Workshop: CENSE – Directorate for Construction

HRN EN 15316: Space heating and domestic hot water systems - energy requirements and efficiencies

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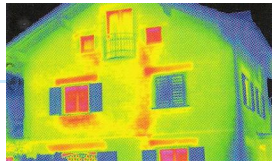


Energy performance certificate, PECZ, NN 113/2008

prema Direktivi 2002/91/EC

Energetski certifikat za nestambene zgrade

Zgrada ☐ nova ☐ postojeća

Vrsta zgrade
K.č. k.o.
Adresa
Mjesto
Vlasnik / investitor
Izvođač
Godina izgradnje

$Q_{H,nd,ref}$ kWh/(m²a)	Izračun	Potrošnja (opcijski)
	49	98

A+	≤ 15		
A	≤ 25		
B	≤ 50	B	
C	≤ 100		C
D	≤ 150		
E	≤ 200		
F	≤ 250		
G	> 250		

Podaci o osobi koja je izdala certifikat

Ovlaštena fizička osoba
Ovlaštena pravna osoba i imenovana osoba
Registarski broj ovlaštene osobe
Broj certifikata
Datum izdavanja/rok važenja
Potpis

Podaci o zgradi

A_K [m²]
V_e [m³]
f_0 [m⁻¹]
H'_T [W/(m²K)]

Klimatski podatci

Klimatski podaci (kontinentalna ili primorska Hrvatska)	
Broj stupanj dana grijanja SD [Kd/a]	
Broj dana sezone grijanja Z [d]	
Srednja vanjska temperatura u sezoni grijanja [°C]	
Unutarnja projektna temperatura u sezoni grijanja [°C]	

Podaci o termotehničkim sustavima zgrade

Način grijanja zgrade (lokalno, etažno, centralno, daljinski izvor)
Izvori energije koji se koriste za
Način hlađenja (lokalno, etažno,
Izvori energije koji se koriste za
Vrsta ventilacije (prirodna, prisil
Vrsta i način korištenja sustava
Udio obnovljivih izvora energ. u

energy need for space heating&DHW, system thermal losses

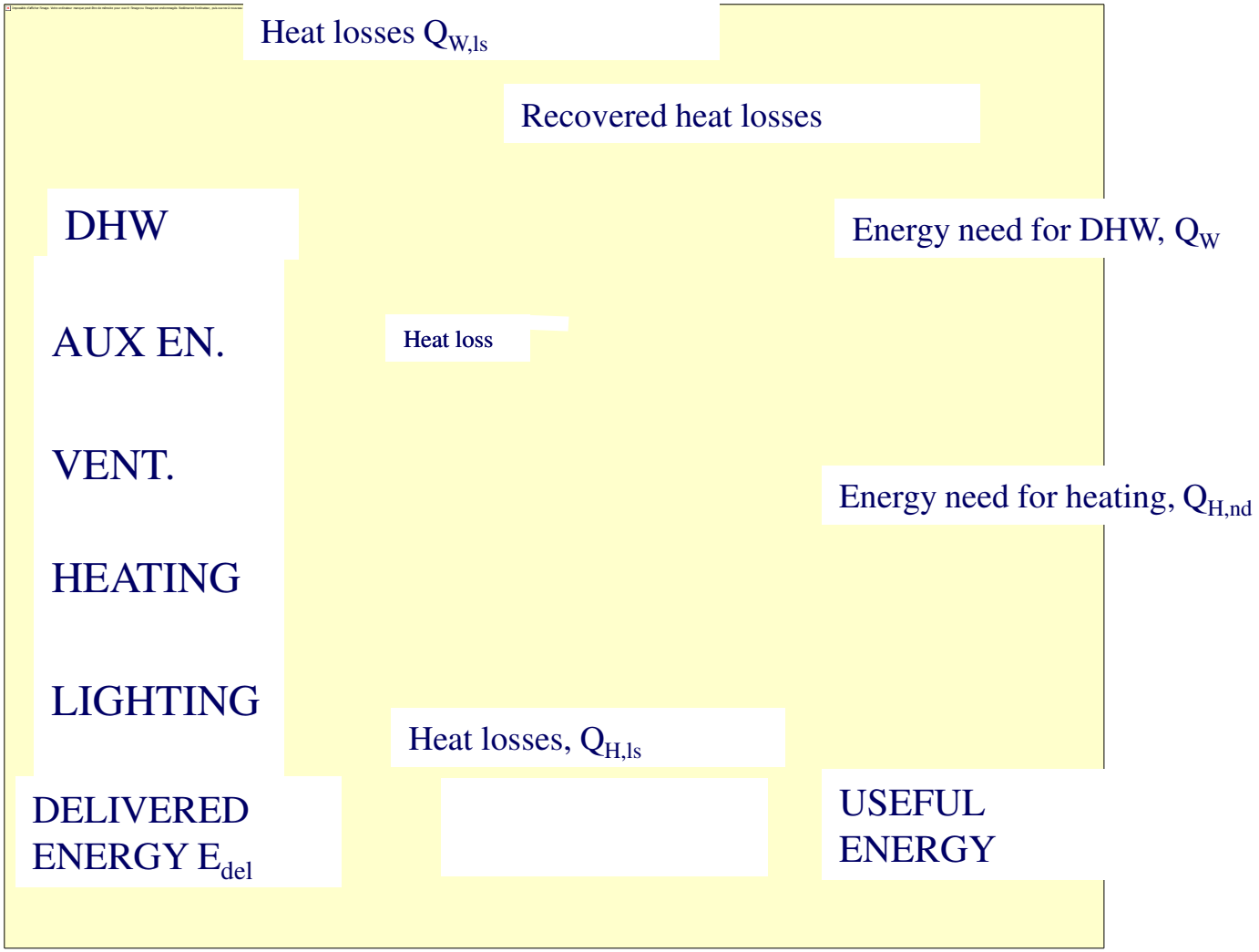
Energetske potrebe

	Za referentne klimatske podatke		Za stvarne klimatske podatke		Zahtjev	
	Ukupno	Specifično	Ukupno	Specifično	Dopušteno	Ispunjeno
$Q_{H,nd}$ [kWh/a],						
Q_W [kWh/a],						
$Q_{H,s}$ [kWh/a],						
$Q_{W,s}$ [kWh/a]						
Q_H [kWh/a]						
$Q_{C,nd}$ [kWh/a], $Q_{C,s}$ [kWh/a],						
Q_C [kWh/a],						
Q_{ve} [kWh/a],						
$E_{\square}$ [kWh/a],						
E_{del} [kWh/a],						
E_{prim} [kWh/a],						
CO_2 [kg/a]						

Objašnjenje: ☐ obavezna ispuna ☐ ispunjava se opcijski

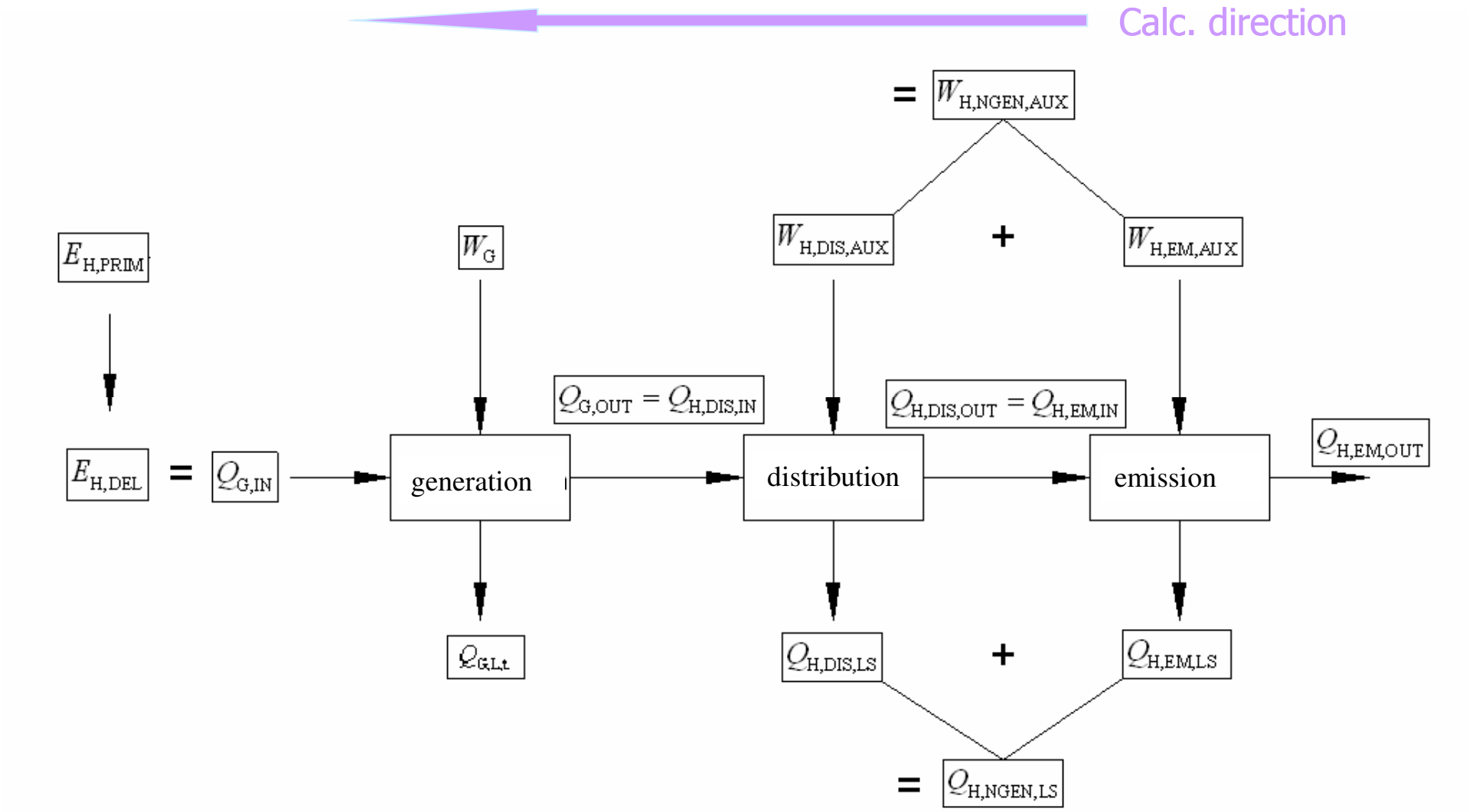
Građevni dio zgrade	U [W/(m²K)],	U_{max} [W/(m²K)]	Ispunjeno
Vanjski zidovi, zidovi prema garaži, tavanu			
Ravni i kosi krovovi iznad grijanog prostora, stropovi prema tavanu			
Zidovi prema tlu, podovi prema tlu			
Stropovi iznad vanjskog zraka, stropovi iznad garaže			
Zidovi i stropovi prema negrijanim prostorijama i negrijanom stubištu temperature više od 0 °C			
Prozori, balkonska vrata, krovni prozori, prozirni elementi pročelja			
Vanjska vrata s neprozirnim vratnim krilom			

Delivered energy-calculation approach



Energy flow thorugh the heating and ventilation system

Input and output data for building subsystems



List of relevant standards

1. *HRN EN ISO 13790:2008* Energetska svojstva zgrada – Proračun potrebne energije za grijanje i hlađenje prostora
2. *HRN EN 15603:2008* Energetska svojstva zgrada – Ukupna potrošnja energije i definiranje energetske procjene
3. *HRN EN 15217:2008* Energijska svojstva zgrada – Metode za izražavanje energijskog svojstva zgrada i za certifikaciju zgrada s obzirom na energiju
4. *HRN EN ISO 6946:2008* Građevni dijelovi i građevni dijelovi zgrade – Toplinski otpor i koeficijent prolaska topline – Metoda proračuna
5. *HRN EN ISO 13370:2008* Toplinske značajke zgrada – Prijenos topline preko tla – Metode proračuna
6. *HRN EN ISO 13789:2008* Toplinske značajke zgrada – Koeficijent transmisijskih toplinskih gubitaka – Metode proračuna
7. *HRN EN ISO 14683:2008* Toplinski mostovi u zgradarstvu – Linearni koeficijent prolaska topline – Pojednostavnjena metoda i utvrđene vrijednosti
8. *HRN EN 15316-1:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – 1. dio: Općenito
9. *HRN EN 15316-2-1:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 2-1: Sustavi za grijanje prostora zračenjem topline
10. *HRN EN 15316-2-3:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 2-3: Razvodi sustava grijanja prostora
11. *HRN EN 15316-3-1:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 3-1: Sustavi za pripremu potrošne tople vode, pokazatelji potreba prema izljevnome mjestu
12. *HRN EN 15316-3-2:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 3-2: Sustavi za pripremu potrošne tople vode, razvod
13. *HRN EN 15316-3-3:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 3-3: Sustavi za pripremu potrošne tople vode, zagrijavanje
14. *HRN EN 15316-4-1:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-1: Sustavi za proizvodnju topline izgaranjem (kotlovi)
15. *HRN EN 15316-4-2:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-2: Sustavi za proizvodnju topline, sustavi dizalica topline
16. *HRN EN 15316-4-3:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-3: Sustavi za proizvodnju topline, toplinski sustavi sunčevog zračenja
17. *HRN EN 15316-4-4:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-4: Sustavi za proizvodnju topline, sustavi kogeneracije uklopljeni u zgradu
18. *HRN EN 15316-4-5:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-5: Sustavi za proizvodnju topline za grijanje prostora, pokazatelji i kvaliteta daljinskog grijanja i sustava velikih volumena
19. *HRN EN 15316-4-6:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-6: Sustavi za proizvodnju topline, fotonaponski sustavi
20. *HRN EN 15316-4-7:2008* Sustavi grijanja u zgradama – Metoda proračuna energijskih zahtjeva i učinkovitosti sustava – Dio 4-7: Sustavi za proizvodnju topline izgaranjem biomase
21. *HRN EN 15241:2008* Ventilacija u zgradama – Metode proračuna energijskih gubitaka zbog ventilacije i infiltracije u poslovnim zgradama
22. *HRN EN 15242:2008* Ventilacija u zgradama – Metode proračuna za određivanje protoka zraka u zgradama uključujući infiltraciju
23. *HRN EN 15243:2008* Ventilacija u zgradama – Proračun temperatura, opterećenja i energije u prostorijama zgrada sa sustavima klimatizacije prostora
24. *HRN EN 15193:2008* Energijska svojstva zgrade – Energijski zahtjevi za rasvjetu

Space heating systems-standards

EN 15316-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 1: General;

EN 15316-2-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies : Part 2.1: Space heating emission systems

EN 15316-2-3 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2-3: Space heating distribution systems

EN 15316-4-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-1: Space heating generation systems, combustion systems (boilers)

Emission subsystem

EN 15316-2-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies : Part 2.1: Space heating emission systems

The standard deals with calculation of:

- Thermal losses
- Auxiliary energy (control, valves, pumps, fans..)
- Recoverable heat losses

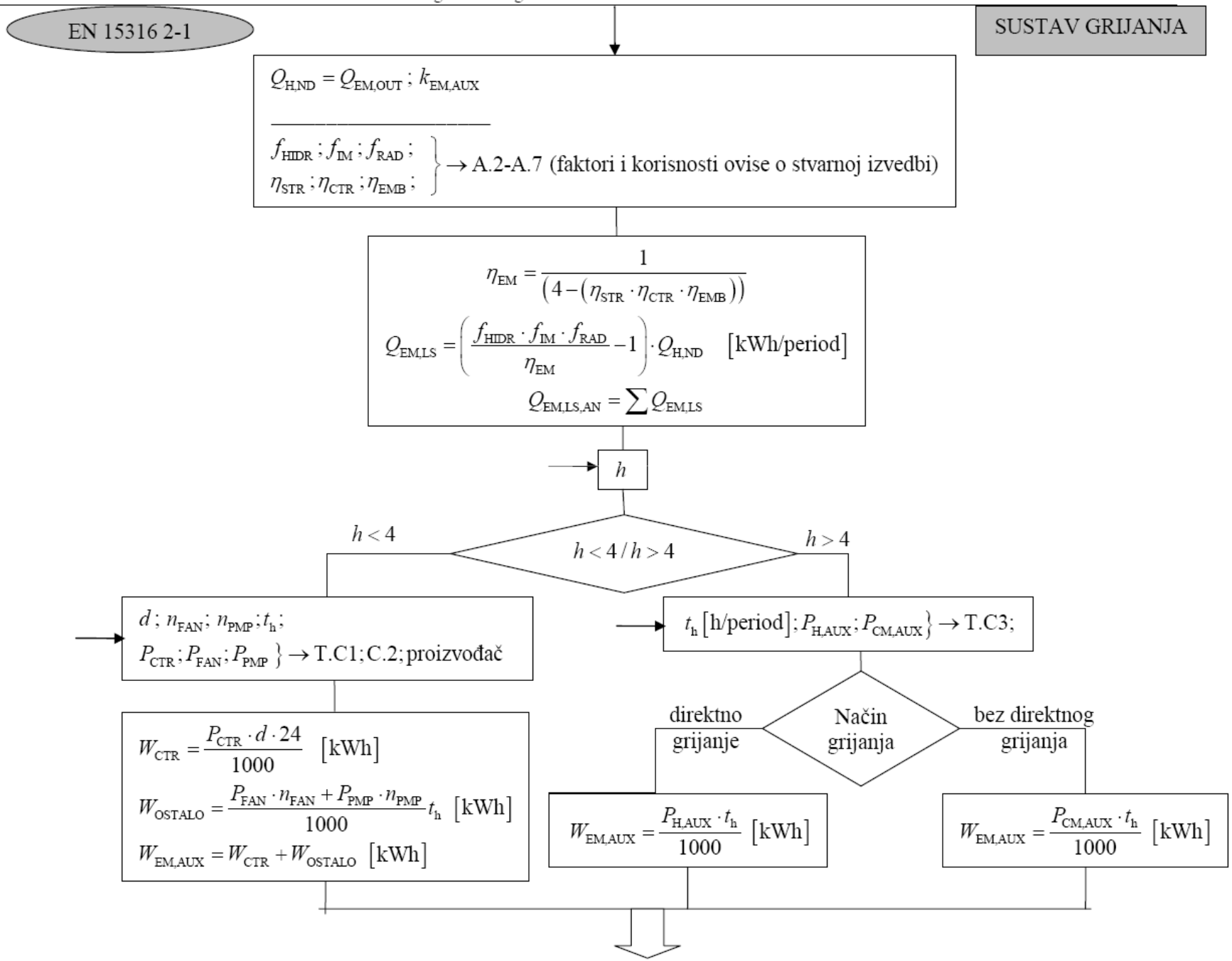
Selected method (out of two recommended) – **Method using efficiences η_{em}**

Calculation interval: **1 month**

$$\eta_{em} = \frac{1}{4 - (\eta_{str} + \eta_{emb} + \eta_{ctr})}$$

$$Q_{H,em,ls} = \left(\frac{f_{hydr} \cdot f_{im} \cdot f_{rad}}{\eta_{em}} - 1 \right) \cdot Q_{H,nd}$$

Prilog I.1. - Algoritam – SUSTAV GRIJANJA



Emission subsystem

EN 15316-2-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies : Part 2.1: Space heating emission systems

Questions and remarks

1. How to calculate recoverable losses Qem,aux,rvd (Eq.2) (i.e. k)?
2. How to estimate t_h (Eq. C.3) –running time of auxiliary devices

Distribution subsystem

EN 15316-2-3 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2-3: Space heating distribution systems

The standard deals with calculation of:

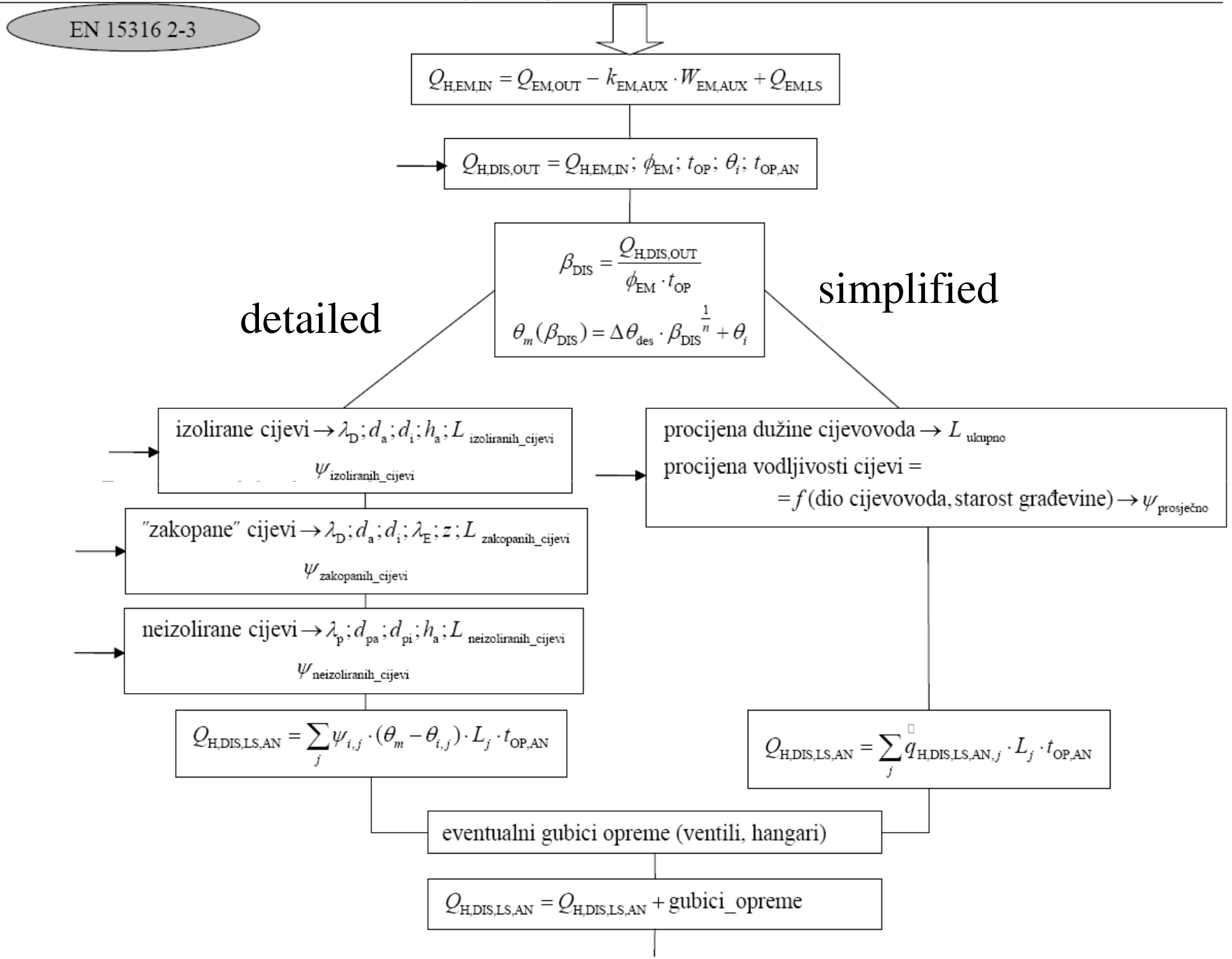
- Thermal losses
- Auxiliary energy (pumps)
- Recoverable heat losses

Selected methods– **Simplified calc. methods** for annual thermal losses and aux energy (**A.1 and A.3 in Annex A)**

Calculation interval: **1 year**

$$Q_{H,dis,ls,an} = \psi \cdot (\theta_m - \theta_i) \cdot L \cdot t_{op}$$

$$\Delta p_{des} = 0{,}13 \cdot L_{max} + 2 + \Delta p_{FH} + \Delta p_G$$


EN 15316 2-3
$Q_{H,EM,IN} = Q_{EM,OUT} - k_{EM,AUX} \cdot W_{EM,AUX} + Q_{EM,LS}$
$Q_{H,DIS,OUT} = Q_{H,EM,IN};\ \phi_{EM};\ t_{OP};\ \theta_i;\ t_{OP,AN}$
$\beta_{DIS} = \frac{Q_{H,DIS,OUT}}{\phi_{EM} \cdot t_{OP}}$
$\theta_m(\beta_{DIS}) = \Delta\theta_{des} \cdot \beta_{DIS}^{\frac{1}{n}} + \theta_i$
detailed
simplified
izolirane cijevi $\rightarrow \lambda_D; d_a; d_i; h_a; L_{izoliranih\_cijevi}$
$\psi_{izoliranih\_cijevi}$
"zakopane" cijevi $\rightarrow \lambda_D; d_a; d_i; \lambda_E; z; L_{zakopanih\_cijevi}$
$\psi_{zakopanih\_cijevi}$
neizolirane cijevi $\rightarrow \lambda_p; d_{pa}; d_{pi}; h_a; L_{neizoliranih\_cijevi}$
$\psi_{neizoliranih\_cijevi}$
$Q_{H,DIS,LS,AN} = \sum_j \psi_{i,j} \cdot (\theta_m - \theta_{i,j}) \cdot L_j \cdot t_{OP,AN}$
procijena dužine cijevovoda $\rightarrow L_{ukupno}$
procijena vodljivosti cijevi =
$= f$(dio cijevovoda, starost građevine) $\rightarrow \psi_{prosječno}$
$Q_{H,DIS,LS,AN} = \sum_j q_{H,DIS,LS,AN,j} \cdot L_j \cdot t_{OP,AN}$
eventualni gubici opreme (ventili, hangari)
$Q_{H,DIS,LS,AN} = Q_{H,DIS,LS,AN} + gubici\_opreme$

proračun pomoćnih energija

$c; \rho; \Delta\vartheta_{DIS,DES}; \phi_{H,EM,OUT}; R; f_{comp}; L_{MAX};$
$\Delta p_{HS}; \Delta p_{CV}; \Delta p_{ZV}; \Delta p_G; \Delta p_{ADD}$

$$L_{MAX} = 2 \cdot \left(L_L + \frac{L_W}{2} + N_{LEV} \cdot h_{LEV} + l_C \right) \rightarrow \text{aproksimacija}$$

$$\Delta p_{DES} = (1 + f_{comp}) \cdot R \cdot L_{MAX} + \Delta p_{HS} + \Delta p_{CV} + \Delta p_{ZV} + \Delta p_G + \Delta p_{ADD}$$

ili aprox.: $\Delta p_{DES} = 0{,}13 \cdot L_{MAX} + \Delta p_{FH} + \Delta p_G \quad [\text{kPa}]$

$$\dot{V} = \frac{3600 \cdot \phi_{H,EM,OUT}}{c \cdot \rho \cdot \Delta\vartheta_{DIS,DES}} \quad [\text{m}^3/\text{h}]$$

$$P_{HYDR,DES} = 0{,}2778 \cdot \Delta p_{DES} \cdot \dot{V} \quad [\text{W}]$$

$f_S; f_{NET}; f_G; f_{SD}; f_{HB}; f_{PM}\} \rightarrow$ funkcijske zavisnosti faktora su u prilogu

$$W_{H,DIS,HYDR,AN} = \frac{P_{DIS,HYDR}}{1000} \cdot \beta_{DIS} \cdot t_{OP,AN} \cdot f_S \cdot f_{NET} \cdot f_G \cdot f_{SD} \cdot f_{HB} \cdot f_{PM} \quad [\text{kWh/period}]$$

$f_\eta; f_{PL}; f_{PSP}; f_C; \} \rightarrow$ korekcije dane u prilogu

$$e_{DIS} = f_\eta \cdot f_{PL} \cdot f_{PSP} \cdot f_C$$

$$W_{H,DIS,AUX,AN} = W_{H,DIS,HYDR,AN} \cdot e_{DIS} \quad [\text{kWh/period}]$$

karakteristike intermitentnog načina rada:

$t_{OP,r}; t_{OP,boost}; P_{EL,PMP,BOOST}; P_{EL,PMP,STB} = 0{,}3 \cdot P_{EL,PMP,MAX}$

$$k_r = \frac{t_{OP,r}}{t_{OP}}; k_b = \frac{t_{OP,boost}}{t_{OP}}; k_{setb} = 1 - k_r - k_b;$$

$$W_{REG} = k_r \cdot W_{H,DIS,HYDR,AN} \cdot e_{DIS};$$

$$W_{SETB} = k_{setb} \cdot \frac{P_{EL,PMP,STB}}{1000} \cdot t_{OP,AN}; \quad \text{ili:} \quad W_{SETB} = 0 \rightarrow \text{ugašena}$$

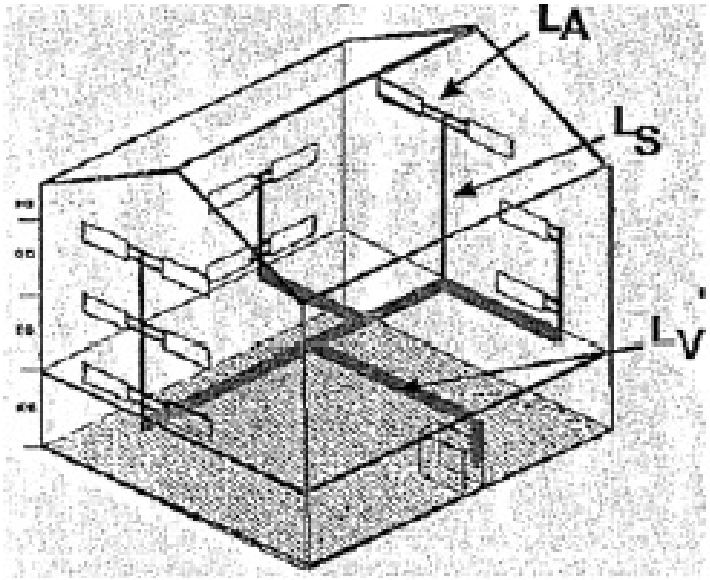
$$W_{BOOST} = k_b \cdot \frac{P_{EL,PMP,BOOST}}{1000} \cdot t_{OP,AN};$$

$$W_{H,DIS,AUX,AN} = W_{REG} + W_{SETB} + W_{BOOST}$$

Thermal losses calculation-simplified method

Simplifications made against the detailed method:

- Length of pipes are determined relevant to the external dimensions of a building or zone
- Linear transmittance is predefined for different types of pipes
- Valves and flanges are taken into account by the equivavalent pipe length



L_V- pipe length between generator and vertical shafts

L_S – pipe length of vertical shafts

L_A- connection pipes

Thermal losses calculation-simplified method

Approximation of pipe lengths (two-pipe heating system)

Values	Result	Unit	Part V (from the generator to the shafts)	Part S (vertical shafts)	Part A (connection pipes)
Mean surrounding temperature		°C	13 respectively 20	20	20
Pipe length in case of shafts in outside walls	L_i	m	$2 \cdot L_L + 0{,}01625 \cdot L_L \cdot L_W^2$	$0{,}025 \cdot L_L \cdot L_W \cdot h_{lev} \cdot N_{lev}$	$0{,}55 \cdot L_L \cdot L_W \cdot N_{lev}$
Pipe length in case of shafts inside the building	L_i	m	$2 \cdot L_L + 0{,}0325 \cdot L_L \cdot L_W + 6$	$0{,}025 \cdot L_L \cdot L_W \cdot h_{lev} \cdot N_{lev}$	$0{,}55 \cdot L_L \cdot L_W \cdot N_{lev}$

Approximation of pipe lengths (one-pipe heating system)

Values	Result	Unit	Part V (from the generator to the shafts)	Part S (vertical shafts)	Part A (connection pipes)
Pipe length in case of shafts inside of the building	L	m	$2 \cdot L_L + 0{,}0325 \cdot L_L \cdot L_W + 6$	$0{,}025 \cdot L_L \cdot L_W \cdot h_{lev} \cdot N_{lev} + 2 \cdot (L_L + L_W) \cdot N_{lev}$	$0{,}1 \cdot L_L \cdot L_W \cdot N_{lev}$

Thermal losses calculation-simplified method

Default values of linear transmittance ψ [W/mK] for new and existing buildings

Age or class of building	Distribution part		
	Part V	Part S	Pars A
From 1995 – assumed that insulation thickness is approximately equal to pipe external diameter	0,2	0,3	0,3
1980 to 1995 - assumed that insulation thickness is approximately equal to half of pipe external diameter	0,3	0,4	0,4
Up to 1980	0,4	0,4	0,4
Non-insulated pipes			
A ≤ 200 m²	1,0	1,0	1,0
200 m² < A ≤ 500 m²	2,0	2,0	2,0
A > 500 m²	3,0	3,0	3,0
Pipes laid in external walls		total / recoverable [a]	
External wall non-insulated		1,35 / 0,80	
External wall external insulated		1,00 / 0,90	
External wall without insulation but low thermal transmittance (U=0,4 W/m²K)		0,75 / 0,55	
[a] (total = total thermal loss of the pipe, recoverable = recoverable thermal loss of the pipe).			

Equivavalent length of pipes

Valves including flanges	Equivalent length in m (diameter d ≤ 100 mm)	Equivalent length in m (diameter d > 100 mm)
not insulated	4,0	6,0
insulated	1,5	2,5

Recovearble heat losses from aux equipment

El. energy for driving a pump released to the water

$$Q_{H,dis,aux,rvd} = f_{aux,rbl} \cdot W_{H,dis,aux,an}$$

Part of el. energy recoverable as a heat to the surrounding air

$$Q_{H,dis,aux,rbl} = (1 - f_{aux,rbl}) \cdot W_{H,dis,aux,an}$$

$f_{aux,rbl}$ = 0,75 uninsulated pump
$f_{aux,rbl}$ = 0,90 insulated

Generation subsystem

EN 15316-4-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-1: Space heating generation systems, combustion systems (boilers)

The standard deals with calculation of:

- Generation total heat losses
- Fuel consumption
- Auxiliary energy (burner, pumps, control..)
- Recoverable heat losses

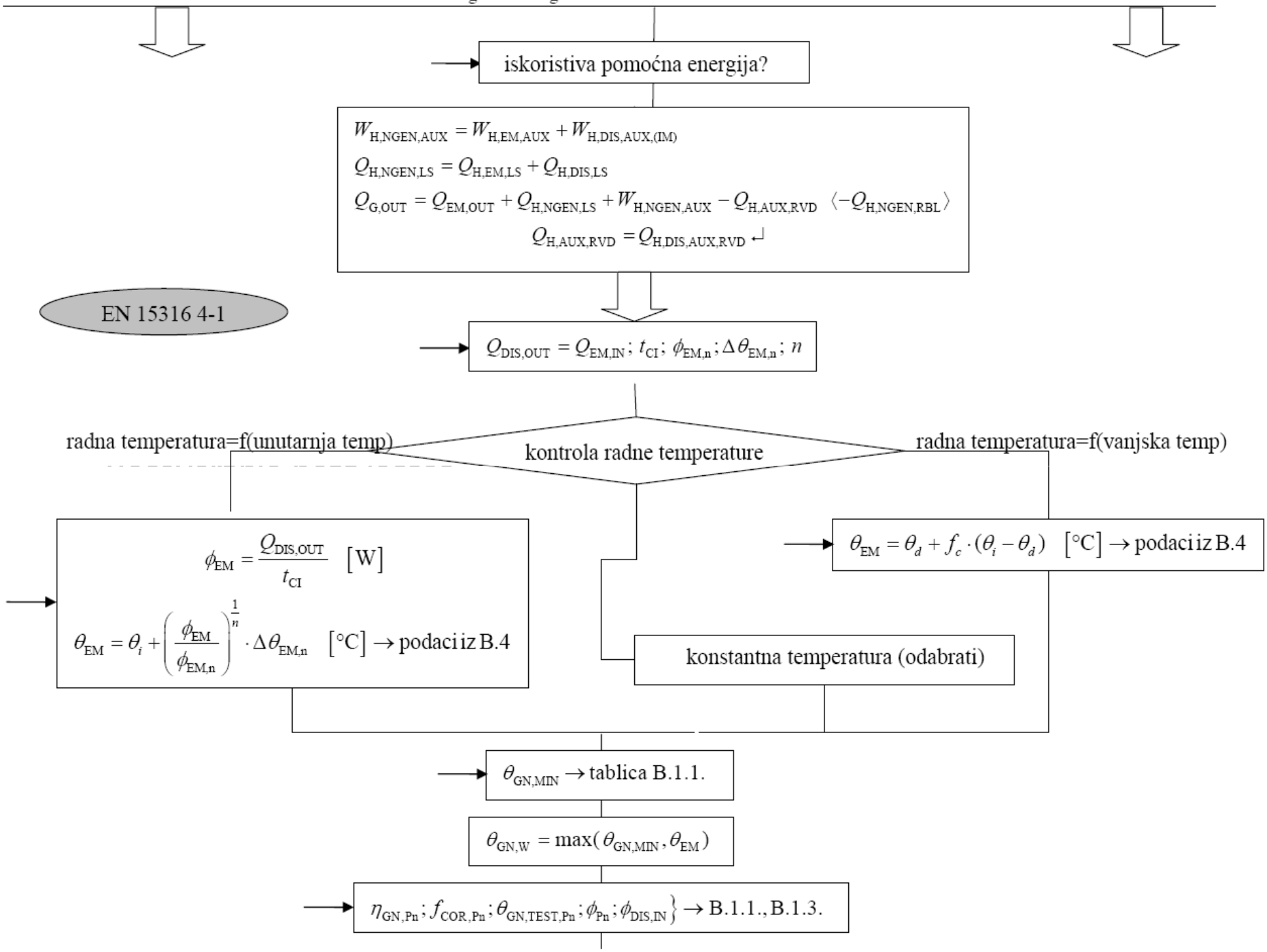
Selected method– **Case specific boiler efficiency method**

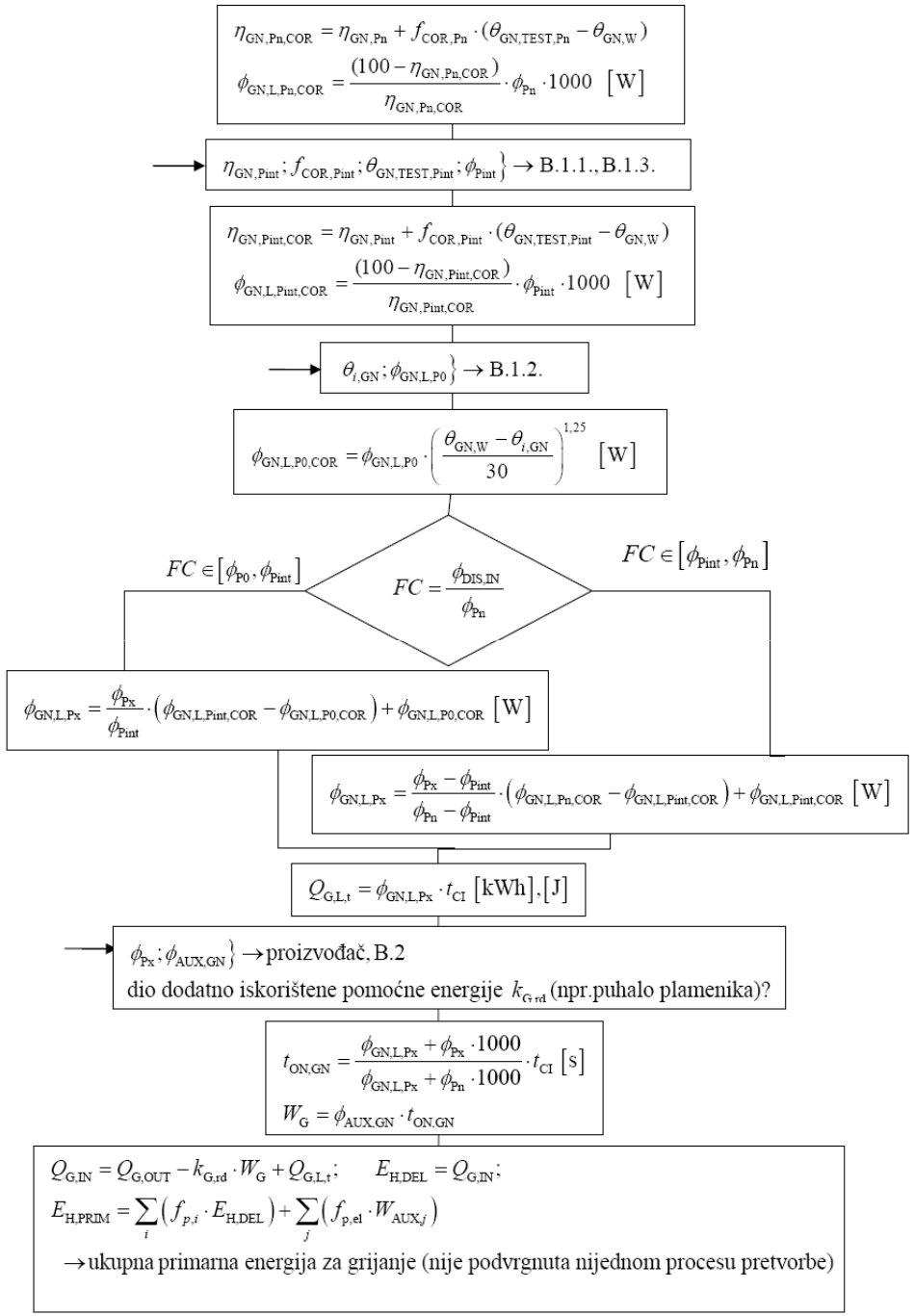
Calculation interval: **1 month**

$$\Phi_{gn,l,Pn,corr} = \frac{\left(100 - \eta_{gn,Pn,corr}\right)}{\eta_{gn,Pn,corr}} \cdot \Phi_{Pn}$$

$$\Phi_{gn,l,P\mathrm{int},corr} = \frac{\left(100 - \eta_{gn,P\mathrm{int},corr}\right)}{\eta_{gn,P\mathrm{int},corr}} \cdot \Phi_{P\mathrm{int}}$$

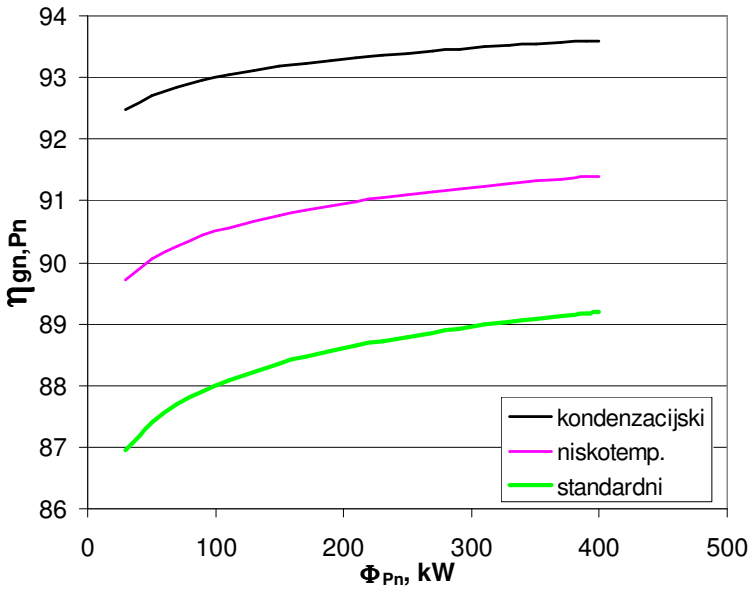
$$\Phi_{gn,l,P0,corr} = \Phi_{gn,l,P0} \cdot \left(\frac{\theta_{gn,w} - \theta_{i,gn}}{30}\right)^{1,25}$$


iskoristiva pomoćna energija?
$W_{H,NGEN,AUX} = W_{H,EM,AUX} + W_{H,DIS,AUX,(IM)}$
$Q_{H,NGEN,LS} = Q_{H,EM,LS} + Q_{H,DIS,LS}$
$Q_{G,OUT} = Q_{EM,OUT} + Q_{H,NGEN,LS} + W_{H,NGEN,AUX} - Q_{H,AUX,RVD}$ 〈$-Q_{H,NGEN,RBL}$〉
$Q_{H,AUX,RVD} = Q_{H,DIS,AUX,RVD}$ ↵
EN 15316 4-1
$Q_{DIS,OUT} = Q_{EM,IN}; t_{CI}; \phi_{EM,n}; \Delta\theta_{EM,n}; n$
radna temperatura=f(unutarnja temp)
kontrola radne temperature
radna temperatura=f(vanjska temp)
$\phi_{EM} = \frac{Q_{DIS,OUT}}{t_{CI}}$ [W]
$\theta_{EM} = \theta_i + \left(\frac{\phi_{EM}}{\phi_{EM,n}}\right)^{\frac{1}{n}} \cdot \Delta\theta_{EM,n}$ [°C] → podaci iz B.4
$\theta_{EM} = \theta_d + f_c \cdot (\theta_i - \theta_d)$ [°C] → podaci iz B.4
konstantna temperatura (odabrati)
$\theta_{GN,MIN}$ → tablica B.1.1.
$\theta_{GN,W} = \max(\theta_{GN,MIN}, \theta_{EM})$
$\eta_{GN,Pn}; f_{COR,Pn}; \theta_{GN,TEST,Pn}; \phi_{Pn}; \phi_{DIS,IN}\}$ → B.1.1., B.1.3.


$\eta_{GN,Pn,COR} = \eta_{GN,Pn} + f_{COR,Pn} \cdot (\theta_{GN,TEST,Pn} - \theta_{GN,W})$
$\phi_{GN,L,Pn,COR} = \frac{(100 - \eta_{GN,Pn,COR})}{\eta_{GN,Pn,COR}} \cdot \phi_{Pn} \cdot 1000$ [W]
$\{\eta_{GN,Pint}; f_{COR,Pint}; \theta_{GN,TEST,Pint}; \phi_{Pint}\} \rightarrow$ B.1.1., B.1.3.
$\eta_{GN,Pint,COR} = \eta_{GN,Pint} + f_{COR,Pint} \cdot (\theta_{GN,TEST,Pint} - \theta_{GN,W})$
$\phi_{GN,L,Pint,COR} = \frac{(100 - \eta_{GN,Pint,COR})}{\eta_{GN,Pint,COR}} \cdot \phi_{Pint} \cdot 1000$ [W]
$\{\theta_{i,GN}; \phi_{GN,L,P0}\} \rightarrow$ B.1.2.
$\phi_{GN,L,P0,COR} = \phi_{GN,L,P0} \cdot \left(\frac{\theta_{GN,W} - \theta_{i,GN}}{30}\right)^{1,25}$ [W]
$FC = \frac{\phi_{DIS,IN}}{\phi_{Pn}}$
$FC \in [\phi_{P0}, \phi_{Pint}]$
$FC \in [\phi_{Pint}, \phi_{Pn}]$
$\phi_{GN,L,Px} = \frac{\phi_{Px}}{\phi_{Pint}} \cdot (\phi_{GN,L,Pint,COR} - \phi_{GN,L,P0,COR}) + \phi_{GN,L,P0,COR}$ [W]
$\phi_{GN,L,Px} = \frac{\phi_{Px} - \phi_{Pint}}{\phi_{Pn} - \phi_{Pint}} \cdot (\phi_{GN,L,Pn,COR} - \phi_{GN,L,Pint,COR}) + \phi_{GN,L,Pint,COR}$ [W]
$Q_{G,L,t} = \phi_{GN,L,Px} \cdot t_{CI}$ [kWh], [J]
$\{\phi_{Px}; \phi_{AUX,GN}\} \rightarrow$ proizvođač, B.2
dio dodatno iskorištene pomoćne energije $k_{G,rd}$ (npr.puhalo plamenika)?
$t_{ON,GN} = \frac{\phi_{GN,L,Px} + \phi_{Px} \cdot 1000}{\phi_{GN,L,Px} + \phi_{Pn} \cdot 1000} \cdot t_{CI}$ [s]
$W_G = \phi_{AUX,GN} \cdot t_{ON,GN}$
$Q_{G,IN} = Q_{G,OUT} - k_{G,rd} \cdot W_G + Q_{G,L,t}$; $E_{H,DEL} = Q_{G,IN}$;
$E_{H,PRIM} = \sum_i (f_{p,i} \cdot E_{H,DEL}) + \sum_j (f_{p,el} \cdot W_{AUX,j})$
→ukupna primarna energija za grijanje (nije podvrgnuta nijednom procesu pretvorbe)

Boiler efficiencies

100% load



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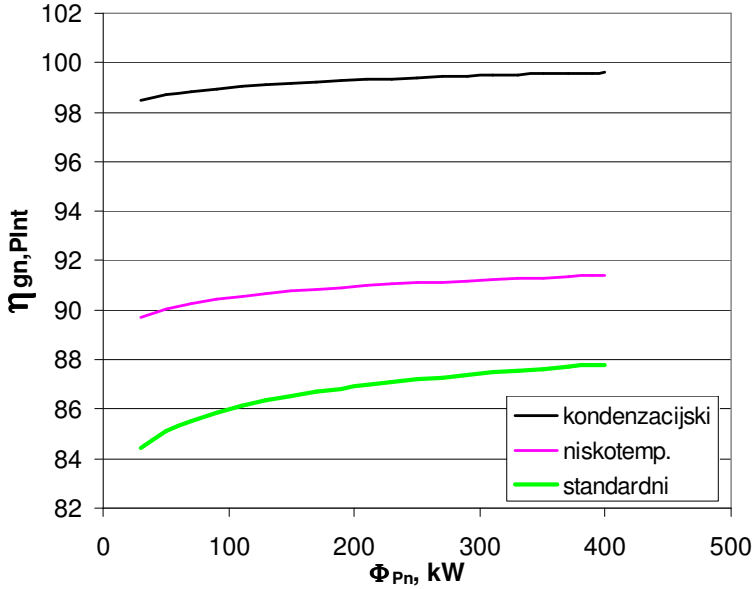


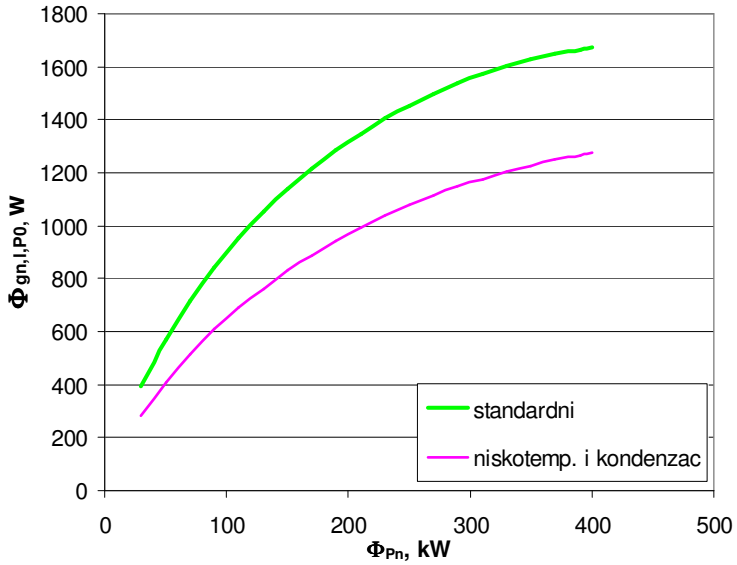
$\eta_{gn,Pn} = A + B \cdot \log \Phi'_{Pn}$

$\eta_{gn,Pint} = C + D \cdot \log \Phi'_{Pn}$

$\Phi_{gn,l,P0} = \Phi_{Pn} \cdot (E + F \cdot \log \Phi'_{Pn})$

$\Phi'_{Pn} = \Phi_{Pn}$ za $\Phi_{Pn} < 400$ kW

$\Phi'_{Pn} = 400$ kW?? za $\Phi_{Pn} > 400$ kW



Stand by losses

Generation subsystem

EN 15316-4-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-1: Space heating generation systems, combustion systems (boilers)

Questions and remarks

1. bg=? for outside of the heated space (Eq. 13, B.3.3)
2. No exact expression stated for recoverable energy transmitted to the heating medium (Wg, rvd) –there is the expression only for Wg,rl (Eq. 13)

$$W_{g,rl}=W_g\cdot(1-b_g)\cdot p_{aux,g}$$

Domestic hot water systems-standards

EN 15316-3-1 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3: Domestic hot water systems

EN 15316-3-2 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-2: Domestic hot water systems, distribution

EN 15316-3-3 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-3: Domestic hot water systems, generation;

DHW distribution subsystem

EN 15316-3-2 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-2: Domestic hot water systems, distribution

The standard deals wtih calculation of:

- Heat losses
- Auxiliary energy (pumps)
- Recoverable heat losses

Out of 5 described methods the following are selected:

Method based on pipe lengths and number of tapping per day (Annex A)

Method based on pipe lenghts and distribution efficiences (Annex B)

-only for residential buildings

For heat losses from circulation loop:

Detailed calculation, physical approach –when detailed design data are available

Simplified calculation based on pipe length and fixed value of heat loss (40W/m!!)

Auxiliary energy for a pump in circulation loop:

Simplified method (continuous operation 24 h/day)

Detailed calc. method

EN 15316 3-1

PTV SUSTAV

odabrati metodu za proračun potrebne energije za zagrijavanje PTV:

1. toplinska potreba prema utvrđenom programu upotrebe (tzv. *"tapping program"*)
2. **toplinska potreba prema potrebnom volumenu tople vode**
3. toplinska potreba prema kvadraturi - površini prostora (definira nac. aneks)
4. tablične vrijednosti toplinskih potreba – ovisno o tipu i namjeni zgrade (definirano u nac. aneksu)

$f, \theta_{W,DEL}; \theta_{W,0}; V_{W,f,DN}\} \rightarrow$ B.1.;B.2.

→ ako se radi o jednom kućanstvu $V_{W,f,DN}$ se proračunava prema:

$$V_{W,f,DN} = \frac{x \cdot \ln(f) - y}{f} = \frac{39,5 \cdot \ln(f) - 90,2}{f} \quad \left[\text{l/m}^2/\text{dn}\right] - \text{za f} > \text{maksimalna vrijednost} = 27 \text{ m}^2$$

ili

$$V_{W,f,DN} = z = 1,49 \left[\text{l/m}^2/\text{dn}\right] - \text{za minimalna vrijednost} = 14 \text{ m}^2 < \text{f} < \text{maksimalna vrijednost} = 27 \text{ m}^2$$

(faktor f u ovom slučaju odgovara površini kućanstva)

→ inače se $V_{W,f,DN}$ i f odabiru iz odgovarajuće tablice

$$V_{W,DN} = \frac{V_{W,f,DN} \cdot f}{1000} \quad \left[\text{m}^3/\text{dn}\right]$$

$$Q_W = 4,182 \cdot V_{W,DN} \cdot \left(\theta_{W,DEL} - \theta_{W,0}\right) \quad \left[\text{MJ/dn}\right]$$

proračun potrebne energije se može provesti za dva "karakteristična" dana iz dvije sezone (npr. ljetna i zimska sezona) u kojima dolazi do značajnije promjene u temperaturama tople i hladne vode ; dobivene vrijednosti se zatim množe s odgovarajućim brojem dana iz sezone (obzirom da je proračun toplinske potrebe proveden na razini jednog dana)

EN 15316 3-2

u sustavu postoji cirkulacijski dio (petlja) cjevovoda?

da

ne

tip metode

jednostavna

"fizikalni pristup"

zadati gubitak po metru

$Q_{W,DIS,LS,COL}$

$U_{W,i}; L_{W,i}; \theta_{W,DIS,AVG,i}; \theta_{AMB,i}; t_W$

→ uvedene aproksimacije; aneks D.2.

$$Q_{W,DIS,LS,COL,ON} = \sum_i Q_{W,DIS,LS,COL,ON,i} = \sum_i \frac{3,6}{1000} \cdot U_{W,i} \cdot L_{W,i} \cdot \left(\theta_{W,DIS,AVG,i} - \theta_{AMB,i}\right) \cdot t_W$$

$\rho; c; V_{W,DIS,i}; n_{NORM}$

$$Q_{W,DIS,LS,COL,OFF} = \sum_i Q_{W,DIS,LS,COL,OFF,i} = \sum_i \frac{\rho \cdot c}{1000} \cdot V_{W,DIS,i} \cdot \left(\theta_{W,DIS,AVG,i} - \theta_{AMB,i}\right) \cdot n_{NORM}$$

$$Q_{W,DIS,LS,COL} = Q_{W,DIS,LS,COL,ON} + Q_{W,DIS,LS,COL,OFF} \quad [MJ/dn]$$

odabrati metodu:

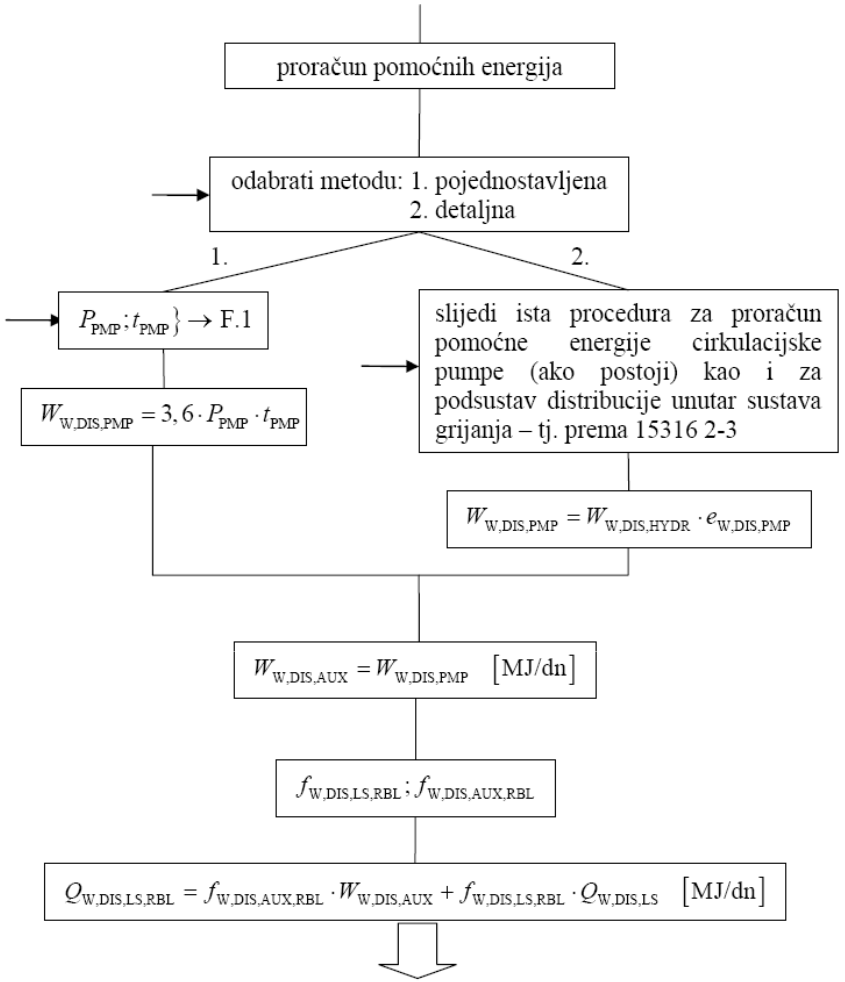
a. gubici prema kvadraturi
b. gubici prema dužini cjevovoda i broju otvaranja ispustnih mjesta
c. gubici prema dužini cjevovoda i efikasnosti
d. gubici prema dužini cjevovoda i profilu upotrebe PTV
e. gubici prema dužini cjevovoda i prosječnoj temperaturi

$L_{KUH} \rightarrow f_{KUH}; L_{KUP} \rightarrow f_{KUP}; \eta_{P,KUH}; \eta_{P,KUP}\} \rightarrow$ B.1.

$$\eta_P = \frac{1}{\left(\frac{f_{KUH}}{\eta_{P,KUH}} + \frac{f_{KUP}}{\eta_{P,KUP}}\right)} = \frac{1}{\left(\frac{0,2}{\eta_{P,KUH}} + \frac{0,8}{\eta_{P,KUP}}\right)}$$

$$Q_{W,DIS,LS,IND} = Q_W \cdot \left(\frac{1-\eta_P}{\eta_P}\right) \quad [MJ/dn]$$

$$Q_{W,DIS,LS} = Q_{W,DIS,LS,COL} + Q_{W,DIS,LS,IND} \quad [MJ/dn]$$

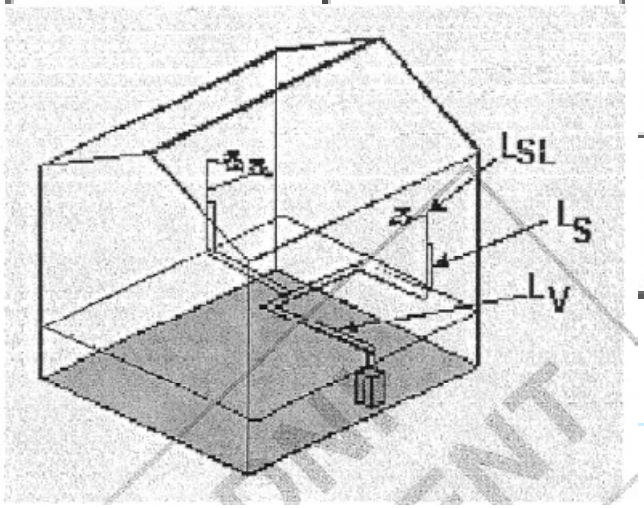

proračun pomoćnih energija
odabrati metodu: 1. pojednostavljena
2. detaljna
1.
2.
$P_{PMP}; t_{PMP}\} \rightarrow$ F.1
slijedi ista procedura za proračun pomoćne energije cirkulacijske pumpe (ako postoji) kao i za podsustav distribucije unutar sustava grijanja – tj. prema 15316 2-3
$W_{W,DIS,PMP} = 3,6 \cdot P_{PMP} \cdot t_{PMP}$
$W_{W,DIS,PMP} = W_{W,DIS,HYDR} \cdot e_{W,DIS,PMP}$
$W_{W,DIS,AUX} = W_{W,DIS,PMP}$ [MJ/dn]
$f_{W,DIS,LS,RBL}; f_{W,DIS,AUX,RBL}$
$Q_{W,DIS,LS,RBL} = f_{W,DIS,AUX,RBL} \cdot W_{W,DIS,AUX} + f_{W,DIS,LS,RBL} \cdot Q_{W,DIS,LS}$ [MJ/dn]

Heat losses from circulation loop- Annex D

Table D.1. Circulation loop and distribution pipes (??),

Physical approach-at a design stage (for floor area of 80 m^2)

Parameters	Symbol	Unit	Section L_V	Section L_S	Section L_{SL}
Ambient temperature outside the heating period	$\theta_{amb,nhp}$	°C	22 °C		
Ambient temperature	θ_{amb}	°C	13 °C in an unheated space and 20 °C in a heated space	20 °C in a heated space	
Length of circulation loop	L	m	$2\times L_B + 0,012\,5\times L_B\times B_B$	$0,075\times L_B\times B_B\times n_l\times h_f$	—
Length of main distribution pipe	L	m	$L_B + 0,062\,5\times L_B\times B_B$	$0,038\times L_B\times B_B\times n_l\times h_f$	—
Length of individual branching pipe, only for transfer into adjacent rooms with a common installation wall	L	m	—	—	$0,05\times L_B\times B_B\times n_f$
Length of individual branching pipe, for all other cases	L	m			$0,075\times L_B\times B_B\times n_f$

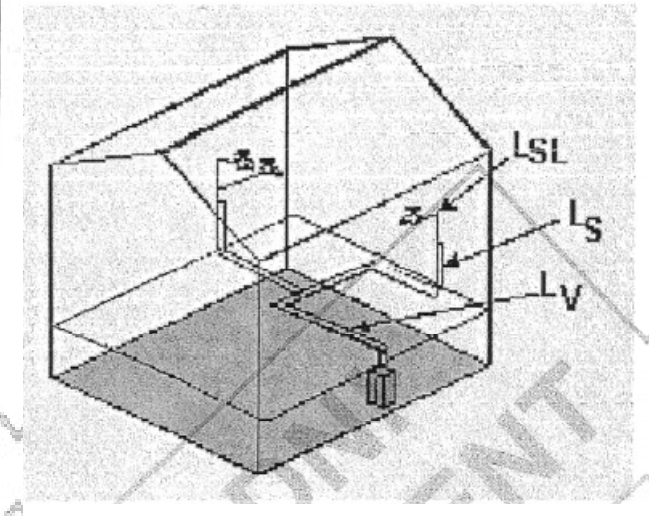


Can it be used also for simplifeid calculations?

Heat losses from circulation loop- Annex D

Table D.2 Length of individual pipes L_{SL}

Parameter	Symbol	Unit	Section L_{SL}
Average ambient temperature	$\theta_{amb,avg}$	°C	20
Pipe length for one tap in a room, e.g. from under-sink heater to tap	L	m	$1 * \left(\frac{A_N}{80}\right)$
Pipe length for more than one tap in a room, e.g. in a bathroom	L	m	$3 * \left(\frac{A_N}{80}\right)$
Pipe length for more than one tap in an adjacent room with a common installation wall	L	m	$2 * \left(\frac{A_N}{80}\right)$
Pipe length for supply central within the home unit	L	m	$6 * \left(\frac{A_N}{80}\right)$



Auxiliary energy calculation

Auxiliary energy for pumps in a circulation loop

- **Detailed method** is similar to the method for space heating distribution subsystem EN 15316-3-1 – pipe lengths are here also detemined relative to the external dimensions of building

- **Simplified method** employs

$W_{dis,pmp}=3,6 \cdot P_{pmp} \cdot t_{pmp}$ (MJ/dan)

where

P_{pmp} – nominal power of the pump pumpe, t_{pmp} = **24 h/day**

Recoverable heat losses

Recoverable losses from distribution, circulation loop and auxiliary equipment released to the surrounding air are taken as $\mathbf{Q_{W,dis,ls,rbl}=0!!}$

Recoverable losses delivered to the water from pump are estimated as 80% of auxiliary energy $\mathbf{W_{W,dis,pmp}}$ and are extracted form the circulation loop heat losses.

EN 15316-3-2 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-2: Domestic hot water systems, distribution

Questions and remarks

1. Are the additional thermal losses from circulation loop during periods of no circulation 6.3.4 part of only physical approach calculation 6.3.3 or need to be determined also when using other methods
2. Eq. (3) how to obtain t_w
3. Eq (4) how to obtain n_{norm}
4. Annex D - D.2.2. Determination of pipe lengths; Existing old buildings (likely with no precise data in design documentation) are not explicitly mentioned - only new buildings
5. Are the tables D.1 and D.2 also applicable for the pipe length calculations other than those described in Physical approach for circulation loop 6.3.3 (e.g. for simplified method from 6.3.2 or distribution pipes losses method from 6.2.4 ?
6. Are the default values in Table D.2 also based on 80m2 floor area like those in Table D.1.
   - What is the largest floor area these tables are applicable to?
   - How to determine pipe lengths for larger floor areas both for distribution pipes and circulation loops if design data are not available?
7. LSL are calculated both in Tables D.1. and D.2 - the text below table D.1 should make clear distinction when to use values for LSL from each table.
8. How to calculate t_{pmp}- running time of pump in Eq. 8 - taking 24 h/day? or maybe the same Eq. F.6 for t_w in Annex F can be used as well
9. Why the important recoverable heat losses for space heating from distribution system (Eq. 9) are set as QW,dis,ls,rbl=0 ?

9.1 How to calculate recoverable losses for space heating from circulation loop QW,dis,ls,col, rbl?

EN 15316-3-2 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-2: Domestic hot water systems, distribution

Questions and remarks

Chapter 6.2.1. - first sentence may cause some confusions in the context of the subsequent text in this chapter regarding types of heat losses and should be reformulated to comply with the one from Annex A following Eq.A.1 – ''Thermal losses due to energy content of wasted water at the user outlets..... ''

Explanation: Losses due to heating up of pipes while desired temp. has not been reached should not be separated from the losses due to cooling down of the pipes material. This is actually the same thermal energy (delivered to the pipes and lost in different time periods) and is accounted for in Eq. A1 by the second term in first brackets. The real loss after start of draw off is the rest of the initial energy content of, at that point already partially cooled down (by pipes material), wasted domestic hot water.

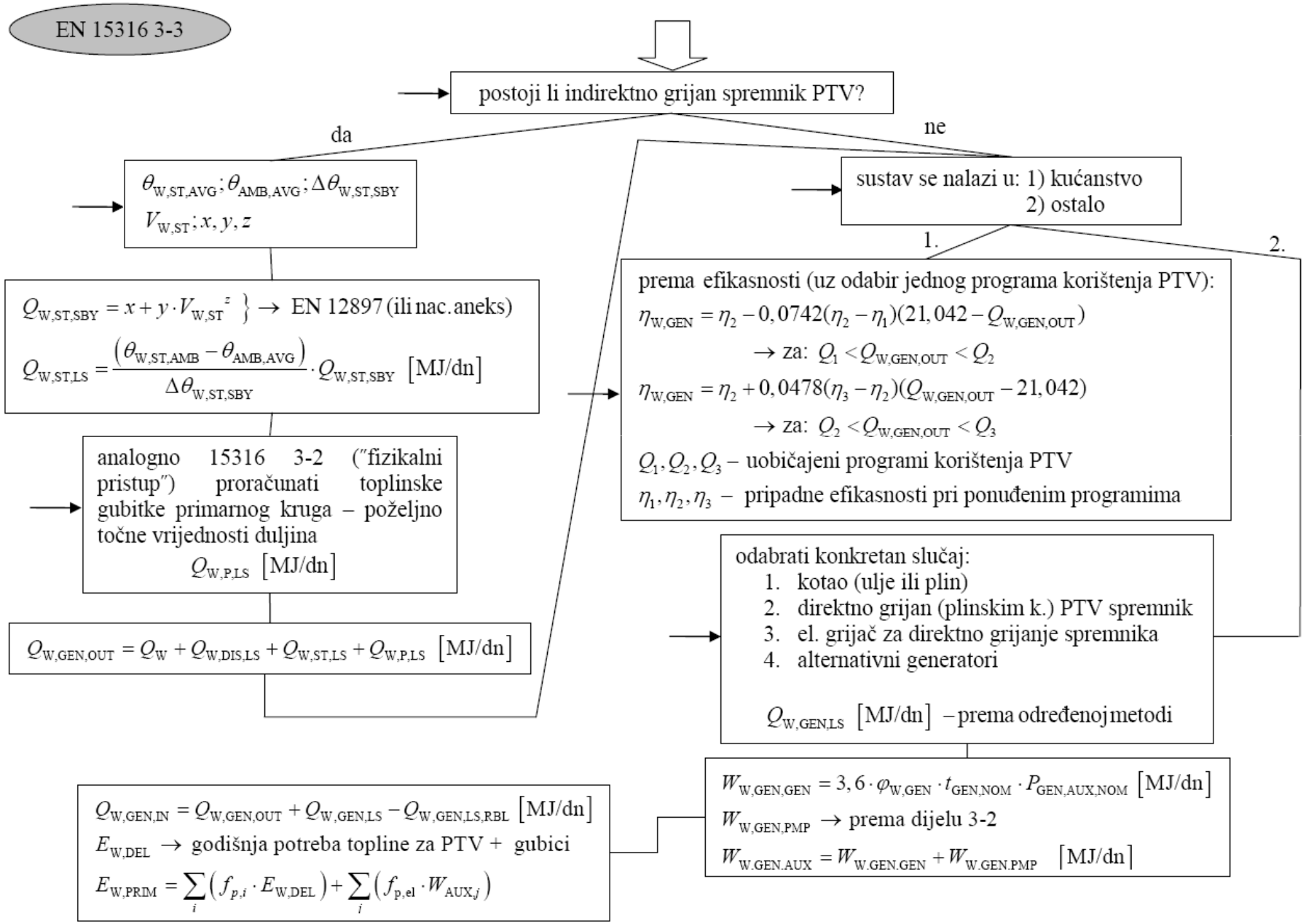
DHW generation subsystem

EN 15316-3-3 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-3: Domestic hot water systems, generation;

The standard deals wtih calculation of:

- Total boiler heat losses
- Total storage tank heat losses
- Auxiliary energy (pumps, burner)
- Recoverable heat losses

Calculation interval: 1 day


EN 15316 3-3
postoji li indirektno grijan spremnik PTV?
da
ne
$\theta_{W,ST,AVG}; \theta_{AMB,AVG}; \Delta\theta_{W,ST,SBY}$
$V_{W,ST}; x, y, z$
$Q_{W,ST,SBY} = x + y \cdot V_{W,ST}^{\ z}$ } → EN 12897 (ili nac. aneks)
$Q_{W,ST,LS} = \frac{(\theta_{W,ST,AMB} - \theta_{AMB,AVG})}{\Delta\theta_{W,ST,SBY}} \cdot Q_{W,ST,SBY}$ [MJ/dn]
analogno 15316 3-2 (″fizikalni pristup″) proračunati toplinske gubitke primarnog kruga – poželjno točne vrijednosti duljina
$Q_{W,P,LS}$ [MJ/dn]
$Q_{W,GEN,OUT} = Q_W + Q_{W,DIS,LS} + Q_{W,ST,LS} + Q_{W,P,LS}$ [MJ/dn]
sustav se nalazi u: 1) kućanstvo
2) ostalo
1.
2.
prema efikasnosti (uz odabir jednog programa korištenja PTV):
$\eta_{W,GEN} = \eta_2 - 0,0742(\eta_2 - \eta_1)(21,042 - Q_{W,GEN,OUT})$
→ za: $Q_1 < Q_{W,GEN,OUT} < Q_2$
$\eta_{W,GEN} = \eta_2 + 0,0478(\eta_3 - \eta_2)(Q_{W,GEN,OUT} - 21,042)$
→ za: $Q_2 < Q_{W,GEN,OUT} < Q_3$
Q_1, Q_2, Q_3 – uobičajeni programi korištenja PTV
η_1, η_2, η_3 – pripadne efikasnosti pri ponuđenim programima
odabrati konkretan slučaj:
1. kotao (ulje ili plin)
2. direktno grijan (plinskim k.) PTV spremnik
3. el. grijač za direktno grijanje spremnika
4. alternativni generatori
$Q_{W,GEN,LS}$ [MJ/dn] – prema određenoj metodi
$W_{W,GEN,GEN} = 3,6 \cdot \varphi_{W,GEN} \cdot t_{GEN,NOM} \cdot P_{GEN,AUX,NOM}$ [MJ/dn]
$W_{W,GEN,PMP}$ → prema dijelu 3-2
$W_{W.GEN.AUX} = W_{W.GEN.GEN} + W_{W.GEN.PMP}$ [MJ/dn]
$Q_{W,GEN,IN} = Q_{W,GEN,OUT} + Q_{W,GEN,LS} - Q_{W,GEN,LS,RBL}$ [MJ/dn]
$E_{W,DEL}$ → godišnja potreba topline za PTV + gubici
$E_{W,PRIM} = \sum_i (f_{p,i} \cdot E_{W,DEL}) + \sum_i (f_{p,el} \cdot W_{AUX,j})$

Storage tank losses

Heat losses of indirectly heated storage tank are determined using data for:

- Av. water temp.
- Surrounding air temp.
- **Measured stand by heat loss**
- If measured data are unknow then use Eq. 5, provided the parameters **x,y,z** are given in a national annex!

DHW generator heat losses

Two cases are distinguished:

- Single family dwelings (kućanstvima)
- Other buildings

For dwelings the **test data** for boiler efficiency recorded at low, average and high tapping program (EN 15316 3-1) are needed!

DHW generator heat losses- oil and gas fired boilers

Calculation is based on

- **Measured** nominal power efficiency
- **Measured** stand by losses $Q_{W,gen,ls,sby}$
- when boiler provides heat to the heating system then $Q_{W,gen,ls,sby}=0$

When measured data are not available we recommend to use the **Case specific boiler efficiency method** from EN 15316-4-1.

DHW generator heat losses-directly gas fired storage heater

- In an absence of test data the heat losses are taken as being 20% lower then max allowed value according to EN 89 i.e.

  $P_{W,gen\ /\ st,ls}$=250 W for period of 24h/day **(6 kWh/dan**-in reality<1 kWh/day**)**
- Total heat losses are obtained by adding heat losses of the boiler itself $(1-\eta_{gen})\cdot Q_{W,gen,out}$ at the output power $Q_{W,gen,out}$

  η_{gen}= 84%

  η_{gen}= 98% for condensing types

DHW generator heat losses-el. heated storage heaters

1. Continuous heating
2. Intermittent heating

Add 1) test data for heat losses are needed

Add 2) test data are not needed

- Daily tapping patterns should be defined
- Standard heat loss is $Q_{W,gen\ /\ st,\ ls,\ nom}$ =**1,7 MJ/day** (0,47 kWh/day)
- After taking into account temp. stratification in a tank the heat losses for 200 Lit vessel are **<1 MJ/day** (<0,3 kWh/day)

Auxiliary energy calculation

- Test data are needed (recorded at 100% power, pressure drop of 10 kPa in the primary loop)
- It is necessary to determine operational time periods when DHW is heated $t_{W,gen,nom}$ and separately runnig time of the generator $t_{gen,nom}$– not defined in the standard how to calculate these values (maybe it is possible to use $t_{ON,gn}$ Eq. (12) from EN 15316-4-1)

Recoverable heat losses

- Heat losses from generator and auxiliary equipment released to the surrounding air are taken as $Q_{W,gen,ls,rbl}=0$!!
- Not defined how to obtain recoverable aux energy delivered to the water (possible use of EN 15316 3-2 for circulation loop-i.e. 80% of $W_{W,dis,pmp}$ F.3)

DHW generation subsystem

EN 15316-3-3 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 3-3: Domestic hot water systems, generation;

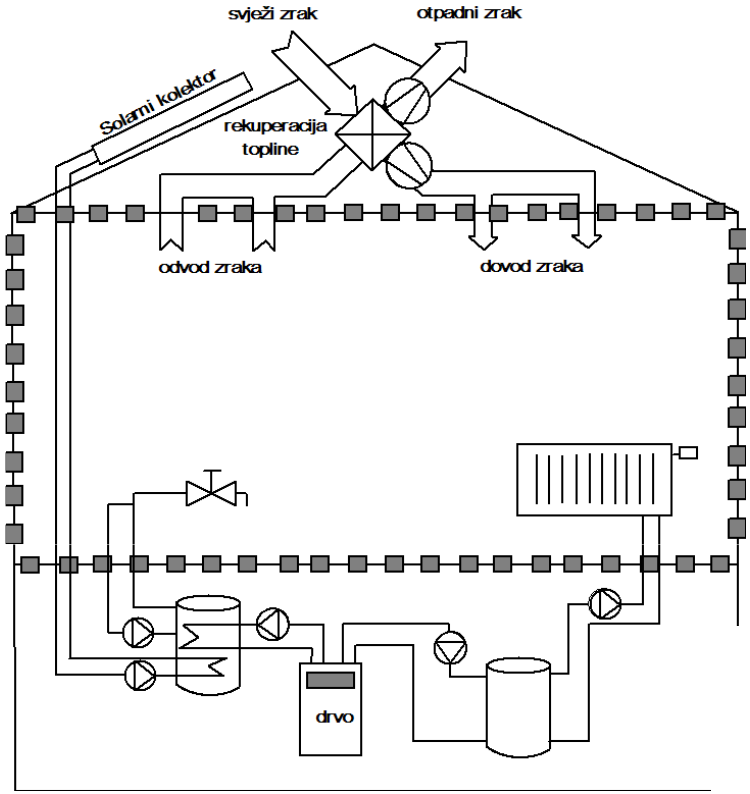
Questions and remarks

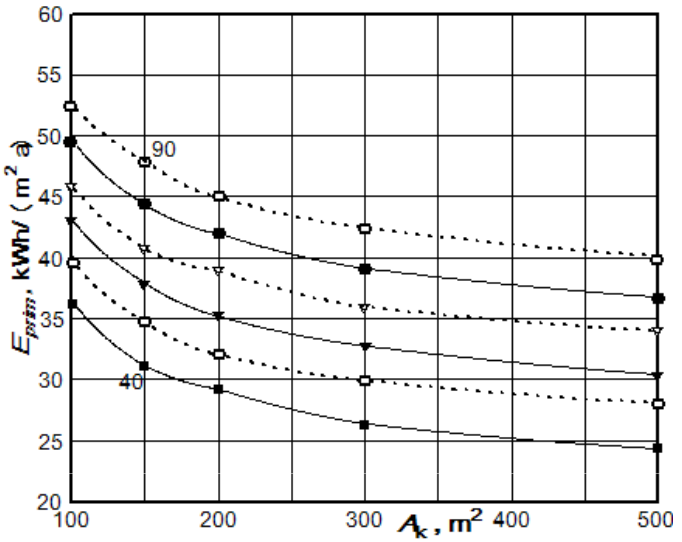
1. Eq. (5) - if parameters x,y,z are unknown and no test dana are available – the water storage vessel losses can not be calculated by using this standard
2. Chapter 7.3 - how to estimate the heat losses form primary pipes if exact pipe length is unknown (and national Annex is not available too)?
3. How to calculate the generation heat losses if test data are not available?

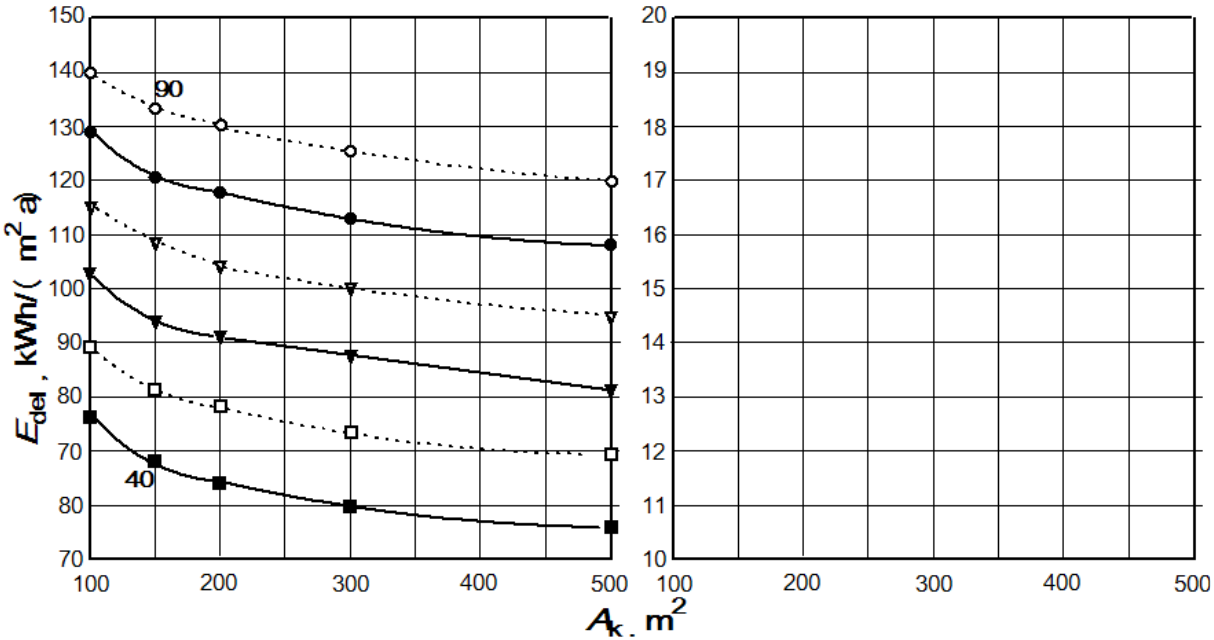
(The case specific boiler efficiency method from 15316 -4-1 (Anex B) can possibly be applied here for for oil and gas fired boilers)

4. How to determine recovered auxiliary energy delivered to the domestic water?
   - 4.1 Is it appropriate to use the value for circulation loop (80% of $W_{W,dis,pmp}$ F.3) from EN 15316 3-2
5. Is it possible to use default value of PW,gen / st,ls=250 W (Eq.B.2) also for indirectly heated hot water storage thermal losses calculation if measured values are not provided?
6. Eq. A.4 How to determine period of provision of domestic hot water $t_{Wgen,nom}$ i.e running time of boiler at nominal power $t_{gen,nom}$- is it possible to use $t_{ON,gn}$ Eq. 12 from EN 15316-4-1?

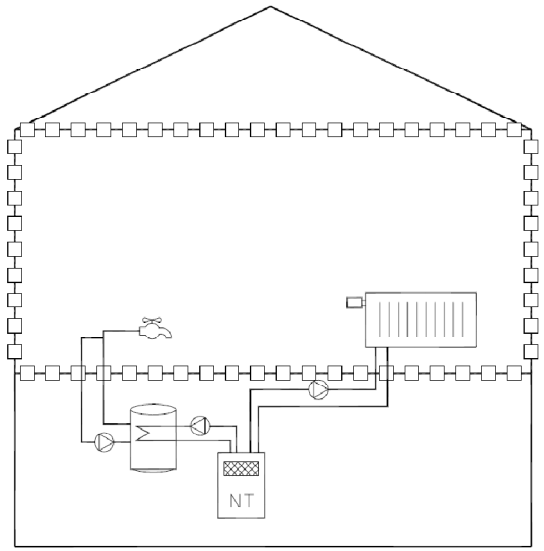
Tables based calculation –DIN V 4701-1; example







Primary energy calculation – examples from the Study of alternative systems usage



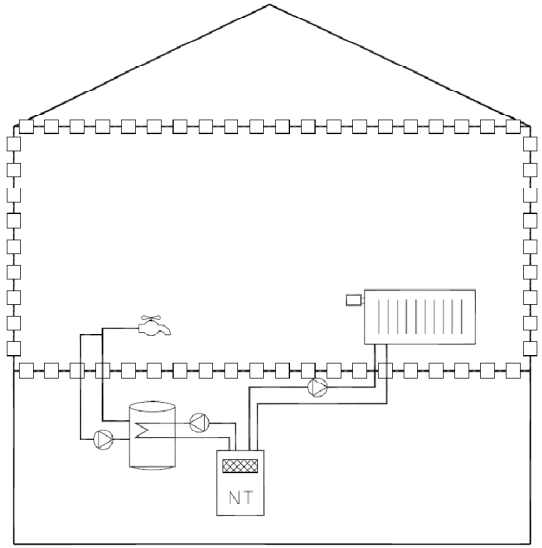
Ulazne veličine

Vrsta zgrade	Nova stambena zgrada s tri kata (>1000 m^2)
Adresa i katastarska čestica	-
Klimatski podaci (kontinentalna/primorska Hrvatska)	kontinentalna
Ploština korisne površine A_k [m^2]	1331

Osnovno rješenje-varijanta I

OPIS MJERA TOPLINSKE ZAŠTITE (prema proračunu i podacima iz arhitektonskog dijela projekta i ISKAZNICI POTREBNE TOPLINSKE ENERGIJE ZA GRIJANJE I TOPLINSKE ENERGIJE ZA HLAĐENJE)		
Koeficijent transmisijskog toplinskog gubitka $H_{tr,adj}$ [W/(m^2K)]	Izračunati: 0,46	Max.. dopušteni: 0,48
OPIS SUSTAVA GRIJANJA, HLAĐENJA I VENTILACIJE		
Izvori energije (grijanje , PTV, hlađenje, ventilacija, rasvjeta)	Niskotemperaturni plinski kotao (70/55℃) kombiniran s indirektno grijanim spremnikom PTV-a	
Način grijanja (lokalno, etažno, centralno, daljinski izvor),	Centralno, radijatori s termostat. ventilom, kotao i spremnik u negrijanoj zoni. Recirkulacija PTV-a.	
Način hlađenja (lokalno, etažno, centralno, daljinski izvor),	-	
Vrsta ventilacije (prirodna, prisilna bez povrata topline, prisilna s povratom topline)	Prirodna	
Vrsta i namjena korištenja sustava s obnovljivim izvorima energije	-	
RASVJETA	-	

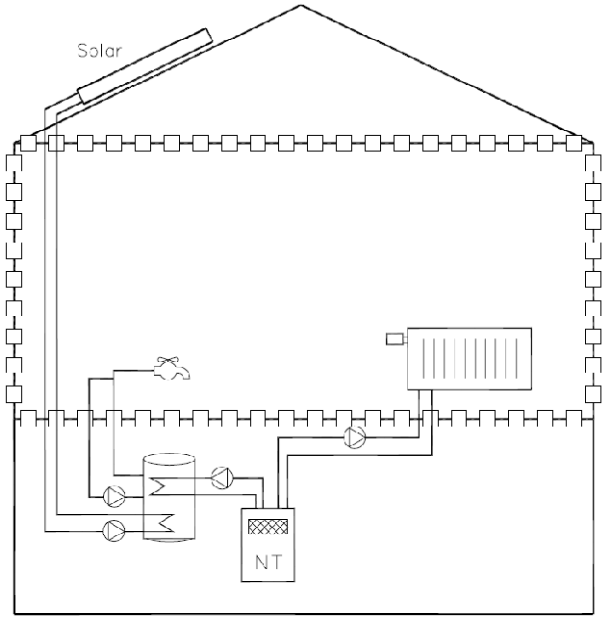
Primary energy calculation - examples



	Izračunato za stvarne klimatske podatke				
	GRIJANJE	**PTV**	**VENTILACIJA**	**HLAĐENJE**	**RASVJETA**
	$Q_{H,nd}$	$Q_{W,nd}$	Q_{Ve}(bez gub.)	$Q_{C,nd}$	E_l
Apsolutna potreba, kWh/a	93170	16638	-	-	-
Svedena potreba na A_k, kWh/(m^2 a)	70	12,5	-	-	-
Najveća dopuštena, kWh/(m^2a)	84,7	-	-	-	-
Neisk.gubici sustava, [kWh/a]	$Q_{H,ls}$	$Q_{W,ls}$	$Q_{Ve,ls}$	$Q_{C,ls}$	-
	13709	13310	-	-	-
Pomoćna energija,[kWh/a]	$E_{H,p}$	$E_{W,p}$	$E_{Ve,p}$	$E_{C,p}$	-
	932	399	-	-	-

Godišnja isporučena energija građevini, E_{del}	138158 [kWh/a]	103,8 [kWh/m^2a]
Godišnja primarna energija, E_{prim}	153997 [kWh/a]	115,7 [kWh/m^2a]
Koeficijent utroška sustava, $e_p = E_{prim,H}/(Q_{H,nd}+Q_{W,nd})$	1,40	
Godišnja emisija CO_2 , [kg/a] (prema NN. 113/08)	28071 (svedeno na E_{del} za plin i el.energiju)	
Udio obnovljivih izvora energije u ($Q_{H,nd}+Q_{W,nd}$), [%]	0	

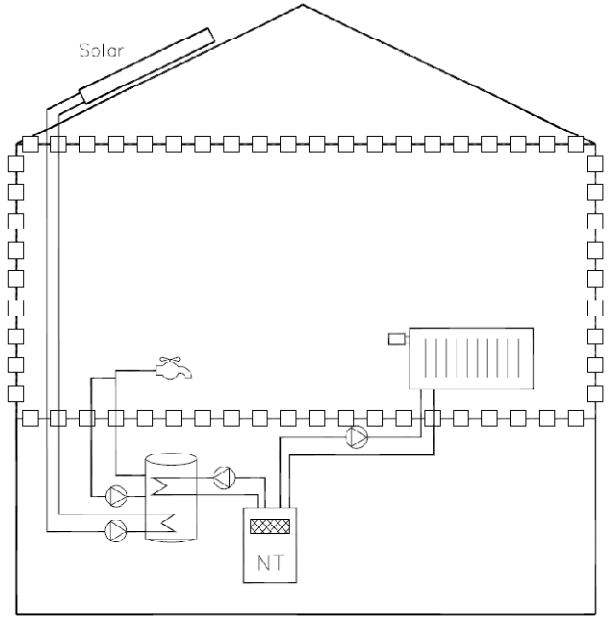
Primary energy calculation - examples



Alternativno rješenje-varijanta II

OPIS MJERA TOPLINSKE ZAŠTITE (prema proračunu i podacima iz arhitektonskog dijela projekta i ISKAZNICI POTREBNE TOPLINSKE ENERGIJE ZA GRIJANJE I TOPLINSKE ENERGIJE ZA HLAĐENJE)		
Koeficijent transmisijskog toplinskog gubitka $H_{tr,adj}$ [W/(m^{2}K)]	Izračunati: 0,46	Najv. dopušteni: 0,48
OPIS SUSTAVA GRIJANJA, HLAĐENJA I VENTILACIJE		
Izvori energije (grijanje , PTV, hlađenje, ventilacija, rasvjeta)	Kondenzacijski plinski kotao (70/55°C) + solarni kolektori kombinirani s indirektno grijanim spremnikom PTV-a i recirk.	
Način grijanja (lokalno, etažno, centralno, daljinski izvor),	Centralno, radijatori s termostat. ventilom, kotao i spremnik u negrijanoj zoni	
Način hlađenja (lokalno, etažno, centralno, daljinski izvor),	-	
Vrsta ventilacije (prirodna, prisilna bez povrata topline, prisilna s povratom topline)	Prirodna	
Vrsta i namjena korištenja sustava s obnovljivim izvorima energije	Pločasti solarni kolektori spojeni na spremnik PTV-a, dogrijavanje kond. kotlom	
RASVJETA	-	

Primary energy calculation - examples

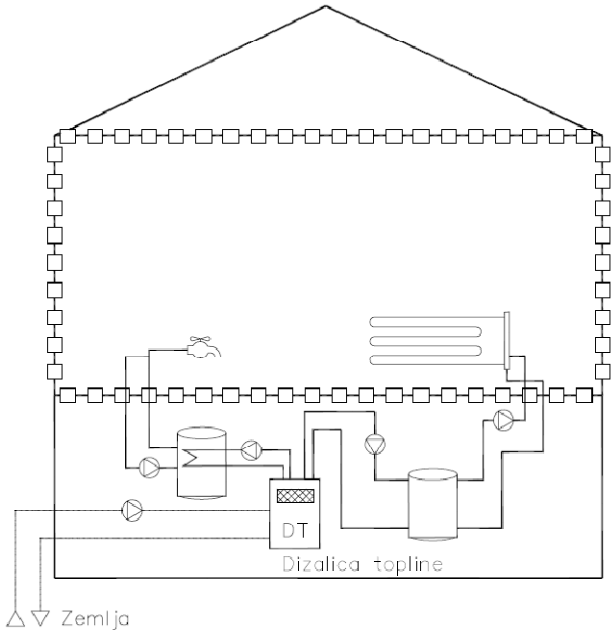


Energetske potrebe zgrade- Alternativno rješenje (Kondenzacijski kotao +sunčeva energija)

	Izračunato za stvarne klimatske podatke				
	GRIJANJE	**PTV**	**VENTILACIJA**	**HLAĐENJE**	**RASVJE**
	$Q_{H,nd}$	$Q_{W,nd}$	Q_{Ve}(bez gub.)	$Q_{C,nd}$	E_l
Apsolutna potreba, kWh/a	93170	16638	-	-	-
Svedena potreba na A_k, kWh/(m^2 a)	70	12,5	-	-	-
Najveća dopuštena, kWh/(m^2a)	84,7	-	-	-	-
Neisk.gubici sustava, [kWh/a]	$Q_{H,ls}$	$Q_{W,ls}$	$Q_{Ve,ls}$	$Q_{C,ls}$	-
	6712	7063	-	-	-
Pomoćna energija,[kWh/a]	$E_{H,p}$	$E_{W,p}$	$E_{Ve,p}$	$E_{C,p}$	-
	1158	250	-	-	-

Godišnja isporučena energija građevini, E_{del}	117261 [kWh/a]	88 [kWh/m^2a]
Godišnja primarna energija, E_{prim}	131769 [kWh/a]	99,0 [kWh/m^2a]
Koeficijent utroška sustava, $e_p = E_{prim,H}/(Q_{H,nd}+Q_{W,nd})$	1,20	
Godišnja emisija CO_2 , [kg/a] (prema NN. 113/08)	23891 (svedeno na E_{del} za plin i el.ene	
Udio obnovljivih izvora energije u ($Q_{H,nd}+Q_{W,nd}$), [%]	7 %	
Uštede u isporučenoj energiji u odnosu na polaz. rješenje.	20897 [kWh/a]	4830 [kn/a]
Period povrata investicije, [a]		

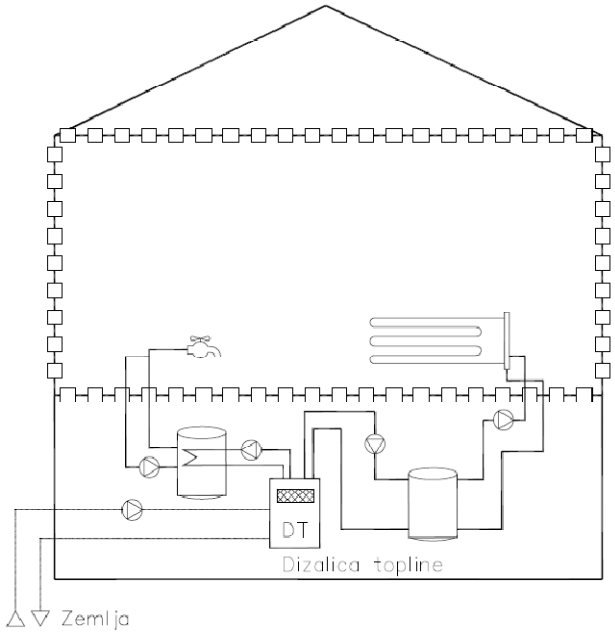
Primary energy calculation - examples



Alternativno rješenje-varijanta III

OPIS MJERA TOPLINSKE ZAŠTITE (prema proračunu i podacima iz arhitektonskog dijela projekta i ISKAZNICI POTREBNE TOPLINSKE ENERGIJE ZA GRIJANJE I TOPLINSKE ENERGIJE ZA HLAĐENJE)		
Koeficijent transmisijskog toplinskog gubitka $H_{tr,adj}$ [W/(m^{2}K)]	Izračunati: 0,46	Najv. dopušteni: 0,48
OPIS SUSTAVA GRIJANJA, HLAĐENJA I VENTILACIJE		
Izvori energije (grijanje , PTV, hlađenje, ventilacija, rasvjeta)	Dizalica topline (55/45°C) sa pripad. spremnikom+ indirektno grijani spremnik PTV-a i recirk.	
Način grijanja (lokalno, etažno, centralno, daljinski izvor),	podno, kotao i spremnik u negrijanoj zoni	
Način hlađenja (lokalno, etažno, centralno, daljinski izvor),	-	
Vrsta ventilacije (prirodna, prisilna bez povrata topline, prisilna s povratom topline)	Prirodna	
Vrsta i namjena korištenja sustava s obnovljivim izvorima energije		
RASVJETA	-	

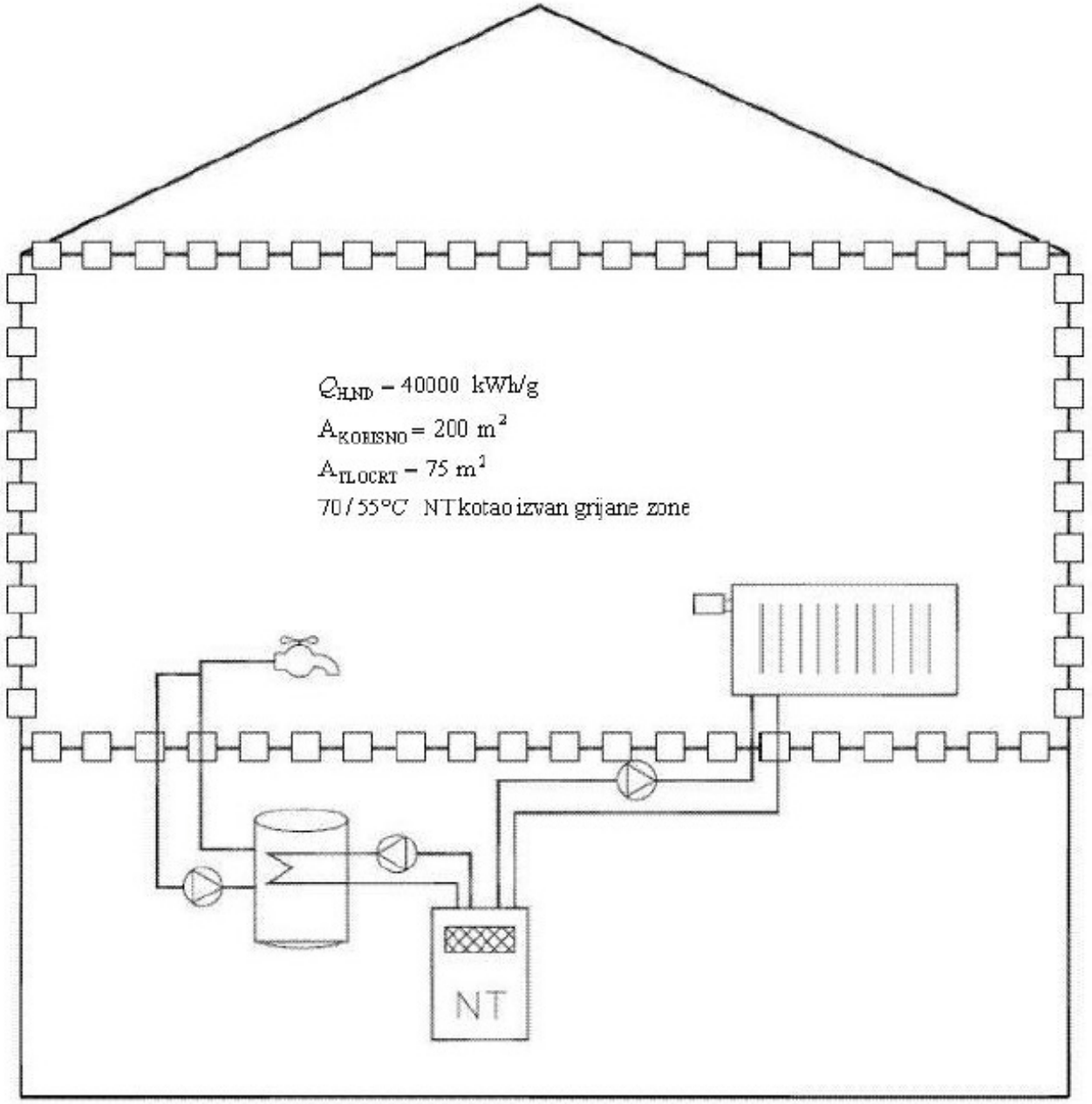
Primary energy calculation - examples



Energetske potrebe zgrade- Alternativno rješenje (Dizalica topline+podno grijanje)

	Izračunato za stvarne klimatske podatke				
	GRIJANJE	**PTV**	**VENTILACIJA**	**HLAĐENJE**	**RASVJETA**
	$Q_{H,nd}$	$Q_{W,nd}$	Q_{Ve}(bez gub.)	$Q_{C,nd}$	E_l
Apsolutna potreba, kWh/a	93170	16638	-	-	-
Svedena potreba na A_k, kWh/(m^2 a)	70	12,5	-	-	-
Najveća dopuštena, kWh/(m^2a)	84,7	-	-	-	-
Neisk.gubici sustava, [kWh/a]	$Q_{H,ls}$	$Q_{W,ls}$	$Q_{Ve,ls}$	$Q_{C,ls}$	-
	3451	14331	-	-	-
Pomoćna energija,[kWh/a]	$E_{H,p}$	$E_{W,p}$	$E_{Ve,p}$	$E_{C,p}$	-
	3101	1238	-	-	-
Napomena: stupanj djelovanja diz. topline COP_h=3,7					
Godišnja isporučena energija građevini, E_{del}			38788 [kWh/a]	29,1 [kWh/m^2a]	
Godišnja primarna energija, E_{prim}			116370 [kWh/a]	87,4 [kWh/m^2a]	
Koeficijent utroška sustava, $e_p = E_{prim,H}/(Q_{H,nd}+Q_{W,nd})$			1,06		
Godišnja emisija CO_2 , [kg/a] (prema NN. 113/08)			20558 (svedeno na E_{del} za el.energiju)		
Udio obnovljivih izvora energije u ($Q_{H,nd}+Q_{W,nd}$), [%]			0		
Uštede u isporučenoj energiji u odnosu na polaz. rješenje.			99370 [kWh/a]	9860 [kn/a]	
Period povrata investicije, [a]					

Primary energy calculation using EN 15316 - example



Primary energy calculation using EN 15316 - example

	Heating (kWh/a)	DHW (kWh/a)	Tot.
Energy need	40000	2050	42050
Emission subsystem	5160		
Distribution subsystem	7621	333,8	
Storage tank		255,5	
Primary circulation		440	
Generation subsystem	6319-only space heat.	1735-summer	
	132- + DHW	132 - winter	
Total losses	19232	2764	21996
Aux. energy	368	8	376
Delivered energy	59232	4844	64076
Primary energy	66230	5320	**71550**
e_p (primary/usefull)			1,575

LITERATURE

[1] Direktiva 2002/91/EC o energetskim svojstvima zgrada / *Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (Official Journal L 001,04/01/2003)*

[2] Tehnički propis o racionalnoj uporabi energije i toplinskoj zaštiti zgrada NN 110/08

[3] Tehnički propis o sustavima grijanja i hlađenja zgrada NN 110/08

[4] Pravilnik o energetskom certificiranju zgrada NN 113/08

[5] HRN EN 15603:2008 – Energy performance of buildings - Overall energy use and definition of energy ratings (EN 15603:2008)

[6] HRN EN ISO 13790:2008 - Energy performance of buildings – Calculation of energy use for space heating and cooling (EN ISO 13790:2008)

[7] HRN EN 15316 Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies

[8] DIN V 4701-10 Energy efficiency of heating and ventilation systems in buildings - Part 10: Heating, domestic hot water supply, ventilation

[9] EIHP/FSB: Studija primjenjivosti alternativnih izvora energije kod novih i postojećih zgrada

Thank you for your attention

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