



USAID
OD AMERIČKOG NARODA

**Asistencija regulativi i reformi
energetskog sektora**

Load Research

BiH REAP

Professor Tatjana Konjić

Sarajevo, 10 November 2011

Bosnia and Herzegovina (BiH) Regulatory and Energy Assistance Project (REAP)

USAID Contract No. EPP-I-00-03-00004-00, Task Order 5

Implemented by Advanced Engineering Associates International, Inc.

This presentation is made possible by support from the American People sponsored by the United States Agency for International Development (USAID). The contents are the sole responsibility of the author/s and do not necessarily reflect the views of USAID or the United States Government.



USAID
OD AMERIČKOG NARODA

**Asistencija regulativi i reformi
energetskog sektora**

CONTENT

- **Introduction**
- **What is load research?**
- **Circumstances that bring about load research**
- **Launching load research activities – Objectives and length of activities**
- **Methodology for Load research**
- **Implementation of results**
- **Conclusion**



INTRODUCTION

- **Electricity load varies during periods in Electricity System (EES). Generation and distribution subsystems at any time should respond to the needs of customers.**
- **Changes of load during time (load diagram) occur under the influence of various factors:**
 - **Customer's factor (type of consumption, type of heating, size of facility, type of customer's facilities, number of employees, ...)**
 - **Time factor (hour in the day, day in the week + special day, period in a year)**
 - **Climate factor (temperature, moisture, ...)**
 - **Other factors (geographic position, impact of one load to another, sudden events, ...)**



What is load research ?

- Activity that includes metering and determination of load profile of customer's use of electricity
- Load profile for customer and group of customers enables better understanding of the electricity use by different time, seasonal or economic conditions



Circumstances that bring about Load research

- **The need for more accurate load profiles**
- **Efficient planning and operation/use of EES** (dimensioning of transformers, load balancing, reconfiguration, loss estimate, ...)
- **Creation of free electricity market** (smaller deviation in the process of market settlement, participation of small customers in the market, ...)
- **Definition of the new tariff scheme**
- **Concept of new customer services**



Launching Load Research activity - Objectives

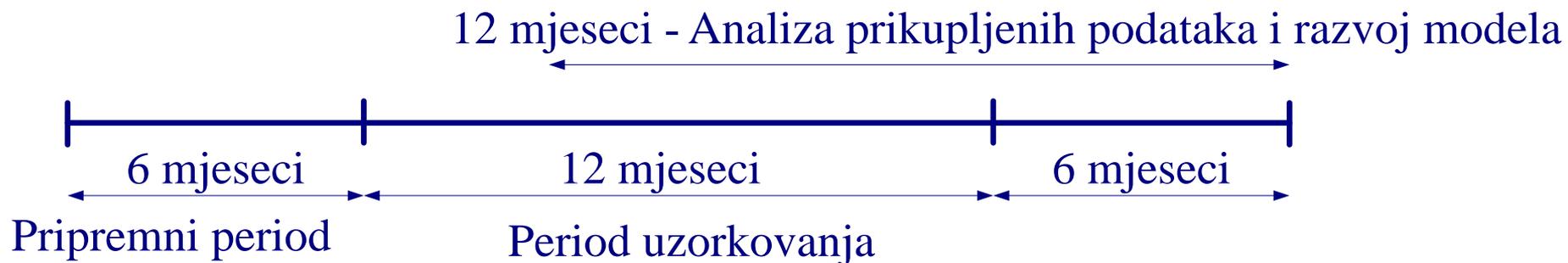
- **Main objectives:**
 - **Grouping/characterization/ customers**
 - **Formation of typical load diagrams**
 - **Customer/customer group consumption analysis**
- **Additional objectives:**
 - **Allocation and evaluation of losses**
 - **Load factor estimate**

...



Launching load research – Duration of activity

- Usual minimum length of project is 24 months





Methodology for load research – Main phases

- **Measuring campaign – Pool***
 - **Data gathering and preliminary analysis of the same**
- **Typical load diagram modeling**
- **Model validation**

- *** desirable option**



Load Research analysis methodology

1. Analysis of the existing data on customers
2. Sample formation for the purpose of metering/questionnaire
3. Metering devices specification and their installation
4. Data gathering
5. Preliminary analysis of gathered data
- 3a. Pool design
- 4a. Distribution and gathering of pool
- 5a. Pool analysis

Measuring
campaign



Load research analysis methodology

- 6. Defining models for typical load diagrams for specific groups/subgroups**
- 7. Verification of model validity**
- 8. Development and check of software validity**



Methodology for load research – Metering campaign

I. Analysis of existing data on customers

Goals:

- Understanding customer classification through analysis of billing data used by EPs;
- Defining customer categories for future work;
- Estimate of average consumption by groups and subgroups: voltage level, type of customers, type of meters, etc.



Methodology of load research diagram –Metering campaign

2. Sample formation for the needs of metering/pool

Objectives:

- Defining criteria for selection of network and customers
- Defining number of customer samples whose load diagrams will be surveyed
 - Selection of sampling method
 - Defining reliability interval and allowed error
- Selection of customers for measuring/questionnaire (make a list of customers that will be used as sample)



Measurement campaign- Why do we use samples?

- Companies that deal with electricity supply have thousands of users
 - To collect data from each user is impractical and inefficient for LV customers
- Sample definition – resource optimization
- Solution is to apply sampling method to different groups of customers, on the basis of which a number of required meters and gathered data is reduced.



Measurement campaign– How large samples should be?

- Relative accuracy of samples is the function of sample size
 - Bigger sample \Rightarrow Better accuracy
 - Better accuracy \Rightarrow Bigger investment for procurement of metering devices
- In one moment, an increase of samples does not contribute to further significant increase of accuracy
- It is good to be capable and „anticipate” which information may be necessary in future and design samples in a way so as to maximize the use of samples in the future.



Measurement campaign – Advantages of sampling method

- **Reduced costs**
 - The cost of sampling method is proportional to the size of population. For example, the size of a sample of 5% of the whole population would be approximately 5% of measurement costs for the whole population
- **Higher speed**
 - Reduced level of data ⇒ higher speed of obtaining information from the load research
- **Better quality of data**
 - Less data ⇒ better quality control in relation to the same level of data source
- **Smaller scope**
 - Reduced scope of activities provides for expanding of samples to other populations



Measurement campaign– Selection of network

- Choosing the best network and customers
- Unique type of zone
 - For example, choose only urban or only suburban, etc.
 - For example, zones with combined urban and rural part are excluded
- Statistical distribution of consumption in selected networks should be very similar to global distribution
- Underground lines or overhead lines (not both types)
- Additional criteria – geographic distribution



Measurement campaign– Customer groups and strata

- **Groups of customers** ⇒ *A priori* defined
 - For example, Households, Commercial customers, Industrial customers, hotels and restaurants, other
 - Number of customers should not be too big – sufficient number of representative customers in the group
- **Strata (subgroups) of customers in defined groups**
 - **Stratified sampling**
 - **Fewer strata within the group**
 - **Define limits of strata**
 - **Determine average consumption and standard deviation of each strata**
 - **Set the value of reliability interval**
 - **Set maximum allowed errors for each strata**
 - **Determine number of samples**



Load research methodology – Measurement campaign

3. Specification of metering devices and their installation

Objectives:

- Draft measurement campaign
- Procurement of devices
- Installation and maintenance of devices



Load research methodology – Measurement campaign

4. Data gathering

Objectives:

- Data gathering in reliable manner
- Data storage
- Maintaining data base



Load research methodology

5. Preliminary analysis of gathered data

Objectives:

- Quality analysis of gathered data – validity test for the purpose of checking reliability of samples (e.g., Average consumption of sample (kWh/year) vis a vis average consumption of population (kWh/year) for each group and strata)
- Filtration and data editing
- Substitutes for non-existing or incorrect data
- Data normalization



Load research methodology - Questionnaire

3a. Designing questionnaire

Objectives:

- To design questionnaires for customers in order to understand their typical profiles related to their use of power appliances and to characterize customers' profiles;
- To define samples of customers who will participate in the questionnaire – the most appropriate is to use samples designated for measurement campaign



Questionnaire

Questions which should be in the questionnaire:

- 1) Questions related to type of facility – apartment, house, summer house? Square meters of facility? Position of facility? How many floors? Year of building? ...
- 2) Questions related to type of heating/cooling of facility
- 3) Questions related to water heating
- 4) Questions related to most frequently used appliances (dish-washer, washing machine, dryer, refrigerator, stove, microwave oven, hair-dryer, TV, PC) – Number of appliances? Time of use? Year of production of appliances?



Questionnaire

Questions which should be in the questionnaire:

- 1) Other appliances. Type? Number? Year of production?
 - 2) Demographic questions – How many people live in residential building during working days? How many people live in residential building during the weekend? Age of people?
- Questionnaire should include questions regarding seasonal use of some power gadgets
 - Different types of questionnaires for each type of customers and season (for example households, etc)



USAID
OD AMERIČKOG NARODA

**Asistencija regulativi i reformi
energetskog sektora**

Load research methodology - Questionnaire

4a. Distribution and gathering of questionnaire

Objectives:

- To get as many as possible responses for each representative group of customers in advance



Load research methodology - Questionnaire

5a. Questionnaire analysis

Objectives:

- To identify power appliances used in each customer class and their manner of use
- To extract information from questionnaire through statistical analysis
- Information from the questionnaire should be compared with the data gathered from metering devices



Load research methodology

6. Defining models for typical load diagrams for specific groups/subgroups

Objectives:

- To form typical load diagrams
- Error analysis

Defined models should show numerous characteristics:

- a) To be consistent with load research samples
- b) To be recognizable in the groups of customers specified in billing data;
- c) To disallow easy classification of new clients that are entered into the commercial data base.



USAID
OD AMERIČKOG NARODA

**Asistencija regulativi i reformi
energetskog sektora**

Load research methodology

7. Verification of model validity

Objectives:

- Estimate of acceptability of results from EPs
- Estimate of acceptability of results from regulators



Load research methodology

8. Development and check of software validity

Objective:

- Development of software package that will successfully apply developed and approved models
- Installation in EP, testing and software validity check



Load diagram application

- Tariff design and cost analysis – peak load study
- Demand management and Energy Efficiency
- Generation planning (generation capacities)
- Transmission network planning
- Planning and operation of distribution network
- Load forecast and energy
- Planning competitive electricity market



Load diagram application

Tariff design and provision of service study

- To great extent cost allocation influences tariff design. Load research is an important tool for determination of adequate cost allocation.
 - Peak load study for customer classes is one of the most important tools in determination of relevant cost allocation.



Load diagram application

Demand management and Energy Efficiency

- Demand management requires the data from load research
- Adequate demand management impact improvement in energy efficiency
- Demand management program is based on the estimate of customer/group of customers consumption



Load diagram application

Planning generation and distribution

- With a view to plan generation, load research enables the company to add more details to the load diagram of the system
 - A diagram of load duration is used to assist the company to make the decision on which generation combination is needed. Better understanding on how consumption influence system diagram may improve generation planning decisions.
- Data on load research is also used in planning distribution network with a purpose to study losses (unbiased and more accurate distribution of losses), and even in load research for substations



Load diagram application

Load forecast and consumption

- Short-term and medium-term load forecast and electricity consumption
- Forecast by different groups
- Connecting electricity parameters with some other parameters in time (for example load-temperature)



Load diagram application

Competitive electricity market

1. Energy markets for all customers
 - LV customers have simple metering devices
 - In an open electricity market, prices may differ for every hour (period)
 - In electricity system, energy cost is different every hour
 - Load profile is a cheaper option to enable customers to participate in energy market
2. Load research diagram for all energy traders
3. Settlement process



Conclusion

1. Load research activities – long-term project
2. Load research activities contain the following main phases:
 - Measurement campaign - Questionnaire
 - Gathered data analysis
 - Development of models for typical load diagrams (customer analysis by groups/subgroups)
 - Validation of results
3. Better preparation and first part of activities \Rightarrow long-term better data base for analysis and modeling
4. Application of load research results cost efficient



USAID
OD AMERIČKOG NARODA

Asistencija regulativi i reformi energetskog sektora

Thank you!