Annex 46
Modelling of Systems

Domestic Hot Water in Multifamily Buildings

Modelling of DHW Systems in Multi Family Buildings

Domestic Hot Water Heat Pumps are traditionally seen as a stand alone product, but the truth is more complex.

The focus of the Annex has broadened as water heaters are one of the most complex product categories due to a large variety of product types, technologies, and fuels used for heating water. Not only ranging from individual to collective systems, but also introducing combined systems, hybrid systems and fresh water systems, with different terminology in different regions of the world.

As new buildings become more energy efficient, CO2 emissions from hot water start to exceed those from space heating. As we move towards more energy efficient houses, a similar level of detail should be applied to hot water system design as to the building envelope and ventilation systems.

The way in which most current building processes with the energy models consider hot water systems is too simplistic for newly build and deep renovation dwellings.

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Modelling of DHW Systems in Multi Family Buildings

In modelling systems it is of importance to be able to compare the different configurations, starting with the awareness that there is a number of different target groups:

- Macro-level of policy decisions
- Meso-level, with the installer, consultant, designer of hot water heating systems
- Micro-level of private house owners, i.e. the end user.

At macro level the overall chain efficiency is of importance, while at micro level it is a simple calculation of costs
Governmental R&D, information and support programs, as well as educational programs for installers support a 'better choice' for the end user. Legislation is another instrument for the government which is marketed through informative labelling of DHW generators and even ban on sales of specific less efficient generators (high efficiency gas boilers are banned in specific applications in Denmark).
Thus it is of great importance to have the right instruments of choice.

A large number of public calculation models on the market focus on the Meso-level, often in relation to governmental procedures.

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As homes become better insulated, energy consumption for spatial heating is decreasing. It is therefore more important to have a clear picture of energy consumption: hot water heating. A basis for a good choice is an objective calculation model in which different concepts of systems can be juxtaposed. In the energy market many calculation models , often on commercial basis are available.

Calculation models can be defined in (at least) two categories:

- calculation for the energy performance of a building in relation to legislative procedures, like the SAP and RdSAP models in the UK with which the EPC for the building is calculated
- calculation for designing the optimal system, used by consultants, building constructors, architects, installers, etc

These models have a number of characteristics:

- Impossible to compare different system concepts
- Innovative concepts are often not in the model
- Domestic hot water is often a secondary part of the energy system, based upon flat rate values
- Economical

More specifically for the Annex, this also means that a model must be set up that can be used for the different countries participating in the Annex.

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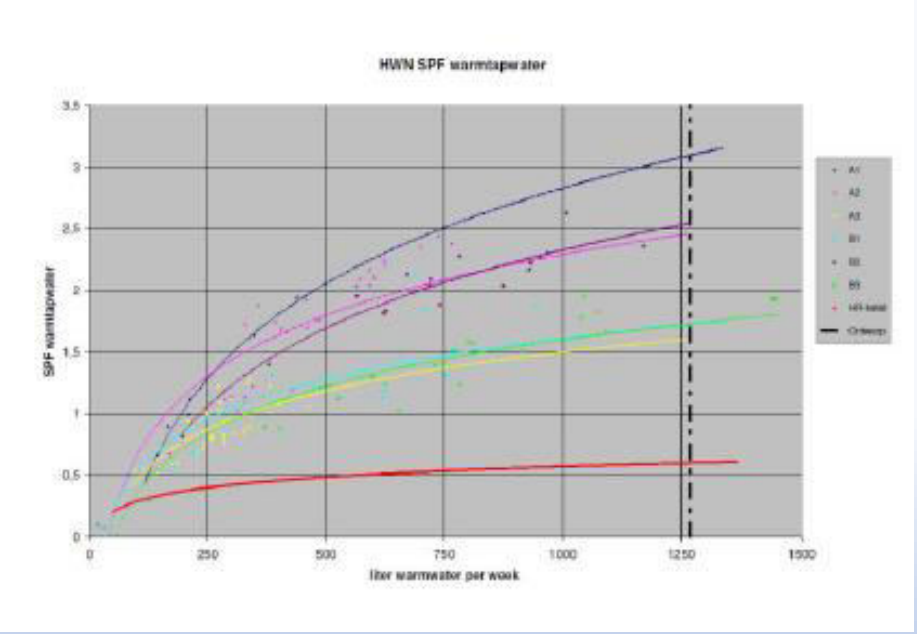
Modelling of DHW Systems in Multi Family Buildings

Models for calculating the Energy Performance of Buildings are discussed from:

- Netherlands,
- France
- United Kingdom
- United States.

A number of these models, although commercial, is part of the legislative processes in these countries, used for getting building permits. These models when accepted are certified by governmental agencies.

Often the calcualtion of the usage of DHW is based upon the floor area of the house, which is in fact not realistic related to the actual practice.



Hot water use in practice much lower than in models!

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Modelling of DHW Systems in Multi Family Buildings

Netherlands: Various certified calculation programs are available that can be used for an EPC calculation according to this standard. Suppliers of EPG software are:

- Bink
- DGMR
- De Twee Snoeken
- Uniec
- Vabi

A number of more advanced models for hot water usage are also available being no part of the legaslative procedures, such as the SIMDEUM® model and models by manufacturers.

Editor	Software	Version	Transmission of DPE to Ademe	pdf
ATLANTE DEVELOPMENT	ATLANTE XPERT	2.0	yes	
Atlibitum	Analysimmo DPE 3CL-2012	2.1.1.2	yes	
BCTI	simetric			
BBS Development	Eco-Diag	1.0	yes	
C2Partner				
Cardonnel	Bati-cube			
Diagamter	W-TAB	21	yes	
Erecie				
FAUCONNET Engineering SAS	Fisa-ECD	Fisa-DPE 2013	yes	
HPC-SA	ArchiWIZARD			
ITGA	Imm'PACT DPE module	7.0.4	yes	
Impartial Software	Diagnosis Suite	7		
Valley of the Kings	ECD-Building	0.3	yes	
LICIEL Environment	LICIEL Diagnostics	4	yes	
Software Perrenoud	DPEWin	4	yes	
OBBC Development	WINDPE		yes	
Office Expert	Expertec PRO	2.0	yes	
PAP	QualiDPE			
Qualiconsult			yes	
Tekimmo				
Deveko	Domofit DPE	1.1	yes	
Deveko	Domofit DPE	2.0	yes	

Certified models in France

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For the calculation of a hot water system important factors are:

- Nomenclature and definitions
- Definition of performance, i.e. SPF1 or SPF4, or SCOP or….. (a clear definition of SPF is missing)
- Climate conditions, especially for air-source DHW HP in cold regions
- Stratification,
- Draw Offs and Quantity of hot water usage
- Control strategy
- Heat Transfer system,
- Heat distribution system

As already reported the in-tank stratification and the control strategy have a significant effect on the overall COP of a DHW Heat Pump.

But the overall chain efficiency and the in-house distribution losses have a great effect on the overall system efficiency.

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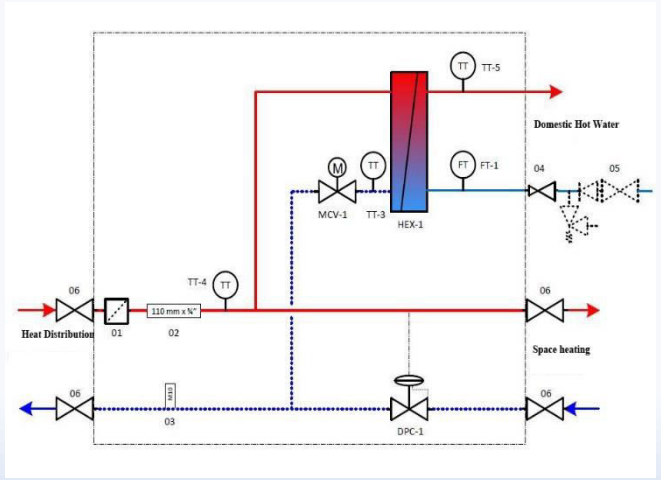
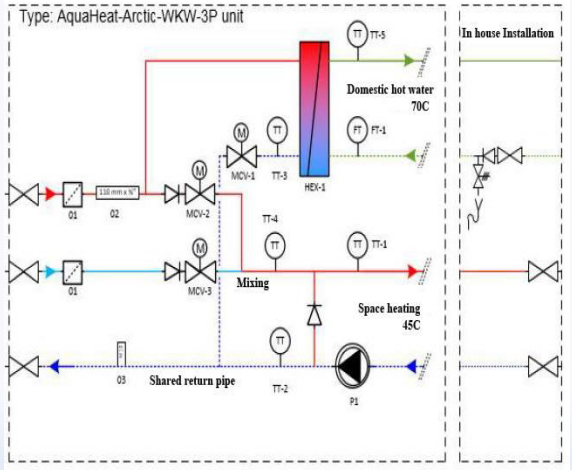
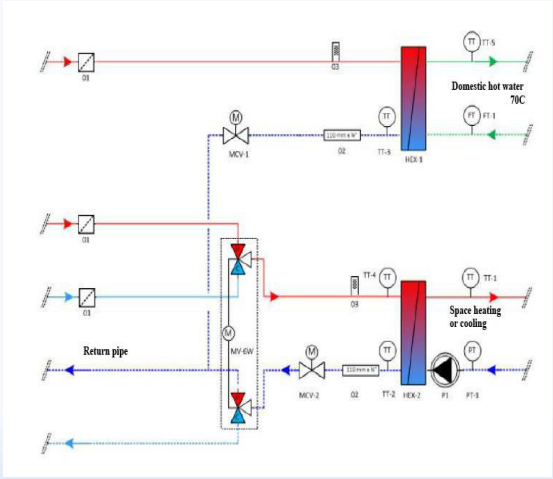
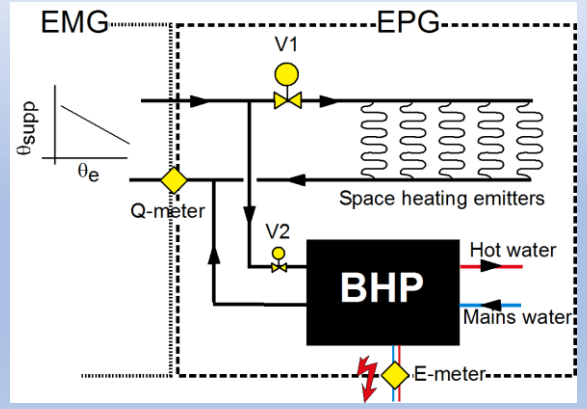
Modelling of DHW Systems in Multi Family Buildings









Some configurations

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There is a clear split between collective systems and semi-collective systems where space heating is split from DHW. But there is also a mix of both based upon optimizing the system (i.e. 3 ½ and 5 ½ pipe systems).

Conditions:

- Collective DHW systems have to deliver high temperatures because of Legionella, but that is 'only' for systems where the circulated water is used as DHW, like in hospitals, hotels, senior nursing homes, sport centers, etc. There the thermal disinfection is of great importance.
- In other circulation systems where the hot water is used as 'energy transport'to heat the DHW in the apartment solutions can be found such as:
    - Volume Limitation Concept for DHW in apartment
    - Booster Heat Pump in collective space heating
    - Individual DHW Heat Pumps, examples as presented by Heinonen

The low efficiency of collective DHW systems is well known by field practitioners. For many new residential building hot water delivery times and water waste have been getting steadily worse with newer buildings. The sources of inefficiency can be found in every one of the diverse phases entailed by DHW systems: from the design of the piping structure and the sizing of equipment to the selection of the applied control strategies.

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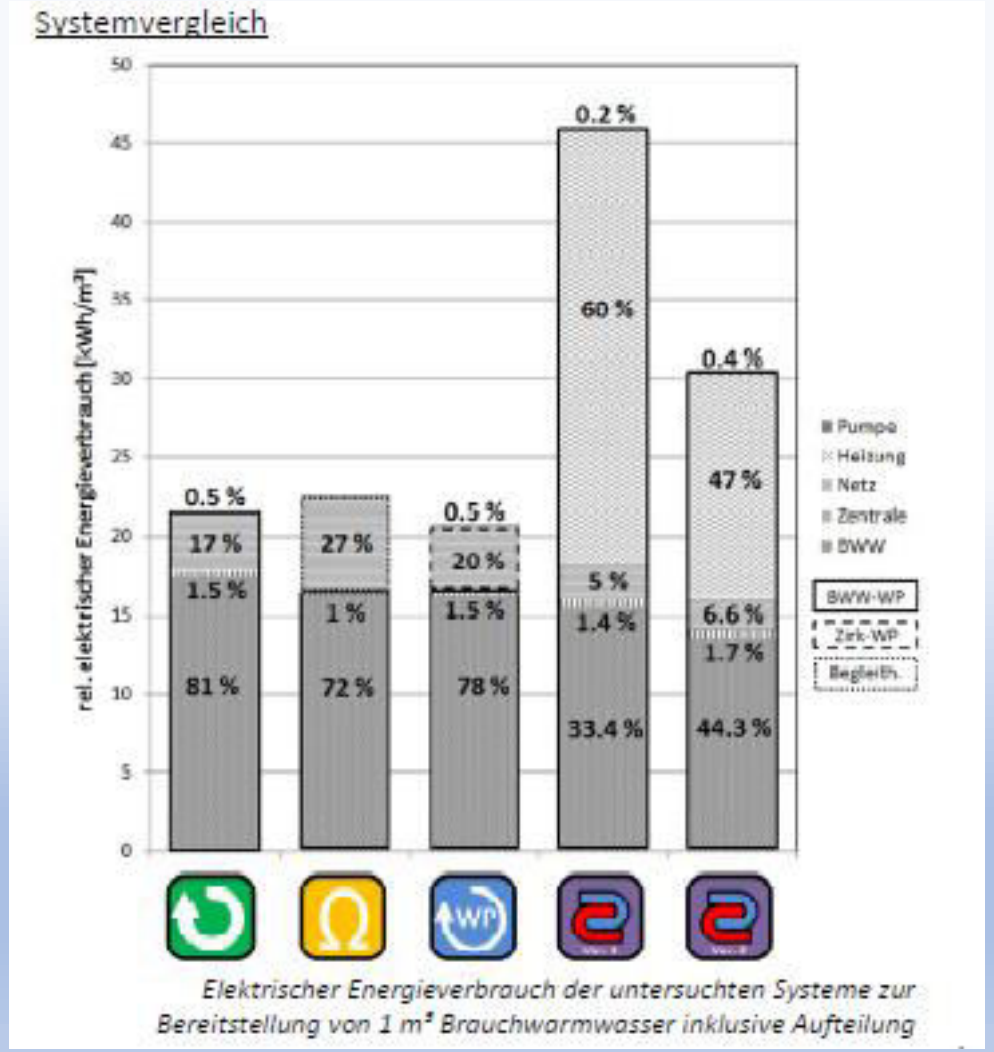
Modelling of DHW Systems in Multi Family Buildings

There is a great number of studies available comparing different systems:

- [01] – Bernard Vetsch, Warmwasserbereitstellung mittels Wärmepumpen in Mehrfamilienhäusern, NTB Interstaatliche Hochschule für Technik Buchs, BFE-Vertrags- und Projektnummer: SI/500574-01
- [07] - Janne Heinonen, Heat Pump Application recovering Exhaust Air Energy in large Apartment Buildings, Enermix Ltd, 11th IEA Heat Pump Conference Montréal 2014
- [10] - Jukka Yrjölä and Eetu Laaksonen, Domestic Hot Water Production with Ground Source Heat Pump in Apartment Buildings, Helsinki Metropolia University of Applied Sciences, Energies 2015, 8(8), 8447-8466
- [13] - Jan Sedlar, Heat pump for water preparation in block of flats, Czech Technical University in Prague, 12th IEA Heat Pump Conference Rotterdam 2017



Elektrischer Energieverbrauch der untersuchten Systeme zur Bereitstellung von 1 m³ Brauchwarmwasser inklusive Aufteilung

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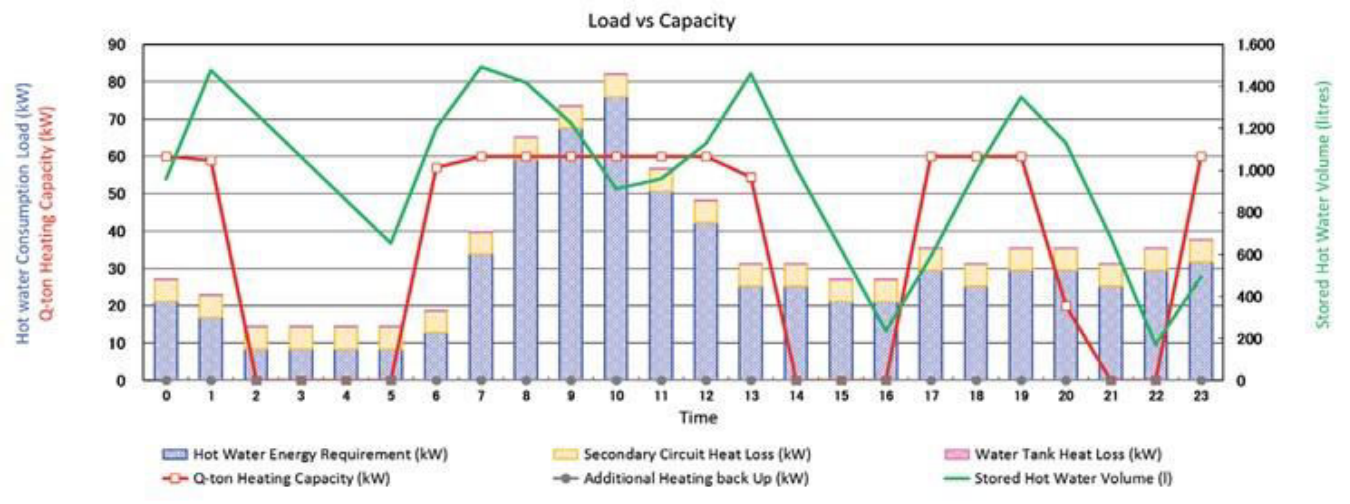
Modelling of DHW Systems in Multi Family Buildings

Usage of hot water in a block of student apartments



There is a lot of litterature on this topic where AIT has studied the effect of load profiles (Félix Iglesias and Peter Palensky, Profile-Based Control for Central Domestic Hot Water Distribution, Austrian Institute of Technology (AIT), IEEE Transaction on Industrial Informatics, Vol. 10, No. 1, February 2014).

A study by the City of Vienna clearly concludes that individual systems for DHW in apartment buildings outperform all collective alternatives and should be preferred where ever possible.

However in general it is clear that there are no good models for comparison of alternative DHW systems publically available.

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Modelling of DHW Systems in Multi Family Buildings

Good models are needed for calculating and assessing systems for heating domestic water in buildings, as hot water becomes the dominant energy demand in future domestic applications. This is needed for:

- Policy to make the right choices at macro level, based upon chain efficiency
- Designers, installers etc. at meso level, needed to design and/or to get a building permit

The Task 2 report has analyzed this and concludes a number of missing aspects to be worked on:

- Many energy models for buildings use generic and old figures for the calculation, in which often flat-rate values are used, such as floor areas for the calculation of the use of tap water.
- Calculation for chain efficiency is often not used to compare alternative systems, or if done often have the same deviations as the standard calculation models
- Innovative concepts are often not in the models (fresh water, booster, solar combi, etc.)
- A comparative calculation model for multi family buildings is missing, taking into account the strategic control options

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