CONSUMERS OF ANCILLARY SERVICES IN THE ELECTRIC SUBSTATIONS

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Keywords: fuel cells; ancillary services;
Abstract*:* *The paper aims to identify the current state of ancillary services consumption in power station. In order to replace current methods of supply internal services with, modern solutions based on renewable, clean solutions that exceed current system performance at the lowest cost.. In addition, it has been identified the main consumers of power stations in order to approach the implementation phase of a hybrid system in substations.*

1. INTRODUCTION

Today the availability of the utility grid is of great importance. The society needs electric power to function, and a power outage can have a severe impact [1], [2].

Transients and short interruptions on the utility grid can also have effects on industrial and commercial power systems [3].

The ancillary services represent a vital consumer for the power systems. Their good operation sustains the functionality of the power plants and substation within the power system [4].

Ancillary services are support services within the power system, those that are necessary to support the transmission capacity and are essential in maintaining power quality, reliability and security of the grid. Considering these facts the supply method of the ancillary services is a key feature for the appropriate operation of the power system.

The consumers of the ancillary services are supplied at 400/230 V a.c. (except specific consumers, where considering the work security aspects, are supplied at smaller values) and some of them, at 24 V d.c., (48/60) V d.c., 110 V d.c., 220 V d.c.

2. CURRENT STATE OF ANCILLARY SERVICES CONSUMERS

2.1 Conventional Sources for Electric Substation Ancillary Services Power Supply

According to [5] the consumers of ancillary services are divided into the following categories:

● Category 1 (main services), which includes the receivers on which a power interruption lasting more than a few minutes lead to disruption of transit of electric energy.

From this category are: oil pumps from the (auto)transformers with an oil forced circulation, cooling fans batteries of the (auto)transformers, heaters which start the diesel group, etc.

● Category 2 (secondary services), which includes receivers on which a power interruption lasting longer than those in category 1, lead to disruption of transit of electricity.

To critical importance electrical stations, these receivers are divided into two groups, namely:

▪ Group A – receivers whose power is assured also by the source of security feeding, namely: electromotors and heating resistance of the tap changer device, motopumps electromotors, heating resistances and lighting lamps of the MOP device, loading chargers of the batteries, compressors, hydrophore and ISI related pump, lighting installation (control room, diesel group), Tc equipment, etc.

▪ Group B – the other receptors from category 2, namely: heating resistances of clamp boxes, relays cabins, electric heating installation from control room, lighting installation from relays cabins and the control room block without control room, heating installations in all places where it is necessary to ensure a microclimate for the equipment from categories 1, 2 or of similar importance.

● Category 3 (ancillary self services), including receivers that do not fall within the category 1 and 2 and whose power can be interrupted for a period of time longer, such as: disconnecting switch's heating resistance and electromotor, heating resistance and lighting plugs for portable lamps in connection boxes, lighting installation and power plugs from outdoor station, oil centrifugation installation, etc.

From ancillary services DC category of consumers may be noted: circuit breakers and disconnecting switches operating devices, protections, automatization, blocking and signalization circuits, remote installations, telecommunications and safety lighting. Ancillary services DC consumers have a special importance in the normal functioning regime of the installations and are vital in case of crash of primary installations. They are, by their nature, very different and in terms of power supply application, we have:

a) **Long term consumers in permanent regime**, for which the power source is a permanent task both in the normal functioning and in the crash regime.
b) **Long term consumers in crash regime**, which in normal operating regime are fueled by AC ancillary services, but are switched on DC power throughout the lack of AC voltage.
c) **Short term consumers**, entering into service in certain maneuvers ordered manually or automatically, which can enter into service in both the normal and crash regime of the primary installations.

DC power supply is a battery, which operates as a buffer with a RUT series rectifier unit (rectifier with universal application that uses on the recovery only thyristors). The battery unit provides power for consumers only during the total fall of AC power sources. In normal functioning regime, DC SP consumers are supplied from the same source as AC consumers.

Electric energy feeding of the ancillary service consumers is made from multiple sources, namely:

- **normal power supply**, which serves to supply receivers in the normal operation, being in operation as long as the parameters are reached;
- **backup power supply**, which under normal operating is not participating in the receivers powering, but can automatically replace the normal power supply, if it is unavailable;
- **safety power supply**, which takes over as soon as possible receiver's supply when the normal and backup sources of supply went out of service.

Normal and backup feeding sources are designed to be able to provide, each, full power required by ancillary services consumers, and the safety source is designed to provide power only to the consumers who need a high level of safety, namely: consumers of the in categories 1 and 2 and DC consumers.

According to [6], the power stations SP consumers' feeding is ensured:

▪ for power stations of special importance, from three independent sources (normal, backup and safety);

▪ for stations with a higher voltage then 220kV, which are not included in the special importance category and for the stations of 110kV, from two independent sources (normal and backup).

Normal and backup sources are conventional sources of energy and represent:

- a system or a section of bus-bars collectors at medium voltage (6-20kV) from that electric station or from a power station nearby;
- a system or a section of bus-bars collectors at low voltage for distribution of electricity in that electric station or in a power station nearby;
- a line of medium voltage in the station area;

- a third coil of medium voltage (10-20kV) of a (auto) transformer that provides transit of power between the networks of high voltage (110-750kV).

In the stations of particular importance, as a safety source, there is used a diesel electrogenic group.

The traditional SP feeding system from electrical stations is represented in *fig. 1*.

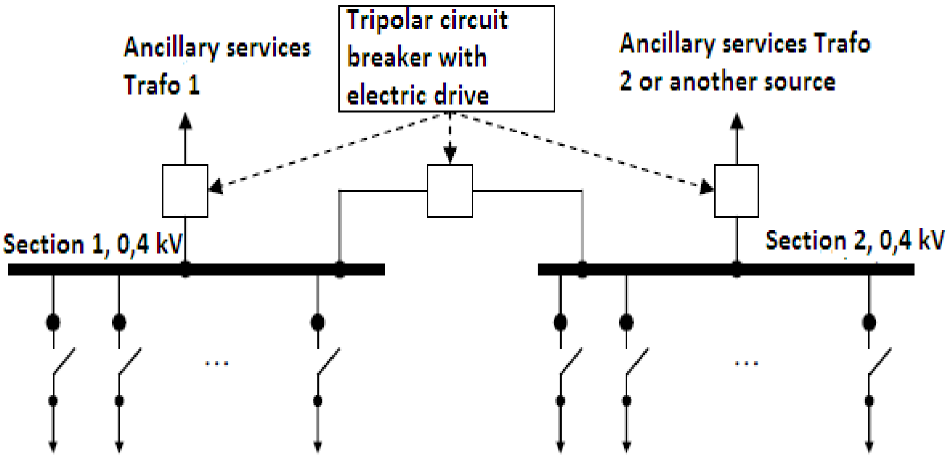

Fig. 1 – The principal scheme for self-services supplying in current situation.

For stations with the highest voltage of 750kV or 400kV, the regulations provides that the normal (basic) power supply to be made, preferably, from AT third coil, through transformers with burden taps and increased security against short-circuits between phases, and backup feeder by medium voltage lines, connected directly to 110/MV stations in the area. In regulations there are no indications on stations with the highest voltage of 220kV, where there are 220/110kV autotransformers, having a tertiary medium voltage coil. Nevertheless established that where we meet 220/110kV autotransformers with an accessible tertiary medium voltage coil, the self-services in the station can be fed from the third coil.

2.2. Unconventional Sources for Electric Substation Ancillary Services Power Supply

Fuel cells offer a clean, quiet and efficient power generation.

Like most new technologies, fuel cells are faced with the challenge to penetrate the market in a very large number of applications, due to the maturity of the product, the engineering system complexity and the durability and sustainability. Many advantages of fuel cells suggest that they may be the main driver in the future for certain applications and products.

Sir William Grove, the inventor of fuel cell technology, proved their operation in London, in the year 1830. Fuel cells have a higher „power density”, efficiently „packing” the power in a reduced space. This property allowed their use in Gemini and Apollo space programs.

In the present, fuel cells include o large variety of technologies and technical solutions. A growing number of investors are involved in developing fuel cells for both stationary and mobile applications.

Five types of fuel cells are usually used in practice:

PEMFC (Proton Exchange Membrane Fuel Cell / Polymer Electrolyte Membrane; AFC (Alkaline Fuel Cell); PAFC (Phosphoric Acid Fuel Cell); MCFC (Molten Carbonate Fuel Cell; SOFC (Solid Oxide Fuel Cell) [7].

The components of a fuel cell are as follows

- the fuel cell itself;
- the gas processor, converting the natural gas in hydrogen rich gas;
- the equipment used for processing electrical energy, converting it in a.c. or d.c.

Internationally, research, renewable and alternative energy have resulted in a variety of wind generator hybrid systems - fuel cell. In the literature there are several papers, which deal with the supply of electricity from renewable resources using hybrid and alternative [8-9], given current conditions: depletion of fossil fuels in the not too distant future and reduce greenhouse gas emissions.

Research in this area is done in various ways:

- Modeling and simulation of renewable energy sources and fuel cells;
- The optimal choice of components and subassemblies systems;
- The problem of energy storage in the form of hydrogen;
- Co-generation of fuel cell;
- Optimal management of resources in order to increase efficiency;
- Integrating distributed system resources - smart electricity networks;
- Development of experimental stands that allow validation of theoretical training and further development;

The main advantage of hybrid systems is the character offsetting variable renewable Offset the variability of renewable can be done only through use of energy storage. For low power are used as storage devices for the most common electrochemical battery. Batteries have the disadvantage that they are very expensive and have a relatively short life. Energy from renewable sources can be stored as hydrogen. This way of storing energy is the most promising storage technology, knowing a huge development in recent years in the field of fuel cells. The applicability of these systems to service internal service power stations is due to the fact that low-maintenance (low defect rate), increasing supply safety of ancillary services. This is particularly important if we consider that the power plants in the near future, will have no operating personnel, will be monitored and remotely controlled from the remote control and remote management centers.

Due to their properties in recent years, fuel cells have been considered as feasible solutions to replace conventional energy sources.

Currently, fuel cells are used to power vehicles, commercial buildings, apartments and even small electrical devices (e.g. mobile phones, laptops); Fuel cells can be constructed to generate power from 1 kW to several tens of megawatts. Some systems can achieve efficiencies (overall) more than 80%, when working in co producing heat and electricity to our communities.

3. ANCILLARY SERVICE CONSUMERS FROM POWER STATIONS

In the following will present the estimated consumption consumers supplied from domestic services of a 400/110 kV power substation.

Table I. Estimated consumption of AC consumer:

No.	***Consumer name***	**Consumption** *kW*
1.	Power distribution panel (GIS)	39,5
2.	Power Body Control overview	40
3.	Rectifier	35
4.	Transformer electric switch box	50
5.	Utilities AC services	0,6
6.	Power control AC internal services	0,1
7.	Heating cabinets counters	1,5
8.	Switch tap changer	2
9.	Hydrophore supply	1,5
10.	Pumps power supply	5
11.	Inverter	4
12.	Diesel group panel	1,5
13.	Surveillance system	1
14.	Fire system	1
15.	Phone system	1
16.	Outdoor lighting panel	6,5
17.	Utilities DC services	0,5
18.	SCADA panel supply	1,1
19.	Heating the panel from central room	1,6
20.	Heating of protection panel	1,7
21.	PT1+2 supply	4
	TOTAL	199,1

To supply internal services must ensure as normative PE 111-8/88 normal power supply and backup power supply.

In this case taking into account the values of the table as a normal power supply and backup power supply that will choose each internal service transformer with an output of not less than 250 kVA. Also be a source of safety chooses a generator with a power greater than 199.1 kVA

Table II. Estimated consumption of DC consumer:

No.	***Consumer name***	**Consumption *kW***
1.	Power distribution panel (GIS)	0,1
2.	Inverter	4
3.	PT-TSI supply	0,2
4.	SCADA panel supply	1
5.	Safety Lighting	2
6.	Metering panel	0,13
7.	BCU	0,05
8.	Ancillary service command (AC)	0,05
9.	AAR 0.4 kV supply	0,05
10.	Protection cabins supply	4,48
	TOTAL	12,06

Regarding the choice of batteries, taking into account a discharge for 3h and a correction factor takes into account the capacity of the battery discharge time of 1.25 can choose a battery with a minimum capacity of 250 Ah.

4. CONCLUSION

Ancillary services are a very important consumer for power systems, the proper functioning of the power substations and plants depend on the operation of this service.

Regarding the supply schemes for the ancillary services there are several variants, the idea being that power to be supplied from two independent sources that can each provide the power required by the ancillary services.

Since the fuel cell can be built to generate power from 1 kW up to several tens of megawatts, and the use of renewable energy sources meets unprecedented growth, supplying the ancillary services from hybrid system based on renewable energy source and fuel cell is a realistic solution.

In future must be investigated how these systems can be implemented in power substations.

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