



การไฟฟ้านครหลวง
Metropolitan Electricity Authority

**THE TWELFTH POWER DISTRIBUTION SYSTEM
IMPROVEMENT AND EXPANSION PLAN,
YEAR 2017 — 2021**



EXECUTIVE SUMMARY

POWER SYSTEM PLANNING DEPARTMENT

Preface

Metropolitan Electricity Authority (MEA) is a state owned enterprise established under the Metropolitan Electricity Authority Act, B.E. 2501, primarily being responsible to distribute power to consumers in Bangkok Metropolis, Nonthaburi and Samutprakarn provinces, covering an area of about 3,192 square kilometers. In light of our previous performance, we have consecutively implemented eleven power distribution system improvement and expansion plans as our major plans with the objectives of effectively satisfying the ever increasing power demand and reinforcing our power system stability and reliability.

MEA has formulated The Twelfth Power Distribution System Improvement and Expansion Plan, 2017 – 2021 based on the Load Forecast dated October 2015 (Base case) which predicts that the increase in power demand in MEA's service area will be as high as 1,541 megawatt or at an average growth rate of 3.15% per annum. The objectives of the plan are to meet the ever increasing power demand, reinforce the power system stability and reliability, and achieve our strategic goals to elevate our power system quality to excellence and international level, as well as function in accordance with the government's policy and relevant executing agencies with the obligations to abide by as follows

1. To hold to the principle of Sufficiency Economy, MEA has efficiently implemented all investment plans in response to the ongoing economic expansion with intention to satisfy our customers' demands in consideration of the Load Forecast prepared by representatives from public sector.
2. To efficiently secure power supply with qualified equipment, MEA uses remote control equipment to reduce outage impact and duration as well as facilitate rapid maintenance.
3. To promote energy saving, MEA has implemented Uprating 12 kV to 24 kV and 69 kV to 115 kV primary line program and installed low impedance transformer and capacitor to reduce energy loss in our power system.
4. To achieve maximum cost effectiveness, MEA has conducted a comprehensive study of the appropriateness of our all investments prior to implementing The Twelfth Power Distribution System Improvement and Expansion Plan.

Table of contents

	Page
1. Introduction	1
2. Objectives	2
3. Load Forecast	2
4. Scope and Target	2
5. Responding to the Government's policy	5
6. Project Implementation	6
7. Investment Cost	6
8. Internal Rate of Return	7

The Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017 – 2021

1. Introduction

Metropolitan Electricity Authority (MEA) is a state owned enterprise responsible for acquiring and supplying electric power to the consumers in Bangkok Metropolis, Nonthaburi and Samutprakarn provinces, covering an area of 3,192 square kilometers. At present, MEA's power distribution system successfully supplies power covering 100 % of our target areas, with the total construction / installation capacity at the end of 2015 as follows:

- 17 Transmission Substations	18,200	MVA
- 145 Distribution Substations	18,120	MVA
- Transmission Lines	1,731	Circuit-km.
- Feeder	18,003	Circuit-km.

The Power Distribution System Improvement and Expansion Plan has been continually implemented as our major plan, with the Eleventh Power Distribution System Improvement and Expansion Plan, Year 2012 – 2016 being currently under implementation. Striving to invariably make progress on the plan toward satisfying the ever-increasing power demand in our service areas, enhancing power system stability and reliability as well as achieving our strategic goals to elevate our power system quality to excellence and international level, accordingly the Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017 – 2021 has accordingly commenced its operations in consideration of the Load Forecast dated December 2015, which forecasts that the increase in power demand in MEA's service area will be as high as 1,541 megawatt or at an average growth rate of 3.15% per annum and the implementation of the plan has been carried out in accordance with government's policy and relevant executing to satisfy the ever increasing power demand with quality, stability, enhance reliability of the power system and maintain customer service standards in response to Thailand's 12th National Economic and Social development Plan (2017-2021) on the subject of enhancing energy security.

2. Objectives

2.1 To improve and expand MEA's power distribution system to sufficiently meet the increasing power demand during 2017 – 2021 in a timely and qualified manner.

2.2 To reinforce the power system reliability, At the end of final year (2021) MEA has determined to achieve the following goals:

- SAIFI (times / year /customer)	0.760
- SAIDI (minute / year / customer)	23.260

3. Load Forecast

The Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017 – 2021 has been made based on the Load Forecast dated December 2015 which is summarized as follows:

	<u>Increasing power demand</u>	
	Increase	Growth rate (%)
● Power Demand (MW)	1,541	3.15
● Energy purchase (Million unit)	8,905	3.15
● Energy sale (Million unit)	8,532	3.13
● Number of customers	379,618	2.03

4. Scope and Target

Programs have been formulated under the Twelfth Power Plan, Year 2017 – 2021 to cover the followings:

- 1) Transmission and Distribution Substation System Program
- 2) Subtransmission Line System Program
- 3) Medium and Low Voltage System Program
- 4) Uprating of 12 kV to 24 kV Primary Lines Program
- 5) Power Distribution Efficiency Improvement Program

The mentioned programs will be implemented in MEA service areas covering Bangkok Metropolis, Nonthaburi and Samutprakarn provinces. Each plan has its targets and subprojects as shown in appendix B. The main targets of the Twelfth Power Plan, Year 2017 – 2021 can be summarized as shown in Table 4-1.

Table 4-1: The summary of targets for the Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017-2021

Description	Unit	Annual Target					Total
		2017	2018	2019	2020	2021	
1. Terminal Station and (T/S) Substation System (S/S) Program							
1.1 Construction and addition of T/S	MVA (NO.)	-	-	1,900 (2)	1,200 (2)	1,200 (2)	4,300 (6)
1.2 Modification of T/S	(NO.)	-	-	(1)	-	-	(1)
1.3 Replacement for worn-out equipment of T/S	(NO.)	-	-	(2)	(1)	(1)	(4)
1.4 Construction and addition of S/S	MVA (NO.)	-	480 (5)	1,060 (8)	360 (4)	900 (9)	2,800 (26)
1.5 Modification of S/S	(NO.)	-	(4)	(1)	(2)	(4)	(11)
1.6 Replacement for worn-out equipment of S/S	(NO.)	-	(12)	(5)	(9)	(2)	(28)
1.7 Land acquisition for construction of T/S and S/S*	(NO.)	-	-	-	-	(19)	(19)
2. Subtransmission Line System Program							
2.1 Construction	cct.-km	5.2	24.0	142.7	13.7	98.2	283.8
2.2 Modification	cct.-km	15.0	17.0	23.7	22.2	15.0	92.9
2.3 Replacement for worn-out lines	cct.-km	1.6	8.3	13.6	3.0	16.0	42.5
3. Medium and Low Voltage System Program							
3.1 Primary Line							
3.1.1 Construction	cct.-km	340	335	340	340	300	1,655
3.1.2 Modification	cct.-km	230	200	190	190	190	1,000
3.1.3 Modification and Improvement**	project	3	3	3	3	3	3
3.2 Secondary Line							
3.2.1 Construction	cct.-km	590	510	480	470	515	2,565
3.2.2 Modification	cct.-km	260	270	270	270	270	1,340
3.3 Installation of Distribution Transformer							
3.3.1 Installation	MVA	410	395	410	410	320	1,945
3.3.2 Replacement for worn-out equipment	MVA	326	326	326	326	326	1,630
3.4 Revenue Meter							
3.4.1 Installation	set	116,360	100,720	94,370	93,040	101,960	506,450
3.4.2 Replacement for worn-out equipment	set	297,890	110,320	112,590	114,710	116,800	752,310
3.4.3 Replacing meters with AMR type 3,4,5	set	2,284	7,250	6,416	5,800	-	21,750
3.4.4 Replacing revenue meters with AMI	set	9,000	14,875	14,875	11,250	-	50,000
3.5 Installation of Capacitor	MVAR	104	94	96	93	84	470
4. Uprating of 12 kV to 24 kV Primary Lines Program	sq.km.	41	48	95	-	-	183
5. Power Distribution Efficiency Improvement Program	project	1	1	1	1	1	1

Remark* -Land acquisition for construction: 5 areas in 12th plan and 12 areas in 13th plan

****** - The modification and improvement project of primary line comprises 3 projects as follows:

- 1 The project for supporting connection between the power system and Renewable Energy
- 2 Smart Fault Circuit Indicator (FCI) project
- 3 The project for improving Silom underground project

1) Terminal Station and Substation System Program consists of

1.1) Construction and addition of Terminal Stations (T/Ss) to receive power from the Electricity Generating Authority of Thailand (EGAT) and transmit to Substations (S/Ss) via MEA's subtransmission lines

1.2) Modification of T/Ss

- Replacement of T/S equipment from Outdoor to Indoor Type
- Improvement of Switchgear for 69 or 115 kV to serve the additional transmission circuits
- General improvement, for example, installing temporary equipment for replacing worn-out equipment of T/S, and modifying control and protection system(including computer system and software)

1.3) Construction, Modification and Addition of S/Ss to serve the increasing load by conversion of voltage levels from 69 kV and 115 kV to 12 and 24 kV and transmitting power via distribution lines to MEA's target area.

1.4) Modification of S/Ss

- Replacing worn-out equipment of S/S, for example, 69 or 115 kV switchgear, power transformer, and 12 or 24 kV switchgear
- Modifying equipment of S/S to enhance power system reliability, for example, 69 or 115 kV switchgear, power transformer, and 12 or 24 kV switchgear
- General improvement, for example, installing temporary equipment for replacing worn-out equipment of T/S, and modifying control and protection system(including computer system and software)

1.5) Land acquisition for construction of T/S and S/S

2) Subtransmission Line System Program consists of

2.1) Construction of new subtransmission lines to serve the increasing load and enhance power system reliability

2.2) Modification of subtransmission lines

- To serve the increasing load, for example, replacing 1 line per phase with 2 lines per phase
- To enhance power system reliability and provide safety in life and property of people, for example, replacing aerial cable with underground cable

- Replacing worn-out subtransmission lines and worn-out equipments of T/S and S/S including their accessories simultaneously, for example, Overhead Ground Wire

3) Medium and Low Voltage System Program

This Program consists of 12 – 24 kV primary distribution lines, secondary lines, distribution transformers, revenue meters, and capacitors. In respect of the primary lines, there is plan for the lines improvement and maintenance to increase stability and reliability.

4) Upgrading of 12 kV to 24 kV Primary Lines Program

In order to enhance the power distribution capacity via primary lines and to solve the problems on voltage drop and reduce energy loss and limited rights of way, MEA, therefore, has gradually converted its voltage system from 12 kV to 24 kV. This program is implemented in continuation of the Eleventh Power Distribution System Improvement and Expansion Plan. Under the Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017 – 2021, the target for the upgrading of 12 kV to 24 kV primary distribution lines has been set to cover an additional area of 183.4 sq.km. It is expected that by the end of Year 2021, 99.7 percentages of MEA service area will be supplied at 24 kV voltage level, so there is 12 kV voltage level in only mesh network area.

5) Power Distribution Efficiency Improvement Program

Procurement and installation of equipment and its accessory including computer system and software for Distribution Management System Project (DMS) will be implemented in both primary underground cable system and primary aerial cable system at 12 and 24 kV voltage levels. Advantage in this project enables MEA to minimize power outage area as well as accelerate the system maintenance, reducing loss from power outage.

5. Responding to Government's policy

MEA has conducted the investment plan in accordance with policies of the government and relevant public authority agencies with the obligations to abide by these following aspects.

1) To hold to the principle of sufficiency economy, MEA has laid out the investment plan to efficiently respond to economic expansion and meet customers' demands in consideration of the Load Forecast prepared by representatives from public sector.

2) To efficiently secure power supply with qualified equipment, MEA uses remote control equipment to reduce outage impact and facilitate and rapid maintenance.

3) To promote energy saving, MEA has implemented Uprating 12 kV to 24 kV and 69 kV to 115 kV programs and installation of low loss transformer and capacitor to reduce energy loss in power system.

4) To achieve maximum cost effectiveness, MEA has conducted a comprehensive study of the appropriateness of our all investments prior to implementing The Twelfth Power Distribution System Improvement and Expansion Plan.

6. Project Implementation

The plan requires these following significant steps: acquisition of proper land for construction of new substations, the geological survey and design for new substations, application for permission for the use of government owned area, civil construction, installation of electric equipment and system testing. These steps will be implemented by MEA and outsourcing.

To achieve the target in satisfying the increasing power demand, MEA has to start the preparation process of the plan, which incorporates land acquisition, survey, design and application for permission to use the land from other public utilities since 2016.

Work Schedule is shown in appendix B.

7. Investment Cost

The investment cost of the twelfth plan, year 2017 – 2021 consists of foreign currency portion for foreign materials and local currency portion for tax of imported equipment, construction and installation labor cost, and overhead charge. This investment cost is estimated using data in 2015 (at exchange rates 37 Baht/US Dollar and 40 Baht/Euro) then adding 5% contingency and adjusting it to current price at the time of payment by using escalation factor 3.0% per annum.

The investment cost is total 84,804.0 million Baht, with the foreign currency at 25,341.0 million Baht (29.9%) and local currency at 59,463.0 million Baht (70.1%), including the interest during construction at 1,954.2 million Baht.

The investment cost of each program is tabulated in Table 7-1 and sources of fund in Table 7-2. Details of investment cost in each subproject are shown in appendix C.

Table 7-1: Investment cost by categories of Program

Program	Investment Cost (million Baht)		
	foreign currency	local currency	Total
1. Transmission and Distribution Substation System Program	14,652.1	12,884.6	27,536.7
2. Subtransmission Line System Program	5,115.6	20,088.0	25,203.6
3. Medium and Low Voltage System Program	5,537.3	19,564.1	25,101.4
4. Uprating of 12 kV to 24 kV Primary Lines Program	36.0	628.9	664.9
5. Power Distribution Efficiency Improvement Program	-	4,343.2	4,343.2
Subtotal	25,341.0	57,508.8	82,849.8
Interest during construction	-	1,954.2	1,954.2
Total	25,341.0	59,463.0	84,804.0
Percentage (%)	29.9	70.1	100.0

Table 7-2: Source of Fund

Source of Fund	Amount (Baht Million)	Percentage (%)
Domestic Loan	66,300.0	78.2
MEA own income	18,504.0	21.8
Total	84,804.0	100.0

8. Internal Rate of Return

Internal rate of return of the twelfth power distribution system improvement and expansion plan, year 2017-2021, for MEA and overall economy is analyzed using 2 methods as follows:

8.1 Net Present Value (Free Cash Flow) method (NPV (FCF)) Both Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR) are evaluated. Also

Sensitivity Study is carried out to study the effect of power demand decreasing and increasing by using forecasted load of October 2015 as based case.

Assumptions

- 1) Internal rate of return includes 3 parts as follows
 - 1.1) revenue from the increasing distribution of electric energy during the plan
 - 1.2) revenue from the original distribution of electric energy got from replacement of worn-out equipment
 - 1.3) loss value due to reducing outage period (only in case of EIRR)
- 2) Investment Cost
 - In case of EIRR: the investment cost is at 2016 constant price including contingencies, but excluding imported tax.
 - In case of FIRR: the investment cost is at market price including imported tax and contingencies.
- 3) The operating and maintenance expenses are calculated at 3.0% of investment cost.
- 4) Project Life: 25 years
- 5) Weighted Average Cost of Capital (WACC)
 - In case of EIRR: rate of 5.65% is used.
 - In case of FIRR: rate of 5.00% is used.
- 6) Energy loss: equal to 3.60% of energy purchased from EGAT.

The highlight of the Eleventh Power Plan, 2012-2016 and the comparison of investment cost in: Base Case and sensitivity study can be summarized as shown in Table 8-1.

8.2 Net Present Value (Economic Profit) method (NPV (EP))

Assumptions

- 1) The Internal Rate of Return is calculated on increasing revenues from energy sale.
- 2) Investment Cost: using investment cost as a market price including import tax and contingencies.
- 3) The operating and maintenance expenses are calculated at 3% of investment cost.
- 4) Project Life: 25 years
- 5) Weighted Average Cost of Capital (WACC): rate of 5.00% is used.
- 6) Energy loss: equal to 3.60% of energy purchased from EGAT.

Table 8-1: Load Forecast and Investment Cost under the Twelfth Power Distribution System Improvement and Expansion Plan Year 2017-2021 (Low case, Base case and High Case)

Description	Unit	Low case	Base case	High case
1. Supplemental Load Forecast				
1.1 Power demand	MW	1,031	1,540	2,070
1.2 Increasing Power Demand per annum	percentage	2.15	3.15	4.15
1.3 Energy purchased	Million Unit	5,958	8,905	11,969
1.4 Energy sale	Million Unit	5,690	8,532	11,486
1.5 Number of customers	number	379,618	379,618	379,618
2. Investment Cost				
2.1 Terminal Station and Substation System Program		Million Baht	Million Baht	Million Baht
		23,168	27,537	33,316
2.2 Subtransmission Line System Program	cct.-km	21,554	25,204	30,743
2.3 Medium and Low Voltage System Program		21,955	25,101	31,021
2.4 Uprating of 12 kV to 24 kV Primary Lines Program	sq.km.	600	665	894
2.5 Power Distribution Efficiency Improvement Program	project	3,862	4,343	4,343
Total		71,139	82,850	100,316

8.3 Results

Results of economic and financial analysis of the Twelfth Power Plan, 2017-2021 are demonstrated in Table 8-2 and Table 8-3 and their details are demonstrated in Table 8-4 to Table 8-10.

Table 9-2: The analysis results of the twelfth power distribution system improvement and expansion plan, year 2017-2021 by using NPV (FCF)

Item	Unit	Low Case	Base Case	High Case
Average rate of Increasing Power Demand per annum	Percentage	2.15	3.15	4.15
Economic Internal Rate of Return (EIRR)	Percentage	14.19	13.95	13.37
Financial Internal Rate of Return (FIRR)	Percentage	11.03	10.80	10.33

Table 8-3: The analysis results of the twelfth power distribution system improvement and expansion plan, year 2017-2021 by using NPV (EP)

Project:	The Twelfth Power Distribution System Improvement and Expansion Plan, Year 2017-2021	
Organization:	Metropolitan Electricity Authority (MEA)	
Date of Project:	2017	
Project Life (years):	25	
Rate of Tax:	0%	
Weighted Average Cost Of Capital (WACC):	5.00%	
Growth rate:	0.00%	
Objectives:		
To sufficiently meet the increasing power demand during 2012-2016 in a timely and qualified manner.		
Investment Evaluation Index		
Net Present Value (NPV):	50,540	Baht Million
Payback Period:	7	years
Discounted Payback Period:	10	years
Internal rate of return (IRR)	10.80	%
Profitability index (PI)	1.4	
Conclusion of the feasibility for the project		
It is worth for the investment with the return 10.80%		

Table 8-4: Economic Internal Rate of Return (EIRR) of the twelfth plan, year 2017-2021 in case of Low case

Year	Internal rate of return (million Baht)				Project expense (million Baht)			Net Cash	EIRR = 14.19%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Loss value due to reducing outage period	Total	Investment cost	Operating cost	Total		Discount Factor at 5.65%	Discount Cash
2558									1.0000	
2559									0.9466	
2560	558			558	12,066	362	12,428	-11,870	0.8960	-10,636
2561	1,301			1,301	12,664	742	13,406	-12,104	0.8481	-10,266
2562	2,151			2,151	13,629	1,151	14,779	-12,628	0.8028	-10,138
2563	3,130			3,130	11,662	1,501	13,162	-10,032	0.7599	-7,623
2564	4,233	6,277	547	11,057	6,737	1,703	8,440	2,617	0.7193	1,882
2565	4,233	6,277	547	11,057		1,703	1,703	9,354	0.6808	6,369
2566	4,233	6,277	547	11,057		1,703	1,703	9,354	0.6444	6,028
2567	4,233	6,277	547	11,057		1,703	1,703	9,354	0.6100	5,706
2568	4,233	6,277	547	11,057		1,703	1,703	9,354	0.5774	5,401
2569	4,233	6,277	547	11,057		1,703	1,703	9,354	0.5465	5,113
2570	4,233	6,277	547	11,057		1,703	1,703	9,354	0.5173	4,839
2571	4,233	6,277	547	11,057		1,703	1,703	9,354	0.4897	4,581
2572	4,233	6,277	547	11,057		1,703	1,703	9,354	0.4635	4,336
2573	4,233	6,277	547	11,057		1,703	1,703	9,354	0.4388	4,104
2574	4,233	6,277	547	11,057		1,703	1,703	9,354	0.4153	3,885
2575	4,233	6,277	547	11,057		1,703	1,703	9,354	0.3931	3,677
2576	4,233	6,277	547	11,057		1,703	1,703	9,354	0.3721	3,481
2577	4,233	6,277	547	11,057		1,703	1,703	9,354	0.3522	3,295
2578	4,233	6,277	547	11,057		1,703	1,703	9,354	0.3334	3,119
2579	4,233	6,277	547	11,057		1,703	1,703	9,354	0.3156	2,952
2580	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2987	2,794
2581	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2828	2,645
2582	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2676	2,504
2583	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2533	2,370
2584	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2398	2,243
2585	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2270	2,123
2586	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2149	2,010
2587	4,233	6,277	547	11,057		1,703	1,703	9,354	0.2034	1,902
2588	4,233	6,277	547	11,057		1,703	1,703	9,354	0.1925	1,801
2589	4,233	6,277	547	11,057		1,703	1,703	9,354	0.1822	1,705
Total	117,209	163,193	14,221	294,623	56,758	48,026	104,784	189,839	NPV = 52,202	

Table 8-5: Financial Internal Rate of Return (FIRR) of the twelfth plan, year 2017-2021 in case of Low case

Year	Internal rate of return (million Baht)			Project expense (million Baht)			Net Cash	FIRR = 11.03%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Total	Investment cost	Operating cost	Total		Discount Factor at 5.00%	Discount Cash
2558								1.0000	
2559								0.9524	
2560	558		558	13,479	404	13,884	-13,326	0.9071	-12,088
2561	1,301		1,301	14,444	838	15,281	-13,980	0.8639	-12,078
2562	2,151		2,151	16,011	1,318	17,329	-15,178	0.8228	-12,489
2563	3,130		3,130	13,921	1,736	15,656	-12,526	0.7836	-9,816
2564	4,233	6,277	10,510	8,193	1,981	10,174	336	0.7463	251
2565	4,233	6,277	10,510		1,981	1,981	8,529	0.7108	6,062
2566	4,233	6,277	10,510		1,981	1,981	8,529	0.6770	5,774
2567	4,233	6,277	10,510		1,981	1,981	8,529	0.6448	5,499
2568	4,233	6,277	10,510		1,981	1,981	8,529	0.6141	5,237
2569	4,233	6,277	10,510		1,981	1,981	8,529	0.5849	4,988
2570	4,233	6,277	10,510		1,981	1,981	8,529	0.5570	4,751
2571	4,233	6,277	10,510		1,981	1,981	8,529	0.5305	4,525
2572	4,233	6,277	10,510		1,981	1,981	8,529	0.5053	4,309
2573	4,233	6,277	10,510		1,981	1,981	8,529	0.4812	4,104
2574	4,233	6,277	10,510		1,981	1,981	8,529	0.4583	3,909
2575	4,233	6,277	10,510		1,981	1,981	8,529	0.4365	3,723
2576	4,233	6,277	10,510		1,981	1,981	8,529	0.4157	3,546
2577	4,233	6,277	10,510		1,981	1,981	8,529	0.3959	3,377
2578	4,233	6,277	10,510		1,981	1,981	8,529	0.3771	3,216
2579	4,233	6,277	10,510		1,981	1,981	8,529	0.3592	3,063
2580	4,233	6,277	10,510		1,981	1,981	8,529	0.3421	2,917
2581	4,233	6,277	10,510		1,981	1,981	8,529	0.3258	2,779
2582	4,233	6,277	10,510		1,981	1,981	8,529	0.3103	2,646
2583	4,233	6,277	10,510		1,981	1,981	8,529	0.2955	2,520
2584	4,233	6,277	10,510		1,981	1,981	8,529	0.2815	2,400
2585	4,233	6,277	10,510		1,981	1,981	8,529	0.2681	2,286
2586	4,233	6,277	10,510		1,981	1,981	8,529	0.2553	2,177
2587	4,233	6,277	10,510		1,981	1,981	8,529	0.2431	2,074
2588	4,233	6,277	10,510		1,981	1,981	8,529	0.2316	1,975
2589	4,233	6,277	10,510		1,981	1,981	8,529	0.2206	1,881
Total	117,209	163,193	280,402	66,048	55,813	121,860	158,541	NPV = 43,520	

Table 8-6: Economic Internal Rate of Return (EIRR) of the twelfth plan, year 2017-2021 in case of Base case

Year	Internal rate of return (million Baht)				Project expense (million Baht)			Net Cash	EIRR = 13.95%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Loss value due to reducing outage period	Total	Investment cost	Operating cost	Total		Discount Factor at 5.65%	Discount Cash
2558									1.0000	
2559									0.9466	
2560	920			920	15,178	455	15,634	-14,714	0.8960	-13,183
2561	2,236			2,236	16,049	937	16,986	-14,750	0.8481	-12,509
2562	3,563			3,563	17,304	1,456	18,760	-15,197	0.8028	-12,200
2563	5,048			5,048	14,228	1,883	16,111	-11,062	0.7599	-8,406
2564	6,348	6,277	574	13,199	8,380	2,134	10,514	2,685	0.7193	1,931
2565	6,348	6,277	574	13,199		2,134	2,134	11,065	0.6808	7,533
2566	6,348	6,277	574	13,199		2,134	2,134	11,065	0.6444	7,131
2567	6,348	6,277	574	13,199		2,134	2,134	11,065	0.6100	6,749
2568	6,348	6,277	574	13,199		2,134	2,134	11,065	0.5774	6,389
2569	6,348	6,277	574	13,199		2,134	2,134	11,065	0.5465	6,047
2570	6,348	6,277	574	13,199		2,134	2,134	11,065	0.5173	5,724
2571	6,348	6,277	574	13,199		2,134	2,134	11,065	0.4897	5,418
2572	6,348	6,277	574	13,199		2,134	2,134	11,065	0.4635	5,129
2573	6,348	6,277	574	13,199		2,134	2,134	11,065	0.4388	4,855
2574	6,348	6,277	574	13,199		2,134	2,134	11,065	0.4153	4,595
2575	6,348	6,277	574	13,199		2,134	2,134	11,065	0.3931	4,350
2576	6,348	6,277	574	13,199		2,134	2,134	11,065	0.3721	4,117
2577	6,348	6,277	574	13,199		2,134	2,134	11,065	0.3522	3,897
2578	6,348	6,277	574	13,199		2,134	2,134	11,065	0.3334	3,689
2579	6,348	6,277	574	13,199		2,134	2,134	11,065	0.3156	3,492
2580	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2987	3,305
2581	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2828	3,129
2582	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2676	2,961
2583	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2533	2,803
2584	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2398	2,653
2585	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2270	2,511
2586	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2149	2,377
2587	6,348	6,277	574	13,199		2,134	2,134	11,065	0.2034	2,250
2588	6,348	6,277	574	13,199		2,134	2,134	11,065	0.1925	2,130
2589	6,348	6,277	574	13,199		2,134	2,134	11,065	0.1822	2,016
Total	176,811	163,193	14,931	354,935	71,139	60,219	131,358	223,577	NPV =60,884	

Table 8-7: Financial Internal Rate of Return (FIRR) of the twelfth plan, year 2017-2021 in case of Base case

Year	Internal rate of return (million Baht)			Project expense (million Baht)			Net Cash	FIRR = 10.80%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Total	Investment cost	Operating cost	Total		Discount Factor at 5.00%	Discount Cash
2558								1.0000	
2559								0.9524	
2560	920		920	16,977	509	17,486	-16,566	0.9071	-15,027
2561	2,236		2,236	18,319	1,059	19,378	-17,142	0.8639	-14,809
2562	3,563		3,563	20,348	1,669	22,017	-18,454	0.8228	-15,184
2563	5,048		5,048	17,003	2,179	19,182	-14,134	0.7836	-11,076
2564	6,348	6,277	12,625	10,203	2,485	12,688	-64	0.7463	-48
2565	6,348	6,277	12,625		2,485	2,485	10,139	0.7108	7,207
2566	6,348	6,277	12,625		2,485	2,485	10,139	0.6770	6,864
2567	6,348	6,277	12,625		2,485	2,485	10,139	0.6448	6,537
2568	6,348	6,277	12,625		2,485	2,485	10,139	0.6141	6,226
2569	6,348	6,277	12,625		2,485	2,485	10,139	0.5849	5,930
2570	6,348	6,277	12,625		2,485	2,485	10,139	0.5570	5,648
2571	6,348	6,277	12,625		2,485	2,485	10,139	0.5305	5,379
2572	6,348	6,277	12,625		2,485	2,485	10,139	0.5053	5,123
2573	6,348	6,277	12,625		2,485	2,485	10,139	0.4812	4,879
2574	6,348	6,277	12,625		2,485	2,485	10,139	0.4583	4,647
2575	6,348	6,277	12,625		2,485	2,485	10,139	0.4365	4,426
2576	6,348	6,277	12,625		2,485	2,485	10,139	0.4157	4,215
2577	6,348	6,277	12,625		2,485	2,485	10,139	0.3959	4,015
2578	6,348	6,277	12,625		2,485	2,485	10,139	0.3771	3,823
2579	6,348	6,277	12,625		2,485	2,485	10,139	0.3592	3,642
2580	6,348	6,277	12,625		2,485	2,485	10,139	0.3421	3,468
2581	6,348	6,277	12,625		2,485	2,485	10,139	0.3258	3,303
2582	6,348	6,277	12,625		2,485	2,485	10,139	0.3103	3,146
2583	6,348	6,277	12,625		2,485	2,485	10,139	0.2955	2,996
2584	6,348	6,277	12,625		2,485	2,485	10,139	0.2815	2,854
2585	6,348	6,277	12,625		2,485	2,485	10,139	0.2681	2,718
2586	6,348	6,277	12,625		2,485	2,485	10,139	0.2553	2,588
2587	6,348	6,277	12,625		2,485	2,485	10,139	0.2431	2,465
2588	6,348	6,277	12,625		2,485	2,485	10,139	0.2316	2,348
2589	6,348	6,277	12,625		2,485	2,485	10,139	0.2206	2,236
Total	176,811	163,193	340,005	82,850	70,040	152,890	187,115	NPV = 50,540	

Table 8-8: Economic Internal Rate of Return (EIRR) of the twelfth plan, year 2017-2021 in case of High case

Year	Internal rate of return (million Baht)				Project expense (million Baht)			Net Cash	EIRR = 13.37%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Loss value due to reducing outage period	Total	Investment cost	Operating cost	Total		Discount Factor at 5.65%	Discount Cash
2558									1.0000	
2559									0.9466	
2560	1,082			1,082	18,413	552	18,966	-17,883	0.8960	-16,023
2561	2,549			2,549	19,568	1,139	20,707	-18,159	0.8481	-15,400
2562	4,255			4,255	21,125	1,773	22,898	-18,643	0.8028	-14,966
2563	6,255			6,255	16,895	2,280	19,175	-12,920	0.7599	-9,818
2564	8,546	6,277	603	15,425	10,088	2,583	12,670	2,755	0.7193	1,982
2565	8,546	6,277	603	15,425		2,583	2,583	12,843	0.6808	8,744
2566	8,546	6,277	603	15,425		2,583	2,583	12,843	0.6444	8,276
2567	8,546	6,277	603	15,425		2,583	2,583	12,843	0.6100	7,834
2568	8,546	6,277	603	15,425		2,583	2,583	12,843	0.5774	7,415
2569	8,546	6,277	603	15,425		2,583	2,583	12,843	0.5465	7,019
2570	8,546	6,277	603	15,425		2,583	2,583	12,843	0.5173	6,644
2571	8,546	6,277	603	15,425		2,583	2,583	12,843	0.4897	6,289
2572	8,546	6,277	603	15,425		2,583	2,583	12,843	0.4635	5,953
2573	8,546	6,277	603	15,425		2,583	2,583	12,843	0.4388	5,635
2574	8,546	6,277	603	15,425		2,583	2,583	12,843	0.4153	5,334
2575	8,546	6,277	603	15,425		2,583	2,583	12,843	0.3931	5,049
2576	8,546	6,277	603	15,425		2,583	2,583	12,843	0.3721	4,779
2577	8,546	6,277	603	15,425		2,583	2,583	12,843	0.3522	4,523
2578	8,546	6,277	603	15,425		2,583	2,583	12,843	0.3334	4,282
2579	8,546	6,277	603	15,425		2,583	2,583	12,843	0.3156	4,053
2580	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2987	3,836
2581	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2828	3,631
2582	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2676	3,437
2583	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2533	3,254
2584	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2398	3,080
2585	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2270	2,915
2586	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2149	2,759
2587	8,546	6,277	603	15,425		2,583	2,583	12,843	0.2034	2,612
2588	8,546	6,277	603	15,425		2,583	2,583	12,843	0.1925	2,472
2589	8,546	6,277	603	15,425		2,583	2,583	12,843	0.1822	2,340
Total	236,336	163,193	15,669	415,198	86,089	72,895	158,984	256,214	NPV =	67,938

Table 8-9: Financial Internal Rate of Return (FIRR) of the twelfth plan, year 2017-2021 in case of High case

Year	Internal rate of return (million Baht)			Project expense (million Baht)			Net Cash	FIRR = 10.33%	
	Revenue from the increasing distribution of electric energy during the plan	Revenue from the original distribution of electric energy got from replacement of worn-out equipment	Total	Investment cost	Operating cost	Total		Discount Factor at 5.00%	Discount Cash
2558								1.0000	
2559								0.9524	
2560	1,082		1,082	20,613	618	21,231	-20,149	0.9071	-18,277
2561	2,549		2,549	22,348	1,289	23,637	-21,088	0.8639	-18,219
2562	4,255		4,255	24,856	2,035	26,890	-22,635	0.8228	-18,624
2563	6,255		6,255	20,207	2,641	22,847	-16,592	0.7836	-13,003
2564	8,546	6,277	14,823	12,293	3,009	15,302	-480	0.7463	-358
2565	8,546	6,277	14,823		3,009	3,009	11,813	0.7108	8,397
2566	8,546	6,277	14,823		3,009	3,009	11,813	0.6770	7,997
2567	8,546	6,277	14,823		3,009	3,009	11,813	0.6448	7,617
2568	8,546	6,277	14,823		3,009	3,009	11,813	0.6141	7,254
2569	8,546	6,277	14,823		3,009	3,009	11,813	0.5849	6,909
2570	8,546	6,277	14,823		3,009	3,009	11,813	0.5570	6,580
2571	8,546	6,277	14,823		3,009	3,009	11,813	0.5305	6,267
2572	8,546	6,277	14,823		3,009	3,009	11,813	0.5053	5,969
2573	8,546	6,277	14,823		3,009	3,009	11,813	0.4812	5,685
2574	8,546	6,277	14,823		3,009	3,009	11,813	0.4583	5,414
2575	8,546	6,277	14,823		3,009	3,009	11,813	0.4365	5,157
2576	8,546	6,277	14,823		3,009	3,009	11,813	0.4157	4,911
2577	8,546	6,277	14,823		3,009	3,009	11,813	0.3959	4,677
2578	8,546	6,277	14,823		3,009	3,009	11,813	0.3771	4,455
2579	8,546	6,277	14,823		3,009	3,009	11,813	0.3592	4,243
2580	8,546	6,277	14,823		3,009	3,009	11,813	0.3421	4,041
2581	8,546	6,277	14,823		3,009	3,009	11,813	0.3258	3,849
2582	8,546	6,277	14,823		3,009	3,009	11,813	0.3103	3,665
2583	8,546	6,277	14,823		3,009	3,009	11,813	0.2955	3,491
2584	8,546	6,277	14,823		3,009	3,009	11,813	0.2815	3,325
2585	8,546	6,277	14,823		3,009	3,009	11,813	0.2681	3,167
2586	8,546	6,277	14,823		3,009	3,009	11,813	0.2553	3,016
2587	8,546	6,277	14,823		3,009	3,009	11,813	0.2431	2,872
2588	8,546	6,277	14,823		3,009	3,009	11,813	0.2316	2,736
2589	8,546	6,277	14,823		3,009	3,009	11,813	0.2206	2,605
Total	236,336	163,193	399,529	100,316	84,829	185,146	214,383	NPV =	55,819

