R&D

## Photovoltaics with standard ABB equipment

Most renewable energy charging sources, including photovoltaics, generate DC power which is stored in batteries. The DC has then to be converted as cheaply and efficiently as possible to standard AC power levels for, say, a household. This vital bridging function is provided by the photovoltaic (PV) inverter.

The photovoltaic inverter market is very heterogeneous and is characterized by a 'cottage industry' of numerous small and local companies selling 'handmade' products. This is in contrast to the market for the solar modules themselves, which is dominated by a few well-established players who offer optimized products.

Although the PV market volume is fast-growing, it is still quite small. The market segment with the largest growth is that which deals with products in the power range below 10 kW. Worldwide, about 30,000 converters are currently sold per year in this range.

Now to the problem: The market price paid for PV inverters is very high compared with industrial drives with similar ratings. Is it possible to somehow adapt these standard industrial drives so that they can be used for PV systems?

The answer is yes.


Engineers at Corporate Research Switzerland explored the idea of taking an off-the-shelf inverter from ABB, changing some of its parameters and making it into a solar inverter.

The inverter they chose was the ACS 140, which turned out to be very easy to use as a PV controller. Such an ACS 140 is now in operation in a small solar system on the roof of the Corporate Research building. Both operating modes, island and grid connection, can be easily accommodated with the ACS 140 and it replaces two bulky inverter boxes that came with the solar system. The remaining challenge is to introduce ABB power electronics products in this new and fast-growing market.

Using standard industrial inverters for PV systems will not only boost this business but also support environmentally friendly technology, in line with ABB's intentions in other fields.

## The ABB Gate Model

**Enabling business-focused R&D execution**

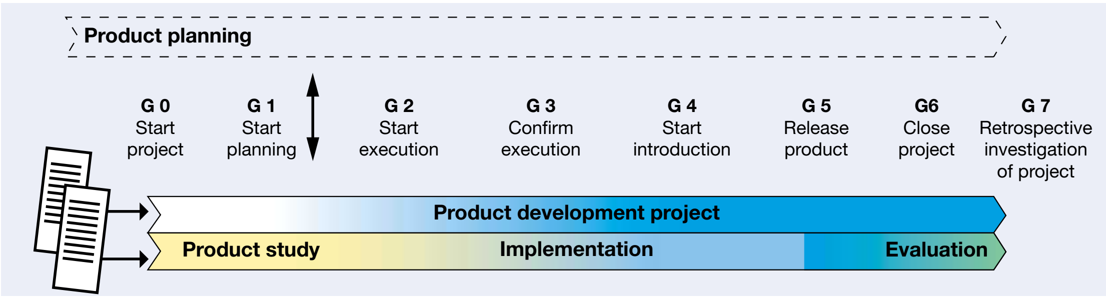
In April, ABB launched the new ABB Gate Model, a harmonized business decision model for R&D projects.

It represents the new standardized way in which every new R&D project will be run and applied in ABB worldwide.

The Gate Model was developed under the auspices of ABB's company-wide software process initiative and is based on best practices derived from former, locally used decision models. The new Gate Model has been reviewed by and pilot-tested in ABB's largest software development units. It is already being used by more than 1000 software developers and will be systematically disseminated through the company during the coming months.

The ABB Gate Model makes the project status visible and provides relevant input for business decisions. This is achieved by defining seven decision points (called Gates G0 to G6) during the R&D project's lifetime. Each of these seven Gates has a carefully designed checklist associated with it.

One additional check point (G7) after project completion is used for checking the achievements






and collecting and collating experience gained for process improvement purposes.

At each Gate, the status as well as the business opportunities and risks for the project, are discussed in a Gate Meeting. Based on a concise assessment report, the Gate Meeting focuses on business decisions; it results in a decision to continue or stop the project.

By enabling timely business decisions to be made, the Gate Model helps ABB's R&D units to quickly adapt to the needs of today's rapidly evolving markets. Through its standardized gates and check-lists it establishes a common language throughout ABB's distributed projects and organizations.
The Gate Model addresses all functions in the development organization, including Marketing, Sales, Product Management, Production, Service, Training and QA. Through this holistic view it improves product quality and optimizes the readiness of the organization to support and maintain each released product.

The Gate Model is ABB's new backbone for excellence in R&D execution. It helps ABB development units to make the right business decisions while ensuring the delivery of consistent quality to every customer.

## Automated Test Floor

Carrying out routine tests on distribution transformers before they leave the factory can be a laborious business. To make life easier for the test engineers ABB has developed the Automated Test Floor.

The Automated Test Floor comprises integrated, programmed systems which are designed to perform all routine tests on distribution transformers. It consists of a four-quadrant, rotating carousel interfaced to a conveyor system and is supervised by a single operator. Capable of testing both pole mount and pad mount transformers, the system is controlled by a single workstation (PC-based) featuring online display of all measurements and controls. The carousel consists of four stations:

- Load/unload station – a new transformer is loaded for testing and a tested transformer is unloaded for repair in case of failure, or for shipment if it passed all performed tests.
- Impulse station – an impulse test is performed on the transformer.
- Applied station – the applied test is performed.
- Test station – ratio, polarity, impedance, induced, load loss, no load loss, and circuit-breaker tests are performed.

The system is controlled by a single workstation interfaced to all PLC controllers, measurement equipment and power suppliers.

The sequence of operations starts with a bar code scanner being used to scan the ID of the incoming transformer, then the control PC fetches a test direction file from the database and signals the operator to load the transformer. At the same time the workstation measures and records the temperature of the piece. The operator presses the unload push button to unload any transformer in station #1, and loads the new test piece. The table rotates and the transformer is in station #2 being tested. The operator repeats the process in station #1.

The control software was custom developed for the system at the ABB Electric Systems Technology Institute research labs in Raleigh, North Carolina. It has built into it all test algorithms (test connection, switch setting for transformer tap selection, pass/fail criteria, etc). The system has two modes of operation

– a fully automatic mode and a diagnostic mode. It also has a configuration utility (pass/fail criteria, hold error, device rating and specifications, etc).

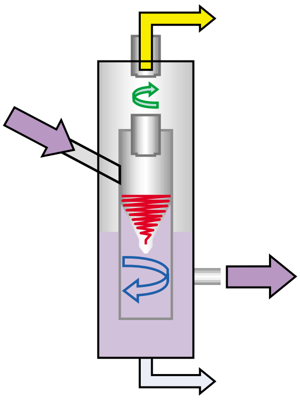
The throughput of the facility is very high; a transformer is loaded every 80 seconds and all the standard required tests are completed in 340 seconds. Reporting and notification to the quality department is performed automatically. The mechanically rotating testing carousel is compactly spaced in a 15' x 22' area.

The Automated Test Floor will reduce test cycle time and perform a quality check and verification of the transformer design. It offers the flexibility of testing pole and pad mount transformers. The system will be installed in other ABB distribution transformer factories.

## Going their separate ways

The Oil & Gas department at ABB Corporate Research in Norway has been working with production fluid separation, both downhole, subsea and topside, for several years now.

As one of its main strategies, ABB is developing offshore systems that make production directly to shore possible without the use of platforms. The first milestone for this was reached in the summer with the successful installation of



SUBSIS – the world's first unit for subsea separation and re-injection of water. (The separation efficiency is very high and the operators are so confident about the nucleonic level detection system used that they want it in topside separation systems too.)

Sand has to be separated from the oil/water mixture in separators both topside and subsea. Otherwise equipment can be eroded and/or blocked.

For this reason, a compact cylindrical concentric cyclone (4C) has been developed. This device separates gas, liquid and sand in one stage. Development of the unit involved extensive use of computational fluid dynamics (CFD) in order to achieve maximum efficiency. The separation process is based on cyclone technology in which centrifugal force is the main separation force. A high-pressure unit has been manufactured and tested in the oil and gas test laboratory at Det Norske Veritas (DNV).

Good results have been achieved regarding sand removal. Modifications are now under way in order to simplify the sand-handling part of the process and to test it on real systems

The unit will be tested offshore as an add-on to other test equipment in the near future.

## Own Goal

The continuing busy and hectic R&D work being conducted in the Oil & Gas and Automation areas at ABB Corporate Research in Norway has increased the need for more dedicated laboratory facilities.

Now, this GOAL has been realized, quite literally, with the opening of the *G*as, *O*il and *A*utomation *L*ab.

The idea in constructing GOAL was to create a flexible and easy-to-use experimental facility close to the office area. After a construction period of about 6 months, GOAL was ready for use in the summer of 1999.

The main activities in GOAL are related to oil and gas research. For this purpose, there is a basic flow loop comprising a large reservoir tank, two liquid pumps, a homogenizer (for mixing), connections for the air supply and a separator tank. This allows for simulation of a flowing mixture of oil, gas and water. Liquids (usually water and a safe oil) and air

**Basic set-up during construction. Separator (left), pumps, reservoir tank and flexible hosepipes.**

(simulating gas) are led through the loop in flexible hoses and PVC pipes which can easily be detached and reconfigured.

Fluid treatment devices for improved oil/water separation, for instance, can be mounted between the mixer and the separator tank and the effect quantified by switching the device on and off; oil droplet size distribution can be studied by putting a T-bend in the loop and diverting some of the fluids into the sample cell of a purpose-made droplet-size monitor; and so on. All in all, the rig provides a very useful and flexible facility.

Using the set-up described above, ABB Corporate Research has put a great deal of effort into testing and developing in-line coalescers. Coalescers are fluid treatment devices aiming to increase droplet size in order to cut separation time. We were able to quantify the effect of three different principles for in-line coalescers. The electrostatic principle – developed and tested in GOAL – reduces separation time by a factor of 10!

During the first year of operation, GOAL has been used at all stages in project life cycles and for a wide range of other products:

- For 'quick and dirty' set-ups as part of feasibility studies, eg on an ultrasonic pipe-length meter.
- For experiments on small-scale models to verify simulations, eg on a plexiglas model of a '4C' cyclone which separates oil/gas/sand in one step. 4C was later built and tested in full scale with some modifications based on the experimental results.
- For rigorous testing of full-scale prototypes, eg a flow meter. The flow-meter tests produced vital information for further development and some important design modifications were suggested as a result.

But it's not all oil and gas. A significant part of the laboratory area is reserved for automation research. This area is dominated by a human-sized IRB2400 industrial robot manipulator bought in 1999. This type of manipulator is mainly used in the automotive industry for applications such as arc welding, material handling, packaging, gluing/sealing and cutting/finishing. At ABB Corporate Research the robot has been used in R&D projects in cooperation with ABB Robotics at Västerås, Sweden, ABB Flexible Automation at Bryne, Norway and ABB Flexible Automation at Fort Collins, Colorado.

Work has focused on making the robots easier to program. A new digitizer and software have been developed which significantly reduces the programming time.

Other projects have focused on system identification and the motion control software. A new product, CutWare, for high-precision laser-cutting applications has been marketed in 2000.

In addition to these projects, the Automation lab has been used by visiting scientists and students from the University of Western Australia, the University of Strasbourg and the Norwegian University of Science and Technology.

**A scientist checks an instrument during a feasibility study on an ultrasonic pipe-length meter.**