Past, Present, and Future of Losses in Turkish Electric Power Systems

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by

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in

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Industrial and Systems Engineering.

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- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
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- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

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Mehmet Emre ÖLMEZ

Abstract

Turkey has an ongoing energy market reforms. The main aims of these reforms are increasing the quality and sustainability of services. It has high yearly demand increase which is foreseen as 7%. Therefore, it needs new generation investments. On the other side, under the frame of power sector reforms, the privatization process of distribution companies was completed in July 2013. Privatization process realized with the purpose of decreasing electric power losses in Turkey. This thesis has explored the past and present of losses and suggested strategies for the future while striving with the losses by using the experiences which has been faced in the Dicle electricity distribution region having the largest loss ratio of Turkey. Losses in power sector depends on mainly geographical structure, socio-economical factors, and political conditions. Therefore, it requires various approaches in implementations of loss reduction plans which make the process hard. This thesis is combining past and current situation with the experiences from Dicle Region and suggests certain policies for loss reduction process in Turkey.

Keywords: Power Loss, Regulaton, Non-technical losses, Reform in Electricity Market, Smart Metering

Türkiye'de Elektrik Kaybının Dünü, Bugünü, ve Yarını

Mehmet Emre ÖLMEZ

Öz

Türkiye enerji piyasalarında reform yaşamaktadır. Bu reformların ana amacı hizmetlerdeki kaliteyi ve sürdürülebilirliği sağlamaktır. Yıllık yüzde 7 talep artışı öngörülmektedir. Bu nedenle yeni üretim yatırımlarına ihtiyaç duyulmaktadır. Diğer taraftan enerji sektöründeki reformlar kapsamında dağıtım şirketlerinin özelleştirme süreci 2013 yılı Temmuz ayında tamamlanmıştır. Özelleştirme süreci kayıp enerjiyi düşürme amacıyla gerçekleşmiştir. Bu çalışma enerji kayıplarının geçmişini ve mevcut durumunu inceleyerek gelecek için Türkiye'nin en yüksek kayıp oranına sahip Dicle elektrik dağıtım bölgesinde yaşananlar ışığında kayıpla mücadelede strateji önerilerinde bulunmak için yapılmıştır. Enerji kayıpları coğrafik, sosyal, ekonomik, politik şartlara bağlı gelişmektedir. Bu nedenle kaybı azaltmaya amaçlı planların farklı yaklaşımlarla uygulanması gerekmektedir ve bu durum süreci daha zor bir duruma getirmektedir. Bu çalışma geçmiş ve mevcut durumu Dicle Bölgesindeki tecrübelerle birleştirerek Türkiye'nin enerji kayıplarını azalma sürecine yönelik yaklaşımlar önermektedir.

Anahtar Sözcükler: Kayıp Kaçak, Düzenleme, Teknik Olmayan Kayıplar, Elektrik Piyasalarında Reform, AkıllıŞebekeler

dedicated to my wife and baby...

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Abbreviations

TEİAŞ	**T**urkish **E**lectricity **T**ransmission **C**ompany
EMRA	**E**nergy **M**arket **R**egulatory **A**uthority
TEDAŞ	**T**urkish **E**lectricity **D**istribution **C**ompany
EPİAŞ	**E**lectricity **M**arket **O**perating **C**ompany
EIA	**U.S. E**nergy **I**nformation **A**ssociation
ENTSO-E	**E**uropean **N**etwork of **T**ransission **S**ystem **O**perators for **E**lectricity
PPIAF	**P**ublic **P**rivate **I**nfrastructure **A**dvisory **F**acility
BOT	**B**uild **O**perate **T**ransfer
BO	**B**uild **O**perate
TOR	**T**ransfer of **O**perating **R**ights
DSİ	**S**tate **H**ydraulic **W**orks
MTA	**G**eneral **D**irectorate of **M**ineral **R**esearch **E**xploration
TEK	**T**urkish**E**lectricity **A**uthority
TEAŞ	**T**urkish **E**lectricity **G**eneration **T**ransmission **C**ompany
TEDAŞ	**T**urkish **E**lectricity **D**istribution **C**ompany
EÜAŞ	**T**urkish **E**lectricity **G**eneration **C**ompany
TETAŞ	**T**urkish **E**lectricity **C**ontracting and **T**rading **C**ompany

Chapter 1

Introduction

Energy is the main item of the world. It occupys people's agenda in daily life and in political area. People want to satisfy their energy needing everytime. Therefore, the policy makers strive for providing sustainable energy systems. They try to design systems by diversifying energy sources, which would make them more eleastic to unexpected cases which may affect energy supply for their citizens. On the other hand, energy issues affect sustainability of the environment. Researches are being continued to provide new technologies which has less adverse effects than conventional ones. However, there are some other alternatives which would make the current circumstances more capable of providing sustainable and environmentall firiendly systems. Losses in electric power systems is one of these topics.

1.1 Statement of Problem

World is facing with developments as new technologies take place in our lives. They require energy source to get benefit from them. Therefore the demand for energy increases day by day. This problem is one of the main subjects being discussed in the energy sector. People are arguing whether focusing on making the technologies more efficient in electricity usage or increasing energy sources to maintain sustainable energy. Another part of these debates is the *losses in electricity system*. This phenomenon affects the service quality of electricity system and causes inefficiency in the system. Generation, transmission and distribution of electrical energy involve many operational losses.[1]

Table 1.1: World Electricity Statistics
Source:[2]

Category	Year	Capacity (MWh)	Generation (TWh)	Net Import (TWh)	Consumption (TWh)	Losses (TWh)	Export (TWh)	Import (TWh)	Loss (%)
World	2000	3.458	14.627	2	13.246	1.383	500	501	9%
	2001	3.560	14.879	0	13.506	1.372	497	497	9%
	2002	3.698	15.393	10	13.950	1.453	521	531	9%
	2003	3.847	15.927	3	14.472	1.457	554	556	9%
	2004	3.984	16.692	1	15.136	1.557	555	556	9%
	2005	4.123	17.330	-1	15.720	1.609	617	616	9%
	2006	4.303	18.033	2	16.401	1.634	618	620	9%
	2007	4.479	18.867	3	17.181	1.689	629	632	9%
	2008	4.650	19.157	2	17.453	1.706	615	617	9%
	2009	4.853	19.093	6	17.388	1.711	582	588	9%
	2010	5.081	20.437	5	18.680	1.763	588	593	9%
	2011	5.315	21.182	2	19.397	1.788	648	650	8%
	2012	5.550	21.532	14	19.710	1.835	668	682	9%
Turkey	2000	27	119	3	99	24	0	4	19%
	2001	28	117	4	97	23	0	5	19%
	2002	32	123	3	103	24	0	4	19%
	2003	36	134	1	110	24	1	1	18%
	2004	37	144	-1	120	23	1	0	16%
	2005	39	154	-1	129	24	2	1	16%
	2006	41	168	-2	141	25	2	1	15%
	2007	41	182	-2	154	27	2	1	15%
	2008	42	188	0	160	27	1	1	15%
	2009	45	185	-1	155	29	2	1	16%
	2010	50	201	-1	170	30	2	1	15%
	2011	53	219	1	187	32	4	5	15%
	2012	57	228	4	197	36	1	6	15%

United States Energy Information Administration reported the world electricity statistics in Table 1.1. In this table,

- The values for the whole world for 2012 show that 21,532 TWh electricity was generated and 19,170 TWh of it was metered at consumer points. Therefore, 1,835 TWh of electrical energy was lost in the system.
- The values for Turkey for 2012 show that 228 TWh electricity was generated and 197 TWh of it was metered at consumer points. Therefore, 36 TWh of electrical energy was lost in the system.

The electricity loss percentage for year 2012 in the world is around 9% while it is around 15% in Turkey for the same period. Each country in the world has different electricity tariffs. When we look at the electricity loss problem in Turkey with financial percepective, the cost of the loss is around 13.7 billion Turkish Liras. (the unit cost of electricity for end users is around 0.38 krs / kWh in 2015) Regulators are supposed to design energy market to maintain sustainable energy for customers. Losses cause some problems for market sustainability.

The main effects of electricity losses can be listed as:

- It affects utility companies by unbalancing the financial conditions of the companies. Therefore it would have reflections on the service quality of the companies.
- It affects the subscribers of the utility as they are exposed to use low quality services which may be faced in the form of outages, fluctuations in the voltage etc. The fluctuations may overload or underload the grid. This affects the performance and even damage appliances of custormers.
- It affects generation plants to insert extra energy into the network. Unless the loss is eliminated, it would force generating more energy. Especially in the case of fraudulent persons who thieve energy from the utility uses energy with prodigality.
- It hardens managing the network because of unpredictable changes in the system.
- It hardens managing the market because of increasing the cost of the electricity [1].
- It creates unrecorded economy for macro economy of the country. In the case of Turkey around 23 percent of the bill amount is directly related with taxes and governmental funds.

The problem is being subject to world media and occupying people's agenda. Some of the headlines mentioning to this problem are:

- Electricity theft a bigger issue than you think [3].
- Saving on electricity by stealing it [4].
- Eliminating theft related power losses [5].

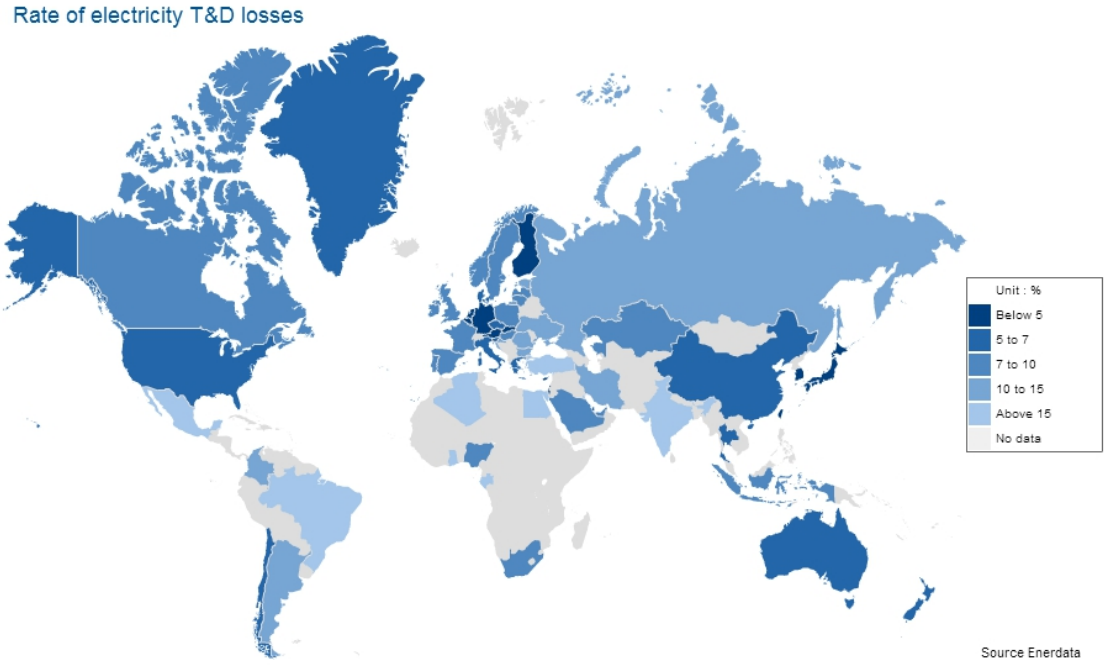

Figure 1.1: Loss Percentages in the World
Source:[6]

1.2 Research Objectives

This research is prepared with the purpose of attracting attention to the losses phenomenon and being helpful to develop well-directed strategies to mitigate electric power loss problem in Turkey. The dynamics of the system resulting in this problem would be mentioned as a guide to overcome it. Past and present of the losses in Turkey are investigated to understand the causes and current situation of the problem. The survey is conducted to bring solution alternatives by investigating literature and combining it with the experiences obtained in the Dicle Electricity Distribution Region which has *a loss ratio around 75%*. Then, solution alternatives presented to make country more succesfull in the mitigation of losses for future.

1.3 Organization of Research

This thesis is composed of 4 chapters.

In Chapter 1, the thesis is introduced with the statement of problem, research objectives of the thesis and organization of the research are explained.

In Chapter 2, Literature is scanned to understand the problem with the academic studies made about this problem. The market structure of the electricity power sector and the losses explained.

In Chapter 3, Past and present values of distribution regions are analyzed to understand Turkish Electricity System. The experiences in the Dicle Region, which is the most important region in the process of mitigating losses problem from the agenda of Turkey, explained and solutions proposed for overcoming with exposed obstacles during the operation.

In Chapter 4, general evaluations are done by suggesting future works.

Chapter 2

Literature Review

2.1 General Overview

Electricity is the main item of today's world. Its importance is increasing day by day, and becoming an essential item to survive. The world is facing with new technological products which result in the increase of electricity utilization. The world is in the era of liberal markets. Electricity markets were used to be monopoly. Most of the electricity markets in the world are liberalizing with the spreading trend around the world. There is a transition from monopoly to competitive market [7]. The characteristics which make electricity market monopoly are being summarized by Leonardo Energy, the global community for sustainable energy, managed by the European Copper Institute [8].

- Economies of scale: The rule of economies of scale in economics is valid in electricity sector. The unit cost decreases as the capacity of investment increases.
- Capital Intensity: Investments in electricity market requires huge amount of money.
- Peak-load based: Electricity systems are designed to fulfill demand every moment. Although the investments may be idle after running in the peak periods, this fact requires huge amount of investments.
- Locationality speciality: Electricity transfer and source transfer are between the main problems in electricity system. Generation units closer to source is more preferable than other alternatives and closer to consumption units are more preferable. Investors give their decision with respect to these constraints.

- Direct connection to consumers: Every consumer has to be connected to electricity grid. It is better to control grid by one controller not to cause mess in the system.

When we think about the voyage of electricity to consumers, there are 4 main phases in this trip: generation, transmission, distribution and utilization. It is visualised in Figure 2.1. These services were used to be performed by vertically integrated utilities. In many cases, they were state-owned monopolies.

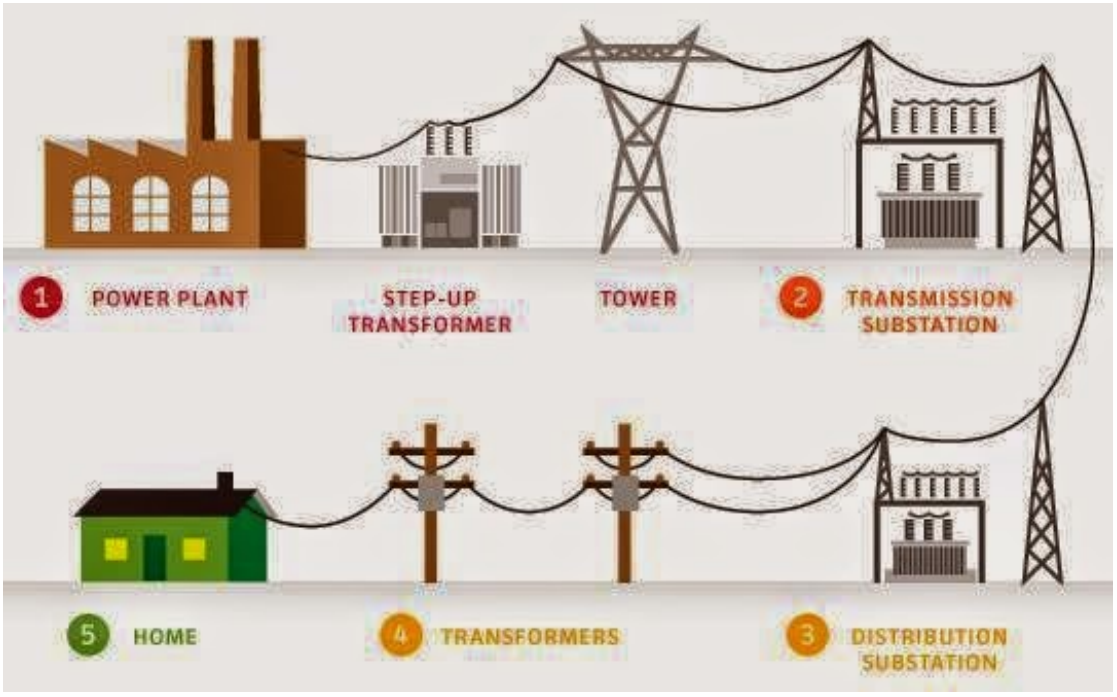

Figure 2.1: Voyage of Electricity

The liberalization process requires the unbundling of these phases. At the same time private sector investors attend to electricity sector which was used to be state owned. The balance between these 4 phases should be regulated by a regulator. Regulation must balance obligations to both customers and regulated companies and also the costs and benefits of the regulatory system itself. The interests of customers are price reduction and protection against monopoly abuse; the interests of companies are fair return and profit opportunities. Therefore, the major target of regulatory system are to prevent monopoly abuse and encourage efficiency increase and lower cost of regulated industry. To reach this target, regulators must be aware with regulatory interventions distort the industry structure, regulation intrusive interventions may bring burden to the system[8]. Regulation control price, quality of supply, market functioning, other areas about the markets to fulfill its responsibility to protect the interests of market participants.

Power liberalization is schematized by the Center for Energy and Environmental Policy, University of Delaware in Table 2.2[9]. Technological innovation, financial problems, economic concerns, environmental concerns, socio-political concerns are stated as the main drivers of power liberalization. These factors triggered each others and this results in power sector reform. At the same time, the world is witnessing the re-design of markets with respect to liberal economy rules as a result of globalization. The combination of the need for reform in power sector and liberalization resulted in power liberalization.

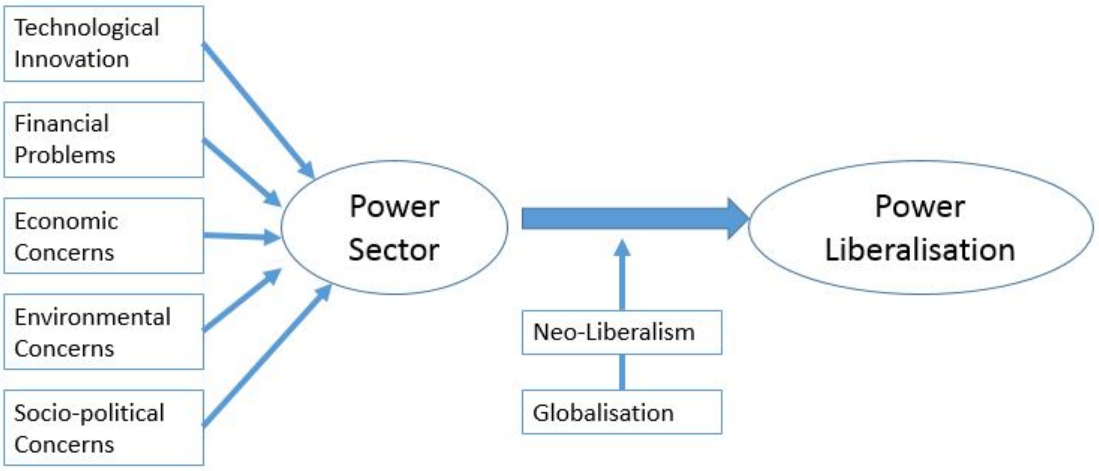

Figure 2.2: Power Liberalization Schema by John Byrne and Yu-mi Mun
Source:[9]

In the Global Electricity Power Reform published by the World Bank, the principal driving forces behind reform movement are listed as follows [10]:

- The poor performance of the state-run electricity sector in terms of high costs and unreliable supply.
- The inability of the state sector to finance needed expansions, investments in the system and the maintenance of the network.
- Transferring the finance used for subsidizing the sector to the other public needs.
- In the cases of financial turmoil, the need to increase government revenue by the income from the sales of public owned assets.

There were no competition and motivation to improve performance during the period of state ownership in electricity utilities. These conditions resulted in:

- Excessive costs
- Low service quality
- Poor investment decisions
- Lack of innovation in supplying customers.

Electricity generation technologies and information systems related with metering and dispatching power have improved in recent years. These changes have made new investment alternatives possible, which state owned enterprises have been too slow to adopt. The private sector offers many new solutions to provide power at a lower cost, especially to consumers with low levels of demand, through capabilities provided in customer service and cost recovery mechanisms such as demand side management [11]. The combination of emergence of private investors and developments in technologies related with utilities improves business models in the sector [12].

Electricity industry is becoming global with increasing interconnections of electricity networks. The reasons behind this fact are providing sustainable energy, maintaining energy security, and making infrastructure adoptable with green energy technologies [13].

Electricity sector was used to be managed by stated owned companies in monopolistic market conditions. The expectations from today's global system requried huge investments as a result of growing economies, increasing efficiency in generation to decrease carbon emissions and in wholesale markets to increase market participants' welfare. Therefore, restructure in energy systems becomed main topics of governments since 1980s in the world.

All systems are designed with the aim of increasing the welfare of people. Electricity usage per capita is one of the most important indicators of welfare. On the other hand, providing energy sustainability is the way of reaching welfare in electricity usage. Countries make energy investment with this purpose. Statistics for electricity utilization in OECD countries are shown on Table 2.4, Table 2.1, Table 2.2, and Table 2.3.

Table 2.1: Electricity Generation of OECD Countries in 2012 by Resources(MWh)
Source:[14]

Countries	**Coal**	**Liquid**	**Gas**	**Renewable +Wastes**	**Thermal Total**	**Nuclear**	**Hydro Total**	**Geo-Thermal**	**Solar+ Wind+Wave**	**Total**
Australia	171	4	50	2	227		14	-	8	249
Austria	6	1	10	5	22		48	-	3	73
Belgium	5	0	24	7	36	40	2		5	83
Canada	64	7	68	9	147	95	381		12	634
Chile	25	6	13	5	49		20		0	70
Czech Republic	47	0	1	3	52	30	3		3	88
Denmark	11	0	4	5	20		0		10	31
Estonia	10	0	0	1	12		0		0	12
Finland	11	0	7	11	30	23	17		1	70
France	22	4	22	7	55	425	64		20	564
Germany	287	8	78	51	423	99	28	0	79	630
Greece	31	6	13	0	51		5		6	61
Hungary	6	0	9	2	18	16	0		1	35
Iceland	0	-			0		12	5		18
Ireland	8	0	14	0	23		1		4	28
Israel	39	13	11	0	63		0		0	63
Italy	54	19	129	15	217		44	6	33	299
Japan	303	181	397	39	920	16	84	3	12	1.034
Korea	239	21	112	2	374	150	8		3	535
Luxembourg	0	-	2	0	3		1		0	4
Mexico	34	56	151	3	244	9	32	6	4	294
Netherlands	27	1	56	9	93	4	0		5	103
New Zeland	4	-	9	1	13		23	6	2	44
Norway	0	0	3	0	3		143		2	148
Poland	136	2	6	10	155		2		5	162
Portugal	13	2	11	3	29		7	0	11	47
Slovak Republic	4	1	3	1	8	16	4		1	29
Slovenia	5	0	1	0	6	6	4		0	16
Spain	56	15	73	6	150	61	24		62	298
Sweden	1	1	1	13	16	64	79		7	167
Switzerland	-0	0	1	3	4	25	40		0	70
Turkey	68	2	105	1	175		58	1	6	239
United Kingdom	144	3	100	17	264	70	8		21	364
USA	1.643	33	1.265	79	3.020	801	298	18	153	4.291
OECD	3.478	387	2.745	312	6.923	1.952	1.453	45	477	10.849
WORLD	9.359	1.128	5.100	439	16.025	2.461	3.756	70	439	22.752

Table 2.2: Electricity Generation Installed Capacities of OECD Countries by Resources (GWe)
Source:[14]

Countries	**Coal**	**Liquid**	**N. Gas**	**Renewable +Wastes**	**Thermal Total**	**Nuclear**	**Hydro**	**Other**	**Total**
Australia	30,91	1,48	17,53	0,55	50,46	-	8,79	3,97	63,22
Austria	2,11	0,17	5,40	0,48	8,16	-	13,08	1,68	22,92
Belgium	..	..	..	..	9,46	5,93	1,43	3,95	20,77
Canada	13,85	6,91	13,63	4,56	38,94	12,67	75,57	7,02	134,20
Chile	3,96	2,51	4,66	0,83	11,96	-	5,99	0,20	18,15
Czech Republic	11,92	-	..	..	11,92	4,04	2,21	2,28	20,45
Denmark	5,53	1,68	2,07	0,23	9,50	-	0,01	4,56	14,07
Estonia	2,38	-	0,25	0,02	2,64	-	0,01	0,27	2,92
Finland	7,90	0,77	2,03	..	10,69	2,75	3,20	0,27	16,91
France	7,91	10,36	9,49	..	27,76	63,13	25,37	12,98	129,24
Germany	..	..	..	..	89,64	12,07	11,26	64,32	177,29
Greece	4,56	2,50	4,12	4,61	15,78	-	3,24	3,29	22,31
Hungary	1,34	0,41	5,10	0,16	7,00	2,00	0,06	0,34	9,40
Iceland	..	0,11	..	..	0,11	-	1,88	0,67	2,66
Ireland	1,20	1,15	3,89	0,05	6,28	-	0,53	1,96	8,77
Israel	4,84	0,06	9,21	0,05	14,16	-	0,01	0,23	14,40
Italy	11,20	9,87	52,74	2,98	76,79		21,88	25,56	124,23
Japan	51,96	41,16	46,68	..	139,80	46,15	48,97	9,71	295,23
Korea	..	..	..	..	65,53	20,72	6,45	1,49	94,19
Luxembourg	-	-	0,49	0,03	0,53	-	1,13	0,13	1,79
Mexico	6,02	9,34	31,30	0,05	46,71	1,61	11,65	2,17	62,14
Netherlands	..	..	..	..	26,51	0,51	0,04	2,86	29,92
New Zeland	0,91	0,16	1,73	0,08	2,87	-	5,25	1,37	9,49
Norway	0,01	0,02	1,42	0,12	1,56	-	29,97	0,75	32,28
Poland	28,41	0,45	0,93	0,59	30,36	-	2,35	2,57	35,28
Portugal	2,26	2,06	4,96	0,08	9,35	-	5,72	4,68	19,75
Slovak Republic	1,43	0,13	1,61	0,25	3,41	1,94	2,52	0,54	8,41
Slovenia	0,85	-	0,38	0,04	1,27	0,69	1,25	0,14	3,35
Spain	..	..	..	..	49,78	7,45	18,55	29,38	105,16
Sweden	..	..	..	..	8,36	9,44	16,41	3,63	37,84
Switzerland	0,27	0,09	0,25	0,35	0,95	3,28	15,59	0,49	20,31
Turkey	13,17	1,29	20,40	0,17	35,03	-	19,61	2,42	57,06
United Kingdom	26,60	4,22	35,50	3,20	69,52	9,95	4,43	10,60	94,50
USA	311,47	46,89	422,37	12,63	793,36	101,89	101,11	71,54	1.067,90
OECD	552,94	143,77	698,12	32,09	1.663,91	306,19	465,50	277,98	2.713,58

Table 2.3: Per Capita Statistics of Electricity Generation and Installed Capacity in OECD Countries for year 2012
Source:[14]

Countries	**Installed Capacity**		**Gross Generation**		**Gross Supply**	
	GW	**percapita**	**TWh**	**percapita**	**TWh**	**percapita**
Australia	63,22	2,73	248,94	10.762,65	233,74	10.105,49
Austria	22,92	5,83	72,62	18.478,37	68,12	17.333,33
Belgium	20,77	1,88	83,07	7.517,65	88,17	7.979,19
Canada	134,20	3,85	634,45	18.189,51	576,55	16.529,53
Chile	18,15	1,04	69,75	4.008,62	65,85	3.784,48
Czech Republic	20,45	1,95	87,57	8.332,06	62,97	5.991,44
Denmark	14,07	4,54	30,73	9.912,90	34,23	11.041,94
Estonia	2,92	0,71	11,97	2.905,34	8,27	2.007,28
Finland	16,91	2,75	70,40	11.447,15	85,00	13.821,14
France	129,24	1,98	564,28	8.624,18	488,58	7.467,22
Germany	177,29	2,16	629,81	7.688,11	564,11	6.886,11
Greece	22,31	2,01	60,96	5.482,01	55,16	4.960,43
Hungary	9,40	0,95	34,59	3.486,90	40,29	4.061,49
Iceland	2,66	8,31	17,55	54.843,75	17,05	53.281,25
Ireland	8,77	1,91	27,59	6.010,89	26,59	5.793,03
Israel	14,40	1,82	63,04	7.969,66	53,44	6.756,01
Italy	124,23	2,04	299,28	4.913,48	328,18	5.387,95
Japan	295,23	2,31	1.034,31	8.109,06	982,41	7.702,16
Korea	94,19	1,88	534,62	10.692,40	509,52	10.190,40
Luxembourg	1,79	3,38	3,81	7.188,68	6,41	12.094,34
Mexico	62,14	0,53	293,86	2.510,55	277,16	2.367,88
Netherlands	29,92	1,79	102,51	6.120,00	115,81	6.914,03
New Zeland	9,49	2,14	44,30	9.977,48	42,80	9.639,64
Norway	32,28	6,43	147,85	29.452,19	127,05	25.308,76
Poland	35,28	0,92	162,14	4.206,93	144,14	3.739,88
Portugal	19,75	1,87	46,61	4.405,01	51,81	4.896,50
Slovak Republic	8,41	1,55	28,66	5.297,60	26,16	4.835,49
Slovenia	3,35	1,63	15,73	7.633,50	13,53	6.565,53
Spain	105,16	2,28	297,56	6.446,27	270,36	5.857,02
Sweden	37,84	3,97	166,56	17.495,27	141,26	14.837,71
Switzerland	20,31	2,56	69,87	8.810,21	63,57	8.015,76
Turkey	57,06	0,76	239,50	3.197,53	230,50	3.077,37
United Kingdom	94,50	1,48	363,84	5.710,80	353,94	5.555,41
USA	1.067,90	3,40	4.290,55	13.651,98	4.099,85	13.045,20
OECD	2.713,58	2,17	10.848,80	8.673,35	10.252,40	8.196,54

Table 2.4: Electricity Statistics of OECD Countries in 2012 (MWh)
Source:[14]

Countries	Gross Generation	Imports	Exports	Own Use	Own Use %	Other Use	Supply	T&D Losses	T&D %	Net Consumption
Australia	248,94			15,1	6,07	0,1	233,74	34,4	14,72	199,34
Austria	72,62	23,3	20,5	1,7	2,34	5,6	68,12	5,1	7,49	63,02
Belgium	83,07	16,8	6,9	3,1	3,73	1,7	88,17	6,8	7,71	81,37
Canada	634,45	10,9	57,9	10,7	1,69	0,2	576,55	74,6	12,94	501,95
Chile	69,75			3,9	5,59		65,85	4,2	6,38	61,65
Czech Republic	87,57	11,6	28,7	6,5	7,42	1	62,97	6,3	10,00	56,67
Denmark	30,73	15,9	10,7	1,5	4,88	0,2	34,23	3,1	9,06	31,13
Estonia	11,97	2,7	5	1,4	11,70		8,27	1,3	15,72	6,97
Finland	70,4	19,1	1,6	2,7	3,84	0,2	85	4,2	4,94	80,8
France	564,28	12,2	56,7	24,5	4,34	6,7	488,58	57,8	11,83	430,78
Germany	629,81	46,3	66,8	37,1	5,89	8,1	564,11	38,3	6,79	525,81
Greece	60,96	6	4,2	7,3	11,98	0,3	55,16	3,1	5,62	52,06
Hungary	34,59	17	9	2,3	6,65		40,29	5,1	12,66	35,19
Iceland	17,55			0,3	1,71	0,2	17,05	0,7	4,11	16,35
Ireland	27,59	0,8	0,4	1,1	3,99	0,3	26,59	2,2	8,27	24,39
Israel	63,04		4,4	5,2	8,25		53,44	2,1	3,93	51,34
Italy	299,28	45,4	2,3	11,5	3,84	2,7	328,18	31,5	9,60	296,68
Japan	1034,31			40,7	3,93	11,2	982,41	59,7	6,08	922,71
Korea	534,62			20,3	3,80	4,8	509,52	28,5	5,59	481,02
Luxembourg	3,81	6,7	2,6	0	-	1,5	6,41	0,1	1,56	6,31
Mexico	293,86	2,3	6,6	12,4	4,22		277,16	50,2	18,11	226,96
Netherlands	102,51	32,2	15	3,9	3,80		115,81	9,3	8,03	106,51
New Zeland	44,3			1,5	3,39		42,8	3,6	8,41	39,2
Norway	147,85	4,2	22	0,5	0,34	2,5	127,05	18,2	14,33	108,85
Poland	162,135	9,8	12,6	14,6	9,00	0,6	144,135	21,4	14,85	122,735
Portugal	46,605	10,8	2,9	1,4	3,00	1,3	51,805	5,6	10,81	46,205
Slovak Republic	28,66	13,5	13,1	2,5	8,72	0,4	26,16	2,2	8,41	23,96
Slovenia	15,725	7,5	8,4	1	6,36	0,3	13,525	1	7,39	12,525
Spain	297,56	7,8	19	11	3,70	5	270,36	31	11,47	239,36
Sweden	166,555	11,7	31,3	3,7	2,22	2	141,255	14	9,91	127,255
Switzerland	69,865	31,5	33,7	1,7	2,43	2,4	63,565	4,6	7,24	58,965
Turkey	239,495	5,8	3	11,8	4,93		230,495	37,7	16,36	192,795
United Kingdom	363,835	13,8	1,7	18	4,95	4	353,935	36,3	10,26	317,635
USA	4290,545	59,3	12	213,3	4,97	24,7	4099,845	373	9,10	3726,845
OECD	10848,8	444,7	459	494,2	4,56	87,9	10252,4	967,2	9,43	9285,2
WORLD	22752,2	681,1	677	1183,1	5,20	114,3	21459	2546,9	11,87	18912,1

2.2 Market Structure in Turkey

The market conditions and reform policy changed from country to country according to its governmental agenda. Reform, regulation, deregulation, unbundling, privatization were the names used for the transformation in electricity markets. The fundemental principles of electricity market reforms are [15]:

- Unbundling of generation, transmission and distribution assets

- Open access to transmission grid
- Establisment of independent regulator
- Competititon in the wholesale market

2.2.1 Electricity Sector Reforming In Turkey

Turkey tried different methodologies in the reforming process. Build Operate Transfer (BOT), Build Operate (BO), Transfer of Operating Rights (TOR) were the methods applied in the earlier times of this course. The operations realized with these methods faced with problems in legislation and the reform process proceeded slowly. Global conditions, economic crisis, European Union membership process are the factrors which accelerated the reforms in Turkish Electricity System[15]. Turkey faced with economic crisis in 1990s and they resulted in stand by agreements with International Monetary Fund and World Bank. After that, some legal amendments done which would facilitate privatizations through the sale of TOR contracts [16] [17] [18].

Milestones in Turkish Electricity System [14][19]

- In 1902, The first power generation had been by a 2 kWh dynamo connected to water-mill in Tarsus-Mersin
- In 1913, Silahtaraga Power Plant was put into service
- In 1935, Operating the power industry under the leadership of State was started upon the establishment of Etibank by the Law No:2805
- In 1948, a big number of thermal and hydraulic power plants constructed by DSI (State Hydraulic Works) and with the supports of MTA (General Directorate of Mineral Research Exploration), EİEİ (General Directorate of Electrical Power Resources Survey and Development Administration) and Iller Bankasi (Bank of Provinces) were connected to national power grid.
- In 1970, Turkish Electricity Authority (TEK) was founded by the Law No:1312, with the aim of servicing in electricity sector in departments of generation, transmission, distribution and trade.

- In 1982, The electricity facilities of municipalities and unions were handed over to TEK.
- In 1993, TEK was split into two seperate public owned enterprises by the decision of the Council of Ministers depending on upon the Decree-in Law 233, namely Turkish Electricity Generation Transmission Company (TEAŞ) and Turkish Electricity Distribution Company (TEDAŞ)
- In 2001, TEAŞ was split into three seperate public owned enterprises by Law 4828, namely Turkish Electricity Transmission Company (TEİAŞ), Electricity Generation Company (EÜAŞ), and Turkish Electricity Conracting and Trading Company (TETAŞ)
- In 2013, Regional Distribution Companies were split into two comanies as Distribution Companies and Retail Companies
- In 2015, Electricity Market Operating Company (EPİAŞ) established and in-day market started to operation as a phase of transforming the market structure into stock market.

Legal Framework of Turkish Electricity Market

Electricity Market is regulated by Energy Market Regulatory Authority whose mission is defined in the law 4628. Electricity Market Law (Law number 6446) and Renewable Energy Usage in Electricity Generation Law (Law number 5346) are the main rules of Turkish electricity market[19].

Electricity Market Law

This law aims to ensure the development of a financially sound and transparent electricity market operation in a competitive environment and the delivery of sufficient, good quality, low cost and environmentally friendly electricity to consumers and to ensure the autonomous regulation and supervision of this market. It covers generation, transmission, distribution, wholesale, retail, import, export of electricty, market management, rights and obligations of all real persons and legal entities directly involved in these activities. The activities in electricity market are

- Generation: Conversion of energy sources into electrical energy.

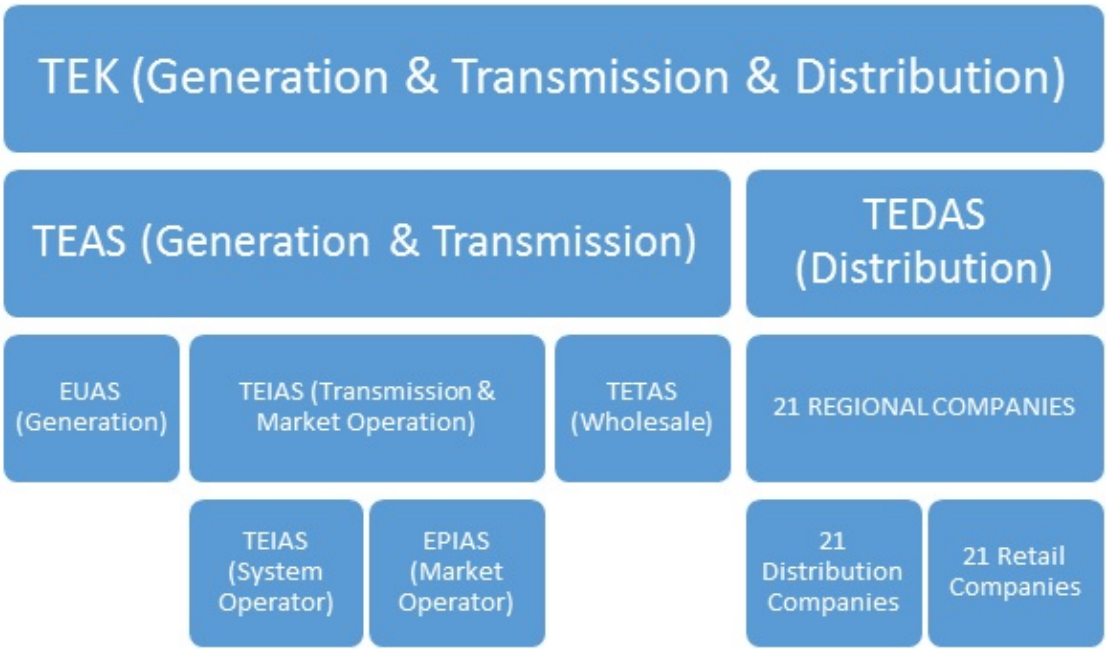

Figure 2.3: Reform in Turkish Electricity Market

- Transmission: Transfer of electrity via network having voltage level greater than 36 kV.
- Distribution: Transfer of electricty via network having voltage level lower than 36 kV.
- Wholesale: Sale of electricity to somebody who will sell it to other actors in the market.
- Retail: Sale of electricity to last users.
- Market Management: Managing the market composed of the actors related with generation, transmission, distribution, wholesale, retail, import, export.
- Import: Buying electricity from other countries.
- Export: Selling electrity to other countries.

The legal institutions who want to attend in electricity market with activities listed above must have license for their operation from Energy Market Regulatory Authority (EMRA). On the other hand EMRA is encouraging establishment of power plants with small size for their own needs to spread the investments with renewable technologies, especially wind and solar. Maximum capacity for small sized facilities is being determined by

EMRA and they have to get connection approval from regional distribution companies in which is planned to be located.

Renewable Energy Usage in Electricity Generation Law

This law aims to increase renewable source usage in energy generation which will have affects on diversifying energy resources, decreasing carbon emissions and protecting environment from dangerous affects which may occur as a result of conventional generation techniques. The certification process of renewable energy usage in electricity generation and the incentives are detailed in this law. Incentive mechanism has two types. They distinguishes according to generetaion technique and the addition of domestic production in investments. An investor in renewable has the alternative to sell its generation with feed in tariff prices for 10 years.

2.2.2 Market Regulator

Energy Market Regulatory Authorithy is the regulator of Energy Market in Turkey. It regulates natural gas, electriciy, petroleum, lpg markets. Its responsibilities are stated in law 4628. The missions about electricity market mentioned are:

- Evaluating license applications to be participant in electricity sector. (Generation, Organized Industry Area Generation, Transmission, Market Operation, Distribution, Organized Industry Area Distribution, Supply)
- Determining electricity wholesale, transmission, distribution, retail tariffs.
- Determining eligible consumer limits every year.
- Make regulations necessary for the delivery of sufficient, good quality, low cost and environmental friendly electricity to consumers.
- Determining financial reporting standards and management information systems according to accepted accounting rules for licence owners.
- Following market development and preparing market development reports.
- Preparing amendment proposals to make market compatible with changing conditions.

- Auditing the market and penalize the participants in case of the executions against the rules.

2.2.3 Electricity Transmission in Turkey

Electricity transmission is defined in law 6446 as transfer of electrity via network having voltage level greater than 36 kV. This operation is managed by TEİAŞ (Turkish Electricity Transmission Company) TEİAŞ has managing position of Turkish Electricity System and Turkish Electricity Market. The main mission is meeting electricity demand in a timely manner via load dispatching as a system operator. It signed long term operation agreement with ENTSO-E (European Network of Transmission System Operators for Electricity) with the aim of stabilizing electricity frequency which is the quality parameter of electricity and incresing the security of supply. TEİAŞ also has the market operator role until July 2015. Day Ahead Market and Settlement activities are transferred to the company Electricity Market Enterprises Company (EPİAŞ)

System Operator Roles

TEİAŞ is system operator. The responsibilities of this role are:

- Forecasting demand a day ahead
- Maintaining the real time balance by providing the quality standard in electricity supply
- Determination of the regions for load pick-up and load throw off proposals
- Operating the system with minimum electricity loss

TEİAŞ operates load dispatching via 9 main load dispathcing regions showed on the Figure 2.5. Load dispatching centers operates network with the responsibility of real time balancing between supply and demand.

Demand can change each moment of time. TEİAŞ as system operator has to provide the balance between supply and demand. In 2014, The maximum consumption occurred on August 14th and the minimum consumption occurred on October 4th. When we compare the total amount the consumption of the maximum date is as much as 2 times

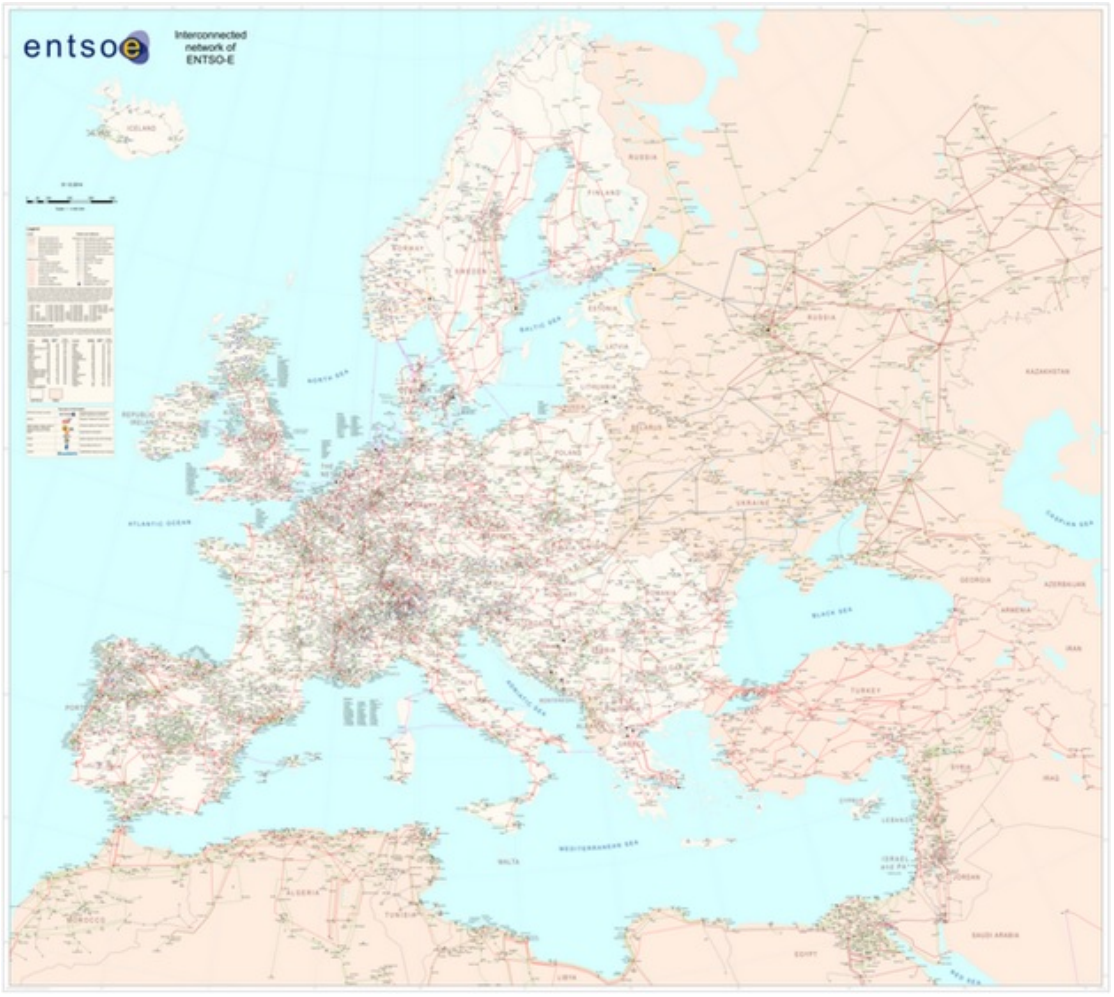

Figure 2.4: Interconnected Network of ENTSO-e
Source:[20]

Figure 2.5: Load Dispatching Centers in Turkey
Source:[14]

Table 2.5: Peak Consumption Date Statistics in 2014
Source:[14]

YTM Region	YTM Center	Generation (MWh)	Consumption (MWh)	Peak Consumption (MWh)	Peak Consumption Hour	Peak Day Generation/ Consumption
TRAKYA YTM	İKİTELLİ	77.886	113.629	6.284	14:30	69%
KBA YTM	ADAPAZARI	184.457	167.925	8.674	14:40	110%
BA YTM	IŞIKLAR	180.119	127.283	6.298	14:10	142%
OA YTM	GÖLBAŞI	44.889	87.645	4.467	14:00	51%
GDA YTM	KEBAN	122.309	134.586	6.271	14:30	91%
O.KARADENİZ YTM	SAMSUN	50.268	29.697	1.602	14:20	169%
D.AKDENİZ YTM	ADANA	93.912	73.118	3.377	14:20	128%
B.AKDENİZ YTM	ANTALYA	47.999	64.731	3.266	14:40	74%
DA YTM	ERZURUM	16.401	21.038	999	14:00	78%

Table 2.6: Minumum Consumption Date Statistics in 2014
Source:[14]

YTM Region	YTM Center	Generation (MWh)	Consumption (MWh)	Peak Consumption (MWh)	Min Consumption Hour	Min Day Generation/ Consumption
TRAKYA YTM	İKİTELLİ	62.002	58.314	2.852	20:30	106%
KBA YTM	ADAPAZARI	134.110	91.896	4.292	20:00	146%
BA YTM	IŞIKLAR	96.931	64.433	2.909	20:00	150%
OA YTM	GÖLBAŞI	25.010	42.669	2.217	22:10	59%
GDA YTM	KEBAN	34.395	54.578	2.602	20:10	63%
O.KARADENİZ YTM	SAMSUN	10.458	20.210	1.059	20:00	52%
D.AKDENİZ YTM	ADANA	46.185	40.661	1.865	19:40	114%
B.AKDENİZ YTM	ANTALYA	6.328	32.660	1.686	20:00	19%
DA YTM	ERZURUM	8.657	18.856	1.003	19:30	46%

of the consumption in the minimum date. The main objective of operator in system network management is feeding the system with the cheapest energy while maintaining the quality standards of the system. The method of providing the cheapest energy is selecting the energy source of minimum cost or decreasing the operational energy loss. The generation and consumption amounts occured on peak and minimum dates shows that energy demand may not be met from the same center. Therefore electricity traffic occurs between regions.

Loss is one of the major issues in electricity systems. It may occur in transmission phase and in distribution phase. In 2014 the loss percentage of Turkish Electricity System is

at the levels of 15The historical development in the transmission loss is shown on figure 2.7. It can be seen that the transmission loss level decreased from 5 % in 1984 to 2.5% in 2013

Market Operator Roles

Market participants are the legal entities having the license for generation, supply, distribution, transmission. Market operator is EPIAS. It is responsible for operating day ahead market, intra day market, data sharing and settlement activities with the principles of indiscriminancy, transparency. The shareholders of EPIAS are TEIAS (30% A Group Share), BIST (30% B Group Share and 4,16% C Group Share) and 97 private investors (35,84% C Group Share)

Balancing mechanism is the complementary of bilateral aggreements in the electricity markets and it covers the activities of day ahead balancing, intra day balancing and real time balancing. Day ahead balancing is done by collecting the supply and demand values from the market participants and determining the price of electricity for each hours of the next day. Intra day balancing is the activities of balancing consumption and production of market participants. If a difference occurs between the day ahead prediction and actual values, the differences are priced in intra day market.

The cost is being calculated by market operator within the scope of settlement activities.Real time balancing is the composition of ancillary services and balancing market. Balancing market provides network operator the ability to insert extra capacity to system. Frequency and demand controls are provided by ancilliary services. Market operator (EPIAS) and Network operator coordinates the system and operates for balancing supply and demand every time.

The characteristic of the cost of electricity shows seasonality behavior shown in Figure 2.6.It decreases with the increase of available cheap sources, especially in spring. On the other side, it increases with the decrease of available cheap sources and the increase of demand by inserting expensive sources to the system, especially in summer and winter.

The transformation of electricity sector has reflections on weight of public actors and private actors in the market. At the end of 2011 the share of public related companies were above 80% over the bilateral agreements in the electricity market. Nowadays it decreased to the levels of 55% shown in Figure 2.7.

Figure 2.6: Weighted Average Costs in Turkish Electricity Market
Source:[21]

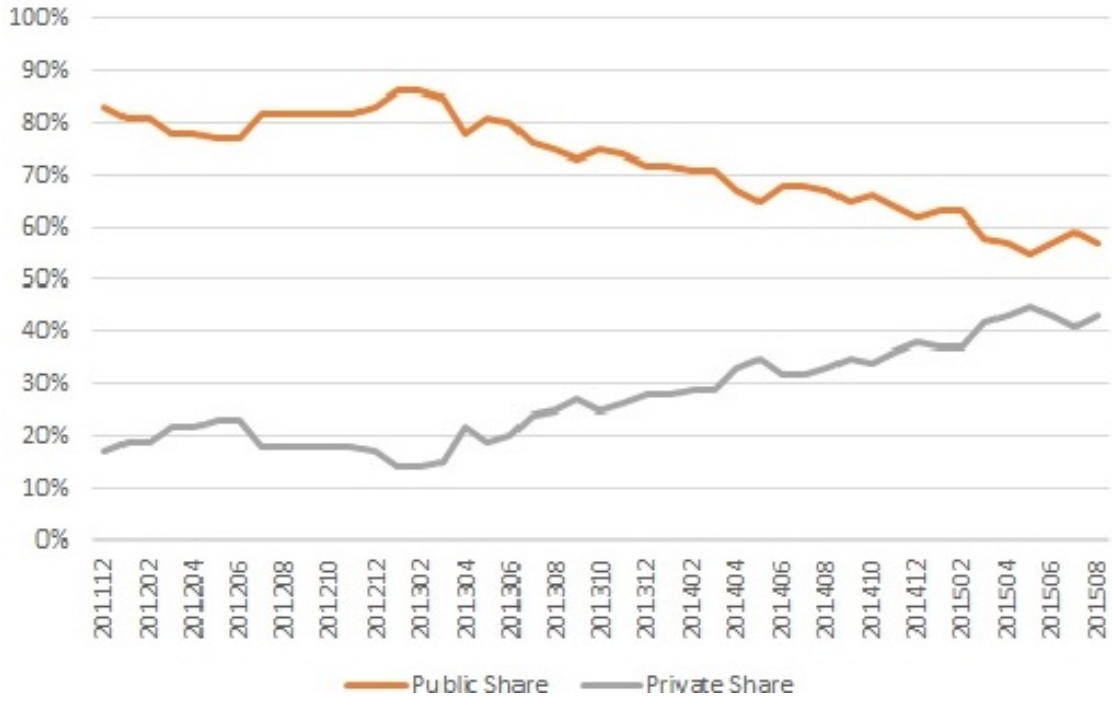

Figure 2.7: Shares of Bilateral Agreement Public vs. Private
Source:[21]

Figure 2.8: Monthly Development of the Number of Eligible Consumers in Turkey Source:[21]

Liberalization of electricity markets gives opportunity to customers to select their electricity supplier. The consumers who select this opportunity are called as eligible consumer. The Figure 2.8 shows the development in the number of eligible consumers on monthly basis. Nowadays the number of eligible consumers is around 1.7 million, which was around 0.2 milliyon 2 years before.

Table 2.7: History of Generation, Consumption, and Losses in Turkey
Source:[14]

Years	**Gross Gen.**	**Increase**	**Consump-tion**		**Net Gen.**	**Imports**	**Supplied to the Network**	**Trans-mission Loss**		**Distri-bution Loss**		**Total**		**Exports**	**Net Cons.**	**Increase**
	MWh	**%**	**MWh**	**%**	**MWh**	**MWh**	**MWh**	**MWh**	**%**	**MWh**	**%**	**MWh**	**%**	**MWh**	**MWh**	**%**
1994	78.322	6,12	4.539	5,80	73.783	31	73.814	1.800	2,44	10.043	13,61	11.843	16,04	570	61.401	3,65
1995	86.247	10,12	4.389	5,09	81.859	0	81.859	2.035	2,49	11.734	14,33	13.769	16,82	696	67.394	9,76
1996	94.862	9,99	4.777	5,04	90.084	270	90.355	2.462	2,72	13.393	14,82	15.855	17,55	343	74.157	10,03
1997	103.296	8,89	5.050	4,89	98.246	2.492	100.738	2.936	2,91	15.646	15,53	18.582	18,45	271	81.885	10,42
1998	111.022	7,48	5.523	4,97	105.499	3.299	108.798	3.337	3,07	17.458	16,05	20.795	19,11	298	87.705	7,11
1999	116.440	4,88	5.738	4,93	110.702	2.330	113.032	2.985	2,64	18.560	16,42	21.545	19,06	285	91.202	3,99
2000	124.922	7,28	6.224	4,98	118.698	3.791	122.489	3.182	2,60	20.574	16,80	23.756	19,39	437	98.296	7,78
2001	122.725	-1,76	6.473	5,27	116.252	4.579	120.832	3.374	2,79	19.954	16,51	23.329	19,31	433	97.070	-1,25
2002	129.400	5,44	5.673	4,38	123.727	3.588	127.315	3.441	2,70	20.491	16,09	23.932	18,80	435	102.948	6,06
2003	140.581	8,64	5.332	3,79	135.248	1.158	136.406	3.331	2,44	20.722	15,19	24.053	17,63	588	111.766	8,57
2004	150.698	7,20	5.633	3,74	145.066	464	145.529	3.423	2,35	19.820	13,62	23.243	15,97	1.144	121.142	8,39
2005	161.956	7,47	6.487	4,01	155.469	636	156.105	3.695	2,37	20.349	13,04	24.044	15,40	1.798	130.263	7,53
2006	176.300	8,86	6.757	3,83	169.543	573	170.116	4.544	2,67	19.245	11,31	23.789	13,98	2.236	144.091	10,62
2007	191.558	8,65	8.218	4,29	183.340	864	184.204	4.523	2,46	22.124	12,01	26.647	14,47	2.422	155.135	7,66
2008	198.418	3,58	8.656	4,36	189.762	789	190.551	4.388	2,30	23.093	12,12	27.482	14,42	1.122	161.948	4,39
2009	194.813	-1,82	8.194	4,21	186.619	812	187.431	3.973	2,12	25.018	13,35	28.991	15,47	1.546	156.894	-3,12
2010	211.208	8,42	8.162	3,86	203.046	1.144	204.190	5.691	2,79	24.531	12,01	30.222	14,80	1.918	172.051	9,66
2011	229.395	8,61	11.837	5,16	217.558	4.556	222.114	4.189	1,89	28.180	12,69	32.369	14,57	3.645	186.100	8,17
2012	239.497	4,40	11.790	4,92	227.707	5.827	233.534	6.025	2,58	29.632	12,69	35.657	15,27	2.954	194.923	4,74
2013	240.154	0,27	11.177	4,65	228.977	7.429	236.406	5.639	2,39	31.495	13,32	37.135	15,71	1.227	198.045	1,60

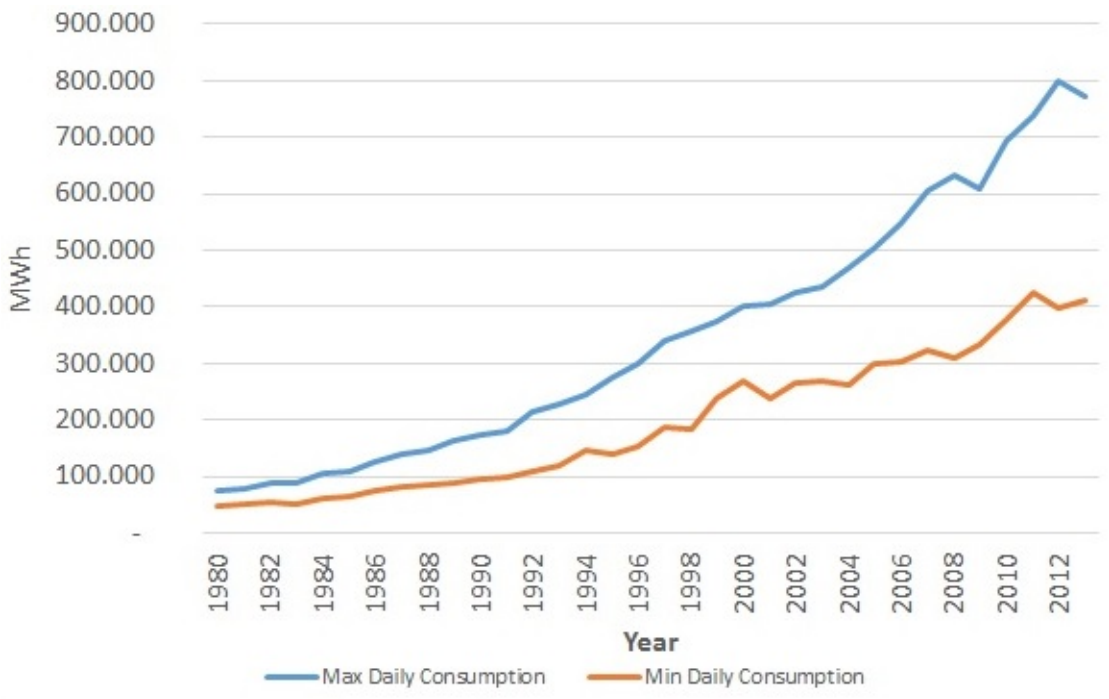

Figure 2.9: Annual Development of Minimum and Maximum Daily Consumption in Turkey
Source:[14]

2.2.4 Electricity Generation in Turkey

Generation plants were used to be state owned. As a result of liberalization process in electricity system, private investors started to take place in generation sector. Also the changes in generation techniques and entrance of renewable technologies caused this reality. The entrance of renewable technologies has been accelerated by private investors. The installed capacity for Hydro + Geotherm + Wind was 1,375 MW in 2006 and it was 11,574 in 2013. Nowadays, EMRA is organizing tenders for solar power plants and expansion of wind power plants.

Electricity storage is one of the main topics of sector. Since the current technologies are not feasible for storing energy, the systems should provide energy needing by generation whenever it occurs. Therefore, the system needs generation infrastructure ever moment. Some part of total capacity may be idle except the period of puant consumption. Annual minimum daily consumotion and maximum daily consumption are shown in Figure 2.9. The increase of puant consumption triggers new investment to sustain the network. The annual development of installed capacity, puant energy and total generated energy in Turkey is shown on Figure 2.10. These three values are correlated with each other.

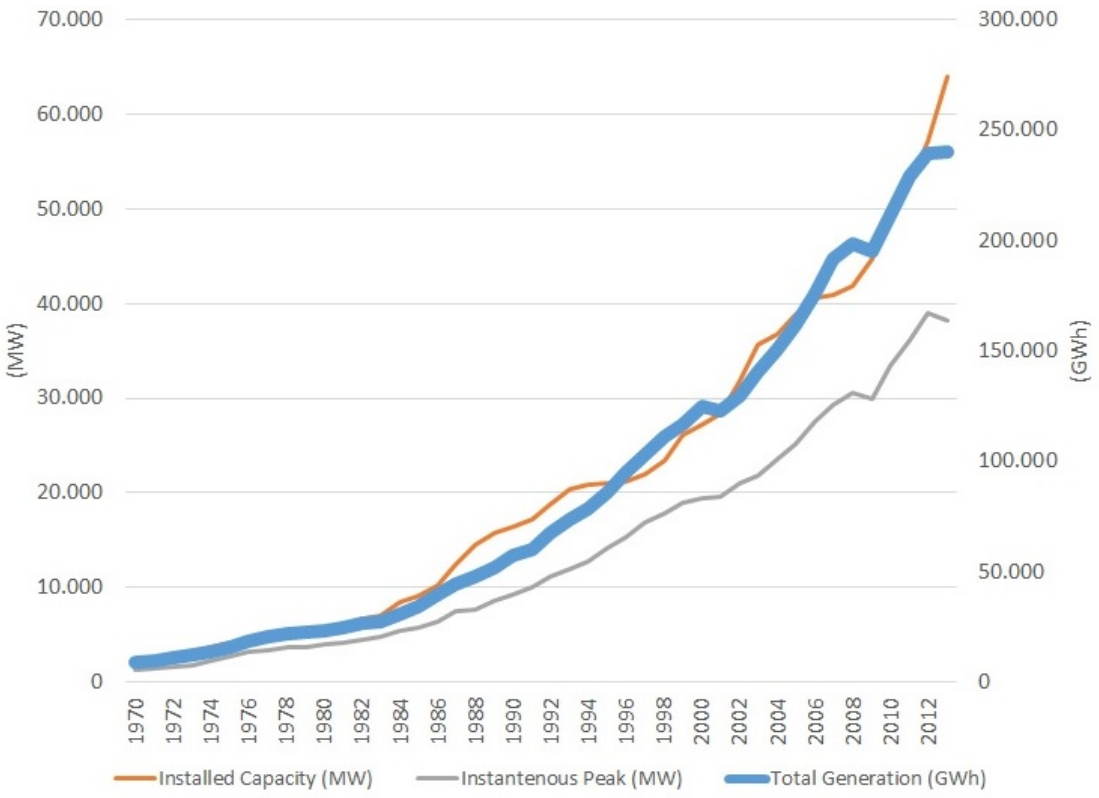

Figure 2.10: Annual Development of Installed Capacity(MW), Instantenous Peak(MW), and Total Generation(GWh)
Source:[14]

The forecasts for the consumption amount of Turkey states Turkey needs more installed capacity. Therefore, Turkey is discussing new electricity sources. The main item of this discussions is nuclear power. The first power plant is started to be constructed in the Mediterannean part of Turkey. The Akkuyu Nuclear power plant is expected to be in operation in 2023 with installed capacity of 4800 MWe. Nowadays, the officials are negotiating with companies for establishment of another nuclear power plant in the northern part of country, Sinop. In nuclear case, geological specifications play the most important roles in location selection.

2.2.5 Electricity Distribution in Turkey

Electricity distribution is totally privatized area of Turkish electricity system. The privatization process started in 2007 and completed in 2013. 21 regional based distribution

Figure 2.11: Map of Distribution Companies in Turkey
Source:[22]

companies are being operated by private sector. The main problem of distribution is high loss ratio which they are exposed to. Public authorities are expecting from private investors to be more effective then before.

The investment budgets for distribution service are being determined by EMRA with respect to the needs in each distribution regions. In electricity tariffs, distribution cost is being paid to distribution companies to finance their investments and operations. If a company decide to realize a new investment which was not foreseen by EMRA, they present it as a new investment proposal to EMRA and if they get approval from EMRA, the project could be financed with the bugdet provided in tariffs can be expanded for this aim. On the other side, if the distributor do not fulfill the planned investments, their share from budget can be cutted in the next tariff periods.

EMRA intervened in the governance of Osmangazi Region with the reason of not fulfilling the responsibilities stated in the regulations. While the shareholder of the company stays the same, it changed the executives and made assignment from official institutions. They will give services until the company turns back to fulfilling its responsibilities.

The distribution loss ration of the country is around 13% as of 2013. Dicle and Vangöl"ăre the regions having the highest loss ratio in the country. Their share in the total loss energy of country is around 60%. If they get down, the distribution loss would be around standard values in distribution sector.

Table 2.10: General Overview of Distribution Companies in Turkey

#	**Distribution Company**	**Cities**	**Privatization Cost(mn)**
1	Dicle	Diyarbakır, Şanlıurfa, Mardin, Siirt, Batman, Şırnak	387
2	Vangölü	Van, Muş, Bitlis, Hakkari	118
3	Aras	Ağrı, Ardahan, Bayburt, Erzincan, Erzurum, Iğdır, Kars	128,5
4	Çoruh	Artvin, Giresun, Gümüşhane, Rize, Trabzon	227
5	Fırat	Bingöl, Elazığ, Malatya, Tunceli	230,25
6	Çamlıbel	Sivas,Tokat,Yozgat	258,5
7	Toroslar	Adana, Gaziantep, Hatay, Kilis, Mersin, Osmaniye	1725
8	Meram	Aksaray, Karaman, Kırşehir, Konya, Nevşehir, Niğde	440
9	Başkent	Ankara,Bartın,Çankırı,Karabük, Kastamonu,Kırıkkale,Zonguldak	1225
10	Akdeniz	Antalya,Burdur,Isparta	546
11	Gediz	İzmir,Manisa	1231
12	Uludağ	Balıkesir, Bursa, Çanakkale, Yalova	940
13	Trakya	Edirne, Kırklareli,Tekirdağ	575
14	Ayedaş	Asian Side of Istanbul	1227
15	Sakarya	Bolu, Düzce, Kocaeli, Sakarya	600
16	Osmangazi	Afyonkarahisar, Bilecik, Eskişehir, Kütahya, Uşak	485
17	Boğaziçi	European Side of Istanbul	1960
18	Kayseri	Kayseri	
19	Aydem	Aydın, Denizli, Muğla	110
20	Akedaş	Adıyaman, Kahramanmaraş	60
21	Yeşilırmak	Amasya, Çorum, Ordu, Samsun, Sinop	441,5

2.3 Losses

2.3.1 Terminology

Electricity is presented to usage by passing though generation, transmission and distribution networks. Generation, transmission and distribution of electrical energy involve many operational losses [1]. As a nature of electricity, a difference is expected between the amount of measurement at the starting point and at the end-user point meters because of the physical rules. The difference is expected to be within some standard levels depending on the physical characteristic of the network and its components.

Loss is defined as the difference between each delivery points of a system. If the loss ratio in the system is higher than expected values, this is a serious problem for the revival of the system. The difference between the consumption metered at end-users' meters and power plants' meters shows the total loss of electricity system.

The experiences from the world shows that the share of distribution losses in total losses is larger in the systems having high loss ratios. Therefore, in the systems exposing high ratios, the importance of distribution sector increases for mitigation of total losses [23],

In other approach, loss is defined based on financial realizations in the power system, the World Bank defines losses as the energy not paid to the utilities despite it is injected to the system [24]. Loss is categorized as technical and non-technical depending on the source of it[25]. Technical Losses are the losses occured because of physical rules which may be in the form of following items:

- Electricity network consists of components like overhead lines, underground cables, switchgear and transformers. They consumes energy in their operation.
- Components operate at different voltage levels and the convertion between voltage levels results in losses.
- Electrical resistance in network components cause energy loss in the form of heat during the transportation of electricity and it has a positive non-linear correlation with transferred energy amount.

Non-tecnical losses are the losses occured because of managerial, sociological, political factors. It may be in the form of theft, unmetered supplies, unregistered customers, incorrect registered subscribers.

- Consumers betray utility company by tending fraudulent ways like tampering with meter, hooking to lines, bypassing the meters.
- Customer relationship processes depend on human factor. Personnel may exhibit immoral behaviors or enter incorrect records like meter multiplier, meter data, tariff data, wrong user.

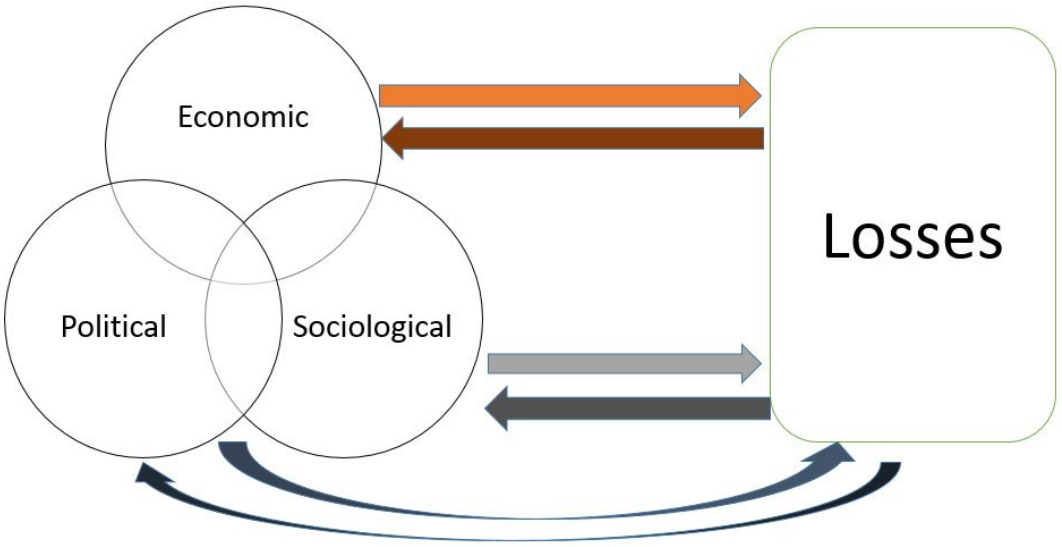

Figure 2.12: Dynamics of Losses

- Consumers who use electricity without registering to system are another part of non-technical losses. They may be stay unregistered because of political reasons or regulatory issues.
- Consumers who do not pay bills regularly.

Dan Suriyamongkol explained technical part of the losses according to the source of the problem as internal and external, stating losses with internal causes of the system as technical and losses with the external causes from the system as non-technical. He states electricity theft as the dominant part of the non-technical losses and defines this phenomenon as a behavior of people to decrease the amount of charge which will be his liability to the utility company for the usage of electricity [26]. Brian Min and Miriam Golden studied on the effects of political election on electrical losses. They concluded that losses in electricity is correlated with elections as it increases during the period of elections [27].

Losses problem can be evaluated as the combination of factors depending on physical, managerial, sociological, political, financial reasons. In fact, an imbalance in one of these factors may trigger others as emerging this issue. If a recipe could not be developed by considering these factors and their inter relations, the problem may turn into a complicated form which is hard to find solution. In this aspect, losses is an issue that should be treated with system dynamics approach.[28]

2.3.2 Financial Aspect of Losses

Electricity utility companies operate to prevent the illegal usage of electricity by metering the consumption points in their region. However, even every person in the region behave with morality and does not tamper the system, loss will occur in the system because of physical rules. The tariff mechanism has to be designed to compansate the financial results of the losses. The tariff mechanism in Turkey is designed to charge unit price for each unit of consumption with respect to the connection and consumer type. The need for each distribution region is calculated with the historical and current background of the system. The collected money under the name of loss cost is shared between the regions with respect to the size of their compensation needing determined by the regulator. If the actual losses of the companies are less than the predicted ratio, the companies may make profit as a result of their success of mitigating loss; otherwise they are exposed to the financial loss because of electrical losses. Setting loss target is an alive mechanism if events occur which may affect operations in market.

The regulator, EMRA, set target as shown on Figure 2.11, in 2010 for the next five years. The companies witnessed that the targets are unreachable and determined without real experiences from the field. After that, the regulator revised the ratios for the regions which have not been privatized. Then the targets revised.

The historical values of electricity tariffs before funds and taxes is shown in Figure 2.13. Most of the consumers exposed to increase in prices except year 2014. The tariff which would be applied to the customers depend on the connection type and consumer type. The items in the tariffs are mainly service related costs and taxes. Service related costs are cost of electricity, theft and loss cost, distribution cost, transmission cost, retail services cost. When we compare the shares of each item in each tariffs, we see that the share of theft and loss cost is increased in the residental customers from 10% in year 2011 to 13% in year 2015.

Table 2.11: Loss Targets of Distribution Companies Determined by EMRA in 2010
Source:[19]

Region	**2011**	**2012**	**2013**	**2014**	**2015**
DİCLE	60,96%	50,63%	42,03%	34,93%	29,01%
VANGÖLÜ	46,15%	38,33%	31,84%	26,45%	21,97%
ARAS	22,92%	19,04%	17,62%	16,30%	15,08%
TOROSLAR	9,38%	8,94%	8,52%	8,12%	7,74%
AKDENİZ	8,86%	8,45%	8,05%	8,02%	8,02%
YEŞİLIRMAK	10,35%	9,87%	9,41%	8,97%	8,78%
BOĞAZİÇİ	9,12%	8,69%	8,28%	7,90%	7,57%
GEDİZ	8,48%	8,08%	7,70%	7,34%	7,00%
FIRAT	12,59%	11,65%	11,11%	10,59%	10,09%
ÇORUH	10,90%	10,39%	10,15%	10,15%	10,15%
BAŞKENT	8,46%	8,07%	7,88%	7,88%	7,88%
OSMANGAZİ	7,21%	7,21%	7,21%	7,21%	7,21%
AYDEM	9,80%	9,34%	8,90%	8,49%	8,09%
AYEDAŞ	7,12%	6,79%	6,61%	6,61%	6,61%
ÇAMLIBEL	7,72%	7,36%	7,02%	6,92%	6,92%
MERAM	8,59%	8,28%	8,28%	8,28%	8,28%
ULUDAĞ	6,96%	6,90%	6,90%	6,90%	6,90%
KAYSERİ	10,01%	10,01%	10,01%	10,01%	10,01%
AKEDAŞ	10,03%	10,03%	10,03%	10,03%	10,03%
SEDAŞ	7,66%	7,31%	6,96%	6,64%	6,33%
TRAKYA	7,70%	7,70%	7,70%	7,70%	7,70%

Table 2.12: Updated Loss Targets of Distribution Companies Revised by EMRA in 2013
Source:[19]

Region	**2013**	**2014**	**2015**
DİCLE	71,07%	59,03%	49,03%
VANGÖLÜ	52,10%	43,27%	35,94%
ARAS	25,70%	21,35%	17,73%
TOROSLAR	11,80%	11,25%	10,72%
BOĞAZİÇİ	10,76%	10,26%	9,78%

Table 2.13: Change in Tariffs Issued in First Month Year Over Year Source:[19]

Connection Type	**Consumer Type**	**2015**	**2014**	**2013**	**2012**
1	Industrial	6%	0%	15%	3%
2	Industrial	9%	0%	15%	15%
2	Commercial	9%	0%	5%	-1%
2	Agricultural Irrigation	10%	0%	-2%	18%
3	Industrial 2 Term	9%	0%	9%	15%
3	Industrial 1 Term	9%	0%	8%	0%
3	Commercial	10%	0%	3%	-4%
3	Agricultural Irrigation	9%	0%	6%	2%
4	Industrial 2 Term	9%	0%	7%	15%
4	Industrial 1 Term and MV	9%	0%	5%	5%
4	Industrial 1 Term and LV	11%	0%	4%	9%
4	Commercial	10%	0%	2%	-1%
4	Residental	9%	0%	8%	9%
4	Agricultural Irrigation	9%	0%	6%	9%
4	Lightning	10%	0%	-1%	10%

Table 2.14: Electricity Tariffs as of 1st of January (Without taxes and funds)2013-2015
Source:[19]

Connection Type	Consumer Type	January 2015 (krs/kWh) Energy Cost	Theft & Loss Cost	Distribution Cost	Total Cost w/o Funds	January 2014 (krs/kWh) Energy Cost	Theft & Loss Cost	Distribution Cost	Total Cost w/o Funds	January 2013 (krs/kWh) Energy Cost	Theft & Loss Cost	Distribution Cost	Total Cost w/o Funds
1	Industrial	18,54	0,00	0,00	19,28	17,60	0,00	0,00	18,16	17,77	0,00	0,00	18,16
2	Industrial	18,54	2,63	0,00	22,78	17,60	1,83	0,00	20,86	17,77	1,84	0,00	20,86
2	Commercial	22,41	3,14	0,00	27,16	20,80	2,58	0,00	24,82	20,53	3,05	0,00	24,82
2	Agricultural Irrigation	19,24	3,44	0,00	24,29	17,81	2,77	0,00	22,01	16,61	4,16	0,00	22,01
3	Industrial 2 Term	18,54	2,79	1,37	24,31	17,60	2,17	1,04	22,24	17,77	1,84	1,38	22,24
3	Industrial 1 Term	18,54	2,84	1,85	24,85	17,60	2,30	1,40	22,73	17,77	1,84	1,87	22,73
3	Commercial	22,41	3,76	3,61	31,39	20,80	3,59	2,73	28,56	20,53	3,14	3,64	28,56
3	Agricultural Irrigation	19,24	2,87	3,70	27,43	17,81	3,02	2,80	25,07	16,61	3,47	3,74	25,07
4	Industrial 2 Term	18,54	2,79	1,37	24,31	17,60	2,17	1,04	22,24	17,77	1,84	1,38	22,24
4	Industrial 1 Term and MV	18,54	2,84	1,85	24,85	17,60	2,30	1,40	22,73	17,77	1,84	1,87	22,73
4	Industrial 1 Term and LV	18,54	4,18	2,90	27,24	17,60	3,40	2,19	24,63	17,77	2,69	2,93	24,63
4	Commercial	22,41	3,69	3,61	31,32	20,80	3,59	2,73	28,56	20,53	3,14	3,64	28,56
4	Residental	21,67	4,05	3,71	31,05	20,79	3,35	2,81	28,39	20,46	2,93	3,75	28,39
4	Agricultural Irrigation	19,24	2,83	3,70	27,40	17,81	3,02	2,80	25,07	16,61	3,47	3,74	25,07
4	Lightning	18,97	4,43	3,93	28,95	18,21	3,67	2,97	26,29	16,31	4,76	3,97	26,28
Retail Services Cost		0,74				0,57				0,39			
Transmission Cost		0,87				0,87				0,85			

Table 2.15: Electricity Tariffs as of 1st of January (Without taxes and funds)2011-2012
Source:[19]

		January 2012 (krs/kWh)				**January 2011 (krs/kWh)**			
Connection Type	**Consumer Type**	**Energy Cost**	**Theft & Loss Cost**	**Distribution Cost**	**Total Cost w/o Funds**	**Energy Cost**	**Theft & Loss Cost**	**Distribution Cost**	**Total Cost w/o Funds**
1	Industrial	15,42	0,00	0,00	15,81	14,94	0,00	0,00	15,31
2	Industrial	15,40	1,54	0,00	18,18	12,80	1,82	0,00	15,86
2	Commercial	19,87	2,55	0,00	23,66	19,83	2,87	0,00	23,95
2	Agricultural Irrigation	17,64	3,47	0,00	22,36	14,60	3,04	0,00	18,88
3	Industrial 2 Term	16,08	1,54	1,46	20,32	13,38	1,85	1,22	17,70
3	Industrial 1 Term	16,30	1,54	1,98	21,06	15,94	2,18	1,65	21,01
3	Commercial	19,97	2,62	3,85	27,68	21,54	2,87	3,21	28,87
3	Agricultural Irrigation	15,49	2,90	3,95	23,58	15,58	3,07	3,30	23,20
4	Industrial 2 Term	16,54	1,54	1,46	20,78	13,73	1,95	1,22	18,14
4	Industrial 1 Term and MV	16,92	1,54	1,98	21,68	15,59	2,22	1,65	20,71
4	Industrial 1 Term and LV	17,17	2,24	3,09	23,74	15,75	2,16	2,58	21,74
4	Commercial	20,32	2,62	3,85	28,03	20,84	2,93	3,21	28,23
4	Residental	18,56	2,45	3,96	26,20	17,17	2,40	3,30	24,11
4	Agricultural Irrigation	15,49	2,90	3,95	23,58	14,13	3,04	3,30	21,72
4	Lightning	17,24	3,97	4,19	26,65	15,22	4,20	3,50	24,16
Retail Services Cost		0,39				036			
Transmission Cost		0,84				0,72			

Table 2.16: Share of Items in Electricity Tariffs
Source:[19]

Connection Type	Consumer Type	2015			2014			2013			2012			2011		
		Energy	Theft & Loss	Distribution	Energy	Theft & Loss	Distribution	Energy	Theft & Loss	Distribution	Energy	Theft & Loss	Distribution	Energy	Theft & Loss	Distribution
1	Industrial	96%	0%	0%	97%	0%	0%	98%	0%	0%	98%	0%	0%	98%	0%	0%
2	Industrial	81%	12%	0%	84%	9%	0%	85%	9%	0%	85%	8%	0%	81%	11%	0%
2	Commercial	83%	12%	0%	84%	10%	0%	83%	12%	0%	84%	11%	0%	83%	12%	0%
2	Agricultural Irrigation	79%	14%	0%	81%	13%	0%	75%	19%	0%	79%	16%	0%	77%	16%	0%
3	Industrial 2 Term	76%	11%	6%	79%	10%	5%	80%	8%	6%	79%	8%	7%	76%	10%	7%
3	Industrial 1 Term	75%	11%	7%	77%	10%	6%	78%	8%	8%	77%	7%	9%	76%	10%	8%
3	Commercial	71%	12%	11%	73%	13%	10%	72%	11%	13%	72%	9%	14%	75%	10%	11%
3	Agricultural Irrigation	70%	10%	14%	71%	12%	11%	66%	14%	15%	66%	12%	17%	67%	13%	14%
4	Industrial 2 Term	76%	11%	6%	79%	10%	5%	80%	8%	6%	80%	7%	7%	76%	11%	7%
4	Industrial 1 Term and MV	75%	11%	7%	77%	10%	6%	78%	8%	8%	78%	7%	9%	75%	11%	8%
4	Industrial 1 Term and LV	68%	15%	11%	71%	14%	9%	72%	11%	12%	72%	9%	13%	72%	10%	12%
4	Commercial	72%	12%	12%	73%	13%	10%	72%	11%	13%	72%	9%	14%	74%	10%	11%
4	Residental	70%	13%	12%	73%	12%	10%	72%	10%	13%	71%	9%	15%	71%	10%	14%
4	Agricultural Irrigation	70%	10%	14%	71%	12%	11%	66%	14%	15%	66%	12%	17%	65%	14%	15%
4	Lightning	66%	15%	14%	69%	14%	11%	62%	18%	15%	65%	15%	16%	63%	17%	14%

The items in the electricity tariffs can be explained as following:

- The cost of electricity and retail services cost are related with trade activities for supplying electricity.
- The cost of distribution and meter reading are transferred to distribution company as a repayment for distribution services which is fulfilled. The company covers its operational expenses, maintenance costs and investments for distribution with this finance.
- The cost of transmission is transferred to transmission company, TEIAS as a repayment for transmission services which is fulfilled. TEIAS covers its operational expenses, maintenance costs and investments for transmission with this finance.
- The cost of theft and losses is transferred to distribution company to compensate the financial losses occured because of high loss ratios. The quantity of theft and loss item in the invoices is determined with respect to the overall loss ratio of the country. Therefore some of the distribution regions which have low target ratios then the country level give money to the mechanism and the companies who have higher ratios then the country gets money from the mechanism.

Losses have financial impact on distribution companies. The compensation mechanism of the electricity losses is designed by consolidating overall ratio of the country under the frame of national tariffs. The regulator is expecting to pass to the regional tariffs which are based on regional consolidation.

The network is affected from the losses which decreases its life and requires extra investments. This result in spending extra money on the network which may not be needed if the region did not have had high loss level.

Losses creates unregistered activity in the sector which decreases the tax income of the public. Therefore, it should take more place in the governors to increase revenue which would turn back to citizens by various ways of services.

Losses have financial impacts on central budget of the country. Turkey is an energy importer. Energy is one of the main subjects of the international relations. Electricity generation depending on sources are shown on Figure 2.17. Total share of domestic

sources is around 45%; 25% hydro, 4% renewable and around 16% domestic coal. This percentage shows the foreign source dependency of Turkey.

Mitigating the losses problem would make the governors more flexible on foreign policy. On the other hand, the consumers in the systems having high loss ratios presesent squandering comsumption. This requires extra installed capacity for generation to feed the system which. This pushes back other investment alternatives that can be developed for public weal.

Table 2.17: Annual Development of Turkey's Electricity Generation by Primary Energy Resources
Source:[14]

Years	**Coal**	**Lignite**	**Fuel-Oil**	**Diesel Oil**	**Lpg**	**Napththa**	**Natural Gas**	**Renew.+ Wastes+ Waste Heat**	**Hydro**	**Geo-ThermalL +Wind**	**Total**
1994	1977,6	26257,1	5546,8	2			13822,3	50,9	30585,9	79,1	78321,7
1995	2232,1	25814,8	5498,2	273,8			16579,3	222,3	35540,9	86	86247,4
1996	2574,1	27839,5	6174,4	365,2			17174,2	175,4	40475,2	83,7	94861,7
1997	3272,8	30587,2	6520,7	531,4	105,2	0	22085,6	294	39816,1	82,8	103295,8
1998	2980,9	32706,6	7275,6	308,6	222,2	116,9	24837,5	254,6	42229	90,5	111022,4
1999	3122,8	33908,1	6472,4	747,7	277,5	581,9	36345,9	204,7	34677,5	101,4	116439,9
2000	3819	34367,3	7459,1	980,6	324	547,1	46216,9	220,2	30878,5	108,9	124921,6
2001	4046	34371,5	8816,6	904	162,1	483,5	49549,2	229,9	24009,9	152	122724,7
2002	4093,1	28056	9505	270,9	34,8	933,1	52496,5	173,7	33683,8	152,6	129399,5
2003	8663	23589,9	8152,7	4,4	2,9	1036,2	63536	115,9	35329,5	150	140580,5
2004	11998,1	22449,5	6689,9	7,3	33,4	939,7	62241,8	104	46083,7	150,9	150698,3
2005	13246,2	29946,3	5120,7	2,5	33,7	325,6	73444,9	122,4	39560,5	153,4	161956,2
2006	14216,6	32432,9	4232,4	57,7	0,1	50,2	80691,2	154	44244,2	220,5	176299,8
2007	15136,2	38294,7	6469,6	13,3	0	43,9	95024,8	213,7	35850,82941	511,1	191558,1294
2008	15857,5	41858,1	7208,6	266,3	0	43,6	98685,3	219,9	33269,8	1008,9	198418
2009	16595,6	39089,5	4439,767	345,8	0,4	17,559	96094,7	340,1	35958,4	1931,1	194812,926
2010	19104,3	35942,1	2143,8	4,3	0	31,9	98143,7	457,5	51795,5	3584,6	211207,7
2011	27347,5	38870,4	900,5	3,1	0	0	104047,6	469,2	52338,6	5418,2	229395,1
2012	33324,2	34688,9	981,3	657,4	0	0	104499,2	720,7	57865	6760,1	239496,8
2013	33524,033	30262,043	1192,478	546,348	0	0	105116,347	1171,201	59420,468	8921,035	240153,953

2.3.3 Methodologies in Solving Loss Problem

Emad S. Ibrahim relates technical losses with engineering processes and non technical losses with managerial processes [29]. Mitigation of these losses requires approaching problems with this percepective [25]. Emas S. Ibrahim, presented a systematic project management approach for activities aiming reduction of losses. He defines losses reduction plan as a medium term investment project. The principles which should be followed in the loss reduction project are:

1. Measuring and evaluating the losses amount and percentage.
2. Interpretation for determination of the level and origin of losses.
3. Collecting project proposals aiming the reduction of losses from the personnel and consultants.
4. Implementation of proposals as pilot projects.
5. Determination of financial results of the actions taken under the frame of project.
6. Following the actions and evaluating the results on financial and operational percepective.
7. Updating the project with respect to the results obtained from project implementations.

Distribution companies receive electricity from transmission system. They distributes the energy through their distribution network to the end users. The consumption of the consumers is being controlled via electricity meters. The companies invoice their subscribers for electricity usage according to measurement at these devices. The companies also have electricity meter at the delivery point of electricity from transmission system to distribution system.

Emad S Ibrahim schematize the loss in Figure 2.13. The amount of energy purchased to the distribution system is A. While electricity is being dispatched through the distribution network, technical losses occur in the system. Then, the real amount of the energy which is reached to consumer becomes D. Distribution company meters consumption of its subscribers and the total amount for same time period, of the measurement at the

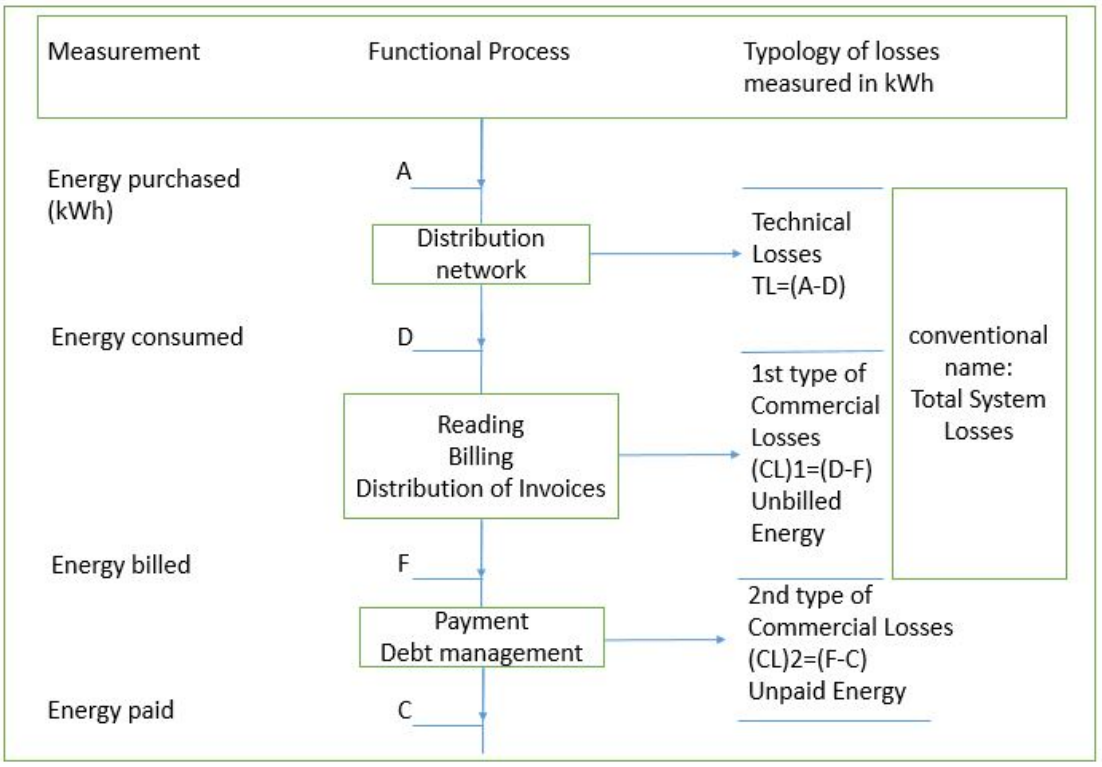

Figure 2.13: Losses Schema by Emad S. Ibrahim
Source:[29]

delivery point of distribution company and at the delivery points before end users, becomes F. After that, company publishes invoice for the amount of consumption metered at its subscribers. The amount of paid invoices is calculated as C. The flow starting with the amount of A lasts with the amount of C in the cash of the company. Amad S Ibrahim defines three types of losses in this process. Technical losses is the difference in the amount of purchased energy and delivered energy to the customers(A-D). 1st type commercial losses is the difference between the received energy of consumers and the total amount metered on subscribers' meters(D-F). 2nd type of commercial losses is the difference between the energy billed to the subscribers and the energy collected from the subscribers. In the ideal case, it is expected to be equal amounts A, F and C. In reality, there is a difference occurs from A to D and D to F and F to C.

The losses in each segment has different characteristics. Therefore, mitigation of losses in each phase requires different approaches. Struggling with losses requires developing a strategy for solving the problem. The main item which would shape the blueprint of it, is the data acquired from metering points. It will define the size and the type of the problem on location based. The number of increasing meters in the network will

make easier to follow the electricity usage in the grid. People are not only striving with electricity losses, other utilities are also exposed to losses phenomenon and their solution depends on metering capabilitiy of the system like in the case of water utilities. [30]

The process of battling with losses has four main headlines. Measuring, diagnosing consumption, developing action plan, tracking and updating action plan according to results. Utility analytics is an evolving phenomenen in the utility sector. The size of the incoming data to the companies is increasing as internet of things spead in the network. The evolution of this phenomenon is summarized by Kim Gaddy, Vice President of the Utility Analytics Institue. The data is started to be treated as strategic asset which contains high potential that may turn into value. The transformation of mentioned potential to value can be accelerated by inserting analytics to the operational processes[31]. The data obtained from metering devices in the field can be shaped by analytics developed by algorithms using different statistical methodologies [32-39]. Therefore, the data becomes more meaningful as turning into forensic and makes the operations more efficient.

Chapter 3

Losses in Turkey with the Experiences in Dicle Region

The Turkish Ministery of Energy and Natural Resources, declared strategy document in 2014. This blueprint is different from the older ones by mentioning on electricity losses and giving quantitative target. Turkey has the aim of decreasing loss to *10 percent level as of 2019*[40].

Table 3.1: Losses Target in Turkey(%)
Source:[40]

Base Year 2013	**2015**	**2016**	**2017**	**2018**	**2019**
15,4	14	13	12	11	10

The history of losses in Turkey is shown in Table 3 . Turkey should perform effort which is dedicated to minimize this ratio. The ratio of transmission losses is around 2 percent. It fluctuates around this level since 1990s. On the other hand, distribution losses fluctuates around 13-14 percent levels. Turkey has 21 distribution region and 4 of it has loss value higher than country average. The development of distribution regions' loss statistics is shown in Table 3.3. Turkey's power system losses problem would be handled with the experiences in Dicle Region which is the main driver of the problem as having the highest ratio in the country.

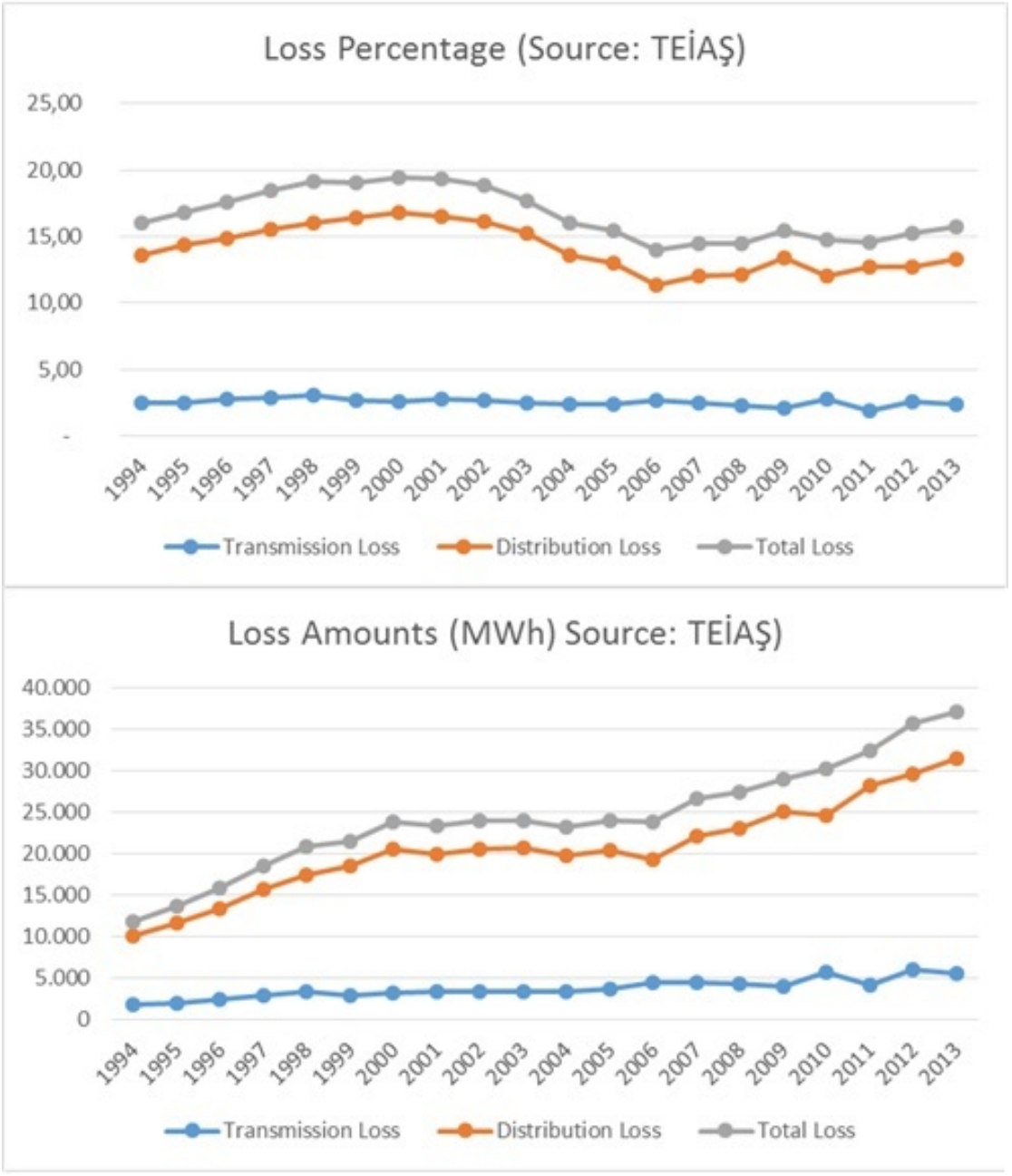

Figure 3.1: Annual Development of Losses in Turkey

Table 3.2: Annual Development of Electricity Statistics
Source:[14]

Statistics	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Gross Generation(MWh)	150.698	161.956	176.300	191.558	198.418	194.813	211.208	229.395	239.497	240.154
Increase in Gross Generation	7,2	7,5	8,9	8,7	3,6	-1,8	8,4	8,6	4,4	0,3
Internal Consumption(MWh)	5.633	6.487	6.757	8.218	8.656	8.194	8.162	11.837	11.790	11.177
Internal Consumption(%)	3,7	4,0	3,8	4,3	4,4	4,2	3,9	5,2	4,9	4,7
Net Generation (MWh)	145.066	155.469	169.543	183.340	189.762	186.619	203.046	217.558	227.707	228.977
Imports (MWh)	464	636	573	864	789	812	1.144	4.556	5.827	7.429
Supplied to Network (MWh)	145.529	156.105	170.116	184.204	190.551	187.431	204.190	222.114	233.534	236.406
Transmission Loss (MWh)	3.423	3.695	4.544	4.523	4.388	3.973	5.691	4.189	6.025	5.639
Transmission Loss (%)	2,4	2,4	2,7	2,5	2,3	2,1	2,8	1,9	2,6	2,4
Distribution Loss (MWh)	19.820	20.349	19.245	22.124	23.093	25.018	24.531	28.180	29.632	31.495
Distribution Loss (%)	13,6	13,0	11,3	12,0	12,1	13,3	12,0	12,7	12,7	13,3
Total Loss (MWh)	23.243	24.044	23.789	26.647	27.482	28.991	30.222	32.369	35.657	37.135
Total Loss (%)	16,0	15,4	14,0	14,5	14,4	15,5	14,8	14,6	15,3	15,7
Export (MWh)	1.144	1.798	2.236	2.422	1.122	1.546	1.918	3.645	2.954	1.227
Net Consumption (MWh)	121.142	130.263	144.091	155.135	161.948	156.894	172.051	186.100	194.923	198.045
Increase in Net Consumption	8,4	7,5	10,6	7,7	4,4	-3,1	9,7	8,2	4,7	1,6

Table 3.3: Annual Development of Loss Percentages of Utilities
Source:[41]

Distribution Region	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Dicle Edaş	62,6	64,3	57,8	64,7	64,2	73,0	65,3	71,4	69,8	75,0
Vangölü Edaş	61,2	62,1	63,8	56,2	55,9	55,6	57,2	52,1	53,3	64,3
Aras Edaş	33,5	31,7	29,4	29,4	27,2	27,7	25,6	26,4	27,6	36,0
Çoruh Edaş	13,4	14,4	12,3	12,0	10,7	11,5	12,0	11,4	10,0	9,4
Fırat Edaş	15,3	14,3	11,7	11,0	10,5	13,6	12,6	11,4	10,4	9,5
Çamlıbel Edaş	11,0	10,3	8,5	8,8	8,8	7,7	7,0	9,4	8,3	7,6
Toroslar Edaş	16,5	13,1	10,9	9,8	8,9	8,3	7,9	11,2	12,5	15,2
Meram Edaş	8,7	7,1	7,8	7,9	8,4	8,5	9,5	9,5	9,0	7,1
Başkent Edaş	9,4	11,1	9,6	8,7	8,3	8,3	8,2	10,3	8,7	7,9
Akdeniz Edaş	10,2	9,3	8,9	9,3	9,0	9,2	9,9	11,0	9,8	11,3
Gediz Edaş	7,5	7,1	6,5	8,6	6,3	7,7	7,5	8,1	8,2	9,7
Uludağ Edaş	7,1	10,1	8,8	7,3	6,0	5,6	6,4	9,6	7,3	7,1
Trakya Edaş	10,8	9,9	9,3	7,9	7,0	6,4	6,8	8,4	6,6	5,3
Ayedaş	10,5	10,4	10,2	9,4	8,6	7,5	6,9	8,3	6,7	7,6
Sakarya Edaş	13,9	12,3	10,1	6,2	6,3	6,8	6,8	8,7	7,0	6,6
Osmangazi Edaş	8,0	6,9	7,2	6,3	5,2	6,1	6,9	6,9	7,2	7,9
Boğaziçi Edaş	19,3	16,2	12,3	12,5	11,0	9,7	10,9	12,9	10,6	9,9
Kayseri Elektrik	8,0	8,2	8,1	7,5	7,0	7,0	7,0	7,1	7,0	6,9
Aydem Edaş	9,4	9,1	7,1	7,0	8,9	9,6	8,6	9,5	8,0	7,6
Akedaş	12,2	10,7	9,3	8,0	7,3	6,9	7,3	7,4	7,1	6,7
Yeşilırmak Edaş	12,7	11,8	9,5	9,1	9,1	10,6	13,5	7,8	6,7	7,8

3.1 Why Dicle Selected to Analyze Turkey

Turkey has around 15% loss ratio and it deviates between regions. The highest loss ratio is seen in the Dicle Electricity Distribution Company which is responsible for operation in the south eastern territory of the country. The losses in Dicle region is more determinant on the losses ratio of the country than other distribution regions shown in Table 3.3 and in Table3.4.

The share of utilities on the total amount of lost energy in Turkish power system is shown on Table 3.4. It resulted in that Dicle region has the largest share over the total lost energy amount. Its share is increasing every year. It shows the importance of Dicle Region in the process of mitigation losses in Turkey.

Analyzing monthly consumption of Turkey and Dicle shows the characteristics of Dicle in the losses problem of the country. The share of Dicle on yearly consumption of the country is around 8%. The shares on monthly consumption fluctuates between 6% to 10%. In the spring and autumn seasons, the share decreases to 6% and it increases to 10% levels in the winter and summer seasons. In other words from spring and autumn to summer and winter the regional consumption share increases around 60% as having share from 6% to 10%. More fluctuations in the electricity consumption is the demonstrator of electricity losses both technical and non-technical.

Analyzing the monthly consumption of Turkey versus Dicle shows that, Dicle deviates more than Turkey. From January 2012 to July 2015, the average monthly consumption in Dicle Region is around 1.7 billion kWh and in Turkey is around 20.4 billion kWh. Standard deviation of monthly consumptions in Dicle is 0.3 billion and in Turkey is 1.4 billion. When we compare the ratio of deviation over average consumption, the ratio is 18% in Dicle and 7% in Turkey. Therefore, Dicle region is main driver of fluctuations resulting in especially technical losses in the average of the country.

Table 3.4: Annual Development of Shares of Utilities in Total Amount of Lost Energy in Turkey

City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Dicle Edaş	28%	30%	29%	33%	37%	42%	38%	38%	40%	41%
Vangölü Edaş	5%	5%	6%	5%	6%	6%	6%	5%	6%	7%
Aras Edaş	3%	3%	3%	3%	3%	3%	2%	2%	2%	3%
Çoruh Edaş	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Fırat Edaş	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Çamlıbel Edaş	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Toroslar Edaş	10%	8%	8%	7%	6%	6%	5%	7%	9%	10%
Meram Edaş	2%	2%	2%	2%	3%	2%	3%	2%	2%	2%
Başkent Edaş	5%	5%	5%	5%	5%	5%	5%	5%	4%	4%
Akdeniz Edaş	2%	2%	2%	2%	3%	2%	3%	3%	2%	3%
Gediz Edaş	5%	4%	5%	7%	5%	5%	5%	5%	5%	6%
Uludağ Edaş	4%	5%	5%	4%	3%	3%	4%	5%	4%	3%
Trakya Edaş	3%	3%	3%	3%	2%	2%	2%	2%	2%	1%
Ayedaş	3%	3%	4%	4%	3%	3%	3%	3%	2%	2%
Sakarya Edaş	7%	6%	6%	3%	4%	4%	4%	4%	3%	3%
Osmangazi Edaş	2%	1%	2%	2%	1%	1%	2%	1%	2%	2%
Boğaziçi Edaş	15%	13%	11%	12%	10%	8%	9%	9%	8%	7%
Kayseri Elektrik	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Aydem Edaş	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Akedaş	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Yeşilırmak Edaş	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%

Table 3.5: Dicle Region Monthly Consumption(MWh)
Source:[42]

Month	**2012**	**2013**	**2014**
1	1.814.310	1.858.636	1.888.716
2	1.677.190	1.584.178	1.689.443
3	1.841.599	1.818.438	1.535.878
4	1.575.855	1.687.068	1.767.349
5	1.500.105	1.169.802	1.478.229
6	1.457.729	1.331.071	1.456.859
7	1.974.106	2.138.662	2.220.281
8	2.058.815	2.155.911	2.230.169
9	1.596.154	1.643.367	1.738.381
10	1.072.832	1.136.553	1.059.030
11	1.254.978	1.310.648	1.507.378
12	1.775.785	1.856.217	1.728.769
Total	19.599.457	19.690.550	20.300.482

Dicle region is exposed to fluctuations in consumption during the year. The reason behind the increases in winter time is usage of electricity for heating and in summer time is agricultural irrigation and cooling. The density of each location can be understood when the network is measured part by part. These consumption behaviour can be understood by analyzing feeder consumption data for the periods in a year. This analysis for Dicle Region would show that:

- The measurements on lines feeding agricultural areas show consumption increase in the transition period from spring to summer because of electricity usage in irrigation.

Table 3.6: Turkey Monthly Consumption(MWh)
Source:[14]

Month	**2010**	**2011**	**2012**	2013	2014
1	16.893.400	18.928.948	20.812.248	18.930.664	21.739.596
2	15.375.776	17.135.336	19.607.684	18.690.512	19.363.844
3	16.195.208	17.831.000	20.530.868	20.294.948	20.949.000
4	15.738.640	17.271.500	17.783.580	18.944.200	19.375.340
5	16.476.132	17.218.184	18.858.052	19.311.520	20.193.164
6	16.886.920	17.574.460	19.632.080	19.907.800	19.992.560
7	18.713.276	20.396.708	22.039.420	22.027.376	22.947.184
8	19.593.356	20.464.124	21.531.104	21.493.788	23.321.768
9	16.673.480	18.500.620	19.743.200	19.826.480	20.510.680
10	16.634.656	18.459.540	17.882.588	18.506.228	18.690.968
11	16.116.280	18.501.580	19.031.160	19.607.760	20.555.460
12	18.610.612	20.823.720	20.788.184	21.373.204	22.200.680
Total	203.907.736	223.105.720	238.240.168	238.914.480	249.840.244

Figure 3.2: A House in the Village with 2 Air Conditioners

Figure 3.3: A House in the Village with 2 Air Conditioners

- The measurements on lines feeding residental areas show consumption increase in the transition period from spring to summer and autumn to winter because of usage in cooling and heating.

The Public Private Infrastructure Advisory Facility (PPIAF) is an organization established with the aim of enabling bridge mission between private investors and the regulator part of the electricity system. It operates with the funding provided by development banks from different countries and the World Bank. They define distribution as the sale of the product to the customers from wires to the house. It is the process composed of billing, collection of the fees and customer services. They claim that private sector

Figure 3.4: A Building Full of Air Conditioners

involvement in the distribution sector would develop the mechanism by applying the best practices of operations as increasing the quality while decreasing the costs [43].

The Dicle Electricity Distribution Company is a private owned distribution company who has the highest weight in the problematic sides of the system in Turkey. The practices they applied should be analyzed and the missing parts of the imlementations should be discussed to have foresight for the future of the system in the country.

3.2 What are done, and faced with what kind of obstacles in the realization of projects

The privatization is realized with the statistics showing that the region has the highest electricity loss ratio and lowest collection ratio in the country. Even the ratios provided by the public officials are seen as it can not be worse than the declared ratios, it is understood that the calculations were done with different approach which result in misleading for company. The losses ratio calculation included some of the incorrect invoices which are impossible to collect them. The company were used to react slowly to these

Figure 3.5: Illegal electricity usege for agricultural irrigation for pumping water to ground and transporting on the ground

kind of situtaions in the state owned times. Therefore, the unclear record mislead the calculations. The receivables taken into control and the ones which source from incorrect invoicing cancelled to make the way of the company more visible and make the current situation of the company more realistic. This result in the truth that the targeted loss ratios determined by EMRA were higher than the real values.

Losses in the electricity system is the result of managerial problems of the company, socio-political problems and technical reasons as discussed in the literature [27][23][44][26]. Managerial problems mainly depend on the unstability of the managers because of the official assignment depending on politicians. The assignment durations of the officials

Figure 3.6: Mobile Transformers Used for Agricultural Irrigation Illegally

were used to last even less than a year because of this reality. It creates a managerial gap in the development and implementation of operations. The managerial gap results in uncontrolling the personnel. The personnel who behave in immoral ways and not taking action to the cases in which consumers thieve energy or they may encourage people to tend to infraudulent ways by taking bribe for to not make operation on their zone. On the other side, the honest personnel do not feel the support of its manager on his shoulder to operate in detected locations with illegal consumption.

Dicle region is the territory in which people live in the shade of political discussion which

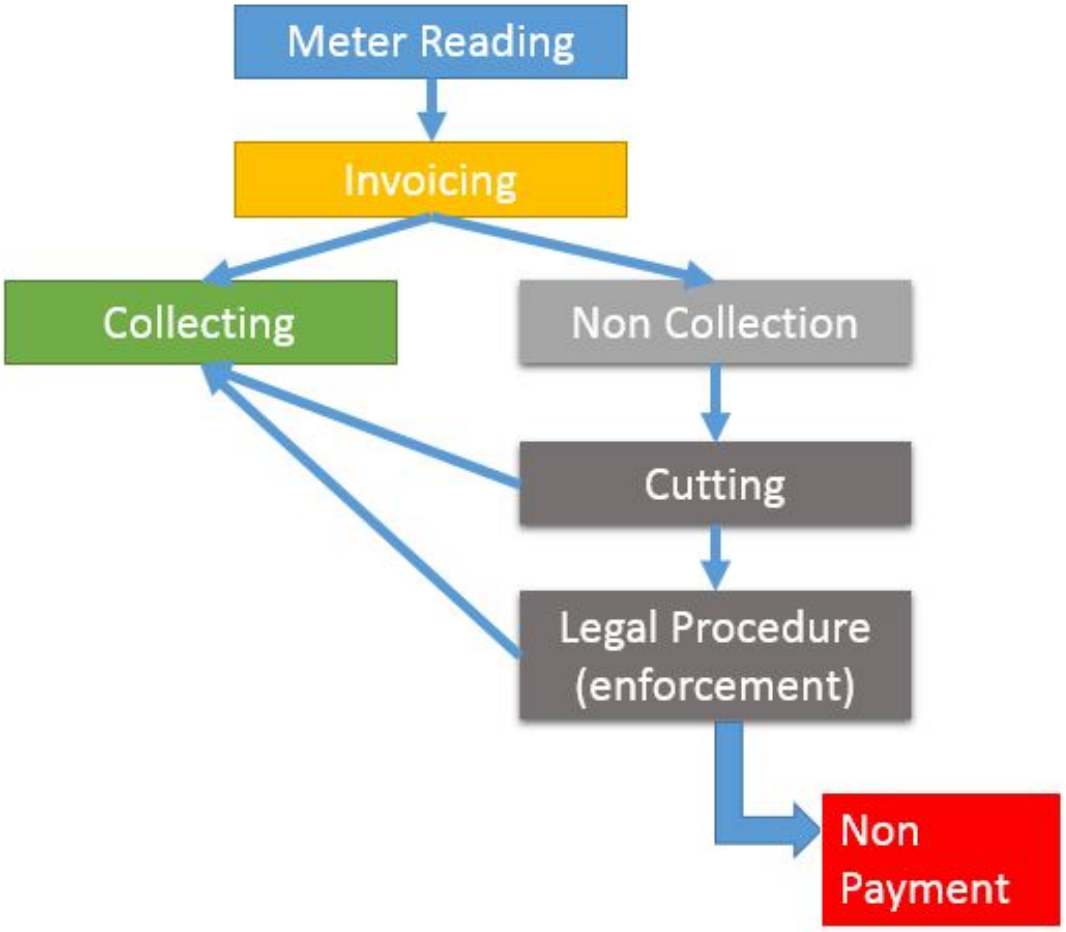

Figure 3.7: Work Process of Utilities

reflects to the country as terrorist attacks from PKK (Kurdistan Workers' Party). The political groups who support this organization declares using electricity without payment is their right and the state can not charge money for electricity usage. The region has atmosphere which does not allow to make investment. Therefore, the investment necessary for renewal of network becomes impossible to put in practice.

The irrigational channel projects play important role for the territory to provide irrigated farming. The Southeastern Anatolian Project [45] aims to install dam and transfer water via channels to the farming areas. While the project could not be progressed on expected timeline, the farmers tend to irrigate soil with groudwater by using electrical motors. The company installed infrastructure because of the political pressures of the politicians and the farmers utilizes electricity in watering without accepting metering their usage and making payment for that utilization. The lines feeding irrigational areas are also utilized by residents in the rural areas. It requires investment to distinguish the lines as feeding

Figure 3.8: Photos after the attacks to Dicle offices

irrigational zones and residental zones. However, even if it is done, some of the users insists on protesting payment of energy. Therefore they keep on electrifying their motors via hooking the lines.

To calculate the return on investment, it is necessary to be able to measure the system and evaluate losses effect in each part of the network. Therefore the main investment focesed on increasing measurability of the network and renewing the meters. The decision on infrastructure investments is expected to be prioritized with respect to metering values which shows the weight of projects in decreasing losses.

A new period started after privatization. The company started its operation by opening a new white page to its customers by organizing campaigns for receivables as giving up late fee for the old unpaid invoices and amnesty for tampered meter owners to gain the people who promise not to tend to fraudulent ways in electricity consumption after the company changes their metering devices. These aproaches did not draw the expected

Figure 3.9: Photos from the Demonstrations in Dicle

Figure 3.10: Photo showing the reaction of municipality after cutting the electricity due to accrued liability

interest. Then the managers decided to make operation on each consumption point in the field.

The main operation of electricity utility is fulfilled via two different companies retail and distribution as the requirements of market regulation. Utilities have to assure their revenues to survive. On one hand, they have to issue billing and on the next step they should collect money. The financial reality shows that the consumption is loss unless the payment is done for it. This approach results in a combined consideration for losses as aggregate total loss which is the amount of uncollected consumption in a system. This approach is being used by sector participants of India which has been in an uphill battle with this problem [46]. Endeavor for mitigating aggregate total loss gives responsibility to retail side and distribution side of electricity utility sector. Main responsibilities of retail side and distribution side can be explained as below:

- Retail side should focus on projects which would increase collecting ratio. Collecting abilitiy increases with the utilization of capabilities which the regulation allows. Some of the ways for this aim are:
  - Keeping actual customer data clean like active user identitiy information, contact details and retail sales aggrement in the customer folder.
  - Reminding customer the invoices before the due date of bills via different media like sms, e-mail.
  - Reinforming the customer about the possible sanctions they may face with.
  - Brightening the customers for providing financement about their electricity bills.
  - Developing new collection methodologies.
  - As a last resort referring to legal department to collect the money.
- Distribution side should focus on increasing billing amount as a result of activities of loss detection. The theft detected areas must not turn into old habits to obtain a sustainable success in distribution area. This target is more reachable if data utilization is inserted to the operation Planning and control mechanism. Distribution side has different data sources; which give chance to increase loss detection and follow customer behaviors. Some of the ways for this aim are:

- Data for the topology of the electricity network which shows the voyage of electricity from transmission system to the customer utilization. This gives ability to make evaluations on different segmentation of the network.
- Data for customer histrical behaviors as consumption, theft detected times.
- Data collected from meters other than consumption amount as tampering alerts, demand values.
- Data about the operation and installed capacity of customer to make comparisons for the usage.

3.2.1 Collection

The company was not used to follow tight collection strategy. The managers were focusing on collection from period to period. However, the company needs money to buy energy from daily market. Cash flow plays an important role not to face with financial turmoil in this process. Collection is the cash inflow. Therefore, it should be planned correlated with cash outflows. Invoicing schedule should be amended by taking this factor into consideration. Reading every consumer once a month is important factor for arranging the balance between cash in flow and out flow. Then, the consumer can plan their own cash flows without facing with cumulated invoices they have to pay. One of the first activities of done by Dicle company was reading every point once a month.

Dicle handled collection problem by analyzing it as grouping consumers. The analysis were done with classifications like:

- Class of consumer
- Number of arrear invoices
- Continuing activity or not
- Data quality of the consumer
- Statue of receivable, referred to legal services or not

The action plans are designed for each segment and sub segments of these classifications. The first step is informing the debtor about his liability and reminding the sanction

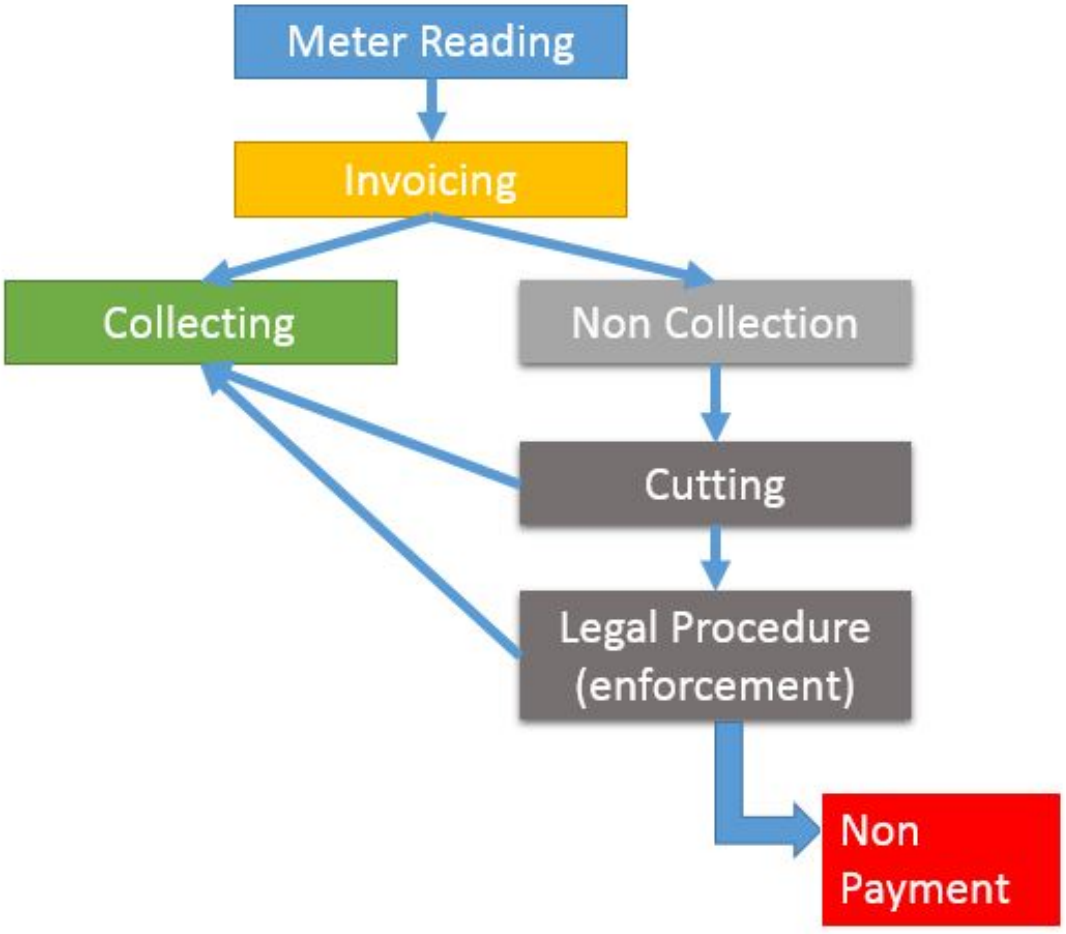

Figure 3.11: Work Process of Utilities

mechanism the regulation projects. Informing channels are written notice, sms, telephone calls.

The regulations give opportunity to cut-off the electricity of the customers who do not pay their invoices. The second step is this. When this step implemented in the field, it is experienced that some of the consumers give reaction by making payment and some of them are not. The struggle with subscribers persistent on not to pay moved to the legal proceedings as third step. Some of them accepted to pay and some of them kept on their attitude. It is understood that they do not take into care of even legal sanctions, since they are not the subscriber defined in that point. In other words, the location they live is subscribed to the utility company on a fake account. Even their electricity is cut by workers, they re-connect it after the team leaves the zone. They do not hesitate on intervening electricity network or tampering their meter. Since the region is under terrorist atmosphere, the supporter are whispering about data cleaning

and updating works of the company as blacklisting the people in the region. Therefore, in some parts of the region, especially rural areas, people are resisting on not to share their information with the company. This reality ties hands of the company. The last option here is operating to the locations with security support. Since the region is exposed to political argumentations, operations with security forces could not been realized as expected.

The consumption of official institutions play important role in the region. Collecting money from especially the subscribers belonging to the municipalities is hard. Their debt is accumulated for years. Since they give public services, it is not practicable to take off the energy of purification plants, water installations etc. It is hard to convince them to find financement for the accumulated debts in return of restructuring the over due debts and obtaining a promise for the payment of actual invoices on time.

The company can develop new methodologies as collection channels. Loss in electricity system is a national issue. Therefore, the governors should be supporting the ones who come with solution alternatives. Some of the subcribers in the region get incentives from central government for their operation in the case of commercial, industrial and agricultural irrigation customers and get subsidies for their needings in the case of residential customers. The subscribers using electricity for agricultural irrigation do not want to make payment for their usage. On the other side they get incentives for their agricultural activities from the ministery of agriculture. The company developed a new methodology to force this kind of consumers to make their payment by blocking their incentive accounts. Therefore, they are not able to withdraw incentive money from bank and they choose the way of aggrement with utility company. This methodology can be used for other segment of customers.

3.2.2 Theft Detection

The investigations are done according to indications provided by different sources. The best source in theft detection is the system equipped with meters in all segments of the network. This would provide the data in which phase and in which area how much energy is lost. Therefore, the operations would be directed to those zones.

The loss control teams take statement about the detected loss in their investigation and the accrual team prepares invoice for illegal use. Some of the people accepts the invoice and pay it, some of them do not accept it with the reasons stated in collection. After a period of time the theft detected users tend again using electricity in fraudulent ways by tampering lines or meters. The motivation behind this behavior is evaluated as the company would never come back to their location again which they have been used to. The company should endeavor again and again to normalize the consumption in that places. However the reasons depending on political argumentations, inadequate security support and legal sanctions hardens the normalization of the consumption.

More frequently control of meters even like reading means more data to analyze the customer behavior. Therefore, being insistive on reading every meter on a monthly time interval is strategic principle of the company. The data provided by meters allows to detect theft usage which are not detected by physical manuel controls.

The company is aware of being insistive on theft detection. They use intelligent ways to imrpove the performance of work force in the field. The data provided by meters and the historic background of the consumption points are the raw materials of their algorithm to operate in efficient way.

Utility sector can be seen as data pool which is getting bigger day by day. The sector needs proposals developed by compiling this data. The company is aware of this opportunity and they are making investments on this area. The analysts develop work orders for the collegues in the field. They make comparisons between the customers expected to present same behavior in consumption. At the same time, they combine these data with the data acquired from meters as the body coverage opened, the meter is exposed to extra magnetic field, connector coverage opened and the data provided from customer relationship management side as the subscriber captured while consuming in fraudulent ways in its history.

Advanced metering infrastructures provide raw data to develop well pointed actions. The suspicious consumers are being determined in back offices. This methodology helps to company to control its workers. Some employees may be in immoral relations with the customers. If an employee can not detect fraud in the areas of having high probability for theft, they send another team to the field. Determining targets of theft controls plays crucial role in these activities.

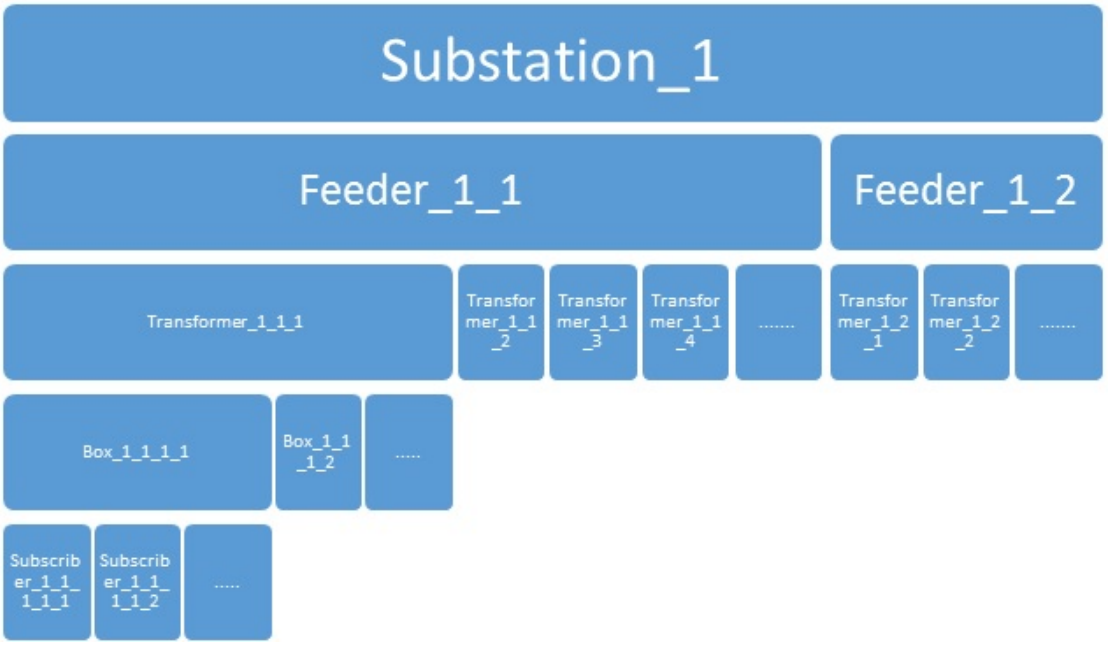

Figure 3.12: Segments of Electricity Network

Company is aware of the importance equipping the network with meters in each segment of the network for this purpose. On the other hand, the topology of the network which shows the place of each consumers in the network. By making comparisons on each segment of the network with the real consumption data and accrual data of the customers connected to that segment of the network. The difference between the consuption and accrual is the target of losses control team in the location of related segment. The analysis of the analyze team would make the workers job easier.

The metering equipments requires finance to make their investment. Dicle developed pilot projects on different segments. In Suruc, they started consolidating meters in boxes. A group of meters in the same neighborhood of consumption points are consolidated in a panel. The incoming energy into that panel is metered by a main meter and it dissipates energy to other meters. The measurement in a given time interval should be same in main meter with the summation of measured consumption from the meters in the box feeding consumers. When a difference occurs it shows an attempt to tamper. This approach can be used for energy accounting at each level of network from substation to subscribers.

3.3 What should be done to improve the projects

The activities in the electricity sector have to obey the rules stated in the related regulations published by EMRA. Loss reduction projects conducted by companies should result in the invoicing the total consumption and collecting them. During the projects, companies may face with unclear, inadequate points in the regulations which congest the system from invoicing to collecting.

Electricity distribution work can be seen as simple buy and sell trade. The amount of flows are monitored by meters and invoicing mechanishm works on them. However, it may be intricate when it is done on the areas having political and sociological debates. Regulational improvements are expected to lead the way to accomplish loss problem.

The transformation of markets from public ownership to private sector brings dynamizm to market. Therefore, the actions in the market changes with different approaches which the market athmoshphere is not used to. Each action has reflection as reaction from the related market participants. The reaction to the actions conducted buy companies gives information about the effects and deficient parts of them in reaching the ultimate goal of invoicing all consumption and collecting them. Regulation should be amended with respect to the needings after the experiences of private sector in distribution system.

The regulator has the responsibility to protect citizens interest and provide fair market conditions. Improving the rules in mitigating electricity losses should be the main subject of the regulator. In this aspect, the experiences of the private investors who have taken place in distribution sector is important for regulator. EMRA should approach this approaches as constructive arguments in reducing losses.

The projects starts with detection of losses in the system. The detected losses should be result in the transformation of consumers to the legal consumption. In the optimistic case, electricity meters are installed each consumption points and the customers do not temper meters or the network. Reaching this case is possible if the security of electricity meters and network are provided by the governors. The socio-politic side of theft problem do not allow to activate in this optimistic conditions. The ways which would make theft detection process easier can be stated as follows:

- The regulator should force distribution companies to install smart metering system. It will enable companies to control the flow of the consumption and detect the losses in the system with location. The clearity of detection would determine the type of sanction mechanism.
  - The regulation should enable companies punishing directly to the customer who is suspected because of the reasons grounding on quantifiable objective values.
  - If the company determine only the amount and the addressee of the theft consumption, there are different alternatives which can be implemented to record the consumption and collecting it. Some of them may be listed as following items:
    * The regulator should give opportunity to impose sanction on a group of customers in the suspected regions. It is expected that this argument would provide chance to transform customers who tends fraudulent ways in consumption with the pressure of their community. In other words, community would force its neighborhood not to thieve energy. Experiences in India witnessed the benefits of this application.
    * Regulator should develop the medium to access the data recorded in the governmental data warehouse which are related to the consumption of electricity. The type of the data changes with the type of subscribers. This action would give opportunity to the governors to control the correctness of the data in their system.
- Industrial consumers have to certificate their operation to be able to benefit from incentives provided by the government. Installed capacity for industrial establishments are known and the productions of them are known according to financial statements of them.
- Taking the usage under control in agricultural areas for irrigation is hard problem if the area owners do not allow you to make investigations in their zone.
- The invoices issued to the subscribers should result in the paymet of them on time. Taking the consumption under record is the first step of the loss reduction projects. After that the second steps starts to collect the money invoiced. Measuring the consumption amount without any loss is not the ultimate solution. The measurement

must turn into cash. The cities in the region are at the bottom of economic level ranking of the cities in the country. The governments have supporting programs for the people who have low income level. The subsidies may be paid by checking related person's status in the distribution network. In the progress of appeal to those programs the decleration of electricity subscription details should be inserted to documents that are obligatory to present. In this way, it would be a deterrent way from tending fraudulent ways. Until a determined level of electricity subsidy may provided to those kind of customer. On the other hand, the subscribers occupied with economic activities as commercial, industrial, agricultutal. They have to be registrated to the financial system of the country. The ones who do not allow measuring their meter via automatic meter reading systems, making control in their location and not sharing their real data should be faced with sanctions. If they reject to pay their invoices, their activities may be blocked.

Chapter 4

Conclusion

The Inter-American Development Bank states electricity loss as performance indicator for efficiency and financial sustainability in the power sector[47] in the Power Loss report. Utilities operation may be evaluated as a chain. They get energy from generation companies and sell it to their subscribers. They have to sustain their network and have to make investment for that aim. Financial structure of electricity is designed as collection of money from subscribers and allocating the money for companies managerial and investment needings. The losses in power sector is the breaking point of this chain which should be solved with persistent methodologies.

In Turkey, tariffs for electricity utilities are being designed as considering loss ratios until the levels which regulator determine. The budget deficit in the companies facing losses are subsidized with this way. If a loss more than envisaged level occurs in the system, utility is exposed to a financial burden and it directly affects it survival. The financials of utility companies get better and companies find sources easily to improve their operation with new investments when the loss ratio decreases and collection ratio increases. Otherwise companies could not make investments even necessary for loss reduction projects.

The people who use electricity in a fraudulent way are not interested in the cost of it. Therefore, they exibit over-consumption and do not be as conservative as the people who do not steal energy. The level of loss ratio directly affects electricity tariffs and honest consumers have to pay more. This situation creates unfair market conditions for consumers. This reality increases the responsibility of regulator to force regions with high loss ratios to mitigate them.

The action plan should be developed with respect to the diagnosis of electricity usage to detect who will be the stakeholders of the projects. Special project should be designed with respect to the characteristic of the usage. Knowing who is using energy for which aim and when is the key of developing the project. The key opens the door of operation alternatives.

The main methodology for loss reduction projects is measuring, analyzing and developing the project with the purpose emerged from the analysis. After detection of losses the companies expect to transform consumer to behave in legal ways. The companies should insist on this aim. On the other side, the people who do not scare of the legal sanctions insist on their fault. The governors should provide security support to combat with these kind of mankind and the sanctions should be tightened to deter consumers tending to illegal ways in utilizing electricity.

The puropose behind the privatization in distribution sector is increasing efficiency and effectiveness in the management and investment. The priority of investment alternatives are changing from region to region with respect to the main problems in the regions. The regions who has low loss ratio prefer to make investment on renewing the infrastructure to increase customer satisfaction. On the other side the regions like Dicle, Vangöü, Aras have to focus on loss reduction projects. The succes in these projects is expected to trigger the investment for renewal of the networks.

The losses reduction projects should be based on the metering values. These regions should be equipped with meters at each level of the grid. After investing on metering, the security of these meters have to be maintained by the government. These would provide the opportunity to operate with the acceleration provided by the data acquired from the network.

Companies face with different scenarios during the implementation of projects such as not allowing to install metering on distribution lines, being insistive on fraudulent ways. There should be an institution playing mediator role in solving the problem related to argumentations in electricity consumption for each event; the companies should be able to notify problem with providing objective indications for theft consumption and collection of invoices and the consumers should be able to notify problem in which they do not accept the consumption written in their invoices. The sanctions should be imposed to

the guilty part. The action alternatives may be detailed by this mediator as defining which suspicion can be investigated in which methodology.

The recommendations for the future of losses problem may be summerized as follows:

- The loss targets for the regions should be realistic.
- Governmental institutios should share the information that may be useful for theft detection, such as the capacities of industries.
- Legal amendments deterrent for fraudulent users should be done.
- Investments for metering systems should be supported.
- Security support should be provided for metering systems.
- Security support shuold be provided for the activities in the field.
- Coordination with institutions should be provided for blocking the activities of fraudulent users and the consumers having non-payment habit.
- Social support projects should be designed for the people with low income level.

Appendix A

Annual Development of Number of Subscribers In Cities

Source:[41]

Table A.1: Annual Development of Number of Subscribers In Cities

City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Diyarbakır	295.224	280.554	308.107	308.230	346.550	363.130	385.953	395.855	412.281	435.999
Mardin	137.214	136.575	139.712	147.150	155.880	163.286	172.403	181.980	191.037	211.675
Siirt	52.006	52.623	56.168	57.911	60.836	63.160	66.457	69.761	72.254	77.227
Ş anlıurfa	281.338	285.792	287.731	295.196	316.704	332.914	352.271	372.839	392.258	472.159
Batman	89.703	93.363	97.899	100.508	105.154	112.856	118.788	122.928	130.742	145.380
Şırnak	50.880	49.419	55.155	56.666	61.394	65.408	70.052	77.372	83.028	90.608
DİCLE EPSAŞ	**906.365**	**898.326**	**944.772**	**965.661**	**1.046.518**	**1.100.754**	**1.165.924**	**1.220.735**	**1.281.600**	**1.433.048**
Bitlis	64.847	66.944	68.539	70.694	67.254	75.713	79.339	82.189	85.504	87.904
Hakkari	36.031	37.395	38.845	40.750	42.301	44.478	47.023	49.577	51.871	54.361
Muş	76.612	80.066	81.815	83.810	86.045	88.961	92.639	96.518	100.546	103.079
Van	172.747	176.347	186.568	195.735	207.374	199.468	226.683	230.462	251.544	270.005
VANGÖLÜ EPSAŞ	**350.237**	**360.752**	**375.767**	**390.989**	**402.974**	**408.620**	**445.684**	**458.746**	**489.465**	**515.349**
Ağrı	99.602	105.033	107.366	110.602	115.233	120.332	125.153	130.412	133.794	139.121
Erzincan	107.462	108.885	111.553	113.112	115.750	118.727	121.461	124.403	126.688	128.678
Erzurum	252.653	258.405	264.948	269.274	276.042	282.739	291.266	300.239	308.486	317.227
Kars	77.760	81.436	85.167	86.372	90.207	92.359	94.925	97.327	99.643	101.483
Bayburt	33.139	34.269	34.858	35.388	36.185	37.306	38.459	39.582	40.827	42.237
Ardahan	38.080	38.735	39.633	40.109	40.175	42.257	43.292	44.956	46.997	48.272
Iğdır	45.282	46.779	47.821	49.698	51.559	53.478	55.459	57.258	58.734	60.405
ARAS EPSAŞ	**653.978**	**673.542**	**691.346**	**704.555**	**725.151**	**747.198**	**770.015**	**794.177**	**815.169**	**837.423**
Artvin	88.842	90.070	94.169	93.187	95.416	98.091	100.726	109.371	106.358	108.534

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Giresun	220.777	223.979	230.508	234.180	235.759	239.743	257.344	266.645	273.263	281.531
Gümüşhane	65.103	64.713	65.678	67.197	69.193	71.125	73.623	75.675	77.857	80.409
Rize	169.702	176.194	178.927	181.417	186.209	189.746	198.578	204.178	209.029	214.595
Trabzon	360.770	371.763	381.228	391.365	401.649	418.850	428.523	448.111	463.423	480.204
ÇORUH EPSAŞ	**905.194**	**926.719**	**950.510**	**967.346**	**988.226**	**1.017.555**	**1.058.794**	**1.103.980**	**1.129.930**	**1.165.273**
Bingöl	68.577	71.445	74.782	76.767	78.947	81.619	85.019	87.210	91.135	96.490
Elazığ	210.616	215.130	231.270	235.495	236.671	243.847	247.405	262.987	274.362	282.158
Malatya	271.089	275.299	285.903	292.216	301.797	311.804	322.348	338.401	349.980	364.833
Tunceli	38.279	38.620	38.280	40.844	42.074	42.967	44.363	45.793	47.486	53.090
FIRAT EPSAŞ	**588.561**	**600.494**	**630.235**	**645.322**	**659.489**	**680.237**	**699.135**	**734.391**	**762.963**	**796.571**
Sivas	250.032	255.898	269.265	276.368	284.943	287.847	285.185	278.320	280.802	281.909
Tokat	225.382	229.280	236.061	241.066	250.526	255.882	248.351	237.931	249.131	260.450
Yozgat	194.251	196.122	200.541	204.536	199.199	202.273	206.081	193.539	193.589	192.749
ÇAMLIBEL EPSAŞ	**669.665**	**681.300**	**705.867**	**721.970**	**734.668**	**746.002**	**739.617**	**709.790**	**723.522**	**735.108**
Adana	676.108	691.389	754.259	707.488	723.348	759.899	767.117	781.106	793.364	858.850
Gaziantep	411.190	402.753	422.632	432.705	447.948	485.524	503.939	521.544	534.456	571.535
Hatay	533.848	537.107	480.138	490.855	509.617	537.268	552.460	573.692	594.777	595.285
Mersin	637.284	646.992	667.069	685.461	718.055	748.148	773.441	778.091	800.190	822.935
Kilis	39.950	41.553	42.300	41.110	42.883	45.399	46.588	48.039	49.313	50.550
Osmaniye	142.628	146.265	149.967	151.109	155.504	165.881	171.806	176.158	180.429	184.902
TOROSLAR EPSAŞ	**2.441.008**	**2.466.059**	**2.516.365**	**2.508.728**	**2.597.355**	**2.742.119**	**2.815.351**	**2.878.630**	**2.952.529**	**3.084.057**
Kırşehir	100.686	101.280	103.651	104.886	105.814	109.003	115.096	119.363	122.938	125.675

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Konya	762.486	782.864	807.465	829.356	856.740	887.318	922.988	929.102	971.740	985.103
Nevşehir	136.480	136.973	139.928	140.366	145.545	149.385	151.841	155.821	161.692	165.577
Niğde	141.726	145.423	149.300	153.742	157.815	162.123	162.395	167.334	176.429	176.557
Aksaray	138.668	139.758	143.413	145.765	151.216	157.167	160.110	171.510	176.194	175.170
Karaman	99.604	102.689	106.158	108.621	113.379	117.145	120.841	124.622	128.213	130.748
MERAM EPSAŞ	**1.379.650**	**1.408.987**	**1.449.915**	**1.482.736**	**1.530.509**	**1.582.141**	**1.633.271**	**1.667.752**	**1.737.206**	**1.758.830**
Ankara	1.707.305	1.809.469	1.889.190	1.975.083	2.075.397	2.157.020	2.239.865	2.369.560	2.460.950	2.260.983
Çankırı	87.268	89.980	90.435	92.531	97.190	99.481	102.291	106.296	108.175	105.932
Kastamonu	198.692	205.160	210.685	216.418	223.248	228.360	234.001	240.046	244.886	242.363
Zonguldak	295.175	304.145	309.848	316.267	325.433	331.574	339.481	347.297	353.724	332.624
Kırıkkale	115.090	117.750	119.930	118.933	121.703	126.727	129.245	131.749	134.292	127.712
Bartın	99.816	102.147	103.849	106.082	109.839	111.797	114.314	117.331	119.578	114.583
Karabük	118.935	121.765	123.731	126.066	126.060	130.446	132.954	136.178	139.329	128.960
BAŞKENT EPSAŞ	**2.622.281**	**2.750.416**	**2.847.668**	**2.951.380**	**3.078.870**	**3.185.405**	**3.292.151**	**3.448.457**	**3.560.934**	**3.313.157**
Antalya	890.774	947.574	1.003.552	1.053.230	1.116.642	1.180.664	1.233.914	1.289.055	1.337.139	1.278.836
Burdur	125.684	127.840	130.544	133.568	138.037	141.696	143.518	146.921	149.464	151.816
Isparta	195.734	198.999	204.153	209.028	215.115	227.666	233.668	240.570	245.916	240.319
AKDENİZ EPSAŞ	**1.212.192**	**1.274.413**	**1.338.249**	**1.395.826**	**1.469.794**	**1.550.026**	**1.611.100**	**1.676.546**	**1.732.519**	**1.670.971**
İzmir	1.600.602	1.652.398	1.641.311	1.682.808	1.738.406	1.803.002	1.841.346	1.886.020	1.924.136	2.031.838
Manisa	545.171	559.787	600.342	604.671	606.154	586.836	597.505	602.417	609.000	634.367
GEDİZ EPSAŞ	**2.145.773**	**2.212.185**	**2.241.653**	**2.287.479**	**2.344.560**	**2.389.838**	**2.438.851**	**2.488.437**	**2.533.136**	**2.666.205**
Balıkesir	654.136	643.591	692.522	703.913	723.518	748.008	752.017	716.009	637.438	746.753

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bursa	1.026.106	1.039.310	1.072.562	1.102.246	1.139.909	1.214.431	1.246.499	1.282.101	1.134.542	1.216.832
Çanakkale	246.758	248.144	261.821	269.761	278.428	285.530	297.195	307.212	255.435	286.530
Yalova	125.207	127.731	129.127	133.900	136.619	140.452	141.877	139.795	126.063	142.994
ULUDAĞ EPSAŞ	**2.052.207**	**2.058.776**	**2.156.032**	**2.209.820**	**2.278.474**	**2.388.421**	**2.437.588**	**2.445.117**	**2.153.478**	**2.393.109**
Edirne	195.688	199.023	204.429	197.350	202.492	209.166	215.319	220.771	228.009	235.112
Kırklareli	162.092	166.228	168.519	171.624	176.410	180.922	186.067	191.337	196.579	202.499
Tekirdağ	341.518	349.621	361.320	372.065	388.856	402.678	420.637	437.606	464.058	490.930
TRAKYA EPSAŞ	**699.298**	**714.872**	**734.268**	**741.039**	**767.758**	**792.766**	**822.023**	**849.714**	**888.646**	**928.541**
AESAS	**1.823.283**	**1.854.834**	**1.911.150**	**1.977.120**	**2.102.234**	**2.242.140**	**2.309.764**	**2.388.702**	**2.464.549**	**2.298.764**
Bolu	137.099	148.114	149.040	137.455	141.686	145.450	148.979	143.369	144.808	149.024
Kocaeli	607.496	640.251	644.514	646.629	654.196	672.835	710.659	740.689	738.813	775.622
Sakarya	334.031	343.060	377.901	353.333	370.843	382.004	396.077	400.879	389.654	407.131
Dü zce	127.551	128.953	147.066	135.943	141.257	146.348	152.452	150.579	149.908	155.608
SakaryaEPSAŞ	**1.206.177**	**1.260.378**	**1.318.521**	**1.273.360**	**1.307.982**	**1.346.637**	**1.408.167**	**1.435.516**	**1.423.183**	**1.487.385**
Afyonkarahisar	278.119	285.251	293.609	298.775	302.050	304.548	310.422	316.978	324.549	377.277
Bilecik	90.141	91.312	94.312	96.514	99.695	103.156	105.983	110.016	113.770	117.184
Eskişehir	323.316	354.196	366.839	378.022	395.926	412.861	430.840	445.620	459.756	483.136
Kütahya	266.290	272.295	295.524	300.851	308.290	315.117	320.309	305.750	313.720	345.805
Uşak	155.765	158.174	161.535	165.516	170.778	175.585	180.251	184.558	188.586	192.457
OSMANGAZİ EPSAŞ	**1.113.631**	**1.161.228**	**1.211.819**	**1.239.678**	**1.276.739**	**1.311.267**	**1.347.805**	**1.362.922**	**1.400.381**	**1.515.859**
BOĞAZİÇİ EPSAŞ	**3.435.261**	**3.521.874**	**3.607.318**	**3.719.089**	**3.832.824**	**3.954.871**	**4.072.336**	**4.202.132**	**4.326.314**	**4.464.469**
KEPSAŞ	**457.909**	**467.303**	**480.074**	**495.379**	**521.453**	**543.670**	**562.263**	**578.438**	**593.670**	**609.880**

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City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Aydın	462.449	474.908	494.233	516.666	541.223	551.119	547.314	558.954	573.294	596.585
Denizli	434.152	447.543	451.860	464.014	484.322	483.786	479.582	494.175	515.632	533.557
Muğla	410.343	423.702	441.721	460.156	482.691	499.645	488.573	502.295	519.276	538.610
AYDEM EPSAŞ	**1.306.944**	**1.346.153**	**1.387.814**	**1.440.836**	**1.508.236**	**1.534.550**	**1.515.469**	**1.555.424**	**1.608.202**	**1.668.752**
Adıyaman	138.077	139.680	146.708	149.795	157.491	157.935	172.131	171.252	176.695	182.176
Kahramanmaraş	292.683	297.168	306.699	316.162	329.965	339.368	366.745	353.720	362.289	407.975
AKEDAŞ EPSAŞ	**430.760**	**436.848**	**453.407**	**465.957**	**487.456**	**497.303**	**538.876**	**524.972**	**538.984**	**590.151**
Amasya	141.215	144.138	148.054	149.892	153.723	157.843	161.484	165.211	170.843	177.355
Çorum	238.225	243.147	248.583	245.425	253.034	259.831	265.938	275.716	295.170	307.089
Ordu	307.428	309.927	340.862	344.748	355.960	364.513	376.639	387.373	425.396	402.948
Samsun	510.297	549.876	562.289	572.921	590.760	609.523	626.909	646.670	665.906	694.037
Sinop	112.802	117.359	119.789	122.490	125.834	129.472	133.034	135.715	140.441	144.736
YEŞİLIRMAK EPSAŞ	**1.309.967**	**1.364.447**	**1.419.577**	**1.435.476**	**1.479.311**	**1.521.182**	**1.564.004**	**1.610.685**	**1.697.756**	**1.726.165**
Total	27.710.341	28.439.906	29.372.327	30.019.746	31.140.581	24.090.299	33.248.188	34.135.263	34.814.136	35.659.067

Appendix B

Annual Development of Consumption (MWh) In Cities

Source:[41]

Table B.1: Annual Development of Consumption (MWh) In Cities

City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Diyarbakır	2.933.912	3.079.041	3.008.516	3.317.277	3.613.663	3.786.313	4.114.563	4.787.423	4.938.753	5.220.243
Mardin	2.021.506	2.300.326	2.280.396	2.574.872	3.139.826	3.569.516	3.850.517	4.033.923	4.505.168	4.500.238
Siirt	404.758	415.729	412.239	469.662	489.282	523.760	535.343	627.115	620.166	656.532
Ş anlıurfa	3.445.583	3.884.229	4.037.402	4.308.220	5.114.860	5.234.059	5.560.630	6.462.968	6.915.779	7.652.053
Batman	952.985	1.015.267	940.057	1.067.951	1.175.611	1.278.667	1.315.168	1.576.889	1.643.685	1.769.663
Şırnak	802.825	596.486	622.295	906.478	1.056.094	1.139.250	1.222.970	1.363.860	1.410.655	1.414.193
DİCLE EDAŞ	**10.545.044**	**11.292.711**	**11.302.239**	**12.644.503**	**14.588.507**	**15.532.242**	**16.604.545**	**18.973.143**	**20.119.425**	**21.353.355**
Bitlis	263.244	277.402	269.659	319.573	351.030	391.670	401.502	517.744	486.610	534.895
Hakkari	284.914	303.843	341.398	388.390	422.742	468.061	493.140	572.290	599.263	638.203
Muş	402.075	392.808	357.583	450.913	471.179	577.886	695.812	695.578	755.669	616.092
Van	1.031.720	1.058.603	1.150.860	1.154.471	1.358.281	1.517.847	1.596.788	1.798.243	2.096.909	2.174.806
VANGÖLÜ EDAŞ	**1.984.103**	**2.034.819**	**2.120.366**	**2.313.412**	**2.603.949**	**2.956.505**	**3.188.828**	**3.580.096**	**3.937.207**	**4.058.211**
Ağrı	467.650	509.444	506.585	537.900	589.694	647.370	667.682	756.380	772.886	830.164
Erzincan	175.549	186.175	201.767	212.041	230.346	254.747	279.149	324.853	341.125	340.918
Erzurum	777.337	807.604	839.476	909.872	991.741	994.351	1.059.516	1.143.161	1.142.290	1.191.902
Kars	294.854	295.798	303.827	318.520	331.434	334.126	341.343	368.149	359.287	378.750
Bayburt	49.224	53.710	60.513	62.039	66.247	66.841	78.154	86.234	82.461	92.407
Ardahan	68.445	68.564	73.429	76.840	81.990	85.370	90.286	101.430	106.562	110.937
Iğdır	161.696	157.080	135.436	157.976	167.183	174.675	176.686	196.091	200.349	206.029
ARAS EDAŞ	**2.002.295**	**2.086.945**	**2.129.617**	**2.288.023**	**2.481.834**	**2.584.980**	**2.730.247**	**3.023.523**	**3.040.505**	**3.179.549**
Artvin	188.091	202.290	230.072	280.465	306.019	294.961	336.236	367.465	367.611	381.473
Giresun	355.379	404.904	436.328	472.729	480.662	498.305	554.622	612.470	615.198	607.192
Gümüşhane	75.780	80.920	90.991	99.281	105.210	137.962	170.753	198.733	230.905	293.053
Rize	429.893	472.520	508.802	549.933	579.377	672.947	612.712	658.049	658.870	660.129
Trabzon	712.731	787.482	876.449	1.003.334	1.080.974	1.090.747	1.174.275	1.343.425	1.362.700	1.393.531

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ÇORUH EDAŞ	**1.761.874**	**1.948.192**	**2.142.574**	**2.405.597**	**2.551.923**	**2.698.315**	**2.847.479**	**3.179.396**	**3.235.302**	**3.335.241**
Bingöl	142.427	153.903	154.562	172.933	173.288	189.693	205.651	229.096	240.861	253.951
Elazığ	683.181	674.908	827.771	913.474	977.495	909.164	1.017.145	1.230.339	1.229.077	1.471.627
Malatya	971.516	1.064.026	1.148.138	1.241.277	1.184.910	1.196.216	1.309.155	1.345.904	1.442.638	1.538.363
Tunceli	66.554	70.177	75.832	81.483	90.426	92.522	96.026	106.071	111.341	128.911
FIRAT EDAŞ	**1.865.022**	**1.964.265**	**2.206.907**	**2.409.709**	**2.426.108**	**2.387.398**	**2.630.530**	**2.917.146**	**3.023.637**	**3.389.973**
Sivas	603.908	781.116	894.520	1.045.626	1.058.938	1.115.608	1.193.531	1.241.315	1.239.557	1.302.703
Tokat	469.890	493.302	520.361	573.535	679.206	684.364	670.825	717.950	808.962	779.321
Yozgat	481.423	505.885	551.534	588.859	598.173	581.563	565.620	645.405	668.147	668.507
ÇAMLIBEL EDAŞ	**1.554.264**	**1.779.081**	**1.965.559**	**2.207.184**	**2.335.548**	**2.380.686**	**2.429.270**	**2.605.376**	**2.714.575**	**2.748.918**
Adana	4.183.206	4.325.890	4.315.076	4.535.539	4.481.303	4.221.595	4.374.726	5.534.413	5.802.299	5.700.801
Gaziantep	3.537.976	3.766.174	3.982.478	4.282.215	4.231.759	4.208.586	4.539.776	4.879.657	5.730.682	5.901.264
Hatay	3.277.831	3.676.878	3.984.484	4.507.530	4.981.620	5.295.109	5.490.758	5.796.945	6.636.848	7.830.111
Mersin	2.723.959	2.858.133	3.077.401	3.183.433	3.343.325	3.165.079	3.453.002	3.857.329	4.034.053	4.323.277
Kilis	92.334	92.167	97.929	104.301	121.096	131.214	138.943	154.681	177.448	218.510
Osmaniye	276.838	294.479	357.749	461.129	672.719	976.835	1.229.554	2.688.766	2.952.583	2.883.828
TOROSLAR EDAŞ	**14.156.880**	**15.037.532**	**15.821.673**	**17.075.541**	**17.845.642**	**18.018.084**	**19.215.308**	**22.943.434**	**25.302.421**	**26.527.759**
Kırşehir	230.354	260.816	286.732	293.821	325.395	330.237	395.328	410.969	429.373	395.767
Konya	3.674.522	4.013.250	4.605.204	4.929.123	4.999.589	4.301.989	5.288.800	5.467.791	5.796.640	5.899.596
Nevşehir	513.390	481.959	543.198	576.703	600.828	561.308	607.939	635.642	659.825	646.106
Niğde	619.466	666.098	759.442	807.953	798.199	760.426	830.968	869.377	976.182	1.000.670
Aksaray	325.835	348.544	406.101	458.602	518.101	526.323	623.202	629.336	713.916	753.179
Karaman	314.352	373.396	391.052	454.163	503.654	500.436	529.026	540.688	631.261	674.276
MERAM EDAŞ	**5.669.298**	**6.160.214**	**6.999.425**	**7.521.670**	**7.745.364**	**6.977.045**	**8.268.476**	**8.563.732**	**9.213.998**	**9.373.606**
Ankara	7.178.306	7.482.550	8.108.577	8.896.570	9.428.335	9.431.237	10.409.595	11.468.507	11.581.879	11.605.128
Çankırı	167.100	183.074	211.029	226.505	245.913	230.694	269.750	324.042	449.024	377.864

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Kastamonu	412.708	459.483	485.527	531.545	625.997	657.667	688.352	709.635	733.419	775.170
Zonguldak	2.497.580	2.579.567	2.662.851	2.701.908	2.675.399	2.815.627	2.906.277	3.039.762	3.043.855	2.990.715
Kırıkkale	407.803	419.756	445.079	469.061	541.488	565.832	572.175	629.571	613.744	618.716
Bartın	210.502	234.523	245.265	266.103	278.404	278.404	310.198	344.629	384.872	446.148
Karabük	579.231	628.362	688.976	720.898	748.225	771.531	802.761	929.193	1.046.160	1.133.601
BAŞKENT EDAŞ	**11.455.985**	**11.986.180**	**12.820.478**	**13.770.822**	**14.543.756**	**14.712.215**	**15.890.416**	**17.406.407**	**17.799.976**	**17.917.401**
Antalya	3.685.386	4.167.258	4.254.648	5.111.793	5.374.586	5.209.072	5.899.505	6.974.402	6.953.920	7.004.216
Burdur	281.254	371.132	399.384	537.176	915.502	1.032.249	800.153	745.542	812.557	743.314
Isparta	806.959	833.568	708.285	859.332	1.003.783	1.007.783	924.218	1.006.820	1.077.089	1.170.881
AKDENİZ EDAŞ	**4.780.007**	**5.374.707**	**5.362.158**	**6.506.141**	**7.305.625**	**7.265.499**	**7.606.065**	**8.711.403**	**8.857.710**	**8.926.917**
İzmir	12.225.716	12.665.847	14.423.485	16.951.987	16.769.537	14.556.137	16.113.179	17.820.021	18.429.321	18.683.717
Manisa	2.023.313	2.153.176	2.468.169	2.781.558	2.874.915	2.573.647	3.143.059	3.536.287	3.813.206	4.100.836
GEDİZ EDAŞ	**14.247.917**	**14.821.758**	**16.890.207**	**19.733.255**	**19.644.616**	**17.128.505**	**19.256.030**	**21.359.298**	**22.256.770**	**22.793.467**
Balıkesir	1.602.593	1.891.927	2.080.518	2.271.743	2.319.273	2.344.313	2.619.307	2.749.112	2.929.961	2.834.285
Bursa	7.933.194	7.979.697	8.399.051	8.036.894	8.454.348	8.110.092	9.214.106	9.993.558	9.791.448	9.962.340
Çanakkale	2.093.124	2.276.686	2.534.508	2.878.237	2.541.169	3.078.027	3.580.507	3.991.794	4.491.018	4.519.831
Yalova	880.494	984.030	885.928	820.817	794.808	568.437	832.985	994.200	986.235	948.328
ULUDAĞ EDAŞ	**12.532.727**	**13.112.075**	**13.888.065**	**13.953.053**	**14.118.523**	**14.115.232**	**16.262.767**	**17.754.678**	**18.262.276**	**18.249.619**
Edirne	736.177	834.367	904.042	958.692	947.089	983.128	1.090.480	1.133.336	1.166.882	1.142.254
Kırklareli	1.608.212	1.458.953	1.656.411	1.906.652	1.819.946	1.690.837	1.683.271	1.808.678	1.967.237	2.099.422
Tekirdağ	3.916.617	4.347.042	5.080.751	5.239.116	5.154.255	5.000.116	5.701.239	6.172.940	6.291.749	5.933.989
TRAKYA EDAŞ	**6.253.233**	**6.633.596**	**7.635.395**	**8.116.651**	**7.928.349**	**7.681.743**	**8.483.666**	**9.092.924**	**9.417.006**	**9.180.637**
AYEDAŞ	**6.852.471**	**7.447.495**	**8.413.331**	**9.442.704**	**9.861.127**	**9.861.460**	**10.455.942**	**11.223.492**	**11.218.342**	**11.716.885**
Bolu	592.225	656.655	682.422	730.939	795.585	778.223	830.860	906.493	948.088	1.022.205
Kocaeli	8.731.093	9.380.160	9.507.841	10.072.298	10.668.385	10.732.378	11.389.085	12.540.688	12.569.863	13.068.798
Sakarya	1.380.869	1.647.421	1.728.953	1.964.607	2.127.507	1.974.675	2.277.241	2.463.869	2.634.408	3.016.893

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Dü zce	439.681	521.222	572.094	625.416	676.656	703.535	788.645	863.958	900.448	958.471
SakaryaEDAŞ	**11.157.559**	**12.198.153**	**12.528.387**	**13.439.777**	**14.298.934**	**14.232.510**	**15.395.331**	**16.808.248**	**17.170.878**	**18.093.107**
Afyonkarahisar	765.211	876.737	964.182	1.071.197	1.131.089	1.078.065	1.205.004	1.299.936	1.416.258	1.532.632
Bilecik	1.716.983	1.258.464	1.103.201	1.250.010	990.676	1.024.217	1.199.334	1.343.859	1.245.800	1.381.528
Eskişehir	1.569.249	1.601.055	1.747.731	1.855.598	1.958.749	1.885.408	2.168.687	2.339.382	2.545.237	2.790.062
Kütahya	718.992	799.860	889.348	935.214	1.010.651	1.058.255	1.234.975	1.400.825	1.462.043	1.445.959
Uşak	717.470	740.800	811.846	886.418	912.676	913.997	972.763	1.041.467	1.093.365	1.195.036
OSMANGAZİ EDAŞ	**5.523.123**	**5.272.884**	**5.504.061**	**5.996.972**	**5.998.545**	**5.951.097**	**6.772.920**	**7.423.683**	**7.747.663**	**8.364.643**
BOĞAZİÇİ EDAŞ	**17.999.001**	**19.774.582**	**20.740.276**	**22.794.925**	**23.585.800**	**22.168.849**	**23.333.404**	**25.693.693**	**25.291.674**	**25.633.036**
KAYSERI ELEKTRİK	**1.944.494**	**2.302.363**	**2.449.880**	**2.537.031**	**2.503.646**	**2.443.489**	**3.042.144**	**3.109.945**	**3.117.468**	**3.195.744**
Aydın	1.321.919	1.478.704	1.612.316	1.812.509	1.843.594	1.746.303	1.882.354	2.094.871	2.243.359	2.287.582
Denizli	2.127.157	2.227.824	2.233.008	2.590.852	2.496.210	2.338.036	2.590.645	2.823.864	3.052.883	3.193.822
Muğla	1.941.317	1.925.124	1.979.555	2.078.453	2.122.695	2.071.588	2.241.577	2.466.732	2.632.190	2.665.407
AYDEM EDAŞ	**5.413.353**	**5.654.886**	**5.834.694**	**6.487.681**	**6.471.486**	**6.157.620**	**6.739.890**	**7.400.921**	**7.944.052**	**8.166.255**
Adıyaman	720.372	805.753	867.443	937.564	919.534	902.304	977.653	1.007.360	1.079.064	1.112.467
Kahramanmaraş	2.114.908	2.291.872	2.409.866	2.502.191	2.689.839	2.989.187	3.229.849	3.236.933	3.352.575	3.674.903
AKEDAŞ	**2.845.494**	**3.101.729**	**3.278.265**	**3.440.160**	**3.609.489**	**3.891.532**	**4.207.692**	**4.245.377**	**4.437.638**	**4.788.263**
Amasya	367.667	383.974	420.563	464.625	482.121	485.082	512.660	547.588	567.982	582.112
Çorum	547.957	600.372	669.441	713.730	728.819	710.096	756.875	824.246	850.432	869.182
Ordu	677.550	744.439	826.848	904.296	940.795	948.740	1.028.767	1.094.619	1.132.378	1.148.216
Samsun	1.476.934	1.597.391	1.824.945	2.018.381	2.142.447	2.164.283	2.243.631	2.610.288	2.669.456	2.761.894
Sinop	183.716	200.842	224.902	249.913	258.389	272.385	315.524	359.058	340.224	334.148
YEŞİLIRMAK EDAŞ	**3.254.432**	**3.529.296**	**3.965.125**	**4.350.007**	**4.552.236**	**4.580.686**	**4.859.896**	**5.435.419**	**5.559.558**	**5.696.522**
Other	1.170.439	1.260.420	1.631.965	282.922	0	0	0	0	0	0

Appendix C

Annual Development of Loss Ratios In Cities

Source:[41]

Table C.1: Annual Development of Loss Ratios In Cities

City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Diyarbakır	62%	65%	56%	65%	65%	71%	71%	72%	73%	75%
Mardin	72%	76%	64%	79%	73%	79%	74%	76%	76%	84%
Siirt	38%	35%	32%	34%	39%	41%	43%	49%	41%	49%
Ş anlıurfa	58%	60%	59%	57%	59%	76%	55%	68%	64%	71%
Batman	66%	66%	55%	65%	67%	67%	64%	70%	70%	72%
Şırnak	71%	60%	61%	74%	71%	71%	77%	82%	79%	81%
DİCLE EDAŞ	**63%**	**64%**	**58%**	**65%**	**64%**	**73%**	**65%**	**71%**	**70%**	**75%**
Bitlis	62%	55%	46%	49%	45%	42%	46%	53%	46%	50%
Hakkari	67%	66%	66%	65%	64%	65%	75%	75%	71%	78%
Muş	56%	53%	52%	57%	53%	51%	57%	53%	54%	45%
Van	61%	66%	71%	55%	57%	58%	55%	44%	50%	68%
VANGÖLÜ EDAŞ	**61%**	**62%**	**64%**	**56%**	**56%**	**56%**	**57%**	**52%**	**53%**	**64%**
Ağrı	40%	51%	52%	56%	55%	56%	53%	54%	62%	69%
Erzincan	10%	9%	9%	7%	6%	6%	5%	6%	7%	9%
Erzurum	29%	25%	22%	21%	16%	16%	12%	12%	11%	25%
Kars	35%	30%	27%	25%	22%	23%	22%	26%	22%	29%

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bayburt	10%	13%	11%	9%	11%	8%	11%	12%	14%	18%
Ardahan	27%	22%	19%	17%	11%	11%	9%	9%	8%	15%
Iğdır	64%	40%	35%	31%	36%	38%	39%	38%	36%	34%
ARAS EDAŞ	**33%**	**32%**	**29%**	**29%**	**27%**	**28%**	**26%**	**26%**	**28%**	**36%**
Artvin	14%	22%	12%	13%	13%	17%	11%	13%	12%	12%
Giresun	15%	15%	11%	15%	12%	15%	19%	16%	14%	12%
Gümüşhane	16%	20%	15%	14%	14%	10%	10%	10%	6%	5%
Rize	12%	11%	10%	9%	7%	8%	6%	8%	7%	8%
Trabzon	13%	13%	14%	12%	11%	10%	12%	11%	10%	9%
ÇORUH EDAŞ	**13%**	**14%**	**12%**	**12%**	**11%**	**12%**	**12%**	**11%**	**10%**	**9%**
Bingöl	40%	44%	35%	35%	25%	26%	32%	33%	29%	23%
Elazığ	13%	11%	8%	8%	7%	10%	6%	6%	5%	3%
Malatya	13%	12%	11%	10%	11%	15%	14%	12%	12%	12%
Tunceli	16%	14%	13%	11%	11%	12%	16%	16%	13%	22%
FIRAT EDAŞ	**15%**	**14%**	**12%**	**11%**	**10%**	**14%**	**13%**	**11%**	**10%**	**10%**
Sivas	8%	7%	6%	6%	6%	6%	6%	7%	7%	6%
Tokat	15%	15%	12%	12%	11%	9%	6%	13%	10%	10%

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City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Yozgat	11%	11%	10%	10%	11%	10%	10%	10%	10%	9%
ÇAMLIBEL EDAŞ	**11%**	**10%**	**9%**	**9%**	**9%**	**8%**	**7%**	**9%**	**8%**	**8%**
Adana	11%	10%	9%	9%	8%	8%	8%	13%	11%	12%
Gaziantep	18%	12%	10%	10%	9%	8%	7%	8%	13%	15%
Hatay	15%	12%	10%	10%	8%	7%	8%	11%	15%	26%
Mersin	23%	20%	15%	12%	12%	11%	11%	14%	12%	13%
Kilis	16%	14%	14%	11%	12%	10%	8%	9%	7%	14%
Osmaniye	10%	8%	8%	7%	7%	5%	2%	8%	9%	6%
TOROSLAR EDAŞ	**16%**	**13%**	**11%**	**10%**	**9%**	**8%**	**8%**	**11%**	**12%**	**15%**
Kırşehir	9%	10%	9%	8%	9%	9%	14%	8%	8%	7%
Konya	9%	6%	7%	8%	8%	9%	10%	9%	8%	7%
Nevşehir	6%	8%	8%	7%	7%	5%	9%	9%	8%	7%
Niğde	10%	9%	9%	9%	8%	10%	7%	11%	11%	9%
Aksaray	10%	8%	8%	8%	8%	9%	11%	11%	10%	8%
Karaman	6%	8%	7%	8%	9%	7%	9%	13%	10%	9%
MERAM EDAŞ	**9%**	**7%**	**8%**	**8%**	**8%**	**9%**	**10%**	**10%**	**9%**	**7%**
Ankara	9%	12%	10%	9%	9%	9%	8%	11%	8%	8%

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City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Çankırı	8%	8%	8%	8%	7%	6%	7%	8%	8%	6%
Kastamonu	9%	11%	9%	8%	7%	6%	8%	9%	12%	8%
Zonguldak	9%	12%	12%	11%	9%	11%	12%	13%	13%	10%
Kırıkkale	13%	7%	7%	7%	7%	8%	8%	9%	6%	7%
Bartın	11%	11%	11%	10%	10%	7%	9%	10%	9%	6%
Karabük	6%	5%	5%	6%	2%	3%	4%	5%	5%	6%
BAŞKENT EDAŞ	**9%**	**11%**	**10%**	**9%**	**8%**	**8%**	**8%**	**10%**	**9%**	**8%**
Antalya	10%	9%	9%	10%	10%	10%	11%	12%	10%	12%
Burdur	10%	9%	8%	8%	7%	6%	5%	7%	8%	12%
Isparta	8%	8%	9%	6%	5%	6%	6%	8%	6%	8%
AKDENİZ EDAŞ	**10%**	**9%**	**9%**	**9%**	**9%**	**9%**	**10%**	**11%**	**10%**	**11%**
İzmir	7%	7%	6%	9%	6%	8%	8%	8%	8%	9%
Manisa	11%	9%	8%	8%	7%	7%	7%	10%	10%	11%
GEDİZ EDAŞ	**8%**	**7%**	**6%**	**9%**	**6%**	**8%**	**7%**	**8%**	**8%**	**10%**
Balıkesir	10%	10%	11%	10%	9%	8%	6%	9%	9%	9%
Bursa	5%	10%	7%	6%	6%	6%	7%	10%	7%	6%
Çanakkale	10%	10%	11%	9%	3%	2%	5%	7%	6%	8%

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Yalova	11%	16%	12%	12%	10%	6%	7%	14%	11%	11%
ULUDAĞ EDAŞ	**7%**	**10%**	**9%**	**7%**	**6%**	**6%**	**6%**	**10%**	**7%**	**7%**
Edirne	10%	10%	9%	10%	9%	9%	8%	9%	7%	6%
Kırklareli	9%	9%	9%	7%	8%	5%	6%	6%	5%	5%
Tekirdağ	12%	10%	10%	8%	6%	6%	7%	9%	7%	5%
TRAKYA EDAŞ	**11%**	**10%**	**9%**	**8%**	**7%**	**6%**	**7%**	**8%**	**7%**	**5%**
AYEDAŞ	**11%**	**10%**	**10%**	**9%**	**9%**	**7%**	**7%**	**8%**	**7%**	**8%**
Bolu	8%	7%	7%	5%	5%	7%	3%	5%	5%	4%
Kocaeli	14%	12%	10%	5%	6%	6%	5%	8%	5%	6%
Sakarya	16%	14%	13%	9%	8%	9%	14%	11%	11%	9%
Düzce	14%	12%	10%	9%	9%	9%	8%	9%	7%	7%
SAKARYA EDAŞ	**14%**	**12%**	**10%**	**6%**	**6%**	**7%**	**7%**	**9%**	**7%**	**7%**
Afyonkarahisar	9%	9%	8%	7%	6%	6%	7%	9%	9%	11%
Bilecik	6%	7%	7%	4%	3%	5%	3%	4%	4%	8%
Eskişehir	7%	8%	10%	8%	6%	8%	10%	8%	10%	6%
Kütahya	9%	4%	5%	7%	5%	5%	6%	6%	7%	7%
Uşak	9%	6%	6%	6%	5%	5%	7%	8%	4%	8%

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
OSMANGAZİ EDAŞ	**8%**	**7%**	**7%**	**6%**	**5%**	**6%**	**7%**	**7%**	**7%**	**8%**
BOĞAZİÇİ EDAŞ	**19%**	**16%**	**12%**	**13%**	**11%**	**10%**	**11%**	**13%**	**11%**	**10%**
KAYSERI ELEKTRİK	**8%**	**8%**	**8%**	**8%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**
Aydın	11%	10%	9%	8%	12%	12%	12%	11%	9%	10%
Denizli	7%	6%	4%	5%	6%	9%	4%	7%	6%	5%
Muğla	9%	11%	9%	9%	9%	8%	10%	10%	9%	8%
AYDEM EDAŞ	**9%**	**9%**	**7%**	**7%**	**9%**	**10%**	**9%**	**10%**	**8%**	**8%**
Adıyaman	18%	13%	10%	11%	8%	7%	8%	9%	11%	8%
Kahramanmaraş	10%	10%	9%	7%	7%	7%	7%	7%	6%	6%
AKEDAŞ	**12%**	**11%**	**9%**	**8%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**
Amasya	10%	12%	10%	9%	9%	8%	9%	10%	8%	8%
Çorum	12%	11%	11%	10%	10%	12%	11%	7%	6%	8%
Ordu	9%	9%	10%	10%	10%	10%	14%	9%	8%	8%
Samsun	15%	13%	8%	8%	9%	11%	15%	7%	6%	7%
Sinop	16%	16%	14%	11%	9%	12%	15%	11%	10%	8%
YEŞİLIRMAK EDAŞ	**13%**	**12%**	**9%**	**9%**	**9%**	**11%**	**14%**	**8%**	**7%**	**8%**

Appendix D

Annual Development of Losses (MWh) In Cities

Source:[41]

Table D.1: Annual Development of Losses (MWh) In Cites

City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Diyarbakır	1.809.763	2.007.987	1.670.836	2.147.379	2.364.819	2.670.602	2.901.444	3.459.642	3.618.579	3.934.497
Mardin	1.447.437	1.743.868	1.454.952	2.040.042	2.281.334	2.820.022	2.830.606	3.069.339	3.424.900	3.771.200
Siirt	153.108	147.038	131.794	161.928	189.109	212.633	231.724	304.682	256.890	322.226
Ş anlıurfa	2.007.130	2.340.070	2.369.069	2.460.528	3.005.122	3.975.388	3.071.446	4.367.548	4.399.719	5.439.844
Batman	626.285	665.920	520.803	698.662	782.231	855.924	847.329	1.105.070	1.143.914	1.266.017
Şırnak	570.711	357.192	379.345	672.598	748.423	805.025	946.710	1.113.438	1.109.087	1.146.204
DİCLE EDAŞ	**6.597.908**	**7.263.709**	**6.528.133**	**8.181.180**	**9.370.208**	**11.340.271**	**10.834.613**	**13.540.683**	**14.038.308**	**16.020.420**
Bitlis	163.207	152.769	124.824	156.469	156.825	164.287	184.148	274.164	222.290	269.106
Hakkari	191.432	199.294	223.992	252.031	272.057	303.225	368.946	428.480	424.602	496.522
Muş	223.767	209.528	186.955	256.903	249.775	296.175	396.460	370.295	408.871	275.516
Van	633.454	700.436	816.732	634.728	776.777	878.220	871.280	796.015	1.045.133	1.472.779
VANGÖLÜ EDAŞ	**1.214.009**	**1.264.191**	**1.353.370**	**1.300.196**	**1.456.151**	**1.642.948**	**1.822.420**	**1.865.195**	**2.099.651**	**2.608.138**
Ağrı	185.843	259.231	265.310	301.562	327.255	360.420	355.843	410.942	479.013	570.572
Erzincan	16.906	15.871	17.216	15.336	13.673	15.034	13.603	19.531	23.582	30.853
Erzurum	228.624	204.484	182.941	193.745	159.183	155.845	131.985	132.604	130.572	302.624
Kars	104.410	88.662	83.317	80.874	74.034	75.387	74.883	94.678	78.038	109.686
Bayburt	5.036	7.138	6.858	5.633	7.420	5.407	8.512	10.540	11.646	16.227
Ardahan	18.213	15.109	14.270	12.883	9.383	9.700	8.036	8.849	8.457	16.840
Iğdır	103.559	62.127	48.048	48.727	60.611	66.774	69.209	74.535	71.563	69.576
ARAS EDAŞ	**670.132**	**661.192**	**626.543**	**671.597**	**674.761**	**716.068**	**699.501**	**798.903**	**838.418**	**1.144.820**
Artvin	26.436	44.042	28.717	37.066	40.512	50.447	36.908	46.497	43.187	46.311

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Giresun	52.438	61.052	48.199	69.777	59.041	76.247	103.528	97.088	83.892	71.649
Gümüşhane	11.929	16.266	13.512	14.014	14.217	13.934	17.408	20.093	13.923	14.360
Rize	50.982	53.885	50.307	50.110	42.591	55.656	39.540	52.639	49.097	50.764
Trabzon	94.469	104.285	122.140	118.048	115.826	110.914	144.160	147.648	133.310	131.689
ÇORUH EDAŞ	**236.254**	**279.606**	**262.807**	**288.870**	**271.867**	**310.591**	**340.426**	**363.219**	**323.426**	**314.635**
Bingöl	56.742	67.064	54.747	61.372	44.180	49.795	65.027	74.543	71.051	59.577
Elazığ	90.283	76.519	69.231	70.761	68.903	91.200	63.484	76.698	61.895	46.945
Malatya	127.072	126.787	123.319	123.210	130.636	173.670	184.793	160.145	168.380	191.218
Tunceli	10.617	9.494	9.790	9.084	9.883	10.951	14.949	16.760	14.659	28.580
FIRAT EDAŞ	**286.057**	**281.116**	**257.691**	**264.969**	**253.591**	**325.420**	**330.807**	**333.882**	**315.706**	**323.442**
Sivas	49.214	56.670	49.543	66.190	68.198	65.797	71.562	89.174	81.277	75.426
Tokat	70.108	73.543	62.345	66.974	74.596	62.040	41.700	91.438	81.496	77.075
Yozgat	51.919	53.403	56.988	60.993	63.880	56.656	57.635	63.376	65.150	57.358
ÇAMLIBEL EDAŞ	**170.284**	**182.394**	**168.021**	**193.321**	**205.906**	**183.644**	**170.192**	**244.694**	**225.832**	**208.246**
Adana	473.943	438.020	407.811	399.903	369.213	347.291	371.299	739.457	649.645	691.507
Gaziantep	635.260	457.279	409.978	408.171	364.079	356.807	317.934	390.675	755.435	866.896
Hatay	494.154	447.438	386.774	434.441	386.196	373.248	428.204	632.114	1.020.295	2.043.659
Mersin	622.267	567.537	464.420	380.248	393.348	334.473	372.827	548.870	475.225	561.161
Kilis	14.643	13.360	13.797	11.991	14.429	12.735	10.855	13.188	12.757	30.897
Osmaniye	26.828	23.152	27.686	33.335	46.661	51.721	28.631	209.506	269.954	179.374
TOROSLAR EDAŞ	**2.331.832**	**1.970.597**	**1.717.023**	**1.669.484**	**1.587.746**	**1.495.942**	**1.518.300**	**2.565.455**	**3.151.820**	**4.043.462**
Kırşehir	20.792	26.553	27.173	24.381	28.685	29.914	55.113	33.562	33.437	26.200

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Konya	339.123	239.513	340.798	383.161	419.313	382.914	512.553	482.496	489.593	388.783
Nevşehir	32.698	39.092	45.175	42.073	44.480	28.461	54.107	56.420	54.432	43.418
Niğde	59.601	62.455	69.392	69.111	67.243	72.346	54.034	96.007	103.435	85.157
Aksaray	32.225	27.370	30.507	35.692	41.125	49.655	69.960	67.684	72.251	62.665
Karaman	19.737	28.504	27.121	34.995	47.303	36.344	46.860	67.794	66.240	59.269
MERAM EDAŞ	**495.557**	**439.639**	**547.861**	**590.718**	**647.747**	**595.960**	**785.839**	**813.893**	**826.188**	**669.504**
Ankara	676.911	876.212	788.547	761.500	820.685	819.650	843.682	1.209.329	953.243	923.768
Çankırı	13.220	14.237	17.565	18.717	17.132	14.097	18.643	27.437	34.274	23.163
Kastamonu	36.854	51.325	43.037	44.654	43.593	40.981	52.130	67.196	84.630	62.556
Zonguldak	235.347	307.625	314.459	309.082	241.205	303.223	357.488	382.835	402.198	297.277
Kırıkkale	52.097	27.852	28.984	35.159	35.606	43.169	46.731	54.523	35.739	41.640
Bartın	24.207	25.682	28.187	27.247	27.370	18.397	28.467	35.821	34.575	27.081
Karabük	37.487	29.243	32.119	40.582	15.927	26.447	28.289	47.856	51.407	70.397
BAŞKENT EDAŞ	**1.078.880**	**1.331.041**	**1.226.070**	**1.195.172**	**1.201.511**	**1.227.188**	**1.306.738**	**1.786.066**	**1.543.089**	**1.415.942**
Antalya	385.772	395.124	377.305	512.048	529.836	529.919	675.547	833.402	721.830	820.894
Burdur	28.805	32.965	32.144	41.893	63.367	63.251	42.890	55.098	65.678	85.778
Isparta	66.504	66.959	66.348	55.625	51.615	57.285	55.155	85.443	65.033	95.427
AKDENİZ EDAŞ	**487.488**	**497.797**	**475.638**	**607.406**	**656.572**	**666.850**	**755.781**	**958.582**	**866.685**	**1.010.605**
İzmir	855.855	864.391	890.902	1.473.901	1.040.638	1.136.501	1.210.605	1.377.461	1.436.671	1.769.348
Manisa	218.208	191.498	205.493	225.481	200.329	177.760	231.597	348.603	367.437	442.480
GEDİZ EDAŞ	**1.072.951**	**1.058.625**	**1.094.948**	**1.699.091**	**1.241.130**	**1.312.982**	**1.441.994**	**1.729.053**	**1.818.352**	**2.220.741**
Balıkesir	166.295	192.602	234.258	226.240	198.788	188.147	150.126	239.998	259.998	255.936

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bursa	394.496	783.199	625.046	493.363	481.874	484.312	640.402	1.018.415	641.923	568.850
Çanakkale	207.078	221.088	272.333	261.736	82.547	68.617	176.526	284.521	262.781	371.530
Yalova	99.255	152.715	104.334	95.440	79.190	33.704	55.640	136.516	111.461	107.351
ULUDAĞ EDAŞ	**890.445**	**1.329.341**	**1.224.032**	**1.022.141**	**851.324**	**789.143**	**1.038.556**	**1.705.463**	**1.339.777**	**1.288.501**
Edirne	73.705	81.701	81.788	95.007	84.821	87.942	88.662	96.560	85.288	73.333
Kırklareli	142.620	131.813	145.995	135.808	139.493	86.129	109.195	111.934	95.357	95.944
Tekirdağ	466.312	452.827	491.185	398.203	324.424	310.875	374.315	575.426	453.277	312.721
TRAKYA EDAŞ	**674.864**	**659.575**	**713.159**	**641.210**	**555.797**	**492.608**	**580.849**	**761.891**	**625.059**	**486.971**
AYEDAŞ	**721.212**	**775.218**	**861.483**	**883.455**	**850.520**	**737.273**	**723.062**	**931.400**	**746.096**	**889.345**
Bolu	49.713	44.562	45.759	38.364	41.326	57.240	23.772	46.035	46.532	39.662
Kocaeli	1.205.918	1.168.011	909.313	510.728	591.981	627.224	541.516	1.040.209	688.286	802.424
Sakarya	219.730	227.764	219.455	182.708	174.484	180.973	311.420	263.071	291.197	269.107
Dü zce	63.622	63.139	56.626	54.835	60.867	60.574	62.966	77.969	62.833	62.396
SakaryaEDAŞ	**1.552.674**	**1.496.171**	**1.268.230**	**833.153**	**899.458**	**969.709**	**1.049.174**	**1.460.522**	**1.206.919**	**1.200.330**
Afyonkarahisar	67.701	76.303	75.719	73.719	69.763	64.645	88.585	117.436	132.524	173.647
Bilecik	97.446	87.909	74.838	47.256	28.671	54.360	32.085	59.172	49.334	107.068
Eskişehir	113.965	120.965	169.669	140.077	120.629	150.456	218.254	181.278	243.833	168.520
Kütahya	64.499	33.514	41.943	63.137	54.243	54.390	69.433	77.411	96.094	94.855
Uşak	61.248	47.585	48.704	54.366	45.595	46.826	67.902	81.171	48.508	94.288
OSMANGAZİ EDAŞ	**440.076**	**362.244**	**398.626**	**377.090**	**313.605**	**361.830**	**468.418**	**514.683**	**555.256**	**657.805**
BOĞAZİÇİ EDAŞ	**3.482.621**	**3.212.647**	**2.540.993**	**2.852.558**	**2.587.606**	**2.145.906**	**2.541.249**	**3.313.500**	**2.679.063**	**2.535.121**
KAYSERI ELEKTRİK	**155.710**	**188.258**	**199.439**	**190.561**	**175.283**	**170.193**	**214.086**	**221.981**	**218.388**	**219.021**

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City-Company	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Aydın	151.142	147.053	140.184	142.958	229.359	214.397	219.811	234.204	210.266	219.837
Denizli	152.477	124.562	94.334	116.999	142.346	217.417	104.127	196.463	182.306	162.885
Muğla	180.330	216.967	170.482	185.135	196.761	156.826	233.491	258.488	227.291	219.630
AYDEM EDAŞ	**506.909**	**511.818**	**414.816**	**450.959**	**577.453**	**590.333**	**582.742**	**704.608**	**635.484**	**621.795**
Adıyaman	127.187	102.033	90.058	105.006	74.825	66.464	77.272	88.818	117.562	91.667
Kahramanmaraş	209.097	224.492	214.707	168.164	188.053	203.185	229.936	225.193	193.536	228.579
AKEDAŞ	**346.498**	**330.629**	**305.720**	**273.575**	**262.993**	**269.689**	**307.398**	**315.094**	**317.096**	**321.139**
Amasya	36.288	44.764	43.727	43.582	42.809	37.893	46.522	53.995	48.154	44.706
Çorum	67.080	64.311	71.106	70.393	69.710	83.470	80.132	59.107	48.134	68.752
Ordu	63.530	65.257	80.177	90.186	93.248	95.349	146.776	96.277	90.451	96.450
Samsun	217.171	206.594	150.916	163.924	182.578	237.193	335.073	174.310	155.154	204.933
Sinop	30.125	32.113	31.189	28.630	24.241	33.072	47.133	39.707	33.141	28.135
YEŞİLIRMAK EDAŞ	**414.802**	**415.317**	**375.543**	**395.775**	**412.250**	**487.075**	**658.073**	**423.017**	**374.121**	**443.947**

Appendix E

Annual Development of Accrual (MWh) In Cities

Source:[41]

Table E.1: Annual Development of Accrual (MWh) In Cities

City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Diyarbakır	1.124.149	1.071.054	1.337.680	1.169.898	1.248.844	1.115.711	1.213.119	1.327.781	1.320.174	1.285.746
Mardin	574.069	556.458	825.444	534.831	858.492	749.494	1.019.911	964.584	1.080.268	729.039
Siirt	251.650	268.690	280.445	307.734	300.173	311.127	303.620	322.433	363.276	334.306
Ş anlıurfa	1.438.454	1.544.159	1.668.333	1.847.692	2.109.739	1.258.671	2.489.184	2.095.421	2.516.061	2.212.208
Batman	326.701	349.347	419.254	369.289	393.380	422.743	467.839	471.819	499.771	503.646
Şırnak	232.114	239.293	242.950	233.880	307.671	334.225	276.260	250.422	301.568	267.990
DİCLE EDAŞ	**3.947.136**	**4.029.002**	**4.774.106**	**4.463.323**	**5.218.299**	**4.191.971**	**5.769.932**	**5.432.460**	**6.081.117**	**5.332.935**
Bitlis	100.038	124.632	144.834	163.104	194.205	227.383	217.354	243.581	264.320	265.789
Hakkari	93.482	104.549	117.406	136.359	150.685	164.836	124.194	143.810	174.661	141.681
Muş	178.308	183.280	170.628	194.010	221.404	281.712	299.351	325.283	346.798	340.575
Van	398.266	358.167	334.128	519.743	581.504	639.627	725.509	1.002.228	1.051.776	702.027
VANGÖlÜ EDAŞ	**770.094**	**770.629**	**766.996**	**1.013.216**	**1.147.798**	**1.313.557**	**1.366.408**	**1.714.901**	**1.837.556**	**1.450.073**
Ağrı	281.807	250.213	241.275	236.338	262.439	286.950	311.838	345.438	293.873	259.592
Erzincan	158.642	170.304	184.552	196.704	216.673	239.713	265.546	305.322	317.542	310.065
Erzurum	548.713	603.119	656.535	716.127	832.558	838.506	927.531	1.010.556	1.011.718	889.278
Kars	190.444	207.136	220.510	237.645	257.400	258.740	266.459	273.471	281.248	269.064
Bayburt	44.188	46.572	53.655	56.406	58.827	61.433	69.643	75.694	70.815	76.181
Ardahan	50.232	53.455	59.159	63.957	72.606	75.669	82.251	92.581	98.105	94.097
Iğdır	58.137	94.953	87.388	109.249	106.571	107.901	107.477	121.556	128.785	136.453
ARAS EDAŞ	**1.332.164**	**1.425.753**	**1.503.073**	**1.616.426**	**1.807.074**	**1.868.912**	**2.030.746**	**2.224.620**	**2.202.088**	**2.034.729**
Artvin	161.655	158.248	201.355	243.399	265.507	244.513	299.328	320.968	324.424	335.162
Giresun	302.940	343.852	388.129	402.952	421.621	422.058	451.094	515.382	531.306	535.543

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gümüşhane	63.851	64.654	77.479	85.267	90.993	124.028	153.344	178.640	216.981	278.693
Rize	378.912	418.635	458.495	499.823	536.787	617.291	573.172	605.410	609.774	609.365
Trabzon	618.262	683.197	754.309	885.285	965.148	979.833	1.030.115	1.195.777	1.229.390	1.261.843
ÇORUH EDAŞ	**1.525.620**	**1.668.586**	**1.879.767**	**2.116.727**	**2.280.056**	**2.387.723**	**2.507.053**	**2.816.177**	**2.911.876**	**3.020.606**
Bingöl	85.685	86.839	99.815	111.562	129.108	139.897	140.624	154.553	169.810	194.374
Elazığ	592.898	598.388	758.540	842.712	908.592	817.964	953.660	1.153.641	1.167.181	1.424.682
Malatya	844.444	937.238	1.024.819	1.118.067	1.054.274	1.022.546	1.124.362	1.185.758	1.274.258	1.347.144
Tunceli	55.937	60.684	66.042	72.399	80.543	81.571	81.077	89.311	96.682	100.332
FIRAT EDAŞ	**1.578.965**	**1.683.150**	**1.949.216**	**2.144.740**	**2.172.517**	**2.061.978**	**2.299.722**	**2.583.265**	**2.707.932**	**3.066.532**
Sivas	554.694	724.446	844.976	979.436	990.740	1.049.812	1.121.969	1.152.140	1.158.280	1.227.276
Tokat	399.782	419.759	458.016	506.561	604.610	622.323	629.125	626.512	727.466	702.246
Yozgat	429.504	452.482	494.545	527.866	534.293	524.908	507.985	582.029	602.997	611.149
ÇAMLIBEL EDAŞ	**1.383.980**	**1.596.686**	**1.797.538**	**2.013.863**	**2.129.643**	**2.197.043**	**2.259.078**	**2.360.681**	**2.488.743**	**2.540.671**
Adana	3.709.263	3.887.871	3.907.265	4.135.636	4.112.090	3.874.304	4.003.428	4.794.955	5.152.654	5.009.294
Gaziantep	2.902.715	3.308.895	3.572.500	3.874.044	3.867.680	3.851.778	4.221.841	4.488.982	4.975.247	5.034.368
Hatay	2.783.677	3.229.439	3.597.710	4.073.089	4.595.424	4.921.860	5.062.553	5.164.831	5.616.553	5.786.452
Mersin	2.101.692	2.290.596	2.612.980	2.803.185	2.949.977	2.830.606	3.080.174	3.308.459	3.558.827	3.762.116
Kilis	77.691	78.807	84.132	92.310	106.667	118.479	128.088	141.492	164.691	187.613
Osmaniye	250.010	271.327	330.063	427.794	626.058	925.114	1.200.923	2.479.259	2.682.629	2.704.454
TOROSLAR EDAŞ	**11.825.048**	**13.066.935**	**14.104.650**	**15.406.057**	**16.257.896**	**16.522.142**	**17.697.008**	**20.377.980**	**22.150.601**	**22.484.297**
Kırşehir	209.562	234.263	259.559	269.440	296.710	300.324	340.215	377.407	395.937	369.567
Konya	3.335.399	3.773.737	4.264.406	4.545.963	4.580.276	3.919.075	4.776.247	4.985.295	5.307.048	5.510.813

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Nevşehir	480.692	442.867	498.024	534.630	556.349	532.846	553.832	579.221	605.393	602.687
Niğde	559.865	603.643	690.050	738.842	730.956	688.080	776.934	773.370	872.746	915.513
Aksaray	293.610	321.174	375.594	422.910	476.976	476.668	553.243	561.652	641.665	690.515
Karaman	294.615	344.891	363.931	419.168	456.351	464.092	482.166	472.894	565.021	615.007
MERAM EDAŞ	**5.173.741**	**5.720.574**	**6.451.563**	**6.930.952**	**7.097.617**	**6.381.085**	**7.482.637**	**7.749.839**	**8.387.810**	**8.704.102**
Ankara	6.501.395	6.606.337	7.320.030	8.135.070	8.607.650	8.611.587	9.565.913	10.259.178	10.628.635	10.681.360
Çankırı	153.880	168.837	193.464	207.788	228.781	216.597	251.107	296.605	414.750	354.701
Kastamonu	375.854	408.159	442.491	486.892	582.405	616.686	636.222	642.439	648.790	712.613
Zonguldak	2.262.233	2.271.942	2.348.392	2.392.826	2.434.195	2.512.403	2.548.789	2.656.927	2.641.657	2.693.438
Kırıkkale	355.706	391.904	416.095	433.902	505.882	522.663	525.445	575.048	578.005	577.077
Bartın	186.294	208.841	217.078	238.856	251.034	260.006	281.731	308.808	350.297	419.067
Karabük	541.743	599.119	656.858	680.315	732.298	745.085	774.472	881.337	994.753	1.063.204
BAŞKENT EDAŞ	**10.377.105**	**10.655.139**	**11.594.408**	**12.575.650**	**13.342.245**	**13.485.027**	**14.583.678**	**15.620.341**	**16.256.887**	**16.501.460**
Antalya	3.299.614	3.772.134	3.877.343	4.599.745	4.844.751	4.679.153	5.223.958	6.141.000	6.232.090	6.183.322
Burdur	252.449	338.167	367.240	495.283	852.135	968.998	757.263	690.444	746.879	657.536
Isparta	740.455	766.609	641.937	803.707	952.168	950.498	869.063	921.376	1.012.056	1.075.454
AKDENİZ EDAŞ	**4.292.518**	**4.876.910**	**4.886.520**	**5.898.735**	**6.649.053**	**6.598.650**	**6.850.284**	**7.752.821**	**7.991.025**	**7.916.312**
İzmir	11.369.861	11.801.456	13.532.583	15.478.086	15.728.899	13.419.636	14.902.574	16.442.561	16.992.650	16.914.369
Manisa	1.805.105	1.961.678	2.262.676	2.556.077	2.674.586	2.395.886	2.911.462	3.187.684	3.445.768	3.658.356
GEDİZ EDAŞ	**13.174.966**	**13.763.134**	**15.795.259**	**18.034.163**	**18.403.486**	**15.815.522**	**17.814.036**	**19.630.245**	**20.438.418**	**20.572.725**
Balıkesir	1.436.298	1.699.325	1.846.260	2.045.503	2.120.485	2.156.166	2.469.181	2.509.114	2.669.963	2.578.349
Bursa	7.538.698	7.196.498	7.774.004	7.543.531	7.972.474	7.625.780	8.573.704	8.975.143	9.149.525	9.393.491

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Çanakkale	1.886.046	2.055.597	2.262.175	2.616.501	2.458.622	3.009.411	3.403.981	3.707.273	4.228.237	4.148.300
Yalova	781.240	831.315	781.594	725.377	715.618	534.733	777.345	857.684	874.774	840.977
ULUDAĞ EDAŞ	**11.642.282**	**11.782.735**	**12.664.034**	**12.930.912**	**13.267.199**	**13.326.089**	**15.224.211**	**16.049.215**	**16.922.499**	**16.961.118**
Edirne	662.472	752.666	822.254	863.684	862.269	895.186	1.001.818	1.036.775	1.081.594	1.068.921
Kırklareli	1.465.591	1.327.140	1.510.416	1.770.844	1.680.453	1.604.707	1.574.076	1.696.744	1.871.880	2.003.478
Tekirdağ	3.450.306	3.894.215	4.589.566	4.840.913	4.829.830	4.689.242	5.326.923	5.597.514	5.838.473	5.621.268
TRAKYA EDAŞ	**5.578.369**	**5.974.021**	**6.922.236**	**7.475.441**	**7.372.552**	**7.189.135**	**7.902.817**	**8.331.033**	**8.791.946**	**8.693.667**
AYEDAS	**6.131.260**	**6.672.277**	**7.551.848**	**8.559.249**	**9.010.608**	**9.124.187**	**9.732.880**	**10.292.092**	**10.472.246**	**10.827.540**
Bolu	542.512	612.093	636.663	692.575	754.259	720.983	807.088	860.459	901.556	982.544
Kocaeli	7.525.175	8.212.149	8.598.528	9.561.570	10.076.404	10.105.153	10.847.569	11.500.479	11.881.577	12.266.373
Sakarya	1.161.139	1.419.657	1.509.498	1.781.899	1.953.023	1.793.702	1.965.821	2.200.799	2.343.210	2.747.786
Dü zce	376.059	458.083	515.468	570.580	615.789	642.961	725.679	785.989	837.616	896.074
SAKARYA EDAŞ	**9.604.885**	**10.701.982**	**11.260.157**	**12.606.624**	**13.399.476**	**13.262.800**	**14.346.157**	**15.347.726**	**15.963.959**	**16.892.778**
Afyonkarahisar	697.510	800.434	888.464	997.479	1.061.326	1.013.420	1.116.419	1.182.500	1.283.734	1.358.985
Bilecik	1.619.537	1.170.555	1.028.362	1.202.754	962.005	969.858	1.167.249	1.284.686	1.196.465	1.274.460
Eskişehir	1.455.284	1.480.090	1.578.062	1.715.521	1.838.120	1.734.952	1.950.433	2.158.104	2.301.403	2.621.542
Kütahya	654.493	766.346	847.405	872.077	956.408	1.003.866	1.165.541	1.323.414	1.365.949	1.351.104
Uşak	656.222	693.215	763.142	832.051	867.082	867.172	904.860	960.296	1.044.856	1.100.748
OSMANGAZİ EDAŞ	**5.083.047**	**4.910.640**	**5.105.435**	**5.619.882**	**5.684.940**	**5.589.267**	**6.304.502**	**6.909.000**	**7.192.407**	**7.706.839**
BOĞAZİÇİ EDAŞ	**14.516.380**	**16.561.935**	**18.199.283**	**19.942.366**	**20.998.194**	**20.022.943**	**20.792.155**	**22.380.193**	**22.612.612**	**23.097.915**

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City-Company	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
KAYSERİ EDAŞ	**1.788.784**	**2.114.106**	**2.250.441**	**2.346.471**	**2.328.363**	**2.273.296**	**2.828.059**	**2.887.964**	**2.899.079**	**2.976.722**
Aydın	1.170.776	1.331.650	1.472.131	1.669.551	1.614.235	1.531.907	1.662.543	1.860.667	2.033.093	2.067.746
Denizli	1.974.680	2.103.262	2.138.674	2.473.853	2.353.864	2.120.619	2.486.518	2.627.401	2.870.577	3.030.937
Muğla	1.760.987	1.708.157	1.809.072	1.893.318	1.925.934	1.914.762	2.008.087	2.208.244	2.404.899	2.445.778
AYDEM EDAŞ	**4.906.444**	**5.143.069**	**5.419.878**	**6.036.722**	**5.894.033**	**5.567.288**	**6.157.148**	**6.696.313**	**7.308.569**	**7.544.460**
Adıyaman	593.185	703.720	777.385	832.558	844.709	835.840	900.381	918.542	961.502	1.020.800
Kahramanmaraş	1.905.811	2.067.380	2.195.159	2.334.027	2.501.786	2.786.003	2.999.913	3.011.740	3.159.039	3.446.324
AKEDAŞ	**2.498.996**	**2.771.100**	**2.972.544**	**3.166.585**	**3.346.495**	**3.621.843**	**3.900.294**	**3.930.282**	**4.120.542**	**4.467.124**
Amasya	331.379	339.210	376.836	421.044	439.313	447.189	466.139	493.593	519.828	537.406
Çorum	480.876	536.061	598.335	643.338	659.109	626.626	676.744	765.139	802.298	800.430
Ordu	614.020	679.182	746.671	814.110	847.547	853.391	881.991	998.342	1.041.926	1.051.766
Samsun	1.259.763	1.390.797	1.674.028	1.854.457	1.959.868	1.927.090	1.908.558	2.435.978	2.514.302	2.556.962
Sinop	153.591	168.729	193.713	221.284	234.148	239.313	268.391	319.351	307.083	306.013
YEŞİLIRMAK EDAŞ	**2.839.630**	**3.113.979**	**3.589.582**	**3.954.232**	**4.139.986**	**4.093.611**	**4.201.823**	**5.012.403**	**5.185.437**	**5.252.576**
Other	1.170.439	1.260.420	1.631.965	282.922						
Total	**121.141.852**	**130.262.759**	**143.070.499**	**155.135.260**	**161.947.528**	**156.894.070**	**172.050.628**	**186.099.551**	**194.923.349**	**198.045.181**

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