

The questions of opening-up Azerbaijan power system into parallel synchronous operation with Russian and Iranian power systems.

Dr. Guseynov A.M. PhD. Yusifov N .A.

AERI - CDC "Azenerji" JSC

The tendency of development of electric power systems (EPS) all over the world certifies that there is an objective process for joining separate systems in parallel operation by creation of large territorial, international and intercontinental associations of power systems.

Azerbaijan Republic (AR) power system has more than 30-year's expertise of operation in integrated electric power systems (UOS) of Transcaucasia and UUES of the former USSR. The high-voltage transmission lines (TL) of Azerbaijan power system were designed as a part of the Transcaucasian power grid. Azerbaijan power system interconnects with Northern Caucasus power network of Russia via 330 kV TL in the east, with Georgian power system via 330 kV TL in the west, with the power system of Islamic Republic of Iran via 230 kV TL in the south part of the power system. Azerbaijan power system also interconnects with Turkish power system via 154 kV TL and with Islamic Republic of Iran via 132 kV TL.

Nowadays, the question of parallel operation is put much more widely.

Azerbaijan power system takes special place on the electric map. The geographic position, the presence of developed high-voltage power grid and fuel resources of Azerbaijan allows not only entering in electric flow bundle of Eastern and Western power systems [1,2] , but also to become connecting point between it and Southern UES, implemented within the framework of the program ECO UES IRI, Turkey, Pakistan etc. Turkish power system is interconnected with the power systems of European countries via interstate TLs, with Bulgarian, Iranian, Pakistan, Turkish power systems and further.

Map of interstate transmission lines around Azerbaijan power system is provided in Figure 1.

330 kV interstate TL Yashma (Azerbaijan) –Derbent (Russia) and 330 kV interstate TL Akstafa (Azerbaijan) –Gardabani (Georgia) were put into operation during 90s, and presently is on operation.

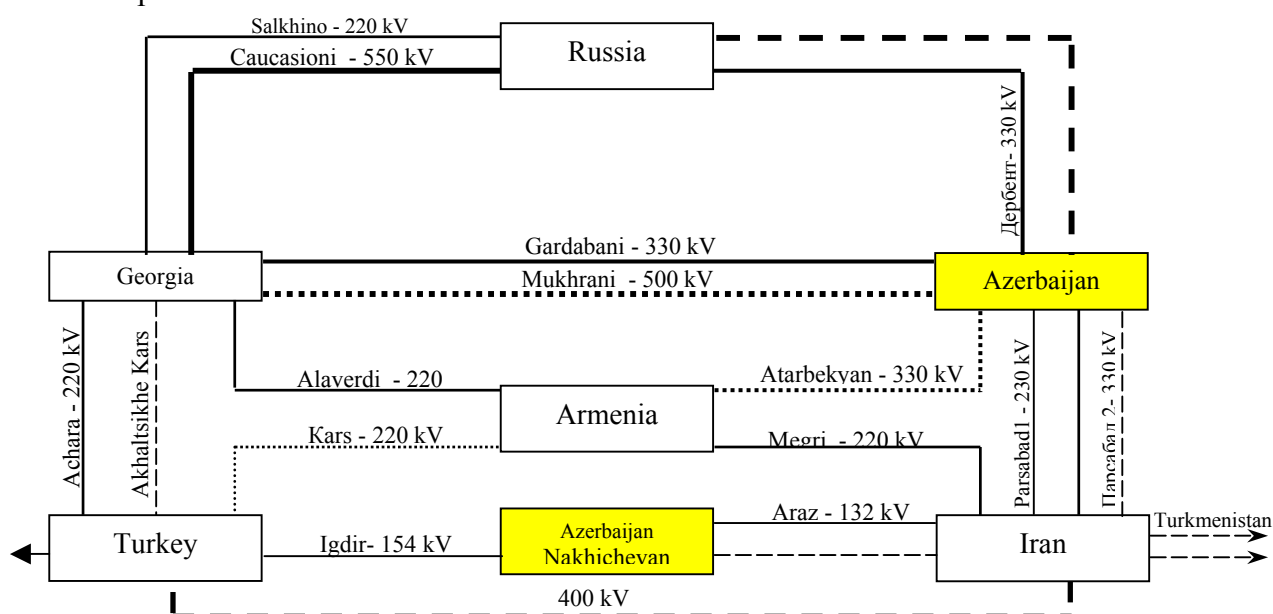


Fig. 1. Scheme of ISTL of Azerbaijan

230 kV TL Imishli (Azerbaijan) –Parsabad (Iran) has been put into operation since March, 2001, via which Islamic Republic of Iran is provided with up to 200-220 MW power during the summer period. The insular and radial conditions between power systems of Azerbaijan and Islamic Republic of Iran are evaluated as the initial stages of interaction, which are of great importance for perspective development providing transfer to a new quality level.

Nowadays, the technical possibilities of increasing power flow between Russian and Azerbaijan power systems via 330 kV Yashma (Azerbaijan) –Derbend (Russia) has exhausted. This link does not meet the requirements of reliability and efficiency any more, and in the future it will not provide transit functions between the power systems. To this end, the construction of the second interstate transmission line of 330 kV between Azerbaijan and Russian power systems is planned. Similarly, construction of the second 330 kV TL between Azerbaijan and Islamic republic of Iran is planned, completion of which is intended at the end of 2004 year. The construction of 110 kV interstate TL at the overall dimension of 220 kV Astara (Azerbaijan) - Astara (IRI) is completed. Parallel operation of power systems of Islamic Republic of Iran, Azerbaijan and Russia is supposed hereinafter.

Technical-economical indices of parallel operation is studied with the power system of Turkey via 500/400 kV TPP Azerbaijan - Akhaltsikhi (Georgia) - Kars (Turkey). In these conditions, Azerbaijan power system can play major role both as exporter of electric energy and its transitor.

Alongside with the strengthening of online operation and building of new interstate transmission lines for providing synchronous parallel operation, bringing the regulatory system of frequency and capacity to the level of advanced standards is of prime value. [3, 4]. The technical–economical questions are also to be developed [5, 6].

The solution of the question on selection of power plants for regulation of frequency and capacity comes from the structure of generating capacities, the stand of major equipment, technical characteristic of the regulatory systems in the power system.

The installed capacity of Azerbaijan power system is 5700 MW for the 01.01.2003, 4700 MW (82%) of which falls to the portion of thermal power plants, 1000 MW (18%) to the hydro power plants.

The following thermal power plants are on operation:

- 300 MWx8 (TPP Azerbaijan)- steam turbines, (type K - 300-240-3 JIM3), period of operation 15 - 20 years;
- 165 MWx7 (TPP Ali Bayramli) - steam turbines, (type K - 150-130 and To - 160-130), period of operation 35 - 40 years;
- 55 MWx2 (CHPP Baku-1) – gas-turbine units, (type GT8C of ABB firm with a boiler - utilizer) period of operation 2 - 3 years;
- 400 MW x1 (Severnaya) - steam-gas combined cycle unit, (type M - 701F, TC2F - 35.4) period of operation 1 - year.

Condensing thermal power plants dominates in the composition of thermal power plants.

The turbine units parameters of backbone power plants in Azerbaijan power system, the dead space of units speed governors at TPP is 15 times above and composes 150 MHz.

More preferential performance is observed at the units of HPP.

Adjusting tests conducted on the turbine unit at TPP Ali-Bayramli (K - 160-130 XTT3- the unit No3) has showed that the dead space of unit regulation is 0,3 % (150 MHz), the coefficient of irregularity - 5,2 %.

Tests conducted on the 300 MW unit at TPP Azerbaijan confirm resulting data of tests, conducted in the similar units of Russian power system, on the necessity of implementing of parallel process of automatic regulation on the part of the turbine and boiler.

The performance of governors at combined cycle unit of 400 MW (TPP Shimal), GTU of 55 MW (CHPP Baku-1) is more preferential. The regulation at combined cycle unit of 400 MW envisages the following 3 (three) operational modes: «Without a governor» (Fig. 2a), «Without a governor providing tracing of load limitation» (fig. 2b), «Load limitation providing automatic tracing of a governor» (Fig. 2v);

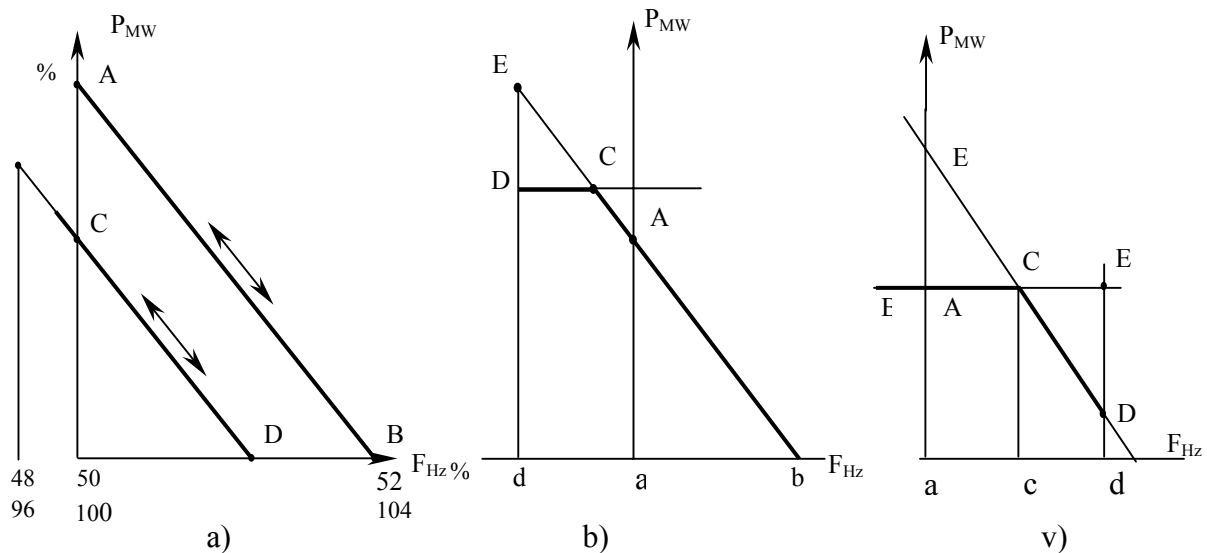
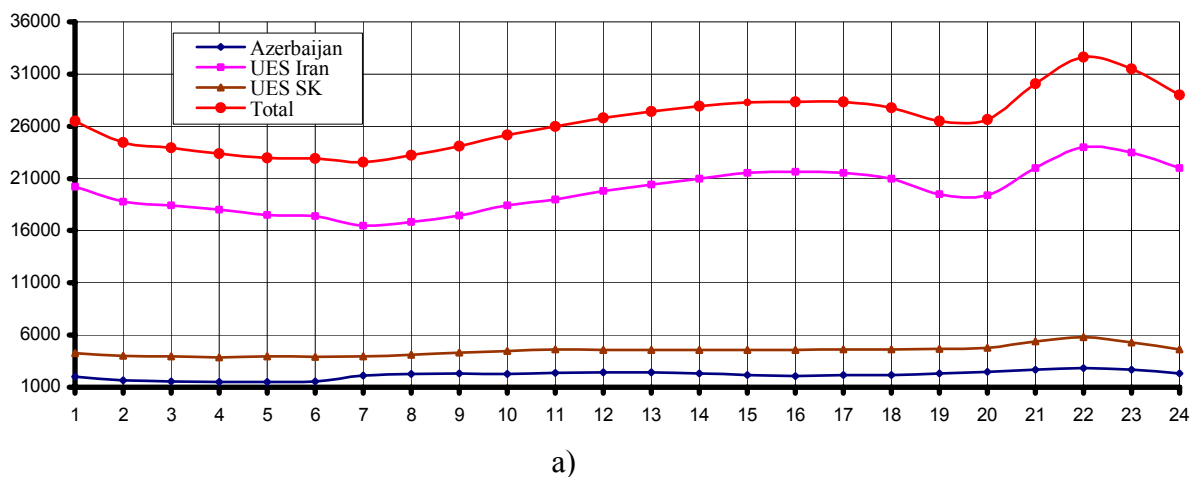


Fig. 2. Characteristics of turbine governors at combined cycle unit of 400 MW.

The power capacity of Islamic Republic of Iran power system is about 28 000 MW, including 62% of which are TPPs, 10% of which are HPPs, 28 % - GTU of combined cycle. The peculiarity of the mode is that minimum load is observed in winter months, maximum - in summer.

The power capacity of adjoining part of UES Russia is 11 500 MW, 7 700 MW (67 %) of which falls to the portion of TPPs, 2800 MW (24 %) to the portion of HPP and 1000 MW (9%) to the portion of NPP.

The load profiles integrating for parallel operation of the power systems, and also cumulative profile for summer and winter periods are provided in the Fig. 3a. and 3б accordingly.



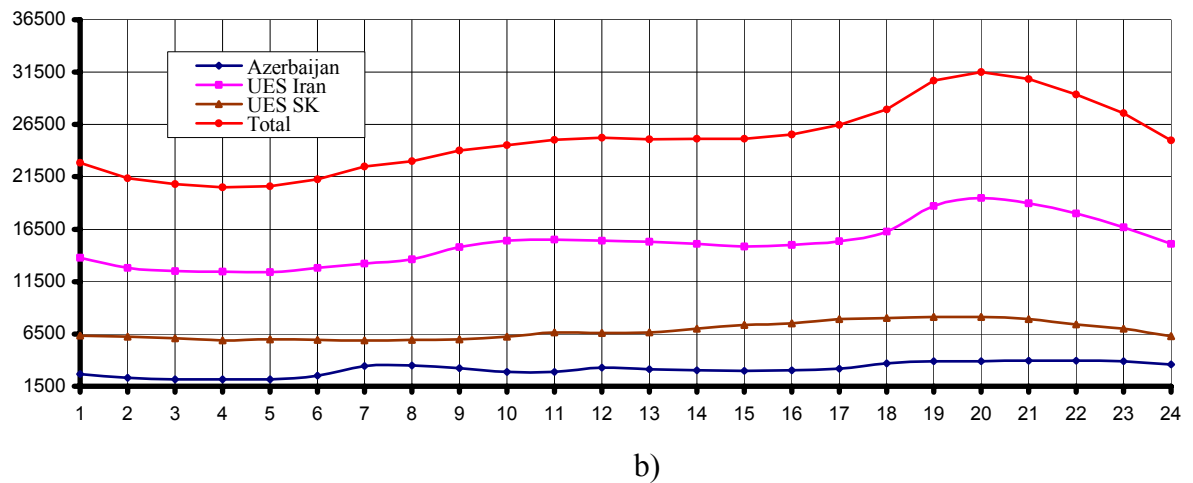


Fig. 3. The load profiles of power systems to de integrated of ES.

On the basis of analysis of modern requests to the regulatory system of frequency and capacity acting in large Western- European Associations, operations conducted in the neighboring power systems, in particular UES Russia on approaching the regulatory systems to the level of international standards, and also state of equipment and controlling devices at the power plants of Azerbaijan at the given stage and for the near future is considered expedient to accept the following positions:

1. All the power plants (TPP) are to participate in the initial regulation with the dead space of 150MHz and statism 4,5-6 % at the support of boiler regulatory system.
2. To formulate 2 groups of initial regulation from the backbone power units of TPP Azerbaijan and TPP Ali-Bayramli and also combined steam-gas cycle Shimal-1, and hereafter Shimal-2 and CHPP-1, the actions of which are to confine the operations of Automatic Frequency Regulation Breaker and special automatic tripping of load. The initial back-up are to be placed at these power plants up to 20% of their nominal capacity at the job of range of automatic control $-7 \div +20 \%$ or $-20 \div +7 \%$.
3. The power units are simultaneously to utilize for the secondary regulation on automatic regulation of frequency and strengthening load within the range of not less than $\pm (20-25)\%$ of nominal capacity, i.e. to place the additional secondary back-up on them at the range of $\pm 20 \%$.
4. HPPs should be involved in the secondary and tertiary regulation.
5. The system of secondary regulation should retain around-the-clock and constantly average value of frequency at a level $\pm 5\text{MHz}$.

Conclusion

The parallel synchronous operation of Azerbaijan power system with the power systems of neighbor countries is evaluated as the important factor of reliability and efficiency. The opening-up for effective parallel operation is carried out in the following reference directions:

- replacement of obsolete inefficient major power equipment by steam-gas combined units and gas turbine installations of high efficiency;
- construction of new and strengthening of operated interstate transmission lines;
- upgrade of antifailure system automations providing reliable operation of interstate transmission lines;
- debugging of regulatory system of frequency and capacity and bringing them to the level of advanced requirements;

It is necessary to coordinate the activity of Russian, Iranian and Azerbaijan power systems for the successful full-scale implementation of complex operations within the framework of comprehensive programs, and in particular Power Committee of CIS.

Literature

1. Беляев Л.С. Воропай Н.И. Конщев Л.А. Перспективы развития межгосударственных объединений на Евразийском суперконтиненте - Изв.АН. Энергетика 2000 №2
2. Окин А.А. Портной М.Г. Тимченко В.Ф. Об обеспечении надежности параллельной работы Евро-Азиатского Объединения энергосистем – Электричество. 1998 №2.
3. Recommendations relatives aux reglages primaire et secondaire de la frequence et de la puissance dans l'UCPTE, Juin 1995.
4. Кучеров Ю.Н. Бондаренко А.Ф. Кочан Ф.Л. и др. О технических аспектах подготовки к параллельной работе ЕЭС России с энергообъединениями Европы – Электричество 2000 №1
5. Гусейнов А.М. Юсифов Н.А. Состояние и проблемы развития Электроэнергетики Азербайджанской Республики. «Электрические станции» № 9/2002. - С. 71 - 75.
6. Соколов В.К. Аменеов Н.Д. Прейчель А.А. Рыночные аспекты проблемы регулирования частоты в Объединенной энергетической системе Центральной Азии – Электричество 2001 №7.
7. *Ground Rules concerning primary and secondary control of frequency and active power within the UCPTE.* UCPTE, 1998.