunshine Project was ended in the year 2000 (Kimura and Suzuki 2006).

2001

- **Introduction of Solar Power in Government Office Buildings**

In order to ensure energy security, the government expanded the solar power installations into government offices as well as encouraging other institutions. Under this program 410 kW of solar systems were installed to 13 eligible government offices. The systems were expected to produce the 0.15% (0.43 million kWh) of the total electricity consumption of the buildings (IEA 2009).

- **New Energy Indicator**

  The government set an energy supply target of 3% to be provided from the new energy forms by 2010 (IEA 2009).

2002

- **Basic Law of Energy Policy Enacted**

In the year 2002, "The Basic Law of Energy Policy" was passed and put into force. The purpose of this policy was to show the future direction of national energy policy (CNIC n.d.).

2003

- **Green Power: Renewable Portfolio Standards (RPS)**

The Renewable Portfolio Standard (RPS) was established in order to enhance the usage of new energy sources. The government has imposed an obligation on electricity retailer to use a specific amount of electricity from new energy sources. The electricity retailers were given the opportunity to meet the obligations from the following options (IEA 2009).

RPS OPTIONS

- Generating electricity from renewable sources
- Purchasing renewable energy from other parties
- Purchasing "New Energy Certificates" from other parties.

2004

- **International Joint Research Grant Program (NEDO Grant)**

New Energy and Industrial Technology Development Organization (NEDO) has conducted an international research grant program with the aim of promoting technology advancement and new industry creation. Support was provided to different types of research projects including power generation and efficient use projects (IEA 2009).

2005

- **Monitoring Program for Residential PV Systems Ended**

"Residential PV System Dissemination Program (1997)" was terminated in 2006 despite the strong opposition from the PV industry and renewable proponents (Kimura and Suzuki 2006), (IEA 2009).

2007

- **Comprehensive Review of Japanese Energy Policy**

The future direction of energy saving measures were determined in 2007. The main policies are shown in the table below (IEA 2009).

ENERGY SAVING MEASURES 2007
▪ Tightening of Regulations: company based/industrial/residential energy management
▪ Expansion of the "Top Runner Program" (World's best energy efficient products)
▪ Improvement of energy saving and innovative technology support mechanisms
▪ Enhancement of information dissemination, public awareness and influencing behavior

The Energy Policy was revised in 2010.

2008

- **Cool Earth Energy Innovative Technology Plan**

Cool Earth 50 is a Japanese plan to reduce global CO2 emissions 50% by 2050, which was discussed at the 34th G8 summit (Wikipedia 2013). Based on the Cool Earth 50, Cool Earth Innovative Energy Technology Program was announced. Twenty-one innovative technologies were selected to be developed and deployed as a priority. Photovoltaic power generation was one of the selected technologies.

The program aims to strengthen international cooperation to accelerate R&D of innovative technology (IEA 2009).

- **Renewable Energy Targets**

The previous target of 3.1% (or 19.1m kl Oil Equivalent) was considered as upper case and a lower case target of 15.1 m kl oil equivalent was set in 2008 (IEA 2009).

2009

- **New Purchase System for Solar Power Generated Electricity**

  The feed-in tariff system was implemented in Japan by this system. Utility companies were obliged to purchase excess power produced from solar PV systems (IEA 2009).

2009 Solar Feed-in Tariffs	
FIT Rate for Households	▪ 48 JPY/kWh (for 2010)
FIT Rate for Non-Households	▪ 24 JPY/kWh (for 2010)

The cost of the FIT scheme was covered by a **monthly surcharge** of approximately 30 JPY to be collected for 10 years after 2010 (IEA 2009).

- **Subsidy for Residential PV Systems**

  A new subsidy scheme was offered after the termination of the previous subsidy program. Under this program, grants are offered for residential PV systems plants at a level of 70,000 JPY/kWh installed (IEA 2009).

PROGRAM CONDITIONS	
Installation Cost Limit	650,000 JPY/kW
Maximum Output	10 kW
Other	▪ Quality & Efficiency standards

2010

- **Strategic Energy Plan**

The 1996 targets were revised in 2008. In 2010 the previous target for supplying energy from new energy sources were increased and new targets were set. The main targets of the program is presented in the table below (IEA 2009).

STRATEGIC ENERGY PLAN TARGETS FOR 2030 (METI 2010)
▪ Increasing the "Energy Independence Ratio" from 38% to 70%
▪ Raising the zero-emission power source ratio from 34% to 70%
▪ Halving CO_2 emissions from the residential sector

- Maintaining and enhancing energy efficiency in the industrial sector at the highest level in the world.
- Maintaining or obtaining top-class shares of global markets for energy-related products and systems.

2011

- **Fukushima Nuclear Disaster**

Prior to the Fukushima nuclear disaster in March 2011, Japan relied on nuclear power for roughly 30% of its energy needs (DLA Piper 2012). According to The Japan Times, "By shattering the government's long-pitched safety myth about nuclear power, the crisis dramatically raised public awareness about energy use and sparked strong anti-nuclear sentiment". In 2012, the prime minister of Japan has announced their goal of making the country nuclear-free by the 2030s (Wikipedia 2013).

2012

- **New Feed in Tariffs**

"Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities" was adopted in 2012 (DLA Piper 2012). Under the act, a new feed-in tariff schedule was offered. The 2012 Feed-in Tariffs have revised the previous FIT (2009) schedule and replaced RPS (2003) system (IEA 2013). The 2012 FIT schedule for solar power is shown in the table below.

2012 Solar Feed-in Tariffs		
FIT Rate for Residential (<10kW)	for 10 years	42 JPY/kWh
FIT Rate for Non-Residential	for 20 years	42 JPY/kWh

In addition to that, 34 JPY/kWh is being offered for the Solar Cogeneration power generators for 10 years (DLA Piper 2012).

The cost burden of the feed-in tariff mechanism is reflected to the retailers through a surcharge mechanism. Similar to Germany a **nationwide equal surcharge** will be charged form the electricity users. The surcharge rate is to be determined by METI each year (DLA Piper 2012). The rates for the dates between July 2012 and March 2013 was set at 0.22 JPY/kWh (METI 2012).

2.2. Alternative Approaches

1. Tokyo Regional Network

It can be said that this system is an alternative way of implementing "Green Energy Certificates".

Tokyo is a mega city with a population of 13.2 million in 2013 and it is the largest city of Japan with the 10% of its population (Wikipedia 2013). The city is the largest consumer if fossil fuels and largest emitter if greenhouse gases. The Tokyo Metropolitan Government (TMG) has launched its renewable energy strategy for 2020 with the aim of increasing the renewable energy usage of nation to 20% and reducing the GHG emissions by 25% by 2020 (Dollery 2010).

The government has established a network agreement with the Aomori Region in line with this objective. Under this network agreement the Aomori Prefecture were to supply Chiyoda-ku (main business district in Tokyo) with renewable power.

The aim of the project was both reaching the 2020 targets and contributing the economic development of Aomori. One of the reasons for selecting this region was the availability of abundant renewable resources, high unemployment levels and low levels of investment in the Aomori Prefecture (Dollery 2010).

In 2010, four more prefectures joined the agreement: Iwate, Akita, Yamagata and Hokkaido Prefectures.

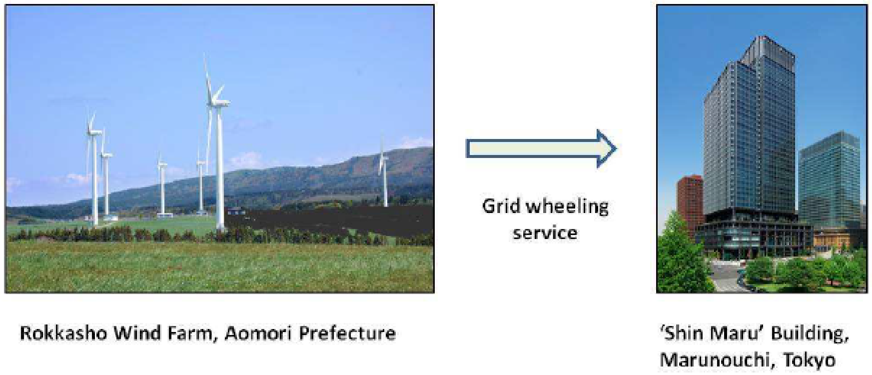
The new framework was aiming to establish a greater demand for green energy sources, establishing a direct grid supply from renewable sources, encouraging local industries and renewable energy finance providers (Dollery 2010).

After the implementation of the network agreement, the Mitsubishi Estate Co, an owner of a new built building in Shin Maru, has entered into an agreement with Futamata Wind Development Co. from Aomori Prefecture.

Under the agreement, the electricity needs of the building were to be fully met by the production of the wind power plants.

The concept of the agreement is shown in the figure below:

Figure 72 - Tokyo Regional Network Example: Rokkasho - Shin Maru Wheeling Service *(Dollery 2010)*



The Mitsubishi Estate Co could have bought green energy certificates instead of implementing the network agreement method (Dollery 2010). However, the reason of selecting network agreements to green energy certificates was that there was no guarantee that sourcing power through the "Green Energy Certificates" would ensure truly sustainable and clean power generation (Dollery 2010). The company had the chance to know where exactly the electricity was being produced.

2. Energy in My Yard (EIMY)

Energy in My Yard (EIMY) can be summarized in the phrase "local energy systems for locals" (Niitsuma and Nakata 2003). The system allows the local residents use the renewable energy potential to provide their electricity needs. Such systems not only increase the renewable energy usage, but also benefit the local economy and energy security in the area (Tetsuro 2002).

The name of the mechanism, Energy in My Yard (EIMY), is given to create a verse reaction to the NIMBY (Not in my Backyard) movement.

In their article Niitsuma and Nakata asserts that EIMY is one of the steadiest ways to decrease CO_2 emissions in the world (Niitsuma and Nakata 2003).

The national dissemination policies are implemented from top to down (Dollery 2010). In other words, government set targets, offer regulations and incentives with a goal of increasing the total renewable energy production. This might be called as a deductive method. On the other hand, the EIMY mechanism offers an inductive method, which starts the dissemination of the renewables from the local resources by considering socio-economic needs of specific localities (Dollery 2010).

In his article Dollery explains EIMY mechanism by stating that “In the long term will contribute to the development of a distributed network systems, but at the same time does not envisage a decline in large-scale, centralized energy distribution grids; both have their place” (Dollery 2010).

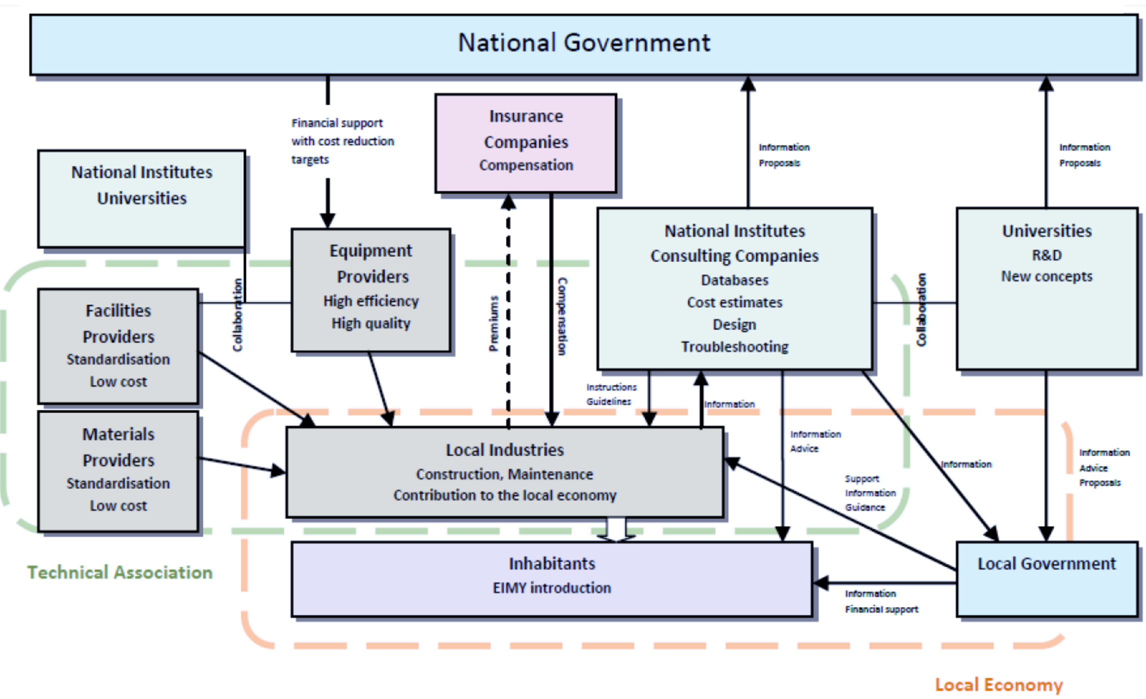
As a result of integration of the EIMY mechanism the goal of forming a truly sustainable society might be achieved (Dollery 2010, 30).

Except some locations with high quality renewable energy sources such as windy or sunny locations, renewable energy sources are generally low density in the nature and widely distributed in regions. Most of the developed countries have already utilized their favorable renewable sources.

Conventional business models work well for developing favorable renewable resources. On the other hand, in order to develop low-density renewable energy projects additional factors should be considered such as environmental benefits, job creation effects, and local energy security. Since the availability of different renewable sources such as solar, wind, geothermal, hydro, and biomass vary with regard to the location, the EIMY mechanism allows the usage of the available renewable potential depending on the source availability.

Niitsuma and Nakata emphasizes this by stating in their article that "The EIMY system seeks to utilize the optimum combination of every green energy resource that is locally available to the maximum extent that practical and economic conditions permit" (Niitsuma and Nakata 2003). The available renewable sources are used to the highest extent by implementing EIMY mechanism. The EIMY mechanism requires the support of many different parties including national government, national institutes, universities, local governments, local industries, material providers and equipment providers.The mechanism is presented in the figure below.

Figure 73 - Schematic of the Energy in My Yard Concept *(Dollery 2010)*



A support infrastructure should be established to finance and maintain the EIMY mechanism. The steps of implementation are explained below (Niitsuma and Nakata 2003) (Dollery 2010).

1. Energy demand profile of a location is identified
2. Local renewable energy sources are identified.

3. Most economical strategy for using the renewable resource is identified through computer modeling.
4. Inhabitants are informed about the benefits of the renewable systems
5. Financial and information support is provided local governments and advisory organizations.
6. Incentives are given to the locals to install renewables.
   - The renewable systems are constructed and maintained by local industries by the informative support of experts from consulting companies, national institutes, universities and similar organizations.
   - Machinery and materials are provided from central industries at reasonable cost
7. An association is established with government support to identify and develop required technologies.
8. Since developing renewable projects involve risk factors, an insurance system is established in order to protect the local industries from unforeseen circumstances.

In order to fully benefit from this system, direct distribution of electricity from renewable resources should be allowed (Dollery 2010). For example, electric distribution of the produced electricity from any renewable source should be allowed to be directly distributed to inhabitants instead of being sent through the electric company's grid.

The EIMY mechanism has been used in many locations of Japan. The Mie Prefecture of Japan has implemented the EIMY mechanism with the goal of creating a locally sustainable society (Dollery 2010). Tohoku University has produced a master plan called "Business Master Plan for the Promotion of Locally Produced-Locally Consumed New Energy" for the prefecture.

Another EIMY application was conducted in Fukishima Prefecture. An action plan was developed by the efforts of community and consultants from academia. During the project, full engagement of the community was found to be a prerequisite for the success of the project.

In his article, Dollery explains that the spirit of collaboration was created with a motto: "By the Strength of the Wind (the outside consultants), By the Strength of the Earth (the community)" (Dollery 2010).

After the evaluation of different renewable energy sources wind power was chosen to be used in the EIMY mechanism in the Fukishima Prefecture. A wind farm site in a Prefectural nature park was selected after an environmental impact assessment. Funding was provided from the national government and consequently four 750 kW wind turbines started producing electricity in 2000 (Dollery 2010). As the Fukushima project succeeded, the community started looking for other renewable sources to be utilized.

A "Regional Revitalization Plan" was created and as a result, a 60kW micro-hydro generation system was installed.

A previously investigated geothermal source, which was not found feasible by NEDO, was utilized and started being used as a heat source for a local nursery school. The geothermal source reduced the energy costs by 45% and CO2 emissions by 60% (Dollery 2010).

Dollery emphasizes on this success by stating, "Renewable resources hitherto thought suboptimal from a standalone perspective become extremely valuable if positioned within an integrated system" (Dollery 2010).

A solar PV unit was also installed through the EIMY mechanism in the Tohoku University. The EIMY mechanism is being considered to be used for spreading the usage of "pellet stoves" with a goal of developing sustainable forest regimes (Japan Government 2010).

The main drivers of this mechanism found to be the collaborative approach and the close relationship between university team, community, government agencies, regional planners and equipment suppliers (Dollery 2010).

The EIMY mechanism is successfully implemented in many places as it is explained above. However, implementation of such a system on a national level requires the technology to utilize resources, establishments of economy system and social system (Niitsuma and Nakata 2003). Implementation of the EIMY mechanism benefited both the community and the nation in many ways (Dollery 2010):

- Encouraged local self-reliance in energy
- Sustained the social capital of the community
- Created a local infrastructure to support the network system

3. Sustainability Zones (SZs)

Another alternative approach is “Sustainability Zones”. This method offers a community-led transition for deploying renewables such that the policy development and administration should start at the local level with full community participation, and the government should be involved in only necessary circumstances (Dollery 2010, 37).

A considerable number of people who live in rural areas immigrate to big cities. As a result, many local cultures and traditions face the risk of vanishing. The sustainability zones method offers an alternative approach to both solve this problem and increase the deployment of renewables.

In sustainable zones, both food and energy should be supplied from the local sources, and in order to achieve this, financial resources should be moved from the central government to the local levels (Dollery 2010, 38-39). The conditions for forming such a place is that there should be means of existence and internal demand for energy and food should be low in that location. The benefits of the Sustainability Zones systems can be summarized as follows (Dollery 2010, 39):

- An example social formation
- A protective mechanism for dissolving communities
- A place for people who would like to leave unsustainable cities

In order to achieve this, policies should be constructed to develop rural areas (Dollery 2010, 39)

4. Other Efforts for Solar PV Deployment

Besides the R&D, subsidy and Feed-in Tariff policies, there were other effort of both government and industry professionals that accelerated the deployment of solar PV systems.

- **Demonstration and Field Test Programs**

  The mentioned policies not only benefited to the public, but also they were used for demonstration programs and field test programs. The accomplishments of three different demonstration projects are presented below (Yamada and Ikki 2011).

Demonstration and Field Test Programs (Yamada and Ikki 2011)		
Project for Promoting the Local Introduction of New Energy (1997 -)	**Project for Supporting New Energy Operators (1997 -)**	**Eco-school Model Promotion Pilot Project (1997 - 2011)**
- FY 1998 - FY 2003: 148 PV systems (18 296 kW) were installed - FY 2004: 45 PV systems (3 433 kW) out of 71 qualified systems - FY 2005: 33 PV systems (870 kW) out of 103 qualified systems - FY 2006: 35 PV systems (1 078,8 kW) out of 111 qualified systems - FY 2007: 49 PV systems (945,4 kW) out of 119 qualified systems - FY 2008: 121 PV systems (3 117 kW) out of 229 qualified systems - FY 2009: 547 PV systems (73 480 kW) out of 676 qualified systems, including continued projects - FY 2010: 354 PV systems (14 527 kW) out of 397 qualified systems - FY 2011: 4 PV systems (41 009 kW) out of 23 qualified systems (all projects are continued) - 1 300 PV systems totaling 115 MW will be installed from the initiation of the project until FY 2013. - Planned installation of multiple numbers of PV systems in local governmental offices, schools, libraries, water purification plants, kindergartens etc., which NPOs operate, as well as factories and large-scale PV power plants engaged in local production/ consumption of new and renewable energy became available. - Installation of larger-scale PV systems with more than 100 kW output became available.	- FY 1997 - FY 2002: 4 PV systems out of 135 qualified systems were installed at a commercial building (118 kW) and a distribution center (100 kW) and others - FY 2003: 2 PV systems out of 39 qualified systems were installed at a factory (200 kW) and a wind power plant (17 kW) - FY 2004: 3 PV systems out of 67 qualified systems were installed at a wind farm (10,8 kW,) a factory (70 kW) and a condominium (66,5 kW) - FY 2005: 3 PV systems out of 90 qualified systems were installed at a golf course and a wind farm - FY 2006: 2 PV systems out of 54 qualified systems - FY 2007: 3 PV systems out of 51 qualified systems - FY 2008: 162 PV systems out of 211 qualified systems - FY 2009: 561 PV systems (52 139 kW) out of 660 qualified systems, including continued projects - FY 2010: 401 PV systems(22 258 kW) out of 422 qualified systems - FY 2011: 5 PV systems(11 110 kW) out of 27 qualified systems (all projects are continued)	- FY 1997 - FY 2004: PV systems were qualified to 284 schools - FY 2005: PV systems were qualified to 59 schools - FY 2006: PV systems were qualified to 45 schools - FY 2007: PV systems were qualified to 52 schools - FY 2008: PV systems were qualified to 69 schools - FY 2009: PV systems were qualified to 114 schools - FY 2010: PV systems were qualified to 133 schools - FY 2011: PV systems were qualified to 62 schools - FY 1997- FY 2011: PV systems were qualified to a total of 818 schools - A larger number of schools introduced PV systems and more students understand PV systems. - Environmental education was implemented and enhanced.

- **Raising Public Awareness**

The government has raised public awareness on climate and energy matters, and on how solar PV can bring global and personal benefits. There were ongoing government publicity campaigns, from both national and local government, on the benefits of PV related to environmental issues.

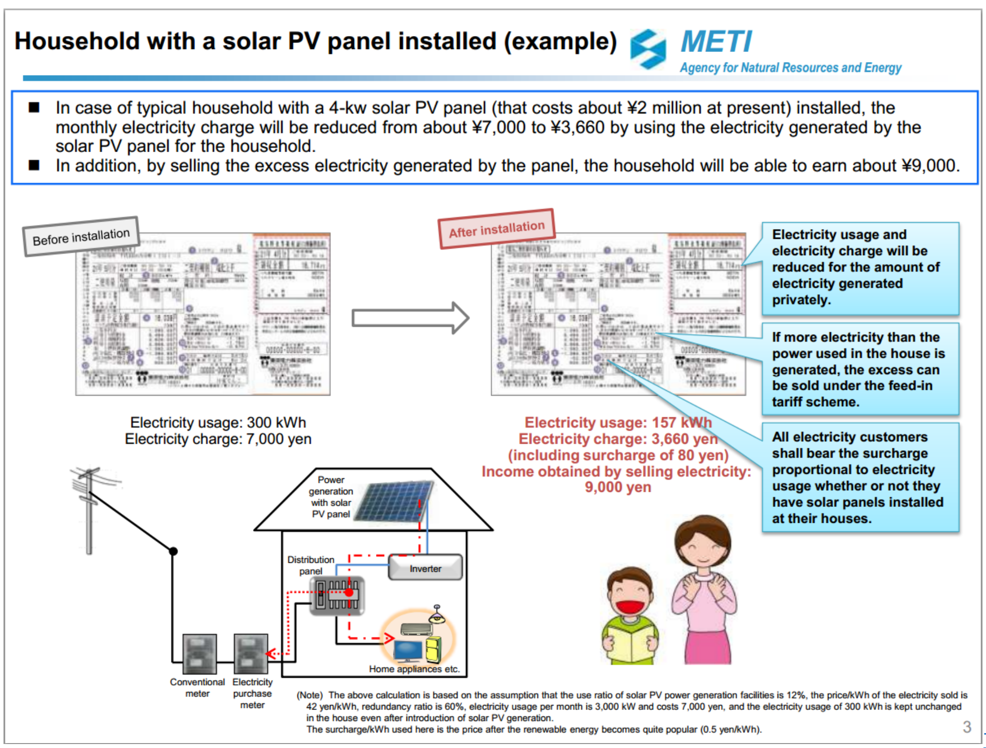
PV technology is promoted through a range of media from newspaper to television (Foster 2005).

- **Presentation of Regulations**

According to Japan Photovoltaics Market Overview Report, "the Japanese PV industry has also made it easy for consumers to understand the performance of their PV systems, which also figures prominently into advertisements. Instrumentation on installations comes from industry. They have their own simple-to-read graphical meters so that homeowners can easily follow their system's performance" (Foster 2005).

In addition to that, some of the government reports has a straightforward language. For example, the benefits of latest feed-in tariff schemes are presented clearly in the Ministry of Economy, Trade and Industry (METI) website. A screenshot from the Feed in Tariff Scheme Report in the METI website is shown below.

Figure 74 - METI Website Screenshot: Household with a Solar PV Panel Installed *(METI 2011)*



3. The United States of America

3.1. Implemented Policies Through the History

A historical trend of solar PV related policies of the USA can be explained as follows:

1974

- **Solar Energy Research Act & Office of Solar Energy Research**

US Department of Energy has implemented the "Solar Energy Research Act" 1974 to allocate research and development funds for solar energy as a major source for increasing energy needs. Under the act, incentives are offered for commercial use of solar technology and "Office of Solar Energy Research" was established (IEA 2009).

- **Solar Heating and Cooling Demonstration Act**

Commercial demonstration of solar heating and cooling systems are offered under the act (IEA 2009).

1978

- **Energy Tax Act**

The Energy Tax Act constituted a program of tax credits. Under the program, tax credits are offered for households (20-30%) and businesses (10%) (IEA 2009).

- **Solar Photovoltaic Energy Research, Development and Demonstration Act**

The solar photovoltaic energy researches are reestablished through the act (IEA 2009).

- **Public Utility Regulatory Policies Act (PURPA)**

PURPA mandated the utility companies to buy electricity from independent producers if the produced electricity cost was less than what utility company's cost (IEA 2009)".

1981

- **Economic Recovery Act**

The act allowed businesses to recover their investments through depreciation deductions (IEA 2009).

1983

- **State-Level Renewable Portfolio Standards (RPS)**

The RPS required electricity providers to acquire a specific percentage of their power from renewable resources by a specified period. The State-Level Renewable Portfolio Standards was the first RPS in the USA. Many of the states have strengthened their standards after 2000 (IEA 2009).

1986

- **Tax Reform Act**

The business tax credit was eliminated for wind energy, phased out for biomass, and extended at 10% for solar and geothermal under the tax reform act (IEA 2009).

- **Modified Accelerated Cost Recovery System (MACRS)**

The system allowed businesses to recover their investment in solar, wind, and geothermal energy sources (IEA 2009).

1990

- **State and Local Climate and Energy Program**

The State and Local Climate and Energy Program was established in the late 1980's[8]. The program is established for assisting state and local governments for their clean energy efforts through technical assistance, analytical tools and outreach support (IEA 2009).

1992

- **Mortgages for Energy Efficiency**

Mortgages were offered for financing energy efficiency measures and renewable energy technologies in new or existing homes. The government secured the lenders of energy efficiency loans under this program. As a result, participants were provided with higher loan amounts. Moreover, borrowers, who would be denied under normal conditions, had the chance to get a loan (IEA 2009). According to IEA, Such programs "adopted special underwriting guidelines to make financing energy efficiency less burdensome" (IEA 2009).

- **Energy Policy Act: Incentives for Renewable Energy**

Under The Energy Policy Act, three incentive types were introduced (IEA 2009):

- ✓ Investment credits (10%) were offered for solar and geothermal technologies.
- ✓ Production tax credit was introduced at the level of $0.015 per kWh for wind and biomass for up to ten years

[8] Late 1980's (http://epa.gov/statelocalclimate/state/topics/energy-efficiency.html)

- ✓ Production incentive payment was introduced of $0.015/kWh for publicly owned utilities that cannot benefit from production tax credits. The incentives are offered for solar, wind, biomass and geothermal.

- **Federal Business Investment Tax Credit (ITC)**

Under the act, commercial entities were enabled to take a tax credit of up to 10% for purchasing and installing renewable energy. ITC were covering only solar technologies at that time (IEA 2009).

1993

- **Environmentally Preferable Purchasing (EPP)**

Due to laws and regulations in USA, federal agencies are required to buy environmentally friendly products. "The Environmentally Preferable Purchasing (EPP) programme was implemented for helping the federal agencies for meeting such criteria (IEA 2009).

1994

- **The Federal Utility Partnership Working Group (FUPWG)**

The group brings Federal Agencies, utilities, and energy service companies (ESCOs) together to develop energy efficiency, renewable energy, and water conservation strategies (IEA 2009).

- **Tribal Energy Program**

The program promotes self-sufficiency of Indian tribes in the USA through deployment of renewable energy and energy efficiency technologies. Under the program, financial and technical assistance for feasibility studies, education and training for sustainable energy projects were offered (IEA 2009).

1996

- **State Energy Program**

The program provided grants for the states that support renewable energy and energy efficiency through some programmes (IEA 2009).

- **Building Energy Software Tools Directory**

Tools for evaluating energy efficiency, renewable energy and sustainability in buildings are provided through the directory. The directory included databases, spreadsheets, component and systems analyses, and programs for energy performance simulation (IEA 2009).

1997

- **Renewable Portfolio Standard (RPS) - Massachusetts**

The RPS required the state to generate 1% of electricity sales from renewable sources by 2003, 4% for 2009, and 1% more each year after 2009 (IEA 2009).

1998

- **Workforce Investment Act**

Under the act, competitive grants are offered for worker training and placement in energy efficiency and renewable energy industries (IEA 2009).

1999

- **Energy Efficiency and Renewable Energy (EERE) International Activities**

The Office of Energy Efficiency and Renewable Energy (EERE) has involved in many events for promoting renewable energy and energy efficiency all over the world including International

Partnership for Geothermal Technology, the International Partnership for Energy Development in Island Nations (EDIN), Major Economies Meetings on Energy Security, Climate Change, and the United Nations Climate Change Conference of the Parties 13 (IEA 2009).

- **Greening of the National Park Service**

Under the program, energy conservation and renewable technologies are used in parks to save money and educate the public (IEA 2009).

- **Tax Relief Extension Act**

This Act extended the expiration date of the Energy Policy Act of 1992to 2001 (IEA 2009).

2001

- **Green Power Partnership**

Green Power Partnership is a voluntary programme for increasing the use of renewable power in leading U.S. organizations through offering expert advice, technical support, and tools and resources (IEA 2009).

- **San Francisco Solar Energy Incentive Program**

Under the municipal incentive program, different levels of incentives are offered for photovoltaic (PV) systems for different properties such as residential, commercial, and low-income residential, non-profit, or multi-family residential owned and operated by a non-profit (IEA 2009).

- **Economic Security and Recovery Act**

The Energy Policy Act of 1992 was extended to 2003 (IEA 2009).

2002

- **Renewable Portfolio Standard (RPS) - California**

The State of California has established a RPS with the target of supplying 20% of its energy demand from renewable sources by 2017. In 2006, electric corporations were obliged to increase renewable energy procurement by at least 1% every year until reaching 20% by 2020. The RPS was revised in 2008 with a target of 33% renewables by 2020 (IEA 2009).

- **Renewable Energy and Energy Efficiency Partnership (REEEP)**

The Renewable Energy and Energy Efficiency Partnership (REEEP) is a multicounty funded, including USA, global partnership for removing the barriers of renewable energy and energy efficiency technologies and projects (IEA 2009)

- **Rural Energy for America Program Grants / Renewable Energy Systems / Energy Efficiency Improvement Program (REAP/RES/EEI)**

Under the REAP/RES/EEI Grants Program, grants were offered for energy audits and renewable energy development assistance to businesses such as agricultural producers and rural small businesses that demonstrated financial needs. The grant-funded projects included retrofitting, lighting, insulation, purchasing or replacing equipment with more efficiency units and renewable energy projects such as wind, solar, biomass, geothermal, hydropower and hydrogen-based sources (IEA 2009).

- **Solar Decathlon**

Solar Decathlon is a competition among college and university students for designing, building and operating the most energy-efficient solar powered house. Not only US students but also students from other countries can attend to this competition. Some of the goals of the decathlon is educating participants, rising renewable and energy efficiency awareness, stimulating the solar energy market, and demonstrating zero-energy houses (IEA 2009).

- **New York State Energy Plan**

The 2002 State Energy Plan is released with the goal of reaching 50% renewable energy production by 2020 and reducing energy usage per product to 25% below 1990 levels by 2010. The plan is renewed in 2009 with further goals such as developing in-state energy supplies and supporting clean energy innovations (IEA 2009).

2004

- **Production Tax Credit – Extension**

Under the program, tax-exempt financing was offered to green buildings and sustainable design projects. This allowed project developers to borrow lower-interest loans. This program gave developers the opportunity to use their savings from lower-interest loans for sustainable and renewable technologies (IEA 2009).

- **Renewable Portfolio Standard (RPS) – Colorado**

The fist RPS of US required Colorado utilities to generate of purchase at least 10% from renewable energy by 2015. In 2007, RPS was increased to a requirement of 20% by 2020. In 2010, RPS was revised again with a goal of 30% renewable energy generation/purchase by 2020 (IEA 2009).

2005

- **Energy Policy Act (Energy Bill)**

The Energy Policy Act of 2005 provided tax incentives and loan guarantees for energy production of various types such as hybrid vehicles, innovative technologies, biofuel, coal (while reducing air pollution), wind, solar, small irrigation power, municipal solid waste, ocean energy, biomass, geothermal, energy conservation, and alternative fuels (IEA 2009).

- **Interconnection Standards for Small Generators**

The interconnection of generators under 20 MW were standardized under this program (IEA 2009).

- **Clean Energy – Environment State Partnership Program**

Under the program, clean energy usage along with achieving public health and economic benefits were supported through assisting states for developing and implementing action plans to improve air quality, decrease energy use, reduce greenhouse gas emissions, promote energy efficiency, clean distributed generation, renewable energy, and other clean energy sources (IEA 2009).

- **Renewable Portfolio Standard (RPS) - Nevada**

The RPS was implemented with the goal of providing 20% of the state's energy from renewable energy sources by 2015. The RPS was updated with a target of 25% by 2025 with the condition of providing 6% from solar resources by 2016 (IEA 2009).

- **State Climate and Energy Program**

Under the program, states are provided with tools and analyses to advance state efforts to improve air quality and public health; increase cost-effective energy efficiency and renewable energy; reap economic benefits; and lower greenhouse gases (IEA 2009).

- **State Utility Commission Assistance**

The Commission offers technical assistance to state utility regulators for increasing clean energy usage through offering best practice policies (IEA 2009).

2006

- **Solar America**

The goal of the Solar America Initiative was to reduce costs of solar PV systems through R&D and to eliminate market barriers through collaborating with industry, universities, state governments, federal agencies and other non-governmental agencies. The program has ended in 2009 (IEA 2009).

- **Credit for Holders of Clean Renewable Energy Bonds (CREBS)**

CREBs are used for financing renewable energy projects by certain entities such as public sector by providing interest-free loan for financing qualified energy projects such as wind; closed-loop biomass; open-loop biomass; geothermal; small irrigation; hydropower; landfill gas; marine renewable; and trash combustion facilities (IEA 2009).

- **Residential Renewable Energy Tax Credit**

Under the Energy Policy Act of 2005, tax credits were offered at 30% for the purchase and installation of residential solar electric, solar water heating, and fuel cells (IEA 2009). The tax-credits were extended in 2008 to include small wind-energy and geothermal heat pump systems. In 2009, the maximum credit amount was removed (except fuel cells) (IEA 2009).

- **Maryland Clean Energy Production Tax Credit**

Under the tax credit program, a USD/kWh credit was offered for a five-year period for eligible resources (IEA 2009).

2007

- **California Solar Initiative**

The California Solar initiative created a ten-year programme to put solar on a million roofs in the state of California. Some of the programs under the initiative are the Low-Income Single Family Program, the Multifamily Affordable Solar Housing (MASH) Program, the Research, Development, Deployment, and Demonstration (RD&D) Program, and the Solar Hot Water Heating Pilot Program (IEA 2009).

- **DOE Loan Guarantee Program**

Under the program, Department of Energy (DOE) offered loans for projects that "avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases" and "employ new or significantly improved technologies as compared to technologies in service in the United States at the time the guarantee is issued" (IEA 2009).

- **Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management**

The order was signed to set more challenging targets than Energy Policy Act of 2005 such as improving energy efficiency and reduce GHG of agencies by decreasing energy intensity levels; 3% by 2015 and 30% by 2015 (IEA 2009).

- **Renewable and Energy Efficiency Portfolio Standard (RPS) – Illinois**

The RPS was implemented with the goal of providing 2% of the state's energy from renewable energy sources by 2008, 10% by 2015 and 25% by 2025 with the condition of providing 75% from wind resources (IEA 2009). Additionally, energy efficiency standards were implemented with the target of reducing electricity consumption by 0.2% in 2008 and 2.0% by 2015 (IEA 2009).

- **Solar America Board for Codes and Standards**

The board gather solar PV stakeholders such as policymakers, manufacturers, installers, and consumers to establish codes and standards for existing and new solar technologies (IEA 2009).

- **Solar America Cities**

"Solar America Cities is part of the Solar Energy Technology Program and is a partnership between the DOE and a select group of cities across the country that have committed to accelerating the adoption of solar energy technologies at the local level (IEA 2009)".

- **Solar America Showcases**

Solar America Showcases provide free technical assistance to projects that feature large-scale installations of commercially available solar technologies to accelerate the demand for solar technologies (IEA 2009).

2008

- **Energy Improvement and Extension Act – Tax Incentives**

Under the act, production tax credits (PTC) and investment tax credits (ITC) were extended for various renewable energy sources and existing tax incentives for energy efficiency investments were modified as well as creating new ones (IEA 2009).

- **Energy Independence and Security Act**

The Energy Independence and Security Act seeks to expand the production of renewable fuels, reduce the US's dependence on oil, increase energy security and address climate change by (IEA 2009):

- ✓ Increasing the supply of alternative fuel sources by setting a mandatory Renewable Fuel Standard (RFS)
- ✓ Supporting R&D, demonstration, and deployment of advanced manufacturing processes, materials, and infrastructure for renewable energy technologies
- ✓ Offering cost-shared Renewable Energy Innovation Manufacturing Partnership Program
- ✓ Providing up to a 50% matching grant for the construction of small renewable energy projects
- ✓ Reducing US demand for oil by setting a national fuel economy standard
- ✓ Improve energy efficiency in lighting, appliances, buildings, and transportation
- ✓ Funding of research into carbon capture and storage.
- ✓ Provisions for the funding of research into hydrogen technologies

- **Energy Provisions – National Defense Authorization Act**

Under the act, the budget on energy efficiency, renewable energy, and use of alternative sources of energy in the armed forces was regulated and the usage of wind and solar energy for expeditionary forces was considered (IEA 2009).

- **Federal Fleet Fueling Centers**

Under the program, every federal agency was obliged to install at least one renewable fuel pump at each federal fleet-fueling center (IEA 2009).

- **Food, Conservation, and Energy Act**

Under the act, regulations were implemented for rural energy efficiency initiatives, and initiatives to encourage the production and use of agricultural and renewable energy sources such as wind, hydropower, solar and geothermal sources. Under the act, loans were offered for renewable energy projects (IEA 2009).

- **Regional Greenhouse Gas Initiative (RGGI)**

The Initiative was the first obligatory market-based effort in the United States to reduce greenhouse gas emissions by setting a cap on the CO2 emissions of fossil fuel-fired power plants with a capacity of 25 MW or higher and allowing trade of emission allowances (IEA 2009).

- **Technology Commercialization Fund**

The Fund promotes early stage product development through prototype advancement to address the needs of national laboratories that are in need of finding post-research, pre-venture capital funding for innovations that are no longer considered research projects but are not sufficiently prototyped to attract private investment (IEA 2009).

- **Western Renewable Energy Zones (WREZ) Project**

The Project was launched for evaluate all feasible renewable resource technologies to develop 30,000 megawatts of clean and diversified energy by 2015 (IEA 2009).

2009

- **American Recovery and Reinvestment Act (ARRA): Appropriations for Clean Energy**

Under the act over $80 billion was allocated to support clean energy research, development, and deployment. $50 billion of $80 was provided in direct appropriations to support new and current government programmes (IEA 2009).

- **American Recovery and Reinvestment Act (ARRA): Tax-Based Provisions**

Under the same act, mentioned above, the rest of the budget ($30 billion) was used for tax-based incentives. Different types of tax incentives were offered as follows (IEA 2009):

- ✓ Production Tax Credit (PTC): Renewable energy technology investors (taxpayers) are provided with a tax credit based on kWh electricity production ($0.021/kWh)
- ✓ Investment Tax Credit (ITC): Renewable energy technology investors (taxpayers) are provided with a tax credit based on project costs (30%) or the same amount is paid as grants.
- ✓ Manufacturing Tax Credit (MTC): Tax credits worth for up to 30% of capital costs were offered for qualified projects.
- ✓ Alternative Refueling Tax Credits: Tax credits were offered for businesses that install alternative fuel pumps such as E85 fuel, electricity, hydrogen, and natural gas (50%).

- **Climate Showcase Communities Grants**

The program was launched for helping communities create replicable models of sustainable community action that generate cost-effective and persistent greenhouse gas reductions while improving the environmental, economic, public health, or social conditions in a community. Under the program, competitive grants were offered to local and tribal governments, as well as training and technical support to grant recipients (IEA 2009).

- **Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance**

The Executive Order expanded the energy reduction and environmental requirements of Executive Order 13423 by making management of greenhouse gases a priority for the Federal Government with detailed targets and timelines for Federal agencies with a focus on transportation, overall energy use, and procurement policies (IEA 2009).

3.2. Alternative Approaches

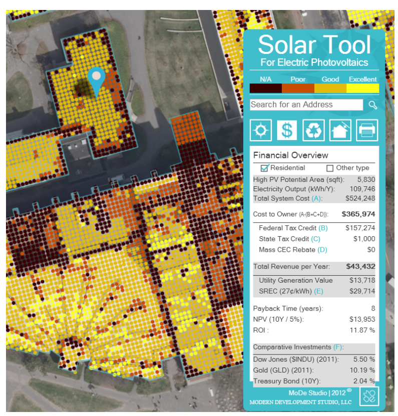
1. Cambridge Solar Map

MIT Sustainable Design Lab and the design workshop Modern Development Studio has developed the USA's most accurate solar map to be used by residents who are willing to know the return of a solar PV installation (Holloway 2013). Light Detection and Ranging (LiDAR) technology, which allows considering the roof shapes and nearby objects, was used for creating a topographical map of the city by aerial flyovers (Holloway 2013).

The map not only takes into account such data but also considers the historical weather data, which affects the energy production (Holloway 2013).

The map provides its users a similar map view like Google maps with additional financial and environmental information. A screenshot of the map is presented below.

Figure 75 - A Screenshot of Cambridge Solar Map *(Cambridge CDD 2013)*



2. California Solar for Affordable Housing Programs

The SMUD, one of the largest publicly owned utilities in USA, offers solar initiative programs for low-income customers (Go Solar California 2012). Under the California Assembly Bill 2723, it is obliged that a minimum of 10% of California Solar Initiative funds to be allocated to low-income programs for solar technology (Grid Alternatives 2013). One of the programs called "Single-family Affordable Solar Housing (SASH) Program" offers fully subsidized 1 kW solar systems to very low-income households (50% or below the area median income), and highly subsidized systems to other low-income households (Go Solar California 2012).

3. Solar Photovoltaic Systems for Low-income Housing Developments

The Northeast Denver Housing Center (NDHC), in partnership with the National Renewable Energy Laboratory (NREL), and some corporations, has developed an innovative financing model for installing solar photovoltaic systems to the low-income houses (DOE 2011).

The innovative financial system was that, an investor were to install PV systems and get the electricity production payments for 20 years. The NDHC would have the option to purchase the PV systems from the investor at the fair market value of the PV systems at the beginning of year seven (DOE 2011).

The benefits of the program was as follows (DOE 2011):

- ❖ Reducing electricity bills of 30 low-income residents
- ❖ PV installation trainings for 15 low-income residents
- ❖ A net profit of $158,000 is foreseen over the 25-year life of the project to be used for additional renewable energy projects.

B. Average Solar Irradiations of IEA Member Countries

The yearly average solar irradiations of IEA member countries are gathered from different sources. In case of the unavailability of the exact data, solar irradiation maps are used for obtaining an approximate average value. The average solar irradiations of countries are presented below.

Table 28 - Yearly Average Solar Irradiation (kWh/m2/year) with Sources

Yearly Average Solar Irradiation (kWh/m2/year)	
Australia (AUS)	2200 (Seligman 2010)
Austria (AUT)	1100 (Solair 2008)
Belgium (BEL)	1125 (Solar Feed-in Tariff 2007)
Canada (CAN)	1240 (TriSolar 2009)
Switzerland (CHE)	1350 (Swiss Solar Energy Professionals Association 2010)
China (CHN)	1460 (China Renewable Energy Information 2006)
Germany (DEU)	1050 (Solair 2008)
Denmark (DNK)	963 (Solar Feed-in Tariff 2007)
Spain (ESP)	1600 (Solair 2008)
France (FRA)	1200 (Solair 2008)
United Kingdom (GBR)	1000 (Seligman 2010)
Israel (ISR)	2000 (World Energy Council 2007)
Italy (ITA)	1600 (Solair 2008)
Japan (JPN)	1427 (Jester and Knapp 2000, 2)
Korea (KOR)	1304 (Goswami and Zhao 2007)
Mexico (MEX)	1825 (GreenTech Solar 2010)
Malaysia (MYS)	1789 (Engel-Cox, Nair and Ford 2012)
The Netherlands (NLD)	1000 (TUDelft 2013)
Norway (NOR)	875 (Wikipedia 2013)
Portugal (PRT)	1550 (Solair 2008)
Sweden (SWE)	850 (Solar Feed-in Tariff 2007)
Turkey (TUR)	1311 (World Energy Council 2007)
US America (USA)	1825 (Jester and Knapp 2000, 3)