A CONNECTIVITY SOLUTION FOR HYDRO-POWER PLANTS IN OPERATION

1 BACKGROUND

Small and medium hydro-power plants (with rated power of 1-30MW), when put into operation, are required to connect with the SCADA systems of the Dispatching - Business Centres in the buying power companies. Besides, investors themselves also need to be able to monitor the power plants' operation for management purposes. However, almost all of the existing small hydro-power companies, when being put into operation, did not satisfy this requirement due to the following main reasons:

- Inability to create a communication line for connection
- Incompatible control technology and terminal equipments
- Investors unable to set appropriate requirements in terms of technology and work load

ATS Co., Ltd., with more than 10 years of experience in the field of System Protection, Control and Integration, has successfully researched and developed a connectivity solution for medium-to-small hydro-power plants, meeting the demand for data and information in the management of power operation, monitoring, and business process.

2 SITUATION ASSESSMENT

2.1 Control System of Hydro-Power Plants

Usually, all hydro-power plants are provided with a DCS system to integrate all information on the plants, which includes data on device technology, energy, electrical equipments, output substation, and the auxiliary system serving the plants' local monitoring and control purposes. The typical structure of a complete DCS system is given in the following diagram:

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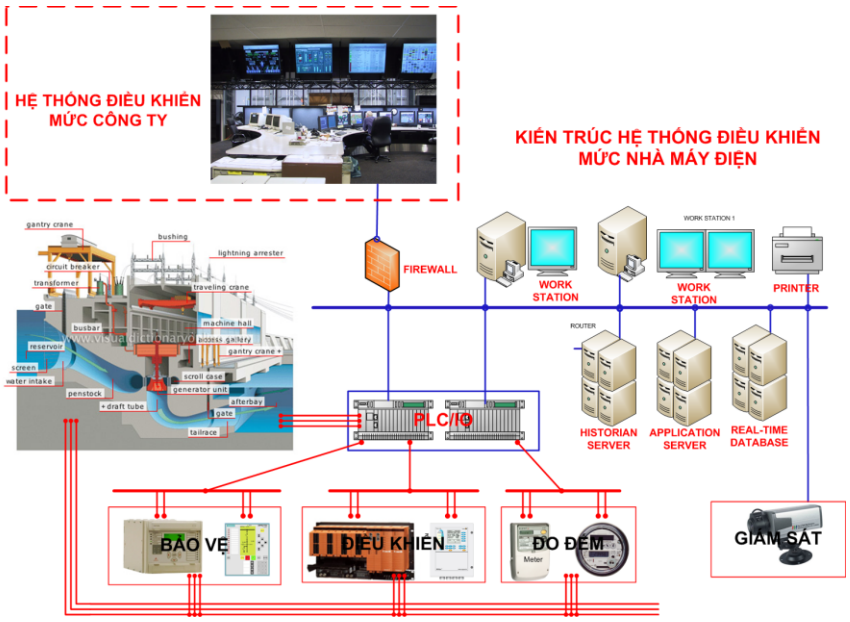


Figure 2-1: The common structure of DCS systems in hydro-power plants

However, due to fact that these systems only serve local monitoring and control purposes, they are often designed with a closed approach in accordance with the information transmission and communication method of individual suppliers. Using closed system will make difficult the process of information exchange and constrain users' intervention when new requirements emerged during

the management and business operation. This is because suppliers rarely provide all necessary equipments and documents for this to be done.

2.2 SCADA and Metering System Connection

In most power projects, as the Consultants are not able to grasp all connectivity requirements of SCADA and Metering Systems in Vietnam, this area of work is usually not clearly specified in the Scope of Supply of Power Plant Supply and Construction contracts. Consequently, nearly 100% of all small and medium hydro-power companies do not have this type of connection. In addition, due to the closed structure, DCS systems can hardly connect to the SCADA and power metering management systems of power companies. Furthermore, since small and medium hydro-power companies are often constructed in remote areas, the work of installing a 4-Wires communication line such as those of existing connectivity solutions is highly costly, including both initial investments and monthly operation expenditures.

However, this connection is a requirement for hydro-power companies according to the rules issued in conjuction with Decision No. 37 by the Ministry of Industry (now Ministry of Industry and Trade). Especially, for power plants participating in CDM emission trading program, the ability to connect and store metering data on the power distributed on the grid is needed by CDM buyers in computing the amount of emission they entitle to.

2.3 Applications for Decision-Making and Operation Optimization

2.3.1 Hydrologic Prediction

At the present, power plants only have recording systems that record hydrologic statistics of rivers related to the hydro-power companies. A hydrologic prediction system has not been created for power plants to use reservoir operation as input data in planning plant operation.

2.3.2 Computation of Power Optimization and Coordination of Ladder Hydro Power Plants

Power plants have not been equipped with these types of softwares to effectively utilize annual volume of water. The work of setting the machine run schedule is still under the authority of Load Dispatching Centres, where control engineers give up/down commands and set capacity points of machine units for control personnel in each shift.

With respect to small hydro-power companies, operation personnel can determine whether or not to start a machine run. However, even in this case, power plants still do not have the necessary equipments to optimize their profits based on the Power Purchase Contracts signed with power companies.

2.3.3 Conditioned-based Maintenance Management

Usually, due to their production scopes, small and medium hydro-power plants are not equipped with this type of maintenance management system. This system will allow companies to set up maintenance procedures and manage maintenance process, starting from schedule planning, risk management, equipment purchases, task assignment, project status management, to evaluation reporting, etc.

2.3.4 Telecommunication System

At the present, power plants can be connected through the following communication channels:

- EVN Telecommunication System, using optic-fibre cables, SDH systems, and BTS ports to connect to local telecommunication network or to the WAN network of EVN.

- Public Telecommunication System, with communication channels connected to VietTel or VNPT
- VSAT Satellite Telecommunication System from service providers such as VietTel or VNPT
- GPRS connection on GSM basis of service providers

The below table gives a preliminary assessment of different connectivity solutions based on several criteria:

Network and Service Provider	Communication Channel Quality	Speed	Service Area	Service Quality	Cost
WAN/SDH Network, EVN	+++	+	+	+	+
Wireless connection, EVN	+	+	+	+	+
Communication Channel, VietTel	++	++	++	+++	++
Communication Channel, VNPT	++	+	+	+	++
VSAT connection, VietTel	+	++	+++	+++	++
VSAT connection, VNPT-I	+	++	+++	++	++
GSM connection, Mobile	+	+++	+	+++	+++
GSM connection, Vina Fone	+	+++	+	+++	+++
GSM connection, VietTel	+	+++	+	+++	+++

+++: Good, ++: Average, +: Not Good

Depending on their specific locations, power plants and their suppliers can pick an optimal solution by reviewing the above criteria.

3 Technology Solution

ATS provides a solution for the development of an Operational Control Centre (OCC) as described in the following.

3.1 The system meets the following basic requirements

- **Open Structure** – The structure of OCC system for hydro-power companies will comply with requirements set out by international standards and standards in popular use by industries.
- **Maintenance Capability** – The structure of the OCC system will support routine operation and local maintenance of components without requiring assistance from suppliers.
- **Application Development Platform** – The structure of OCC system will provide a powerful platform for the development of applications used for device control, monitoring, and management as well as information communication with internal and external systems. In addition, the system has the capability to provide data services for internal and external users via Web applications.
- **Integration Capability** – The system is capable of flexibly integrating new components, new solutions and other advanced applications (such as GIS or Risk/Damage management and Team work management), ready to serve as a platform for the the future Vietnam's Power Market.

3.2 Main Technical Features

3.2.1 Hardware System

The entire system consists of 3 components:

- **Central component:**

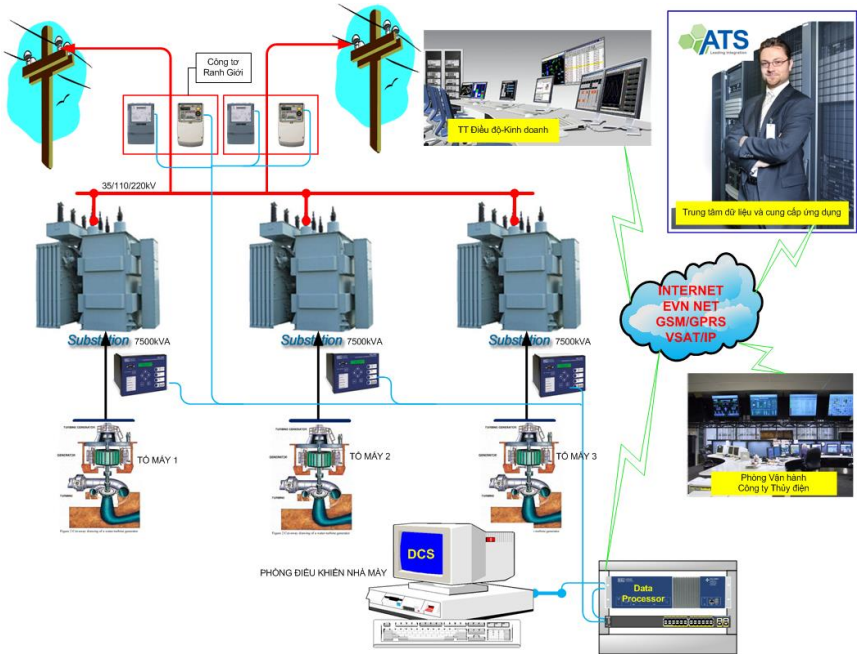
- The SCADA system at Regional Load Dispatching Centre (Northern Regional Dispatch Centre (A1), Power Company 1 and provincial power companies): As agreed upon by both power plants and power companies, all information necessary for the supervision and operation of the power plants will be collected, processed, and distributed by the SCADA system to appropriate applications, allowing operation staffs to interact with all devices necessary for the supervision, control and communication with other applications.
- ATS Data and Application Center System: The central system will support the control centres of power plants. Through the control authority distribution and supervision systems, the centres of these plants will also connect to the central system of the companies using high-speed channel.
- The hardware as well as the software of the central system are based on an open structure, can be apply, modify, and replace, and are simple to use during operation process.

➢ **Component located in power plants**

- Solution #1: DCS systems in power plants will exchange data with SCADA and OCC systems through a real-time database using appropriate data conversion mechanisms. This mechanism ensures that data is updated simultaneously in both the DCS systems of the plants and the OCC systems. With this method of data communication, the work of control supervision at OCC is no differently done from that done in the control rooms of power plants.
- Solution #2: In hydro-power plants, devices that collect metering data and plant equipment status and alarm to be transmitted to SCADA and Operation Control Centre will be installed. Boundary meters (delivery/ receiving meters), including both the main and backup meters, will be connected on the same channel.

➢ **Telecommunicaton system**: The telecommunication system between power plants and OCC systems will use one of the solutions examined above as the main solution; it can also pick a backup solution with the basic criteria being a solution most ready and least expensive.

The connectivity system is illustrated in the below diagram.



Figue 3-1: Basic connection of the data collecting and SCADA connection system

3.2.2 Software system

At the Control Centre, the LAN network will be configured to support a Client/Server structure as well as front-end computers to communicate with the data collection and communication systems of the hydro-power plants and other centres.

Depending to the level of reliability and readiness, the system can be structured with one main server and one backup server to provide the functions required by the OCC, including managing real-time database, reacting to alarms, recording historical events, accessing historical event data, and providing graphical user interface. According to the requirements of investors, these servers need to have the ability to support a number of plant equipments of operators/ managers in order to supervise and monitor subjects within their control.

The structure of the software system is designed according to the 3-layer model, including:

- **Data-collection Layer**:
  - This is the lowest layer in the central system, performing direct communication with real-time database of meters, RTU, and involved Dispatch centres.
  - This layer also monitors the condition of transimission channels, manages data resulted during the communication process, and gives out warning on the communication process with the terminals.
  - This layer, through telecommunication systems, sends/receives data to/from the terminals using standardized protocols and processes these data into formats that can be understood by OCC systems before tranmiting them to the Data Server layer.
- **Data Server Layer:**
  - This layer receives data from the Interface Layer, processes them, and makes them ready for applications. The functions of this layer are equivalent to those of the real-time database of the DCS and include unifying different databases from different devices/data sources into a single format.
  - It should be noted that this layer needs to be implemented with a SoftPLC-Logic Processor according to the IEC61131 standard, assisting users in creating logic maps for supervision and control appropriate with their own applications.
  - This is an especially important layer because all applications access data through it, in which the SCADA systems exchange data using IEC 60870-5-101 protocol and the metering systems IEC65026-21 protocol.
- **Application Layer:**
  - This is the highest layer in the central system.
  - The users communicate with the system through this layer. Here, applications can be the human-machine interface system HMI, the event management system, or the historical data system, etc.
  - Using conmmunication tools with Data Server Layer, users can plug-in other applications according to their working and managing needs, such as report compilation and data summarization.
  - Based on the infrastructure of the control centre, the system can provide the ability to access areas of data to support the different functional areas of involved groups, such as technical analysis, schedule planning, power load monitoring, payment management, operation optimization, and maintenance management. In addition, this system has the ability to monitor access security of the area where IT “connects” to Control Centre network.

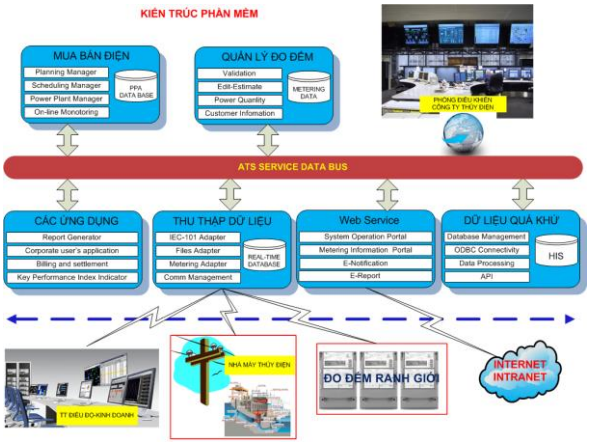


Figure 3-2: Overall System Structure

3.2.2.1 Stardard Comliance

The system hardware and software are manufactured and developed in accordance with standards in popular industrial use, mainly ANSI/IEEE, ISO, and IEC standards. This allows hydro-power companies to use and integrate products from different manufacturers without being dependent on any specific manufacturer.

4 Conclusion

With ATS solution, the process of connection with small and medium hydro-power plants will become much simpler. Meanwhile, parties involved in power operation, management, load dispatching, and business process will have complete data to better perform their tasks, thus conserving energy and improving energy utilization efficiency.

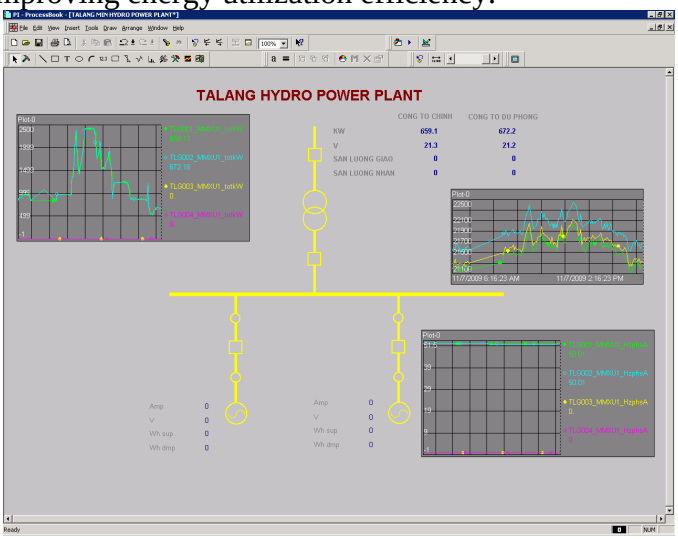


Figure 4-1: Console display of Ta Lang Hydro-power Plant in Bac Can Province

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