Calculation of the integrated energy performance of buildings

EN 15316: Heating systems in buildings
Method for calculation of system energy requirements and system efficiencies
Part 3-1/2/3: Domestic hot water systems
(DHW needs, distribution systems, generation systems)

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Contract: EIE/07/069/SI2.466698 Duration: October 2007 – March 2010 Version: July 7, 2009

The EU CENSE project
(Oct. 2007 - March 2010)

Aim of the project:

To accelerate adoption and improved effectiveness of the EPBD related CEN- standards in the EU Member States

These standards were successively published in the years 2007-2008 and are being implemented or planned to be implemented in many EU Member States. However, the full implementation is not a trivial task

Main project activities:

A. To widely communicate role, status and content of these standards; to provide guidance on the implementation

B. To collect comments and good practice examples from Member States aiming to remove obstacles

C. To prepare recommendations to CEN for a “second generation” of standards on the integrated energy performance of buildings

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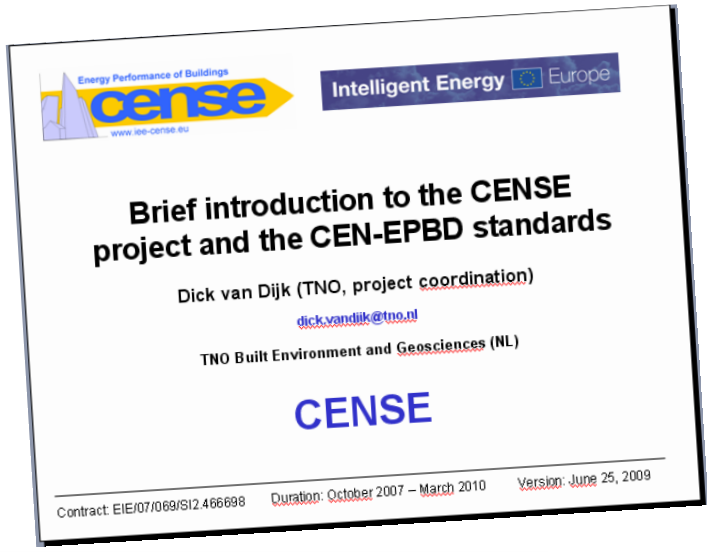
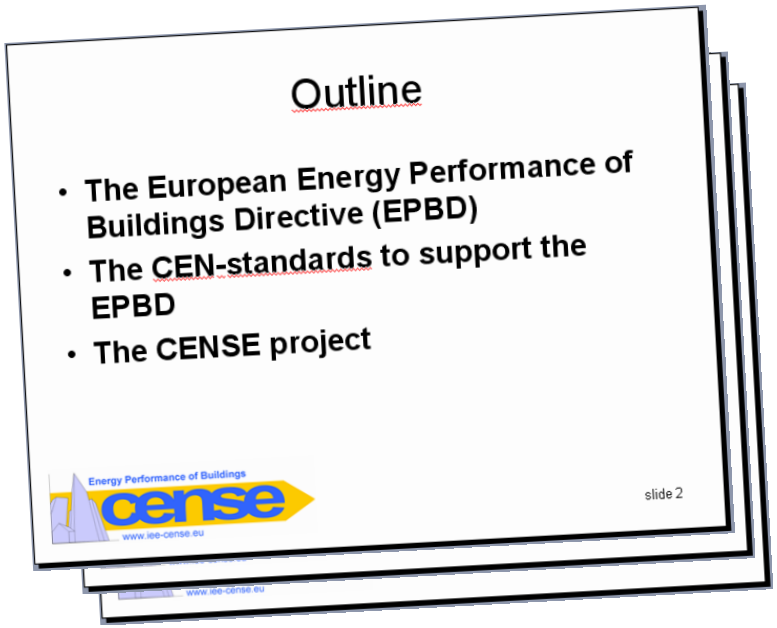
Brief introduction

A brief introduction to the CENSE project and the CEN-EPBD standards is provided in a separate presentation:





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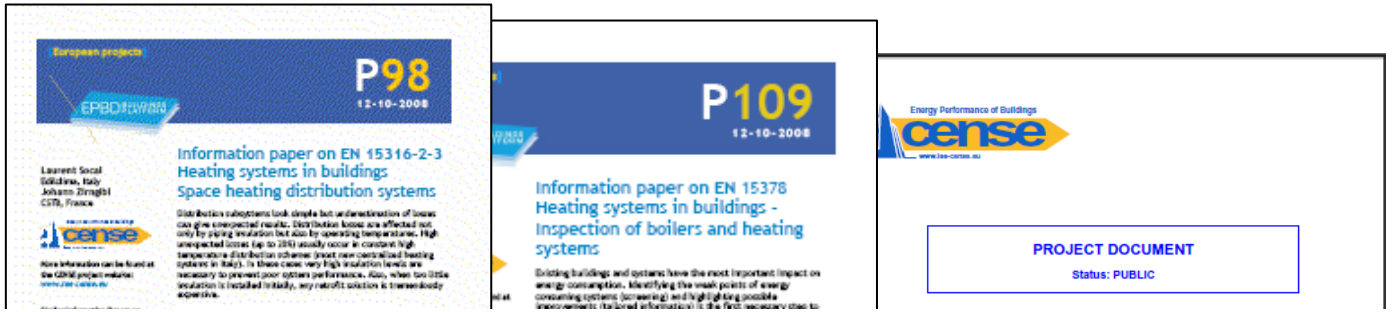

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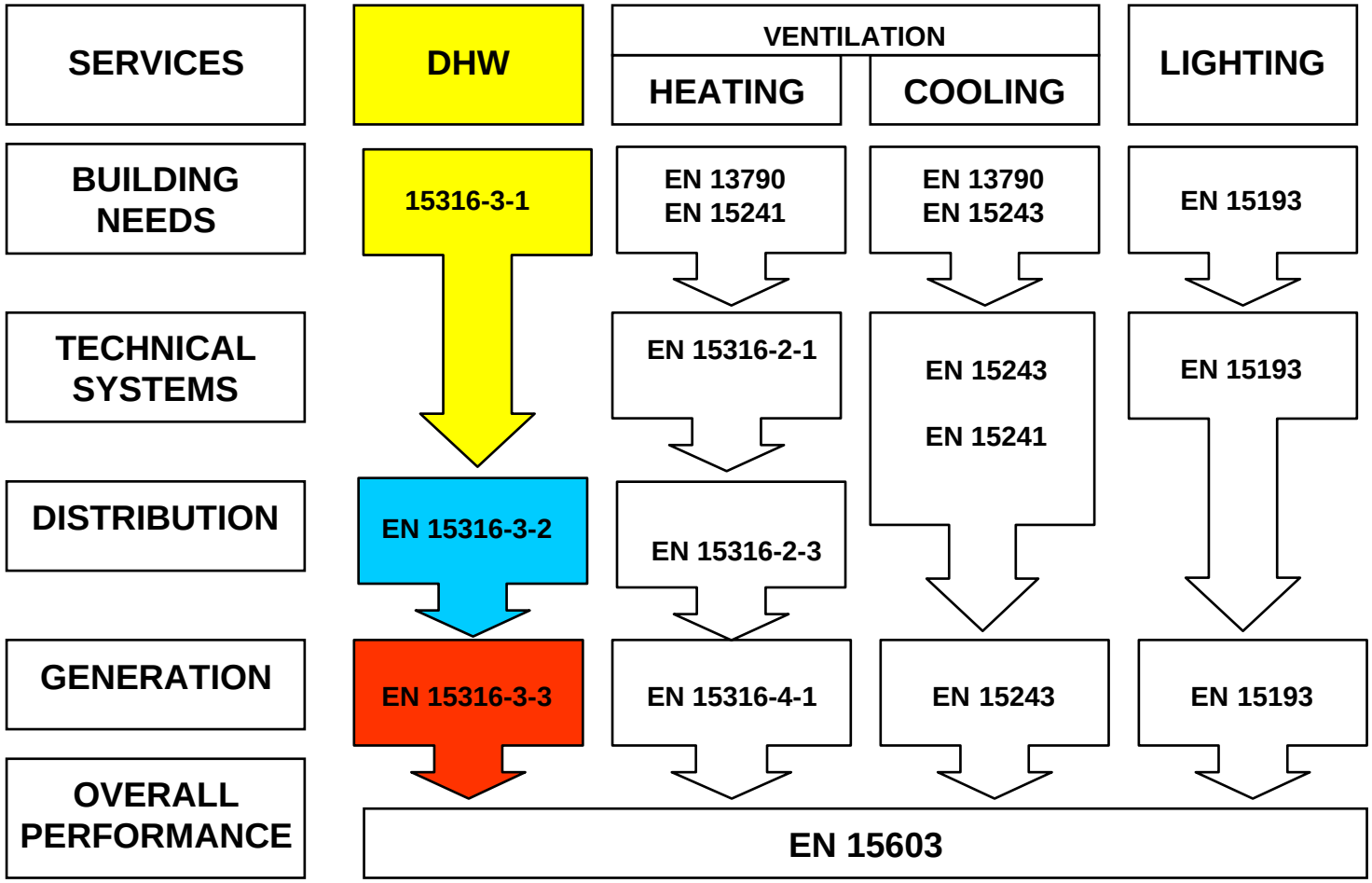
FITTING INTO THE PUZZLE



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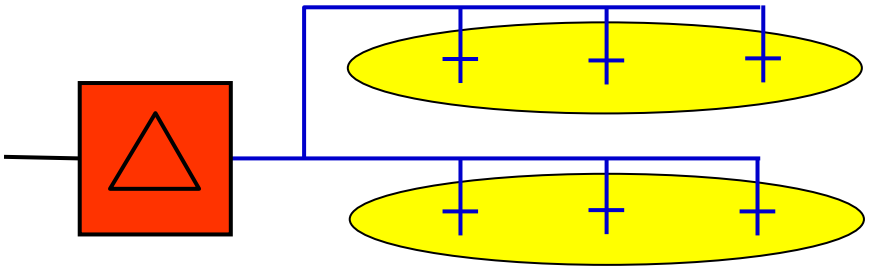
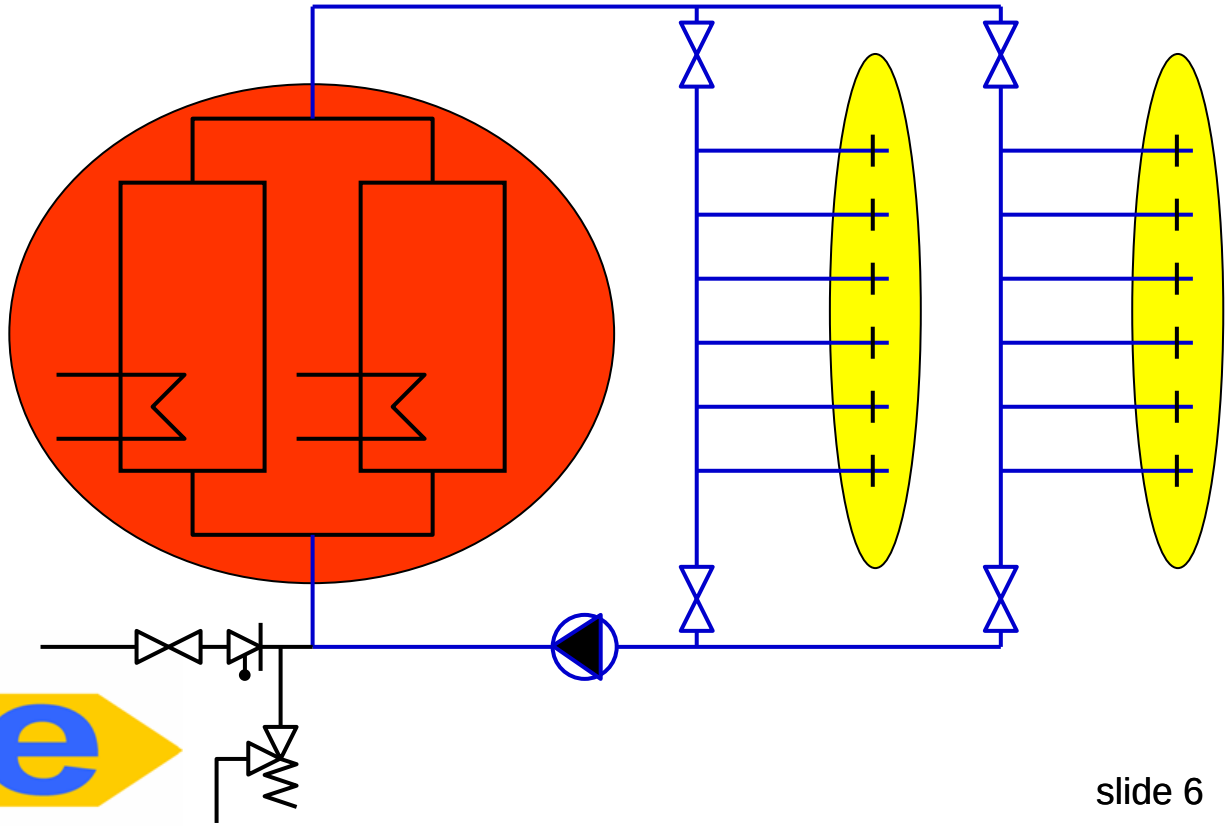
Hot water needs
15316-3-1

Distribution
15316-3-2

Generation
15316-3-3

Primary Energy
15603





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Energy needs for DHW – 3.1

- 4 methods:
  - level of detail for DHW demand
  - national annex: which method for which building use
  - calculations of daily DHW requirement

Inputs, generally:
. building type or function
. floor area

Output:
. Hot water energy demand

- In addition to the needs, a tapping pattern may be needed; especially for dwellings and individual appliances

Energy needs for DHW – 3.1

- Methods based on:
  - tapping patterns
    - longer periods needs: combination of dayly patterns
  - required volume
    - specified delivery temperature
    - cold (inlet) water temperature
    - floor area or appropriate units (beds, …)
  - floor area
  - Tabulated values
    - type of building
    - type of activity
    - use of a zone
    - standards or class of activity (ex: hotels: stars)

Example for
No. 2 tapping pattern

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.15	1,400	Shower		30
3	07.30	0,105	Small		15
4	08.01	0,105	Small		15
5	08.15	0,105	Small		15
6	08.30	0,105	Small		15
7	08.45	0,105	Small		15
8	09.00	0,105	Small		15
9	09.30	0,105	Small		15
10	10.30	0,105	Floor cleaning	30	0
11	11.30	0,105	Small		15
12	11.45	0,105	Small		15
13	12.45	0,315	Dish washing	45	0
14	14.30	0,105	Small		15
15	15.30	0,105	Small		15
16	16.30	0,105	Small		15
17	18.00	0,105	Small		15
18	18.15	0,105	Household cleaning		30
19	18.30	0,105	Household cleaning		30
20	19.00	0,105	Small		15
21	20.30	0,735	Dish washing	45	0
22	21.15	0,105	Small		15
23	21.30	1,400	Shower		30
Total		5,845			

Equivalent hot water litres at 60 °C | 100,2 |

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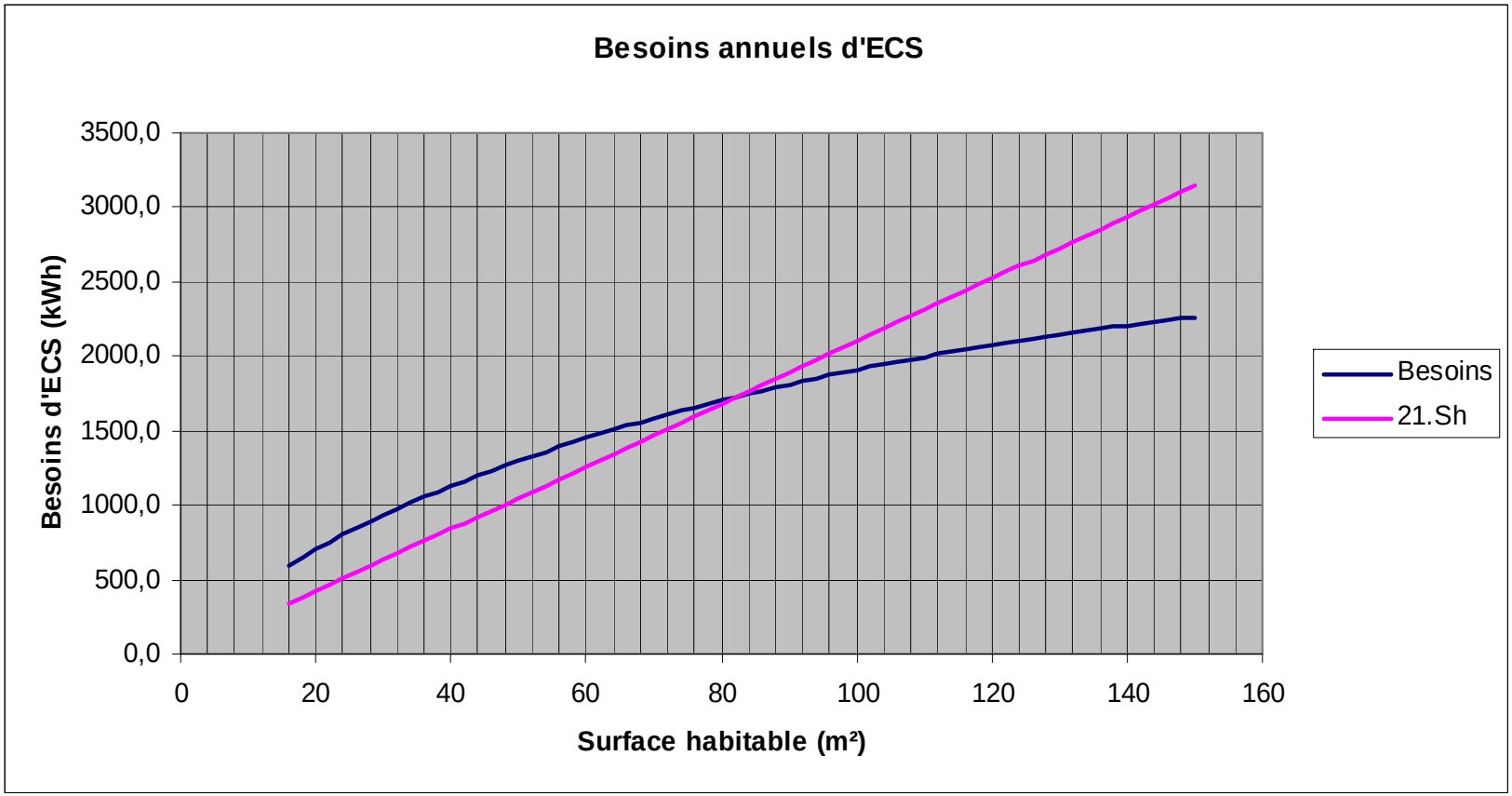
Dutch example:

Building function	Specific energy need MJ / (m^2.year)
dwelling	68
bar	15
restaurant	10
prison	15
hospital	55
health service	10
office	5
hotel	45
school	5
sports	45
shops	5

French example: single family, individual dwelling

Yearly DHW needs expressed in kWh



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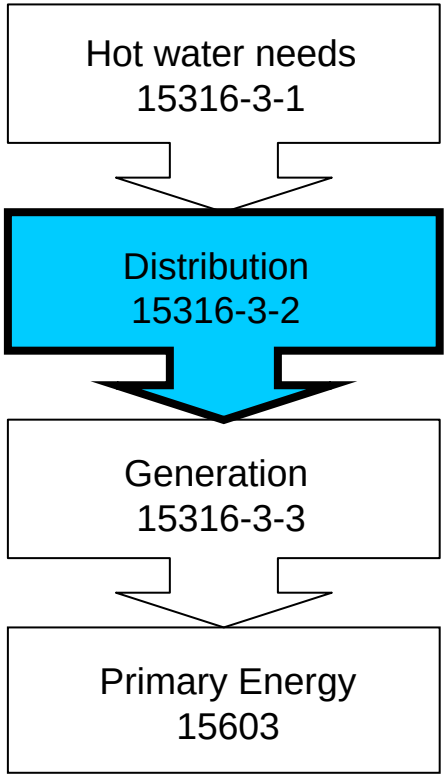
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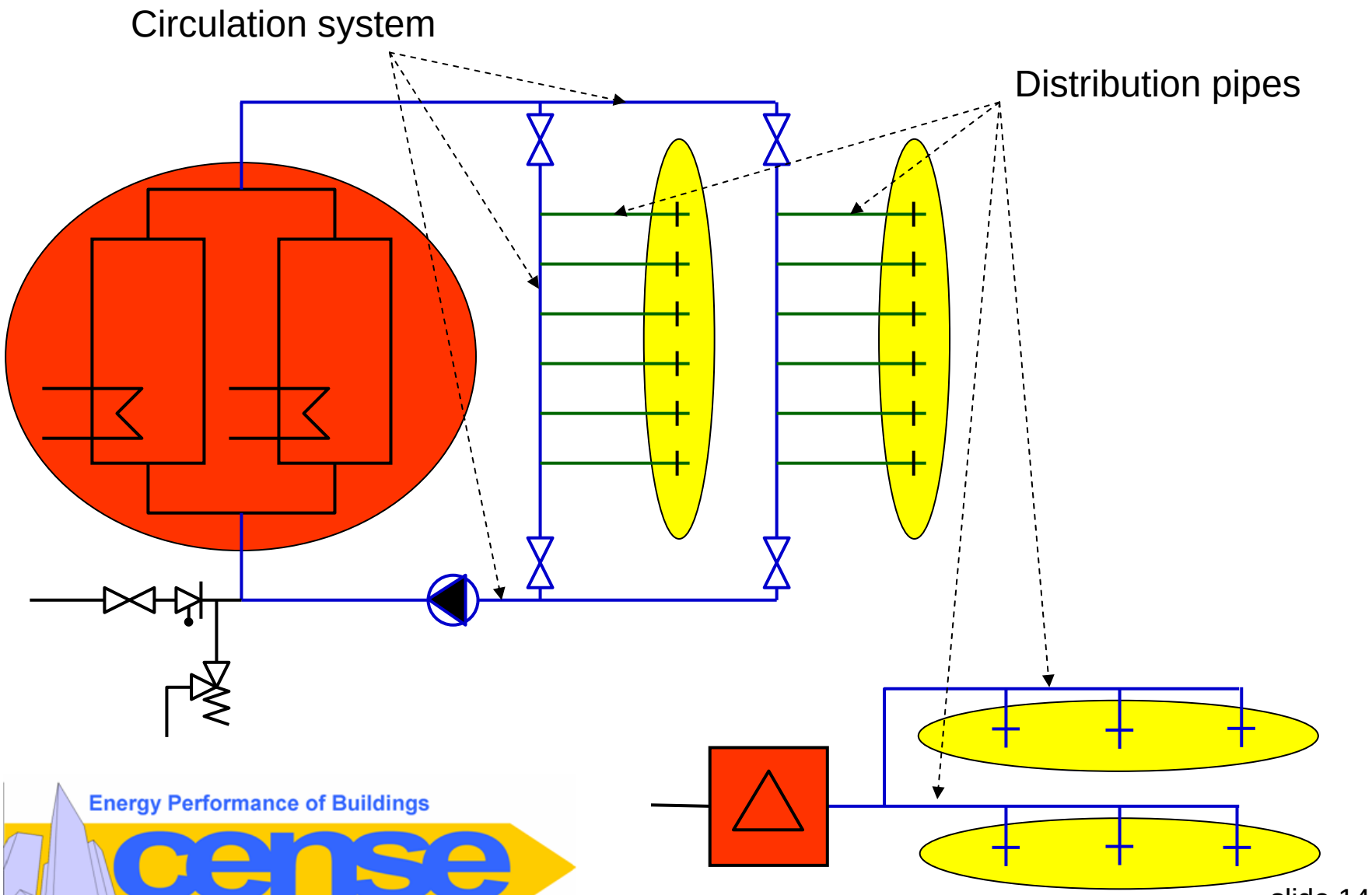
Principle



Principle

- Circulation system
  - Constant loss with circulation on
  - Diminished loss with circulation off
- Distribution pipes
  - Loss dominated by heating up and cooling down at any tapping
  - Pipes in general short when a circulation system is applied
  - Pipes may be very long (> 10m) in dwellings without circulation system

Distribution pipes – method 1

- Heat losses related to floor area
  - Simplified method
  - Requires no information on actual distribution system
  - Usually restricted to domestic buildings without circulation system
  - National annex required – including maximum distribution pipe length

Distribution pipes – method 2

- Heat losses related to pipe lengths – simple method
  - Heat loss due to cooling down of pipe and water after any tapping
  - Required inputs: pipe length, inner and outer diameter, pipe material mass and heat capacity, nominal hot water temperature and average ambient temperature, number of tappings per day
  - National annex required

Distribution pipes – method 3

- Heat losses related to pipe lengths – tabulated data method
  - National annex required with tabulated loss factors, including effect of cooling down of pipe and water after any tapping
  - Required inputs: pipe length to kitchen and bathroom, optional inner diameter

Distribution pipes – method 3

- Example distribution efficiency

L_{xxx} [m]	<2	2-4	4-6	6-8	8-10	10-12	12-14	>14
Kitchen				$\eta_{tube;kitchen}$				
D_{int} < 8mm over 2/3 of the pipe length	1.00	0.86	0.75	0.67	0.60	0.55	0.50	0.46
D_{int} < 10mm over 2/3 of the pipe length	1.00	0.79	0.65	0.55	0.48	0.43	0.38	0.35
Other tubes	1.00	0.69	0.53	0.43	0.36	0.31	0.27	0.24
Bathroom				$\eta_{tube;bath}$				
All tube types	1.00	0.95	0.90	0.86	0.82	0.78	0.75	0.72

Distribution pipes – method 4

- Heat losses related to tapping pattern and pipe lengths
  - National annex required with tabulated equivalent energy loss factor
  - Required inputs: DHW need, pipe length, position of pipes (inside/outside building)

Distribution pipes – method 5

- Heat losses based on detailed calculation
  - Requires a national annex with an “average temperature” in a pipe section
  - Required inputs: pipe length, pipe thermal transmission coefficient, average hot water temperature and average ambient temperature, daily utilization period at these temperatures

Circulation pipes – method 1

- Heat losses related to pipe lengths
  - National annex with specific pipe loss
  - Circulation pipe length

Example: Insulation of existing circulation systems may be poor

Circulation pipes – method 2

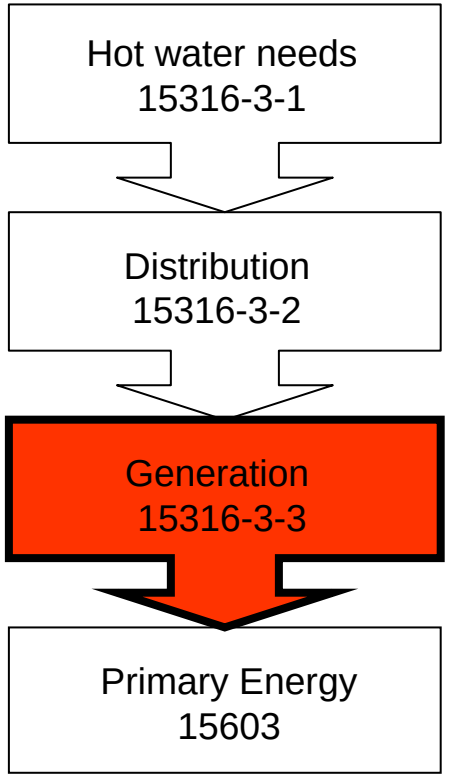
- Heat losses based on detailed calculation
  - Required inputs: pipe length, pipe thermal transmission coefficient, average hot water temperature and average ambient temperature, daily utilization period at these temperatures

Circulation pipes – circulation off

- Method in addition to both previous methods for systems with circulation off
  - Required inputs:
    - circulation pipe volume,
    - average hot water temperature,
    - average ambient temperature

Auxiliary energy

- Pump power consumption for circulation system
  - Required inputs:
    - pump power,
    - off-time per day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Principle

- Complete **tested** appliances, for single family dwellings
  And (large) direct heated storage water heaters
- Component based appliances
  storage vessel, primary circulation pipes, heat generators

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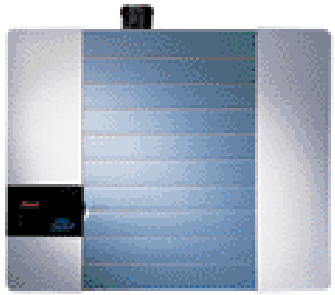
Complete **tested** appliances



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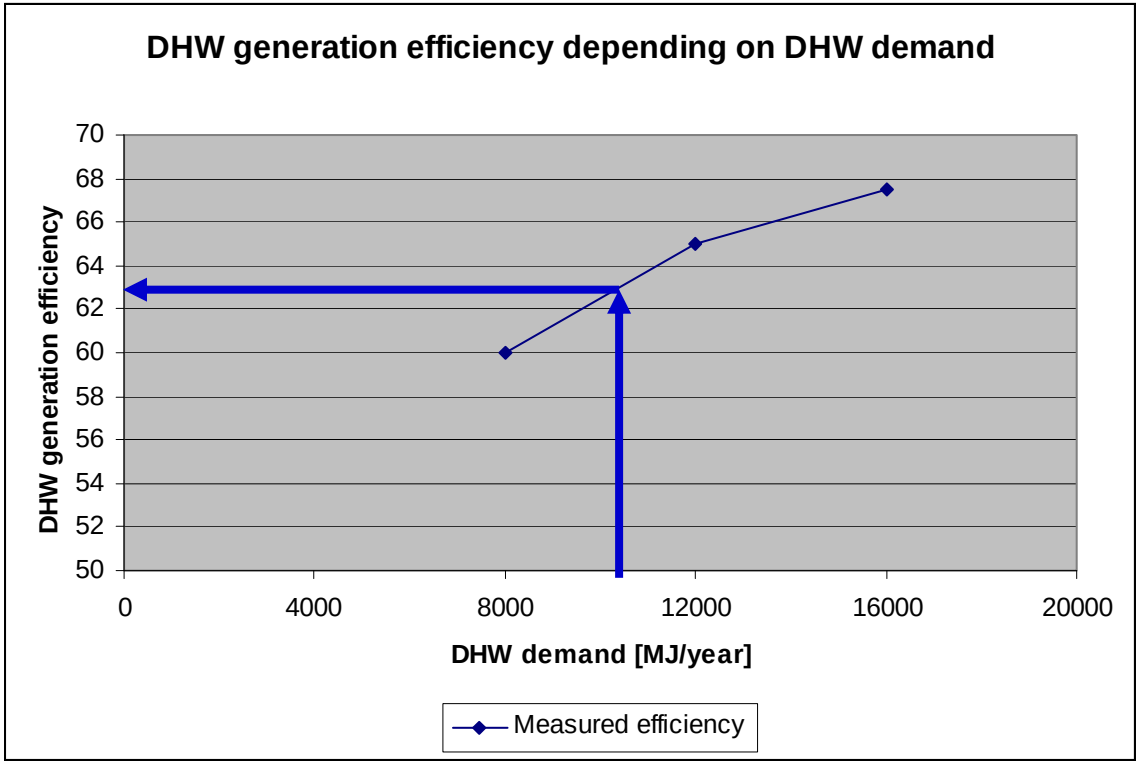
Complete **tested** appliances

- Interpolation between measured efficiencies



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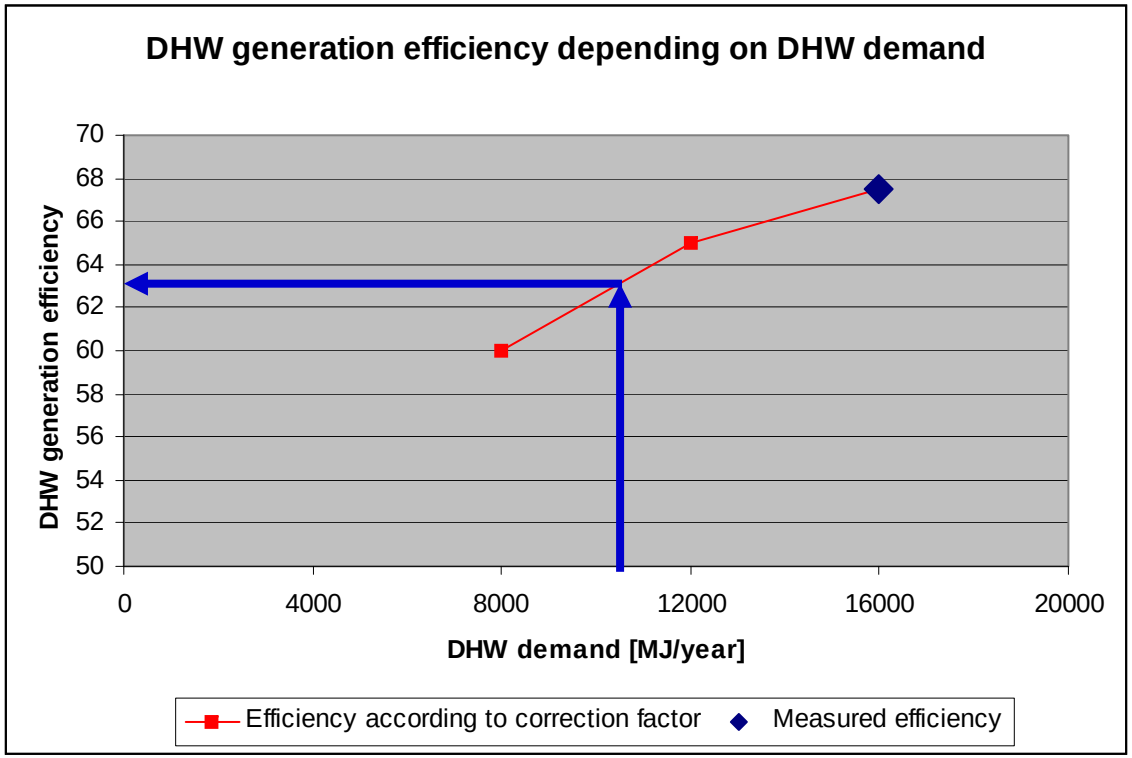
Complete **tested** appliances

- Extrapolation by applying a correction factor on measured efficiencies



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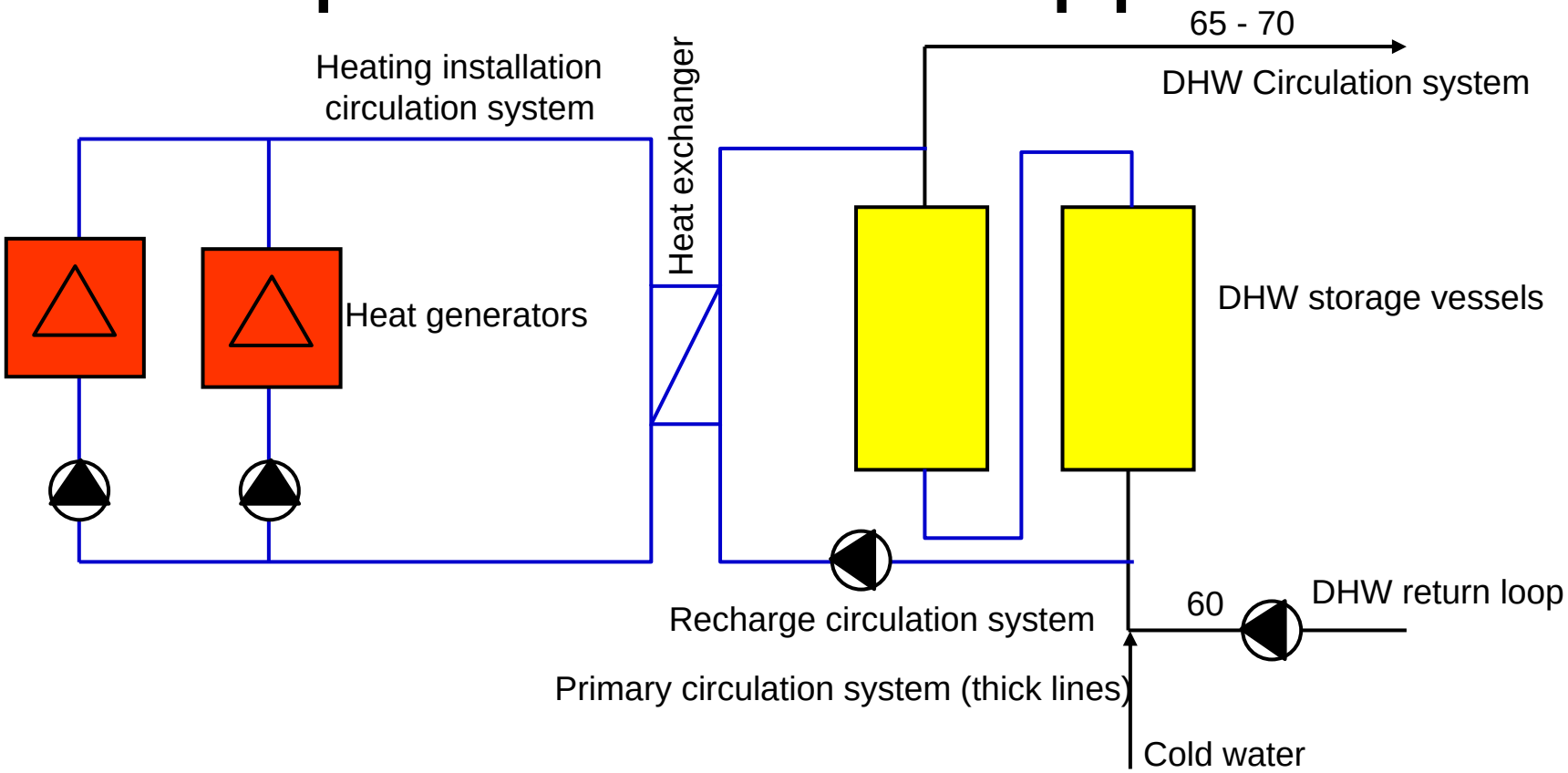
Component based appliances



Component based appliances

- Storage vessel losses
  - Measured stand-by loss or
  - National annex with default values (storage volume, insulation type and thickness)

Component based appliances

- Primary circulation pipes
  - Continuous or intermittent operation ?
  - National annex with default value
  - Detailed methods equal to methods for heating distribution system (pipe length, pipe thermal transmission coefficient, average water temperature and average ambient temperature, daily on-time)

Component based appliances

- Heat generators
  - For Boilers:
    - nom. output efficiency,
    - stand-by heat loss,
    - nom. heat output.
  - National annex with default value

Component based appliances

- Auxiliary energy
  - Required inputs:
    - pump power,
    - daily on-time for DHW

Thanks for your attention

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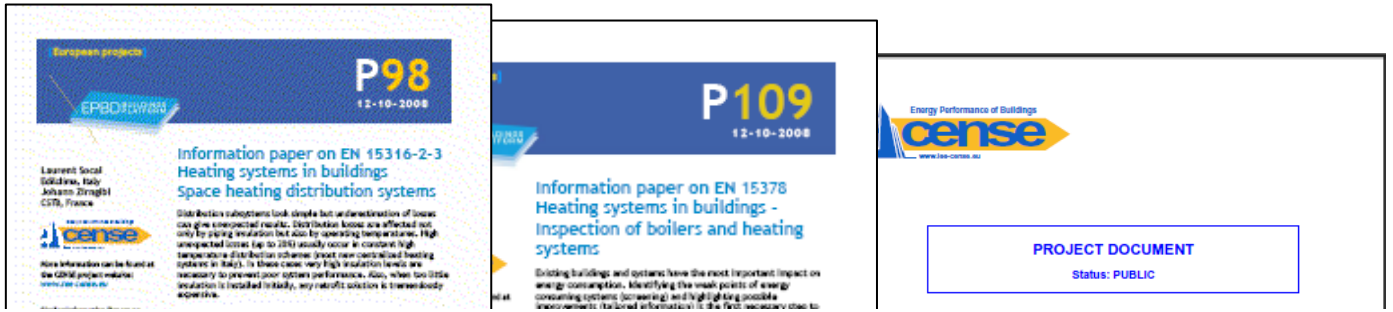

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