Chapter K
Energy Efficiency in electrical distribution

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1 Introduction

Certain information in this chapter is taken from guides published by Carbon Trust (www.carbontrust.co.uk) GPG119 and GPG231.

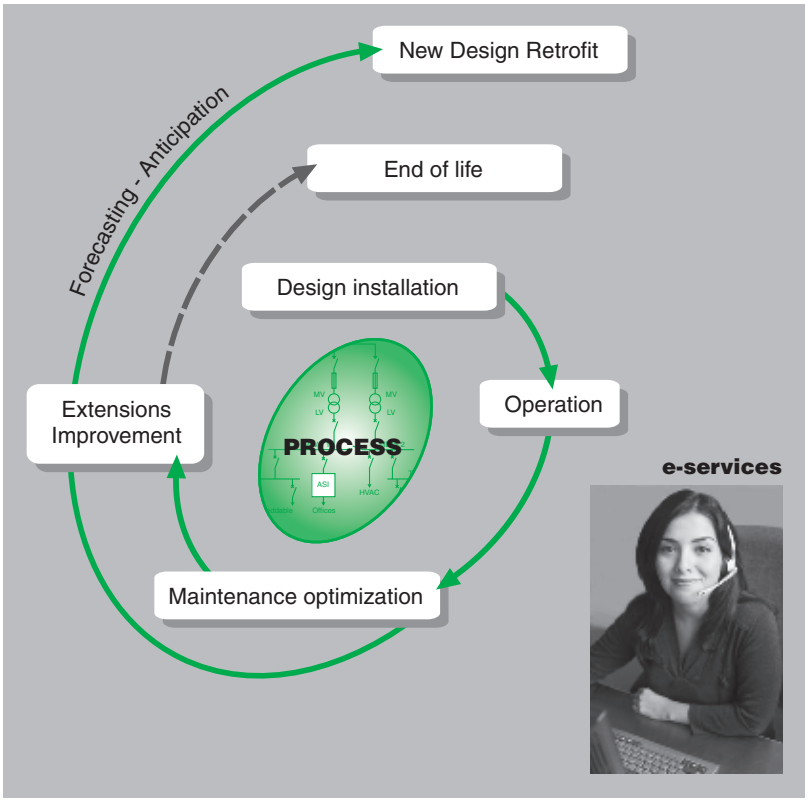
Power monitoring and control system may be of high benefice for the owner of an electrical network as a strategic piece in the global “Energy Efficiency” approach.

Calculating Total Cost of Ownership (TCO) of an electrical network not only includes the initial equipment investment but also its economic performance in operation. Safety staff, the electrical billing manager, the chief site electrician or the facility manager, are all becoming increasingly concerned. The profiles vary, but each of these people's mission includes careful management of electricity, its procurement and the network that distributes it.

Fewer expensive power outages for the company’s business, less consumption wastage, no more maintenance operations than necessary, these are the objectives that a decision making assistance system focused on Energy Efficiency must satisfy and make available to each person, whatever their profile.

Nowadays, entering the “Energy Efficiency” approach doesn’t mean setting-up a complex and expensive system. Some simple features are really affordable with a very good payback because they can be directly embedded in the power equipment.

Once the electrical installation is equipped with measurement functions, it can share the communication medium of the user’s Intranet site. In addition operation won’t need specific skills and training. It will only require the use of license-free software such as Intranet browsers.
Upgradeability or e-services through Internet are also now a reality, based on new technologies that come from the Office and Communication world. Then being in a position of taking advantages of these new possibilities will be more and more a differentiating behavior.



2 Energy efficiency and electricity



2.1 The world is now ready for energy-efficient actions and programs.

The first big movement was initiated by the Kyoto protocol in 1997, updated in 2006.

This well known world wide agreement requires participating countries to collectively reduce greenhouse gas emissions to an annual average of about 5 percent below the 1990 level over the 2008-2012 period.

The protocol is based on three primary market mechanisms:
- The Clean Development Mechanism (CDM), arrangement for reductions to be "sponsored" in countries not bound by emission targets
- Joint Implementation, program that allows industrialized countries to meet part of their required cuts in greenhouse-gas emissions by implementing projects that reduce emissions in other countries.
- Emissions trading, mechanism through which Parties with emission commitments may trade units of their emission allowances with other Parties because they are ahead of their target. This is the so called “carbon market”.

All geographic areas at country, regional and federal level have launched programs, actions, regulations:
- regulations and standards enforced in Europe (**Fig. K1**),
- vision and strong initiatives in Asia.
- strong programs in the US



***Fig. K1** : European parliament and counsel directive 2006/32/CE dated 5 April 2006 relative to the energy efficiency for end users and energy services*

ISO 14001 that defines principles and processes to permanently reduce energy consumption and waste emission in any organization.

Drivers to develop energy efficiency programs – especially on the electrical form of energy - are getting stronger and stronger. Energy Efficiency plan is at the top of the agenda for a growing number of companies:
- Buildings are the biggest energy consumers and a priority target,
- With cost of energy multiplied by 2 in the last 3 years, electricity saving is becoming a significant source of productivity gain for the industry,
- Saving energy is now a part of the Corporate Social Responsibility commitment of most listed companies,
- With production and distribution networks under increased pressure from rising demand and scarce resources, availability of electricity is a rising concern for Industry heavily impacted by the consequences of outages,
- The residential sector is a key sector and more and more impacted.

2.2 A new challenge: electrical data

All of the features of the current developments lead to the appearance of a “New Electrical World” in which the key considerations will be:
- controlling risks related to power outages
- energy yield or efficiency and control of costs: MWh price increased between 2003 and 2006 from 30€ up to 60€ for deregulated markets in Europe
- renewable energy
- the environment and sustainable development.

Electricity usage will become smarter and more rational to contribute both to the competitiveness of companies, their energy independence and protection of the environment. These new ground-rules mean that corporate decision makers have to implement new resources, and in particular products and services to accompany electricity consumers in this approach.

In particular, the setting up of a global information system in the company will allow comprehensive electrical performance data to be streamed, in real time and remotely for (**Fig. K2**):
- Predicting electrical network non-availability,
- Recording electrical quality,
- Optimizing consumption per building, sector, unit, workshop, site, excessive consumption or abnormal variations. We will therefore have all of the data required to make direct savings on electricity billing. End users can therefore take advantage of electrical network monitoring to avoid any wastage and to supply energy where it is really necessary.
- Organizing electrical equipment maintenance.
- Better purchasing of electrical energy and in certain cases, better resale.

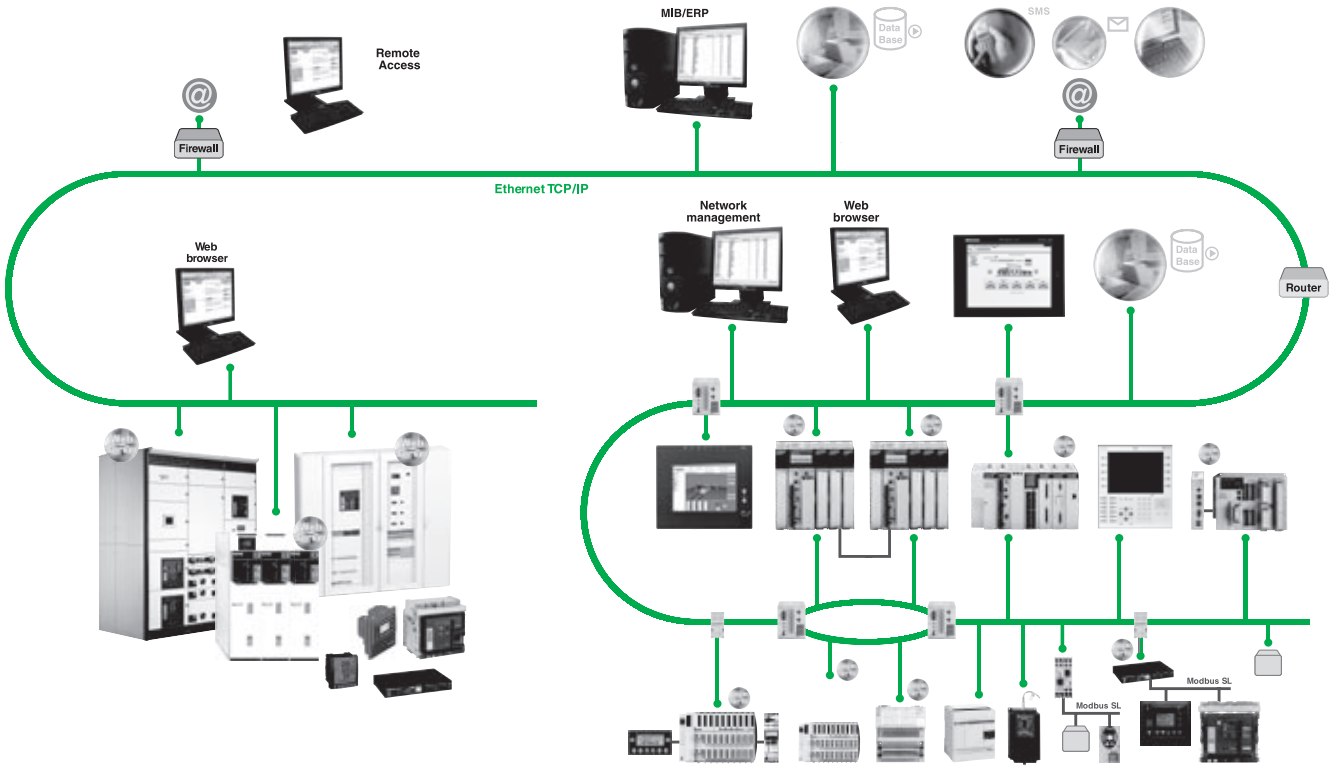


Fig. K2 : The Schneider Electric Solutions for Power & Control

3 One process, several players

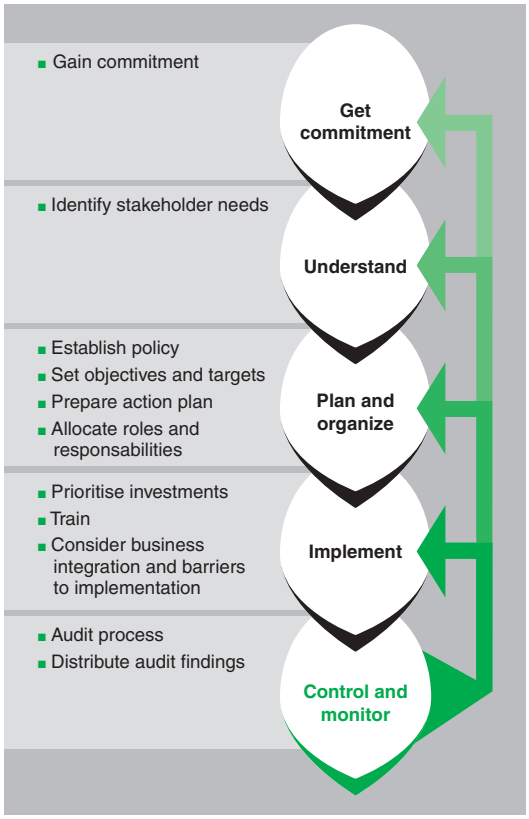


Fig. K3 : Step by step approach to organizing energy management

3.1 Energy Efficiency needs an Enterprise approach

An information system must be integrated in a global approach in the company.

The following step by step approach to organizing energy management (as shown in **figure K1**) is a structured method for managing projects and achieving results. It can be applied to very simple as well as complex tasks and has proved itself to be both robust and practical.
Refer to 6 Sigma philosophy - Define, Measure, Analyze, Improve, Control - you cannot fix what you do not measure.

Gain commitment

In order to achieve action towards lasting energy efficiency, it is essential to gain the commitment of the most senior members of the management team as individuals and part of the corporate body.

Understanding begins with:

- learning about current energy consumption levels and costs
- mapping the ways in which energy is used
- determining the standards for efficient consumption in the organization
- analyzing the possibilities for saving costs through reducing energy consumption so that realistic targets can be set
- recognizing the environmental effects of energy consumption.

Plan and organize

The first step should be to produce a suitable energy policy for the organization. By developing and publishing such a policy, senior managers promote their commitment to achieving excellence in energy management. They should do this in a way that harnesses the culture of the organization to best effect.

Implement

Everyone must have some involvement in implementing the energy policy. However, to facilitate a structured approach, start by assigning special responsibilities to some individuals and groups.

Control and monitor

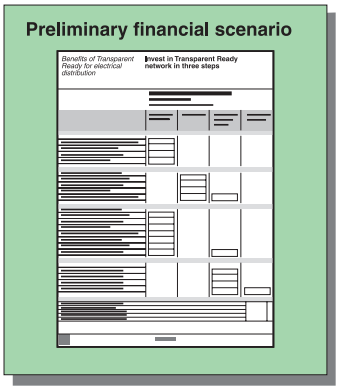
Each project should have an owner – an individual or a team with overall responsibility for monitoring efforts and steering it to a successful conclusion. Again Information System linked to electrical energy use and its impact on the core activity of the company will support the owner's actions.

Senior executives should underline the importance of projects by requiring regular progress reports, and by publicizing and endorsing success, which can further support individual motivation and commitment.

The energy management matrix:

Level	Energy policy	Organising	Motivation	Informations systems	Marketing	Investment
4	Energy policy, action plan and regular review have commitment of top management as part of an environmental strategy	Energy management fully integrated into management structure. Clear delegation of responsability for energy consumption	Formal and informal channels of communication regularity exploited by energy manager and energy staff at all levels	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking	Marketing the value of energy efficiency and the performance of energy management both within the organisation and outside it	Positive discrimination in favour of "green" schemes with detailed investment appraisal of all new-build and refurbishment opportunities
2	Unadopted energy policy set by energy manager or senior departmental manager	Energy manager in post, reporting to ad-hoc committee, but line management and authority are unclear	Contact with major users through ad-hoc committee chaired by senior departmental manager	Monitoring and targeting reports based on supply meter data. Energy unit has ad-doc involvement in budget setting	Some ad-doc staff awareness training	Investment using short term pay back criteria only
0	No explicit policy	No energy management or any format delegation of responsibility for energy consumption	No contact with users	No information system. No accounting for energy consumption	No promotion of energy efficiency	No investment in increasing energy efficiency in premises

3.2 Economic competitiveness study



An information system on energy efficiency related to electrical usage must also be looked at in terms of an economic study to ensure the growth of economic competitiveness.

This study basically depends on allocating financial value to electricity consumption, to operating losses related to the non-availability of energy and to maintenance costs in order to better manage the electrical installation.

Preliminary stage: review the current situation and build a financial study (Figure K4).

The need for a measurement installation is justified by the gains that this generates. A solution that covers the full installation represents a major improvement in the company's competitiveness, but it requires the team concerned to actually use this capacity.

Example :
The figure below is an example for calculating the return on investment – available in Excel on www.transparentready.com.

Company data / 00000 Automatic calculation	Contributing factors	Savings per Item	Savings / Investment per category	Total savings or investment
Background: your organisation's characteristics				
Annual revenues	100,000,000 €			
Net profit (%)	10 %			
Annual work hours (hours/day x days/week x weeks/year)	1.950 hrs			
Average hourly wage (loaded rate)	75 €			
Annual electrical energy costs	1,000,000 €			
Interest rate	15 %			
Corporate tax rate	30 %			
Annual energy cost savings potential				
Reduction in energy usage (% estimated)	10 %			
Reduction in energy usage		100,000 €		
Reduction in demand charges		20,000 €		
Power factor penalties avoided		20,000 €		
Energy billing errors avoided		5,000 €		
Energy costs allocated to tenants		0 €		
Annual energy cost savings		145,000 €		
Downtime cost avoidance potential				
Number of downtime events per year	2			
Hours of downtime per event	1.5 hrs			
Hours to recovery per downtime event	2 hrs			
Employees idled per downtime event	250			
Manufacturing employees required for line start-up	10			
IS employees required for computer system recovery	2			
Reduction in equipment replacements (e.g., transformers)		25,000 €		
Reduction in scrapped products or parts		50,000 €		
Corporate profit increase		15,385 €		
Increase in productive work hours		56,250 €		
Reduction in computer system recovery hours		600 €		
Reduction in manufacturing line start-up costs		3,000 €		
Annual downtime cost avoidance			150,235 €	
Operations & maintenance savings potential				
Employees assigned to manually read meters	3			
Employees assigned to maintenance	2			
Employees assigned to energy data analysis	2			
Activity-based costing savings (e.g., equipment or process removal)		50,000 €		
Equipment maintenance savings		10,000 €		
Automatic meter reading		7,875 €		
Fewer maintenance inspections		2,250 €		
Fewer hours for data analysis		10,500 €		
Operations & maintenance savings			80,625 €	
Total annual gross savings potential				375,860 €
Transparent Ready system investment				
Number of buildings where energy is to be managed	2			
Metering devices, main/critical feeders, per building	10			
Metering devices, non-critical feeders, per building	15			
Metering devices, simple energy usage, per building	15			
Device costs			125,000 €	
Software costs			15,000 €	
Computer equipment costs			8,000 €	
Installation			160,000 €	
Configuration			8,000 €	
Training			3,500 €	
Support contract			14,338 €	
Total system investment				333,838 €
ROI summary				
Invested capital				-333,838 €
Gross annual savings				375,860 €
Yearly depreciation				-66,768 €
Corporate tax				-112,758 €
Net annual savings (after taxes and depreciation)				196,334 €
Payback period (before tax & dep) (in months)				11
Payback period (after tax & dep) (in months)				20
Net present value				324,304 €
Discounted return on investment (NPV / Invested Capital)				97 %

Fig. K4 : Example for calculating the return on investment

3 One process, several players

Invest in three steps
1- Formulate priorities
2- Define key electrical values
3- Select components

Step 1 : formulate priorities

Each industrial or tertiary site has its own requirements and a specific electrical distribution architecture. According to the site's requirements, determine the appropriate energy efficiency applications (**Figure K5**):

Objective	Application
Consumption optimization	Cost allocation
	Energy usage analysis
	Pumps & fans for Industry & Infrastucture Pumps & fans for Buildings
	Lighting control
Energy purchasing optimization	Peak demand reduction
	Electricity procurement optimization
	Sub-billing
Improving the efficiency of teams in charge of electrical installation operation	Electrical Distribution alarming and event logging
Improving energy availability and quality	Electrical Distribution network remote control Electrical Distribution network automation
Asset optimization	Statistical analysis of equipment usage - Power Factor Correction

Fig. K5 : Objective and application

Step 2 : define key electrical values

- once we have formulated the priorities, we can define the key electrical values to be included in the measurement system
- the parameters to take into account must allow us to detect a disturbance or a phenomenon as soon as it appears, in other words before it has a detrimental effect to the electrical installation and its current consumers
- the method includes installing an appropriate device on each feeder concerned so as to be as ready as possible for requirements, and another at the site installation head so as to have an overview. However, we also need to identify vital feeders for the company's business and feeders on costly processes so as to take account of this information in the solution.

Example: if the application consumes a lot of electricity and is not sensitive to quality, the metering system involves the appropriate measurement products. In the same way, a highly sensitive application in terms of energy quality requires a different type of metering product.

Step 3 : select components

For existing installations: some of your electrical equipment already includes measurement products.

Example: protection relays often include measurement functions. You simply have to make them communicate via a Modbus series link to the intranet site.

3.3 The varied profiles and missions of players in the company

The setting up of an information system allows access to important data from electrical equipment and must involve staff with a IT and electrical knowledge profile which by definition is very varied in the company. (**Figures K6 and K7**).

Example : the table below shows a few examples of the profiles in a hypermarket. There are others such as Facility Management staff, workshop production managers or factory production managers.

Profile	Org	Skill	Role	Data display	When?	Data format
Security staff	Site	No specific technical electrical skills.	Safety of people and property.	Via an alarm screen in the central security station. By DECT*, GSM or general circulation.	Rarely, on event	Application order for planned procedures according to the type of electrical event and a warning to site managers according to a predefined list.
Maintenance Manager	Site	People management, overall electrical network skills, has been in his position for 3 to 8 years, technician level with strong decision making independence. Delegates electrotechnical problems to outside organizations (e.g.: calculating protection settings).	With his team, ensuring the correct technical operation in all areas (refrigeration, air conditioning, electricity, security, public safety etc.). Priority is given to availability, he is challenged on overheads and therefore on electrical consumption, decides on the involvement of outside companies and contributes to investment dossiers.	MMS/SMS, PC on Intranet, email.	Rarely, on event, periodic consultation of reports, frequent consultation of information on request.	The data is shared with his team: - measurement screens with assistance as to possible interpretation (limits etc.) - consumption screens (KWh and Euro), - time-stamped events, - address book for outside players, - electrical single-line diagram of the site, drawings of electrical cabinets and a link to manufacturing notices, - financial report, data used for the investment dossier, - indicators to be filled in on electrical network performance.
Site Manager	Site	Competency in corporate management and in executive management.	Responsible for a profit centre. Ensures compliance with procedures by staff via a management chart with performance indicators. Challenged on margin and turnover and therefore on overheads.	Economic report	Monthly	Financial aspects including electrical consumption, the link between the turnover generating business and electricity, the cost of maintenance of the electrical network.
EE Manager for a multinational company	Site/HQ	Buyer/ global energy purchasing contract negotiator.	Responsible for the global energy bill for the company via subsidiaries throughout the world and challenges entities with one another.	Economic report	Monthly	Financial features including electrical consumption for each of the multinational entities.

***Fig. K6** : The varied profiles and missions of players in the company*

3 One process, several players

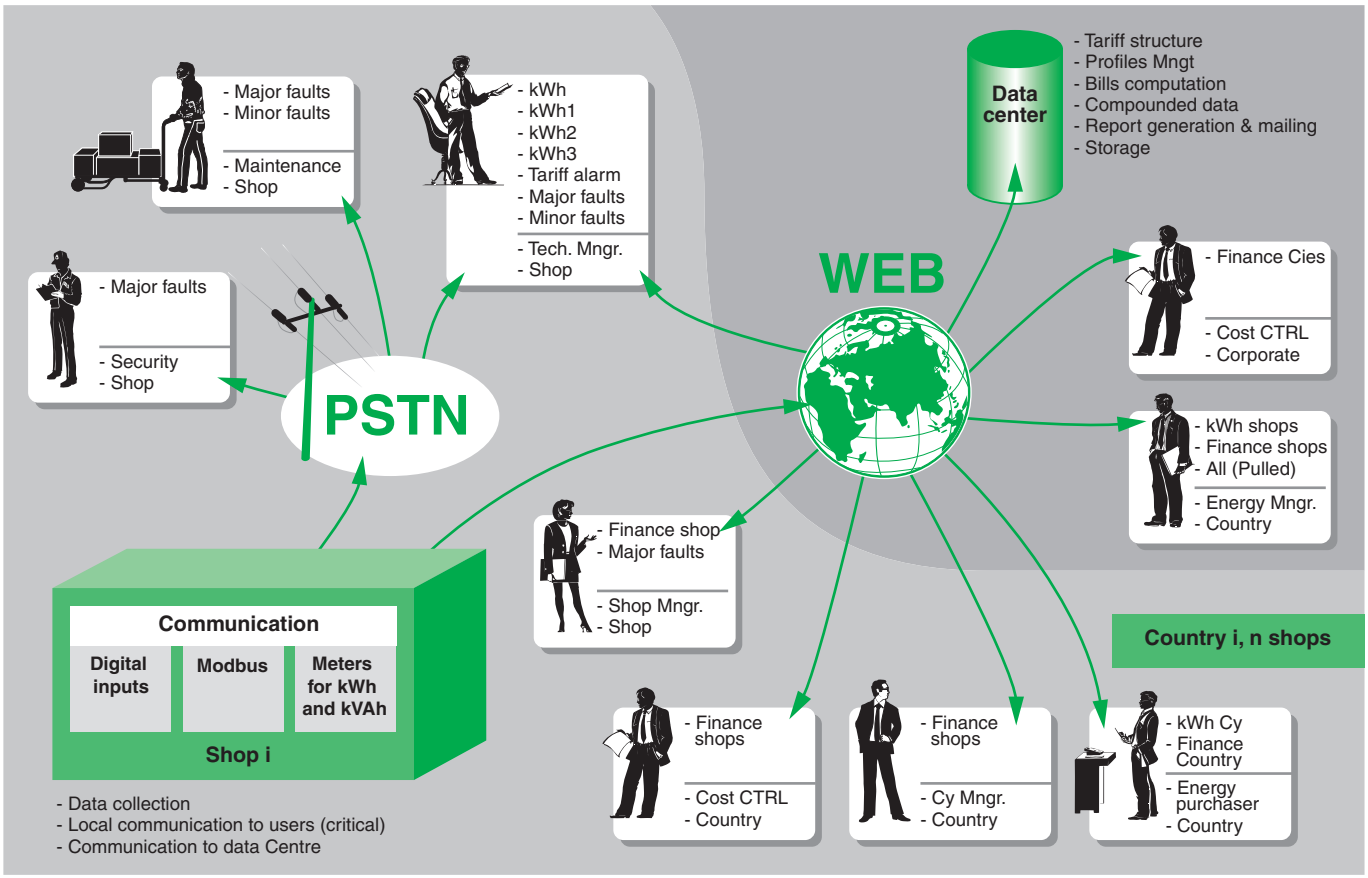


Fig. K7 : Example: configuration of a shopping centre with various players in place