

EFFLOCOM WORKSHOP 13-06-2003



## DISTRIBUTION SYSTEM LOAD ESTIMATION

Maija Lehtonen

VTT Technical Research Centre of Finland



## Load curves

- τ Load curve method provides estimates of the hourly mean power and standard deviation for any customer combination
- τ Data needed: customer class and annual energy for each customer, outdoor temperature
  
- τ 46 load curves in five categories
  - residential (18)
  - agriculture (8)
  - industrial (9)
  - commercial (8)
  - public (3)

## Model structure

- τ The expectation value and standard deviation depend linearly on customer annual energy
- τ  $Y$  = Average power for two-week period, 26 values
- τ  $D$  = Mean power for hour  $t$  and daytype  $d$  (working day, Saturday, Sunday ), 3\*24 values for each two-week period
- τ Standard deviation is modelled as coefficient of variation (Std/E), model structure is similar to expectation value
- τ Simple linear model for temperature dependency (-4 %/°C - 2 %/°C )

$$E[P_t] = \frac{W_a}{8760} * Y_t * D_t$$

$$Std[P_t] = k_t * E[P_t]$$

## Real-time state monitoring of distribution network

- τ Application jointly developed by Tekla Co and VTT Technical Research Centre of Finland
- τ Pilot user Espoon Sähkö
  
- τ Provides tools for better utilisation of network capacity
  - Real time information about network loads
  - Margins of the components' load capacity
  - Customer voltage estimation
  - Forecasts for network loading state
  
- τ Load flow computation uses type user load models or on-line load modelling using network measurements

## Long-term forecasting of regional load (1)

- τ Regional load forecasts for municipalities and towns
- τ Information provided: composite annual power consumption for five load categories in each municipality
  
- τ How to divide the composite energy to load curves?
  
- τ Residential
  - Building information database
  - Number of flats and information about heating system
- τ Agriculture
  - Farm information database (Ministry of Agriculture and Forestry)
  - Number of farms and production lines

## Long-term forecasting of regional load (2)

### τ Industrial

- StatFin-online service: statistical information about Finland
- Number of manufacturing plants according to branch (food industry, textile industry etc.)

### τ Commercial

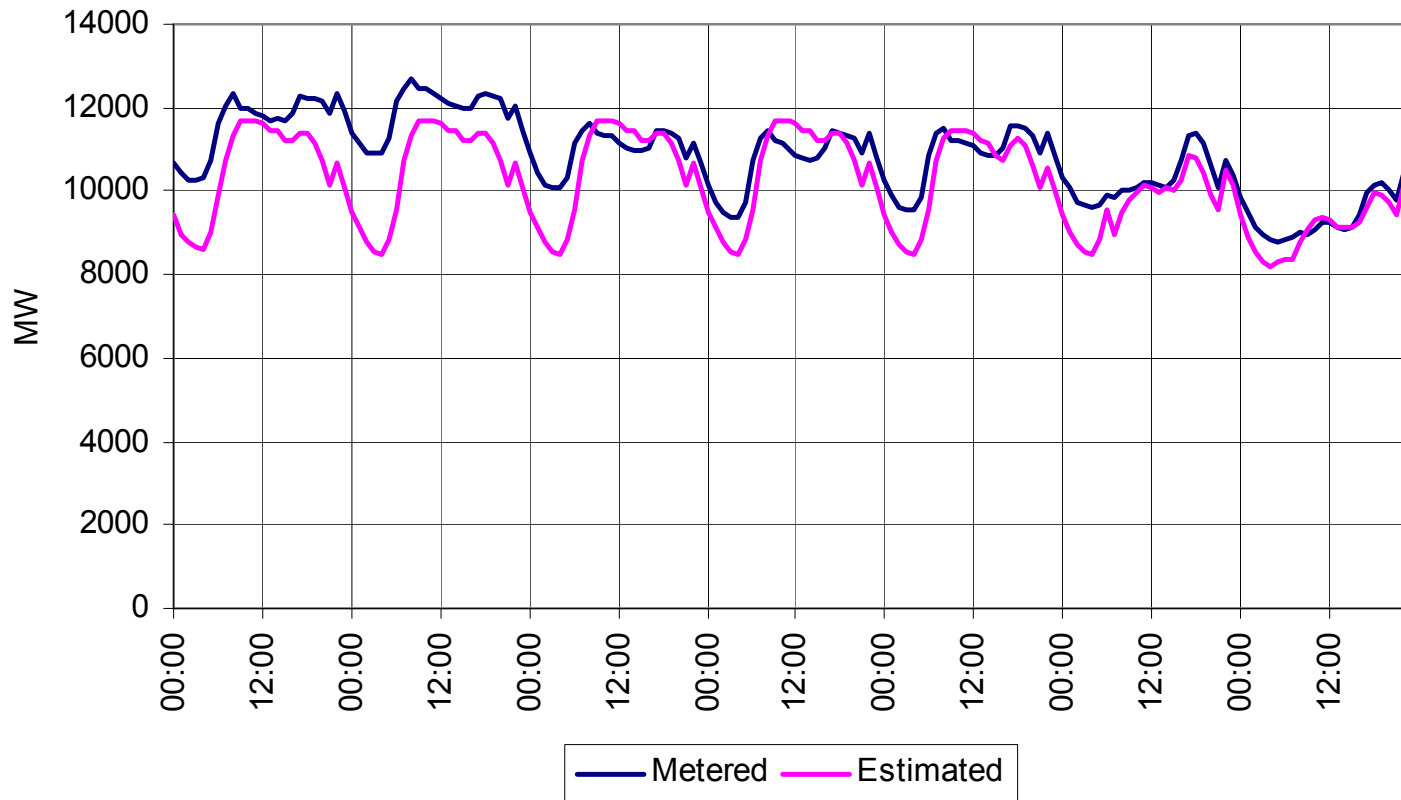
- No specific information about energy use

### τ Public

- The Association of Finnish Local and Regional Authorities
- Average annual energy according to building type (schools, hospitals etc.)
- Power consumption was divided to 4 load curves in same ratio in every municipality



## Metered and estimated system load 24.-30.1.2000



## Results

- τ Hourly metered power in three municipalities
  - Annual energies different
  - When scaled to the same annual energy, average error ~10 %
  
- τ Total system hourly power consumption
  - estimated and metered peak load at same two-week period
  - estimated load shape quite good
  
- τ Load curve method provides rather good long-term load forecasts with minimal input data