DISTRIBUTION INVESTMENT REGULATION: PRINCIPLES AND PRACTICES IN POWER SECTOR OF ARMENIA

Final Report

June 2019

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Acknowledgement

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Valuable comments were received from peer reviewers Katharina Gassner and Victor Loksha. The report also benefited from valuable ideas, opinions, and expertise of Richard Schlirf.

The financial and technical support by the Energy Sector Management Assistance Program (ESMAP) is gratefully acknowledged. ESMAP—a global knowledge and technical assistance program administered by the World Bank—assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Canada, ClimateWorks Foundation, Denmark, the European Commission, Finland, France, Germany, Iceland, Italy, Japan, Lithuania, Luxembourg, the Netherlands, Norway, the Rockefeller Foundation, Sweden, Switzerland, the United Kingdom, and the World Bank.

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Acronyms

AMD	Armenian Drams
bln	Billion
CAIDI	Customer Average Interruption Duration Index
ENA	“Electric Networks of Armenia” CJSC
EPSO	Electric Power System Operator
GoA	Government of Armenia
HVEN	High Voltage Electric Networks
kV	Kilovolt
kWh	Kilowatt Hour
mln	Million
MoENR	Ministry of Energy and Natural Resources of Armenia
PBR	Performance Based Regulation
PSCS	Power supply monitoring and control system
PSRC	Public Services Regulatory Commission of Armenia
RoA	Republic of Armenia
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
US$	United Stated dollar
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital

Objective the Study

1. The objective of this study is to identify the factors that need to be improved in the existing regulatory framework with respect to regulation of investments at power distribution level. The study was initiated by the World Bank to inform the thinking of Public Services Regulatory Commission (PSRC) on further improvements that may be required in the process of preparation, review and approval of investments for power distribution company and some other incremental improvements in the regulatory framework for the power distribution. The primary aim of those improvements would be to increase the efficiency of investments and clearly link those to the quality of electricity service for consumers. This link is currently not well-established, and the investment program submitted by the power distribution company does not clearly justify the relevant investments by the quantitative targets of electricity supply improvements. Additionally, there are some other inefficiencies in regulatory framework and end-user tariff structure.

2. The key next steps would be for the PSRC to carry out the public consultations of the proposed regulatory improvements following the requirements of public disclosure and consultations as per PSRC regulations, and draft the amendments to the relevant regulations to start implementing those.

3. The study focuses exclusive on the investment planning, review, and approval issues related to power distribution company. The similar issues may exist also on the power transmission level; however, those are beyond the scope of this analytical work. It should also be noted that some of the recommendations may also apply to other sectors (e.g. power generation and transmission), however, those are outside of the scope of this study.

4. The key data on historical and planned investments directions and the costs was based on the publicly available reports of Electric Networks of Armenia (ENA) published on the PSRC's web-site. The data on electricity supply reliability indicators, such as System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI), is taken from the publicly-available PSRC reports.

5. Power sector investments are essential for ensuring reliable, safe and quality services to consumers. Assuming cost-reflective tariffs principles, these investments will also significantly affect the level of end-user tariffs. It is therefore essential for investments to be used, useful, and realized at minimum cost. Regulatory frameworks should incentivize operators to realize investments under such principles. Power system investments[1] consist of three major components: investments in generation, power transmission; distribution and supply assets.

6. PSRC regulates investments in the Armenian power sector. PSRC is also responsible for tariff setting, service quality and licensing of power sector activities. PSRC pre-approves ex ante investment plans and validates ex post the final values considered for tariff determination on basis of a used and useful principle.

7. The analyses and recommendations of this report were specifically focused on the investments in the power distribution network made by the privately-owned power distribution company - ENA. ENA has the largest 5-year investment program in the power sector at around AMD97.4 billion (US$200 million)[2] for the 2017-2021 period. ENA is the single buyer and single seller of electricity in the country. ENA provides distribution and supply services to about 1 million customers, including 850,000 households. Summarized below are the key issues identified as part of this study and the proposed recommendations to address them.

8. **Issue No. 1: Capital expenditures in power distribution have not been prioritized based on detailed cost-benefit analysis (CBA) and no electricity service quality targets have been specified at distribution level**. The review of power distribution investments in 2011-2015 with total volume of AMD44.3 billion suggests that 31 percent was allocated to service quality improvements. However, basic quality indicators such as SAIFI and SAIDI showed no improvement over the same period. Moreover, capital expenditures in the approved power distribution investment plans were no linked to specific service reliability targets.

9. **Recommendation**: **PSRC to consider requiring the power distribution company to link power sector investments to service quality improvements.** The sector and the investment regulation would benefit from the implementation of a *performance-based regulatory regime* (PBR), with a focus on CBA of investments and on service quality indicators (e.g. outages and voltage fluctuations), which are important issues in Armenia. PSRC has been computing and publishing service quality indicators, including SAIFI, SAIDI, number of voltage fluctuations, since 2007. PSRC should require ENA to use those indicators as outcomes in its investment plans. Additionally, ENA should be required to present detailed economic CBA to justify prioritization of investments. The use of proposed PBR approach, coupled with thorough review of investment plans by the regulator prior to approval, would also eliminate the need for ex-post sample-based audit of investments by PSRC, where the company and PSRC do not easily agree on conclusions from such ex-post audits.

10. It should also be noted that requirement for detailed CBA for distribution investments would ensure that the proposed investments are economically justified and would not lead to unjustified

[1] Investments referred to in this report include tangible assets and software.
[2] 2015 average annual exchange rate: 1US$1=AMD478.

increases of end-user tariffs. Under current framework, the inclusion of constructed assets into the regulated asset based takes place after ex-post audit by PSRC of a sample of investments. This is not an efficient process.

11. **Issues No. 2: Ex-post review by PSRC of investments implemented by ENA.** Currently, due to absence of PBR, PSRC does an ex-post review of the investments to decide on the size of the investments by ENA that will be included into the regulated asset base. However, the standards and rules that PSCR follows to determine recoverable efficient investment costs are not clear and such reviews often time result in extended disputes between ENA and PSRC. Moreover, PSCR does not have all required types of in-house specialists to perform such assessments.

12. **Recommendation: PSRC to consider focusing on thorough review of ENA's capital investment programs instead of ex-post audits**. The assessment of the "used, useful, and efficient" nature of the assets is one of the most difficult tasks of regulators. The introduction of PBR system would limit or eliminate the need for such ex-post audits given that ENA would have incentives to achieve the specified service quality indicators even if it manages to realize investment cost savings. However, successful implementation of PBR would require thorough review of investment plans by PSRC prior to approval and this may require involvement of a specialized engineering firm unless PSRC builds the required in-house capacity. The task is essential because service quality improvement related investments are expected to account for 32 percent for the period from 2016 to 2020. The other large category is related to connection of new customers, which account for 50 percent of investments. However, the efficiency of this category is relatively easy to assess because regulatory commission has detailed knowledge about technical aspects and costs.

13. **Issue No. 3: Cost of capital used by PSRC in ENA's tariff margin computation is not adjusted regularly to reflect changes in the financial market conditions impacting the cost of borrowing**. As per current approach, the after-tax return on investments should not be lower than 12 percent. While this approach could be in favor of the energy companies, it could result in higher-than-justified end-user tariffs if the financial market and risk conditions warrantee an after-tax cost of capital lower than this 12 percent. The issue is exacerbated by the fact that current tariff-setting regime does not allow factoring in the interest during construction period of new assets. As a result, ENA is incentivized to invest only in short term projects that can be completed during a year. This practice is suboptimal: if assets are not "recognized" in tariffs until they are operational, an interest rate should be taken into account during construction period. Various approaches are used internationally for the determination of that interest rate.

14. **Recommendation**: **PSRC to considering using the approach of predefined weighted average cost of capital (WACC) to compute the allowed return of energy companies on regulated asset base**. The regulations should not include a reference to a specific figure for the return on investments. Instead, the WACC should be computed by regulator. Specifically, it should be assumed to be comprised of certain percentage of debt (e.g. 60 or 70 percent) and equity (40 and 30 percent). The elements included into computation of real cost of debt and pre-tax cost of equity should be transparent and include the real risk-free cost of debt (e.g. government bonds), debt premium, equity risk premium, and equity beta (volatility compared to the broader market). The WACC should be adjusted regularly (once in two or three years) to reflect changes in the market conditions.

15. **Issue N. 4: Lack of fixed charge in end-user tariffs is not conducive to distribution investments.** Fixed transmission and distribution network and retail costs represent approximately 30 percent of

the total sector costs. The end-user tariff structure in Armenia does not include a fixed charge that would reflect such costs (all costs are energized). This is not conducive to distribution investments, especially in some cases where the future network extensions cover low-income users with low consumption (as it would not allow for proper fixed cost recovery).

16. **Recommendation.** Consider introducing two-part end-user tariff structure, which would allow to make return on distribution investments more predictable. The proposed end-user tariff structure includes:

- **Per kWh charge.** Per kWh charge reflects energy and capacity costs, which differ based on the time of use. Capacity costs would ideally be based on a per kW charge, particularly for the largest customer classes (commercial and industrial) whose demand can pose a capacity constraint at the distribution level. However, data were not available to estimate a per kW charge based on monthly demand.
- **Fixed monthly charge.** The fixed monthly charge reflects costs incurred with the addition of each new customer. These include the cost of investment in meters as well as investments in and operations and maintenance of local distribution facilities.

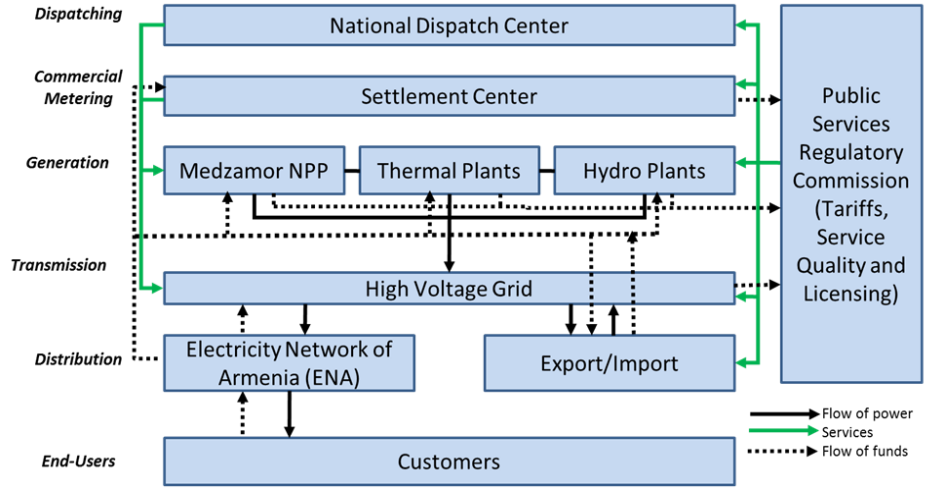
Part A. Existing Investment Regulation Framework

Part A. Current Situation

I. Overall Regulatory Framework for Investments

17. The power system is unbundled and consists of independent electricity generation, transmission, and distribution companies as well as the electric power system operator (EPSO) and the settlement center. The power system is regulated by an independent regulatory agency – PSRC. The regulatory framework is overall adequate with tariff-setting methodology allowing for cost-recovery. Presented below is the summary description of key entities in the power sector and their responsibilities:

Figure 1. Power Sector Structure.



Source: Project Appraisal Document for Power Sector Financial Recovery Program-for-Results of the World Bank (2016).

- **Generation:** Independent companies providing capacity and energy services as per schedules agreed upon with EPSO and under electricity sale contracts with the power distribution company.
- **Transmission:** The state-owned High Voltage Electric Networks of Armenia (HVEN) maintains and develops the high-voltage electric network in the country.
- **Distribution:** ENA operates and develops the distribution network. ENA is owned by Liormand Holding and Inter-energo B.VENA, which are 100 percent owned by the privately-owned Tashir Group (Russia). ENA is the single buyer and single seller of electricity in the country and all generating plants are required to sell to ENA. There is no competitive power market either on distribution or on generation side. Distribution is not unbundled from supply. ENA provides distribution and supply services to about 1 million customers, including 850,000 households. Distribution network is operating at voltages ranging from 110 kV to 0.4 kV: up to delivery points of all the customers, including households. It consists of 200

transformers at 110 kV and 2,800 km of 110kV lines, 400 transformers at 35 kV and 2400 km lines, 9,400 transformers at 6(10) kV and 12,250 km lines as well 15,000 km of 0.4 kV lines.

- **System Operation and Dispatch:** EPSO is 100 percent state-owned joint stock company and is responsible for managing transmission and dispatch of generation to meet the domestic demand as well as exports and imports.
- **Settlement Centre:** The Settlement Centre is 100 percent state-owned joint stock company and conducts commercial settlements between electricity generators and the single buyer as well as electricity exports and imports. It does not take any risks in case of payment shortfalls by ENA given that it receives a small fixed annual monetary payment for its services associated with domestic supply and a fixed per kWh fee its services related to exports.
- **Regulation:** The sector is regulated by the PSRC, an independent state regulator responsible for tariff setting, service quality and licensing.

18. Relations among power sector entities and PSRC are governed by the Energy Law of Armenia as well as secondary legislation adopted by PSRC and License agreements.

19. The Energy Law defines[3] that one of the main means of regulation is the review of investment plans submitted by licensed entities to PSRC for approval and inclusion in rate base. According to the Energy Law,[4] PSRC reviews investment plans of licensed entities and makes decisions whether to approve the proposed investments and include them into the rate base. Moreover, the Energy Law defines[5] that entities holding a license must submit their investment plans to the PSRC for approval.

20. The Investment Review procedures are established by the PSRC Decision Procedures for Review of Investment Plans.[6] In accordance with the above decision, investments should be aimed at expanding, replacing or improving core business related assets. The investment plans should be approved ex ante by PSRC's decision through a public hearing procedure. Representatives of non-governmental organizations (NGOs) have a right to take part in those public hearings to protect interests of customers.

21. The License Agreement[7] additionally specifies that ENA should submit 3-5-year investment plan for PSRC approval each year before 15th of October. The prudent level of actual investments will be recovered through a 4 percent average depreciation rate and the company should get a post-tax profit on those investments that should not be lower than 12 percent. These dispositions are not adequate: (i) the accounting depreciation rate should not be unique, but adapted to the type and technical life of assets; (ii) the "post-tax profit" should not have a fixed threshold; this profit depends on the cost of capital that is related to the level of interest free risk rates, country and regulatory risks and other factors not subject to such threshold.

[3] Energy Law of Armenia, Article 10, (g)
[4] Energy Law of Armenia, Article 17, (jd)
[5] Energy Law of Armenia, Article 28, (g)
[6] PSRC's Decision N365 of 2010 on Investment Coordination Procedures.
[7] License Agreement of the ENA approved by the PSRC's N79 decree of 2002.

22. PSRC is receiving quarterly reports[8] from the licensed companies on the actual investments. The reports are reviewed according to the Prudent Investment Rule.[9] However, it should be noted that there are no exact standards and rules how the PSRC determines recoverable investment costs.

23. The distribution network should meet specified reliability, safety and service quality requirements in the short- and long-term through an adequate investment planning, implementation and monitoring systems. The primary objective of the power distribution company should be to ensure uninterrupted power supply to consumers at minimum cost, while complying with the specified reliability and quality indicators for any period. In other words, the key objectives of the power distribution network should be:

- Providing electricity service access at minimum cost to all consumers who wish to be connected and purchase electricity;
- Have sufficient network capacity to meet the peak demand of those consumers;
- Provide satisfactory continuity of service (reliability) to the connected consumers; and
- Provide stable voltage quality regardless of load level or conditions.

II. Investment Plan Review Procedures of PSRC

24. According to Investment Review Procedures, investment plans of the regulated companies should be aimed at meeting one or more of the following priorities:

a. increase of electricity production,
b. improvement of service quality,
c. reduction of technical and commercial losses,
d. replacement of depreciated assets,
e. increase of safety and reliability,
f. environmental protection,
g. energy efficiency,
h. innovation and new technologies, as well as effective use of local resources,
i. fulfillment of PSRC's or other eligible bodies' legal requirements,
j. other activities aimed at increasing the overall efficiency of licensed activity.

25. According to above regulation, an investment plan must include:

a. justification of investment priorities,
b. expected results for each component,
c. budget estimate for each component,
d. implementation timetable,
e. sources and terms of financing.

26. The current Investment Review Procedure does not require the distribution company to develop a long-term plan for meeting the forecasted peak demand. Currently, investment plans of

[8] PSRC's Decision N166 of 2012 on the Actual Investment Reporting Forms
[9] Prudent Investment Rule refers to a series of standards, which determine the fiscal soundness of a utility in the course of rate recovery for recoverable capital costs to be determined by PSRC.

the distribution company do not contain quantifiable outcome indicators, which will be used to measure whether the goals specified in the investment plan were achieved.

27. While reviewing investment plans, the PSRC's staff focuses on below:

- Review of priorities, justification and economic efficiency of the proposed investments included in the investment plan. For this purpose, there is a separate department (Economic Department), which is responsible for review of investment projects and for the evaluation of actual investments. However, the investment plans do not undergo rigorous evaluation process based on economic cost-benefit analyses.
- Identification of investments aimed to resolve technical problems (low voltage, frequency of outages, metering, etc.), which were identified when compiling the data to compute SAIDI and based on consumer complaints, which are registered by PSRC
- Discussions with representatives of ENA and NGO's,
- Development of draft decrees for approval of investment plans taking into account results of discussions and submission of those decrees to commissioners to make final decisions.

28. The commissioners may make decisions by fully or partially approving an investment plan. Representatives of the Government and NGOs protecting consumers' interests take part in the sessions of PSRC. Media also is present during such sessions.

29. It should be noted that recently PSRC introduced the practice of determining the priorities in investment plans. In such cases, investments for non-priority projects are included in the tariff only after completion of priority projects. Non-priority investments, which do not exceed 10 percent of the total, are mainly financing improvement of administrative buildings, purchase of office furniture, computers, software, transportation and other assets for improvement of business processes.

30. PSRC should approve or reject investment plans during 60 working days from the submission date. If PSRC has comments and suggestions on the investment plans, then those should be communicated to respective companies in 30 working days. After receipt of requested clarifications and responses, PSRC should make final decision on the investment plan within 30 working days. Companies are allowed to make changes in the approved investment plans during the year. Changes are made in the investment plans through the same procedures presented above, in case variation orders exceed 3 percent of the approved investment plan. In case of variations below 3 percent, the procedure is streamlined, and companies are only required to send a notification to PSRC and request written response.

III. Investment Priorities of ENA

31. The investments in ENA investment plans are typically subdivided into four components. First component relates to the service quality, mainly power interruptions and voltage fluctuations. The second and third components are targeting new connections and metering. The fourth component includes investments aimed to improving efficiency of the business processes or other activities within the company. These priorities have remained the same during last ten years. Below is the structure of the ENA's 2011-2015 investment plans of 2011-2015. Investments in power distribution reduced significantly staring from 2012 because of the deterioration of the financial standing of ENA and accumulation of financial losses. The deterioration was caused by deficiency in the tariff

methodology for adjustment of its margin. Specifically, in 2012-2014, ENA incurred a cumulative loss of AMD25 billion due to revenue shortfall because its margin was not adjusted by the PSRC to fully reflect the difference between the actual and forecast cost of purchased electricity. The difference between the actual and forecast cost of purchased electricity is important for financial health of ENA because if the actual cost of electricity is larger than the forecast, then ENA incurs a loss. As per current regulatory approach (specified in the ENA's License), that loss is recovered in equal installments in three years and it does not include compensation for interest costs ENA incurs to finance the shortage of working capital until the losses are compensated.

32. There was material deviation between the actual and forecast cost of electricity due to lower-than-forecast generation from hydropower plants (HPPs) from poor hydrology conditions in 2012-2014, and longer-than-planned periodic maintenance of Armenian Nuclear Power Plant (ANPP) in 2013. ENA had to make up for electricity supply shortfall from low-cost HPPs and ANPP by buying substantially more expensive electricity from Hrazdan TPP and Hrazdan-5 Thermal Power Plants, which are the two most expensive generating plants in the power system. The additional electricity purchase costs of ENA were not fully compensated within one-year period, which is the accepted practice. As part of the Government's Financial Recovery Program for Power Sector (2016), which was also supported by the World Bank's Power Sector Financial Recovery Program-for-Operations, the shortcoming in the methodology was fixed and ENA has significantly improved its financial performance since then. However, the details of ENA's financial performance are not the focus of this report.

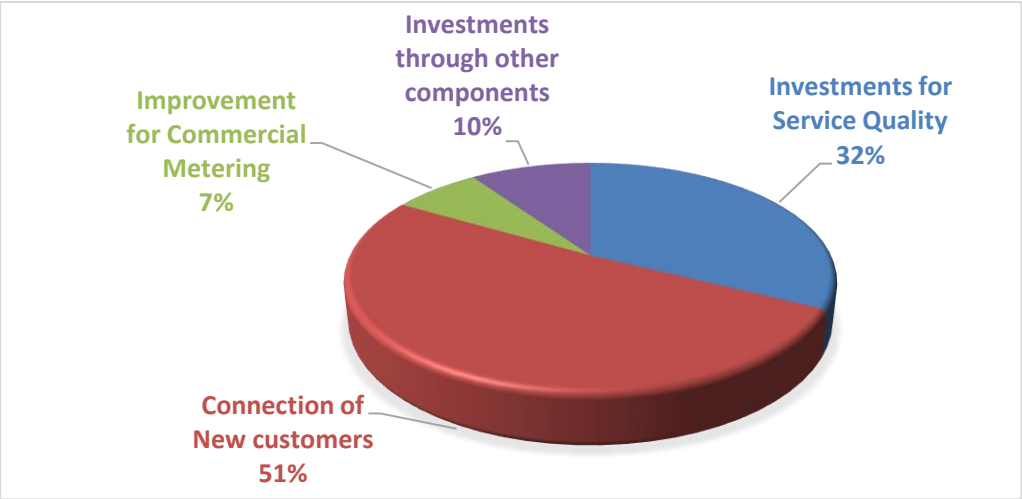
Table 1: ENA's 2011-2015 Investment Plan (in million AMD, VAT exclusive).

N	The main components of investment plan	2011	2012	2013	2014	2015	Totally
1	Investments targeting Service Quality	8,258.6	2,244.0	2,094.0	1,850.0	2,208.2	16,654.8
2	Connections of New Customers	7,180.2	3,966.0	4,468.7	6,205.0	4,412.3	26,232.2
3	Improvement of Commercial Metering	1,251.5	1,304.0	395.53	226.6	399.9	3,577.5
4	Investments through other components	1,508.0	918.0	547.42	654.9	1,314.3	4,942.6
5	**Total**	**18,198.3**	**8,432.0**	**7,505.7**	**8,936.5**	**8,334.7**	**51,407.1**

Source: Investment Plan Implementation Reports by ENA.

33. Total distribution of the investments between the priorities during the 2011-2015 is presented below:

Figure 2. Distribution of Investment Priorities.



Source: Public Services Regulatory Commission.

a. Investments Targeting Service Quality

34. Investments targeting service quality are mainly aimed at reducing average duration and frequency of outages, which are measured by SAIDI and SAIFI indicators, as well as problems of voltage fluctuations.

35. This component accounts for 32 percent of the total investments. This component includes main projects for reconstruction of 110 kV lines and substations, as well as for repairing distribution assets of medium and low voltage range in residential areas. This component also includes a list of projects, which were prioritized taking into account customers' complaints related to service quality. Those are targeting the sections of the distribution network with the lowest levels of reliability.

b. Investments for Connection of New Customers

36. The biggest component of the ENA's investment plan, which accounts for more than 50 percent of the overall investments, is the connection of new customers. While PSRC is determining the recoverable investment costs for the specific tariff period, the costumer connection fees are reduced from the total value of investments. However, customer connection fees during the same period do not exceed 20 percent of connection investments. Thus, the current customers pay the uncovered part of the investments for connecting new customers because additional revenue from the growth of the demand is considerably smaller. Furthermore, it should be mentioned that introduction of fixed charge for the customers will allow separating fixed costs and connection costs of the network, which will ensure a fair allocation of all the costs for different groups of customers.

37. This component also includes investments for rehabilitating the high voltage part (110 kV) of the distribution network, which is aimed at meeting the forecast demand in 3-5-year period, and takes into account the urban development programs.

c. Investments for Improvement of Commercial Metering System

38. Investments under this component, which accounts for 7 percent of the total, include expenses for changing obsolete meters, disposal of old meter boxes and installation of new boxes, as well as costs associated with installation of new smart meters covering areas of distribution network with

relatively higher losses. It should be noted that since 2016, ENA has initiated a new investment program to transition all the customers, including residential, into the smart metering system during the next 3-5 years.

d. Investments Through Other Components

39. This part of the investment plan includes projects for repairing administrative buildings, purchasing of office furniture, computers, software, transportation and other elements for improvement of business processes.

IV. Common Investment Prudency Rules

40. Analyses of investments are performed by the PSRC's staff on annual basis. The report presenting results of those analyses is published on the PSRC's website annually. This chapter presents a summary of the PSRC's analysis of such investment plans for the period of 2011-2015.

41. The company's annual report on the actual investments that is published until May 10th of the year following the fiscal year stands as a basis for analysis. It should be mentioned that the PSRC performs analysis of the projects that are already commissioned and operated as a Used and Useful asset. This stimulates companies to invest only for short term projects that can be completed during a year. For longer-term projects, PSRC doesn't allow reimbursement of the interest during the construction period. This practice is incorrect if assets are not "recognized" in tariffs until they are operational. The interest during construction should be recognized.

42. The investment analysis report of the PSRC has the following structure:

a. Composition of the investment plan,
b. Quantitative analysis: analysis of the volume of investments,
c. Qualitative analysis: efficiency of investment projects,
d. Procurement analysis,
e. Conclusions, including a table of the investments subject to recovery through tariffs.

a. Quantitative Analysis

43. This section provides quantitative analysis on the investment plan, mainly focused on the volumes of the investments as well as on proportionality of investments that was carried out by using the own workforce and equipment instead of hiring third party contractors. Below is a summary table of ENA's actual investments during 2011-2015.

Table 2: Structure of ENA's actual investments during 2011-2015 (in million AMD, VAT exclusive).

N	Main component of investment plan	2011	2012	2013	2014	2015	Total
1	Investments targeting Service Quality	7,788.5	2,061.1	1,393.12	1,387.7	1,297.4	**13,927.8**
2	Connections of New Consumers	6,536.1	3,753.1	4,064.79	5,153.4	2,886.0	**22,393.4**
3	Improvement in Commercial Metering	1,537.9	1,059.2	296.65	293.5	413.2	**3,600.4**
4	Other investments	1,348.5	1,342.6	503.06	307.7	851.1	**4,352.9**

N	Main component of investment plan	2011	2012	2013	2014	2015	Total
5	**Total**	**17,211.0**	**8,216.0**	**6,257.6**	**7,142.3**	**5,447.7**	**44,274.6**

Source: Investment Plan Implementation Reports by ENA.

44. If we compare investment plans of ENA approved by the PSRC with the actual volumes of investments, we will see that the program was substantially implemented (86 percent of the total planned) and the structure of actual investments is very close to the planned ones.

Table 3: Structure of ENA's planned and actual investments during 2011-2015.

N	Components of the investment plan	Planned for 2011-2015		Actuals for 2011-2015		Actual / Planned
		million AMD	%	million AMD	%	
1	Investments targeting Service Quality	16,654.8	32%	13,927.8	31%	0.84
2	Connections of New Consumers	26,232.2	51%	22,393.4	51%	0.85
3	Improvement to Commercial Metering	3,577.5	7%	3,600.4	8%	1.00
4	Other Investments	4,942.6	10%	4,352.9	10%	0.88
5	**Total**	**51,407.1**		**44,274.6**		**0.86**

Source: Investment Plan Implementation Reports by ENA.

45. PSRC provides a summary table for the proportionalities of investments, which were carried out by using the companies' own workforce and equipment vs third party contractors. This is a vital issue because ENA is already getting reimbursements for covering the labor costs as an operational expense, thus investments should not include any of costs (labor, maintenance, etc.) already included in the operational expenses. The following is the summary table for 2011-2015.

Table 4: Investments by using the Own Resources vs Third Party Contractors during 2011-2015 (in million AMD, VAT exclusive).

N	Main component of investment plans	2011	2012	2013	2014	2015	Total
1	Construction in progress of the previous years	2,785.6	348.5	363.5	1,657.8	1,225.7	6,381.0
2	Third Party Contractors	4,572.7	3,987.1	2,529.7	2,042.6	1,308.6	14,440.7
3	Fixed Assets (not requiring installation)	134.4	230.6	694.5	203.6	240.8	1,503.9
4	Investments by using own resources	9,718.3	3,650.0	2,670.0	3,238.2	2,672.6	21,949.0
4.1	*Labor*	329.0	*306.7*	*274.2*	*260.3*	*236.3*	*1,406.5*
4.2	*Raw materials*	1,892.9	*1,852.2*	*1,791.8*	*1,480.8*	*1,507.9*	*8,525.5*
4.3	*Equipment*	7,334.1	*1,145.0*	*556.7*	*1,138.6*	*799.8*	*10,974.2*
4.4	*Other*	162.3	*346.2*	*47.3*	*358.5*	*128.6*	*1,042.8*
5	**Total**	**17,211.0**	**8,216.1**	**6,257.6**	**7,142.2**	**5,447.7**	**44,274.6**

Source: Investment Plan Implementation Reports by ENA.

46. When performing quantitative analysis PSRC reviews the connection fees received from the customers as well as other possible income of the company related to the investments (parts from decommissioned assets used for investments, assets sold or acquired at no cost, etc.)

b. Qualitative Analysis

47. While performing Qualitative analysis, PSRC should use different indicators to screen investments to ensure that targets are achieved.

48. First, it should be mentioned that starting from 2004 ENA has been providing quarterly reports on the service quality indicators, which are published on the PSRC's web site.[10]

Those indicators include:

- power outages of the customers due to any reason (except non-payments),
- voltage fluctuations affecting customers,
- reliability of main electric equipment by voltage level (transformers, lines, etc.),
- power system frequency on hourly basis,
- customer complaints classified by groups.

49. PSRC has also published a full list of customers that were compensated[11] by the ENA when the distribution company failed to meet the individual service quality indicators.[12]

50. However, PSRC provides only very limited analysis describing only actual investments and changes in service quality indicators without any measurable outcomes and conclusions. Moreover, there are inaccuracies in data reported by ENA regarding power outages, which, in its turn, creates deviations of those indicators. It should be mentioned that there is no data acquisition system supporting data collection process, and everything is done through the dispatch center of the ENA. In case of voltage fluctuations there are no actual measurements. Voltage fluctuations are assessed through the engineering calculations provided by the Scientific Research Institute of Energy,[13] which again depends on the accuracy of the technical information (consumption, power flows, electrical schemes, etc.) provided by ENA. This has been the practice for over 10 years. On the one hand, ENA is making investments to improve service quality without having any proper instrument for measuring efficiency of these investments. On the other hand, PSRC is making decisions on efficiency of those investments without having any targets for the service quality indicators. Both the company and the regulator should take immediate actions for rectifying the situation.

b.1 Investments Targeting Power Outages

51. Investments aimed at reducing power outages have two main components. The first is to improve average SAIDI and SAIFI indicators, and the second is to improve the worst parts of the distribution network based on the actual reported situation and customer complaints. Starting from

[10] http://www.psrc.am/am/sectors/electric/service-quality-indicators

[11] The Distribution use and supply rules require that ENA pay penalties directly to the customers while failed to meet the individual service quality standards without being asked for that in any formal way. The maximum level of the penalty is about 5 USD, the actual average is about 2.5 USD. Annually about 25.000 getting penalties from the ENA through this mechanism.

[12] http://www.arlis.am/DocumentView.aspx?DocID=107826

[13] http://www.energinst.am/?lang=en

2017, PSRC requested ENA to provide information on quarterly basis for 10 distribution areas with the worst indicators for power outages, as well as the investments needed to improve the situation. Throughout the year this information should be collected and analyzed to include those areas in the next investment plans of the company.

52. There are no targets set for improvement of average SAIDI and SAIDI indicators. PSRC monitors the changes in these indicators without measuring efficiency of the investments aimed at improvement of those indicators.

53. The following table presents how investments affected power outages during the period of 2011-2015.

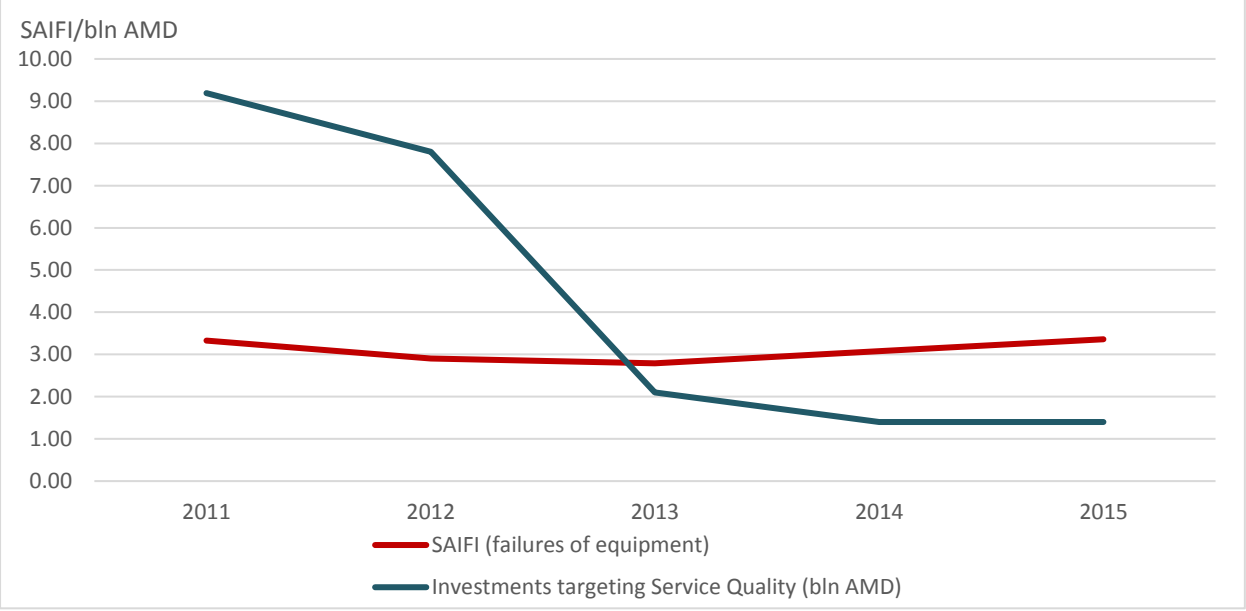
Table 5: Power Outages vs Investments for 2011-2015.

Indicator	Unit	2011	2012	2013	2014	2015
Average annual quantity of planned and unplanned outages per consumer	interruption of supply per consumer	1.86	1.62	1.48	1.36	1.41
Average annual unplanned outages due to equipment failurs[14]	interruption of supply per consumer	3.33	2.90	2.79	3.08	3.36
Investments targeting service quality	bln AMD	7.80	2.10	1.40	1.40	1.30
Total investments	bln AMD	17.20	8.20	6.30	7.10	5.40

Source: PSRC data.

54. There is no correlation between the service quality indicators and the investments aimed at improving reliability of power supply. The figure below shows the correlation between reliability related investments per customer in the given year and the average frequency of unplanned outages due to failures of equipment in the distribution network with one-year lag.

Figure 3: Power Outages vs Investments (shifted) for 2011-2015.



[14] "Equipment failures" cause large number of outages compared to "unplanned outages," which are service interruptions by ENA to carry out some works without prior notice to consumers.

Source: PSRC data.

55. The above figure shows lack of correlation between investments and power outages. While investments reduced substantially, power outages remained almost unchanged. The higher level of the investments in 2011 might explain the reductions of interruptions over the 2011-2013 period, and the subsequent reduction of investments the following years, may be the reason for reversal of those improvements in 2014 - 2015. Going forward, it would be essential to ensure that new investments are clearly linked to improvements in electricity supply reliability. Otherwise, incentives may be in place for ENA to make significant investments without clear linkages to improvement of electricity supply reliability at distribution level.

b.2 Investments Targeting Voltage Fluctuations

56. Investments targeting voltage fluctuation are small. There are 2,500 hours[15]/year/customer when the voltage fluctuations are observed. There are different areas of distribution grid where service quality is low, and the voltage is continuously in the range of 160-170 volts, which is 25 percent lower than it should be.

57. In case of voltage fluctuations, efficiency of investments is clearly measured. While ENA is asking for recovery of those investments, technical metering data should be provided on the actual voltage measurements for the part of the distribution grid that has been reconstructed under any investment project.

58. However, ENA's investment plan for voltage fluctuations is only formed based on the customer complaints and includes very limited parts of the distribution network. That does not affect even 1 percent of the customers while the incidence of low-quality service per customer is 13 times per year. Thus, investments aimed at improving voltage fluctuations should be increased dramatically. The Table 7 presents investments and voltage fluctuations during 2011-2015. It can be seen that voltage fluctuation related indicators are changing in both directions while practically there are no investments made.

Table 6: Voltage Fluctuations vs Investments for 2011-2015.

Indicator		2011	2012	2013	2014	2015
Average annual duration when customers received low quality electricity supply	hour per consumer	3,144.36	4,553.1	3,479.32	2,442.72	2,493.32
Average annual frequency when customers received low quality electricity	frequency per consumer	17.78	24.84	19.13	12.59	13.16
Investments targeting voltage fluctuations	bln AMD	0.45	0.31	0.026	0.036	0.028

Source: PSRC data.

b.3 Connection of the New Customers

[15] ENA's report on Voltage Fluctuations for 2015
http://www.psrc.am/images/docs/service/electric/2015/4-er/Larman_shexum_Ampop_4_15.xls

59. This is the biggest component in the investment plans and accounts for 51 percent of total investments. During 2011-2015, AMD22.4 billion was invested under this component. It consists of two main parts: (a) connection of new customers to the service; and (b), investments to cover the future demand.

60. PSRC receives a separate report on the customer connections that is providing detailed information on each customer connected to the distribution network and connection related expenditures incurred. While performing qualitative analysis, PSRC compares both reports and if the customer is not connected yet, but capital expenditures are included in the investment report, those are removed until the connection is completed. Therefore, the analysis performed for this component is effective and complete.

61. However, customer connection fees cover only 20 percent of the investments made under this component. Annually, ENA connects about 4,000 customers, which is only 0.4 percent of its current customer base. In 2011-2015, the electricity demand has been growing at an average annual rate of 2.2 percent. More than 80 percent of the new customers are the households with 0.22 kV connections without any significant expected demand growth. Introduction of a fixed charge that covers fixed costs and connection costs of the network will provide fare allocation of all the costs for different groups of customers.

62. Below is the table presenting investments supporting new connections compared to the number of the customers connected to the distribution grid.

Table 7: New Customers vs Investments for 2011-2015 (in million AMD, VAT exclusive).

Indicator	2011	2012	2013	2014	2015	Total
Investments to meet future demand	2,811.4	281.1	68.5	235.1	48.5	**3,444.6**
Investments to connect new customers	3,724.8	3,472.0	3,996.3	4,918.3	2,837.6	**18,949.0**
Number of new customers connected to the grid	-*	3,706	4,261	4,285	3,773	**16,025**
Customers connected to the 0.22 kV grid	-	*2,988*	*3,346*	*3,353*	*3,047*	12,734

Source: PSRC data.

b.4 Investments into Commercial Metering

63. It should be noted that 100 percent of consumption in Armenia is metered on commercial, residential, and other sectors. Investments under this component also consist of two main parts and account for 8 percent of the total investments (AMD3.6 billion). The first part includes investments to replace old commercial electro-mechanical induction meters with the electronic meters. The second part includes investments for installation of new Power Supply Monitoring and Control System (PSCS), i.e. smart metering system, and connection of customers.

64. About 35 percent of all customers are equipped with electronic meters. The cost of meter replacement for one customer is around AMD35,000, including AMD20,000 (VAT excluded) for a new meter and AMD15,000 (VAT excluded) for a new meter box and installation costs.

65. PSCS system is only installed in the areas with relatively high commercial losses. About 50,000 customers at the end of 2018 should be integrated into the PSCS system. Additional AMD15,000 is needed for integrating each customer in the system. This means that equipping each customer with an electronic meter and integrating into the metering system additional AMD31 billion will be needed.

66. Under the current approach, no quantitative analysis is performed for this component showing possible impact of such investments on further reduction of commercial losses, operational efficiencies in ENA, and on the tariffs. Such analysis will be needed when ENA starts investing more intensively in commercial metering. The following table presents investments for commercial metering.

Table 8: Investments for Commercial Metering 2011-2015 (in million AMD, VAT exclusive).

Component	2011	2012	2013	2014	2015	Total
Investments for installation of electronic meters	1,136.7	683.3	101.6	242.7	262.6	**2,426.9**
Investments to PSCS	401.2	375.9	195.0	50.8	150.6	**1,173.5**
Total	**1,537.9**	**1,059.2**	**296.6**	**293.5**	**413.2**	**3,600.4**

Source: PSRC data.

b.5 Other Investments

67. The investments through other components are generally aimed at covering the administrative needs of ENA. Those include computers, office furniture, cars, etc.

68. ENA invested AMD4.35 billion under this component. PSRC does not conduct qualitative analysis for this component. However, starting from 2014, if primary investments targeting service quality are not realized (that happened during 2011-2013); PSRC does not allow for recovery of investments under this component. The following table presents investments made through other components.

Table 9: Investments through Other Components for 2011-2015 (in million AMD, VAT exclusive).

Component	2011	2012	2013	2014	2015	Total
Office equipment	303.3	460.9	71.8	174.9	116.8	**1,127.7**
Office furniture	45.4	52.2	26.1	40.3	36.7	**200.7**
Transportation	0	24.6	286.9	0	0	**311.5**
Administrative buildings	285.7	84	25.3	18.9	17.6	**431.5**
Others	714.1	720.9	93.0	73.6	680.0	**2,281.6**
Total	**1,348.5**	**1,342.6**	**503.1**	**307.7**	**851.1**	**4,353.0**

Source: PSRC data.

c. Procurement Analysis

69. PSRC performs procurement analysis to determine if ENA ensures Value for Money[16] through the procurement procedures it uses to buy goods and services. PSRC verifies procurement expenditures on goods, services and works in comparison with budgeted amounts, market prices, and other factors that can influence the unit prices.

70. ENA provides a separate detailed procurement report to PSRC, which is used for the purposes of analyses. The report provides detailed information on the types of bidding procedures (local or international competitive bidding, request for quotations, single-source procurements, etc.), as well as prices of the goods procured.

71. General conclusion from such procurement analysis is that ENA does not ensure Value for Money. In case of goods procured by ENA, prices are on average by 30 percent higher than the prevailing market prices, and in case of construction services prices are higher by about 15 percent.

72. PSRC listed the following general reasons for that:

a. ENA procures electric equipment through national competitive bidding process (in small packages) while there are no local suppliers for such equipment. As a result, ENA buys the required equipment from different local small intermediary companies at prices higher than those, which could have been secured in case of international competitive bidding. Those local companies are simply intermediaries and do not have the required experience in production, supply, and maintenance of such equipment.

b. ENA does not conduct careful market assessment before preparing procurement budgets and initiating bidding. It mainly uses historical costs of its own procurements that do not rely on market prices. Moreover, ENA does not implement efficient inventory management, which occasionally results in shortage of inventory. As a result, in order to ensure compliance with regulatory requirements (mainly new connections and time to restore the outages), it procures goods from the local suppliers with often time significantly higher prices compared to international prevailing prices.

c. Local intermediary companies are paid by ENA 90 business days after the goods are supplied to the company. This results in about 6-7 percent higher margin for those small suppliers to cover the working capital costs during that time period.

d. When ENA purchases engineering (construction) designs, the design companies are paid as a percentage of the total cost of the engineering (construction) project. This creates incentives for designers to make engineering (construction) as expensive as possible so to maximize the profitability on particular contracts.

73. It should be noted that PSRC also does not have the required in-house experience and capacity to perform complete procurement analysis including assessment of market prices of power equipment. Market prices are assessed through the published (on the Internet) unit prices in the price lists of some manufacturers and suppliers, which can deviate significantly from actual prices in the commercial contracts. Moreover, PSRC will never have enough resources or should perform such

[16] "Value for Money" is a concept generally used to assess an organization's capacity to obtain the maximum benefit from the goods, services or work it acquires or provides, in close relation to the resources available to it.

an analysis. Thus, PSRC should discontinue the traditional approach of in-house procurement analyses and involve private engineering consultant companies to perform independent review of actual investments by power companies vs. planned investments, including procurement review. It should also be mentioned that even with its limited in-house capacity PSRC historically assessed 30 percent of the procurement conducted by ENA as inefficient, i.e. with prices significantly above the prevailing market rates.

V. Unrecovered and Recovered Investments

74. This part of the report summarizes unrecovered and recovered investments of ENA during 2011-2015 according to the PSRC's analysis. In practice, PSRC estimates the size of investments to be recovered through tariffs during any period of time consistent with below formula:

$$R_I = A_I + U_I - E_I - C_{CF} - I_{DA} - I_{AS} - I_{AR}$$

Where:

- R_I is the value of used and useful fixed assets, which should be included in the regulatory asset base;
- A_I is the value of the fixed assets, which are created under the current Investment plan during current fiscal year;
- U_I investments not included in the Investment Plans approved by the PSRC, but which are required due to some urgent reasons;
- E_I is the value of the fixed assets that PSRC evaluated as "inefficient" through the investment prudency procedures;
- C_{CF} customer connection fees collected during the current fiscal year;
- I_{DA} income from raw materials of decommissioned assets during the current fiscal year;
- I_{AS} income from the assets sold during the current fiscal year;
- I_{AR} Income from the assets received during the current fiscal year at no cost.

75. PSRC has been using above mentioned approach historically, however, there is no formal regulation stipulating the above or other approach on how the volume of Recovered Investments should be determined. Moreover, there are no established Investment Prudency Rules.

76. Below is the summary table presenting the Volume of Unrecovered and Recovered Investments during the 2011-2015.

Table 10: Recovered Investments for 2011-2015.

No.	Indicator	million AMD, VAT exclusive	%
1	**Fixed Assets (created during 2011-2015)**	**44,607.1**	**100%**
1.1	*Under the Investment plan approved by the PSRC*	*44,276.6*	*99.3%*
1.2	*Investments made for any urgent reasons*	*330.5*	*0.7%*
2	**Reduction of Investments through the Quantitative Analysis**	**7,222.1**	**16.2%**
2.1	*Investments already included in the regulatory asset base of previous years*	*1,933.2*	*4.3%*
2.2	*Investments exceeding volumes of the investments*	*944.3*	*2.1%*

No.	Indicator	million AMD, VAT exclusive	%
	agreed with the PSRC		
2.3	*Customer connection fees*	*4,246.8*	*9.5%*
2.4	*Income from raw materials of decommissioned assets, assets being sold or received with no cost*	*97.8*	*0.3%*
3.	**Reduction of Investments through the Qualitative Analysis**	**5,179.0**	**11.6%**
3.1	*Expenditures already recovered by the maintenance costs*	*1,107.8*	*2.5%*
3.2	*Labor costs already recovered by the operational costs*	*753.4*	*1.7%*
3.3	*Investments through service quality with no results (after the projects have been completed voltage fluctuations remain the same)*	*420.0*	*0.9%*
3.4	*Investments made for new connections, but customers are not connected yet*	*2,198.4*	*4.9%*
3.5	*Investment though other components, while investment targeting service quality has been made*	*298.7*	*0.6%*
3.6	*Engineering Design costs not used for the construction*	*175.4*	*0.4%*
3.7	*Other reasons*	*225.3*	*0.5%*
4.	**Reduction of Investments through the Procurement Analysis**	**4,495.3**	**10.1%**
4.1	*Due to the reduction in the costs of the goods procured*	*3,000.6*	*6.7%*
4.2	*Due to the reduction in the costs of services of the third party contractors*	*1,489.1*	*3.4%*
5.	**Investments recovered through the tariffs**	**27,710.7**	**62.1%**

Source: PSRC data.

PART B. Investment Plan of ENA for 2017-2021

I. Main Priorities of the 2016-2020 Investment Plan

77. The Investment Plan of ENA for 2016-2020[17] is the largest after the privatization of the company in 2002. In terms of priorities, it hasn't changed compared to previous investment plans. Specifically, investments are aimed at improving service quality (reducing power outages and voltage fluctuations), connecting new customers, commercial metering and investments for administrative needs. The total volume of the planned investments is AMD97.4 billion AMD (about US$200). Investment plan was approved by PSRC on December 21, 2016[18] at a size and composition proposed originally by ENA in its application. Below is a summary table of the planned investments for the abovementioned period.

Table 11: ENA's 2016-2020 Investment plan (in million AMD, VAT exclusive).

N	The main components of investment plan	2016	2017	2018	2019	2020	Total
1	Investments targeting Service Quality	3,682	5,142	3,632	10,470	11,090	34,117
1.1	*Reliability and Safety*	*3,342*	*4,922*	*3,212*	*10,050*	*10,420*	*31,947*
1.2	*Voltage fluctuations*	*340*	*220*	*420*	*520*	*670*	*2,170*
2	Improvement of Commercial Metering	4,656	9,700	12,232	5,320	4,391	36,299
3	Connections of New Customers	4,717	6,000	3,600	3,600	3,600	21,515
4	Investments through other components	3,032	925	500	500	500	5,457
5	**Total**	**16,085**	**21,769**	**19,964**	**19,990**	**19,581**	**97,388**

Source: PSRC data.

78. The major components of the investment plan are the service quality (35 percent) and commercial metering (37 percent) followed by new connections (22 percent) and investments for other needs (7 percent). However, ENA allocated only 2 percent of the total investment program to address voltage fluctuations, which are one of the most pressing issues on the network.

79. The two components of the 5-year investment plan of ENA that has a specific outcome is the installation of smart metering system and connection of the new customers. With the smart metering, ENA specifically wants to achieve the distribution loss target of 8 percent by 2021 and reduce the number of employees involved in meter-reading to 1000. Currently, based on the 2016 data, distribution loses are close to the 10 percent[19] and company has about 2,200 employees engaged in monthly meter-reading process. The loss target ENA plans to achieve was set by PSRC. In the second case ENA is going to connect about 23,500 new customers.

[17] http://www.psrc.am/images/News/2016/Gas/HEC_IP_2016-2020.pdf
[18] http://www.psrc.am/am/announcements/announcement/2350-1
[19] http://www.psrc.am/images/docs/reports/electric/2016/3-er/KVT.pdf

II. Structure of Investment Plan

a. Investments targeting reduction of power outages

80. Investments aiming to decrease power outages are about AMD32 billion. As it was mentioned before, there are no outcomes associated with those investments, which typically should be linked to the SAIDI and SAIFI indicators.

Table 12. Investments targeting Power Outages during 2016-2020 (in million AMD, VAT exclusive).

N	The main components of investment plan	2016	2017	2018	2019	2020	Total
1	Reconstruction of 0,4 kV distribution grid	544	360	450	450	450	2,254
2	Reconstruction of 6(10) kV distribution grid	433	1,096	495	495	505	3,024
3	Reconstruction of 35 kV and 110 kV distribution grid	237	158	232	135	145	3,024
4	Reconstruction of distribution grid in Apartment Houses	355	400	355	400	400	1,890
5	Reconstruction of worst parts of distribution grid under special programs	1,453	2,638	1,500	8,400	8,800	22,792
5	**Total**	**3,042**	**4,672**	**3,032**	**9,900**	**10,320**	**30,967**

Source: PSRC data.

81. As we see from the Table 13, 74 percent of investments are aimed at reconstruction of the most dilapidated and unreliable sections of distribution network. In 2016-2017, those special projects are clearly shown in the investment plan, but for 2018-2021 there is nothing mentioned except the total figure, which is AMD18.7 billion or 60 percent of the all investments targeting power outages. Again, investments are not linked to any outcomes. Investment decisions are largely driven by various needs and are not linked to main outcomes that should be achieved with respect to service quality, reliability and connection of new customers.

82. Below presented is some analytical data that can be used to support decision-making on investment-planning. First, when choosing mid and long-term targets, PSRC can require ENA to use SAIFI and SAIDI indicators (as well as others service quality and performance indicators such as Energy-Not-Served). For comparison below is a table presenting actual SAFI and SAIDI data on 30 European or post-Soviet countries.

Table 13: SAIFI and SAIDI Indicators in Different Countries as of 2016 (Doing Business).[20]

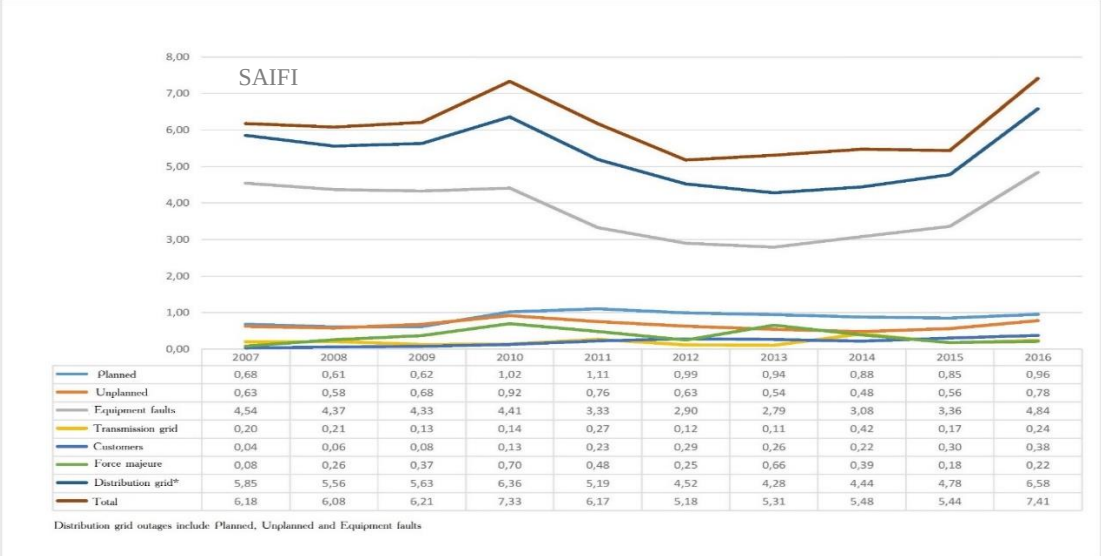
Economy	SAIFI	SAIDI	Economy	SAIFI	SAIDI
Armenia[21]	6.16	9.20	**Kazakhstan**	1.15	0.85
Belarus	0.02	0.21	**Latvia**	0.49	0.92
Belgium	0.50	0.53	**Lithuania**	0.37	0.45
Bosnia and Herzegovina	0.81	2.76	**Moldova**	1.68	1.70
Bulgaria	4.12	6.29	**Romania**	3.48	3.32
Croatia	1.66	5.04	**Serbia**	3.51	4.92
Czech Republic	0.33	0.49	**Singapore**	0.01	0.01
Denmark	0.36	0.42	**Slovak Republic**	0.67	0.73
Estonia	0.35	0.88	**Slovenia**	0.83	0.66
Finland	0.20	0.09	**Spain**	0.53	0.41
France	0.20	0.19	**Switzerland**	0.14	0.20
Georgia	1.98	3.58	**Ukraine**	1.74	3.52
Germany	0.20	0.17	**United States - Los Angeles**	0.70	1.42
Greece	1.10	1.00	**United States - New York City**	0.11	0.21
Italy	1.97	0.58	**Russian Federation - Moscow**	0.01	0.01

Source: Doing Business Report, 2016, World Bank.

83. The Table above shows that Armenia's SAIFI and SAIDI indicators are among the worst-performing. There is a lot of background and analytical information to support investment decisions. Figure 4 below shows changes of SAIFI indicator during 2006-2016. The year of 2016 is the worst among during the last 10 years. Compared to 2015, the growth of frequency of power outages by 36 percent was mainly the result of equipment faults. Basically, equipment faults are causing 65 percent of all power outages, which means this should be the first outcome indicator when deciding on investment plan composition.

[20] http://www.doingbusiness.org/data/exploretopics/getting-electricity
[21] http://www.psrc.am/images/docs/service/electric/2016/4-er/ENA_SAIDI_SAIFI_CAIDI_2007-2016.pdf

Figure 4: SAIFI Indicator in 2006-2016.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Planned	0,68	0,61	0,62	1,02	1,11	0,99	0,94	0,88	0,85	0,96
Unplanned	0,63	0,58	0,68	0,92	0,76	0,63	0,54	0,48	0,56	0,78
Equipment faults	4,54	4,37	4,33	4,41	3,33	2,90	2,79	3,08	3,36	4,84
Transmission grid	0,20	0,21	0,13	0,14	0,27	0,12	0,11	0,42	0,17	0,24
Customers	0,04	0,06	0,08	0,13	0,23	0,29	0,26	0,22	0,30	0,38
Force majeure	0,08	0,26	0,37	0,70	0,48	0,25	0,66	0,39	0,18	0,22
Distribution grid*	5,85	5,56	5,63	6,36	5,19	4,52	4,28	4,44	4,78	6,58
Total	6,18	6,08	6,21	7,33	6,17	5,18	5,31	5,48	5,44	7,41

Source: PSRC data.

84. In addition to the above, PSRC publishes reports on actual reliability of all the equipment in distribution network. Below is the summary table showing reliability of distribution network equipment during 2016.

Table 14: Distribution Main Equipment Reliability for 2016.

N	Equipment	Voltage	Quantity (item/km)	Faults	Reliability (fault/unit)
1	**110 kV grid**				
1.1	Transformers	110/10(6) kV	69	10	0.15
1.2	Transformers	110/35/10 kV	124	56	0.45
1.3	Other equipment	110 kV	1,013	0	0
1.4	Lines	110 kV	2,778.3	726	0.26
2	**35 kV grid**				
2.1	Transformers	35/10(6) kV	376	40	0.11
2.2	Transformers	35/0.4 kV	6	0	0
2.3	Other equipment	35 kV	2,533	17	0.01
2.4	Lines	35 KV	2,307.1	868	0.34
2.5	Cables	35 kV	65.3	177	3.14
3	**10(6) kV grid**				
3.1	Transformers	10(6)/0.4 kV	9,423	110	0.01
3.2	Other equipment	10(6) kV	37,952	70	0
3.3	Lines	10(6) kV	8,757	4332	0.49
3.4	Cables	10(6) kV	3,531	3924	1.11
4	**0.4 kV grid**				
4.1	Other equipment	0.4 kV	9,077	25	0
4.2	Lines	0.4 kV	12,887	3,867	0.3
4.3	Cables	0.4 kV	2,400	969	0.4

Source: PSRC data.

85. Information in the above Table can be used by PSRC for any assessments of ENA's investment plans comparing presented above technical data on equipment faults with volume of the planned investments. Moreover, ENA having all the detailed background information on power outages can clearly measure how will be affecting investments on the SAIFI and SAIDI measures while renewing any single part of the distribution grid.

b. Investments Targeting Voltage Quality

86. Investments aiming to improve voltage quality are AMD2.2 billion or only 2% from the total, while each customer on average is supplied with low quality electricity about 2500 hours annually and many of them are receiving electricity at 160-170 volt regularly. Investment plan is detailed only for 2016 and 2017, which is again confirming that there is no long-term planning approach to address this very important supply reliability issue. In general, this small amount of investments targeting voltage quality means that prioritization of investments by ENA does not reflect the issues faced by the distribution network.

c. Improvement of Commercial Metering

87. ENA is planning to make large investments into commercial metering and during next 5 years AMD 36 billion will be directed for integration of about 300,000 customers or 33 percent of total into smart metering system. There is no clarity on the time-line for integrating the remaining 700,000 of the customers into the same system during next period of a time. It should be noted that those investments will have large impact on the end-user tariffs. On one hand, reduction of losses by 2 percent and employees by 1000 will have positive impact on the tariffs. On the other hand, those new investments will be added to the current asset base, but more importantly, will change dramatically the income structure.

88. Currently, customers with electronic meters can benefit from time-of-use (TOU) tariffs, i.e. day-time tariff and night-time tariff (Annex 2). About 30 percent of all customers are equipped with electronic meters. If a customer wants to transition to TOU tariffs, then it should make an advance payment of AMD10,000 that will be returned to him after 1 year of installation of the meter through reductions from his electricity bill. The rationale behind the current regulation is that customers will switch to TOU tariffs and will start consuming more at the night-time tariff. Although the company is going to install new electronic meters for the current customers, those automatically will switch to the TOU tariffs, which will decrease income of ENA. Therefore, in the next regulatory period, ENA will ask PSRC to increase its tariff margin to cover the financial loss and as a result the same customers will start paying more.

89. However, there is no assessment in the Investment plan showing how various factors will be affecting the end user tariffs and if customers are ready to pay for such a change.

d. Connections of New Customers

90. Investments for connection of new customers are AMD21.5 billion or 22 percent of total. These investments will be mainly aimed at meeting the forecast peak demand in the center of the Yerevan city and at connection of individual customers to the network. Planned investments for meeting peak demand AMD3 billion, and the remaining AMD18.5 billion will be used for new connections. Looking to the distribution of the investments it could the assumed that there will be no change of

“low connection fee” philosophy, while for connection of very small amount of the new customers value of the new assets are mainly covered by current customers, which is unfair. Fixed transmission and distribution network and retail costs represent approximatively 30 percent of the total sector costs. The end-user tariff structure in Armenia does not include a fixed charge that would reflect such costs (all costs are energized). This could not favor distribution investments, especially in some cases where the future network extensions concern low-income users with low consumption (as it would not allow for proper fixed cost recovery).

e. Investments Through Other Components

91. Investments through other components are generally aimed to cover the administrative needs of ENA. Those are computers, office furniture, cars, and repairing of the offices. The total amount is about AMD5.5 billion or 5.6 percent of the total. On average, annual investments for such a need are comparable with historical spending.

PART C. Recommendations to Improve Investment Regulation

92. **PSRC to consider requiring ENA to link power sector investments to service quality improvements.** The sector and the investment regulation would benefit from the implementation of a PBR, with a focus on service quality indicators (e.g. outages and voltage fluctuations), which are important issues in Armenia. PSRC has been computing and publishing service quality indicators, including SAIF, SAIDI, number of voltage fluctuations, since 2007. However, the power distribution company's investments were not directly linked to improvements in service quality as measured by those indicators. The key next step for PSRC would be to improve the accuracy of the raw data that can be used for the calculation of the indicators. Then, PSRC should require ENA to use those indicators as outcomes in its investment plans. Additionally, ENA should be required to present detailed economic cost-benefit analyses to justify prioritization of investments.

93. **PSRC to consider focusing on thorough review of ENA's capital investment programs instead of ex-post audits**. The assessment of the "used, useful, and efficient" nature of the assets is one of the most difficult tasks of regulators. The introduction of PBR system would limit or eliminate the need for such ex-post audits given that ENA would have incentives to achieve the specified service quality indicators even if it manages to realize investment cost savings. However, successful implementation of PBR would require thorough review of investment plans by PSRC prior to approval and this may require involvement of a specialized engineering firm unless PSRC builds the required in-house capacity. The task is essential because service quality improvement related investments are expected to account for 32 percent for the period from 2016 to 2020. The other large category is related to connection of new customers, which account for 50 percent of investments. However, the efficiency of this category is relatively easy to assess because regulatory commission has detailed knowledge about technical aspects and costs.

94. **PSRC to consider specifying WACC for energy companies and regularly adjusting it to reflect the changes in capital market conditions**. PSRC should regularly revise (e.g. at least once in two or three years) the cost of capital for energy sector companies. The regulations should not include a reference to a specific figure for the return on investments; they should instead refer to a methodology (e.g. weighted average cost of capital - WACC) that PSRC would apply to the determination of WACC. The WACC should be assumed to be comprised of certain percentage of debt (e.g. 60 or 70 percent) and equity (40 and 30 percent). The elements included into computation of real cost of debt and pre-tax cost of equity should be transparent and include the real risk-free cost of debt (e.g. government bonds), debt premium, equity risk premium, and equity beta (volatility compared to the broader market). The WACC should be adjusted regularly (once in two or three years) to reflect changes in the market conditions.

WACC Assumptions
Risk Free Rate (r_{rf})
Debt Premium (DP)
Market Risk Premium ($r_m - r_{rf}$)
Cost of Debt ($r_d = r_{rf} + \mathrm{DP}$)
Return on Equity ($r_e = r_{rf} + \beta \times [r_m - r_{rf}]$)
Profit Tax (T)
Share of debt (g)
Sectoral Risk (β)

95. **PSRC to consider introducing two-part end-user tariff structure, which would allow to make return on distribution investments more predictable**. Fixed transmission and distribution network and retail costs represent approximately 30 percent of the total sector costs. The end-user tariff structure in Armenia does not include a fixed charge that would reflect such costs (all costs are energized). This is not conducive to distribution investments, especially in some cases where the future network extensions cover low-income users with low consumption (as it would not allow for proper fixed cost recovery). The proposed end-user tariff structure should include.

- **Per kWh charge.** Per kWh charge reflects energy and capacity costs, which differ based on the time of use. Capacity costs would ideally be based on a per kW charge, particularly for the largest customer classes (commercial and industrial) whose demand can pose a capacity constraint at the distribution level. However, data were not available to estimate a per kW charge based on monthly demand.
- **Fixed monthly charge.** The fixed monthly charge reflects costs incurred with the addition of each new customer. These include the cost of investment in meters as well as investments in and operations and maintenance of local distribution facilities.

96. The next step would be assessment of the marginal cost of supply to determine the marginal cost-based allocation of revenue requirement among various categories of consumers.

Annex 1: Power Generation Tariff Methodology for Large Generators

The Armenian multi-sectoral regulator, the Public Services Regulatory Commission (PSRC) relies on what is known as a "rate-of-return" tariff regime to determine the allowed revenue of the power companies. Under this regime, the revenue that the operators are allowed to collect is expected to cover:

- eligible costs related to licensed activities,
- asset depreciation and
- an allowed return on invested capital.

Eligible costs include operating and maintenance costs, fuel costs (for thermal and nuclear plants), tax expenses, other than profit tax and VAT, and other state duties and costs envisaged by RA legislation. In case of nuclear power plants, eligible costs shall also include costs related to storage of nuclear fuel, creation of power plant decommissioning fund and safety enhancement measures.

Annual depreciation of fixed assets is calculated using a linear method based on historical value of fixed assets and their useful life.

Allowed return is calculated as a product of return base and allowed rate of return. Return base is the value of net assets which equals to the sum of the value of non-current assets recognized by PSRC as useful and operational, net of accumulated depreciation, and the allowed amount of working capital. Allowed rate of return is defined as a weighted average cost of capital.

Depending on types of services provided to the power system, power generation companies may have different tariff structures: one-part and two-part. One-part tariffs are set for generating plants the operating regime of which is not regulated by the power system operator, such as unregulated hydropower plants, wind plants and other renewable resource-based power plants, which do not offer systemic services other than power generation. One-part tariff is determined as a ratio of require revenue to annual dispatched electricity.

Two-part tariffs are set for plants whose participation in the electricity and capacity balance of the system is instructed by the system operator. Two-part tariffs are composed of charges for electricity to cover variable costs of power generation and capacity charge for ordered capacity to cover fixed costs of the plant.

Annex 2: Power Distribution Tariff Methodology

Methodology for computation of ENA's tariff margin stipulates that the forecast and actual difference between the revenue requirement and cost of electricity purchased by ENA is computed to the according formula:

$$CA = (D_e - D_a)*(1 + I/100)$$

$\mathbf{D_e}$ = the forecast difference between the required revenue of the Licensee (including revenue from distribution service) and cost of purchased electricity for the period from April 1 of the year preceding the revision of tariff margin till March 31 of the current year (in AMD);

$\mathbf{D_a}$ = the actual difference between the required revenue of the Licensee (including revenue from distribution service) and the cost of purchased electricity for the period from April 1 of the year preceding the revision of tariff margin till March 31 of the current year (in AMD), which is determined in accordance with paragraphs 14-17 of the methodology.

I = interest rate on the compensated amount, which is equal to 12 percent.

The difference between actual revenue and the cost of the purchased electricity ($\mathbf{D_a}$) shall be computed as per below formula:

$\mathbf{D_a = D_{a1} + D_{a2} + D_{a3}}$**:**

$\mathbf{D_{a1}}$ shall be calculated for those months of the period from April 1 of the year preceding the revision of tariff margin till March 31 for which actual data is available, using the following formula:

$$D_{a1} = R_{a1} - (E_{KWTH1} + HVEN_1) \quad \frac{(1 - L_{DNA1}/100)}{(1 - L_{DNE}/100)} - E_{c1} - C_{a1},$$

$\mathbf{R_{A1}}$ is the actual revenue from sale of electricity and provision of electricity distribution services by the Licensee to legal entities (in AMD);

$\mathbf{E_{KWTH1}}$ is the actual cost of electricity purchased from generators and importers and actually imported by Licensee (in AMD);

$\mathbf{HVEN_1}$ is **t**he cost of electricity transmission service (in AMD);

$\mathbf{L_{DNA1}}$ is the actual loss of electricity in the distribution network (%);

$\mathbf{L_{DNE}}$ is the estimated loss of electricity in the distribution network in the calculation period preceding the current period as approved in calculation of Tariff Margin (%);

$\mathbf{E_{c1}}$ is the actual cost of capacity purchased from the generators (in AMD);

$\mathbf{C_{a1}}$ is the actual cost of services provided by the settlement center and the power system operator (in AMD).

For the five year period defined in paragraph 22 of this method $\mathbf{L_{DNA1}}$ is assumed equal to L_{DNE}.

$\mathbf{D_{a2}}$ is calculated as the difference between estimated required revenue (including revenue from distribution service) and the cost of purchased electricity for those months of the period from April 1 of the year preceding the revision of tariff margin till March 31, for which the actual data is not available.

D_{a3} shall be calculated as difference between the value of **D_{a2}** adjusted on the basis of the actual data included in the calculation of tariffs effective at the time of the tariff margin revision and **D_{a2}** included in the calculation of the same tariff.