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**ARMENIA:
RESULTS OF PILOT PROJECT
ON
NIGHTTIME ELECTRIC TARIFF**

**Contract No. LAG-I-00-98-00005-00
Task Order No. 2**

Prepared for:

United States Agency for International Development
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SUMMARY

A pilot project is being conducted in the Republic of Armenia to test the effectiveness of a Nighttime electricity tariff for residential and small commercial customers. The project is part of the Armenia Power Sector Metering Improvement Project being sponsored by the United States Agency for International Development (USAID). Subsequent to the initiation of the project, the Armenian Energy Regulatory Commission designed and adopted a Nighttime tariff available to all low-voltage customers in the country after October 1, 1999.

The purpose of the Nighttime tariff was to induce consumers to either:

- shift load from the on-peak periods to the off-peak periods (load shifting); or
- increase the load during the off-peak period (so-called "valley filling").

The Nighttime rate for the pilot participants was implemented on September 1, 1999 and is still in effect. This report presents the results of the pilot through the end of April 2000. However, there will be an on-going analysis and evaluation by the Energy Regulatory Commission and the distribution companies involved in the pilot.

Interim results

The results of the pilot project through the end of April 2000 indicate that:

- No load shift from day to night has occurred
- A savings in the average monthly billing for each participant has been about 10%, and results from the lower price at night, not from shifting load to the night time.

It appears that the implementation of the Nighttime tariff has had little effect on the load shape of the participating customers but has resulted in a lower monthly billing for all participants. The lower bill is a result of the rate design which only provides for a lower rate during the night hours but maintains the same rate as all other customers during the day time hours.

The monthly savings to the customers is less than one U.S. dollar (savings < \$1.00/month). Under the current money rates in Armenia (i.e. the current costs of paper), the costs of the meters alone, without any installation or other costs, can never be cost-effectively recovered by the savings.

Appendices

Appendix A provides a summary of the surveys of the participating customers and demographic data. Appendix B includes a summary of the monthly billings for the participants. Appendix C shows the hourly load profiles of the participants for the months prior to, and following the

implementation of the rate. Appendix D includes the order of the Energy Regulatory Commission, dated May 31, 1999, that implemented the Nighttime tariff throughout the country.

The subsequent sections and appendices of this report describe the details of the pilot project, including the work involved in the development of the rate, the procurement and installation of meters, and the development and implementation of the new meter reading and billing procedures.

BACKGROUND AND HISTORY

A time-of-use tariff pilot project was originally designed following the recommendations of a Working Group established to define the components of the Armenian Power Sector Metering Improvement Project. However, when the Commission instituted the Nighttime tariff, the pilot was modified to study the impacts of this new tariff.

The purpose of the pilot was to test the rate with a small group of customers (330) and determine the impacts on both the energy companies and the customers. The potential benefits to the energy companies are reduced costs by shifting load to off-peak periods, or to build load during the nighttime (off-peak) hours. The potential benefit to consumers is simply the reduction in their electricity bill due to the lower rate.

METERING & CONSTRUCTION

In order to accomplish the pilot project, meters were procured and installed at the customer sites. Additionally, local electrical contractors completed some line construction work.

A. Meters

Time-of-Use meters were procured for the project. In addition to the billing meters, load profile metering equipment was also procured. Following a competitive bidding process, ABB meters were selected for billing use in Armenia for the project. Data loggers and appurtenant equipment was procured from Pacific Science and Technology, Inc. Each meter was tested and programmed for the daytime and nighttime hours prior to the installation at the customer sites.

The load profile loggers were used to obtain hourly load profile data at each substation. Due to the high cost of individual load profile recorders, it was decided to monitor the loads at the substation since they could be separated between those who were on the tariff and those who were not. The manufacturer of the load profile equipment conducted a training session for the distribution company personnel. The training included both a technical portion on the installation and use of the equipment as well as the analysis of the data from the loggers.

B. Construction

Line construction in both locations was accomplished following a competitive bidding process with local electrical contractors. The line construction included the replacement of some distribution poles and the installation of insulated wiring to prevent energy theft on the lines. Also, new meter boxes were procured from local vendors and installed at the customer locations by the electrical contractors. These boxes are sturdy, metal, weatherproof boxes with locks and windows for the meter readers to read the monthly usage without opening the boxes.

C. Costs of Materials and Construction

The costs incurred for materials and construction include the costs of meters, meter boxes, poles, wire and miscellaneous other materials. Additionally, there were labor costs incurred for line construction and meter installations. The additional costs to the distribution companies for meter reading, billing and O&M have not yet been determined.

The materials and construction costs incurred for the participating customers were:

Meters	\$ 72,420
Shipment	\$ 17,021
Meter Boxes	\$ 8,357
Line construction	\$ 28,800
	=====
Total	\$126,598

This total represents a cost of \$ 384 per customer (330 participants).

RATE DESIGN

Hagler Bailly completed the initial design of the time-of-use rates. Concurrently, the Energy Regulatory Commission designed and approved a Nighttime tariff. Because the Commission had approved the Nighttime tariff for implementation throughout the country, it was this rate design that was ultimately used for the pilot monitoring project.

Hagler Bailly designed rates using historical system load curves provided by the Energy Institute. It was assumed that the current tariffs were cost-based and that they collected the revenue requirements of the energy companies. Based on this premise, revenue neutral rates were designed and provided to the Ministry of Energy and the Energy Regulatory Commission for review. Revenue neutral rates are designed to provide the same revenues for customers who do not shift load to the off-peak period, but who use electricity in the same manner as always (i.e., they do not change their energy use behavior). By designing the rate in this fashion, customers are not harmed for being on the rate, but they can save money by shifting to the off-peak period. Sixteen scenarios were presented to the Ministry of Energy and the Commission for review. Each scenario was based on different pricing periods and different off-peak prices.

The Energy Regulatory Commission designed a Nighttime tariff (Appendix D) which is not revenue neutral, but which the Commission believes reflects the costs that will be incurred when the generating plants are dispatched in a more efficient manner. In fact, the Commission stated that the purpose for the Nighttime tariff was not to shift load from the peak, but to build load during the night hours. They believe that the lower night rate will induce customers to use more during those hours, not necessarily shift the load from the day time hours. They also stated that one of the reasons for the new tariff was to provide new, more accurate, meters for all customers within the country.

The pricing periods for the daytime and nighttime rates are the same for all days of the week. The weekend days are not considered as off-peak periods for pricing purposes. The rate design is:

Daytime	7:00 a.m. to 11:00 p.m.	25 Drams/kWh (\$0.047)
Nighttime	11:00 p.m. to 7:00 a.m.	15 Drams/kWh (\$0.028)

PARTICIPANTS

Two sites were selected for participation in the project, including Yerevan and Abovian. It was decided that this scheme would provide information from both urban (Yerevan) and rural (Abovian) areas of Armenia. At each site, residential and small commercial customers are served from a single substation, that provides electricity at 380/220 volts to a distribution line, and then to the customers. The customers are split between apartment dwellers and those who live in single family houses. There are also some small commercial customers included in the study at each location. Most customers have single-phase service; however, a small number have three-phase service (both residential and commercial).

The local staff of Hagler Bailly conducted a fact-to-face survey of the participants. The purpose of the survey was to collect demographic and appliance saturation information. This information can then be used to verify that the participants are representative of the population of electricity consumers in the country. The summary of the results of the survey is shown in Appendix A.

BILLING AND METER READING

Changing to a system for reading the meters and billing the customers on the new Nighttime tariff was a major task for the participating distribution companies. Due to the current systems, much work was needed to train personnel and implement procedures for accurately billing the customers and for recording payments.

The billing system in the Komitas (Yerevan) region was installed by Hagler Bailly under a USAID contract and is well suited to the new rate design. However, in Abovian, an antiquated system resulted in many problems, all of which were resolved. These problems pointed out, however, the problems that will be faced by all electric company district offices throughout the

country. For example, these systems only allow for a four-digit meter reading, whereas the new meters have five, or six, digits.

For each month, the meter readings and billing were collected and analyzed to determine the billing and usage differences resulting from the Nighttime tariff. Appendix B summarizes this information.

IMPACT ANALYSIS

Analyzing the impacts of the Nighttime tariff involves three distinct areas: load shape, billing and cost/benefits. This section discusses the results of these analyses. A summary of the average daily load profiles for the participating customers are shown in Appendix C.

A. Load Shift

It can be seen that the Nighttime tariff has had little, or no, effect on the shift of usage from daytime to nighttime hours. There has been no measurable changes in the daily load shape of the participants, indicating that either the price differential is not great enough to induce the change, or that the savings from the tariff are too small to induce a customer to shift load to the off-peak pricing period.

B. Savings

The monthly saving of less than 400 drams per participating customer (\$0.075) indicates that the costs of purchasing and installing the meters would have a very long payback period. Under the current inflation rates and costs, the meters would never be cost beneficial to the customers required to purchase the meters.

This pilot project work does not include any analysis of the costs incurred, or saved, by the distribution companies involved.

LESSONS LEARNED

There are a number of lessons that were learned throughout the implementation of the pilot project including:

1. The Nighttime tariff has not caused any measurable load shift changes for the participants. It is reasonable to assume that this result would hold true for most customers in Armenia and that the overall daily load shift expected by the Commission will not occur, at least unless the economic signals (i.e., a higher day time price) are changed.
2. The participants have received a lower monthly bill, due to the lower nighttime price, but not as a result of load shifting.

3. The procedures for importing meters into Armenia are not clear cut, even under agreements between USAID and the Government of Armenia in place. This results in delays and higher costs of administration of the import work.
4. Obtaining Gosstandart certificates is not straightforward. There seems to be no clearly developed method for obtaining the certificates. The procedure is expensive and very time-consuming.
5. Distribution line construction methods and materials in Armenia are not up to western standards. Poles, insulators, wire, transformers and customer service wires are of low quality.
6. Meter reading and billing procedures are antiquated, particularly in the Central Distribution Company. Changing to a new system for the pilot project was difficult due to these systems, together with the attitudes of some of the Armenian staff members. The USAID sponsored metering, billing and collection system was used in the Komitas region with little difficulty.
7. In designing the rates, there is little customer information readily available for use. Historical usage, number of customers, load profiles, and other customer information is nearly non-existent.
8. The change to/from daylight savings time is not a set date in Armenia. The Government makes the decision on the day for the change sometime during the year and then informs the citizens. This creates a problem with the time-of-use meters since they all need to have the time clocks changed semi-annually to handle this. In other countries where the change to daylight savings time is the same weekend each year, the meters have these dates pre-programmed into the meters' calendar.

RECOMMENDATIONS

There are a number of recommendations resulting from this pilot project:

1. The Nighttime tariff does not appear to be producing the desired results of increasing the nighttime load. It is only providing lower billings to those who are on the rate. The costs of the meters, together with the increased costs of meter reading and billing can not be justified by the rate and thus, Hagler Bailly recommends that it be discontinued.
2. The Energy Regulatory Commission should not implement tariffs, such as the Nighttime tariff, that are detrimental to any of the energy providers, as well as the consumers. In the case of the Nighttime tariff, the distribution companies were ordered to increase their costs (meters, new meter reading and billing procedures) and reduce their revenues (due to the decrease in the nighttime price). The distribution companies were not provided the opportunity to be included in the decision.

3. Each time the change to/from daylight savings occurs (semi-annually), the meters all need to be re-programmed, which entails an on-site visit to each meter. Unless the Government sets the time change to be the same each year, the re-programming costs of a potentially large number of time-of-use meters could be enormous.
4. If the Nighttime tariff is continued throughout the country, the meter reading and billing systems in the distribution companies need to be upgraded to handle the tariff.
5. The Commission should conduct a careful analysis of the impacts of future rates and tariffs, which impose new policies and procedures for the distribution companies. For example, if the new tariffs require new meters, then the costs of procuring, installing and maintaining these should be considered and factored into the rates. Also, the meters may require new equipment, procedures and policies for testing, calibrating and installing.
6. Before any new tariffs are implemented, there should be an appropriate amount of customer education provided through advertisements, TV programs, etc. so that the customers are aware of the changes and potential impacts.

APPENDIX A

No.	Information Description	Choice	Yerevan (Komitas)			Abovian			Total		
			Apts	Houses	Total	Apts	Houses	Total	Apts	Houses	Total
<u>Demographics</u>											
1	Number of People Residing	Number	4	4	4	4	4	4	4	4	4
2	Number of Rooms	Number	2	3	3	2	3	3	2	3	3
3	Length at locations (years)	Number	21	36	29	5	34	24	15	35	27
<u>Questions</u>											
4	Natural Gas Cooking	Yes	66.70%	90.24%	79.73%	78.95%	97.44%	91.38%	71.15%	93.75%	84.85%
		No	33.30%	9.76%	20.27%	21.05%	2.56%	8.62%	28.85%	6.25%	15.15%
5	Natural Gas Heating	Yes	0.00%	75.61%	41.89%	0.00%	97.44%	65.52%	0.00%	86.25%	52.27%
		No	100.00%	24.39%	58.11%	100.00%	2.56%	34.48%	100.00%	13.75%	47.73%
6	Awareness of Nighttime Tariff	Yes	87.88%	82.93%	85.14%	0.00%	100.00%	67.24%	55.77%	91.25%	77.27%
		No	12.12%	17.07%	14.86%	100.00%	0.00%	32.76%	44.23%	8.75%	22.73%
7	If aware, will they use more at	Yes	69.70%	70.73%	70.27%	78.95%	5.13%	29.31%	73.08%	38.75%	52.27%
		No	30.30%	29.27%	29.73%	21.05%	94.87%	70.69%	26.92%	61.25%	47.73%
8	Aware of Nighttime Tariff Prices	Yes	87.88%	82.93%	85.14%	100.00%	100.00%	100.00%	92.31%	91.25%	91.67%
		No	12.12%	17.07%	14.86%	0.00%	0.00%	0.00%	7.69%	8.75%	8.33%
9	Aware of New meter installed	Yes	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
		No	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

ARMENIA ELECTRIC TIME-OF-USE RATE PILOT ♦ 9

No.	Information Description	Choice	Yerevan (Komitas)			Abovian			Total		
			Apts	Houses	Total	Apts	Houses	Total	Apts	Houses	Total
	Energy Uses										
A	Refrigerator	Yes	100.00%	80.49%	89.19%	73.68%	74.36%	74.14%	90.38%	77.50%	82.58%
		No	0.00%	19.51%	10.81%	26.32%	25.64%	25.86%	9.62%	22.50%	17.42%
B	Electric Cooking	Yes	39.39%	9.76%	22.97%	78.95%	7.69%	31.03%	53.85%	8.75%	26.52%
		No	60.61%	90.24%	77.03%	21.05%	92.31%	68.97%	46.15%	91.25%	73.48%
C	Gas Cooking	Yes	66.67%	90.24%	79.73%	89.47%	92.31%	91.38%	75.00%	91.25%	84.85%
		No	33.33%	9.76%	20.27%	10.53%	7.69%	8.62%	25.00%	8.75%	15.15%
D	Electric Space heating	Yes	60.61%	4.88%	29.73%	10.53%	0.00%	3.45%	42.31%	2.50%	18.18%
		No	39.39%	95.12%	70.27%	89.47%	100.00%	96.55%	57.69%	97.50%	81.82%
E	Television	Yes	96.97%	95.12%	95.95%	94.74%	97.44%	96.55%	96.15%	96.25%	96.21%
		No	3.03%	4.88%	4.05%	5.26%	2.56%	3.45%	3.85%	3.75%	3.79%
F	Radio	Yes	63.64%	41.46%	51.35%	15.79%	2.56%	6.90%	46.15%	22.50%	31.82%
		No	36.36%	58.54%	48.65%	84.21%	97.44%	93.10%	53.85%	77.50%	68.18%
G	Computer	Yes	12.12%	2.44%	6.76%	0.00%	0.00%	0.00%	7.69%	1.25%	3.79%
		No	87.88%	97.56%	93.24%	100.00%	100.00%	100.00%	92.31%	98.75%	96.21%
H	Washing Machine	Yes	81.82%	68.29%	74.32%	68.42%	74.36%	72.41%	76.92%	71.25%	73.48%
		No	18.18%	31.71%	25.68%	31.58%	25.64%	27.59%	23.08%	28.75%	26.52%
I	Electric Water heater	Yes	96.97%	4.88%	45.95%	84.21%	7.69%	32.76%	92.31%	6.25%	40.15%
		No	3.03%	95.12%	54.05%	15.79%	92.31%	67.24%	7.69%	93.75%	59.85%
J	Gas Water Heater	Yes	0.00%	82.93%	45.95%	0.00%	89.74%	60.34%	0.00%	86.25%	52.27%
		No	100.00%	17.07%	54.05%	100.00%	10.26%	39.66%	100.00%	13.75%	47.73%

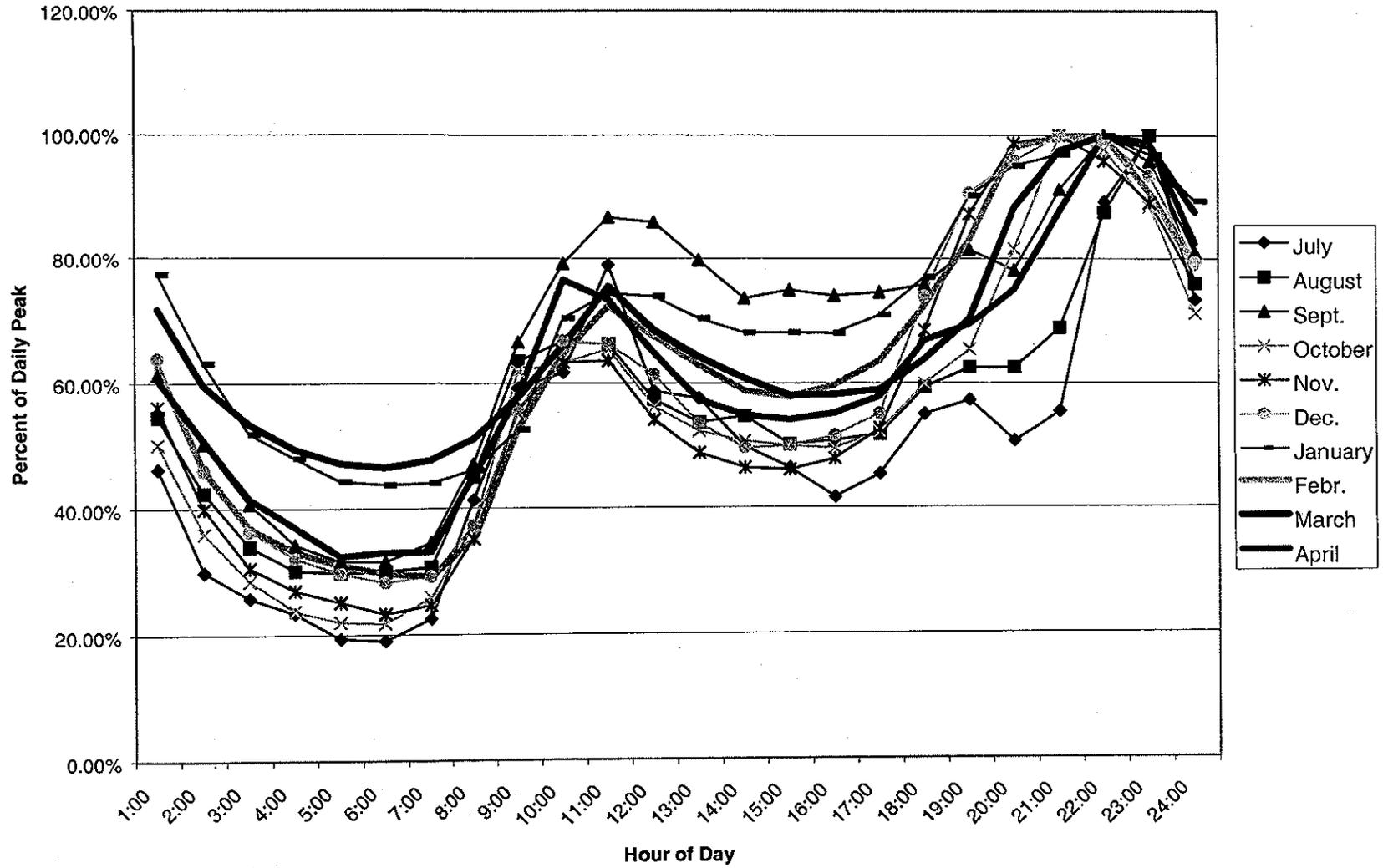
APPENDIX B

Average for September 1999 through April 2000

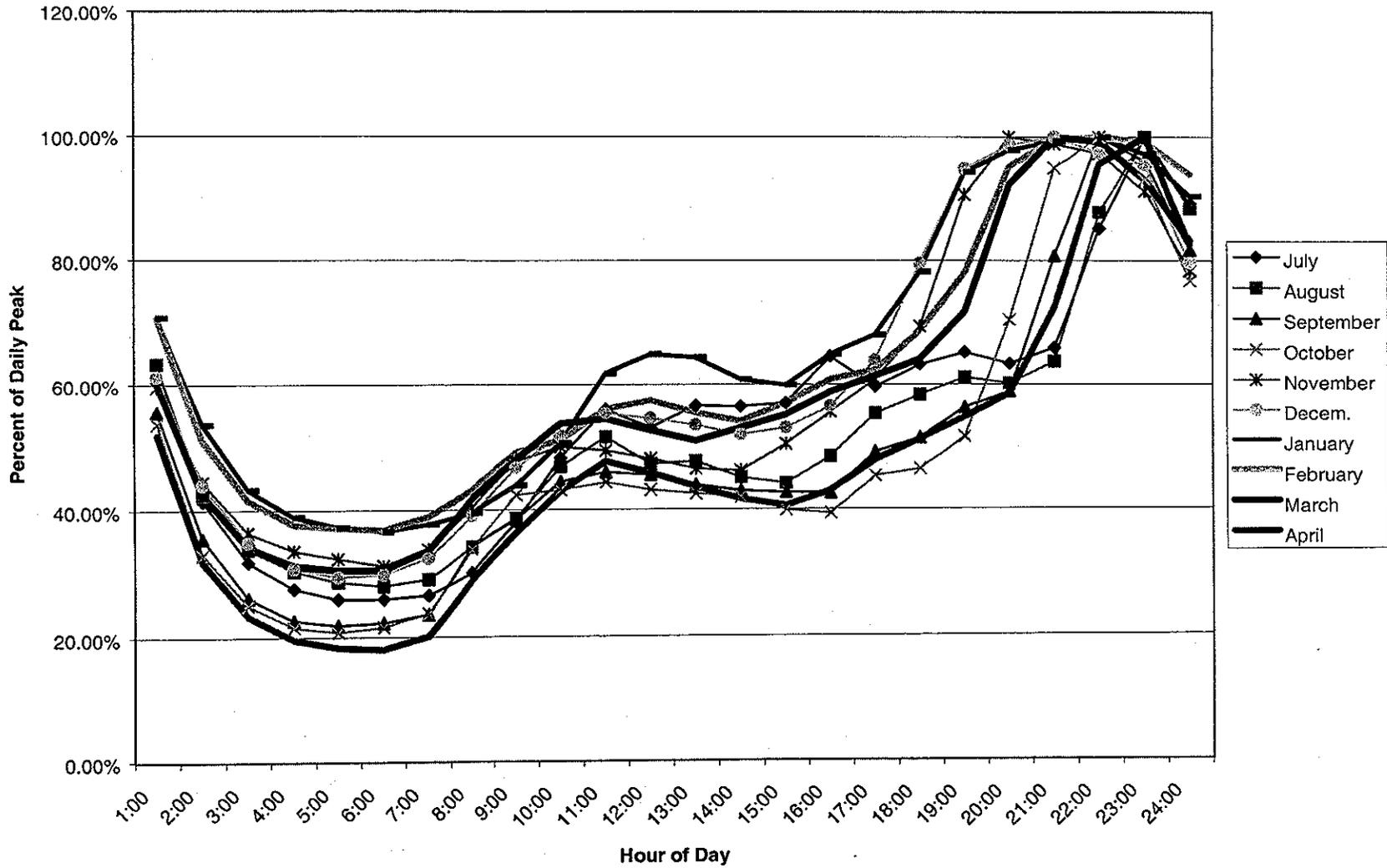
	<u>Use per customer</u>		<u>Billing per customer</u>		<u>Bill w/o Tariff</u>	<u>Savings per Customer</u>	
	<u>kwh</u>	<u>%</u>	<u>Drams</u>	<u>%</u>	<u>Drams</u>	<u>Drams</u>	<u>%</u>
<u>Apartments</u>							
Day	226	75.59%	5,650	83.77%			
Night	73	24.41%	1,095	16.23%			
Total	299	100.00%	6,745	100.00%	7,475	730	9.77%
<u>Individual Homes</u>							
Day	131	77.51%	3,275	85.18%			
Night	38	22.49%	570	14.82%			
Total	169	100.00%	3,845	100.00%	4,225	380	8.99%
<u>Total Participants</u>							
Day	164	76.28%	4,100	84.28%			
Night	51	23.72%	765	15.72%			
Total	215	100.00%	4,865	100.00%	5,375	510	9.49%

APPENDIX C

Papazian (Apartments)



Ushakov Street (Houses)



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APPENDIX D

ENERGY REGULATORY COMMISSION OF THE REPUBLIC OF ARMENIA

1. RESOLUTION

N5 May 31, 1999

Yerevan

On the Night Tariffs for the Energy Provided to Low Voltage Customers

Based on the point "d" of the article 14 and point "a" of the article 20 of the RoA Energy Law, the RoA Energy Regulatory Commission **resolves:**

1. Set up the night tariff of 15 drams/kWh included the VAT for the energy provided to low voltage customers (included residential customers)
2. The tariff set up according to the point 1 of this Resolution will be active from 11p.m. to 7 a.m. of October 1, 1999 for residential customers and July 1, 1999 for other low voltage customers
3. The members of the ERC, heads of Departments (coordinator N.Grigoryan) are to bring up in three days to the RoA ERC discussion the list of timetables and procedures necessary to ensure the implementation of this Resolution. They should take into consideration that they are supposed to be approved by ERC by September 1, 1999 (for residential customers) and June 20, 1999 (for other low voltage customers). The mentioned documents are to be discussed in public with the participation of the interested parts.
4. The Resolution comes into force from the moment of publication.

RoA ERC Chairman

V. Movsesyan