Towards improved electrical installations in European homes

Improved safety levels can save lives, improve lifestyle and increase property value

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ABOUT THE PARTNERS

The Forum for European Electrical Domestic Safety (FEEDS) is a partnership of 5 international organisations working together with the aim of improving electrical installations through regular periodic inspection. The following organisations participate in FEEDS:

AIE:

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International Federation for the Safety of Electricity Users is a Federation which brings together a number of organisations sharing a common objective, namely the promotion of electrical safety, by working for the setting up of installation inspection systems and their harmonisation in terms of reference standards, procedures and methods.

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UIE:

International Union of Electricity Applications is made up of associated members from more than 15 countries. The Union was set up in 1953 with the aim of promoting the rational use of electrical energy and encouraging its development.

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Executive Summary

While standards of safety in most areas of life are constantly improving, the safety of domestic electrical installations is not keeping pace. People expect to be at their safest when in their own homes and tend not be aware of the risks that face them there. Incidents resulting from unsafe installations - deaths and injuries from fire and electrical shock - are preventable. As the population and housing stock age, the need to introduce regulation to preserve and enhance their safety becomes an increasing priority.

The current completion rate for new build dwellings implies the average lifetime of a European dwelling is 200 years and the majority of European housing stock (60%) is already over 30 years old. Unless these buildings are properly adapted, maintained and renovated, their technical installations become progressively less suited to the higher standards of functionality, security and safety[1] required by today's society. Although the cost of renovation is one of the main barriers to overcome, this report concludes that it is not insurmountable. Appropriate measures to overcome the cost barrier include careful segmentation of the market, scheduling implementation according to levels of risk and fiscal incentives to share costs between government, owners and tenants. Proactive maintenance, through periodic inspection, will help to manage the housing stock - one of society's biggest capital items.

To reach these functional, social and economic goals the following actions are proposed:

- Introduce periodic inspections which:
  - require a recent inspection certificate when changing the meter or supply contract, or at change of owner or tenant.
  - are carried out by a professional inspector such as a certified installer, municipal inspector, utility representative or an independent certified body.
  - are optimised by inspecting all technical installations (electricity, gas, water and central heating) together.
  - ensure that any necessary renovation work identified is carried out in a reasonable time scale.
- Raise awareness of electrical safety among residents, landlords, building managers and owners

These actions would primarily take place at national level and their implementation would bring the following benefits to occupants and owners:

- Improved safety and sense of security
- Increased property value
- Enhanced lifestyle through greater comfort
- Reduced overall cost of ownership/maintenance

and the following benefits to society:

- Reduced healthcare costs
- Energy saving
- The creation of employment, with its double dividend of reduced unemployment benefits and increased tax income.

This report demonstrates that improving electrical safety in the home justifies the regulatory effort required.

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1 Introduction

Europe is proud of its well maintained heritage of old buildings, showing its history and a variety of styles throughout the region. The culture of using and maintaining older buildings is continuing - the current completion rate for new-build dwellings is 0.5% of the existing stock, implying an average lifetime of 200 years[2]. 60% of the European housing stock is over 30 years old and, each year, another 1% of the existing stock moves into this category. Only 0.32% of the existing stock is renovated each year (Manson [75]). Consequently, ageing electrical installations are a growing problem.

Furthermore, the lifestyle of European citizens is changing faster than ever. Over the past 40 years, electricity use has been steadily increasing as a consequence of the increasing amount of electrical equipment in kitchens, living rooms and children's rooms. The popularity of PCs, Hi-Fi, TVs, telephone and the internet are a major factor. In relation to the lifetime of buildings, the use of the internet and personal computers have become widespread in a very short time scale. The interest in home automated systems and home-cinema equipment is growing, and the trend towards home-working is further stimulating the demand for Information and Communications Technology (ICT) equipment. And who knows what the future will bring? Designing a building with an extended lifetime in mind is nearly impossible because expectations and building standards are constantly changing, requiring better facilities and infrastructure, better and safer materials, and greater convenience.

Even if our lifestyle stays the same, electrical installations do not retain their original condition without maintenance. Age degrades materials, insulation materials harden and can crack, joints can become loose. In this way, electrical installations lose their functional characteristics over time and are no longer fit for the original purpose.

The consequence is that the majority of European electrical installations are inadequate. Built during the building booms of the 60s and 70s, designed according to the standards current at that time, and intended for lighting and small appliances, these installations now do not comply with present standards and the most elementary rules of safety[3]. Upgrading these electrical installations is now a matter of increasing priority.

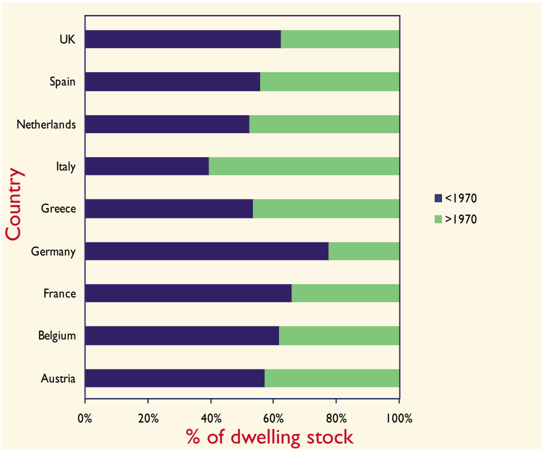


Figure 1 - Age profile of EU housing stock (EU Housing Report)

Increased safety and a feeling of security are the most important reasons for upgrading older electrical installations but there are also additional benefits, for example providing:

- Sufficient sockets available at the right locations
- Adequate lighting
- New functionality (eg additional telephone and TV outlets)
- Energy and cost saving (eg by including monitoring and control devices).

In any European country, housing represents a major cost of total consumer spend, which is rarely below 20% (Figure 2). Regular inspection and proper maintenance can be instrumental in keeping the ownership cost of houses under control. Escalating housing costs would affect all sectors of the economy.

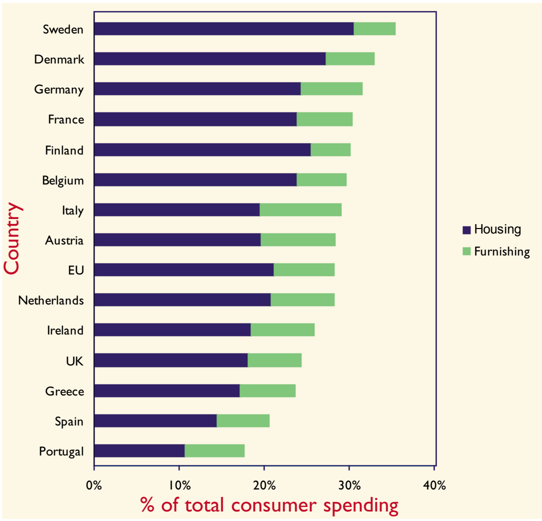


Figure 2 - EU spending on housing & furnishings (Eurostat)

To summarise, this report will show how increased attention to the electrical installations in residential buildings is a major factor in maintaining and increasing both safety and comfort of living.

2 Towards a culture of safety

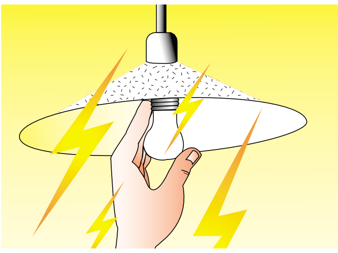
Electrical safety in a home starts with its occupants. An electrical installation designed and maintained for optimal safety is indispensable but occupants need to be informed on its safe use, and invest in maintenance. Even the best designed electrical installation, anticipating all possible eventualities, such as misuse, abuse and human mistakes, will never create a safe home unless occupants use it in a safe way.

This report is a contribution towards creating such a culture by combining regulatory initiatives with information campaigns targeted at owner-occupiers, tenants, landlords and building managers.

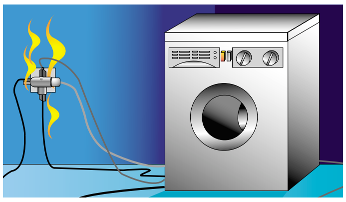
Electrical renovation projects intended to enhance electrical safety can also improve comfort in the home. Upgrading electrical installations hence increases quality of life of European citizens through an improved feeling of security, and increased electrical comfort.

Don't use electrical equipment in a bathroom

Don't let children play near sockets



Don't change a light bulb with the power still switched on



Don't use adapters for heavy duty appliances

2.1 Safety issues in existing homes

A first group of safety issues is directly related to the age of the installation. An electrical installation built over 30 years ago typically has the following two problems:

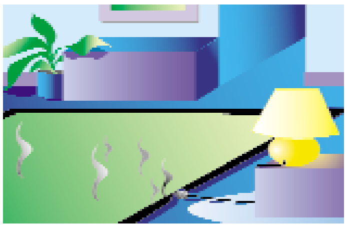
- The installation has deteriorated over the years
- The functionality provided when the installation was built no longer meets today's needs.

Although electrical installation standards in Europe are being harmonised, the process is still not complete and there are significant differences in the national codes. As a result, the deficiencies found in installations vary from country to country. Though not applicable to all countries, the following are examples of critical problems:

- Power sockets or lighting points that are not earthed.
- Absence of a proper earthing electrode.
- Mains supply is not protected by a Residual Current Device[4] (RCD) (often the case in dwellings over 20 years old).
- No protection by an RCD for bathroom and wet areas.
- No protection by an RCD for circuits supplying power to appliances used out of doors.
- Wear and tear of the electrical equipment, causing electric shocks.
- Frequent, unexplained (so-called 'nuisance') tripping of circuit breakers. As the use of the installation changes, the load on some circuits may be higher than initially expected, causing circuit breakers to trip.
- Sockets, switches and panels become hot, or even display black burn marks. This indicates over-loading or bad contacts, and requires immediate action.

A second group of safety issues is related to the functionality of electrical installations in homes, due to the age of the installation and the increasing use of electrical equipment:

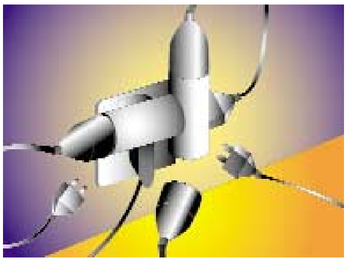
- Frequent use of extension leads due to insufficient socket outlets. When these are routed under carpets, the leads may be damaged and are a fire risk. When left as trailing leads they become a tripping hazard.
- Overloading of sockets using multi-way adapters poses a fire risk.
- 'Do-it-yourself' (DIY) modifications are often carried out by untrained people without knowledge of standards and are therefore not likely to be safe. In some countries DIY work is forbidden or restricted.



Don't run cables under carpets

2.2 Need for maintenance

Electrical installations do not deteriorate quickly, so they do not require continuous maintenance. However, considering the long life span of installations, they do need periodic inspection, maintenance and renovation to counteract the effects of ageing and to adapt to new demands and changing lifestyle of the occupants. Studies show that in many homes too little electrical renovation work is done to maintain safety. UK studies by CFR [50] and BSRIA [43] calculated that, of the 46% of households which make some improvement to their home each year, only 4.5% of them improve the electrical installation. For instance, when a new owner first occupies a dwelling, the bathroom and kitchen are often renovated, but the electrical installation is rarely improved, let alone completely upgraded. Even if some improvement to the electrical installation is made, this does not necessarily mean that safety rises to an acceptable level and, in fact, in about half of the cases it merely involves the addition of new sockets. Only about 20% include the replacement of the consumer unit and as little as 15% include complete rewiring. The average value of the electrical work is around €600.



Don't over use adapters

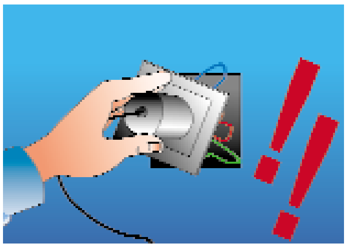
Periodic inspection[5], for example every 10 years, would identify emerging safety issues which could be corrected at a relatively early stage.

Don't repair fuses with anything other than the correct fuse wire

Another important consideration is that the installation should be upgraded each time the pattern of electricity consumption in the dwelling changes significantly. To ensure this, inspections at each change of ownership or tenancy - often the most convenient time - are a good measure.

Long term maintenance is most vital for the safety of electrical installations, but nevertheless, some specific areas of ad hoc attention are equally important. The following danger areas should be publicised via information campaigns:

- Loose sockets - when a socket is loosely mounted on the wall, it should be fixed. Pulling out the plug causes wear and tear on the wiring, and eventually loosens contacts which become hot spots and can cause a fire.
- Aluminium wiring - in Eastern Europe, there is still a lot of aluminium wire in houses. Because aluminium creeps easily, screw connections at sockets and fittings often become loose, leading to the high resistance joints that generate heat. This could explain why casualties from fire in Eastern Europe[6] are higher than the European average.
- Frequent tripping of circuit breakers - when a circuit breaker frequently trips, the load current is too high. The rating of the breaker can only be increased if the circuit wiring is large enough - wire size and circuit breaker must be properly co-ordinated - otherwise, the circuit must be rewired using a cable with a higher current rating.



Don't neglect loose sockets

2.3 Functionality and safety

Even a correctly designed, installed and maintained installation can be rendered unsafe by consumer abuse, particularly in situations where the installation does not meet the needs of the occupants. The mismatch between provision and demand is most apparent in the provision of socket outlets in terms of both number and position. It is vital to make provision for sufficient socket outlets in all installations, including new dwellings, extensions and renovations, to reduce fire risk through overloading circuits.

The demand for socket outlets needed in a dwelling has been rising over the years due to:

- An increase in the number of electrical devices and appliances used, eg dishwashers, microwaves, home entertainment systems, PCs and a myriad of rechargeable devices such as mobile phones and power tools
- Changes in working practices with an increasing trend of working from a 'home office' with associated PC and other electronic equipment.

Consumers with inadequate provision of socket outlets increase their risk of fire and shock by:

- Using and overloading adapters
  - risk of fire
- Using trailing extension leads
  - risk of fire if placed under carpets
  - risk of shock from reduced integrity of protective conductor

The lack of socket provision is not only to be found in older dwellings, where it might be expected that installations were not designed to meet future needs. A recent survey in the UK shows that up to 70% of owners of 2 year old homes didn't have enough sockets (Chapman [65]). Similar results have been recorded in Benelux and Italy.

In the UK, the IEE (Institution of Electrical Engineers) fully recognises this issue. In 2000 it revised 'Guidance Note 1 - Selection and Erection' to include recommended levels of socket provision. In this Guidance Note the required number of sockets in a dwelling varies with the size of the rooms and the type of occupants. This explains the ranges in some of the figures in Table 1.

The IEE guidance points out a few areas of the home where the number and position of the outlets requires extra attention:

- Close to TV signal outlets, where there is often the need for connecting ancillary equipment such as satellite decoders, video recorders, DVD players etc.
- Near any telephone socket, where there could be a connection for an answering machine, fax machine etc.
- Adjacent to network points
- Bedrooms of young people, where there are often computer and electronic equipment that needs to be connected
- The home office, with its computer and electronic equipment.

Location	No. of outlets
Lounge	6 to 10
Dining Area	3
Kitchen	6 to 10
Double Bedroom	4 to 6
Single Bedroom	4 to 6
Bed-sitter	4
Hall	2
Stairs/Landing	1
Loft	1
Study/Home Office	6
Garage	2
Utility Area	2

Table 1 - Recommended provision of socket-outlets - all socket-outlets are twin (IEE Guidance Note 1)

Germany has the most detailed functional recommendations[7] (Table 2) of this kind with three levels of installation (one, two and three star) defined covering the number of sockets per room, the number of circuits per dwelling and other functionalities.

Interior design RAL-RG 678		Sockets			Lighting points		
Location		*	**	***	*	**	***
Kitchen		7	9	11	2	3	3
Kitchenette		5	7	8	2	2	2
Bathroom		3	4	5	2	3	3
Hall	Length <= 2.5m	1	1	1	1	2	3
Hall	Length > 2.5m	1	2	3	1	2	3
Bed/Living room	Area <= $12m^2$	3	5	7	1	2	3
Bed/Living room	$12m^2$ < Area <= $20m^2$	4	7	9	1	2	3
Bed/Living room	Area > $20m^2$	5	9	11	2	3	4
Basement		1	2	2	1	1	1
Open air space (Balcony, Loggia, Terrace)	Width <= 3.0m	1	1	2	1	1	1
Open air space (Balcony, Loggia, Terrace)	Width > 3.0m	1	2	3	1	1	2
Toilet		1	2	2	1	1	2
Storage room		1	2	2	1	1	1
Study		4	7	9	1	2	3
Hobby room		3	5	7	1	2	2
		One-phase AC circuit			Three-phase AC circuit		
		*	**	***	*	**	***
Standard circuit		7	11	13	1	2	2
Additional circuit for water heating, if electrical		1	1	1	-	-	-
Additional circuit for study, if available		1	1	1	-	-	-
		*		**		***	
Doorbell or gong		+		+		+	
Door entry in 1- to 2- family houses		According to need		+		+	
Door entry in larger buildings		+		+		+	
Intercom in 1- to 2- family houses		According to need		+		+	
Intercom in larger buildings		+		+		+	

Table 2 - German recommendations for electrical installations in private dwellings (RAL-RG 678)

Interior design '' is equal to the minimum requirements of DIN 18015*

The numbers above are valid for dwellings between 75 and $100m^2$

Where there are other types of rooms, appropriate adjustments have to be made.

The fact that some modern standards and standards' guidance are now addressing the increasing demand for electrical functionality reinforces the link between safety and functionality. As new technologies arise and their usage becomes more common, electrical installations will become important, not just for basic lighting and the use of electrical appliances, but for the operation of sophisticated control and monitoring systems.

Two areas where new technologies are emerging for residential installations are energy efficiency and telemedicine. Lighting controlled by presence detectors can be switched off when a room is empty, saving energy and hence money. With an ageing population the demand for health monitoring and assisted living systems in homes will rise and these will require installations with increased functionality and the highest level of reliability. Growth in these areas will be another driver for improving functionality and maintenance of installations.

3 ELECTRICITY: HAZARDS AND SAFETY

The preceding chapter explains why electrical installations in Europe's dwellings are not as safe as might be expected, identifying the safety issues and suggesting the measures needed to improve safety. In this chapter the possible consequences of inadequate safety, and the occurrence of electrical incidents or accidents, are examined in order to prioritise where actions are needed.

The use of electricity in the home introduces two hazards: fire and electric shock:

- *Fire hazard.* Three conditions are needed to create fire (the so called 'triangle of fire'):

  i) the presence of oxygen

  ii) combustible material and

  iii) ignition.

  The first two are present everywhere in dwellings. Electricity is one of the potential ignition sources in dwellings, others being cooking and heating appliances and careless handling of fire (candles, cigarettes, etc).

- *Electric shock.* Every piece of electrical equipment has the potential to develop a fault. Occupants must be protected from the effect of the electrical fault current.

Don't expose occupants to electric shock from an unprotected installation

3.1 Fire incidents and damage[8,9]

There is no official European database on fire incidents. In order to attempt to understand the scale of the problem and the deaths, injuries and cost consequences of electrical fires in Europe, the partners to the FEEDS forum, and their member organisations throughout Europe, collected the published national fire statistics (30 reports from 10 countries - Belgium, Canada, Finland, France, Italy, Netherlands, Norway, Sweden, UK, USA). In addition, fire statistics published at municipal level (Amsterdam, Frankfurt, Madrid, Munich, Paris) were checked. Other statistics were collected from the Geneva Association's world-wide fire statistics programme. Based on this primary data, a demographic model was constructed, deriving the following ratios from primary data where available for all fires:

- number of fires per thousand persons per year
- number of fires per thousand dwellings per year
- number of deaths per fire
- ratio of injuries to deaths
- property loss per fire
- total cost of fire/direct property loss.

Based on these ratios, secondary data has been derived for other countries, resulting in an assessment of fire statistics, fire damages, injuries and deaths for each European country and for EU-15 and EU-25. The resulting model has then been qualified by the networks of the FEEDS partners. The total figures for fires in Europe have been checked, and found consistent with the figures used by the European Fire Sprinkler Network. Throughout the tables in this report, primary data is shown in bold and derived figures in italics.

3.1.1 Incidence of domestic fires

Based on the demographic model, we can estimate, for Europe[11]:

- Per 1 000 dwellings, about 3.2 fires in dwellings are reported by the fire services each year.
- Over 60% of reported building fires occur in the domestic sector.

It is estimated that only about 25% of fires are actually reported, so the total number of fires is four times higher than that reported, meaning that 60% of EU citizens are exposed to a fire during their lifetime.

Extrapolating the number of fires per 1 000 dwellings gives the total reported fires as 510 000 in EU-15 and 620 000 in EU-25.

Country	Population (000s)	Dwellings (000s)	Total Fires/year
Austria	**8 100**	**3 300**	*10 461*
Belgium	**10 200**	**4 200**	*13 314*
Czech Republic	**10 300**	**3 700**	*11 729*
Denmark	**5 300**	**2 500**	*7 925*
Finland	**5 200**	**2 300**	*7 291*
France	**61 700**	**28 000**	**100 000**
Germany	**82 000**	**37 500**	*118 875*
Hungary	**10 000**	**4 100**	*12 997*
Italy	**57 500**	**22 000**	*69 740*
Netherlands	**15 900**	**6 800**	**17 000**
Norway	**4 500**	**2 100**	*6 657*
Poland	**38 600**	**13 400**	**41 000**
Spain	**39 900**	**12 500**	*39 625*
Sweden	**8 800**	**4 400**	*13 948*
Switzerland	**7 200**	**3 100**	*9 827*
UK	**59 400**	**24 300**	**72 000**
Total	**423 600**	**174 200**	*552 389*
EU-15		160 000	507 360
EU-25		195 000	618 345

Table 3 - Estimate of total dwelling fires per year by country

3.1.2 Costs

The best fire data available[10] comes from the UK and the USA (Weiner [89], Karter [106], Schofield,[67]). Using this data property loss and the total cost to society can be estimated.

The average total cost to society per domestic fire is €32 000 including the cost of injuries, intervention, fire prevention and insurance administration (Weiner [89]) and the direct property loss per reported domestic fire is estimated at an average €8 000 (UK). Extrapolating these figures and using the data in Table 4 the total cost of domestic fires is €14 billion[12] per year for EU-15 and €17 billion for EU-25. The direct property loss for domestic fires is estimated to be €3.1 billion in EU-15 and €3.8 billion in EU-25, excluding the property loss from non-reported fires.

In the UK, electrical fires represent 10% of total domestic fires, with 40% of electrical fires requiring intervention by the fire brigade (Aust [85]). The average cost of an electrical fire is five times the average fire cost[13]. This figure is consistent with the figure in Manson [75], based on studying fire statistics for eight European countries.

In France it is estimated that 25% of fires in dwellings are due to electrical causes (sources: CNPP: Centre National de Prévention et de Protection).

Country	GDP	Property loss	Total cost of fire in dwellings	Total cost of fire
	€ billion	€ billion per year		
Austria	**189**	*0.07*	*0.29*	**0.87**
Belgium	**227**	*0.18*	*0.81*	**2.43**
Czech Republic	**51**	*0.03*	*0.11*	**0.34**
Denmark	**162**	*0.10*	*0.45*	**1.36**
Finland	**122**	*0.05*	*0.20*	**0.60**
France	**1 294**	*0.69*	**3.00**	**5.60**
Germany	**1 873**	*0.80*	**3.52**	**4.70**
Hungary	**46**	*0.02*	*0.09*	**0.26**
Italy	**1 074**	*0.43*	**1.87**	**5.90**
Netherlands	**365**	*0.08*	*0.36*	**2.60**
Norway	**162**	*0.12*	*0.51*	**1.52**
Poland	**158**	*0.02*	*0.07*	**0.21**
Spain	**559**	*0.05*	*0.22*	**0.67**
Sweden	**227**	*0.11*	*0.46*	**1.39**
Switzerland	**240**	*0.11*	*0.50*	**1.49**
UK	**1 403**	**0.54**	**2.55**	**9.11**
Total	**8 151**	3.38	15.01	**39.05**
EU-15		3.1	13.8	
EU-25		3.8	16.8	

Table 4 - Direct property loss and total cost of dwelling fires

3.2 Fire deaths and injuries

According to Schofield [72], 61% of the casualties due to fire and 81% of the injuries occur in residential dwellings (based on the 1999 UK figures). Dwellings are therefore a major attention area in all fire prevention programmes.

In Europe, there are about, on average, 7 fire deaths/million citizens (Table 5) which means that about 1 in 200 fires in dwellings results in a fatality. Approximately 1 in 14 dwelling fires results in an injury, though it should be noted that the definition of 'injured' seems to differ widely across Europe.

Based on these calculations there are about 2 700 domestic fire deaths and 37 000 injuries each year in EU-15 and 3 250 domestic fire deaths and 45 000 injuries each year in EU-25.

Although 10 to 20% of fires have an electrical cause, they result in a disproportionate amount of the associated injuries (20 to 30%).

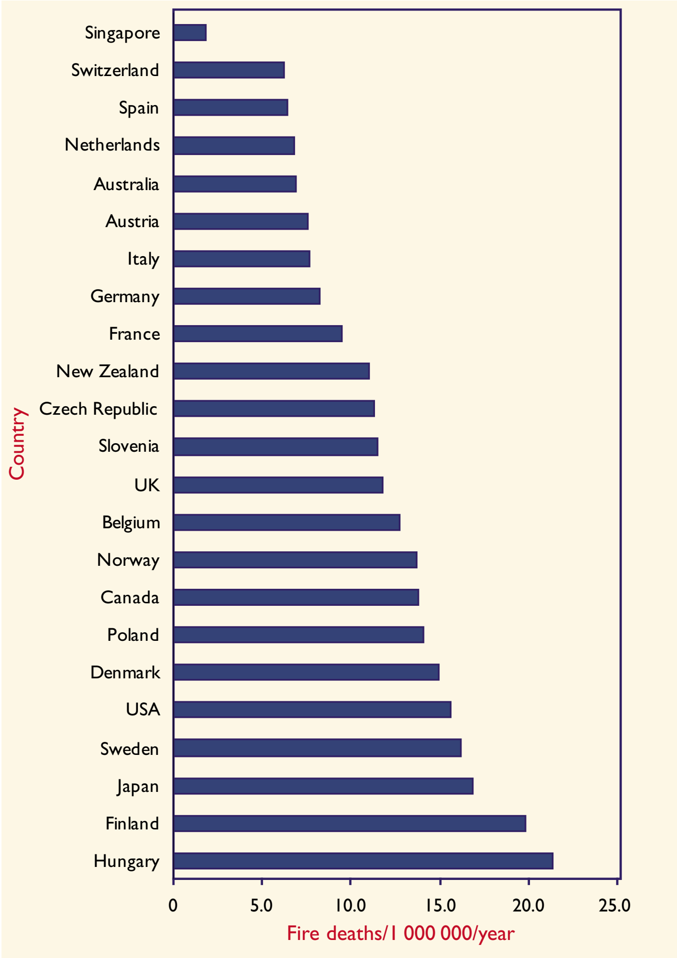


Figure 3 - Fire deaths/million citizens/year for selected countries - all fires (Geneva Association)

Country	Population (000s)	Dwellings (000s)	Deaths/ year	Injuries/ year	Deaths/10^6 persons/year	Deaths/10^6 dwellings/year
Czech Republic	**10 300**	**4 700**	**66**	*660*	**6.4**	**14.0**
France	**61 700**	**28 000**	**800**	**10 000**	**13.1**	**28.5**
Germany	**82 000**	**37 500**	**380**	*3 800*	**4.6**	**10.1**
Hungary	**10 000**	**4 100**	**114**	*1 140*	**11.4**	**27.8**
Italy	**57 500**	**22 000**	**240**	*2 400*	**4.2**	**10.9**
Netherlands	**15 900**	**6 800**	**38**	**725**	**2.4**	**5.6**
Poland	**38 600**	**13 400**	**336**	*3 360*	**8.7**	**25.1**
Spain	**39 900**	**12 500**	**150**	*1 500*	**3.8**	**12.0**
Switzerland	**7 200**	**3 100**	**24**	*240*	**3.3**	**7.7**
UK	**59 400**	**24 300**	**400**	**12 500**	**6.7**	**16.5**
Total	**388 800**	**156 400**	**2 623**	*36 323*		
Average					**6.7**	**16.7**

Table 5 - Injuries and deaths in domestic fires for some European countries

3.3 The European housing market

Electrical safety and fire protection also have a social dimension. New dwellings use new protection technologies, are built according to the latest standards, and their protection systems are in good condition. In older dwellings this may not be the case due to lack of care and maintenance. Often, older dwellings are occupied by the less affluent, so poor living standards coincide with poor standards of electrical safety.

It is therefore helpful to segment the housing market and to examine the safety issues in each segment. The following market segmentation is proposed:

- By occupancy:

  - Common rented accommodation (30% of European dwellings), and social rental (10%), where a landlord is responsible for the maintenance. When responsible for a large building stock (like a local government for social rented housing), the landlord's liability is often statutory or covered by other guidelines or regulations (eg Health & Safety/Environmental Health regulations).

  - Owner-occupied dwellings (60%).

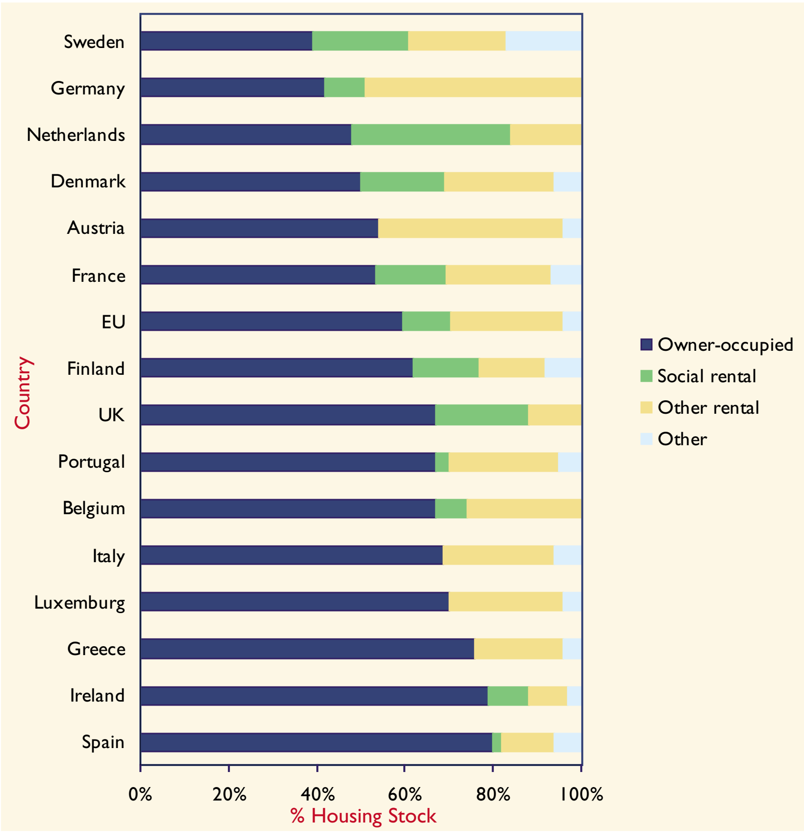


Figure 4 - Profile of EU housing stock (EU Housing Report)

- By type:

  - Apartments (50%), where maintenance is the joint responsibility of the owner/tenant and the co-operative owners. A disproportionate number of casualties from fires occur in buildings of more than 3 floors without connected terraces or external fire escapes.

  - Houses (50%), where maintenance is the exclusive responsibility of the owner or tenant.

  - Others (hotels, caravans, boats etc), representing a very small proportion of the total dwelling stock, and are not further considered in this report.

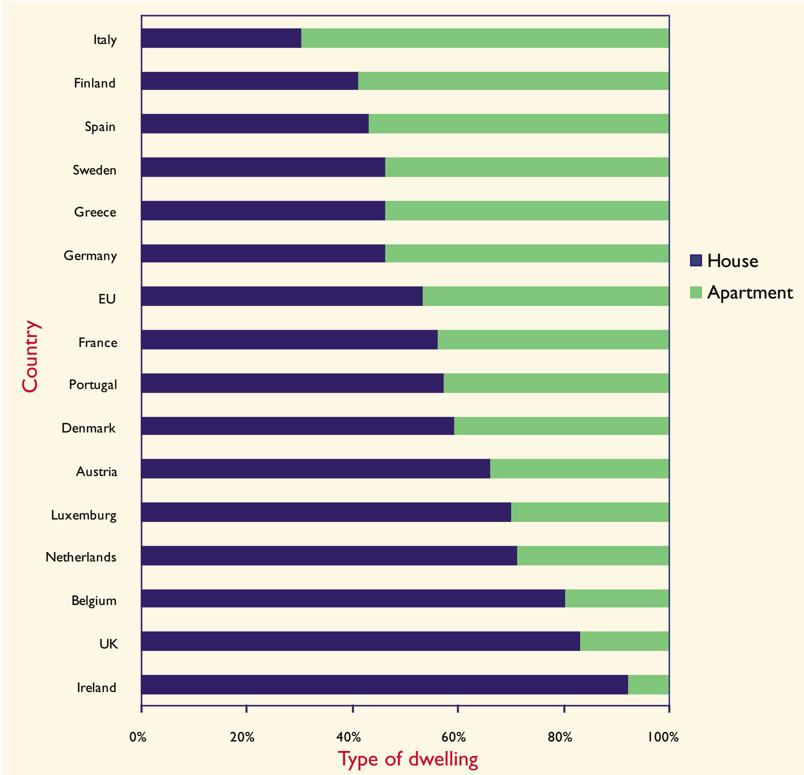


Figure 5 - Types of dwellings (EU Housing Report)

Owner-occupied dwellings tend to be safer than rented ones and houses safer than apartments. Social housing, often occupied by the most vulnerable and least affluent, presents the highest risk. Therefore the regulatory and educational actions needed to enhance fire protection should be targeted at the following housing market segments, in order of priority:

1) Social housing

2) Tenant-occupied dwellings

3) Owner-occupied dwellings

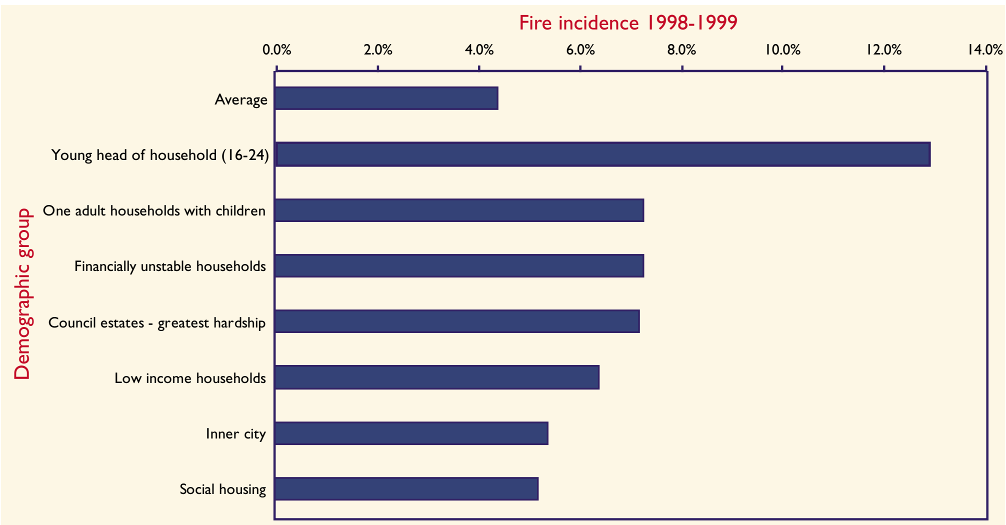


Figure 6 - Relationship between fire incidence & income (Fires in the home (Aust [85])

3.4 Electric shock and the effect of current on the human body

Few statistics exist on accidents due to electric shock in dwellings. The consequences of electric shock range from transitory discomfort to death, depending on the severity, timing and duration of the shock.

The major functions of the human body are controlled by electrical signals and can be seriously affected by electric shocks. Most of the body's interior acts as a salt solution and conducts electricity very well. The effect of an electric shock depends on the magnitude of current passing through the body, not on the voltage (although for a given pathway, the current is almost proportional to the voltage). Current densities in the body are determined by the resistance of the tissues in the path of the current and many electrical experiments have been carried out to investigate this body resistance. The skin, the usual entry point for electricity, has the highest resistance (in the order of several thousand ohms for dry skin and much less for wet skin). Once inside the body, current conduction is affected by the density, shape, orientation and size of tissue cells. It has been determined that, for power frequencies, roughly half the body's resistance resides in the wrist when electricity travels from hand-to-hand or hand-to-foot. This is because it is comprised mainly of ligament and bone. Typically, the internal resistance between two limbs is a few hundred ohms.

Current paths between both arms (the most likely path) and between a leg and an arm are the most hazardous because the current will pass through the area of the heart as well as through the muscles that control breathing. The physiological effects of a 50 Hz current vary with current magnitude, timing and duration and with the contact points on the body. The heart is particularly sensitive to shock during the period of recovery from excitation during each heartbeat. This means that the response to short shocks is unpredictable - a person may survive several severe short shocks by chance, so gaining a false sense of security, and yet be killed by a similar shock in the future.

<table>
<tr><th>Current (mA)</th><th>Duration (ms)</th><th>Effect</th></tr>
<tr><td>0 - 0.4</td><td>unlimited</td><td>No effect</td></tr>
<tr><td>0.4 - 20</td><td>unlimited</td><td rowspan="7">Usually no harmful physiological effects</td></tr>
<tr><td>20</td><td>< 500</td></tr>
<tr><td>30</td><td>< 400</td></tr>
<tr><td>50</td><td>< 100</td></tr>
<tr><td>100</td><td>< 30</td></tr>
<tr><td>200</td><td>< 10</td></tr>
<tr><td>20</td><td>> 400</td><td rowspan="4">Muscular contractions and pain
Difficulty in breathing
Burns</td></tr>
<tr><td>50</td><td>> 100, < 1 000</td></tr>
<tr><td>100</td><td>> 30, < 500</td></tr>
<tr><td>200</td><td>> 10, < 400</td></tr>
<tr><td>50</td><td>> 1 000</td><td rowspan="3">Severe burns
Cardiac and breathing arrest
Risk of ventricular fibrillation, increasing with current and duration</td></tr>
<tr><td>100</td><td>> 500</td></tr>
<tr><td>> 500</td><td>any duration</td></tr>
</table>

Table 6 - Effect of current on the human body [14]

Installation standards require that electrical installations are designed to ensure that the users of the installation are not exposed to dangerous shocks; for example, for portable appliances, the protection is arranged so that a fault will be disconnected within 400 ms and the shock current limited to about 30 mA, corresponding to the bold figures in Table 6. This level of protection can be provided by a properly earthed supply and an installation with a separate protective earth conductor, and/or by a 30 mA RCD.

In France, the ANAH (Agence Nationale pour l'Amélioration de l'Habitat) estimated that about 200 000 individuals suffer burns in their homes each year (population 61.7 million) and that one in four of these victims are children under 5 years old (ANAH [79]). Electric shock is a major cause of these accidents. These figures indicate that many people are receiving electric shocks that are far greater than should be possible with a properly designed and maintained installation. Some of these incidents may be due to human error or abuse, but most must be the result of poorly maintained installations.

4 Means of protection

Designing for electrical safety is a technical issue for which regulations, standards and technical solutions exist. At the end of the 19^{th} or the beginning of the 20^{th} century, when public use of electricity started, standardisation bodies emerged in most European countries. Their establishment was largely stimulated by insurance companies whose interest was to reduce their fire losses but was also necessary because of the potential hazards of electric shock.

Considering its widespread and frequent use, electricity's late 20^{th} century safety record is nothing less than a success story, being a safer fuel source than coal, petrol and natural gas. However, electricity, like every energy source, can be dangerous. The safety level of an electrical installation is dependent on the standards in place at the time of construction, how carefully they were followed, and how well the installation has been maintained. Today, with increasing requirements for the electrical infrastructure, safety provision, as it exists in the ageing housing stock, should be given more attention.

The safety and reliability of electrical installations requires the use of highly technical systems. Many - such as circuit breakers - have been used for decades and continuously developed to cope with modern requirements, others - such as over-voltage protectors - have been used in industry but are new to domestic installations and some - such as arc detectors - are completely new. Older installations will not benefit from these developments without a regime of periodic inspection.

4.1 Protecting electrical equipment and installations[15]

A 'protective measure' is an element that is intended to eliminate the risk of danger arising from the installation. In this way, it reduces the risk of fire, injury or material loss. We can divide measures into the following categories:

- *Adequate earthing.* This enables a fault current to flow safely and directly to the earth. Following the low resistance earthing path, a fault current will be sufficiently large to operate over-current protective devices within the required time.

- *Adequate protection against earth leakage.* Today, an increasing number of electrical appliances permit a small current to 'leak' into the protective conductor of the main wiring system of a home. This 'earth leakage' current is, for each individual device, quite small but, when there are many items of equipment, the sum of the currents is large enough to be potentially dangerous. To avoid this danger, various design features (such as RCDs) should be installed in every domestic installation.

- *Over-current protection.* Circuits are designed to carry the expected load and are fitted with a protective device, i.e. a fuse or a circuit breaker. When the demand for current exceeds the rating of the protective device the circuit is disconnected. Without this protection, the excessive current generates heat in the wiring and can cause a fire. If protective devices operate frequently, it indicates that the circuit capacity is inadequate for the load and it should be re-wired with a cable of a larger conductor cross-sectional area. Increasing the rating of the protective device is sometimes permissible, but only after a complete appraisal of the conductor size and lengths installed.

- *Correct sizing of wires.* Inadequate conductor size can cause overheating. It should be stressed that wires that were acceptable some 25 or 30 years ago, when electricity demand was lower, are often inadequate today. In theory, assuming the over-current protection devices are correct, those older wires will not cause safety problems. However, the circuit capacity will be inadequate for the power required by today's users. There has been a general increase in both the average and peak current demand (some devices require high starting currents followed by a lower running current).

- *Over-voltage protection.* As electrical equipment in the home is becoming more sophisticated and more expensive (audio-visual entertainment, information technology equipment, white goods, etc.), the potential material loss due to over-voltage is increasing. Consequently, over-voltage is a new and increasingly important issue. Over-voltages can be caused by lightning and also by switches in the distribution grid.

4.2 New requirements for dispersed generation

The bulk of our electricity is generated in large, central power plants. Recently, spurred on by the need to reduce the environmental impact of electricity production, it has been recognised that there are many opportunities to generate small but useful amounts of power from, for example, Combined Heat and Power (CHP) units or solar roofs. This dispersed generation is now practical and economic at a domestic level with individual homes selling excess electricity back to the electricity suppliers. The transmission grid is less loaded and more efficient as a result, fossil fuels are used more efficiently and more renewable energy can be produced.

Neither the distribution grid nor the installation standards for domestic installations were designed with this in mind. There is an urgent need for standardization in this area so that this market can develop.

4.3 Other aspects

Electromagnetic disturbances (or 'EMC-problems'). Homes are becoming increasingly rich in equipment that emits electromagnetic waves which may interact in unpredictable ways. Large condominiums containing a lot of IT equipment (eg 2 PCs per dwelling plus auxiliary equipment) are likely to suffer similar quality issues to office environments.

The reliability of the power supply is becoming a significant society issue. Costs to businesses of up to €500 per non-deliverable kWh are very common. In homes, the consequences of the loss of power will depend on the duration of the outage and the type of occupants and can range from the minor inconvenience of losing the lights and the TV to the more serious consequences of a fall or failure of telemedecine equipment.

Outdoor safety. The use of electricity out of doors increases the risk of electric shocks or electric burns. Attention areas include:

- use of weather-proof equipment and cables
- consistent use of 3-pin plugs
- avoidance of product or cable misuse
- avoidance of over-long cables
- unwinding the cable completely before using a retractable cable on a reel
- use of a local RCD.

According to Aust [85], about 10% of all domestic fires actually start outside the house.

Outdoor safety - appropriate protective measures need to be in place and care must be taken for safe use of electrical equipment out of doors

5 Ensuring electrical safety: service providers, standards & techniques

Ensuring electrical safety requires that:

- Design and installation work is carried out in accordance with the standards in force at the time, using appropriate materials, techniques and equipment
- The installation is properly maintained and, if necessary, modified.

In both areas, the electrical sector has an essential role to play. The electrical sector designs, manufactures and installs the products and materials that are required for a safe installation and promotes them to the market. It has a financial interest in doing so and will therefore be interested in helping to promote these solutions to the consumer chain. However, the trade cannot bring about a fundamental change in attitude alone; there must also be a regime of regulation on inspection as discussed in Chapter 6.

5.1 The service providers

The 'electrical sector' for residential electrical installations is made up of five groups:

1) *Utilities, Network Operators and Suppliers:* are responsible for the supply of electricity and have social obligations. Network Operators are also responsible for the provision of the main earth connection in some countries.

2) *Manufacturers:* have a business interest in the supply of devices and equipment to ensure electrical safety. They participate in regulatory activities via their trade associations. They could support a campaign through promotion and marketing activities.

3) *Wholesalers:* have a commercial interest in promoting electrical safety. Since they have frequent contact with installers, they are an ideal channel to market for a promotional campaign.

4) *Installers:* are key to promoting improved safety. They have constant contact with the public and are able to promote safety. Because they have obvious commercial interests, they need neutral, independent and authoritative information to support them. Installers' Trade Associations have a role in ensuring that their members are kept informed about new trends and developments and that their levels of professional competence are maintained.

5) *Architects and House Builders:* are concerned about safety at the initial design stage, but their liability is time limited (usually 10 years). Their responsibility is to ensure that the finished building meets the relevant building and health and safety regulations. Electrical installation standards are included in one of these groups in most countries.

The electrical sector operates within a regulatory and legal framework established by the following:

1) *Standards Bodies:* define the installation standards to ensure the safe use of electricity. Standards bodies are reactive; they respond to requests from interested parties for standards but do not initiate them on their own initiative.

2) *Government:* should be aware of the issue and should be willing to introduce regulation if:

   - solid data is available

   - costs will be reasonable.

3) *Inspectors:* ensure that installers implement the intentions of the standards bodies. They may be independent, employees of suppliers, network operators, installers' trade associations or self certified.

4) *Insurance Companies:* currently view improving electrical safety as low priority, since claims from fires caused by electricity are lower than other risks in their payout portfolio. Insufficient statistical data on the real costs to society are available to support greater backing. However, this report uses the available statistics to build a picture for Europe that suggests that action should be of interest to them.

5) *Consumer Organisations:* are in an ideal position to stimulate a regulatory effort, possibly supported by the above parties. These groups have to be convinced to raise the priority of this issue in their work programmes.

6) *Academia:* have a review function to ensure a balanced approach.

5.2 Standards

The International Standard series governing electrical installations is IEC 60364. The European equivalent is CENELEC HD384. There are national equivalents in all European countries (AREI/RGIE - B, VDE100 - D, REBT - ES, NF C 15-100 - F, CEI 64-8 - I, NN 1010 - NL, BS 7671 - UK). There are, however, significant differences between national and international standards' implementation.

There are 7 parts in the IEC Standard. Part 4 deals with protection measures in installations and Part 6 with inspection (initial verification, reporting and periodic verification). Special Installations are treated in Part 7 (eg medical installations, marinas, bathrooms, photovoltaic installations).

Part 6 of the IEC Standard is currently under revision. The document recommends defining a time interval for periodic inspection in national statutory requirements. If no such time interval is defined, an inspector could recommend a time interval in the initial verification report. A 10-year interval for residential dwellings is mentioned as an example. Periodic inspection is furthermore strongly recommended when there is a change in occupancy[16] (ownership or tenancy).

In May 2000, a working group of CENELEC[17] (Comité Européen de Normalisation Electrotechnique) published a 'European Specification for Inspection and Testing of Electrical Installations in Domestic Properties'[18]. This document states a maximum interval of 10 years for periodic inspections of residential properties.

It should be noted that changes in installation standards most often apply to new buildings and not to existing ones. Hence, a major proportion of the housing stock does not yet have safety features that were introduced as new in the 70s and 80s, such as circuit breakers and residual current devices[19] (RCDs). Most countries do not require existing buildings to be made compliant with new standards that come into force after the building has been constructed[20].

5.3 Techniques for electrical renovation

When renovating the electrical system of a dwelling, the first area that should be examined is the consumer unit (De Saint-Albin [8]). Often, units have been installed in the 50s and 60s and may have too few circuits (only 2 or 3), or be mounted on wood (not allowed under current standards).

New modular panels allow for the addition of circuits and devices. Timers, for instance, can shift electricity use for high power demand applications to off-peak tariffs. Some utilities offer relays that allow shut-down of high power demand appliances during peak loading.

Another important aspect of the renovation is 'rewiring' which is **desirable** if:

- the wiring is old and the insulation has become brittle - especially around light fittings where heat can build-up
- the insulation is rubber, rather than PVC - rubber insulation can crack with age and heat leaving uninsulated sections of wiring
- the wiring is early (before 1954) PVC insulated cable - the plasticisers used can be lost leaving brittle insulation and a blue liquid in accessory boxes.

Rewiring is **essential** if:

- lights flicker or appliances work intermittently, indicating poor connections
- accessories - switches, sockets or light fittings - become warm in use
- fuses blow or circuit breakers operate frequently - the circuit is too small to provide the power required.

New circuits should always be 3-wire, i.e. including a protective earth conductor.

Rewiring will often focus attention on the need for additional power sockets, as well as additional telephone, data and television connections. The additional wires do not need to be installed in the walls. A range of accessories is available to integrate the wiring in plinths or skirtings. Integrated skirtings allow the separation of power circuits and other cables, (telephone/TV/data wires) as required by most wiring codes. Power sockets, TV or telephone outlets can be installed at any desired location on the skirting. The use of skirtings and plinths allows rewiring to be carried out with a minimum amount of damage to the property, so overcoming the biggest barrier to rewiring - the damage and disruption that can be caused.

The use of fire retardants can be considered, as they provide additional protection for a relatively small additional cost, but care must be taken not to reduce the free air circulation around cables, or to increase the cross-sectional area of the cables accordingly.

Finally, lighting greatly influences atmosphere in the home and appropriate direct, indirect, diffused and mixed lighting systems can be selected. Installing additional lighting points allows greater choice and flexibility. Lighting is responsible for about 10% of the household electricity consumption, so controlling by presence detectors or timers can reduce energy consumption and enhance safety.

6 Ensuring electrical safety: regulation and cost

Most countries have a standard or code covering electrical installations in buildings that is derived from the International IEC or CENELEC Standards and is incorporated into building regulations, health and safety regulations or is legally enforceable. The problem is that standards are very rarely retrospective, so existing buildings and their occupiers do not benefit from safety improvements. As a result, some form of regulation is necessary for older buildings. The effort of introducing regulation can be justified by improved safety and the secondary benefits in the quality of life that result. A good regulation regime should have reasonable compliance costs and work as a catalyst for the market.

6.1 Types of regulation

Initial verification. An initial verification for new build properties is compulsory in most European countries. Certified inspection bodies exist in Belgium, France, Ireland, Portugal, Spain and Switzerland. Other countries rely on certification of electrical contractors (Germany, UK, Netherlands) or inspection by utilities[21]. In Italy, initial verification of electrical installation is compulsory by law and should be carried out by the installer who has done the work. Municipal inspection regimes, which are common in North America, hardly exist in Europe.

Verification that initial inspection is done can be performed through public authorities or electrical utilities. Often, utilities require an inspection report to be produced before connecting electricity meters in new properties.

Periodic inspection. For most EU countries, there are no periodic inspection regimes for existing dwellings. In Czech Republic, Hungary, Poland and Russia, periodic inspection regimes at a 5 to 9 year interval officially exist but, due to a lack of enforcement, do not achieve their goal. France and Italy are working towards a regulation for periodic inspections.

Event-triggered inspection. Spain, Portugal, Ireland and France require an electrical inspection (or at least a 'proof of compliance') for buildings that are entirely renovated or for which a building permit application is submitted. Other inspection triggers include change of the supply contract (Belgium) and a change of tenant. With a change of occupancy, the electricity supply contract can usually be transferred by a simple administrative procedure. This is a missed opportunity. The obligation to present a recent (less than 10 years old) inspection report at such time could become a strong lever for increasing the safety of European dwellings and for ensuring the application of recent standards.

Mandatory inspection and renovation. In 1990[22] Italy made inspection - and renovation where required - statutory for all dwellings built before 1999. One of the very positive results is that only 7% of dwellings in Italy do not have RCD protection, compared to no less than 68% in France. In particular, the installation of a differential switch of not more than 30 mA in case of absence of an earth protection circuit, was imposed.

6.2 Recommendations for inspection

The following regulatory system could be designed, according to the three main types of dwellings:

- *Owner-occupied dwellings.* A mandatory event-triggered inspection when there is a change of ownership. When the electricity supply agreement is transferred to a new owner, this new owner will be required to produce a recent certificate of inspection. In addition, a periodic inspection every 10 years should be recommended.

- *Tenant-occupied dwellings.* Landlords should be responsible for maintaining the electrical installation in a safe condition. This should be enforced by requiring a recent (less than 10 years) inspection certificate to be produced at each change of tenancy. French law requires that landlords must maintain rented dwellings in reasonable condition. This means that the landlord might become responsible for incidents in the home related to the technical installations.

- *Social housing.* A mandatory periodic inspection programme should be included in the general maintenance programme for the housing stock. The period should not exceed five years and should be reduced for high turnover properties.

	Owner-occupied dwellings	Tenant-occupied dwellings	Social housing
New	No issue - inspection as part of the construction process		
Existing	Mandatory transaction-oriented regime - change of ownership Recommended maximum inspection period 10 years	Impose landlord liability Mandatory inspection every 10 years, more frequently for fast turnover housing	Housing managers have duty of care Mandatory inspection every 5 years, more frequently for fast turnover housing

Table 7 - Optimum regulation for various segments in the housing market [23]

6.3 A regulator's checklist

The following issues should be on the checklist for drafting regulations:

- Qualification of installers. The training and continuing professional development of installers is a key requirement. Entry and continued participation in the trade needs to be regulated.
- A system to ensure that inspections are carried out when required on existing installations. The mechanism may vary according to the type of housing.
- A system to verify that steps have been taken to correct identified deficiencies in a timely fashion.
- A workable system of inspection of new installation work. This can be operated by an accredited body, by the utility, by local authorities or by approved installers.
- A training scheme for inspectors. Streamlining the inspection of the electrical installations with other technical safety inspections in the house, such as gas, water and heating systems, would make the whole system more efficient, without lowering the quality of the inspections.

6.4 Social dimension

According to Aust [85], some demographic groups run a higher than average fire risk (Figure 6). It is precisely these groups who tend to be disadvantaged already in several other areas. Fires in apartments represent 16% of all fires, but lead to 50% of the casualties[24]. Tall buildings claim a disproportionate portion of the fire death bill.

Taking these considerations into account, it can be estimated that about three quarters of the European housing stock[25] is in need of inspection, i.e. about 190 million dwellings out of the total of 263 million and about half i.e.130 million dwellings require renovation. Many of these dwellings can be identified by demographics and others will be identified at change of ownership or tenancy. An awareness campaign, carried out with the co-operation of the supply companies, could be used to identify the remainder.

6.5 Cost of inspection and renovation

The average cost of an inspection for existing dwellings is estimated to be €100 for EU-15 and €50 for non-EU-15 countries. For 190 million dwellings the total cost is estimated at €13 billion. Over a 10-year period, this will require about 13 000 inspectors[26].

The average cost of renovation varies from €300 for upgrading a consumer unit to €2 000 for a full rewiring[27]. An average cost per dwelling of €1 000 for the EU-15 countries and €500 for non-EU-15 countries has been assumed for renovating dwellings with two or more safety concerns. For 130 million dwellings the total cost is estimated at €83 billion. This will require about 140 000 contractors.

The total cost of inspections and renovations in Europe[28], according to the proposed scheme, can be estimated as €96 billion, or €9.6 billion/year over a 10-year period. This would double the turnover of the residential electrical contracting market in Europe.

6.6 Macro-economic model

The €9.6 billion annual cost of carrying out the necessary inspections and renovations needs to be considered in the context of the following benefits to society:

- Up to €14 billion[13] per year saved due to reduced property damage, injuries, casualties and fire fighting
- Up to €3 billion per year in emission reductions and reduced energy costs[29]
- Net employment creation.

As well as enhanced safety, users benefit from:

- Improved lifestyle (through increased electrical convenience and functionality)
- Increased property value
- Improved sense of security
- Reduced energy cost[30].

The costs and benefits can vary considerably by country and some benefits are hard to quantify. The quantification above assumes a substantial incentive from government subsidies, tax advantages, or regulation.

To upgrade all the inadequate dwellings in Europe to a reasonable level of electrical safety, 140 000 new contractors and 13 000 new inspectors have to be trained and available to execute the renovation work over a period of 10 years. It is expected that some of these additional contractors are needed anyway to take care of the increasing complexity and functionality of electrical installations in buildings (smart homes, telemedicine, domestic co-generation, energy and demand side management). When considering the creation of employment through any scheme it is important to look at the overall net creation of employment and its influence on the whole economy, so the following should be taken into account:

1) Jobs would be created through inspection, contracting work, the manufacture of components and the supply of material to manufacturers (positive).

2) The people working in the newly created jobs would have improved purchasing power, which would create further jobs (positive).

3) There is a cost attached to renovating and improving the safety of an electrical installation. This cost would have to be borne by the owners or inhabitants of the dwelling, so their purchasing power would decrease. eg they will buy fewer clothes, will dine out less frequently etc. This would eventually lead to a reduction in employment (negative).

4) If the inhabitants of the dwellings take out a mortgage to finance the renovation works, this would result in an increase in money in circulation, which would stimulate the economy (positive).

5) If the government subsidises part of the process, eg the inspections, then this money could not be invested in other measures that might also create jobs (negative).

Of those five influences, the first one is expected to be decisive. Inspection and contracting work are labour intensive compared to other activities - nearly all of the investment flows to wages. So when investing in electrical safety through regulation and inspections, net job creation is to be expected. Another advantage is that all these jobs will be created at a local level.

7 Conclusions and recommendations

A significant majority of domestic electrical installations in Europe are inadequate. The high average age of homes coupled with an intense electricity-based lifestyle and increasing safety standards are factors that require a regular, periodic renovation of electrical installations. Presently, this is not the case. The renovation rate for electrical installations in Europe is low.

The lack of adequate safety measures can have serious consequences. Electrical defects are one of the common causes of fire. Research has shown that fires caused by electrical defects result in more damage and personal injuries than average fires. Poorly maintained electrical equipment can also cause injuries through electric shock. Electrical defects can cause vital telemedicine equipment to malfunction with serious consequences.

Technical solutions exist. Most of the protection measures for electrical equipment have been available for a long time. Others are new or adapted to the new environments. In most homes, however, these protective solutions are not being introduced. Primary efforts should be directed at the installation of new consumer units, rewiring and the addition of extra sockets where necessary.

Regulation is the catalyst needed to increase the pace of implementing the necessary renovations. The required international standards are already in place. In some European countries, there is also some limited regulation. From the existing body of law, a complete set of inspection guidelines could be established. For example, supplying an inspection certificate when a home changes owner or tenant could be made mandatory, where it currently is not, as part of the transition process. For municipal housing, an inspection programme could be included in the general maintenance programme. As an added component, legislation could be passed authorising an inspection of domestic electrical installations every 10 years. For the sake of efficiency, this inspection could be made together with gas, water, and heating installations.

Information campaigns would help create an awareness of safety. Safety begins with the appropriate technical installation, but requires an awareness among occupants of safety issues so that they can monitor the condition of their installations. This could lead to them having improvements and minor repairs carried out during the interval between major renovations and inspections.

Better electrical installations generate a number of secondary benefits. Besides reducing damage, injuries and deaths, improving installations:

- increases the convenience of using electricity in the home
- raises the feeling of security
- lowers energy consumption (and consequently emissions)
- increases the value of the property
- creates employment.

Improving the electrical safety in Europe's dwellings is worth the effort. The overall benefits to society of raising safety standards are significant. Action must be taken to prevent an increase in accident statistics.

8 Annex I: Bibliography on electrical safety and related topics

8.1 Articles in press and journals

1 Domen, J, Performance-based fire safety engineering, Ingenieursblad, 1995/11, 9 pages

2 Fesaix, P, Le risque electrique (I), Face au risque, Avr 1996, 6 pages

3 Fesaix, P, Le risque electrique (II), Face au risque, Juin-Juill 1996, 5 pages

4 Camm, J, Clear and present danger, Electrical Review, Vol 233 No 3, 2 pages

5 Guyette, J E, Safety counts, LPGas magazine, June 2001, 6 pages

6. Paap, G C, Slootweg, J G, van der Sluis, van Voorden, A M, Potentieel voor duurzame energie in bestaande netten, Energietechniek, jaargang 79, June 2001, 5 pages

7 Le Gall, Y, Valentin, M, Votre installation electrique est-elle dangereuse?, Le Parisien, 8 August 2001, 2 pages

8 De Saint-Albin, S, Mary, J, Roger, R, Rénover sans casser: au coeur du savoir-faire de l'électricien, l'électricien info, Dec 2002, 8 pages

9 Sagot, F, Comment assurer le bien-etre dans la maison, l'electricien e+, Oct-Nov 2003, 4 pages

10 Renovez sans degat au niveau des murs, l'electricien e+, Nov-Dec 03, 2 pages

11 Franz, A, Keller, J, Aus Unfällen lernen, Bulletin des Schweizerischen Elektrotechnischen, 21/2003, 9 pages

12 Ris, H R, Fortschritt oder Gleichschritt?, ET Elektrotechnik, 1/2004, 1 page

13 De Boni, R, Gut geklemmt ist die halbe Funktion, Elektrotechnik, 2/03, 2 pages

14 Meyer, W, Mindestausstattung für Einfamilienhäuser, de, 6/2003, 1 page

15 Soboll, R, Müssen Bäder mit RCDs nachgerüstet werden?, de, 6/2003, 1 page

16 Bluhm, H, Brandgefahr elektrischer Anlagen verringern, Elektro Praktiker, 57 (2003) 7, 4 pages

17 Mallein, P, Les gens ne veulent pas gerer leur logis, Liberation, 17 mai 2003

18 Chapman, D, Socket science, Electrical Contracting News, June 2003, 2 pages

19 Bikmaniene, I, Martinaitis, V, Rogoza, A, Criterion to evaluate the 'twofold benefit' of the renovation of buildings and their elements, Energy and Buildings, 36(2004), 6 pages

20 Simmonds, R, Transmission terminated, Electrical Review, Vol 236 No 14, 3 pages

21 Serafini, T, Alerte au feu sur les installations electriques, Liberation, 12 Jan 2004, 1 page

22 Hochbaum, A, Elektrische Anlagen in der Landwirtschaft, Elektro Praktiker, 1/2004, 5 pages

23 Feldmann, E, Versuchs- und Ausbildungszentrum CEF, ET Elektrotechnik, 1/2004, 2 pages

24 De Boer, R, Innovaties met toekomst gezocht, intech K&S, Jan 2004, 2 pages

25 Reiff, E-C, Schubnell, H, Brandverhalten von Kabeln und Leitungen, de, 4/2004, 1 page

26 Chen, Y, Rousseau, D, Sustainability options for China's residential building sector, Building Research & Information, Vol 29 Issue 4, 9 pages

27 Floyd, I, Electrical safety - Arc flash analysis: are we missing the point?, IEEE Industry Applications, Jan-Feb 2003, 2 pages

28 Dechert, B, Wohnen im Alter - ein Wachstumsmarkt mit Potenzial, de, 6/2004, 2 pages

29 Stoecklhueber, A, Wohnen ohne Grenzen, de, 6/2004, 3 pages

8.2 Reports and publications

30 R. W. King, Industrial hazard and safety handbook, Butterworth & Co, London, 1979, ISBN 0-408-00304-9

31 W. Hammer, Occupational safety management and engineering, Prentice-Hall, Englewood Cliffs, N.J., 1976, ISBN 0-13-629-402-2

32 Home electrical safety audit, US Consumer Product Safety Commission, 1984, 11 pages

33 Miller, C, Schwab, C V, Westphal, J F, Reduce Fires with Electrical Safety, Safe Farm Programme, 1992, 3 pages

34 Guida alla sicurezza elettrica nel condominio, Prosiel, 1993, 40 pages

35 In home electrical safety check, ESFI, 1994, 13 pages

36 Your Home Fire Safety Checklist, US Consumer Product Safety Commission, 1994, 9 pages

37 Repairing Aluminum Wiring, US Consumer Product Safety Commission, 1994, 4 pages

38 D. Leibovici, J. Shemer, S. C. Shapira, 'Electrical injuries: current concepts,' In Injury, 26 (9), pp. 623 - 627, 1995

39 Elektrische installatie OK? Elektrisch comfort OK!, Sibelgas, 1995, 17 pages

40 Residential electrical maintenance code for one- and two-family dwellings (NFPA73), NFPA, 1996, 7 pages

41 Electrical Safety in the Home, Copper Development Association UK, 1997, 4 pages

42 Baggini, A, Casa sicura 2003 - anteprima principali resultati, Prosiel, 1997, 28 pages

43 Samuelson-Brown, G, Thornton, M, Repair, maintenance & improvement in housing - electrical supply, the supply side, BSRIA, 1997, 43 pages

44 Brandveilig grbruik van woningen, NIBRA, 1997, 36 pages

45 Health for All database, World Health Organisation, 1997

46 Blondal, S, Pilat, D, The economic benefits of regulatory reform, OECD, 1997, 41 pages

47 Dossier economique, CICLA, 1997, 16 pages

48 D. Skinner, A. Swain, R. Peyton, C. Robertson, Cambridge textbook of accident and emergency medicine, Cambridge University Press, Cambridge, 1997, ISBN 0-521-43379-7

49 Testez votre installation, Copper Benelux, 1998, 6 pages

50 The GB Private Home Improvement Market - the demand side for electrical & security system improvements, Construction Forecasting and Research Limited, 1998, 69 pages

51 Migliora la sicurezza e il comfort della tua casa. E il momento giusto, Sistema Casa, 1998, 11 pages

52 D'Ambrosio, D, Informazioni di base per vivere in una CasaPiùSicura, Associazione Ambiente e Lavoro, 1998, 20 pages

53 Guide de mise en sécurité de l'installation électrique, Promotelec, 1998, 22 pages

54 Electrical safety in the home, Electrical Contractors Association, 1998

55 De woning brandt, Centraal Bureau voor Statistiek, 1999, 2 pages

56 Protection against electrical shock (IEC 60364-4-41), IEC-TC64, 1999, 45 pages

57 Investment and Construction Industry perspectives in the integrated Europe of the year 2 000 (47th Euroconstruct Conference), Euroconstruct, 1999

58 Nuove prospettive per la sicurezza, AFIS, 1999, 8 pages

59. ICA suggestions for your house wiring, International Copper Association, Ltd, 1999, 32 pages

60 Structure fires in one- and two-family dwellings in which the form of heat of ignition was the heat from electrical arcing, US Fire Marshals, 1999, 2 pages

61 Rookmelder(s) in woningen, CCRB, 2000, 12 pages

62 Blyth, W, Collingwood, J, Heady, C J, Markandya, A, Taylor P G, Study on the relationship between environment/energy taxation and employment creation, University of Bath, 2000, 48 pages

63 Dandini, V, LaChance, J, Nowlen, S P, Wyant, F, Circuit analysis - failure mode and likelihood analysis, Sandia National Laboratories, 2000, 155 pages

64 Schokker, J, Sprinklerbeveiliging in woningen, NIBRA, 2000, 48 pages

65 Chapman, D, Electrical Convenience in New Build Homes - Survey Report (Builders), Copper Development Association UK, 2000, 10 pages

66 Chapman, D, Electrical Convenience in New Build Homes - Survey Report (Contractors), Copper Development Association UK, 2000, 10 pages

67 Schofield, R, Fire Statistics, Estimates United Kingdom, 1999, Home Office - Research, Development and Statistics Directorate, 2000, 16 pages

68 Nute, R, Equipotentiality and grounding, Hewlett Packard, 2000

69 Simonson, M, Stripple, H, LCA study of TV sets with V0 and HB enclosure material, IEEE International Symposium on Electronics and the Environment, 2000, 10 pages

70 Foley, J, Hewett, C, Employment Creation and Environmental Policy: a literature review, TUSDAC, 2000, 31 pages

71 World Fire Statistics 2000, The Geneva Association, 2000, 7 pages

72 Schofield, R, Fire Statistics - United Kingdom 1999, Home Office - Research, Development and Statistics Directorate, 2000, 19 pages

73 Elias, I C, Hagen, R R, Kobes, M, Onderzoek - oorzaken en gevolgen van woningbranden, NIBRA, 2000, 56 pages

74 Home wiring hazards, US Consumer Product Safety Commission, 2000, 40 pages

75 Manson, J, Improving electrical wiring safety standards, inspection periodicity and providing more effective controls, European Copper Institute, 2000, 16 pages

76 El libro azul de la electricidad, AENOR, 2000, 251 pages

77 George, C, Vernon, J, Employment effects of waste management policies, European Commission - DG Environment, 2001, 160 pages

78 Helsloot, I, Jaarboek onderzoek 2000, NIBRA, 2001, 160 pages

79 Limiter les risques de brulures et d'electrocutions, ANAH, 2001, 8 pages

80 Limiter les risques d'incendie, ANAH, 2001, 8 pages

81 Blazy, P, De Keulenaer, H, Taildeman, F, Improving electrical wiring safety standards and inspection periodicity - case for France, European Copper Institute, 2001, 14 pages

82 De Keulenaer, H, Ionov, V, Improving electrical wiring safety standards and inspection periodicity - case for Russia, European Copper Institute, 2001, 19 pages

83 Testo unico delle disposizioni legislative e regolamentari in materia edilizia, Italian Parliament, 2001, 73 pages

84 Housing and health in Europe, World Health Organisation, 2001, 27 pages

85 Aust, R, Fires in the home: findings from the 2000 British Crime Survey, UK Department for Transport, Local Government and Regions, 2001, 69 pages

86 De Keulenaer, H, Targosz, R, Improving electrical wiring safety standards and inspection periodicity - case for Poland, European Copper Institute, 2001, 16 pages

87 14o censimento generalte della popolazione e delle abitazioni, ISTAT, 2001, 30 pages

88 Brand voorkomen thuis, KBC Insurance, 2001, 28 pages

89 Weiner, M, The economic costs of fire, Home Office - Research, Development and Statistics Directorate, 2001, 48 pages

90 Controlelijst brandveiligheid in woningen, Brandpreventieweek, 2001, 10 pages

91 Dol, C P, Haffner, M E A, Housing Statistics in the European Union 2001, Finnish Ministry of Environment, 2001, 100 pages

92 Observatoire de l'habitat existant, ANAH, 2001

93 Statistik der Versicherungs-dienstleistungen, European Commission - EUROSTAT, 2001, 8 pages

94 Requirements for special installations or locations - Solar photovoltaic power supply systems (IEC 60364-7-712), IEC - TC64, 2002, 13 pages

95 Protection for safety - protection against voltage disturbances and electromagnetic disturbances (64/1208/CDV), IEC - TC64, 2002, 11 pages

96 De Keulenaer, H, Targosz, R, Improving electrical wiring safety standards and inspection periodicity - the case for Czech Republic, European Copper Institute, 2002, 16 pages

97 De Keulenaer, H, Targosz, R, Improving electrical wiring safety standards and inspection periodicity - the case for Hungary, European Copper Institute, 2002, 16 pages

98 Housing in England 2000/1, UK Department for Transport, Local Government and Regions, 2002, 300 pages

99 IEC 60479: Effects of current on human beings and livestock - New part 4, IEC, 2002, 20 pages

100 AFCI inquiry and report, National Association of Fire Marshals, 2002, 88 pages

101 Helsloot, I, Jaarboek onderzoek 2001 2002, NIBRA, 2002, 156 pages

102 Brand - tips en een checklist, NIBRA, 2002, 24 pages

103 Measures against electromagnetic influences (IEC 60364-4-44, 64/1274/CD), IEC - TC64, 2002, 26 pages

104 World Fire Statistics #18, Oct 2002, The Geneva Association, 2002, 8 pages

105 Jenkins, D, Domestic Electrical Safety, RoSPA, 2002, 13 pages

106 Karter, M J, Fire loss in the United States during 2001, NFPA, 2002, 39 pages

107 Fire safety research looking for partners, ERFA, 2002, 3 pages

108 Ooh ... which electrician should I choose?, NICEIC, 2002, 8 pages

109 Outdoor electrical safety check, ESFI, 2002, 37 pages

110 Housing statistics 2002, Office of the Deputy Prime Minister, 2002, 160 pages

111 De verzekering in Belgie 2002, BVVO, 2002, 80 pages

112 World Health Report 2002 - Annex Table 2, World Health Organisation, 2002, 2 pages

113 Do you need an electrician?, CDA Inc, 2002, 2 pages

114 Fire statistics 2002, Svenska Brandförsvarsföreningen, 2002, 6 pages

115 Sicurezza in casa, PROSIEL, 2003, 24 pages

116. Geef brand geen kans ... met veilig doe-het-zelven, NIBRA, 2003, 2 pages

117 Is there a struggle for power in your home?, Copper Development Association UK, 1999

118 Au feu!, Commission de la Sécurité des Consommateurs, 2003, 4 pages

119 Risocoanalyse veiligheid gas- en elektra-installaties in de woning, VROM, 2003, 85 pages

120 Ontario fire losses 2001, Office of the Fire Marshal - Ontario, 2003

121 So many electrical hazards in just one home ..., NICEIC, 2003, 16 pages

122 Jong, W, Miljoenenbranden, NIBRA, 2003, 82 pages

123 Revision de l'installation electrique, ANAH, 2003, 97 pages

124. Regular inspection and maintenance of technical building equipment, CEETB, 2003, 13 pages

125 De Keulenaer, H, Esendal, S, Oztoprak, A, Tepiroglu, A, Status of wiring in Turkish residential installations, European Copper Institute, 2003, 12 pages

126 Recommendations for small renewable energy and hybrid systems for rural electrification - Part 5: Safety rules, IEC, 2003, 29 pages

127 Rapport d'activite 2002, CONSUEL, 2003, 31 pages

128 Avoid electrical hazards, care for your life and property, Copper Development Centre - South East Asia, 2003, 6 pages

129 Measures for safer electrical installations in homes, Copper Development Centre - South East Asia, 2003, 6 pages

130 The European electrical contracting industry and the building electronic system market towards 2007, AIE, 2003, 28 pages

131 Brandursachen, Feuerwehr Mainz, 2003, 6 pages

132 CENELEC Work Shop - Smart House, CENELEC, 2003, 55 pages

133 Bastide, J C, Gilet, J C, Le risque electrique, INRS, 2003, 4 pages

134 World Fire Statistics, The Geneva Association, 2003, 9 pages

135 Siekkinen, H, Ageing - a new potential for European construction sector, VTT Building and Transport, 2003, 23 pages

136 L'assurance francaise en 2002, Federation Francaise des Societe d'Assurances, 2003

137 Effectiveness of sprinklers in residential premises, BRE, 2004, 15 pages

9 Annex II: End notes

1 Safety in this report is defined as: 'A safe electrical installation is one that is designed to comply with standards, is correctly installed, regularly maintained, meets consumers' current and future needs, and is used with care'.

2 Source Dol [91]. All figures for EU. Building stock in 1999 was 164 million dwellings. Annual new build completions is 1.9 million. Considering a population growth of 0.3% per year (0.5 million new dwellings), and a reduction in family size (2.5 to 2.4 persons per family over the 90s, requiring 0.6 million new dwellings per year) implies 0.8 million dwellings are demolished and reconstructed each year.

3 The number of unsafe dwellings is based on a survey of occupants covering 13 specific home safety issues (see http://safety.copperwire.org/method.php). A dwelling is considered safe when there is no safety concern, as potentially unsafe (requiring inspection) when there is 1 safety concern and definitely unsafe (requiring inspection and renovation) when there are 2 or more safety concerns. The underlying logic is that 2 or more safety concerns can interact to create a hazardous situation (such as the lack of a residual current device (RCD) combined with a lack of earthing). The results obtained using this methodology to determine the level of safety are reasonably consistent with the results from physical inspections on a sample of dwellings, as performed in France, Italy and Spain.

4 Since no European database exists on the issue of electrical safety, the following principles were used in this report:

i) The use of official, published statistics, where available.

ii) The derivation of figures, based on reasonable assumptions, where data does not exist. This was done either through benchmarking, or by collecting expert opinions.

iii) Documentation of all sources, so that improvements to this knowledge base can be made in the future.

Many conclusions are based on UK statistics, since the UK is the country for which the most detailed information is available. The UK has a high installation standard, and hence extrapolating UK results to other markets tends to underestimate the real safety hazard, and err on the conservative side.

5 Residual Current Device (RCD): a device that detects small earth leakage currents (typically 30 - 500 mA) and switches off the installation.

6 CENELEC European Specification ES59009 recommends periodic inspection every 10 years. Other standards organisations, like IEC, are also discussing a 10 year inspection interval for residential installations.

7 Homes wired in aluminium are 55 times more likely to catch fire than copper-wired homes. Source: US Consumer Product Safety Commission www.cpsc.org.

8 RAL Deutsches Institut für Gütesicherung und Kennzeichnung e.V., Elektrische Anlagen in Wohngebäuden RG 678. The single star rating in the RAL system has been taken over as a DIN standard (ref 18015).

9 There is a wide variation of reported fire statistics. This is because:

- the safety levels vary from country to country
- there are different terms of reference, primarily because the figures relate to:

  - all fires, or to fires in buildings only. Major places for the origins of fires are buildings, vehicles, and forests.

  - reported fires only, or the total amount of fires. Many fires are self-extinguishing, or can be easily solved without intervention (for example a burning candle falling on a dinner table). Only the most serious fires require intervention by the Fire Brigade, and are reported.

  - total fires (TF): the total number of fires that occur in a country or region per year. This usually includes outdoor fires, vehicle fires, forest fires and fires in buildings.

EU-15 = the European Union prior to May 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden, UK).

EU-25 = the new, extended Union of 25 countries (including Poland, Czech Republic, Slovakia, Hungary, Slovenia, Estonia, Latvia, Lithuania, Malta and Cyprus).

Total reported fires (TRF): the total number of fires that require intervention. A large portion of outdoor fires never require intervention. Also indoor fires are often dealt with by the building occupant, without intervention from the Fire Brigade. Reported fires are collected into national, regional or municipal statistics through reports completed by fire officers.

Total fires in buildings (TFB) and **total reported fires in buildings** (TRFB): the equivalent of the above two categories, but for the 'indoor' subcategory.

Total electrical fires (TEF) and **total reported electrical fires** (TREF): equivalent subcategories for electrical fires in buildings.

10 Good sources of statistical fire information can be found at:

- UK: Home Office Research, Development and Statistics Directorate (Schofield [67], Weiner [89], Aust [85] www.homeoffice.gov.uk/rds/index.html)
- USA: National Fire Protection Association (Karter [106], www.nfpa.org)
- World: World Fire Statistics from The Geneva Association ([104], www.thegenevaassociation.org)

11 Cf Karter [106]: US 2001: 521 500 fires per year; Schofield [67] UK 1999: 115 500 fires. Total 637 000 fires on a population of 310 million means 2.054 fires/million citizens per year.

12 In this paper, billion is used as '1 000 million'

13 Aust [85] reports a mean cost for domestic fire and a mean cost for a domestic electrical fire. No average cost is reported, but because of the skewed nature of the distribution of fire damage, we expect the average fire cost to be above the mean, and hence, using the mean as approximation for the average errs on the conservative side.

14 Source: Prof. R. Belmans, Katholieke Universiteit Leuven, Belgium

15 This definition was contributed by R. Belmans, Professor at the Katholieke Universiteit Leuven (Catholic University of Leuven), Electrical Engineering Department (http://www.esat.kuleuven.ac.be/electa), and President of the UIE.

16 See IEC 60364-6-61 and IEC 60364-6-62 at www.iec.ch. Standardisation work in progress is not published. Information may be obtained from national standards committees, see members listing of IEC.

17 CENELEC, the European Committee for Electrotechnical Standardisation, was created in 1973 as a result of the merger of two previous European organisations: CENELCOM and CENEL. Nowadays, CENELEC is a non-profit making technical organisation set up under Belgian law and composed of the National Electrotechnical Committees of 27 European countries. In addition, 8 National Committees from Central and Eastern Europe are participating in CENELEC work with an affiliate status. CENELEC members have been working together in the interests of European harmonisation since the 1950s, creating both standards requested by the market and harmonised standards in support of European legislation, which have helped to shape the European internal market.

18 ES 59009:2000, May 2000. www.cenelec.org

19 Cf Survey of 16 000 dwellings on electrical safety in Europe (www.electric-safety.org). On average, 67% of dwellings do not have mains protection by RCD, a safety device which has been available for over 20 years.

20 Except when non-compliance to the new standard represents a safety hazard (eg CH, CZ, D, I)

21 Source: Survey by CENELEC BTTF95 on periodic inspection.

22 Legge 46, Norme per la sicurezza degli impianti, March 5, 1990

23 Source: Prof. R. Belmans, Katholieke Universiteit Leuven, Belgium

24 D Phillips, Councillor Mid and West Wales Fire Authority http://www.the-fic.org.uk

25 Table: results from interviews with 16 000 home occupants in Bulgaria, Czech Republic, France, Hungary, Italy, Poland, Romania, Russia, Spain, Turkey, Ukraine (results in bold). For other countries, an assumption of 'similar to France' has been made)

Country	dwelling stock (millions)	no issues (%)	1 issue (%)	2 or more issues (%)	Inspection cost (€ Million)	Renovation cost (€ Million)
Source	(1)	(2)	(3)	(4)	(5)	(6)
Austria	**3.7**	*56*	*31*	*13*	*163*	*481*
Belgium	**4.0**	*56*	*31*	*13*	*176*	*520*
Bulgaria	**3.0**	**4**	**26**	**70**	**144**	**1 050**
Czech Republic	**3.7**	**8**	**42**	**50**	**170**	**925**
Denmark	**2.5**	*56*	*31*	*13*	*110*	*325*
Finland	**2.4**	*56*	*31*	*13*	*106*	*312*
France	**28.0**	**56**	**31**	**13**	**1 263**	**3 731**
Germany	**29.7**	*56*	*31*	*13*	*1 307*	*3 861*
Hungary	**4.1**	**2**	**31**	**67**	**201**	**1 374**
Italy	**25.0**	**46**	**34**	**20**	**1 350**	**5 000**
Netherlands	**6.6**	*56*	*31*	*13*	*290*	*858*
Poland	**13.4**	**2**	**17**	**81**	**657**	**5 427**
Romania	**7.7**	**2**	**11**	**87**	**377**	**3 350**
Russia	**51.7**	**1**	**14**	**85**	**2 559**	**21 973**
Spain	**18.7**	**14**	**19**	**67**	**1 608**	**12 529**
Sweden	**4.3**	*56*	*31*	*13*	*189*	*559*
Turkey	**15.8**	**1**	**10**	**89**	**782**	**7 031**
UK	**20.4**	*56*	*31*	*13*	*898*	*2 652*
Ukraine	**18.7**	**0**	**5**	**95**	**935**	**8 883**
Total	263.4	73.0	60.2	130.9	13 293	94 124

(1) EU housing stock, Economist World in Figures 2003

(2-4) Figures based on interviews with a random sample of home owners; figures in italics derived from France. For assumptions see End Note 1.

(5-6) The average cost of an inspection for existing dwellings is estimated at €100 for EU-15 and €50 for non-EU-15 countries. The cost of renovation varies between €300 for upgrading a distribution panel to €2 000 for a full rewiring source. The average cost is assumed to be €1 000 for the EU-15 and €500 for non-EU-15 countries per dwelling with 2 or more safety concerns.

26 In France, 280 inspectors inspect 140 000 dwellings/year and issue 550 000 proofs of compliance (1 dwelling in 43 is physically inspected). Source www.consuel.com

27 A full rewiring represents one man week of work. There are 46 man weeks in a working year.

28 All European states, including Russia and the European part of Turkey

29 We assume 5% of annual electricity consumption can be saved through installation upgrade, or 200 kWh/year. This is equivalent to 80 kg of CO_2 emissions. Over 130 million dwellings, this means 26 TWh of electricity and 10 million tonne of CO_2 emissions per year, equivalent to almost €3 billion in costs.

30 We estimate the energy saving benefits of rewiring at 5% of residential electricity use, 10% of residential electricity cost and 10% of emissions related to residential electricity. This is based on 5% savings in lighting and wiring and an additional 5% from shifting the peak loads. Residential electricity use is 3 500 kWh / household per year, and emissions are 0.4 kg CO_2/kWh.

Notes

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