

Poraba energije v gospodinjstvih

Energy Use in Households

Jurij Modic

V Sloveniji je približno 660.000 gospodinjstev. Z uporabo statističnih podatkov (dobljenih v okviru mednarodnega projekta SACHA 2/Energy 2000) smo analizirali električne gospodinjske aparate in njihovo porabo energije v slovenskih gospodinjstvih. Emisije CO₂ in SO₂ so izračunane na podlagi znanih energijskih virov (premog, hidroelektrarne, jedrska elektrarna) in porabe. Zamenjava manj učinkovitih električnih naprav z učinkovitejšimi se kaže pri zmanjšanju porabe električne energije, manj je tudi konic obremenitev in emisij iz elektrarn.

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(Ključne besede: gospodinjstva, poraba energije, aparati gospodinjski, učinkovitost energijska)

There are about 660,000 households in Slovenia. Based on questionnaire data (as part of the SACHA 2/Energy 2000 international project) we have analysed the electrical appliances in Slovenian households and their energy consumption. The CO₂ and SO₂ emissions were calculated on the basis of known electricity consumption and known electricity sources (coal, hydro and nuclear power plants). The replacement of less efficient electrical appliances is reflected in a reduced electricity consumption, reduced peak loads and a reduction in the emissions from power plants.

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(Keywords: households, energy consumption, household appliances, energy efficiency)

0 OSNOVE IN PREDSTAVITEV

Od leta 1995 so Evropska komisija, Program EU SAVE in Ekonomska komisija ZN za Evropo (Projekt energijske učinkovitosti 2000) sponzorirale t. i. projekt SACHA glede domače in terciarne električne energije ter porabe v srednjih in vzhodnoevropskih državah. SACHA je akronim naziva prvega projekta: "*State of the Art of Cooling Household Appliances - Stanje tehnike gospodinjskih hladilnih naprav - Standardi, trg in tehnologija v srednje in vzhodnoevropskih deželah za uporabo programov energetske učinkovitosti v državah članicah srednje in vzhodne Evrope*", ki je bil končan oktobra 1997 (trajal je 20 mesecev). Decembra 1998 so pričeli s projektom SACHA-2¹, v juniju tega leta pa je bil financiran tudi SACHA-2.1².

Glavni namen tega projekta sta bili analiza in interpretacija hladilnih gospodinjskih naprav (HGN) v štirih vzhodnoevropskih državah (Belorusija, Bolgarija, Madžarska in Ukrajina), da bi: i) povečali dosedanje znanje in ii) napisali scenarije za izboljšanje glede na energijsko

0 BACKGROUND AND INTRODUCTION

Since 1995 the European Commission in the form of the EU SAVE Programme and the Economic Commission for Europe of the UN (Energy Efficiency 2000 Project) have jointly sponsored the so-called "SACHA" projects in Central and Eastern European Countries on domestic and tertiary electrical end uses. SACHA is the acronym from the title of the first project: "*State of the Art of Cooling Household Appliances Standards, Market and Technology in Central and Eastern European Countries for Energy Efficiency Programmes Implementation in ECE Member State*", which was completed in October 1997 (20 months duration). In December 1998 the SACHA-2¹ project started, and in June of this year the SACHA-2.1² project was also financed.

The main objective of the first project was to analyse and interpret the situation with respect to Cooling Household Appliances (CHA) in four ECE Countries (Belarus, Bulgaria, Hungary and Ukraine), in order to: i) increase current knowledge, and ii) identify possible scenarios for improvement with regard to the issues of energy efficiency and environmental friendliness, and there-

učinkovitost in prijaznost okolju in nato iii) predlagali pristojnim oblastem politiko in ukrepe v elektrogospodarstvu. Glede na velik uspeh prve naloge, so pri projektih SACHA-2 in 2.1 povečali število proučevanih držav na sedem, dodali so Češko republiko, Romunijo in Slovenijo. Kot dodatni sektorji in izdelki pa so bili vključeni še pralni gospodinjski aparati (PGA) in domača/terciarna osvetljava (DTO).

Projekt SACHA-2 in dodatni del za razsvetljavo SACHA 2.1 uporabljata in posodabljata metode, ki so bile določene in učinkovite pri prvem projektu, da bi s tem povečali znanje na področju gospodinjskih naprav/osvetljave v državah srednje in vzhodne Evrope.

1 NAMEŠČENE NAPRAVE – GOSPODINJSKI APARATI

1.1 Hladilne gospodinjske naprave

Funkcionalno delovanje se povečuje z zmanjševanjem temperature v vsakem prostoru. Temperatura in ustrezna zmogljivost so podane v mednarodnih/evropskih standardih.

V Belorusiji, Romuniji, Sloveniji in Ukrajini imajo skoraj vsi nameščeni modeli zamrzovalnik, sledijo Madžarska z 84% takih modelov, Bolgarija in Republika Češka s približno 70% (69,4% v Republiki Češki in 67,5% v Bolgariji).

1.1.1 Porazdelitev prostornine hladilnih gospodinjskih naprav

V Belorusiji ima več ko 70% nameščenih hladilnikov prostornino med 200 in 300 litri ali več,

fore iii) identify and propose to national authorities possible policies and measures in the domestic electrical end-use sector. As a result of the great success of the first exercise, the SACHA-2 and 2.1 projects increased the number of investigated countries to seven, with Czech Republic, Romania and Slovenia joining the Working Group, and Washing Household Appliances (WHA) and Domestic/Tertiary Lighting (DTL) added as sectors and products to be analysed.

The SACHA-2 project and the additional part relating to lighting in the SACHA 2-1 project make use of and update the methodology defined and validated in the first project to increase knowledge in the field of household appliances/lighting Central and Eastern European Countries.

1 PROFILE OF INSTALLED HOUSEHOLD APPLIANCES

1.1 Cooling Household Appliances

In general, the performance increases with a decrease in the temperature reached in each type of compartment. The temperature and corresponding performance are set by international/European standards for most of the compartments.

In Belarus, Romania, Slovenia and Ukraine almost all installed models have a freezer compartment, followed by Hungary with 84% and then by Bulgaria and Czech Republic with around 70% (69.4% in Czech Republic and 67.5% in Bulgaria).

1.1.1 Cooling Household Appliances Volume Distribution

In Belarus, more than 70% of the installed refrigerators have a volume between 200 and 300 litres, while small

Preglednica 1. Primerjava nameščenih hladilnih naprav v srednje in vzhodnoevropskih državah
Table 1. Estimated compartment composition for installed refrigerators in ECE countries

Nameščene naprave Installed appliances	Belorusija Belarus		Bolgarija Bulgaria		Češka Czech Rep.		Madžarska Hungary		Romunija Romania		Slovenija Slovenia		Ukrajina ('95) Ukraine ('95)	
	Št. No	%	Št. No	%	Št. No	%	Št. No	%	Št. No	%	Št. No	%	Št. No	%
enote z zamrzovalnikom units with freezer compart.	1002	100	672	67,5	705	69,4	818	84,1	924	99,4	973	98,6	911	99,9
enote brez zamrzovalnika units without freezer compart.	0	0	321	32,5	311	30,6	155	15,9	6	0,6	14	1,4	1	0,1
skupaj total	1002		988		1016		973		930		987		912	
baza (lastniki hladilnikov) base (RF owners)	1002		996	99,2	1016		1007	(96,6)	930		989	(99,8)	915	(99,7)

¹ Projekt SACHA-2: Stanje tehnike gospodinjskih hladilnih in drugih večjih naprav - Standardi, trg in tehnologija v srednje in vzhodnoevropskih deželah za izboljšanje izkoristka v državah članicah ECE.

¹ SACHA-2 project: "State of the Art of Cooling Household and Other Major Appliances Standards, Market and Technology in Central and Eastern European Countries for Energy Efficiency Improvement in ECE Member States".

² Projekt SACHA2.1: Stanje tehnike osvetljevalnih sistemov in gradnikov - Standardi, trg in tehnologija v srednje in vzhodnoevropskih deželah za izboljšanje izkoristka v državah članicah ECE.

² SACHA-2.1 project: "State of the Art of Lighting Systems and Components, Standards, Market and Technology in Central and Eastern European Countries for Energy Efficiency Improvement in ECE Member States".

majhnih hladilnikov tu ni. V Bolgariji, če izločimo majhne in velike enote, se giblje 25% prostornin hladilnikom med 250 in 300 litri, manjše število pa je takih med 150 in 200 litri. Republika Češka in Madžarska imata zelo podobno porazdelitev prostornine, 100 do 250 in 150 do 200. Tudi v Romuniji imajo modeli prostornine med 100 in 250 litri, največ pa jih je med 200 in 250 litri (kar 43%, medtem ko je takih na Madžarskem le 30%); naprav s prostornino manjšo od 100 litrov in večjo od 250 je skupno manj ko 5%. V Sloveniji je približno 90% naprav manjših od 200 litrov, 40% jih je med 100 in 150 litri. V Ukrajini ne obstajajo hladilniki do 100 litrov, tam je kar 75% vseh med 150 in 250 litri.

1.1.2 Značilnosti zamrzovalnih predelov

V vseh državah razen Češke republike so zamrzovalniki z dvema zvezdicama najbolj pogosti, razlikujejo se glede odstotka, od 73% v Romuniji do 32% v Bolgariji (leto 1995). Drugi najpogostejši zamrzovalnik s tremi zvezdicami je v Belorusiji (32,4% v 1995, glede odstotkov zelo blizu zamrzovalniku z dvema zvezdicama), Madžarski (33,3%, v istem letu), Romuniji (12,4%) in Sloveniji (37,3%, tudi glede odstotkov zelo blizu zamrzovalniku z dvema zvezdicama). Zamrzovalnik brez zvezdic je najpogostejši v Bolgariji (24,3%, v letu 1995), z eno zvezdico v Ukrajini (23,6%, leta 1995), in s štirimi zvezdicami v Republiki Češki (32,2%). V Bolgariji je bilo leta 1995 okoli 22% zamrzovalnikov s štirimi zvezdicami.

V Bolgariji in Češki republiki imajo najbolj enakomerno porazdelitev prostornin po kategorijah, tam so zamrzovalniki do 75 litrov

appliances are absent. In Bulgaria, excluding very small and large units, volumes are more evenly distributed, with 250 to 300 litre units corresponding to 25% of the stock with fewer units in the range 150 to 200 litres. Czech Republic and Hungary show a very similar volume distribution, with most of the appliances distributed in the range 100 to 250 litres, with a peak at 150 to 200 litres which is slightly higher Hungary. For Romania most of the installed models also lie in the range 100 to 250 litres, with a large peak (about 43%, against about 30% of Hungary) at 200 to 250 litres; appliances with a volume lower than 100 litres and larger than 250 account for less than 5%. In Slovenia about 90% of the installed units are less than 200 litres, with 40% between 100 and 150 litres. In Ukraine no units of less than 100 litres exist, and about 75% are between 150 and 250 litres.

1.1.2 Freezer-Compartment Characteristics

In all countries except Czech Republic two-star freezers are the majority, but with different percentages, ranging from about 73% in Romania down to about 32% in Bulgaria in 1995. The next most common types of freezer are the three-star in Belarus (32.4% in 1995, very close in percentage to the two-star), Hungary (33.3% in the same year), Romania (12.4%) and Slovenia (37.3%, similar to the number of two-star freezers, the 0-star in Bulgaria (24.3% in 1995), the one-star in Ukraine (23.6% in 1995), and the four-star in Czech Republic (32.2%). In Bulgaria four-star freezers were also around 22% in 1995.

Bulgaria and Czech Republic show the most even distribution of models in volume categories, with compartments up to 75 litres more common than larger volumes. In Hungary and Slovenia around 70% of the installed units have a freezer compartment up to 25 litres, and this percentage increases to around 80% in Roma-

Preglednica 2. Položaj zamrzovalnikov s štirimi zvezdicami v kombinaciji hladilnik/zamrzovalnik v srednje in vzhodnoevropskih državah (leta 1995 in 1997)

Table 2. Position of the four-star freezer for installed fridge/freezers in ECE (1995 and 1997)

Dežela Country	Zgoraj Top		Spodaj Bottom		Skupaj Tot. Št. No.
	Št. No.	%	Št. No.	%	
Belorusija ('95) Belarus ('95)	75	72,1	29	27,9	104
Bolgarija ('95) Bulgaria ('95)	102	68,9	46	31,1	148
Češka republika Czech Republic	49	34,3	94	65,7	143
Madžarska ('95) Hungary ('95)	73	57,9	53	42,1	126
Romunija Romania	52	89,7	6	10,3	58
Slovenija Slovenia	102	74,6	33	24,4	135
Ukrajina ('95) Ukraine ('95)	15	83,3	3	16,7	18

najbolj pogosti. Na Madžarskem in v Sloveniji ima 70% nameščenih enot zamrzovalnikov do 25 litrov, v Romuniji je teh 80%. V Belorusiji so najbolj pogosti zamrzovalniki s prostornino med 25 in 50 litri, medtem ko v Ukrajini prevladujejo taki do 25 litrov.

Za Češko republiko, Romunijo in Slovenijo so raziskovali tudi nižjo kategorijo. Zasedili so enak trend; 86,1% in 92,8% zamrzovalnikov s tremi zvezdicami v Romuniji in Sloveniji in le 47,3% v Češki Republici.

1.1.3 Druge značilnosti hladilnikov in hladilnih zamrzovalnikov

Druge značilnosti hladilnikov in hladilnih zamrzovalnikov, tj. število zunanjih vrat in termostatov, prosto stoječi ali vgradni, debelina izolacije ter odtajevalni sistem, se razlikujejo po državah.

Vse naprave imajo ena glavna ali dvojna vrata, po tri ali štiri imajo le zelo redki. Naprav z enimi vrati le od 60% pa do več ko 93%; le v Češki republici ima malo manj ko 40% hladilnikov dvojna vrata. V šestih od sedmih držav ima 90% ali več naprav po en termostat, dva termostata sta bolj običajna na Češkem (20,2%). Vgradni aparati predstavljajo več ko 25% vseh nameščenih v Sloveniji, 30% v Italiji in 8,6% v Češki republici. V vseh drugih državah imajo več ko 98% stoječih naprav. Za Belorusijo, Bolgarijo, Madžarsko in Ukrajino je bila v okviru projekta SACHA-1 kot možna izolacija uporabljena mineralna volna in je sedaj prikazana kot "drugi" tip izolacije.

Zamrzovalniki so bolj pokončnega (navpičnega) tipa v primerjavi z zabojastrim (vodoravnim) v vseh državah, razen v Sloveniji, kjer je takih približno dve tretjini; na Madžarskem je število pokončnih in zabojastrih skoraj enako (pokončnih je malo več, tabela 2.3). V zadnjem stolpcu so prikazani odstotki dobljenih odgovorov.

Skoraj vse enote (najmanj več ko 94%) so stoječe. Izolacija ima normalno debelino v nekaj več kot 40% naprav, pri približno polovici v Belorusiji in Ukrajini, približno 70% na Madžarskem in v Romuniji ter skoraj pri vseh napravah v Češki Republici (85%) in Sloveniji (92,1%). Nadpovprečno izoliranih naprav je od 20 do 30% v vseh državah, razen v Češki Republici in Sloveniji, kjer jih je 9,7% in 4,5%. Pri prvem projektu SACHA je bila v raziskave vključena tudi izolacija z mineralno volno, ki je sedaj vključena v "druge tipe" izolacij.

Ročni sistem odtajanja je najpogostejši v Češki republici, na Madžarskem, v Romuniji, Sloveniji in Ukrajini od 66,7% do 94,1%; le v Belorusiji je 70,6% naprav avtomatsko odtaljivih,

in. In Belarus and Ukraine most of the units belong to the first two volume categories, but in Belarus compartments from 25 to 50 litres are the majority, while in Ukraina freezers up to 25 litres are more common.

For Czech Republic, Romania and Slovenia, the position of the freezer compartments with a lower star rating was also investigated. The same trend was detected, with 86.1% and 92.8% of the three-star freezer compartments on top in Romania and Slovenia, respectively, but only 47.3% in Czech Republic, where the majority of the freezers were again located at the bottom of the appliances.

1.1.3 Other refrigerator and fridge-freezer characteristics

Other features of installed refrigerators and fridge-freezers, such as the number of external doors and thermostats, free-standing or built-in design, insulation thickness and defrosting system vary from country to country.

Almost all appliances have one or occasionally two doors; three- and four-door models are very rare. Single-door units account for 60% to 93% of the total; only in Czech Republic do slightly less than 40% of the refrigerators have two doors. In six countries out of seven 90% or more of the appliances have one thermostat, two-thermostat models are again more common in Czech republic (20.2%). Built-in units represent more than 25% of the installed stock in Slovenia, very close to 30% in Italy, and 8.6% in Czech Republic. In all other countries free-standing models account for more than 98%. For Belarus, Bulgaria, Hungary and Ukraine, the alternative of mineral wool insulation was asked for in the framework of SACHA-1 project, and it is now indicated as "other" types of insulation.

Installed freezers tend to be of the upright (vertical) type, rather than chest (horizontal) models in all countries but Slovenia, where chest freezers account for about two thirds of the installed stock; in Hungary the distribution between vertical and horizontal units is almost even, with the upright type being slightly more common (Table 2.3). In the last column the percentage of answers from freezer owners is shown when less than 100% was achieved.

Almost all units (more than 94%) are "free-standing". Insulation has a normal thickness in slightly more than 40% of the appliances in Bulgaria, in about half in Belarus and Ukraine, around 70% in Hungary and Romania and almost all appliances in Czech Republic (85%) and Slovenia (92,1%). Super-insulated models are about 20-30% of the stock in all countries except for Czech Republic and Slovenia, where they account for 9.7% and 4.5%, respectively. Some mineral wool insulation was found in appliances from countries in the first SACHA project. This is now included in "other type" of insulation.

The defrosting system is mostly manual in Czech Republic, Hungary, Romania, Slovenia and Ukraine with the percentage going from 66.7% in Ukraine to 94.1% in Romania; only in Belarus are 70.6% of the appliances

Preglednica 3. Tipi nameščenih zamrzovalnikov v državah srednje in vzhodne Evrope v letih 1995 in 1997
Table 3. Installed freezer type in ECE countries in 1995 and 1997

Dežela Country	Pokončni Upright		Zabojasti Chest		Skupaj Tot. Št. No.
	Št. No.	%	Št. No.	%	
Belorusija ('95) Belarus ('95)	28	80,0	7	20,0	35
Bolgarija ('95) Bulgaria ('95)	185	66,5	93	33,5	278
Češka Republika Czech Republic	299	72,2	115	27,8	414
Madžarska ('95) Hungary ('95)	356	54,0	303	46,0	659
Romunija Romania	343	95,5	16	4,5	359
Slovenija Slovenia	234	33,1	474	66,9	708
Ukrajina ('95) Ukraine ('95)	9	90,0	1	10,0	10

medtem ko je v Bolgariji 40% avtomatskega in 40% ročnega. Zamrzovalnikov, ki jih ni treba odtajevati, ni ali pa jih je le majhen odstotek, izjema je tu Bolgarija, kjer imajo 12% takih primerov.

1.2 Pralni stroji

1.2.1 Splošne značilnosti pralnih strojev

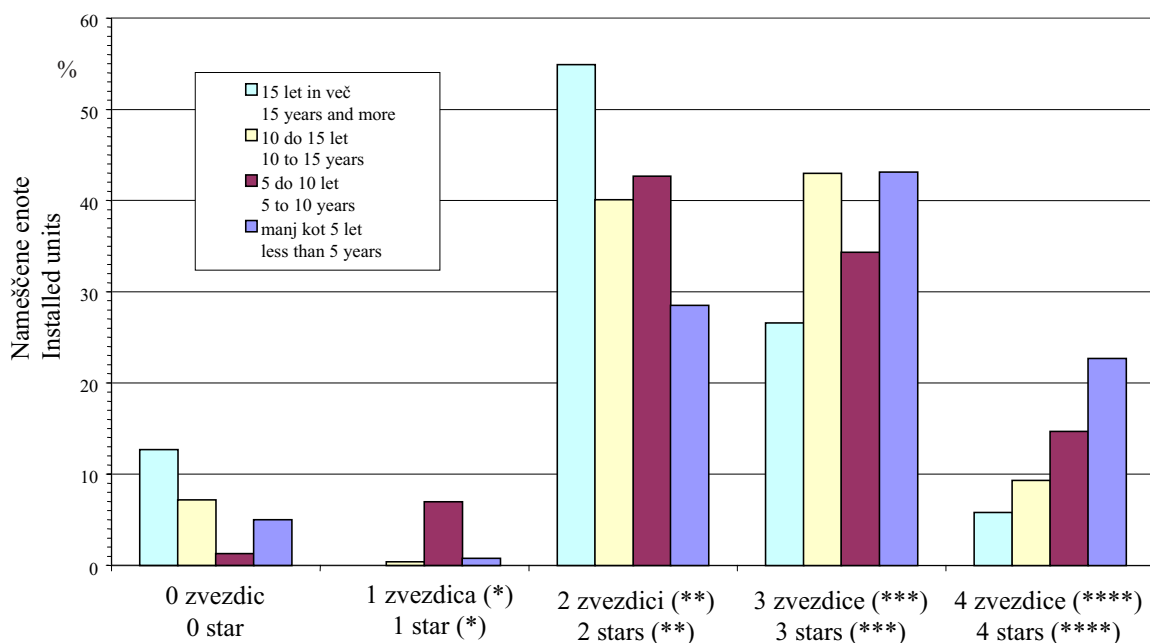
V različnih državah se odstotek posameznega tipa (avtomatski, polavtomatski ali ne-avtomatski) razlikuje. Neavtomatski modeli prevladujejo v Belorusiji, Romuniji in Ukrajini

automatically defrostable. In Bulgaria, automatic and manual defrosting account for about 40% each. No-frost freezers are either absent or represent just a few percent in all countries, the exception being Bulgaria where about 12% of the units are of the No-frost type.

1.2 Washing Machines

1.2.1 General characteristics of washing machines

The percentage of each type (automatic, semi-automatic or non-automatic) in the different countries varies. Non-automatic models are the great majority in Belarus, Romania and Ukraine (87.8%, 70.2% and 82.3%

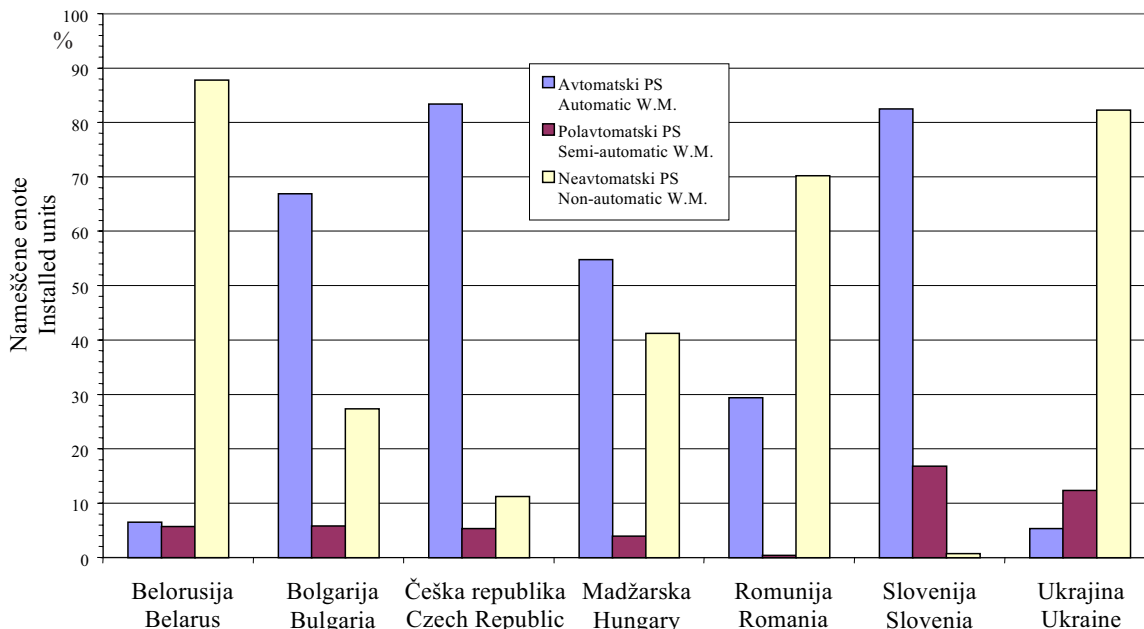


Sl. 1. Nameščeni hladilniki in spremembe prostornin z leti (Slovenija)

Fig. 1. Installed refrigerators and volume modification with age (Slovenia)

(87,3%, 70,2%, 82,3%) in jih praktično ne najdemo v Sloveniji (manj kot 1%), medtem ko avtomatski prevladujejo v Bolgariji, Češki republiki in Sloveniji (66,9%, 83,4% in 82,5). V Belorusiji in Ukrajini jih je približno 5-6%. Na Madžarskem pa je: avtomatskih je približno 55%, neavtomatskih pa 41%. Primerjava med državami je prikazana na sliki 2.

respectively), and practically absent in Slovenia (less than 1%), while automatic appliances are the majority in Bulgaria, Czech Republic and Slovenia (66.9%, 83.4% and 82.5% respectively) and around 5-6% in Belarus and Ukraine. Hungary is in an intermediate position, with automatic and non-automatic models accounting for about 55% and 41%, respectively. A comparison among countries is shown in Figure 2.



Sl. 2. Tipi nameščenih pralnih strojev v državah srednje in vzhodne Evrope
 Fig. 2. Installed washing machines type in ECE countries

Z razliko od HGN imajo domači pralni stroji le pet možnih nominalnih obremenitev prostornine. Največja količina perila, ki ga operemo v pralnem stroju, je lahko 3 kg ali manj, 4,5 kg, 5 kg in 7 kg. Obremenitev avtomatskih pralnih strojev v Evropski skupnosti je med 4,5 in 5 kg, manj običajne so vrednosti 3 kg ali več kot 5 kg. Medtem pa polavtomatske in neavtomatske modele uporabljajo le redko in le za določene namene in njihova prostornina znaša 3 kg ali manj.

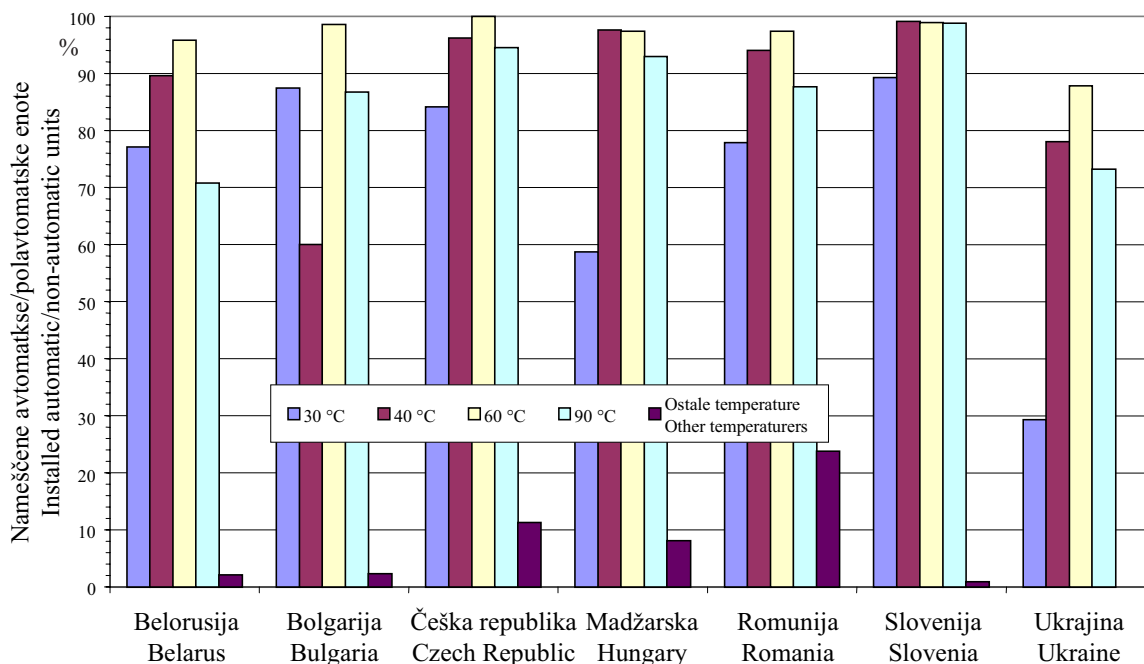
Pralnih strojev, katerih obremenitev znaša 5 kg, je manj kot 5% v Romuniji in Ukrajini, približno 10% v Češki republiki, približno 12 do 13% v Belorusiji, Bolgariji in na Madžarskem in 39% v Sloveniji. Več je pralnih strojev z nominalno obremenitvijo 7 ali več kg.

Naprave, ki imajo odprtino za vlaganje perila s čelne strani, prevladujejo v Bolgariji in Sloveniji. Medtem ko prevladujejo v Belorusiji, na Madžarskem, v Romuniji in Ukrajini naprave, ki imajo odprtino na vrhu. V Češki republiki uporabljajo oba tipa. Najpomembnejša tehnična značilnost je program pranja (temperatura in vrsta tkanine), ki ga ponuja posamezen model in so predstavljeni na sliki 3.

Unlike CHA, domestic washing machines present only five possible nominal loading capacities, i.e. the maximum amount of laundry that can be washed together in a washing cycle. These loading capacities are 3 kg or less, 4.5 kg, 5 kg and 7 kg. In the European Union, automatic washing machines are mostly 4.5 kg and 5 kg, with 3 kg and more than 5 kg much less common. Semi-automatic and non-automatic models are rare and used only for specific applications, their loading capacities are 3kg or less.

Five kg load washing machines account for less than 5% in Romania and Ukraine, around 10% in Czech republic, around 12 to 13% Belarus, Bulgaria and Hungary and around 39% in Slovenia. Larger washing machines, with a nominal load of 7 kg or more are rare.

Front-loading appliances are the majority in Bulgaria and Slovenia, while top-loading machines are more common in Belarus, Hungary, Romania and Ukraine. Czech Republic is in an intermediate situation with front-loading and top-loading machines accounting for about half of the installed stock, with the former type of washing machine being slightly more common. The most important technical characteristic is the washing programme (temperature and textile to be washed) offered by each model, as presented in Figure 3.



Sl. 3. Temperature pranja nameščenih pralnih strojev v državah srednje in vzhodne Evrope (1997)
 Fig. 3. Washing cycle temperatures for installed automatic machines in ECE countries (1997)

2 EMISIJE CO₂

Slovenska gospodinjstva potrebujejo za HGN in PGA približno 25% celotne energijske porabe Slovenije, kar pomeni 2670 GWh v enem letu.

Iz termoelektarn pridobijo 33% oz. 885 GWh. Za tri različne vrste premoga so izračunali emisije CO₂. Izračuni so pokazali, da slovenska gospodinjstva za HGN in PGA "proizvedejo" 890 Mt CO₂ na leto.

2 CO₂ EMISSIONS

Slovenian households account for about 25% of the Slovenian electricity consumption, which means 2670 GWh in one year.

The rate of thermo power plants is 33%, or 885 GWh. For 3 concrete kinds of Slovenian coals we calculated their CO₂ production. So the CO₂ pollution for CHA and WHA in Slovenian households is 890 Mt in one year.

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