

# 1. Electricity Power Utilities - Economical and Political Aspects

## 1.1 Electricity:

- in nature
  - electric and magnetic static fields
  - lightning pulses
  - frictional load
  
- in the electricity industry
  - generation of AC 16 2/3, 50, 60 Hz in power plants
  - transformation into different AC voltage levels
  - transformation into DC voltages
  
- electric-magnetic waves
  - propagation speed in air ~ 300 000 km/s
  - in cables ~ 150 000 ...200 000 km/s
  
- electric field:            tension
- magnetic field:        current



Polar light in the magnetic earthfield



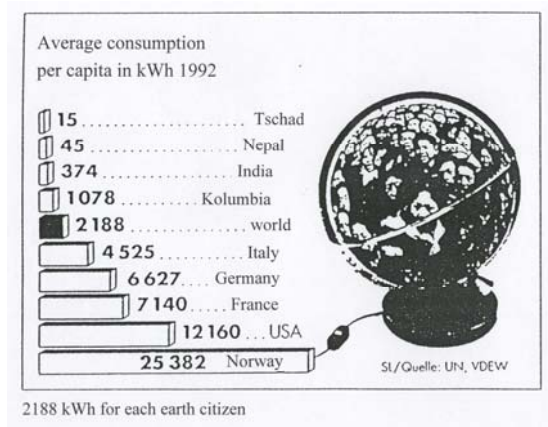
Lightning cloud to earth

|                              |              |       |                                       |
|------------------------------|--------------|-------|---------------------------------------|
| Beginning of electricity use |              | ~1880 | (treatment of ill persons very early) |
| DC transmission              | 1,5... .2 kV | 1882  |                                       |
| AC transmission              | 15... 30 kV  | 1892  | (175 km)                              |
|                              | 110 kV       | 1911  | D                                     |
|                              | 220 kV       | 1922  | D                                     |
|                              | 380 kV       | 1956  | D                                     |
|                              | 500 kV       | 1960  | USSR                                  |
|                              | 735 kV       | 1965  | Canada                                |
| DC transmission              | ~ 200 kV     | ~1964 | Denmark-Sweden                        |
|                              | ~ 600 kV     | today |                                       |

1.2 Electric power supply - political and economical aspects

**In developing countries:**

- diesel power generators for special consumers or water supply
- electrification of the capital and big cities
- rural electrification supplied by isolated diesel or hydro power generators
- interconnecting the islanded networks
- Consumers:
  - Industry, handicraft, motors, trade,
  - governmental institutions, hospitals, schools, police, army, ...
  - household, light, fan, cooking, refrigerators



| Energy Consumption Worldwide in (1992) 2004 |            |           |                   |
|---|------------|-----------|-------------------|
| Country                                     | Mio. kWh   | Pop./Mio. | kWh/p.c.          |
| World                                       | 16.330.000 | 6.640,0   | ( 2.188 ) 2.460   |
| Norway                                      | 116.200    | 4,5       | ( 25.382 ) 23.240 |
| USA   | 3.717.000  | 280,6     | ( 12.160 ) 13.228 |
| France                                      | 482.400    | 59,8      | ( 7.140 ) 8.040   |
| Germany                                     | 587.900    | 83,3      | ( 6.627 ) 7.080   |
| Italy                                       | 321.000    | 57,7      | ( 4.525 ) 5.534   |
| UK  | 345.200    | 59,8      | 5773              |
| Kolumbia                                    | 46.050     | 41,0      | ( 1.078 ) 1.123   |
| India                                       | 524.600    | 1.046,9   | ( 374 ) 501       |
| Nepal                                       | 2.464      | 25,8      | ( 45 ) 96         |
| Tschad                                      | 78         | 9,0       | ( 15 ) 87         |
| Iran  | 140.300    | 66,6      | 2.107             |
| Mongolia                                    | 2.726      | 2,7       | 1.001             |
| China                                       | 2.494.000  | 1.284,3   | 1.942             |
| Russia                                      | 940.000    | 145,0     | 648               |

- Electric power supply:  
is part of the infrastructure measures as water supply, streets, telecommunication, hospitals, ...
- Financed generally by donors or credits of development banks in most of Asian, African and South American countries.
- Electrification programs are often political instruments; normally the tariffs don't defray the production and distribution costs. Specific costs are relatively extreme high compared with the income of the population.

***Price structure must manage the wanted consumer behaviour !***

Reliability normally is poor; this is acceptable in the first step because of the low outage costs. It follows a period of continuous amelioration parallel with the economical and social development of the population..

**In industrialised countries:**

Electricity is

- a key industry; all wheels stop in case of an interruption
- an indicator for economical development and living standard
- the basic component of the infrastructure
- influenced by the political parties and the governmental administration.

**Tasks of the electric power industry:**

- Supply on a high level of continuity and quality
  - \* to cover the demand of the customers 24 h/d by an adequate capacity of power plants and transmission/distribution lines.
  - \* to fulfil the requirements of quality of the customers paid for.  
Average reliability for nearly all customers; graduation roughly by additional technical measures as redundant line connection or automation devices.
  - \* to guarantee the long term supply security by planning generation plants and networks considering load forecast, available primary energy sources and the local demand development.

**Supply at a favourable price. The price structure should reflect**

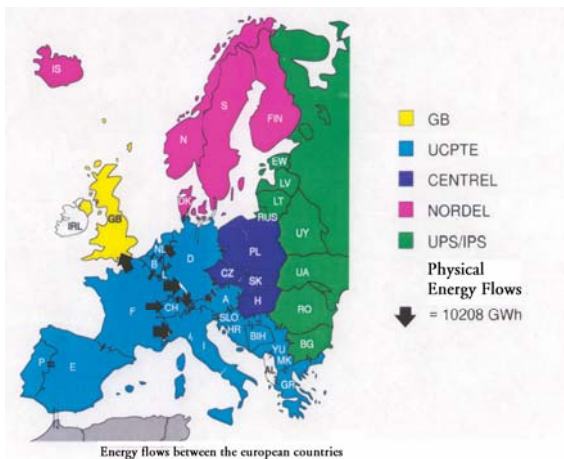
- \* the caused costs, means the customers load curve, the timely claim of the different power plants, the network used for the transportation of electric energy, the operation and maintenance of the equipment,...
- \* the target to reach the high utilisation of power plants to minimise the specific fix production costs (pump storage pp, seasonal and annual storages)
- \* a good utilisation of transmission and distribution networks (consumer control, specific central load shedding measures; automatically peak load limitation)
- \* a social componente.

### 1.3 Structure of the electricity industry in Europe and other industrialised countries

- Privately organised; shares hold by private persons or companies and/or communities, counties, countries, state
- EDF/France and ENEL/Italy are state owned companies; they are on the way to become privatised.
- public control by laws and regulations: tariffs, quality, environmental aspects, licenses and permissions
- European grids are coupled by DC and AC including too countries of the former Soviet Union and their economically associated countries.

#### UCTE (former UCPT):

- mutual help
  - improving reliability and quality
  - use of large-sized generating units even in small countries
  - exchange of energy to improve overall economies
  - utilising seasonable and daytime differences
  - optimisation of reserve capacity
- spot market
  - exchanges on short terms with neighboured countries
  - exchanges on longer terms with neighboured countries



- solidarity based rules for fair play
  - to arrange automatic help during forced outages
  - to keep free reserve in generators and lines
  - general arranged settings for primary regulations
  - general arranged settings for secondary regulations
  - underfrequency load shedding schemes
  - transfer power - frequency control
  - operation with surveillance by control centres

- common investigations for transit bottlenecks.

Fig. 3 - Electricity Generation and Consumption in the EU (1994)

Source: UNIPED (Electricity barometer" 1995)

| Country        | Max. net. capacity (GW) | Tot. net. production (TWh) | Peak demand (GW)* | Tot. consumption (TWh) |
|----------------|-------------------------|----------------------------|-------------------|------------------------|
| Austria        | 16,8                    | 51,7                       | 7,7               | 46,3                   |
| Belgium        | 14,9                    | 68,6                       | 11,1              | 67,9                   |
| Denmark        | 10,3                    | 38,0                       | 6,6               | 30,8                   |
| Finland        | 14,5                    | 62,1                       | 10,4              | 65,4                   |
| France         | 107,2                   | 454,0                      | 70,0              | 358,5                  |
| Germany        | 114,9                   | 488,2                      | 81,8              | 463,7                  |
| Greece         | 8,9                     | 37,4                       | 5,5               | 34,2                   |
| Ireland        | 4,0                     | 15,9                       | 2,7               | 14,0                   |
| Italy          | 64,3                    | 220,4                      | 41,3              | 236,5                  |
| Luxembourg     | 1,2                     | 1,1                        | 0,7               | 4,7                    |
| Netherlands    | 17,8                    | 76,3                       | 13,5              | 83,4                   |
| Portugal       | 8,6                     | 29,4                       | 5,0               | 26,8                   |
| Spain          | 40,5                    | 137,5                      | 24,0              | 132,9                  |
| Sweden         | 35,0                    | 138,1                      | 24,4              | 129,7                  |
| United Kingdom | 65,4                    | 286,9                      | 54,8              | 284,5                  |
| Total EU 15    | 524,5                   | 2105,8                     | -                 | 1979,4                 |

Fig. 5 - ESI Structure in the EVU (1993)

Source: UNIPED/EURELECTRIC (EURPROG 1995)

| Country        | Utilities with Generation | Utilities with Transmission | Utilities with Distribution |
|----------------|---------------------------|-----------------------------|-----------------------------|
| Austria        | 2                         | 4                           | 44                          |
| Belgium        | 2                         | 1                           | 39                          |
| Germany        | 485                       | 9                           | 950                         |
| Denmark        | 10                        | 2                           | 105                         |
| Spain          | 12                        | 1                           | 11                          |
| Finland        | -                         | 2                           | 117                         |
| France         | 1                         | 1                           | 193                         |
| United Kingdom | 7                         | 4                           | 15                          |
| Greece         | 1                         | 1                           | 1                           |
| Ireland        | 1                         | 1                           | 1                           |
| Italy          | 502                       | 6                           | 226                         |
| Luxembourg     | 14                        | 1                           | 14                          |
| Netherlands    | 4                         | 1                           | 33                          |
| Portugal       | 2                         | 1                           | 4                           |
| Sweden         | 93                        | 1                           | 278                         |
| Total EU 15    | 1 168                     | 36                          | 2301                        |