RIPPLE CONTROL IN THE CZECH REPUBLIC AND DEMAND SIDE MANAGEMENT

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ABSTRACT
In view of the increasing lack of electricity facilities in Europe there is constantly more talk about the methods of controlling demand by the demanding side, i.e. Demand Side Management (DSM). Ripple control (RC) in the Czech Republic is an elaborated system of management by technical means at the relevant rates for electricity distribution especially for 8 and 20 hours per day at a low tariff (LT). The combination of LT rates above all for 8 hours (storage heaters) and 20 hours (direct heating appliances) creates from a ripple control a system that can shape a demand side load profile according to energy requirements. Due to the liberalisation of the electricity market and the legal unbundling of the biggest energy companies in the Czech Republic the capabilities of ripple control are being forgotten. The purpose of the paper is to show the regulatory possibilities of the Ripple Control System in the Czech Republic.

RIPPLE CONTROL TECHNOLOGY
Today it is possible to set up a viable solution in the distribution network for ripple control/demand side management using very different technologies – from developing AMM/AMR electric meters and PLC (Power Line Carrier/Communication) systems through tools of mobile telephone operators and radio ripple control to ripple control on the principle of the transmission of a signal with an audio frequency transmitter to very high voltage (VHV) and high voltage (HV) levels. The last of the possibilities is used in the Czech Republic.

RC Principle
The audio frequency is superposed to the network frequency and the signal is transmitted to the consumption points up to LV level through standard distribution network. This system of mass ripple control is fully owned by the distribution companies and has been built up in the Czech energy sector for over 50 years. To begin with the ripple control was used as a replacement for switching hours (at that time both inaccurate and insufficient) for switching the low tariff for electric heating and preparation of hot utility water (HUW), later also for controlling public lighting. Gradually with the development of transmitter technology and later of the receivers, the reliability of the entire system increased. In the early 1990s the first applications appeared for more active demand side management and thanks to the development of computer technology the turn of the century saw routine operative demand side management using RC and its connection to demand prediction systems. The control of receivers is really done en masse, the telegram used (in the Czech Republic this is the ZPA impulse-impulse system) does not allow individual control. Other systems of telegrams enabling individual addressing (Versacom system) were tested in some territories but were never extended. This always entails the control of receivers without the possibility of feedback, i.e. without the possibility of ascertaining how a specific RC receiver responded to a command. The response of receivers is estimated from monitored changes in the load after transmitting the command and also by various technical means, including monitoring the level of the signal in LV networks. Commands are also transmitted repeatedly thereby reducing the risk of the RC receiver not switching due to grid failure. When using RC for controlling electrical heating and preparation of HUW the command is transferred from the receiver to the electric meter (switching on and off of the low tariff) and through the contactor it directly switches on (unblocks) and switches off (blocks) the controlled appliances. The RC system is bound by the distribution payment tariff system in which rates were introduced e.g. with 8 and 20 hours of LT.

RC Transmitters
Currently the RC signal is transmitted by transmitters from almost 90 switching stations in distribution networks to 110 kV, 35 kV and 22 kV voltage levels. 2-4 units are regularly used to transmit in 110 kV switching stations.
The frequency most often used is 216.6 Hz, 183.3 Hz, 194.0 Hz and 283.3 Hz. The commands are transmitted by ZPA impulse-impulse telegram. A total of 512 area codes, i.e. 512 groups into which individual customers can be divided, are available in the Czech Republic for normal transmission.

**RC Automation**
Central automation ensures transmission of the RC telegrams in the required quantity and in predefined times. Central automation is used to discharge commands and control transmission at the individual distribution companies. Its task is to control individual RC transmitters and central transmission (automatic control of the group of transmitters, control of the preparedness for transmission, control of the transmission lines). Central automation ensures the synchronic transmission of RC telegrams to stop accidental composition of a signal thereby preventing transmission of unwanted telegrams to which receivers not intended for them would respond.

Local automation operates at the sites of the transmitters. The local automation is programmed in compliance with the relevant central automation and in case of its failure or interruption in communication lines they are able to ensure transmission and satisfy customers’ needs.

**RC Receivers**
The territory of the Czech Republic is fully (100%) covered by the signal, with the exception of areas in parts of North Bohemia, Central Bohemia and North Moravia where the coverage ranges from 90-95%.

The RC receiver is a part of the measuring system – either this is a separate instrument or it is integrated into an electric meter. Some 1,170,000 RC receivers are installed in the distribution systems while there are about 5,600,000 consumption points in the Czech Republic. The RC receiver is used by 20% of customers. These are various types of producers (ZPA, Enermet, Zellweger…) with various capabilities as their development progressed – thus there are used receivers with the simplest functions (solely switch on/switch off) to intelligent ones with learning functions, switch on delay (for removal of output surges) time loops, functions for restoring the voltage in the network, mutual blocking of the position, etc. As regards the number of relays, single and multi command receivers are used which separately control the rate, separately control the switching of storage heating appliances and separately control direct heating appliances.

**RC Development**
In the mid 1990s the ripple control experienced its greatest boom. The quality significantly improved of RC receivers and their possibilities. Recording of receivers in the grid and the level of their controlled input has considerably improved (a receiver no longer had to be changed all the time because it did work).

The low tariff always applies to all demand of the measured consumption point, not just to the demand of the controlled appliances. The long-term price policy of two-tariff electricity ripple controlled rates contributed to the perception of the demand side management of storage heating appliances (8 hours of low tariff – LT) and direct heating appliances (20 hours of LT) as a normal part of the electricity system. Thanks to the split LT bands and LT switching during the day, a number of customers, above all household customers, wait for the switching to the low tariff and at that moment switch on energy demanding appliances – to wash, iron, cook ….

Energy distribution companies built their first sales dispatching centres whose task was to reduce purchased electricity costs, i.e. preconceived reduction of purchased power output. Among the possibilities used was ripple controlled demand. RC receivers at customers are grouped so that demand is affected by RC and at the same time the number of groups was reasonable.

As well as new software instruments used to forecast (predict) the load profile, companies also used the RC system for operative DSM – above all in winter (the peak season) the load can almost always be shifted to more appropriate hours (with a lower load), operatively remove the load, increase demand in low load hours, balance out the load profile. So a combination of storage and direct heating appliances fulfils the function of a sort of virtual pumped power plant because the demand can be increased by storage heating appliances (LT 8 hours) and vice versa almost always reduce the demand using direct heating appliances (LT 20 hours). The regulatory input and regulatory capabilities are obviously significantly lower in summer.

Thanks to modern computer technology companies changed their transmission programmes virtually every day. So information is improved for customers about the situation concerning RC transmission and observance of tariff conditions, they also came up with a series of Internet applications with accurate information about the situation concerning RC transmission.

**Number of RC Receivers in the Czech Republic**

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<th>780 000</th>
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<td>ČEZ</td>
<td>E.ON</td>
<td>PRE</td>
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USE OF RIPPLE CONTROL

RC is the property of the distribution licence holder. In 2004 distribution companies estimated total costs for the purchase of RC systems at 5 billion CZK. (195 million Euro). After legal unbundling of all the regional distribution companies as of 31.12.2005, the importance of RC for demand side management fell significantly. The operative demand side management virtually disappeared. The RC system is used by distribution companies for:

- reducing losses in the networks (equal load)
- distribution of manageable demand to ensure the satisfaction of the biggest possible number of customers and optimum use of the networks and increase of their penetrability
- ensuring support services in the distribution system required for the regular operation of the electricity system as a whole
- dealing with extraordinary operational situations by emergency lightening of the load in the distribution systems even during an emergency and its prevention, exclusion and removal of its consequences
- optimising the system load from the sources up to consumption by enabling the move of part of electricity demand in time according to the load and price signals that are reflected in the conditions of the electricity system of the Czech Republic.

The RC system controls public lighting (usually in connection with photocells), the switching is tested of branches on VHV/HV transformers, however above all it was developed for electric heating management and preparation of hot utility water (HUW).

The ripple controlled load represents usually 10-15% of the distributor’s total network load. The importance of the controlled input is evident from the following two graphs. For practical reasons the starts on axis Y are in different positions on the graphs.

Storage Heaters

In the area of storage heating this concerns an application that requires charging for 8 hours daily to work faultlessly while the operator of the distribution system sets the hours in which a low tariff will be fixed for the distribution and the charging of appliance will simultaneously be unblocked. The Energy Regulatory Office determines the rules and conditions for setting the charging hours. Provided the dimensions of appliances are right, 8 hours must be adequate for the storage heaters to work properly even on days of great frost (with a calculated temperature of -15°C or -20°C depending on the location) and for the correct function of a storage boiler should it be used to heat cold water.

The survey carried out in 2003 shows that almost 2,500 MW of storage heating appliances, whose synchronic attainable input is 1,350 MW, are ripple controlled in the Czech Republic. For Pražská energetika (PRE) this represents 240 MW of storage heating appliances with a synchronic attainable input of up to 185 MW. The real attainable input is lower – on the one side the attainable input is reduced by the non-synchronic switching of individual RC groups, on the other side it is increased by the demand of appliances when the customers who use them wait for the switch to a low tariff.

MO AKU DEL represents an output content of retail storage heating controlled by commands with a split charging period usually of 5 hours at night and 3 hours during the day, or 6 hours at night and 2 hours during the day.
MO AKU SOU represents an output content of retail storage heating controlled by commands with a continuous eight-hour charging period at night usually from 10:00 p.m. to 6:00 a.m.

**Direct Heaters**

In the area of direct heating this is an application that requires a daily 20-hour heating period so it can work faultlessly and the distribution system’s operator sets the hours during which a low tariff will apply for distribution and simultaneously the direct heating appliance will be unblocked. The Energy Regulatory Office will again set the rules and conditions for setting the low tariff hours.

The survey carried out in 2003 shows that almost 1,900 MW of direct heating appliances (for heating and HUW heating), whose concurrent attainable input is 1,050 MW, are ripple controlled in the Czech Republic. For Prazska energetika this represents 130 MW of direct heating appliances with a synchronic attainable input of up to 100 MW. The real attainable input is shown in the following figure.

**RIPPLE CONTROL AND LEGISLATION**

Despite the liberalisation of the electricity market and the legal unbundling of the distribution companies, one era of successful RC demand side management has ended. The liberalisation of the electricity market in the Czech Republic has seen the growth in importance of RC for the basic shaping of the load profile so it corresponds as much as possible to the profile that the trader buys. The trader was always the relevant regional distributor. After legal unbundling RC remained in the hands of the regional distribution systems’ operators, and the interest and legal possibility of operative RC demand side management fell.

Secondary legislation that regulates RC has tightened the conditions for RC demand side management:

**Price Decision of the Energy Regulatory Office (ERÚ)**

In the Price decisions for distribution rates concerning storage and direct electric heating and HUW heating it was possible to select rates with operative management of the validity period for the low tariff (LT), or programmed management of the LT validity period. During programmed management the LT time bands were fixed for a period of at least 3 months while during operative management the LT time band could be altered at any time as required by the supplier and under the conditions set by the ERÚ. LT prices were lower in the operative rates than in the programmed rates – the energy sector was interested in gaining the maximum possible input for operative management. Currently all operative rates for distribution have been cancelled. So the customer cannot be rewarded for the fact that he is making his regulatory input in the storage and direct heating appliances available to the distributor.

**Operative Transmission and the Grid Code**

Formerly there was nothing to prevent operative transmission. There was only technical (or technological) restriction and operative management was subject only to the ability of the distributor to correctly estimate the trend of demand. After unbundling the Grid Code were amended. The rules now lay down that the distributor is obliged to inform about the RC switching mode at least one week in advance either by remote access (Internet), or as requested. This virtually removed the possibility of operative transmission for other than emergency reasons.

**Emergencies in the Electricity System of the Czech Republic**

Today RC is again being considered for resolving states of emergency and any situation immediately prior to states of emergencies. The RC system allows targeted use while preventing and resolving a state of emergency and its consequences:

- throughout the entire area of supply
- differentiated by the voltage level (220, 400 kV network)
- differentiated by the nodal area

**RIPPLE CONTROL AND AMM**

RC allows the load to be shifted and the demand diagram to be altered both operatively and from a long-term aspect. Some customers perceived operative changes negatively because they had to constantly adapt their consume behaviour to the current valid low tariff times of which there were several daily – so during operative transmission lower distribution rates were applied and the customer had a choice. After unbundling some traders could be placed at a disadvantage by the unplanned change of demand raised by
RC customers and so the possibility of operative changes ended. Customers do not perceive long-term changes (weeks and months) negatively and traders can prepare for them in advance. Lastly, there is a lot of talk about the possibilities of new AMM systems. It must be realised that demand side management through AMM will result in the same non-technical (legislative) problems as with the present operative RC demand management. It is in the interest of the energy sector and electricity customers to return to the possibility of operative demand side management whether it is performed by using RC, AMM or entirely different technical means.

REFERENCES


[3] Prazska energetika, Corporate materials

