



“Energy Pattern Generator”

Understanding the effect of user behaviour on energy systems

Joost Paauw (ECN)

Myriam Aries (TNO)

Olivia Guerra Santin (OTB)

Bart Roossien (ECN)

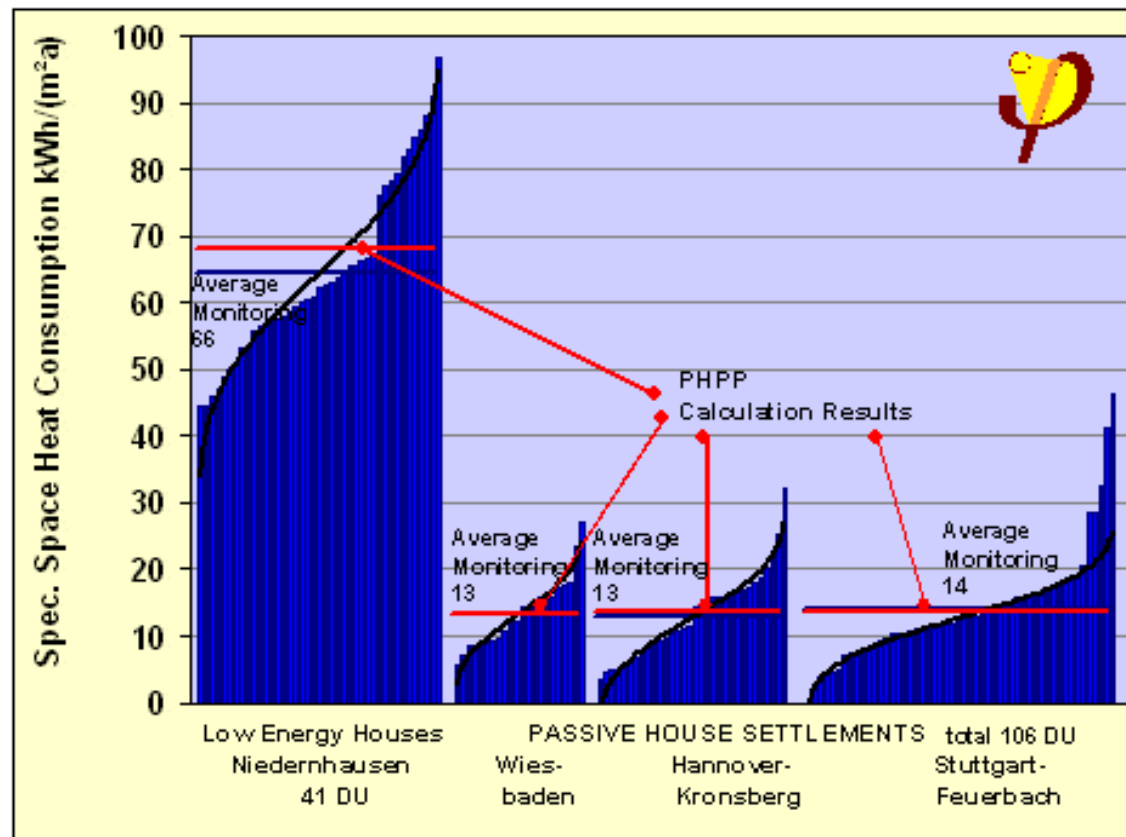


About Building Future

- ✚ Ambition: Energy neutral built environment around 2050
- ✚ Implications for residential and non-residential sector
 - New buildings
 - Existing buildings
- ✚ Both building and user related energy consumption



User Behaviour and Energy Consumption



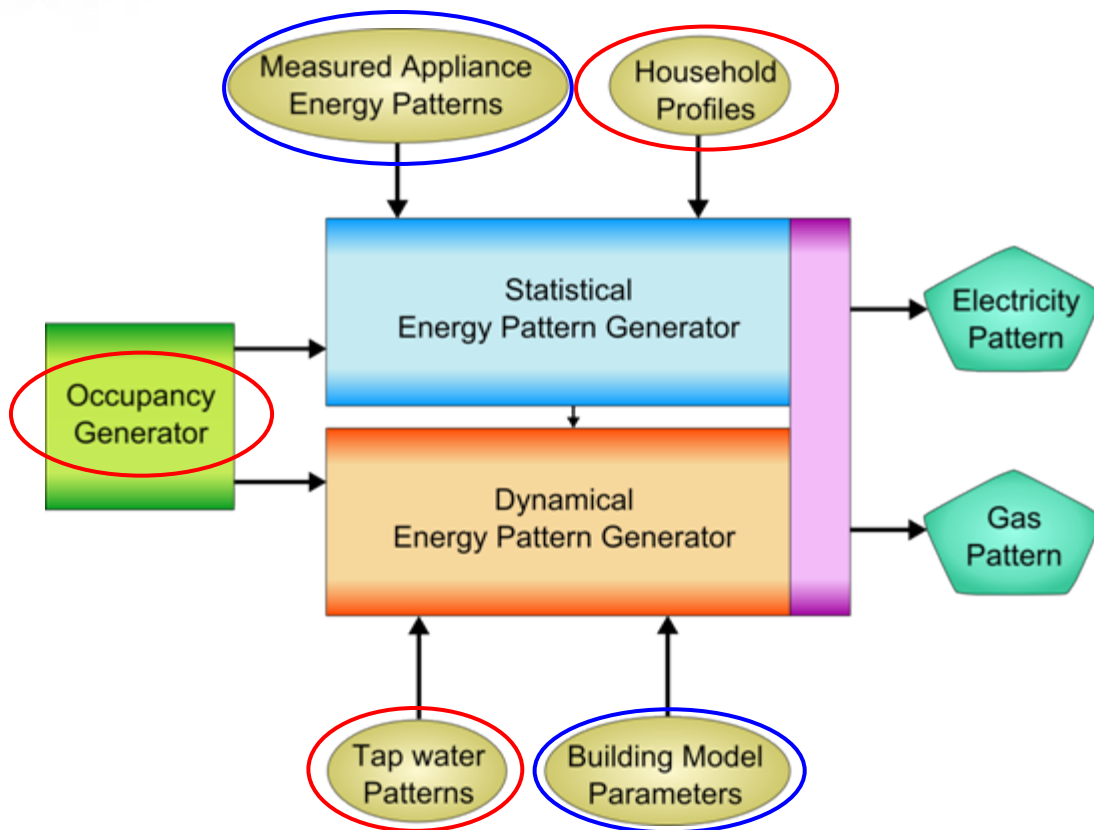


Challenge

- ✚ Understanding the effect of user behaviour on energy consumption
- ✚ In order to develop robust 'user proof' Building Concepts
- ✚ Minimize total energy use



Energy Pattern Generator





Statistical Pattern Generator

- ✚ For user related energy consumption
- ✚ Models each household appliance individually
- ✚ Based on user profile
- ✚ Statistics used for:
 - Frequency of use
 - When appliance is switched on
 - Length of use



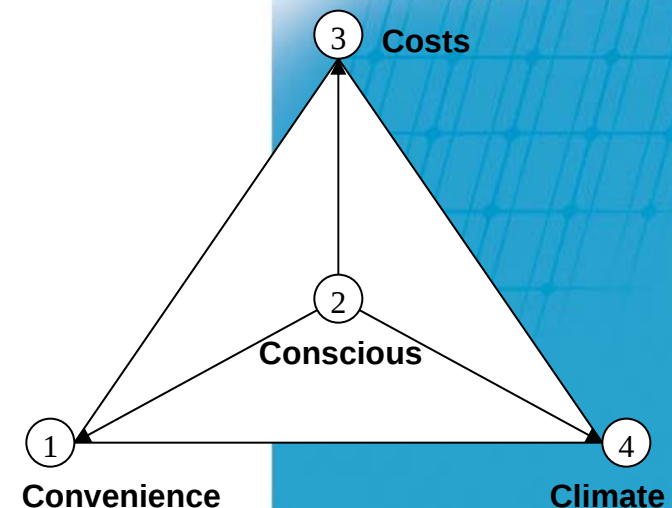
Dynamical Pattern Generator

- + EPG also for building related energy consumption
- + For 5 typical Dutch types of residences
- + Energy equipment modeled for:
 - Space heating
 - Space cooling
 - Domestic hot water
 - Electricity Generation
- + Internal heat gain from statistical pattern generator
- + Temperature set points based on user profile



Drivers for energy saving behaviour

- ✚ 80 households interviewed
- ✚ Three drivers for energy saving behaviour:
 - Cost reduction
 - Environmental concern
 - Personal comfort
- ✚ Resulting in 4 specific household profiles





Household profiles and energy use

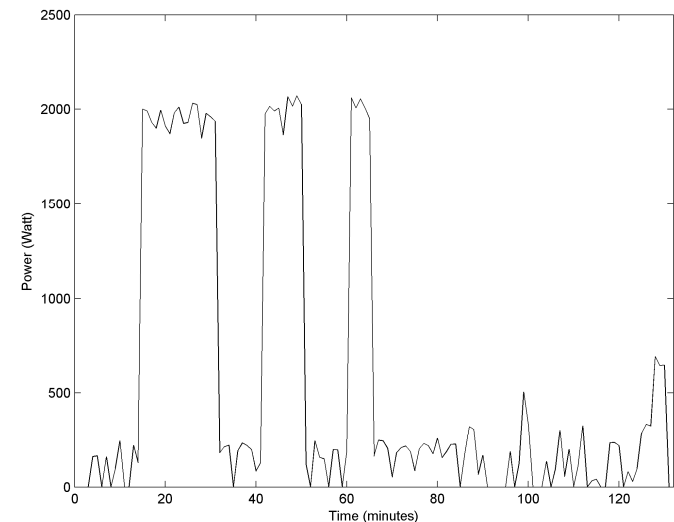
- ✚ Total energy use: both building and user related

	Energy use	Energy use per profile			
	Average	Convenience	Conscious	Costs	Climate
Gas (m ³)	1736	3544	1477	1027	1308
Electricity (kWh)	3345	6695	2830	1975	2463
Total (GJ)	73,1	146,3	61,8	43,1	53,8
% of average	100%	200%	85%	59%	74%



Measured Appliance Electricity Patterns

- 41 measured appliances account for 90% of household electricity consumption
- Resulting in 75 electricity demand patterns
- Database of profiles to be completed

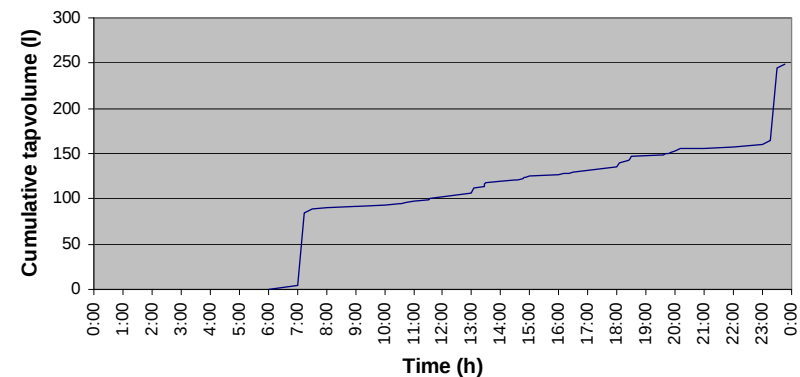


E.g. Washing Machine, 60°C



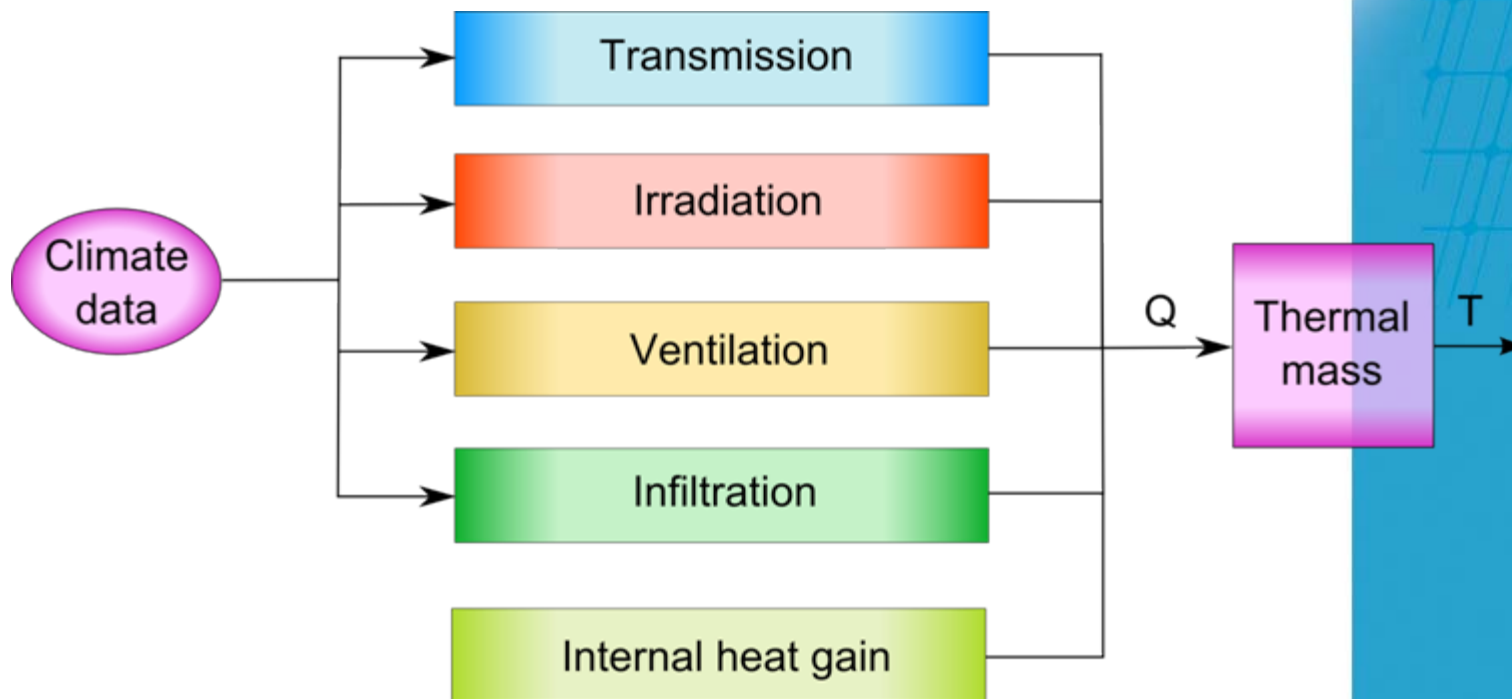
Tap Water Pattern

- Same pattern for all user profiles (CW3)
- According to NEN 5128
- More realistic patterns desired





Building Model



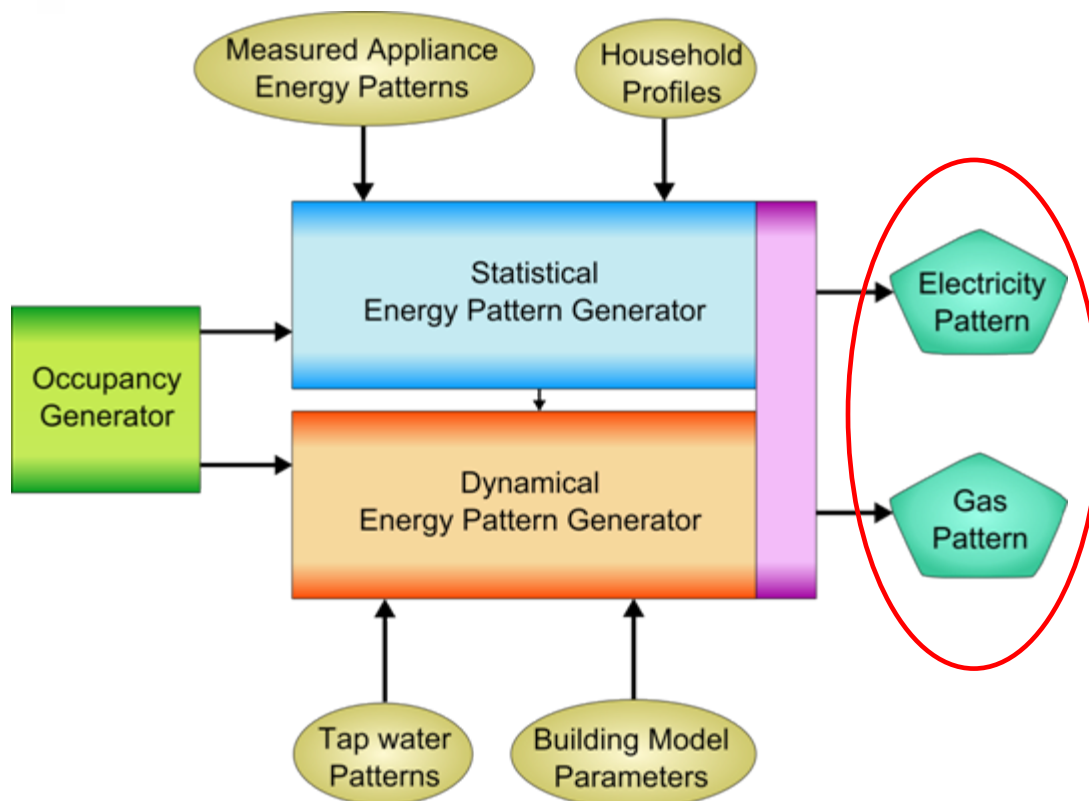


Occupancy Generator

- ✚ Needed for statistical and dynamical pattern generator
- ✚ Distinction between active and sleeping occupancy
- ✚ Based on Time of Use Survey and first order Markov-Chain technique

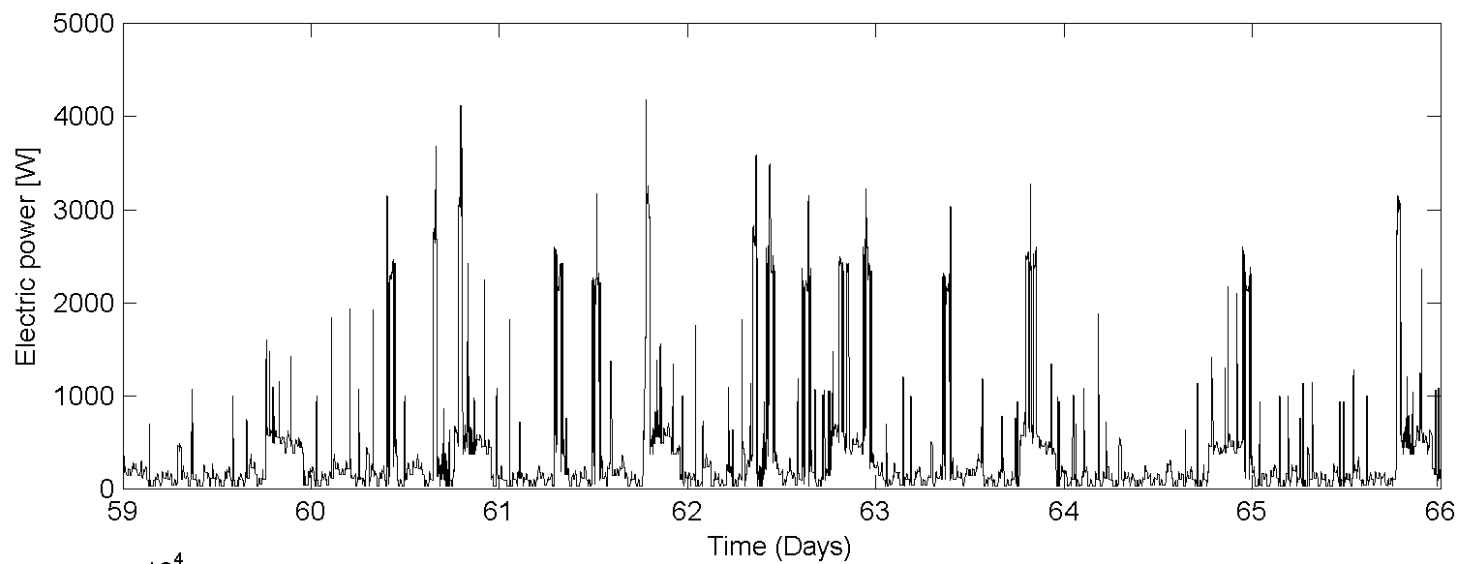


Energy Pattern Generator





Output: Electricity Pattern





Applications

- ✚ Develop robust 'user proof' building concepts
- ✚ Optimize indoor comfort (reduce overheating)
- ✚ Power and heat management: matching supply and demand
- ✚ Optimize contribution renewable electricity sources, reducing fossil fuel consumption
- ✚ Design of (intelligent) electricity grids



Conclusions

- ✚ EPG gives insight in the impact of user behaviour on energy consumption
- ✚ EPG is a tool for developing robust 'user proof' building concepts
- ✚ More applications of EPG



Outlook



EPG as validated software tool

- Validation of user profiles → questionnaire under development
- Validation of household electricity profiles
- To use in combination with building simulation tools



Improvements:

- More realistic tap water pattern
- More measured energy demand profiles of household appliances
- Energy demand profiles of new household appliances



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Thank you! Questions?

Joost Paauw

Paauw@ecn.nl