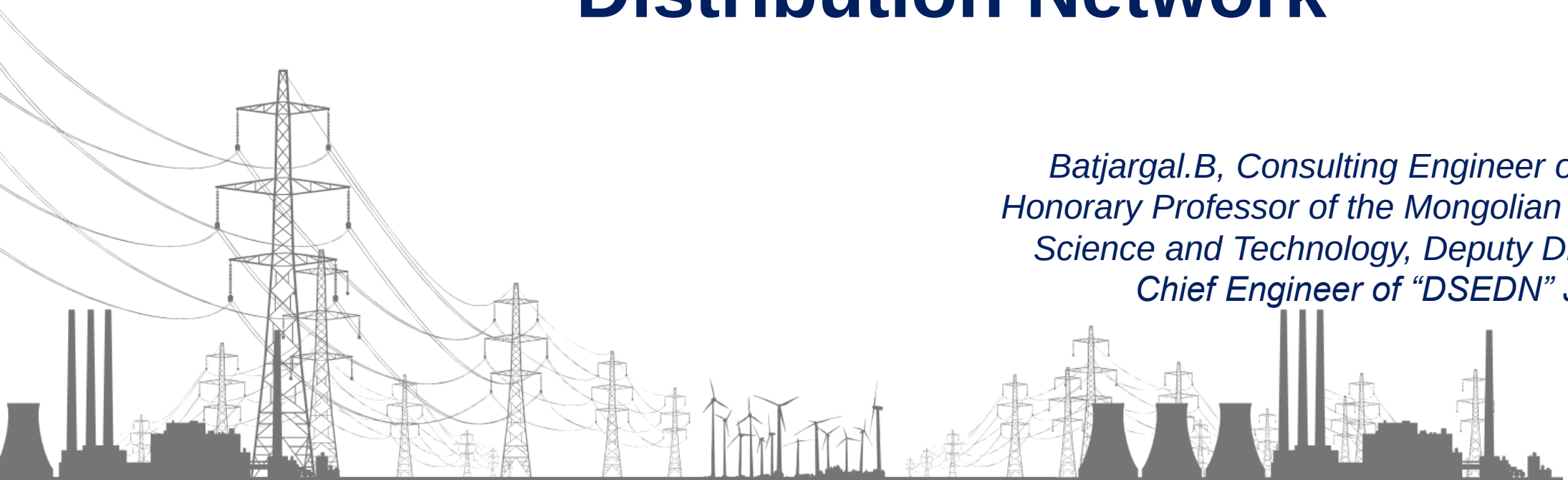
Regulatory Results, Progress and Achievements in Electricity Distribution Network

Batjargal.B, Consulting Engineer of Mongolia, Honorary Professor of the Mongolian University of Science and Technology, Deputy Director and Chief Engineer of "DSEDN" JSC



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ДАРХАН–УУЛ	СЭЛЭНГЭ
Дархан	Алтанбулаг
Орхон	Түшиг
Хонгор	Цагааннуур
Шарын гол	Зүүнбүрэн
ТӨВ АЙМАГ	Шаамар
Сүмбэр	Хүдэр
Борнуур	Ерөө
Угтаал	Сайхан
Заамар	Орхон
Жаргалант	Орхонтуул
Цээл	Хушаат
	Сүхбаатар
	Жавхлант
	Сант
	Мандал
	Баянгол

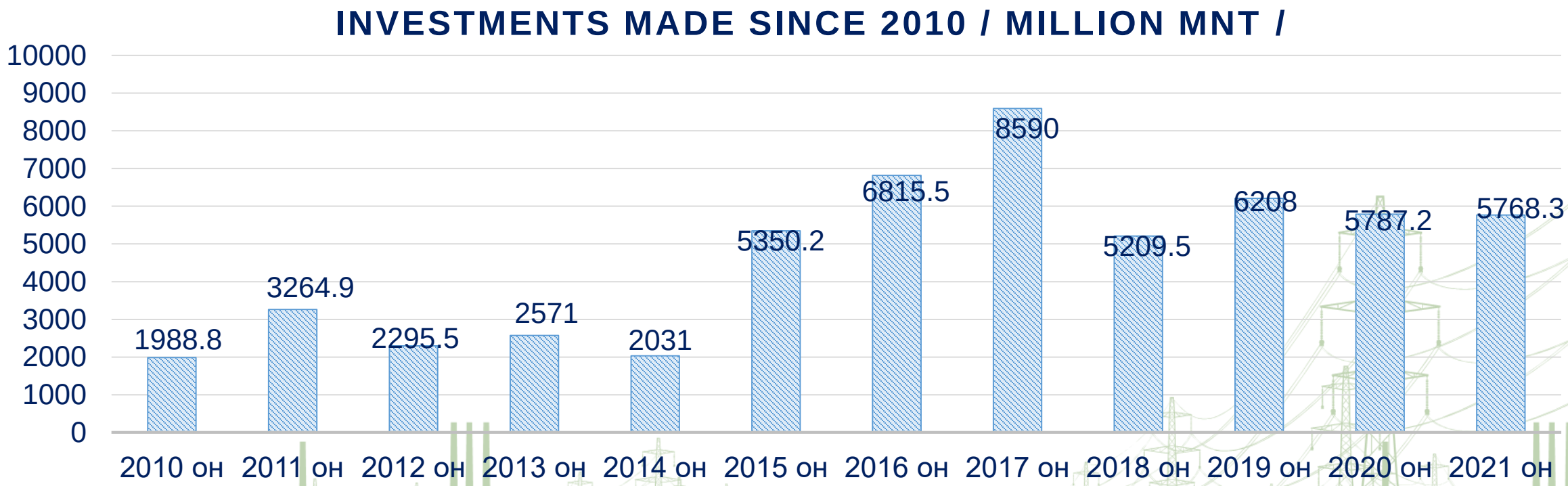
DSEDN JSC provides electricity distribution and regulated supply services to 51 thousand consumers of 26 Soums of 3 provinces such as Selenge, Darkhan-Uul and Tuv (6 Soums).

We are introducing technological innovations in order to upgrade old distribution lines and equipment within a short period of time, to improve the reliability of operation. Also, we are introducing new technologies to reduce distribution losses and increase efficiency without additional investment or any foreign long-term loans.

Over the last 10 years, with the tariffs approved by the Energy Regulatory Commission (ERC) the company was able to upgrade about 40 percent of its distribution network according to international standards. DSEDN has introduced a comprehensive automated commercial control system protected as company's intellectual property and installed smart meters for 92 % of the consumer and was able to decrease distribution losses up to 7%.

TECHNOLOGICAL REFORM

Since 2010, 55.8 billion MNT has been invested in new technologies and renovations with depreciation expenses approved by the Energy Regulatory Commission

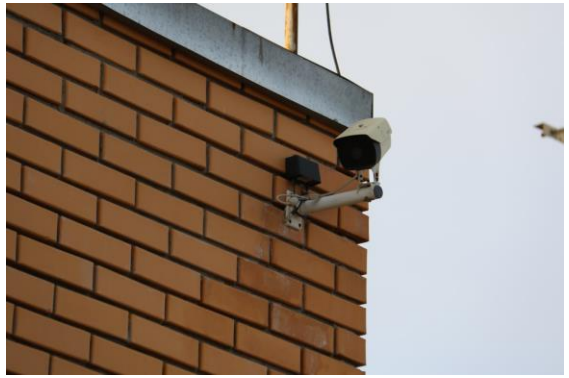


Renovation of Substations and Switch gears:

The following equipment complying with European standard are deployed for the renovation of 35 kV substation and 6-35 kV distribution facility. It includes

- **Transformers**: Russian-made power transformers, Italian GBE dry-type transformers for domestic use.
- **Circuit breakers**: SION vacuum circuit breaker from SEIMENS, Germany, SF6 circuit breaker from ABB
- **Relay protection**: Relay protection from Woodward SEEG, Germany
- **Other equipment**: Breakers and cabinets from UESA complying with European standars.

Substation and Switchgears



View of the camera inside and outside the substation

Microprocessor relays and smart meters

Dry transformer for own use

Renovation of Substations and Switchgears

2010 year
РП-8 switchgear

2011 year
РП-10 switchgear

2012 year
РП-9 switchgear

2014 year
Orkhon tuul subtsation

2015 year
1. **Shaamar,**
2. **Zaamar substation**

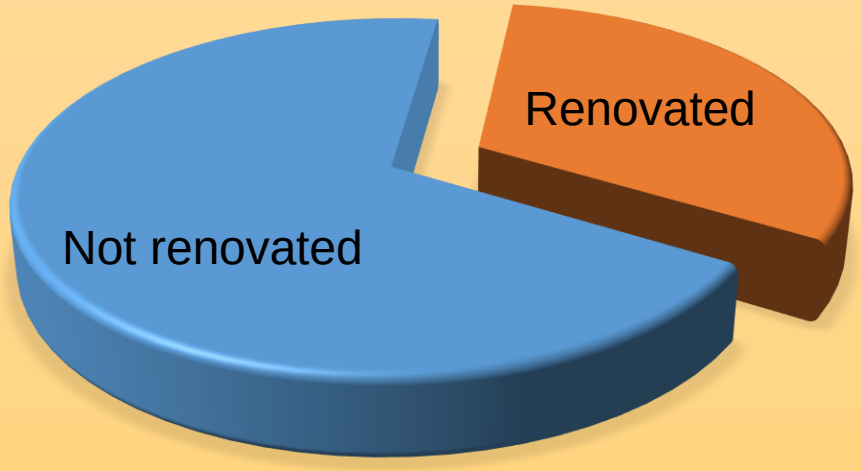
2016 year
1. **Khanjargalan**
2. **Ugtaal subtation**

2017 year
Tunkhel substation

2020 year
Altanbulag substation

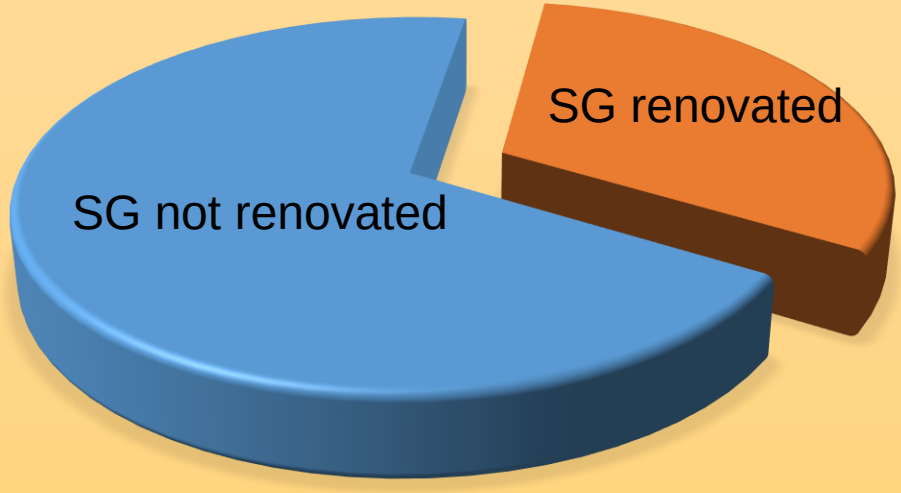
2021 year
1. **Khongor substation**
2. **РП-2** switchgear

35 KV SUBSTATION



Renovation of 35 kV substation

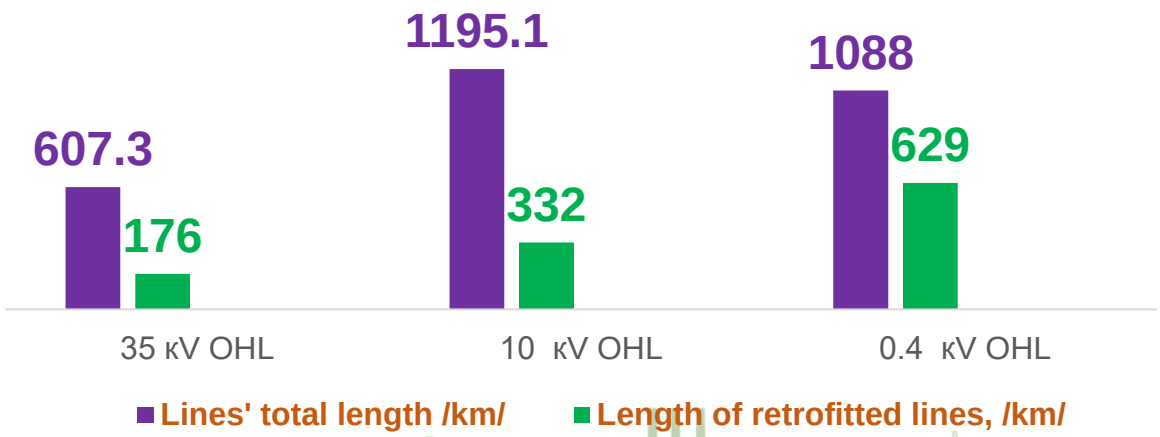
6-35 KV SWITCHGEAR

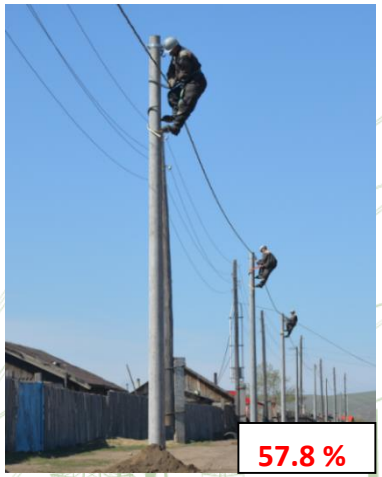


Renovation of 6 (10) kV switchgears

Overhead Transmission Line Upgrade

Overhead transmission lines are gradually being retrofitted with masts fabricated in-house.





Renovation of Other Equipment

We are purchasing equipment complying with Euro standard from Germany to replace the old ones. For example, low voltage equipment is being upgraded by German company EFEN products, and medium voltage equipment is being upgraded by Siemens and Uesa products.

Upgrading transformers to Dry Transformers from GBE, Italy.

Transformers for indoor substations, 35 kV substations and 6-10 kV distribution facilities are purchased directly from the GBE firm dry transformers manufacturer in Italy.

Dry transformers

Transformer and aerial bundled cables purchased from Russia for renovation

As for power transformers, since 2016, we have been purchasing and upgrading TMC-type transformers directly from Russian factory.

AABLu cables and aerial bundled cable- 2a overhead line conductors are being upgraded with new ones from Russia.

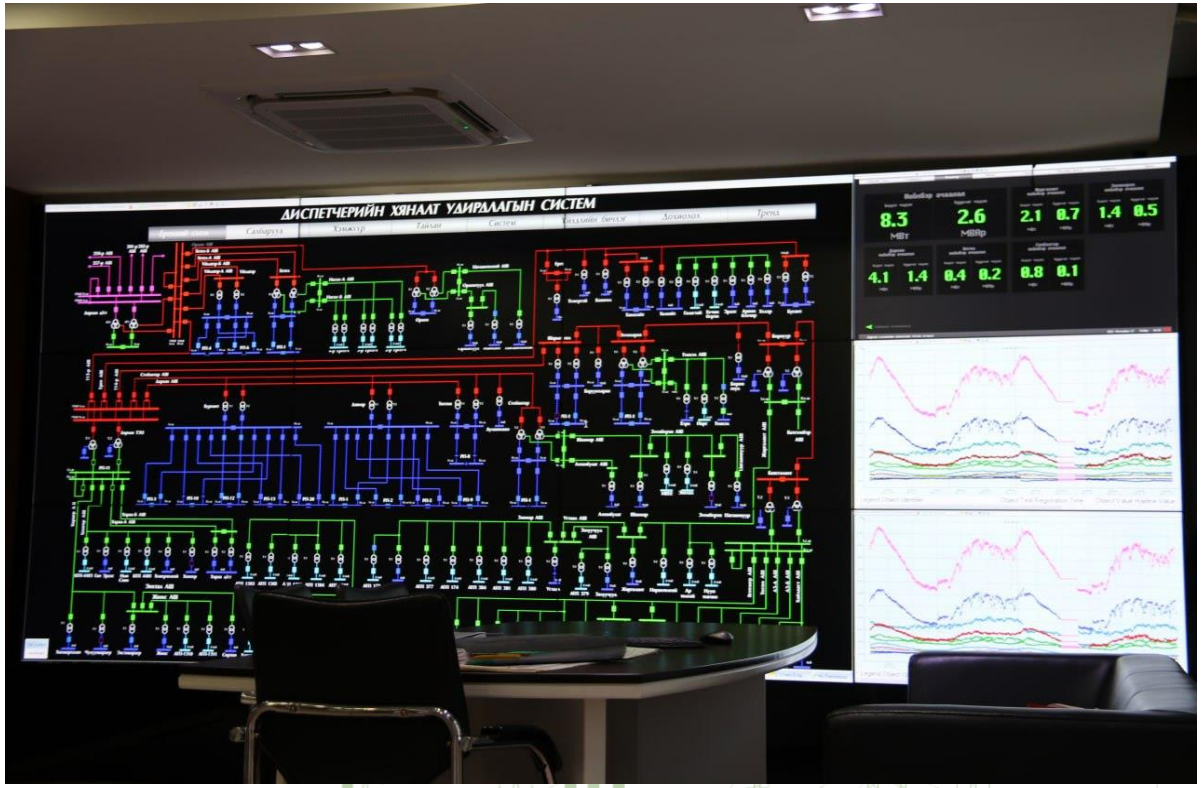
81 transformers of TMG-U1 brand were installed at the Electric Plant of Russia

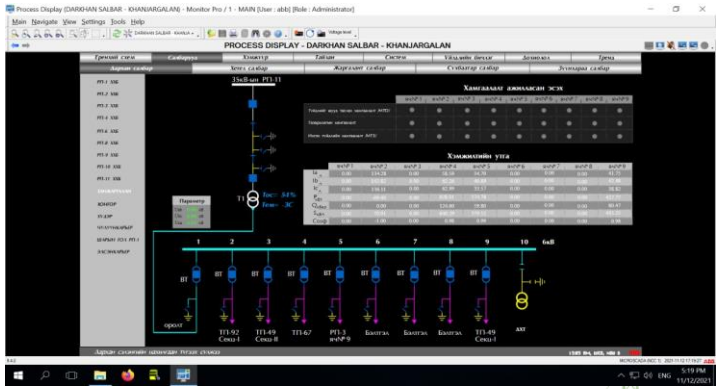
Power cable line

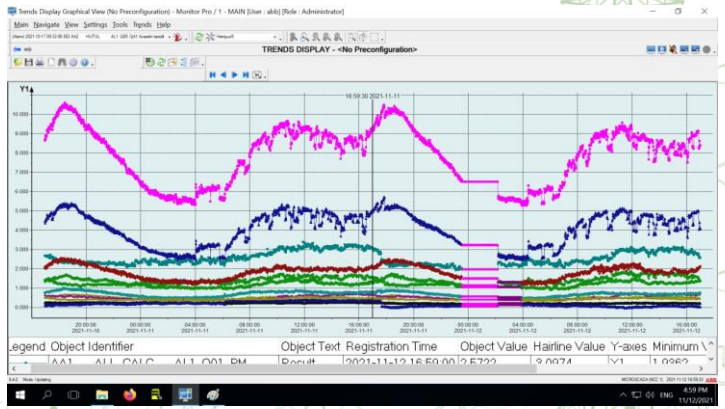
NEW TECHNOLOGIES

Dispatcher Control System

IFIX scada had been used since 2013, was replaced in 2020 Microscada SYS-600 pro from ABB.

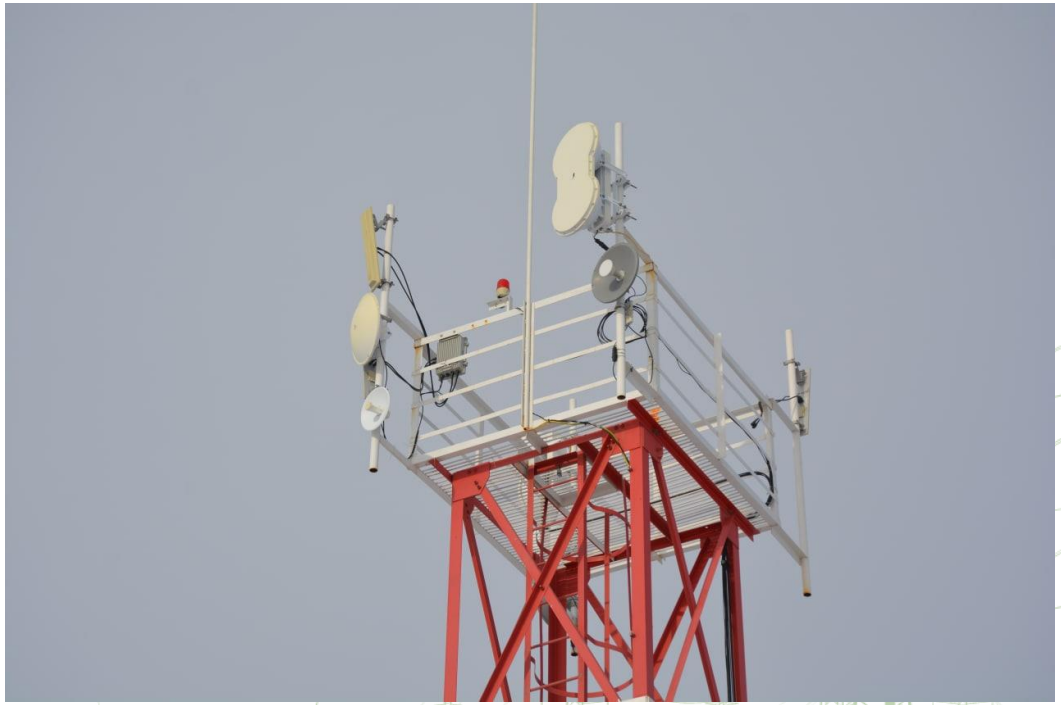






Radio Communication Network

A 12.5M high towers have been built at 3 elevated locations in Darkhan soum, and connected as ring network to exchange data between the substations without time delay.

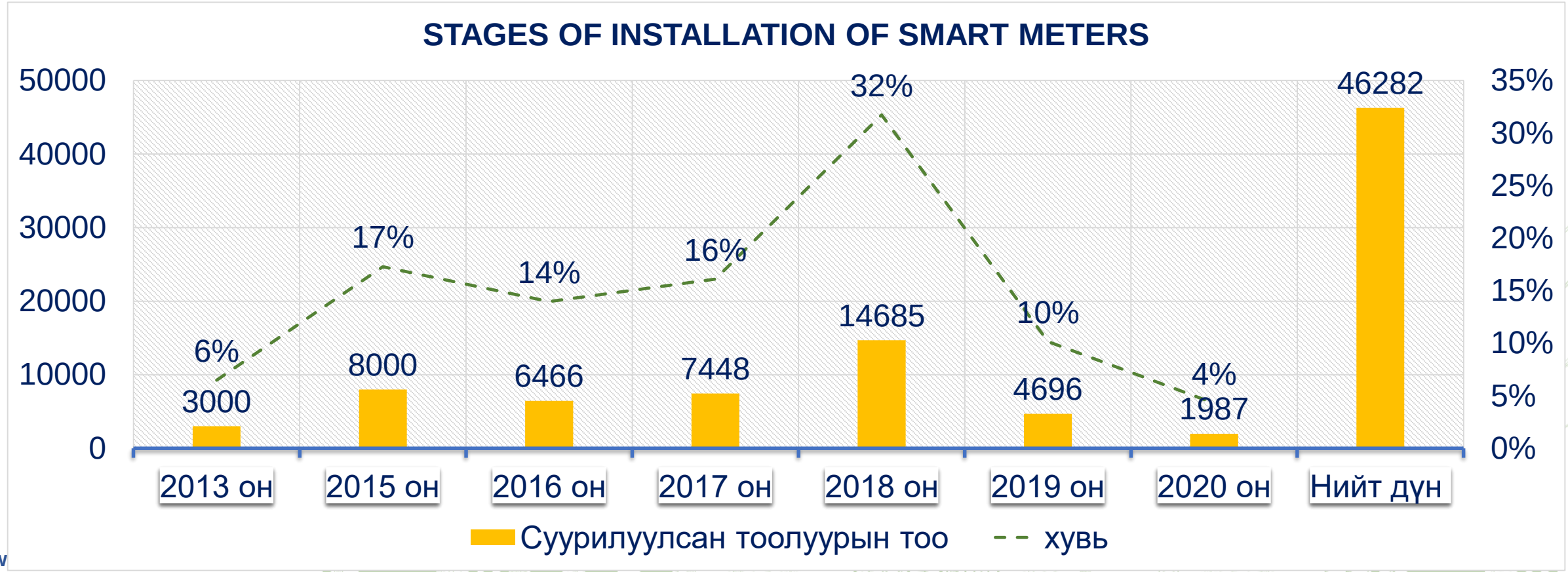


In December 2012, for the first time in Mongolia, 3,000 smart meters were installed in Darkhan soum of Darkhan-Uul aimag and Sukhbaatar soum of Selenge province.

The installation of a smart meter system completely solved the billing problem such as on site meter readings, manual recording processes etc.

The system is a part of an automated commercial power management system which is registered by the Intellectual Property Office.

HES (Head End System) system was introduced along with smart meter system. The system is connected to the Sales and Trading System and operating in an automated mode without human intervention.



Phases of Smart Meter System Introduction

2012 year

Research work has been started.

2013 year

The single-phase smart meter was tested in the Standardization and Metrology Agency. We received a model certificate for this measuring instruments. Initially, 3,000 smart meters were installed in 2,000 ger area households and 1,000 apartment households.

2014 он

CL730D21 маркийн 3 фазын 5А-ийн тоолуурыг загварын туршилтанд оруулж хэмжих хэрэгслийн загварын гэрчилгээг авлаа.

2015 year

380 volt 100A meter CL730S11 and CL730D18, along with PLC and GPRS modules were tested and obtained a model certificate for measuring instruments

2016 он

CL730S11, CL730D18, PLC8, GPRS модултай 380вольт 100А-ийн тоолуурыг загварын туршилтанд оруулж хэмжих хэрэгслийн загварын гэрчилгээг авлаа.

2017 year

лаботортай болсон. Organized the “Information Technology Development -2017” theoretical and practical scientific conference in the energy sector and established a smart meter test and maintenance laboratory.

2018 year

Customer information is now exchanged online with commercial banks.

2019 он

Expanded the user online system.

2020 year

Optimized and upgraded the intelligent meters, automated trading systems and dispatch control systems.

2021 year

Work is in progress to introduce more smart meters, control and commercial automation systems in other distribution networks.

RESEARCH AND ANALYSIS

1. In order to test a smart meter function under extreme weather conditions, a smart meter was installed on the banks of the River Kharaa for the first time in winter 2011. The meter data was transmitted via PLC Power communication Line by DCU, then received via 3G network to the company's central server.

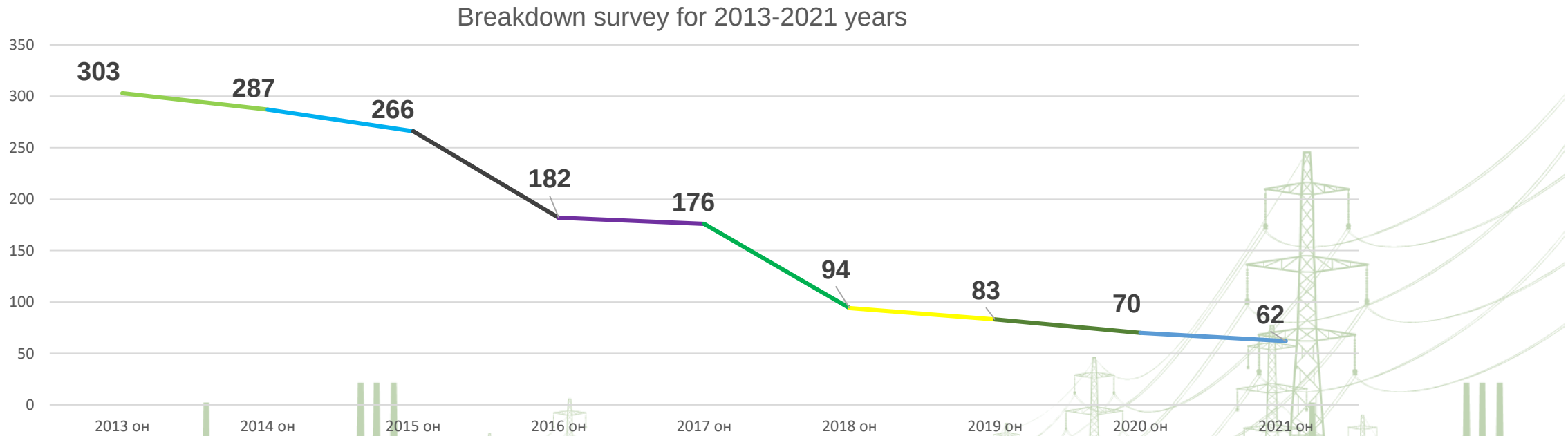
After successful transmitting meter data to the server at -42° C, it was decided to introduce a single-phase CL710K1 type PLC module with smart meter system.

1. In order to develop a method for calculating the losses of old lines, measuring instruments have been installed in new and old overhead lines and an obsolescence factor has been introduced to calculate losses based on the measurement results. The method was developed by the company's engineers and technicians.
2. The wear angle of the power transformer’s insulation was determined by the lecturers of the Mongolian University of Science and Technology - Z.Tserendorj and G.Bekhbat.
3. Grounding Current Calculation. Lead by the lecturers of the Mongolian University of Science and Technology - Z. Tserendorj and G.Bekhbat
4. A study on regime and energy losses was conducted by R.Batnyam, Engineer, DSEDN JSC.

RESULTS OF REGULATION

The number of accidents and distribution delays has been decreased

Since 2010, the line equipment has been upgraded and the line interruption has been reduced year by year, and equipment damages weren't registered in retrofitted substations and distribution facilities.



Decrease in Number of Customer Calls

The main reason for the decrease in the number of calls is that the power supply network of ger area households has been upgraded with a sheathed transmission line, which are weatherproof avoids damages caused by wind, heavy rain or natural disasters.

The average call time was reduced to 18.9 minutes due to the upgrade of lines and deployment of smart system.

The number of planned power interruptions has been decreased

As a result of renovation of the substations and distribution facilities, their maintenance work was reduced, and only calibration work need to be carried out.

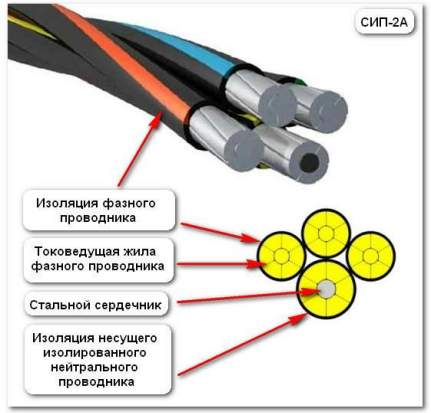
In addition, without the use of toxic organic substances, the new facilities are no longer harmful to humans and the environment.

Decrease in Losses

A voltage drop and large losses occurred due to long distance of the low voltage network to ger area.

- The substation was moved near the customer
- Replacement of conductor
- Installation of low loss power transformer
- Build a new substation at the end of the long line and share the load
- Increase the number of outputs from the transformer substation and perform phase balancing

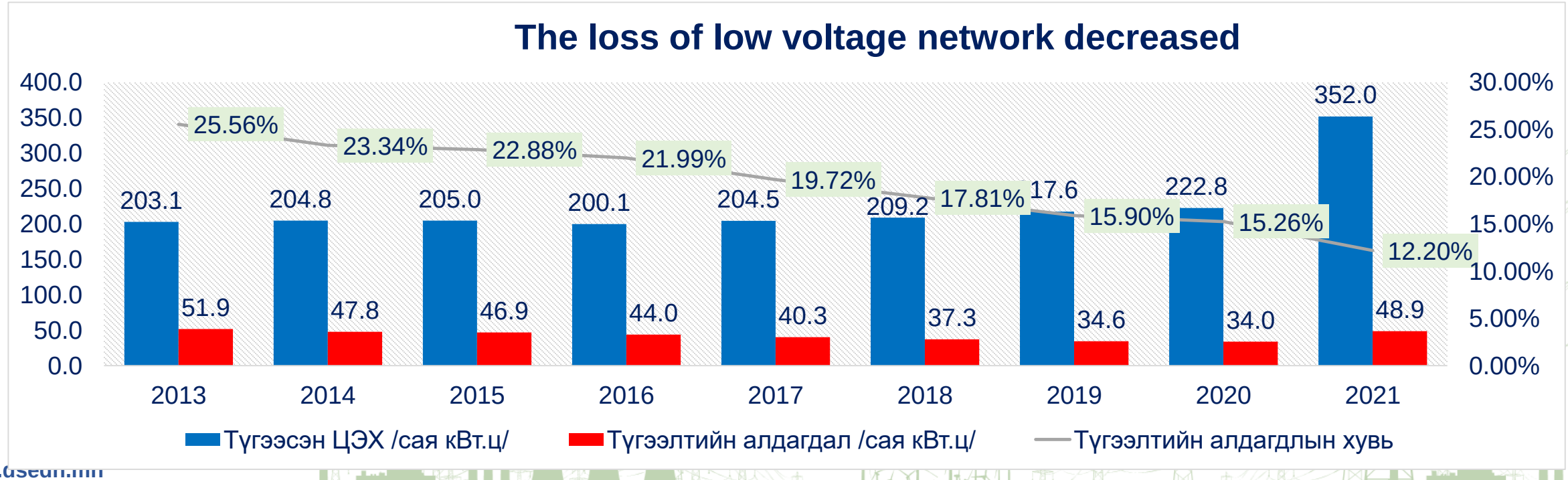
According to the organization report, losses were halved to 15.2%..



Distribution Losses Decreased

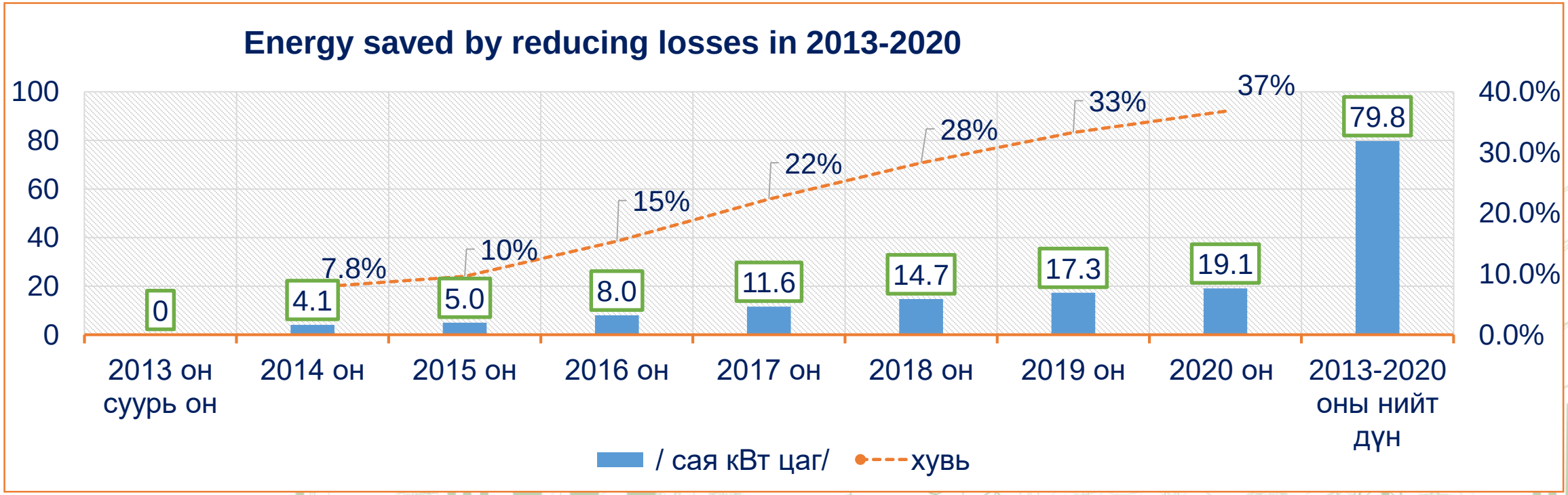
One of the keys to improve the efficiency and profitability of distribution networks is to reduce total electricity losses (own consumption, line losses, unreasonable losses, technical losses) to acceptable levels.

With the introduction of the smart meter system, the power distribution loss in the low voltage network has been decreased from 25.56% to 12.20%, which is a decrease of 13.3 points in 8 years



Energy Savings by Reducing Losses

Since 2013 as we began with installation of smart meter until 2020, the accumulated electricity savings by reducing losses of 35/10/6/0.4 kV network have reached 79.8 million kWh in 7 years and increased corporate's profit.



Created conditions to bill capacity charges:

With the introduction of an intelligent metering system that allows to store and monitor power values over a certain time period, it has enabled to calculate the customer's electricity bill more accurately.

By taking the true value of power, the consumers will no longer have settlement disputes.

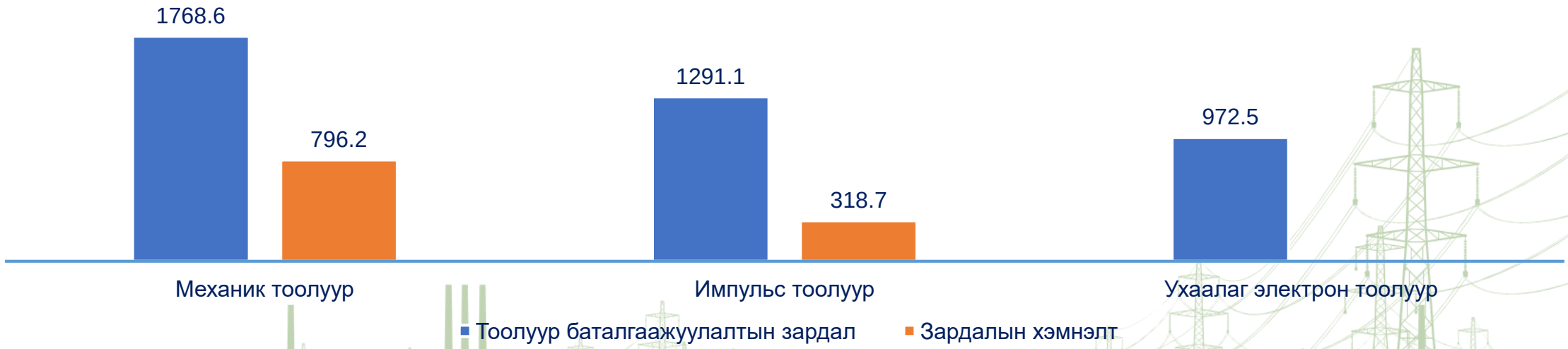
The power charges calculated by the three different power calculation methods and comparison with total charges:

Customer type	Hours with load	by a simple meter	Meter with power registration	Time of us meter with 3 time zones
/Budget user / 1 shift /	8-17 hours	15.9%	8.8%	8.3%
Customer working 2 shifts	7-24 hours	14,7%	9,0%	7,7%
Customer working 3 shifts	1-24 hours	15.9%	10.1%	8.4%
customers with night tariffs	22-06 hours	22.9%	2.4%	2.2%
Average amount		**17,4%**	**7.6%**	**6.7%**

Meter Verification Cost Saving

It is estimated that the transition to smart meters will reduce the company's meter verification costs, compared to the cost of mechanical meter verification. In addition to meter verification costs, the cost of manpower and fuel for disassembly and reassembly of meters for the verification process of each branches have also been reduced.

Cost savings on meter verification by switching to smart electronic meter / million MNT /



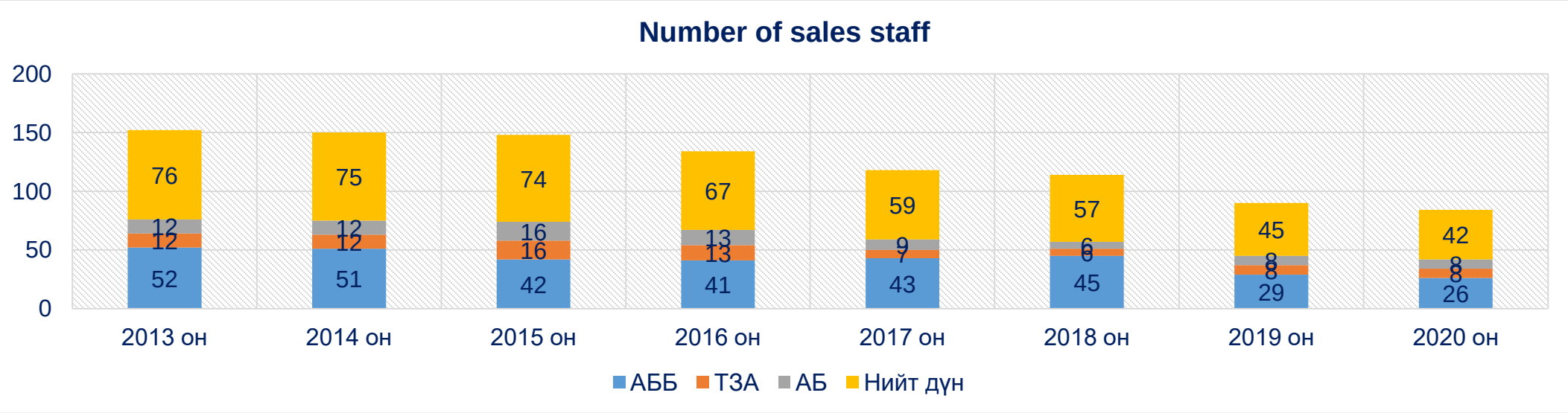
Fuel Saving

The company distributes and sells electricity to about 51.0 thousand consumers in an area of 74,000 km2.

By connecting to the smart meter system, we are able to save fuel, manpower and reduce travel costs.

Changes in Organizational Structure

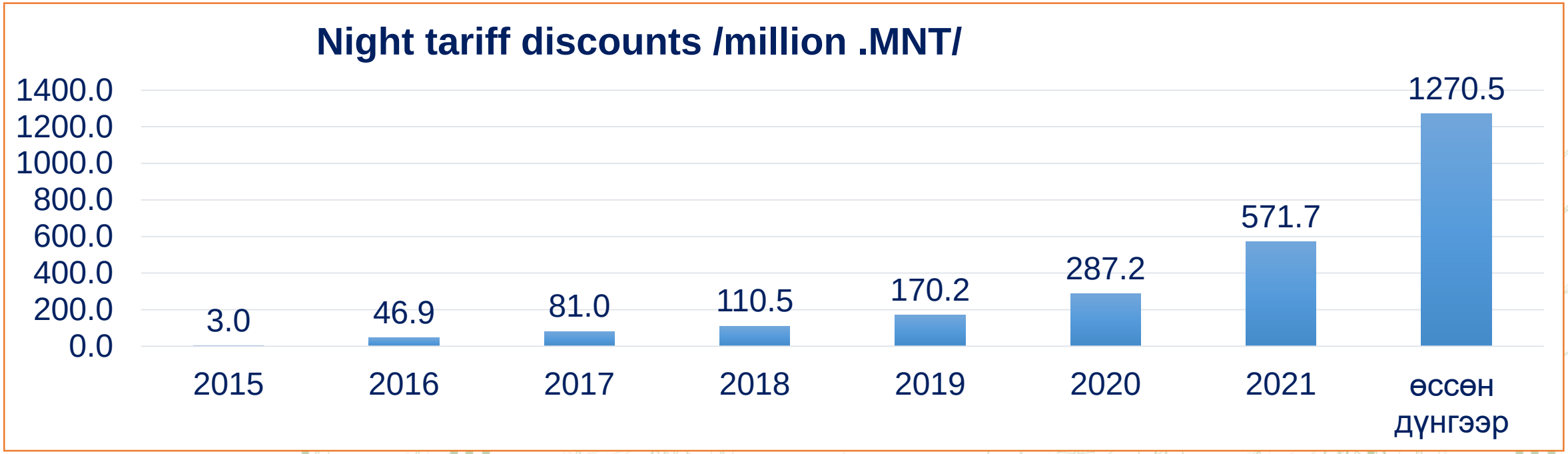
The structure of sales staff has changed as a result of introducing the smart meter system. With smart meter system, the number of sales inspectors has been decreased from 76 to 42, and 34 sales staff were transferred to other technical and office services. With the introduction of the system, rural branches now have permanent staff to serve customers.



Consumers enjoy Electricity Discounts

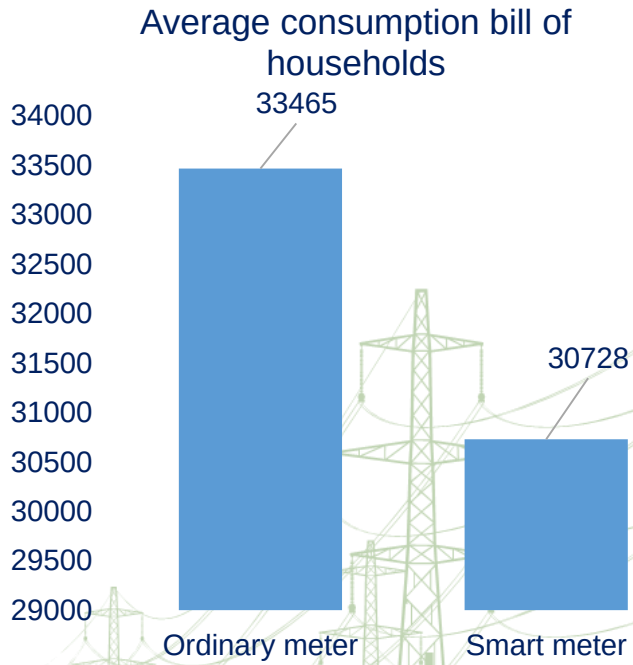
By applying smart system which enables to combine consumption data with time of use tariff options, it is possible to reduce the peak load of the system by demand response.

1.27 billion MNT night tariff discount was provided to ger area households in 2015-2021.

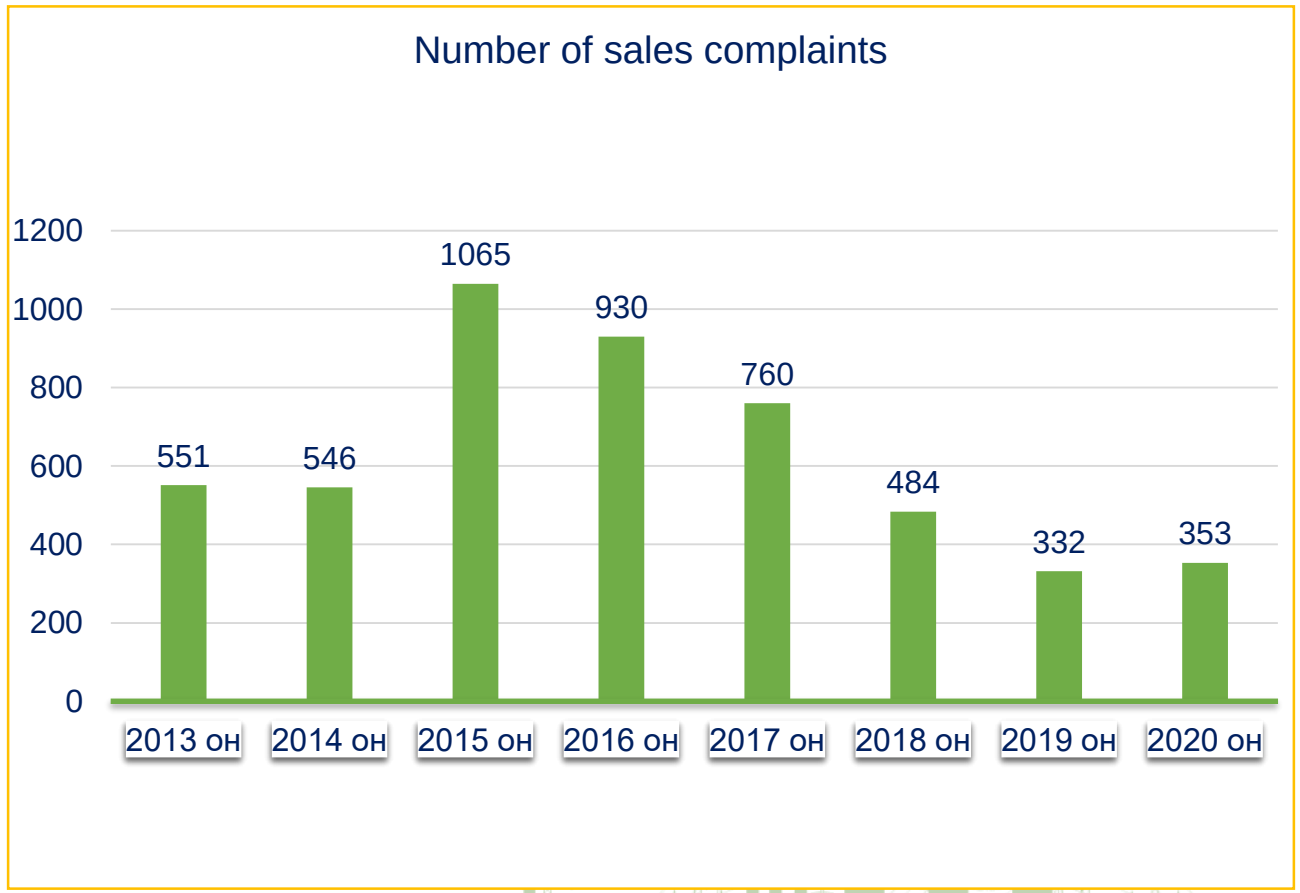


Consumers enjoy Electricity Discounts

With the installation of smart meters, consumers can manage their consumption and get up to 8 percent discount comparing to ordinary meters.



Complaints related to electricity billing, meter readings have been decreased



The intelligent system automatically downloads the meter data at a time cycle without human intervention and the data will be processed the settlement calculations in the sales trading program.

As a result, the number of complaints decreased by about 70 percent due to reduction of errors such as incorrect meter readings, incorrect calculations, and mistyping.

Enhanced Security and Control

The installation of surveillance cameras at substations and distribution facilities and regular monitoring by dispatchers have made it possible to ensure the integrity of power facility reducing a number of guards. In addition, the camera surveillance system allows supervisors monitor the staff remotely.

Workplace Conditions Have Improved

- Construction of new office buildings in branches at soum level improved employees working conditions.
- Working conditions of the staff working on overhead lines have improved.
- As a result of the renovation of the substation and swithgears, the use of vacuum circuit breakers and dry-type transformers has improved the working conditions of the repair crews, and there is no negative impact on the health of workers.

Workplace Conditions Have Improved

- Demolition of complex distribution facilities and closure of 6-10 kV distribution facilities improved the working conditions of emergency workers.

- The machinery has been upgraded to increase the productivity of the repair crew and enable the crew members to perform their duties comfortably.

We are producing own concrete poles

We are using our own concrete poles for the construction of the overhead line.

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Employees are being trained and retrained abroad

As part of the technical upgrade, the personnel have participated in abroad training. These include:

- Training at Siemens, 2 times, Germany .
- Training at UESA, Germany.
- ABB’c factory
- Smart meter factory Shengjen clou

Engineers are being trained and retrained abroad

- S.Erdenebileg, Design Engineer, studied in Energy Management in Japan and improved his skills
- B.Boldsukh, Renovation Engineer, has been trained in Energy Management in India
- 5 staff members were trained in renewable energy area at the North China Energy School in China.
- Employees who are in charge of equipment from German suppliers are trained every year.

Adequacy of machinery has improved

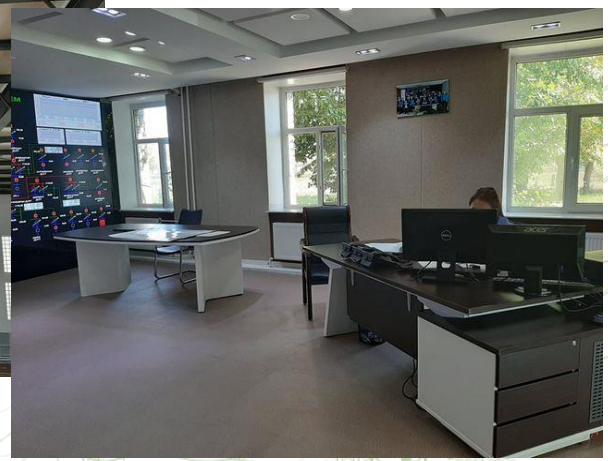
Remote area branches are now able to perform repairs on their own machines and mechanisms on time. As a result, we are able to response to a accident more quickly and restore the customer's power supply in a very short time.

Increased changes in the machinery of remote branches

No	Name of branch	As of 2010	As of 2021
1	Sukhbaatar	4	6
2	Zuunkharaa	3	5
3	Jargalant	1	3
4	Khutul	1	2
Amount		9	16

Energy Saving

95% of the company's total lighting has been replaced with energy-efficient LED lighting. This has reduced lighting consumption by 40 percent.



Energy Saving

Heaters for substations and switchgears have been replaced with temperature and time adjustable heaters. In addition, a control mechanism with a clock mechanism and a heat sensor was installed in the DBMs. As a result, it is possible to save energy by reducing the operating time of the heater automatically, which used to consume a lot of energy during the winter time by turning it on 24 hours a day.

Renovation of old office buildings, substations, roofs, windows and doors of DBs with foam board to reduce air leakage was considered in the planning step by step to reduce energy consumption and avoide usage of additional heaters.

Modern Software is used for Research and Calculation

In order to increase the productivity of engineers and technicians, and to make realistic research and calculations

- We are using Power Factor from a German company.
- Network information is recorded in the database of the Arc Gis program.
- With the development and deployment of a new technical application program, the electronic technical passport is automatically maintained, inspection and repair plans are scheduled and executed. And the action and performance reports will be processed and issued in a short time without human intervention. In addition, the dispatcher's Daily News Program allows them to generate Interruption, Call Surveys and some related reports.
- Develops balance and settlement software for better operations.

SALES SYSTEM

STS SYSTEM

CUSTOMER'S ONLINE SYRTEM

COS SYSTEM

METER CONTROL MANAGEMENT SYSTEM

AMI SYSTEM

НЭГТГЭЛИЙН ПРОГРАМ ХАНГАМЖ

RECONCILIATION

HUMAN RECOURCE SOFTWARE

HUMAN system

TECHNICALOPERATION AND MAINTANCE SOFTWARE

TECHNICAL OPERATION AND MAINTENANCE SOFTWARE

ДИСПЕЧТЕРИЙН ХЯНАЛТЫН СИСТЕМ

SCADA SYSTEM

ЭХ-НИЙ СИСТЕМИЙН ДҮН ШИНЖИЛГЭЭНИЙ ПРОГРАМ

POWERFACTORY

САНХҮҮ, ЭДИЙН ЗАСГИЙН ЦОГЦ СИСТЕМ

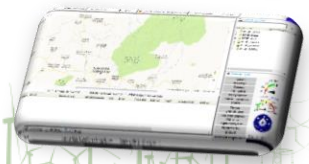
ACCOUNTING SYSTEM

ХАЦЭХ-ИЙН ЭНЕРГИ БАЛАНС ТООЦООНЫ ПРОГРАМ ХАНГАМЖ

ENERGY TOTAL POSSIBLE SUPPLY

ХЯНАЛТЫН КАМЕРЫН СИСТЕМ

CAMERA SYSTEM



ТЭЭВЭРИЙН ХЭРЭГСЛИЙН ХЯНАЛТЫН СИСТЕМ

GAIKHAM SYSTEM

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conclusion

As a result of effective coordination by the Energy Regulatory Commission:

1. 40% of the equipment is upgraded and comply with international and European standards
2. 92% of customers have installed smart meters.
3. “Automated Electricity Control and Management Commercial System”, which consists of 12 software and systems, have been introduced.
4. Customers are able to view, pay and renew their billing and meter readings on a daily basis.
5. We have created conditions for employees to work in a healthy and safe workplace
6. Distribution losses have been reduced year by year
7. No electricity receivables
8. The number of interruptions has been decreased
9. The number of customer calls decreased
10. Environmentally friendly equipment is being used
11. Introduced international standards ISO9001, ISO45001, ISO17025

THANK YOU FOR YOUR ATTENTION