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Mednarodna konferenca daljinske energetike 2016

Portorož, 20.-22. marec 2016

International Conference on District Energy 2016

Portorož, 20-22 March 2016



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Priložnosti
daljinske
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sprememb /
The challenges of
District Energy
in a changing
World

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 Energetika.NET

Priložnosti daljinske energetike v času sprememb

prof. dr. Alojz Poredoš

Mednarodna konferenca daljinske energetike je osrednji dogodek v delovanju Slovenskega društva za daljinsko energetiko. Ponuja priložnost za srečanje strokovnjakov iz celotne energetike, predvsem pa aktivnim na področjih daljinskega ogrevanja in hlajenja ter oskrbe s plinom.

Zanesljiva in učinkovita oskrba z energijo je ključnega pomena za uspešno gospodarstvo in za zagotavljanje ustreznega življenjskega standarda ljudi. Pri tem je daljinska energetika vedno igrala pomembno vlogo, vendar je bila do sedaj velikokrat spregledana. V zakonodajnih dokumentih je bila komaj omenjena.

Temeljite analize ukrepov za doseganje ciljev učinkovite rabe energije so v zadnjem času to področje prepoznale kot izjemno pomembno. Tako na primer evropska Direktiva o energetske učinkovitosti iz leta 2012 izpostavlja daljinsko ogrevanje in hlajenje na osnovi odvečne toplove iz kogeneracije in tudi v kombinaciji s plinom kot ključno tehnologijo za doseganje energetskih in okoljskih ciljev.



prof. dr. Alojz Poredoš

Na letošnji konferenci SDDE smo dali poseben poudarek plinu in plinskim tehnologijam. Plin ima in bo tudi imel v bližnji prihodnosti pomembno vlogo v energetski oskrbi, ker je najbolj čisto fosilno gorivo. Pri tem moramo poskrbeti, da se raba plina ne bo povečevala zaradi energetske neučinkovitosti, ampak morda zaradi uporabe plina namesto preostalih fosilnih goriv. Samo kurjenje plina ali drugih energentov za ogrevanje je nesprejemljivo. Pri plinu in tudi pri vseh preostalih fosilnih energentih moramo težiti k temu, da najprej iz njih proizvedemo kar največ električne energije kot najbolj kakovostnega energetskega produkta, pri tem pa imamo na razpolago še velike količine toplove za ogrevanje. Plin je odličen energent, ki ga z lahkoto in brez izgub transportiramo na večje razdalje, zato ga uporabljajmo lokalno, vendar ne individualno, v sistemih kogeneracije in v povezavi z manjšimi sistemi daljinske energetike ter s krajsimi transportnimi potmi toplove in hladu z manjšimi toplovnimi izgubami.

Tako kot na vseh dosedanjih konferencah SDDE je tudi tokratni namen srečanja, da si izmenjamo poglede in izkušnje ter skupaj poiščemo odgovore na aktualna in pomembna vprašanja, izpostavljenе probleme pa pretvorimo v izzive.

Vsi prispevki na tej konferenci bodo vsak na svoj način pomembno prispevali k odgovoru na vprašanje, kako s tehničnimi in ekonomskimi ukrepi dosegati zanesljivo in varno ter tudi učinkovito energetsko oskrbo. Prepričan sem, da se bodo ob predstavivah razvile za marsikoga zelo koristne razprave. Najlepše se zahvaljujem vsem avtorjem za pravočasno pripravljene in vsebinsko raznolike prispevke, ki nam bodo na razpolago v obliki povzetkov in predstavitev na konferenci SDDE.

Energetika.NET je postala naš stalni partner pri organizaciji mednarodnih konferenc SDDE. Vesel sem, da z vedno novimi pristopi popestrijo naš tridnevni tradicionalni dogodek. Najlepše hvala za odlično sodelovanje in pravočasno opravljeno delo.

Hvala vsem zvestim in tudi nekaterim novim razstavljavcem, ki prav posebej obogatijo program konference in ponudijo številne informacije o novih izdelkih in rešitvah na področju energetike.

Posebno zahvalo namenjam podjetju Plinovodi, ki je prevzelo generalno pokroviteljstvo in nosilno vlogo organizacije letošnje mednarodne konference SDDE. Naše sodelovanje od začetka organizacije do danes je bilo izjemno dobro in prijetno.

Zahvaljujem se vsem sponzorjem in podpornikom ter vsem članom organizacijskega in strokovnega odbora za dobro sodelovanje v vseh fazah priprav konference.

Na najboljši mogoči način se bomo potrudili, da bo tudi letošnja konferenca SDDE vsem udeležencem ostala v prijetnem in trajnem spominu. Izkoristimo priložnost za iskanje poenotenih strokovnih stališč, ki jih bodo zaradi njihove resnične teže pripravljavci Energetskega koncepta Slovenije morali upoštevati in v omenjenem dokumentu daljinski energetiki nameniti vlogo, ki temu pomembnemu sektorju energetike tudi dejansko pripada.

The challenges of District Energy in a changing world

prof. dr. Alojz Poredoš

The International Conference on District Energy is the main annual event of the Slovene District Energy Association (SDDE). This conference gives experts from all sectors of the energy industry an opportunity to meet, discuss technical problems and find new business opportunities. This is especially so for those experts working in the fields of district heating, cooling, and gas supply.

Reliability and efficiency of energy supply represent the key to a successful economy and a good living standard for citizens. Here, district energy has always played a vital role, but has often been disregarded. Moreover, this important topic has rarely achieved its place in legislative documents. However, the recent analyses of energy efficiency measures have started to recognise the significance of district energy. The 2012 EU Energy Efficiency Directive, for instance, highlights district heating and cooling using waste heat from co-generation units or natural gas as the key technology in meeting energy and climate goals.

This year's SDDE conference will have a special focus on gas supply and utilisation and related gas technologies. As the cleanest fossil fuel, gas plays an important role in energy supply and will continue to do so in the near future. Our job is to assure that gas consumption increases not because of energy inefficiency, but as the replacement of other fossil fuels. Burning of a

gas or any other energy source for heating purposes only is unacceptable. When using gas, or any fossil fuel, our aim should be to maximise the generation of electricity as the highest-grade energy product, and use the remaining heat for heating. As an important energy source, which can easily be transported across long distances without significant losses of energy, gas should be used locally, but not individually. Its application should be mainly focused on co- or poly-generation systems, connected to small district energy systems with short heating and cooling energy transport distances and small heat losses or gains.

As with all previous SDDE conferences, the purpose of this annual meeting is to exchange our views and experiences, together find answers to important questions, and turn the existing problems into future challenges.

Each paper will, in its own way, make an important contribution to solutions on how technical and economic measures can help to achieve reliability and security as well as the efficiency of energy supply. I am confident that the presentations at the conference will result in many very useful discussions.

My sincere thanks go to all the authors, who kept to the submission deadlines and sent us contributions with a variety of different and important topics. These will be available as abstracts and SDDE conference presentations.

Energetika.NET has become our regular partner in organising SDDE international conferences. I am happy to see its team's ever new approaches enriching our traditional three-day event. Many thanks for their excellent co-operation and jobs done within desired time-lines.

I would also like to thank all our loyal exhibitors as well as new ones. They never fail to bring added value to the conference programme, providing a vast pool of information about new energy products and solutions.

Special thanks go to Plinovodi, the company which has taken over general sponsorship and the lead partner in the organising committee of this annual SDDE conference. From the very beginning, the organisation of this event has represented a very fruitful and pleasant collaboration.

I thank all the sponsors and supporters, as well as all the members of the organising and technical committees for their contribution in all phases of the organisation of the conference.

We will do our best to make this SDDE conference a memorable and enjoyable experience for all attendees. Let us take the opportunity to seek agreement over different expert opinions and proposals, in order to bring an important basis, which will be considered by the policy makers and creators of the Slovenian Energy Concept. This will ensure that district energy plays an essential role in existing and future strategic documents – one that this important energy domain represents.



Priložnosti daljinske energetike v času sprememb

Marjan Eberlinc

glavni direktor, Plinovodi d.o.o.

Letošnja *Mednarodna konferenca daljinske energetike* je že XIX. Posebej pomembna je, saj se dogaja v obdobju intenzivnih priprav nacionalne energetske strategije. To že vrsto let pogrešamo. Pogrešamo jo kot dokument, ki mora usmerjati v nacionalne cilje in pogrešamo jo zaradi poti, ki smo jih dolžni zastaviti in prehoditi v prihodnje. Naučili smo se, da morajo biti poti do nacionalno zavezujočih ciljev predvidljive.



Marjan Eberlinc

Res je, da vodijo vse poti v Rim. Tudi v energetiki je tako, zavezujoče cilje je mogoče doseči po mnogih poteh. Katera je tista, prava, ki bo najprimernejša za nas in za zanamce, je odvisno od nas samih. Vprašanje je, če smo že sedaj tako modri, da ocenjujemo vse naše dosedanje in vidimo priložnosti prihodnjih poti? Ali že sedaj vemo, katera bo zmotna, predraga, nekoristna in katero je sploh potrebno izbrati? Koristno je, da jih na tej konferenci

pogledamo v luči daljinske energetike in sklenemo, katerih ovinkov in strmin ni smiselno prehoditi.

Daljinska energetika je nedvomno del energetskih poti, ki imajo lep razgled, so raznolike in niso lahke. V nacionalnem energetskem zemljevidu so bile doslej med tistimi v »prilogi«. Te naše *Mednarodne konference* so prispevale, da so bile te poti vzdrževane in pohodne. Prepričan sem, da postajajo z novim energetskim konceptom pomembnejše. Tako pomembne, da se bodo na njih združevali vsi energenti, vse energetske storitve in vsi energetski trgi ter tako dokazale upravičenost investiranja v njih. Poraba vse energije v državi pada, ocene za leto 2015 kažejo, da smo je porabili 264,6 PJ, kar je 4,7 % manj kot leto prej. Poraba daljinske toplotne v državi za leto 2015 je ocenjena na 9.210,4 TJ, torej se njena poraba praktično ni zmanjšala.

Trdim, da je plin, čeprav fosilno gorivo, okolju prijazen emergent, ki z lahkoto potuje po poteh daljinske energetike in da je z njim mogoče dosegati najvišje vrhove, kjer stojijo energetski cilji. V naši družbi Plinovodi si prizadevamo, da ga vodimo tja, kjer je zanj priložnost, kjer lahko tekmuje z drugimi energenti in kjer dokazuje svojo sonaravnost. V naši družbi smo kos vsem izzivom, katerim je na stežaj odprla vrata evropska energetska usmeritev in ta konferanca.

V družbi Plinovodi smo ponosni, da smo lahko eno od nosilnih podjetij Mednarodne konference daljinske energetike 2016 v organizaciji Slovenskega društva za daljinsko energetiko SDDE, posebej v času snovanja nacionalne energetike, osebno se veselim srečanja z vami ter strokovne izmenjave znanja in izkušenj.

The challenges of District Energy in a changing world

Marjan Eberlinc

General Manager, Plinovodi, d. o. o.

This year's International Conference on District Energy celebrates its 19th edition. It is of particular importance that it is being held during the intensive last stages of the creation of a national energy strategy, a document Slovenia has lacked for years. The strategy has been lacking as a guiding document which must navigate towards national targets, as well as a roadmap along the paths we are obliged to set and walk in the future. We have learned that the paths leading towards nationally binding targets should be predictable. It is true that all roads lead to Rome. This could very well apply to the energy industry, as binding targets can be met in various ways. Which is the right one, the most suitable for us and for future generations, depends solely on our decisions. Nevertheless, the question is whether we are already wise enough to evaluate the distance travelled and, at the same time, recognise the possibilities of future paths. Have we already established which way is false, or too expensive, futile, or which one to choose at all? From the outset of the conference, it will be beneficial to consider and focus on these possibilities in the light of district energy, and to establish which directions and obstacles to avoid.

Without doubt, district energy is one of the promising energy paths – albeit a dynamic but difficult one – which, in the national energy map, has so

far been pushed to the ‘appendix’. Our international conferences have contributed to the paths being well maintained and passable.

I am confident that with Slovenia’s new Energy Concept these areas are gaining in importance – to the degree that they will combine all energy sources, all energy services, and all energy markets – thus justifying investments in them. Furthermore, the demand for energy in Slovenia is waning, with estimates for 2015 indicating a consumption of 264.6 PJ, down 4.7 % from the previous year. Meanwhile, the country’s district heat consumption in 2015 is estimated at 9,210.4 TJ, seeing almost no decrease.

I believe that gas, nevertheless a fossil fuel, is an environmentally friendly energy source which can easily travel the district energy paths, and which can help us climb the highest peaks of our energy targets. Our company, Plinovodi, strives to take gas where opportunities lie, where it can compete with other energy sources and prove its sustainability. Our company can tackle any challenge to which the EU energy guidelines and this conference have thrown open the door.

Plinovodi is honoured to have the opportunity to be one of the leading companies behind the *International Conference on District Energy 2016*, which is organised by the Slovene District Energy Association (SDDE), especially during the development of the National Energy Policy. Personally, I look forward to meeting you and to our exchange of knowledge and experience.

Nedelja, 20. marec 2016

- 16.00 – 18.00 Postavitev razstavnih prostorov
18.00 – 19.00 Izvršni odbor SDDE
19.00 – 21.00 Druženje na razstavnem prostoru ob večernem prigrizku
-

Ponedeljek, 21. marec 2016

- 9.00 – 10.00 Registracija
10.00 – 10.30 Uvodni pozdravi
Marjan Eberlinc, Plinovodi
Alojz Poredoš, predsednik SDDE
Peter Gašperšič, minister za infrastrukturo
Iztok Golobič, ZSIS
10.30 – 11.30 Plenarni predavanji
Franc Žlahtič, Plinovodi
David Hesseling, ACER
11.30 – 13.00 Osrednje omizje: *Priložnosti daljinske energetike v času sprememb*
Moderira: **Alenka Žumbar Klopčič**, Energetika.NET
Gostje omizja:
Alojz Poredoš, SDDE
Danijel Levičar, Direktorat za energijo
Franc Cimerman, Plinovodi
Duška Godina, Agencija za energijo
Hinko Šolinc, Eko sklad
Rok Vodnik, Petrol
Samo Lozej, Energetika Ljubljana
13.00 – 14.30 Kosilo

14.30 – 16.00

SEKCIJA 1:

**SISTEMI DALJINSKEGA OGREVANJA
IN HLAJENJA – VZPOREDNA SEKCIJA**

Moderator sekcije: *Ervin Miklavžina, KP Velenje*

- Izkoriščanje koristne topote metalurških procesov za namene daljinskega ogrevanja na Ravnah na Koroškem,
Kristijan Plesnik, Metal Ravne, Miran Fužir, Petrol Energetika
- Upravičenost električno gnanih topotnih črpalk v Sloveniji – energetski vidik,
Andrej Kitanovski, Alojz Poredoš, Tjaša Duh, Laboratorij za hlajenje in daljinsko energetiko, Fakulteta za strojništvo, Univerza v Ljubljani
- Analiza tarifnih sistemov in cen topote iz reguliranih sistemov daljinskega ogrevanja v Republiki Sloveniji,
Aleksander Trupej, Agencija za energijo
- Analiza delovanja sistemov ogrevanja in hlajenja med evropskim prvenstvom v waterpolu v beograjski areni Kombank,
Bojan Bogdanović, Petar Vasiljević, Vladimir Jelin, Javno podjetje "Beogradske elektrane", Stevan Matić, KOMBANK Arena

SEKCIJA 2 (3):

ZEMELJSKI PLIN IN EKS – VZPOREDNA SEKCIJA

Moderator sekcije: *Dejan Koletnik, Plinovodi*

- Daljinsko gretje in hlajenje v EKS – vloga plina,
Peter Novak, Fakulteta za tehnologije in sisteme
- Poslovanje operaterjev distribucijskih sistemov zemeljskega plina znotraj regulacije v obdobju 2016 – 2018,
Urška Ritonja, Agencija za energijo
- Razvoj slovenskega trga z zemeljskim plinom – novi produkti zmogljivosti, virtualna točka in trgovalna platforma,
Jošt Štrukelj in Marko Širovnik, Plinovodi
- Zemeljski plin in plinovodni sistemi v perspektivi ambicioznih okoljskih ciljev,
Marko Ileršič, Plinovodi

16.00 – 16.30

Odmor za kavo

16.30 – 18.00

SEKCija 4:

VODENJE PROCESOV V DALJINSKI ENERGETIKI

– VZPOREDNA SEKCija

Moderator: *Jože Torkar*, Petrol

- Letalska termografija – uspešen način sistemske kontrole vročevodnega omrežja Energetike Ljubljana,
Primož Matičič, Marko Cimerman, Blaž Jamnik Energetika Ljubljana, Matevž Lenarčič, Domen Grauf, Aerovizija
- Centralni historian kot temelj obvladovanja procesov v sistemih daljinske energetike,
Aljaž Stare, Milan Dobrič, Saša Sokolič, Metronik, Mojmir Debeljak, Energetika Ljubljana
- Hidravlično uravnoteženje sistemov daljinske energetike, ki delujejo po načelu »PUSH«,
Oddgeir Gudmundsson, Marek Brand, Jan Eric Thorsen, Danfoss A/S, Oddelek za ogrevanje, Nordborg, Application Center, Danska
- IoT v energetskih omrežjih,
Tomaž Fatur, Gašper Lakota, Marko Šepič, Solvera Lynx

SEKCija 5:

INOVATIVNE REŠITVE IN ENERGETSKA UČINKOVITOST – VZPOREDNA SEKCija

Moderator: *Hinko Šolinc*, Eko sklad

- Izkoriščanje odpadne toplotne trgovinskega hladilnega sistema za daljinsko ogrevanje kot del pametnega energetskega sistema,
Jan Eric Thorsen, Torben Green, Danfoss A/S, Oddelek za ogrevanje, Torben Funder-Christensen, Danfoss A/S, Oddelek za hlajenje, Danska
- Ogljično nevtralno daljinsko ogrevanje v København z okolico leta 2025 – od vizije do ukrepov,
Lars Gullev, VEKS
- Energetska samooskrba lokalne skupnosti do 2020,
Uroš Plikl, Energetika Šentrupert
- Podpostaja daljinskega ogrevanja z električnim grelnikom za pripravo vode z vstopno temperaturo 40 °C,
Marek Brand, Danfoss A/S, Oddelek za ogrevanje, Application & Technology, Danska, Christian Holm Christiansen, Danski tehnološki inštitut, Danska, Niels Vilstrup, COWI, Danska, in Lars Overgaard Lisberg, Odder Varmevarerk, Danska

20.00 – ...

Gala večerja

Poseben gost večera: **Paul Voss**, Euroheat & Power

Torek, 22. marec 2016

9.00 – 11.00

SEKCIJA 6:

SISTEMI DALJINSKEGA OGREVANJA IN HLAJENJA

– VZPOREDNA SEKCIJA

Moderira: *Mitja Dolinšek, Energetika Maribor*

- Rekonstrukcija sistemov daljinskega ogrevanja v tranzicijskih državah
 - velik energetski izviv,
Amer Karabegović, Centralno grrijanje Tuzla
- Ocena toplotne učinkovitosti in tehnično-ekonomska analiza ekonomizatorja toplovodnega kotla v toplarni Konjarnik,
Vladimir Tanasić, Branislav Vidačić, Javno podjetje "Beogradske elektrane", Nikola Tanasić, Univerza v Beogradu, Fakulteta za strojništvo, Beograd, Srbija
- Aktivnosti na področju reguliranja cen toplote za daljinsko ogrevanje,
Tina Štok, Agencija za energijo
- Priložnosti decentralizirane proizvodnje električne in toplote v stanovanjskih stavbah,
Boris Vidrih, Sašo Medved, Univerza v Ljubljani, Fakulteta za strojništvo
- Eksergoekonomska optimizacija cevne mreže daljinskega hlajenja,
Tjaša Duh, Andrej Kitanovski in Alojz Poredoš, Katedra za toplotno in okoljsko tehniko, Fakulteta za strojništvo, Univerza v Ljubljani

SEKCIJA 7:

ZEMELJSKI PLIN – VZPOREDNA SEKCIJA

Moderira: *Franc Cimerman, Plinovodi*

- Distribucija zemeljskega plina 9 let po odprtju trga,
Aleš Žurga, Agencija za energijo
- Novi načini pregledov plinovodov,
Marko Kogovšek, Plinovodi
- Medsebojni vpliv energetskih objektov,
Leopold Lovšin, Plinovodi
- Sodelovanje DVGW in GIZ DZP na področju tehničnih predpisov in izobraževanja,
Aida Bučo Smajić, DVGW Sarajevo in Urban Odar, GIZ DZP

11.00 – 11.30

Odmor za kavo in sadje

11.30 – 13.00

SEKCIJA 8:

VODENJE PROCESOV V DALJINSKI ENERGETIKI

Moderira: *Andrej Kitanovski*, Fakulteta za strojništvo

- **Problematika meritev pretoka v vročevodu,**
Jernej Böhm, Tjaša Oštir, Marjeta Petrišič, Energetika Ljubljana, Martin Vuk, Univerza v Ljubljani, Fakulteta za računalništvo in informatiko
- **Sistem SCADA kot osnova za rabo poslovnih informacijskih sistemov Javnega podjetja Beogradske elektrane,**
Tatjana Nušić, Dubravka Jovančić, Petar Vasiljević, Javno podjetje "Beogradske elektrane", Beograd, Srbija
- **Uporaba programske opreme za analizo tokov v cevnih sistemih za ugotavljanje puščanja vode v vročevodu daljinskega ogrevanja,**
Matjaž Perpar, Matej Konstantini, Primož Škerl, Iztok Žun, Univerza v Ljubljani, Fakulteta za strojništvo, *Energetika Ljubljana*

13.00 – 13.30

Zaključek konference

PROGRAM

Sunday, 20 March 2016

16.00 – 18.00 Sponsor registration

18.00 – 19.00 SDDE general assembly

19.00 – 21.00 Welcome reception in the exhibition area

Monday, 21 March 2016

9.00 – 10.00	Participant registration
10.00 – 10.30	Conference opening Marjan Eberlinc , Plinovodi Alojz Poredoš , President of SDDE Peter Gašperšič , Ministry of Infrastructure Iztok Golobič , ZSIS
10.30 – 11.30	Plenary lecturers Franc Žlahtič , Plinovodi David Hesseling , ACER
11.30 – 13.00	Round table session: <i>The challenges of District Energy in a changing world</i> Moderator: Alenka Žumber Klopčič , Energetika.NET
	Guests: Alojz Poredoš , SDDE Danijel Levičar , Slovenian Energy Directorate Franc Cimerman , Plinovodi Duška Godina , Energy Agency, Slovenian National Regulatory Authority Hinko Šolinc , Eko sklad Rok Vodnik , Petrol Samo Lozej , Energetika Ljubljana
13.00 – 14.30	Lunch
14.30 – 16.00	SESSION 1: DISTRICT HEATING AND COOLING SYSTEMS – parallel session Moderator: <i>Ervin Miklavžina</i> , KP Velenje
	<ul style="list-style-type: none">• Utilisation of waste heat from metallurgical processes for district heating in Ravne na Koroškem, <i>Kristijan Plesnik</i>, Metal Ravne, and <i>Miran Fužir</i>, Petrol Energetika• Energy viability of electric heat pumps in Slovenia, <i>Andrej Kitanski</i>, Alojz Poredoš, Tjaša Duh, University of Ljubljana, Faculty of Mechanical Engineering, Laboratory for Refrigeration and District Energy• Analysis of tariff systems and prices of heat from regulated district heating systems in the Republic of Slovenia, <i>Aleksander Trupej</i>, Energy Agency, Slovenian National Regulatory Authority• Analysis of performance of heating and cooling systems during the European Water Polo Championship at the Kombank Arena in Belgrade, <i>Bojan Bogdanović</i>, Petar Vasiljević, Vladimir Jelin, Public Utility Company "Beogradske elektrane", Stevan Matić, KOMBANK Arena

SESSION 2 (3):

NATURAL GAS AND NATIONAL ENERGY CONCEPT – parallel session

Moderator: *Dejan Koletnik, Plinovodi*

- **District heating and cooling in Slovenia's Energy Concept: The role of gas,**
Peter Novak, Faculty of Technologies and Systems
- **Business plans of Distribution System Operators for gas for the 2016-2018 regulatory period,**
Urška Ritonja, Energy Agency, Slovenian National Regulatory Authority
- **Development of the Slovenian natural gas market: New capacity products, virtual trading point and trading platform,**
Jošt Štrukelj and Marko Širovnik, Plinovodi
- **Natural gas and gas systems in view of ambitious environmental targets,**
Marko Ileršič, Plinovodi

16.00 – 16.30 Coffee break

16.30 – 18.00

SESSION 4:

PROCESS MANAGEMENT IN DISTRICT ENERGY – parallel session

Moderator: *Jože Torkar, Petrol*

- **Aerial thermography: An effective inspection method for Energetika Ljubljana's district heating pipeline,**
Primož Matičič, Marko Cimerman, Blaž Jamnik, Energetika Ljubljana, Matevž Lenarčič, Domen Grauf, Aerovizija
- **Central historian as a basis for managing processes in district energy systems,**
Aljaž Stare, Milan Dobrič, Saša Sokolić, Metronik, Mojmir Debeljak, Energetika Ljubljana
- **Hydraulic balancing in district heating systems operated according to the PUSH philosophy,**
Oddgeir Gudmundsson, Marek Brand and Jan Eric Thorsen, Danfoss A/S, Heating Segment – Nordborg – DK, Application Centre
- **IoT in energy networks,**
Tomaž Fatur, Gašper Lakota, Marko Šepič, Solvera Lynx

SESSION 5:

INNOVATIVE SOLUTIONS AND ENERGY EFFICIENCY – parallel session

Moderator: *Hinko Šolinc*, Eko sklad

- Utilising excess heat from supermarket refrigeration systems in district heating grids as part of a smart energy system,
Jan Eric Thorsen, Torben Green, Danfoss A/S, Danfoss Heating Segment, Torben Funder-Christensen, Danfoss A/S, Danfoss Cooling Segment, Denmark
- CO₂-neutral district heating in Greater Copenhagen 2025 – From vision to action,
Lars Gullev, VEKS
- Energy self-sufficiency of the local community by 2020,
Uroš Plik, Energetika Šentrupert
- District heating substation with electrical heater supplied by 40°C district heating water, Marek Brand, Danfoss A/S, Danfoss Heating Segment, Application & Technology, Denmark, *Christian Holm Christiansen, Danish Technological Institute, Denmark, Niels Vilstrup, COWI, Denmark, Denmark and Lars Overgaard Lisberg, Odder Varmeværk, Denmark*

20.00 – ...

GALA DINNER

Special guest: **Paul Voss**, Euroheat & Power

Tuesday, 22 March 2016

9.00 – 11.00

SESSION 6:

DISTRICT HEATING AND COOLING SYSTEMS – parallel session

Moderator: *Mitja Dolinšek*, Energetika Maribor

- District heating system re-engineering in a state of transition – a great energy challenge,
Amer Karabegović, Centralno grijanje Tuzla
- Thermal performance evaluation and techno-economic analysis of the hot water boiler economiser in the Konjarnik district heating plant,
Vladimir Tanasić¹, Vidačić Branislav¹, Nikola Tanasić¹, ¹Public Utility Company „Beogradske elektrane“, ²University of Belgrade – Faculty of Mechanical Engineering, Belgrade
- Activities in price regulation of district heating,
Tina Štok, Energy Agency, Slovenian National Regulatory Authority

- Opportunities for decentralised production of heat and power in residential buildings,
Boris Vidrih, Sašo Medved, University of Ljubljana, Faculty of Mechanical Engineering
- Exergoeconomic optimisation of district cooling pipeline network,
Tjaša Duh, Andrej Kitanovski in Alojz Poredoš, University of Ljubljana, Faculty of Mechanical Engineering, Laboratory for Refrigeration and District Energy

SESSION 7:

NATURAL GAS – parallel session

Moderator: *Franc Cimerman, Plinovodi*

- Natural gas distribution 9 years after market opening,
Aleš Žurga, Energy Agency, Slovenian National Regulatory Authority
- DVGW and GIZ DZP co-operation in the field of technical regulations and education,
Aida Bučo-Smajić, DVGW Office Sarajevo and Urban Odar, Direktor, GIZ DZP
- New gas pipeline inspection methods,
Marko Kogovšek, Plinovodi
- Interaction between energy facilities,
Leopold Lovšin, Plinovodi

11.00 – 11.30 Coffee and fruit break

11.30 – 13.00 **SESSION 8:**
PROCESS MANAGEMENT IN DISTRICT ENERGY
Moderator: *Andrej Kitanovski, Fakulteta za strojništvo*

- Measuring flow in district heating pipelines,
Jernej Böhm, Tjaša Ošir, Marjeta Petrišč, Energetika Ljubljana, Martin Vuk, University of Ljubljana, Faculty of Computer and Information Science
- SCADA system as a base for implementation of PUC Business Information Systems “Beogradske elektrane”,
Tatjana Nušić, Dubravka Jovančić, Petar Vasiljević, PUC “Beogradske elektrane”, Belgrade, Serbia
- Utilisation of pipeline flow analysis software for water leakage assessment in district heating pipelines,
Matjaž Perpar, Matej Konstantini, Primož Škerl, Iztok Žun, University of Ljubljana, Faculty of Mechanical Engineering, Energetika Ljubljana

13.00 – 13.30 Closing ceremony

IZKORIŠČANJE KORISTNE TOPLOTE METALURŠKIH PROCESOV ZA NAMENE DALJINSKEGA OGREVANJA NA RAVNAH NA KOROŠKEM

Kristijan Plesnik, Metal Ravne, Miran Fužir, Petrol Energetika

Načrtovanje in realizacija izkoriščanja koristne toplote metalurških procesov za namene daljinskega ogrevanja na Ravnah na Koroškem je rezultat dobrega poslovnega sodelovanja med podjetjema Metal Ravne in Petrol Energetika. Družbi se nahajata na območju bivše Železarne Ravne (Zaokroženo gospodarsko območje (ZGO) Ravne). Prva kot eden izmed vodilnih proizvajalcev orodnih in specialnih jekel v Evropi, druga kot ponudnik celovitih energetskih rešitev, tudi proizvajalec, dobavitelj in distributer različnih vrst energije in okoljskih storitev tako na lokacijah ZGO Ravne in Štore kot v z njimi geografsko povezanih lokalnih skupnostih, v Tehnološkem parku v Ljubljani, v Hrastniku in drugod po Sloveniji.

Koristna toplota, ki nastaja pri hlajenju elektroobločne peči (EOP) v Metalu Ravne, se je doslej preko hladilnih stolpov odvajala v okolje, ob prenovi hladilnega sistema EOP med letnim remontom poleti 2015 se je v obvod dodatno instaliral 4,2MW toplotni menjalnik. V Petrolu Energetiki, ki na geografskem območju Občine Ravne na Koroškem izvaja dejavnost gospodarske javne službe dobave in distribucije toplote, poleg tega pa s toploto oskrbuje tudi območje ZGO Ravne, katerega del je Metal Ravne, smo doslej daljinsko toploto proizvajali v toplarni, ki je od novega vira koristne tehnološke toplote oddaljena okrog 500 m, zato je bil kot najprimernejši ponor te toplote identificiran sistem daljinskega ogrevanja na Ravnah na Koroškem, ki ga upravljamo v Petrolu Energetiki.

Z izkoriščanjem koristne toplote EOP temperaturnega režima 75/55 °C bomo do leta 2017, ko načrtujemo celovito prenovo toplarne, letno pridobili okrog 3.000 MWh toplote, po letu 2017, ko bo imela prioriteto koristna toplota EOP, pa okrog 8.000 MWh. To pomeni, da bo v mestu Ravne vsaka druga MWh dobavljeni toplote izvirala iz metalurških procesov.

Dejavniki, ki so nas motivirali pri iskanju načinov izkoriščanja čim večjega deleža koristne toplote metalurških procesov proizvodnje jekla v sistemu daljinskega ogrevanja, so bili: priložnost sodelovanja gospodarstva in lokalne skupnosti pri iskanju inovativnih rešitev, konkurenčna in trajnostna oskrba odjemalcev, zakonodaja, evropski energetski trendi, zagotavljanje zanesljivega, konkurenčnega, dolgoročno vzdržnega in okolju prijaznega sistema daljinskega ogrevanja ter želja po iskanju novih poslovnih priložnosti v dvigovanju deleža samooskrbe odjemalcev v lokalni skupnosti pri prehodu v nizkoogljično družbo.

S pilotnim projektom v praksi dokazujemo, da se lahko tudi industrijsko in energetsko intenzivna gospodarska okolja razvijajo v sinergiji z lokalno skupnostjo in prispevajo k varovanju okolja.

Novembra 2015 realizirani projekt izkoriščanja koristne toplote, ki pomeni prvo fazo izkoriščanja koristne toplote jeklarske industrije, je primer odlične prakse tako v slovenskem kot tudi v širšem mednarodnem prostoru.

Na Okoljskem srečanju 2015 smo 10. novembra skupaj z Metalom Ravne dobili za projekt izkoriščanja koristne toplote iz Metalove EOP nagrado za okolju prijazen postopek.

Projekt je prvi v Sloveniji in je zato pomemben tudi za promocijske namene in za prenos znanja pri razvoju sistemov izkoriščanja industrijske toplote tudi v drugih slovenskih mestih.

Ključne besede: daljinsko ogrevanje, koristna toplota, učinkovitost

UTILISATION OF REMAINING HEAT FROM METALLURGICAL PROCESSES FOR DISTRICT HEATING IN RAVNE NA KOROŠKEM

Kristijan Plesnik, Metal Ravne, Miran Fužir, Petrol Energetika

The planning and implementation of the project for the utilisation heat from metallurgical processes for district heating in Ravne na Koroškem, Slovenia, is the result of a successful business collaboration between the companies Metal Ravne and Petrol Energetika. These companies are based in the area of the former Železarna Ravne ironworks (the Ravne industrial area), the former being one of Europe's leading manufacturers of tools and special steel, and the latter a provider of comprehensive energy solutions as well as producer, supplier and distributor of various energy sources and environmental solutions in the Ravne and Štore industrial areas, the local communities geographically linked to them, the Ljubljana Technology park, Hrastnik, and other places around Slovenia.

The remaining heat produced in the process of cooling the electric arc furnace (EAF) in Metal Ravne had previously been emitted in the atmosphere through cooling towers. When the EAF cooling system was remodelled during the annual overhaul in the summer of 2015, a 4.2 MW heat exchanger was added to the bypass. Petrol Energetika, which provides the public utility service of heat supply and distribution in the geographic area of the municipality Ravne na Koroškem – this includes supply to Metal Ravne as part of the heat supply for the Ravne industrial area – had previously produced heat in a heating plant, located about 500 m from the new source of waste industrial heat. Therefore, the Ravne na Koroškem district heating system, operated by Petrol Energetika, was identified as the most suitable sink for this heat.

By using the EAF waste heat with a temperature range of 75/55 °C, we expect to save around 3,000 MWh of heat annually by 2017, and around 8,000 MWh after a thorough heating plant refurbishment planned for 2017, when the EAF waste heat will be given priority. This means about half of all the heat supplied in the town of Ravne will originate in metallurgical processes.

The factors which motivated us to seek ways of using the biggest possible proportion of waste heat from steel production processes in the district heating system were as follows: an opportunity for industry and the local community to work together in seeking innovative solutions; competitive, sustainable supply; policy; European energy trends; the desire to ensure a reliable, competitive, sustainable and environmentally-friendly district heating system; and a desire to find new business opportunities in increasing the self-sufficiency of the local community as part of the transition to a low-carbon society.

The pilot project has demonstrated in practice that industrially and energy intensive areas can find synergies with the local community and contribute to protecting the environment.

The waste heat utilisation project implemented in November 2015, which is Phase 1 of the project for utilising waste heat from the steel industry, is an example of good practice in Slovenia as well as in a broader international context.

For the project utilising waste heat from Metal's EAF, Petrol Energetika and Metal Ravne were presented with an award for the most environmentally friendly process at the Okoljsko srečanje 2015 environmental conference on 10 November 2015.

As the first of its kind in Slovenia, the project has great potential for promotion of, and knowledge transfer for, the development of industrial heat utilisation systems in other towns across Slovenia.

Key Words: district heating, waste heat, efficiency

ENERGETSKI VIDIK UPRAVIČENOSTI UPORABE TOPLOTNIH ČRPALK

Andrej Kitanovski, Tjaša Duh, Primož Poredoš, Alojz Poredoš, Univerza v Ljubljani,
Fakulteta za strojništvo, Laboratorij za hlajenje in daljinsko energetiko

V Sloveniji in v svetu skokovito narašča uporaba električno gnanih topotnih črpalk za ogrevanje objektov in sanitarne tople vode. Tako v splošni kot strokovni javnosti se pogosto pojavljajo polemike glede upravičenosti njihove uporabe. Znani so primeri implementacije topotnih črpalk v sodobne sisteme daljinske energetike, kjer lahko prispevajo k izboljšanju učinkovitosti ali ekonomičnosti sistemov daljinskega ogrevanja in/ali hlajenja. To velja še posebej za novejše, nizkotemperaturne generacije sistemov daljinskega ogrevanja. Ponekod v Sloveniji se uporaba topotnih črpalk administrativno izključuje s sistemi daljinske energetike. Takšno stanje zahteva strokovno analizo in prikaz dejanskih energetskih ter okoljskih učinkov oskrbe s topoto za ogrevanje iz daljinskega ogrevanja ali s topotno črpalko ali morda s kombinacijo obeh načinov.

Prispevek na podlagi obširnih analiz podaja osnove, ki določajo pogoje, pri katerih je uporaba električno in plinsko gnanih topotnih črpalk v Sloveniji smiselna in energetsko ter okoljsko upravičena.

Analizo in primerjavo smo izvajali na osnovi faktorjev primerne energije PEF. V okviru individualnih sistemov smo primerjali topotne črpalke z nizko in visoko učinkovitim kotli na zemeljski plin, UNP, ELKO, lesna polena, lesne pelete in lesne sekance. Na strani električno gnanih topotnih črpalk je bila zaradi fleksibilnosti trga z električno energijo upoštevana možnost uporabe elektrike kot energetske mešanice iz omrežja, elektrike iz različnih obnovljivih virov in jedrske energije. Na strani zemeljskega plina je bilo poleg obstoječega stanja upoštevano dodatno dejstvo, da bo morda ta nekoč zamenjan z biometanom. Kot izjemen primer, čeprav jasen strokovni javnosti, je bila izvedena primerjava topotnih črpalk in električnih grelnih sistemov.

Poleg tega smo izvedli primerjavo topotnih črpalk z vročevodnimi daljinskimi sistemi. Pri slednjih smo upoštevali tako možnosti uporabe različnih vrst kotlarn kot kogeneracij. Pri kogeneracijah smo v analizi upoštevali vrsto tehnologije in učinkovitost pretvorbe v električno energijo oziroma vpliv odjema pare na soproizvodnjo.

Dodatno smo analizirali sisteme bivalentnih sistemov (t. i. hibridnih topotnih črpalk) in jih primerjali z drugimi vrstami ogrevanja.

Na podlagi analize so bili izdelani diagrami, ki prikazujejo mejne vrednosti grelnih števil topotnih črpalk, pri katerih te presegajo učinkovitost in okoljsko sprejemljivost drugih sistemov ogrevanja. Rezultati iz prispevka so lahko uporabni za načrtovalce energetskih konceptov, politik in sistemov ter za podjetja daljinske energetike.

Ključne besede: topotna črpalka, energetska učinkovitost, primarni faktor energije, daljinska energetika

ENERGY VIABILITY OF HEAT PUMPS IN SLOVENIA

Andrej Kitanovski, Tjaša Duh, Primož Poredoš, Alojz Poredoš, University of Ljubljana,
Faculty of Mechanical Engineering, Laboratory for Refrigeration and District Energy

The use of electric heat pumps for space and water heating has been growing rapidly in Slovenia as well as globally. This often creates dilemmas among both experts and consumers as to the viability of their use. There have been cases of implementation in modern district energy systems where heat pumps could help improve the efficiency or economy of district heating and/or cooling systems. This is particularly true when it comes to more recent generations of low-temperature district heating systems. In some places in Slovenia, the use of heat pumps and district energy systems are mutually exclusive according to administrative rules. This calls for expert analysis and a demonstration of the actual impacts of heat supply from a district heating system or by means of a heat pump, or as a combination of both, in terms of energy and environment.

Based on a thorough analysis, the paper provides a foundation to define the conditions in which the use of electric and gas-fired heat pumps in Slovenia is reasonable and viable in terms of energy and environment.

The analysis and comparison were made based on primary energy factors (PEFs). For each system, a comparison was made between heat pumps with low- and high-efficiency natural gas-fired boilers, LPG, extra-light fuel oil, firewood, wood pellets, and wood chips. For electric heat pumps, two possibilities were considered due to the flexibility of the electricity market: using electricity as a mix of sources from the grid, and using electricity from renewables and nuclear energy. For gas-fired heat pumps, the possibility of replacing gas with biomethane was considered in addition to the present situation. As an exception – yet something experts are familiar with – a comparison was made between heat pumps and electric heating systems.

Moreover, a comparison was made between heat pumps and district heating pipeline systems. With regard to the latter, the possibilities considered in the paper include various types of boilers as well as combined heat and power. With CHP, the analysis focused on factors including the type of technology as well as energy conversion efficiency, or the impact of steam use on co-generation.

Additionally, bivalent systems (i.e. hybrid heat pumps) were analysed and compared with other heating methods.

The analysis was used to produce diagrams showing threshold values for the coefficient of performance at which heat pumps are more efficient and environmentally viable than other heating systems. The results of this paper can benefit energy concept- and policy-makers, system designers, as well as district energy companies.

Key Words: heat pump, energy efficiency, primary energy factor, district energy

ANALIZA TARIFNIH SISTEMOV IN CEN TOPLOTE IZ REGULIRANIH SISTEMOV DALJINSKEGA OGREVANJA V REPUBLIKI SLOVENIJI

Aleksander Trupej, Agencija za energijo

Dejavnost distribucije toplote (pare, tople ali vroče vode) ter hladu se na območju Republike Slovenije v skladu z določili Energetskega zakona (EZ-1) lahko opravlja kot izbirna lokalna gospodarska javna služba ali tržna distribucija, dejavnost distribucije toplote pa izvajajo tudi lastniški distribucijski sistemi, ki pa jih EZ-1 razen v delih 282., 301. in 311. člena ne zajema.

Na območju Slovenije je v letu 2014 po podatkih, pridobljenih od Agencije za energijo (v nadaljevanju: agencija), oskrbo s toploto iz distribucijskih sistemov daljinskega ogrevanja zagotavljalo 54 distributerjev in 10 proizvajalcev toplote v 54 občinah iz 80 distribucijskih sistemov. Odjemalci toplote so iz sistemov daljinskega ogrevanja prevzeli kar 1.640,4 GWh toplote. Največji delež ali 36,4 odstotka je bil namenjen oskrbi 109.754 gospodinjskih odjemalcev; 30,9 odstotka oskrbi 9.950 poslovnih odjemalcev, preostanek toplote pa 1.726 industrijskim odjemalcem.

Ker je cena toplote v veliki meri odvisna predvsem od primarnega energenta, uporabljenega za proizvodnjo toplote, ter od vodenja, upravljanja in tehničnih značilnosti posameznega distribucijskega sistema, je bila za posamezne skupine tarifnih odjemalcev v različnih lokalnih skupnostih po Sloveniji zelo različna (fiksni in variabilni del cene).

Velika odstopanja med tarifnimi postavkami posameznih tarifnih odjemalcev, nepostenoti in v nekaterih primerih neprimerljivi tarifni sistemi ter nepregledni ceniki so predvsem zaradi potrebe po vzpostavitvi transparentne dejavnosti distributerjev toplote, ki izvajajo to dejavnost kot lokalno gospodarsko javno službo, ter zaradi novih pristojnosti agencije na področju regulacije cen toplote in analiz cen toplote iz sistemov daljinskega ogrevanja povzročali potrebo po podrobni analizi cen in tarifnih sistemov, ki jo uporablajo distributerji toplote na območju Republike Slovenije.

Ta prispevek podaja nekatere pomembnejše kazalnike in značilnosti trenutnega stanja oskrbe s toploto iz distribucijskih sistemov daljinskega ogrevanja v Sloveniji. Prav tako so predstavljene pomembnejše ugotovitve izvedene analize tarifnih sistemov in cen toplote iz reguliranih sistemov daljinskega ogrevanja v Sloveniji, ki jo je leta 2014 za agencijo izvedel Inštitut za daljinsko energetiko.

Ključne besede: zaključeni distribucijski sistemi, oskrba s toploto, cene toplote iz distribucijskih sistemov daljinskega ogrevanja

ANALYSIS OF TARIFF SYSTEMS AND PRICES OF HEAT FROM REGULATED DISTRICT HEATING SYSTEMS IN THE REPUBLIC OF SLOVENIA

Aleksander Trupej, Energy Agency, Slovenian National Regulatory Authority

Under the Energy Act (EZ-1), heating (steam, hot water of two temperature ranges) and cooling energy distribution in the territory of the Republic of Slovenia may be provided as an optional local public utility service or as a market-based distribution activity, while heating energy distribution may also be provided by distribution systems partly or wholly owned by end users, which EZ-1 makes no mention of except in parts of Articles 282, 301, and 311.

According to data acquired from the Energy Agency, Slovenian National Regulatory Authority (hereinafter referred to as 'the Agency'), in 2014 heat supply from district heating distribution systems in Slovenia was provided by 54 distributors and 10 heat producers from 80 distribution systems across 54 municipalities. Heating energy consumers were supplied as much as 1,640.4 GWh of heat from district heating systems. Household users totalling 109,754 accounted for the biggest proportion of heat supply with 36.4 percent, followed by 9,950 business users with 30.9 percent, and 1,726 industrial users with the remaining share.

As the heating price largely depends on the primary energy source used in producing heat, on management and operation, and on technical characteristics of the distribution system in question, prices (fixed and variable price components) for various groups of tariff consumers in local communities across Slovenia varied considerably from community to community.

Big differences between tariff items for various tariff consumers, non-harmonised and in some instances incomparable tariff systems, and non-transparent pricing, have created the need for a thorough analysis of prices and tariff systems used by heat distributors in Slovenia. This is in order to, above all, make heat distribution a transparent activity for the distributors who provide this service as a local public utility service, and because of the new powers of the Agency in the fields of heating price regulation and district heating price analysis.

The paper discusses some of the key indicators and features of the present situation in heat supply from district heating distribution systems in Slovenia. Moreover, it presents the main findings of the analysis of tariff systems and prices of heat from regulated district heating systems in Slovenia, conducted in 2014 for the Agency by the District Energy Institute (IDE).

Key Words: closed distribution systems, heat supply, prices of heat from district heating distribution systems

ANALIZA DELOVANJA SISTEMOV OGREVANJA IN HLAJENJA MED EVROPSKIM PRVENSTVOM V VATERPOLU V BEOGRAJSKI ARENI KOMBANK

Bojan Bogdanović, Petar Vasiljević, Vladimir Jelin, Javno podjetje Beogradske elektrane, Stevan Matić, KOMBANK Arena

Novembra 2015 in januarja 2016 sta se v Beogradu odvila dva pomembna dogodka. Najprej je 3. in 4. decembra 2015 potekalo zasedanje ministrskega sveta OVSE z 88 delegacijami in več kot 1500 delegatov iz različnih držav, nato pa je Srbska vaterpolska zveza med 10. in 23. januarjem 2016 organizirala 32. evropsko prvenstvo v vaterpolu. Oba dogodka sta potekala v naj sodobnejšem večnamenskem objektu na tem območju, areni Kombank (v nadaljnji besedilu: arena) v Beogradu, ki sprejme več kot 20.000 gledalcev.

Oskrba s toploto poteka prek toplotnih postaj za priključitev na sistem daljinskega ogrevanja Javnega podjetja Beogradske elektrane (v nadalnjem besedilu: PUC BE). Sistemi za klimatizacijo, ogrevanje in hlajenje prostorov, kjer ljudje vsakodnevno ne bivajo (igrisče, dvorane, hodniki in drugi prostori), delujejo samo v času dogodkov. Glede na veliko zmogljivost in precejšnje obratovalne stroške je osnovno načelo upravljanja sistemov doseči optimalne rezultate, kar pomeni realizacijo nazivnih parametrov ob maksimalnih prihrankih energije.

Skupini inženirjev PUC BE in arene sta pred omenjenima dogodkoma dobili naloge, da zagotovita pogoje nadstandardnega udobja, ki v nazivnih parametrih arene niso opredeljeni (načrtovana notranja temperatura 18 °C). Za vrh OVSE so bili zgrajeni začasni komunikacijski koridorji in v dvorani začasne pisarne, kjer je bilo treba zagotoviti temperaturo 21–22 °C. Za evropsko prvenstvo v vaterpolu so bile zahteve strožje, saj je bilo treba temperaturo prostora ohranjati na 25–26 °C, temperaturo vode v dveh novozgrajenih bazenih pa v ozkem razponu 25 +/- 0,5 °C. Doseči in ohranjati vse naštete parametre, predvsem ustrezno vlažnost zraka, je bil precejšen izziv, saj arena v prvi vrsti ni namenjena takim dogodkom in sistem hlajenja v okviru sistema klimatizacije v zimskih mesecih ni v obratovalnem stanju. Zato so bile med pripravami izdelane natančne analize vseh scenarijev in vpliva vlage, ki jo oddajajo voda v bazenu, obiskovalci ipd., na relativno vlažnost.

V prispevku so predstavljene uporabljene metode in obratovalni parametri, s katerimi sta ekipi inženirjev izpolnili zadane naloge. Poseben izziv so bili zahtevani parametri temperature in vlažnosti. PUC BE je z uporabo svojih regulativnih mehanizmov zagotovil nemoteno oskrbo s toploto za zanesljivo delovanje obstoječih toplotnih postaj in za ogrevanje novozgrajenih bazenov.

Ključne besede: ogrevanje bazenske vode, vlažnost zraka, zagotavljanje udobja

ANALYSIS OF THE PERFORMANCE OF HEATING AND COOLING SYSTEMS DURING THE EUROPEAN WATER POLO CHAMPIONSHIPS AT THE KOMBANK ARENA IN BELGRADE

Bojan Bogdanović, Petar Vasiljević, Vladimir Jelin, Public Utility Company
"Beogradske elektrane", Stevan Matić, KOMBANK Arena

Two very important events took place in Belgrade in November 2015 and January 2016. First, on 3rd and 4th December 2015 a meeting of the OSCE Ministerial Council was held with 88 delegations and more than 1,500 delegates from different countries. Later, from 10th - 23rd January 2016, the 32nd European Water Polo Championship was organised by the Water Polo Federation of Serbia . Both events were held in the Kombank Arena (hereinafter referred to as the Arena) in Belgrade, the most modern multi-purpose building in this area, with a capacity for more than 20,000 spectators.

Heat supply takes place through substations for connection to the district heating system of PUC "Beogradske elektrane" (hereinafter: PUC BE). Air conditioning, heating and cooling systems, provide ambient conditions for where people are not residing on a day to day basis (playing area, lodges, halls, corridors and other rooms), are on only during the time of an event. Given the large installed capacity and significant operating costs, the basic logic of systems management is to achieve optimal results i.e. the realisation of design parameters with maximum energy savings.

Before the aforementioned events, the engineering teams from PUC BE and the Arena were given the task of providing special comfort conditions that are not defined by design parameters for the Arena (an internal design temperature of 18°C). For the purpose of the OSCE summit, temporary offices in the hall and communication corridors were built, with the required temperature of 21-22°C. The European Water Polo Championships requirements were more rigorous because it was necessary to maintain an ambient temperature of 25-26°C and the water temperature in the two newly built swimming pools had to be maintained within a narrow range 25 +/- 0.5°C. To achieve and maintain all of the above parameters, especially the proper air humidity, was a particular challenge due to the fact that the Arena had not been intended for these events and therefore the cooling system within the air conditioning system is not in a functional condition during the winter months. Therefore, during preparation, detailed analyses were made of all scenarios and impacts on the relative humidity due to humidity discharged from the pool water, visitors, etc.

This paper presents applied methods and realised operational parameters used by the engineering teams to achieve set tasks. The provision of the required design parameters of temperature and humidity was a particular challenge. PUC BE used its regulatory mechanisms to ensure a stable supply of heat energy for reliable operation of the existing substations as well as for heating of the newly built swimming pool installations.

Key Words: heating of the pool water, air humidity, comfort conditions

DALJINSKO GRETJE IN HLAJENJE V EKS – VLOGA PLINA

Peter Novak, Fakulteta za tehnologije in sisteme, Novo mesto

Energetski koncept Slovenije bo do leta 2055 začrtal vlogo fosilnih goriv in obnovljivih virov energije (OVE) v široki rabi, prometu in industriji. Daljinsko gretje in hlajenje (DGH) imata pri sonaravnih oskrbi stavb s toploto in hladom posebno mesto. Glede na sprejetne mednarodne obveznosti se bodo morali tudi sistemi DGH v Sloveniji prilagoditi novim pogojem in zmanjšati emisije toplogrednih plinov do leta 2030 za najmanj 40 %. V posebnem položaju je daljinsko gretje v mestu Ljubljana, ki sedaj oskrbuje mesto pretežno s toploto iz premoga. V prispevku je prikazana možnost prilaganja sistemov DGH v Sloveniji z večjo ali pretežno uporabo naravnega ali sinteznega plina – metana, pridobljenega iz odpadne biomase. Ocenjene so posledice zmanjšanja linjske gostote toplotnega odjemna, ki jih bodo za sisteme DGH prinesli ukrepi za učinkovito rabo energije in lokalna uporaba navadnih ali hibridnih topotnih črpalk. Hibridne topotne črpalki in lokalni sistemi za soproizvodnjo ter njihova povezava v sistem pametnega omrežja elektrodistribucije bodo bistveno spremenili sedanji energetski sistem. Posebno pozornost bo treba v sistemih DGH posvetiti hranilnikom topote, ki bodo omogočali premoščanje kratkotrajnih konic v električnem omrežju, ko bo oskrbovano s pretežnim delom elektrike iz OVE. Posebej sta prikazana možnost večje oskrbe Slovenije z domaćim sinteznim plinom (ki je obnovljiv in ne prispeva k povečanju emisij) v generatorjih topote DGH in njihov vpliv na ceno daljinske topote. Polnjenje slovenskega plinskega omrežja s sinteznim plinom iz biomase, kar imenujemo »hibridizacija plinskega omrežja«, bo prineslo tudi nove načine oskrbe s plinom in nov način obračuna. Ker v Sloveniji še nimamo daljinskega hlajenja v večjem obsegu, je nakazana tudi možnost uporabe plina v te namene, predvsem pri modernizaciji trgovskih kompleksov, letališč ali že zgrajenih poslovnih središč. Ekonomski posledice vseh teh sprememb so težko predvidljive. Ker je treba zagotoviti osnovno pokrivanje stroškov infrastrukture in obratovanja sistemov za DGH, bo končna cena za potrošnike višja kot pri uporabi fosilnih goriv. Država lahko uravnava stroškovni del s splošnim subvencioniranjem sistemov iz podnebnega sklada, ki je namenjen zmanjševanju emisij in prilagajanju, ali pa proces prepusti dogajjanju na trgu, kar bo povzročilo množične odklope od daljinskih sistemov in v končni fazi njihovo insolventnost. V EKS morajo biti pravilno opredeljeni vloga in realni pogoji za nadaljnji obstoj obstoječih sistemom, ki imajo infrastrukturo s primerno življenjsko dobo, treba pa je tudi dolgoročno opredeliti vlogo centralnih sistemov v energetskem sistemu ob upoštevanju principov iz energetskega svežnja EU. Nove sisteme pa je treba graditi na osnovi celovite presoje njihove vloge pri oskrbi urbanih področij s toploto in hladom tako z vidika ekonomičnosti kakor z vidika njihovih dolgoročnih vplivov na okolje. Zagotavljanje njihove vključitve v krožno gospodarstvo okolja, v katerem se nahajajo, je najboljše jamstvo za njihovo uspešnost.

Ključne besede: energetski koncept, daljinsko gretje in hlajenje, plin

DISTRICT HEATING AND COOLING IN SLOVENIA'S ENERGY CONCEPT: THE ROLE OF GAS

Peter Novak, Faculty of Technologies and Systems, Novo mesto

Slovenia's Energy Concept will define the role which fossil fuels and renewable energy sources will play in mass consumption, transport, and industry until 2055. District heating and cooling (DHC) holds a special place in sustainable heating and cooling of buildings. Considering the international obligations Slovenia has undertaken, DHC systems in the country will have to adapt to new conditions and cut greenhouse gas emissions by at least 40% by 2030. District heating in the city of Ljubljana stands out as a system primarily based on coal.

The paper discusses the modification of DHC systems in Slovenia by partly, or largely, using natural or synthesis gas – methane produced from waste biomass. It assesses the implications of reducing linear density of heat consumption for DHC systems, brought on by energy efficiency measures and local use of typical or hybrid heat pumps. Hybrid heat pumps and local co-generation systems and their integration into a smart power distribution network will transform today's energy system. In DHC systems, special attention will have to be given to thermal storage, which will help accommodate short-term peaks in the power grid once it is largely supplied by renewable energy generation.

The paper also discusses a possible increase in local syngas supply (a renewable, zero-emission source) in DHC heat generators, and the impact of DHC heat generators on district heating prices. Supplying the Slovenian gas network with synthesis gas from biomass – also referred to as gas network hybridisation – will bring new gas supply and billing methods. As district cooling in Slovenia is still small-scale, the paper indicates the possibility of using gas for this purpose, especially in modernising commercial centres, airports, or the existing business premises. The economic implications of these changes are difficult to predict. Due to the basic cost of infrastructure and DHC system operation, the end price for consumers will be higher than in the case of fossil fuels. The state can regulate the cost by subsidising DHC systems from its climate fund for emissions reduction and adaptation, or decide to leave the process to the market and risk a surge of disconnections from district energy systems, which can ultimately result in their bankruptcy.

Slovenia's Energy Concept should adequately define the role and realistic conditions for the survival of those existing systems with infrastructure with a reasonable operational life, and specify the long-term role of central systems within the energy system, taking into consideration the principles of the EU energy and climate package. Meanwhile, investment decisions regarding new systems should be based on comprehensive assessments of their role in supplying urban areas with heating and cooling energy in terms of economic viability as well as their long-term impacts on the environment. Ensuring their integration in the circular economy of the community in which they are located, is the biggest guarantee of their success.

Key Words: energy concept, district heating and cooling, gas

POSLOVANJE OPERATERJEV DISTRIBUCIJSKIH SISTEMOV ZEMELJSKEGA PLINA ZNOTRAJ REGULACIJE V OBDOBJU 2016–2018

Urška Ritonja, Agencija za energijo

Leto 2015 je bilo na področju regulacije zemeljskega plina predvsem leto načrtovanja in priprav na novo regulativno obdobje 2016–2018, tako s strani Agencije za energijo (v nadaljevanju: agencija) kot s strani operaterjev distribucijskih sistemov. V tem letu je agencija med drugim skladno z zahtevami Energetskega zakona (EZ-1) sprejela novo metodologijo za določitev regulativnega okvira operaterja distribucijskega sistema zemeljskega plina, na podlagi katere so operaterji distribucijskih sistemov pripravili zahteve za izdajo soglasja k regulativnemu okviru, tarifnim postavkam omrežnine in tarifnim postavkam za druge storitve za regulativno obdobje 2016–2018. Zahteve so morali agenciji posredovati najkasneje do 15. julija 2015. Agencija je prejela 18 zahtev 15 operaterjev distribucijskega sistema. Prejete zahteve je obravnavala in decembra 2015 operaterjem distribucijskih sistemov izdala soglasja. Tarifne postavke omrežnine za distribucijski sistem vseh 15 operaterjev distribucijskega sistema so bile objavljene v Uradnem listu Republike Slovenije z začetkom veljave 1. 1. 2016. Kot vsako leto je tudi leta 2015 agencija analizirala in obravnavala poslovanje operaterjev distribucijskih sistemov z namenom preveritve pravilnosti ugotovljenih odstopanj od regulativnega okvira za preteklo poslovno leto. Odstopanja od regulativnega okvira se odražajo v presežku ali primanjkljaju omrežnin in so jih na podlagi 255. člena EZ-1 dolžni ugotavljati operaterji sistemov. Če agencija ugotovi drugačna odstopanja od regulativnega okvira kot operaterji sistemov, izda posebno odločbo, s katero ugotovi višino presežka oziroma primanjkljaja omrežnin.

V prispevku bo predstavljeno načrtovano poslovanje operaterjev distribucijskih sistemov v regulativnem obdobju 2016–2018 s poudarkom na posameznih segmentih upravičenih stroškov. Prispevek se osredotoča na primerjavo načrtovanih stroškov delovanja in vzdrževanja, amortizacije in reguliranega donosa na sredstva med posameznimi operaterji distribucijskih sistemov. Prav tako se bo načrtovano poslovanje operaterjev distribucijskih sistemov v regulativnem obdobju 2016–2018 primerjalo z njihovim poslovanjem v regulativnem obdobju 2013–2015. Primerjave bodo temeljile na načrtovanih upravičenih stroških, na dejanskih upravičenih stroških, ki jih priznava regulator v okviru postopka ugotavljanja pravilnosti odstopanj od regulativnega okvira, in na realiziranih upravičenih stroških operaterjev distribucijskih sistemov, ki izhajajo iz njihovih temeljnih računovodskih poročil.

Ključne besede: agencija za energijo, regulacija, distribucija zemeljskega plina

BUSINESS PLANS OF DISTRIBUTION SYSTEM OPERATORS FOR GAS FOR THE 2016-2018 REGULATORY PERIOD

Urška Ritonja, Energy Agency, Slovenian National Regulatory Authority

In the field of natural gas regulation, 2015 was, above all, a year of planning and preparations for the new regulatory period 2016-2018, both for the Energy Agency, Slovenian National Regulatory Authority (hereinafter referred to as 'the Agency') and Distribution System Operators. It was in that year that the Agency adopted, pursuant to Slovenia's Energy Act (EZ-1), a new methodology for developing gas DSOs' regulatory frameworks. Based on this methodology, DSOs could seek approval for their regulatory frameworks, tariff components of network charges, and tariff components for other services for the 2016-2018 regulatory period. Their requests had to be submitted to the Agency no later than 15 June 2015. The agency received 18 requests from 15 DSOs. The requests were examined, and approvals were granted to DSOs in December 2015. Tariff components of distribution system network charges of all 15 DSOs were listed in the Official Gazette of the Republic of Slovenia, effective from 1 January 2016. As with every previous year, the Agency analysed and examined the business results of the DSOs in 2015 in order to verify the validity of the identified derogations from the regulatory framework for the previous business year. DOSs are obliged to identify derogations from the regulatory framework, manifested as a network charge surplus or deficit, under Article 255 of EZ-1. If a discrepancy is found between the derogations from the regulatory framework identified by the Agency and those identified by DSOs, the Agency issues a special decision in which it establishes the network charge surplus or deficit.

The paper presents business plans of DSOs for the 2016-2018 regulatory period, focusing on individual groups of eligible costs. At its centre is a comparison of DOSs by their planned operation and maintenance costs, amortisation and the regulated return on assets. The envisaged business results of DSOs for the 2016-2018 regulatory period are discussed against their business results in the 2013-2015 regulatory period. The comparisons are based on their planned eligible costs, the realised eligible costs recognised by the regulator in the process of verifying the validity of derogations from the regulatory framework, and the realised eligible costs of DSOs arising from their basic financial statements.

Key Words: energy agency, slovenian national regulatory authority, regulation, natural gas distribution

RAZVOJ SLOVENSKEGA TRGA Z ZEMELJSKIM PLINOM – NOVI PRODUKTI ZMOGLJIVOSTI, VIRTUALNA TOČKA IN TRGOVALNA PLATFORMA

Jošt Štrukelj, Marko Širovnik, Plinovodi

Družba Plinovodi d.o.o. je kot operater prenosnega sistema v Republiki Sloveniji, v skladu z določili Sistemskih obratovalnih navodil za prenosni sistem zemeljskega plina (v nadaljevanju SON), Uredbe Komisije (EU) št. 984/2013 in Uredbe Komisije (EU) št. 312/2014, v letu 2015 na spletini rezervacijski platformi PRISMA omogočila dodeljevanje združenih prenosnih zmogljivosti in dodeljevanje prenosnih zmogljivosti znotraj dneva na mejnih povezovalnih točkah ter vzpostavila virtualno točko za izmenjavo količin zemeljskega plina na slovenskem prenosnem sistemu.

Leta 2015 je bilo na mejnih točkah Plinovodov izvedenih preko 4.000 dražb, sklenjenih pa je bilo preko 110 pogodb. V skladu z določili SON in Uredbe Komisije (EU) št. 984/2013, smo 1. 11. 2015 na platformi PRISMA omogočili dodeljevanje združenih prenosnih zmogljivosti. Zakup združenih zmogljivosti pomeni, da uporabniki sistema na obeh straneh posamezne mejne povezovalne točke prenosne zmogljivosti zakupijo hkrati na eni dražbi. Združeno zmogljivost sosednja operaterja prenosnega sistema objavita skupaj, začetna dražbena cena pa se določi kot seštevek obeh reguliranih cen. Če se na dražbi doseže dražbena premija, si jo operaterja prenosnega sistema razdelita v skladu z medsebojnim dogovorom. Plinovodi smo 1. 11. 2015 na platformi PRISMA omogočili tudi dodeljevanje prenosnih zmogljivosti znotraj dneva za mejne povezovalne točke. Z uvedbo produkta zmogljivosti znotraj dneva je uporabnikom sistema omogočen zakup prenosne zmogljivosti od izbrane ure znotraj plinskega dneva do njegovega izteka. S tem je uporabnikom sistema ponujena večja prilagodljivost in možnost optimiziranja izvedbe zakupa prenosnih zmogljivosti.

Na podlagi SON in Uredbe Komisije (EU) št. 312/2014 smo Plinovodi 1. 10. 2015 vzpostavil virtualno točko za izmenjavo količin zemeljskega plina na slovenskem prenosnem sistemu. Skladno z EZ-1 je virtualna točka navidezna točka med vstopnimi in izstopnimi točkami prenosnega sistema, v kateri se šteje, da so podjetja plinskega gospodarstva in končni odjemalci v Republiki Sloveniji izvedli vse transakcije s količinami zemeljskega plina. V virtualni točki so uporabnikom sistema na voljo tri vrste storitev: izvedba transakcij, trgovalna platforma (TP) in oglasna deska. Storitve TP omogočajo udeležencem trgovanja sklepanje transakcij s kratkoročnimi standardiziranimi produkti za potrebe izravnave njihovih portfeljev. Kratkoročni standardizirani produkt je priglašena urna količina zemeljskega plina. Na trgovalni platformi Plinovodi ponujamo dva različna kratkoročna standardizirana produkta: za dan vnaprej in znotraj dneva.

Z uvedbo dodatnih novih produktov prenosne zmogljivosti je operater prenosnega sistema izpolnil zahteve evropske zakonodaje in s tem omogočil uporabnikom sistema dodatno prilagodljivost pri izvajjanju optimalnega zakupa prenosnih zmogljivosti na mejnih povezovalnih točkah. Pri vpeljavi virtualne točke smo se v Plinovodih odločili implementirati potrebno infrastrukturo za delovanje trga in omogočanje trgovanja z zemeljskim plinom v Sloveniji. Virtualna točka omogoča razvoj trga z zemeljskim plinom v Sloveniji, saj ponuja možnost organiziranega bilateralnega trgovanja. Plinovodi se bomo tudi v prihodnje zavzemali za nadaljnji razvoj predmetne infrastrukture z namenom, da imajo uporabniki sistema omogočen kar najbolj enostaven dostop do likvidnega trga z zemeljskim plinom. Tako se posredno povečuje tudi konkurenčnost zemeljskega plina kot energenta.

Ključne besede: združene zmogljivosti, virtualna točka, trgovalna platforma

DEVELOPMENT OF SLOVENIAN NATURAL GAS MARKET: NEW CAPACITY PRODUCTS, VIRTUAL TRADING POINT AND TRADING PLATFORM

Jošt Štrukelj, Marko Širovnik, Plinovodi

Pursuant to the system operation rules for a natural gas transmission system (hereinafter referred to as SON), the Commission Regulation (EU) No. 984/2013 and the Commission Regulation (EU) No. 312/2014, in 2015 Plinovodi d.o.o. as the gas transmission system operator of the Republic of Slovenia, introduced as part of the PRISMA capacity platform the allocation of bundled transmission capacity and intraday transmission capacity on interconnection points, and established a virtual trading point for trade in natural gas in the Slovenian transmission system.

More than 4,000 auctions were held on Plinovodi's interconnection points in 2015, with over 110 concluded contracts. Pursuant to SON and the Commission Regulation (EU) No. 984/2013, bundled transmission capacity allocation was introduced on the PRISMA platform on 1 November 2015. When booking bundled capacity, system users on both sides of the interconnection point book transmission capacity at the same time, at the same auction. The neighbouring TSOs auction the bundled capacity together, while the starting price is the sum of both regulated prices. If the auction premium is achieved, the TSOs split it in line with their bilateral agreement. On 1 November 2015 on the PRISMA platform, Plinovodi also introduced intraday transmission capacity allocation for interconnection points. The introduction of this intraday capacity product enabled system users to book transmission capacity from the selected hour within the gas trading day until the end of the day. This gives users more flexibility and an opportunity for transmission capacity booking optimisation.

Pursuant to SON and the Commission Regulation (EU) No. 312/2014, on 1 October 2015 Plinovodi established a virtual trading point for trade in natural gas in the Slovenian transmission system. In Slovenia's Energy Act EZ-1, this point is defined as a virtual point between the entry and exit points of the transmission system in which gas companies and final consumers in Slovenia shall be considered to have completed all natural gas transactions. In a virtual trading point, system users are offered three types of service: transactions, a trading platform, and a bulletin board. Trading platform services allow trading participants to trade in short-term standardised products in order to balance their portfolios. A short-term standardised product is an hourly notification quantity. On its trading platform, Plinovodi provides two different short-term standardised products: day-ahead, and intraday.

By introducing additional new transmission capacity products, the TSO has met the obligations arising from EU law, thus giving system users access to additional flexibility in optimising their transmission capacity booking on interconnections points. When implementing the virtual trading point, Plinovodi decided to build the infrastructure required for market operation and trade in natural gas in Slovenia. By enabling organised bilateral trade, the virtual trading point creates the right conditions for the development of Slovenia's natural gas market. Plinovodi will continue to strive for further development of the relevant infrastructure in order to facilitate access to a liquid natural gas market for system users. This also increases competitiveness of natural gas as an energy source.

Key Words: bundled capacity, virtual point, trading platform

ZEMELJSKI PLIN IN PLINOVODNI SISTEMI V PERSPEKTIVI AMBICIOZNIH OKOLJSKIH CILJEV

Marko Ilersič, Plinovodi

Evropska unija si je naložila ambiciozne okoljske cilje za obdobje do leta 2030 in do leta 2050. Predvideno je bistveno znižanje emisij CO₂ in drugih emisij toplogrednih plinov. Istočasno sta predvideni tudi povečanje učinkovitosti uporabe energije in zmanjševanje energetske odvisnosti.

V naslednjem obdobju se bo nadaljevala rast proizvodnje električne energije iz obnovljivih virov. Ta razvoj bo povečal nihanje v proizvodnji električne energije, zaradi česar se bo povečala potreba po skladiščenju in transportu električne energije. Pomembne spremembe je pričakovati tudi na področju prometa, ki je eden večjih onesnaževalcev v EU.

Z večim številom sprememb pa bo vedno bolj postajalo pomembno tudi vprašanje, kako zastavljene cilje doseči čim bolj racionalno, to je s čim manjšimi stroški. Ta izziv postaja vedno bolj očiten v zadnjih letih, ko je (tudi v Sloveniji) začelo primanjkovati finančnih sredstev za spodbujanje ukrepov učinkovite rabe energije in uporabe obnovljivih virov energije.

V tej luči postaja zemeljski plin vedno bolj aktualen emergent. Prva, dokaj preprosta možnost je, da goriva, ki emitirajo več toplogrednih plinov, v čim večji meri nadomestimo z zemeljskim plinom. Pričakovati je tudi rast porabe zemeljskega plina v distribucijskih omrežjih. Pri tem Slovenija izrazito zaostaja za večino držav EU, saj slovenska gospodinjstva le 10 % svoje rabe energije pokrivajo z zemeljskim plinom. Analize kažejo, da je mogoče z enim najcenejših in najpreprostejših ukrepov – z zamenjavo starega kotla na kurično olje s sodobnim plinskim kondenzacijskim kotlom – zmanjšati emisije CO₂ za približno 50 %. Zemeljski plin je zaradi visokih izkoristkov kogeneracij zelo primeren tudi kot emergent za sisteme daljinskega ogrevanja. Z večjo uporabo zemeljskega plina bi se tudi pomembno zmanjšala vsebnost za zdravje nevarnih trdnih delcev v zraku. Skladno z direktivo EU o vzpostavitvi infrastrukture za alternativna goriva v prometu je predvideno pomembno povečanje rabe zemeljskega plina v prometu, tako stisnjenega zemeljskega plina kot tudi utekočinjenega (predvsem za težke tovornjake in ladijski promet). V nekolič daljši perspektivi pa je zelo pomembno povezovanje elektrosistema s sistemom zemeljskega plina. Pri tem so v preizkusnih fazah sistemi za pretvarjanje električne energije v vodik in naprej v metan (angl. power-to-gas). V tem okviru lahko iščemo najbolj racionalne rešitve za skladiščenje občasnih presežkov električne energije iz obnovljivih virov in za učinkovit transport energije na velike razdalje. V naslednjem obdobju bo vedno več metana proizvedenega tudi iz odpadkov ali z uplinjanjem biomase (biometan). S tem postajajo omrežja zemeljskega plina vedno bolj omrežja za transport obnovljivih virov energije in se integralno vključujejo v energetsko sliko tudi po letu 2050.

Za uspešnost energetske tranzicije, ki poteka v EU, je ključno, da se vsi emergenti in tehnologije ocenjujejo po enakih merilih. Pomembno je tudi ohraniti osredotočenost na cilj, ki ni uporaba obnovljivih virov za vsako ceno, temveč tåko zmanjšanje emisij toplogrednih plinov, ki omogoča trajnostni razvoj. Kot zadnji element pa je treba izbrati optimalno dinamiko sprememb, ki bo omogočila kar najbolj racionalno izrabo obstoječih investicij ter ustrezno prilagoditev gospodarstva.

Ključne besede: zemeljski plin, okoljski cilji, obnovljivi viri

NATURAL GAS AND GAS SYSTEMS IN VIEW OF AMBITIOUS ENVIRONMENTAL TARGETS

Marko Ileršič, Plinovodi

The European Union has adopted ambitious environmental targets for the periods up to 2030 and 2050. The targets oblige countries to cut their CO₂ and other greenhouse gas emissions, while increasing energy efficiency and reducing their energy dependence.

Renewable power generation will continue its growth in the coming years. This will increase fluctuations in electricity generation, intensifying the need for electricity storage and transfer. Considerable changes can also be expected in the transport sector, one of the biggest polluters in the EU.

These growing changes will increasingly draw attention to the question of how to meet the set targets in the most rational way possible, i.e. at the lowest possible cost. This has become more and more of a challenge in recent years as countries (including Slovenia) have started to lack funds to encourage energy efficiency and renewable energy measures.

In these circumstances, natural gas is gaining new momentum. The first option, a fairly simple one, is to replace the more polluting fuels with natural gas to the largest extent possible. Natural gas consumption is also expected to increase in distribution networks. Here, Slovenia is lagging far behind most of the EU Member States, with natural gas accounting for just 10% of the energy needs of households in Slovenia. Analyses show that one of the cheapest and simplest measures – replacing an old fuel oil boiler with a state-of-the-art gas condensing boiler – can cut CO₂ emissions by around 50%. Thanks to high efficiencies of co-generation plants, natural gas is also a very rational choice as an energy source for district heating systems. An increase in the use of natural gas would result in a significant reduction of particulate matter air pollution. The EU Directive on the deployment of alternative fuels infrastructure envisages a considerable increase in the use of natural gas in transport, both as compressed natural gas and liquefied natural gas (particularly for heavy-duty vehicles and shipping). In the long term one of the key measures is to link the power system with the natural gas system. Tests are now underway for systems transforming power into hydrogen, and subsequently into methane (power-to-gas). In this field the most rational solutions should be found to store occasional surplus renewable electricity and transfer energy efficiently across long distances. In the coming years, methane will also be increasingly produced from waste or by gasifying biomass (biomethane). This will increasingly turn natural gas networks into networks for renewables transfer, and become an integral part of the energy picture after 2050.

For the energy transition now under way in the EU to succeed, it is vital that all energy sources and technologies are rated using the same criteria. It is also important to keep focusing on the goal, which is not using renewables at any price; it is cutting greenhouse gas emissions to the extent that will enable sustainable development. Ultimately, the dynamics of implementing change should be best suited to allow for the existing infrastructure to be used as efficiently as possible and the economy to adapt accordingly.

Key Words: natural gas, environmental targets, renewable energy sources

LETALSKA TERMOGRAFIJA – USPEŠEN NAČIN SISTEMSKE KONTROLE VROČEVODNEGA OMREŽJA ENERGETIKE LJUBLJANA

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Za sistemsko kontrolo in odkrivanje puščanja vročevodnega omrežja v Energetiki Ljubljana uporabljamo različne metode, med katerimi se je za najučinkovitejšo izkazalo termografsko presnemavanje omrežja z IR-kamerou. Prvotno smo presnemavanje izvajali z ročno IR-kamerou, kar pa se je zaradi obsežnosti omrežja izkazalo za zelo zahteven postopek, saj so le v krajšem obdobju leta zagotovljene primerne meteorološke razmere, poleg tega je treba snemanje izvajati ponoči in pri tem prehoditi velika območja, ki so včasih tudi težko dostopna. Zato je bilo smiselno uvesti dodatno metodo, ki bi nam v krajšem časovnem obdobju omogočila termografsko sliko celotnega omrežja.

Kot možna metoda se je ponujalo termografsko snemanje omrežja iz zraka. Tako smo po prvih poizkusnih snemanjih dveh manjših območij leta 2013 v ogrevalni sezoni 2014/15 izvedli termografsko snemanje iz zraka celotnega vročevodnega omrežja Energetike Ljubljana.

Pri izvedbi termografskega aerosnemanja je treba upoštevati oziroma zagotoviti cel niz pogojev, od meteoroloških do tistih, povezanih z letalom, snemalno opremo ter omrežjem. Vse to pa nas pripelje do želenega rezultata, torej do jasne termografske slike omrežja, umešene v prostor, kar pa je šele prvi korak do nadaljnjega dela in zahtevne analize, ki vodi do odkritja puščanja omrežja.

Pri snemanju so se upoštevali tudi okoljski vidiki, saj se je izvajalo z ultralahkim letalom, ki minimalno obremenjuje okolje s hrupom in izpušnimi plini ter s tem tudi prebivalce na območju snemanja v nočnih oziroma zgodnjih jutranjih urah.

Termografsko aerosnemanje se je izkazalo za zelo uspešno, saj smo na osnovi analize posnetkov odkrili oziroma potrdili preko 16 puščanj vročevodnega omrežja, ki smo jih uspešno sanirali in puščanje omrežja znatno zmanjšali.

Z uvedbo letalske termografije na vročevodnem omrežju Energetike Ljubljana smo naredili velik kakovostni preskok pri zmanjševanju puščanja omrežja, ob upoštevanju drugih prednosti oziroma možnosti, ki jih metoda omogoča (vsakoletna sistemski kontrola omrežja in spremljanje sprememb na omrežju, vodilo pri obnovah /npr. indiciranje vročevodov s slabo topotno izolacijo/, snemanje in kontrola nedostopnih delov vročevoda, kratek čas snemanja celotnega omrežja, razbremenitev sodelavcev za delo v nočnem času pri nizkih zunanjih temperaturah ...), pa je termografsko aerosnemanje vročevodnega omrežja nujno potrebno za sistemski nadzor in kontrolo omrežja ter za odpravljanje okvar na njem tudi v prihodnje.

Ključne besede: vročevodno omrežje, letalska termografija, sistemski kontrola

AERIAL THERMOGRAPHY: AN EFFECTIVE INSPECTION METHOD FOR ENERGETIKA LJUBLJANA'S DISTRICT HEATING PIPELINE

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Of the various methods used by Energetika Ljubljana for systemic control of, and leak detection in, the district heating pipeline, thermographic scanning of the network by means of an infrared camera has been recognised as the most effective. Originally, a hand-held IR camera was used for this purpose. However, this has proven to be a very difficult task, as the right meteorological conditions are available for very short periods of time during the year and because scanning has to be carried out at night time, on foot, and across vast and occasionally poorly accessible areas. A reasonable decision was therefore to introduce an additional method that would provide a thermal image of the entire network in a shorter period of time.

Aerial thermography was identified as a possible method of scanning the network. After the first scanning tests on two smaller areas in 2013, aerial thermography of the entire district heating network of Energetika Ljubljana followed in the 2014/15 heating season.

In aerial thermography a long list of conditions have to be met, ranging from meteorological to those concerning the aircraft, image recording equipment, and the network. All this helps us arrive at the desired result, i.e. a clear thermal image of the network in its environment, which is just the first step in a very complex analytical process of detecting leaks.

Environmental aspects have been considered in the scanning process by using an ultralight aircraft with minimal noise and exhaust impacts on the environment and subsequently on the residents of the area where thermal images are made at night time or in the early morning hours.

Aerial thermography has proven to be a very successful method, with more than 16 leaks in the district heating network identified or confirmed, and subsequently repaired, based on image analysis. As a result, network leakage has been reduced significantly.

The introduction of aerial thermography in the district heating pipeline of Energetika Ljubljana was a major step forward in reducing network leakage. Considering all the other benefits or possibilities provided by the method (annual systemic control of the network and monitoring of anomalies in the network, indication of needed repairs (e.g. pipes with inefficient thermal insulation), scanning and control of inaccessible parts of the district heating pipeline, short scanning times, employees relieved of working at night time at low outdoor temperatures, etc.), aerial thermography of the district heating pipeline is vital for systemic control and network scanning, and repairing its faults in the future.

Key Words: district heating pipeline, aerial thermography, systemic control

CENTRALNI HISTORIAN KOT TEMELJ OBVLADOVANJA PROCESOV V SISTEMIH DALJINSKE ENERGETIKE

Aljaž Stare, Milan Dobrič, Saša Sokolić, Metronik, Mojmir Debeljak, Energetika Ljubljana

Energetska, infrastrukturna, proizvodna in druga podjetja v svetu in pri nas se že dolgo zavedajo pomembnosti zbiranja podatkov za potrebe analize, izboljšave procesov ter pregleda proizvodnih in poslovnih kazalnikov.

Z namenom izboljšanja vizualizacije procesov, produktivnosti, učinkovitosti, optimizacije stroškov itd. so podjetja v zadnjih 20 letih vpeljala veliko različnih regulacijskih, nadzornih in drugih sistemov v avtomatiki. Vsi ti sistemi so bili pogosto izvedeni prek različnih izvajalcev, ki v večini primerov delujejo neodvisno drug od drugega in uporabljajo različne tehnologije za shranjevanje, prikazovanje, obdelavo in distribuiranje zajetih podatkov. Posledično zaposleni v podjetjih težko hitro prihajajo do pravih informacij v realnem času in ne dobijo kakovostnega vpogleda v delovanje celotnega sistema z enega mesta.

Zato je bistveno, da vse procesne podatke, ki so pomembni s stališča upravljanja, delovanja, vzdrževanja in drugih inženirskih funkcij, pa tudi podatke, ki se obdelujejo na proizvodnem oz. poslovнем nivoju, integriramo v enoten sistem – centralni procesni historian. Ta koncept zagotavlja sistematično ureditev procesnega arhiva in enostavnejše vzdrževanje in administracijo. V arhitekturnem smislu je centralni historian postavljen nad procesnim nivojem, to pa zagotavlja od procesa neodvisno delovanje in onemogoči njegov vpliv na proces, kar je pomembno s stališča informacijske varnosti.

Procesni historian različnim profilom uporabnikov omogoča hiter in enostaven vpoled v procesne podatke, izvajanje analiz in izdelovanje poročil preko različnih orodij in tehnologij, ki so za določeno skupino uporabnikov najprimernejše. Po drugi strani je procesni historian sposoben tudi povezovanja in posredovanja teh podatkov različnim proizvodnim in poslovnim informacijskim sistemom z uporabo standardnih tehnologij in vmesnikov, s čimer je zagotovljena odprtost rešitve ter enostavna širitev oz. vključevanje dodatnih sistemov v podjetju.

Pomembno je tudi, da izbrani procesni historian sledi sodobnim smernicam in omogoča uporabo oz. vključitev novih tehnologij (npr. mobilne naprave, podpora novim operacijskim sistemom, standardnim vmesnikom in protokolom) ter omogoča enostavno nadgradnjo in širitev brez večjih posegov in s tem povezanih dodatnih del. Konec concev je za uporabnike zelo pomembno tudi, da imajo za opremo, ki jo uporabljajo v osrčju svojih procesov, močno podporo in da je ne uporablja in razvija samo en sistemski integrator, s čimer naročnik ni odvisen le od enega izvajalca, ki lahko v nekaj letih izgine s trga.

Z vse večjim številom povezanih naprav (t. i. *Industrial Internet of Things*) pa se poračajo tudi novi načini za izrabo podatkov (npr. prediktivna analiza) in v kontekstu teh, t. i. »Big Data« sistemov je lahko odlična osnova ravno procesni historian.

V prispevku je prikazana uporaba centralnega historiana – Proficy Historian, proizvajalca GE IP, kot temeljne tehnologije za integracijo in obvladovanje različnih procesnih podatkov v sistemih daljinske energetike. Predstavljene so tudi konkretna arhitektura sistema, uporabljenе tehnologije in oprema ter koristi uvedbe tovrstnega sistema na področju daljinske energetike na primeru podjetja JP Energetika Ljubljana.

Ključne besede: procesni historian, zajem podatkov, shranjevanje podatkov, analiza podatkov

CENTRAL HISTORIAN AS A BASIS FOR MANAGING PROCESSES IN DISTRICT ENERGY SYSTEMS

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Energetika Ljubljana

Energy, infrastructure, production and other companies in Slovenia and worldwide have long been aware of the importance of collecting data for analysis, process improvement, and monitoring of production and business indicators.

Aiming to improve process visualisation, increase productivity and efficiency, optimise costs, etc., businesses have introduced a number of automated regulation, control and other systems over the last two decades. These systems have often been implemented through various different providers, who mainly operate independently from each other, using different technologies to store, display, process, and distribute the captured data. This is why company employees struggle to acquire the right information in real time, and fail to get a good insight into the functioning of the system as a whole in one place.

It is therefore essential to integrate all the process data which is important in terms of management, operation, maintenance and other engineering activities, as well as the data processed at production or business levels, into a single system: the Central Process Historian. This concept enables a systematic arrangement of the process archive, while facilitating maintenance and administration. The architectural position of the central historian above the process level guarantees its independence from the process and prevents its influence on the process, which is essential in terms of information security.

The Process Historian provides quick and easy access to process data for various profiles of users, enabling them to conduct analyses and make reports using the tools and technologies best suited for their user group. The Process Historian can also connect and send the data to various production and business information systems by using standard technologies and interfaces, allowing for open solutions and easy sharing or integration of additional systems.

Very importantly, the selected Process Historian follows modern trends, supporting the use of new technologies (e.g. mobile devices, new operating systems, standard interfaces and protocols) and allows for easy upgrade and expansion with no major activities or additional measures. Ultimately, strong support is available for users as the equipment they use at the heart of their processes is not developed by just one systems integrator. This is important as it prevent situations where the user is dependent on a sole provider, who can disappear from the market in a matter of years.

With a growing number of connected devices (the so-called Industrial Internet of Things), new ways of using data are emerging (e.g. predictive analysis). In the context of these Big Data systems, a Process Historian can be an excellent starting point.

The paper deals with the use of a central historian – Proficy Historian developed by GE IP – as a basic technology for the integration and handling of process data in district energy systems. It examines the example of the Public Company Energetika Ljubljana to discuss its specific system architecture, the applied technology and equipment, as well as the benefits of implementing this kind of a system in district energy.

Key Words: process historian, data capture, data storage, data analysis

HIDRAVLICNO URAVNOTEŽENJE SISTEMOV DALJINSKE ENERGETIKE, KI DELUJEJO PO NAČELU »PUSH«

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Tradicionalno so sistemi daljinskega ogrevanja delovali po enem od dveh načel dobave toplove, PUSH ali PULL. V sistemih PUSH je obračunavanje za odjemalce fiksno (neodvisno od porabe toplove), nabor krmilne opreme za prilagajanje dobave glede na dejanske potrebe pa je pri odjemalcu omejen ali pa te opreme sploh ni. V sistemih PULL se obračun za odjemalca opravi glede na porabljeno toploto, odjemalci pa imajo lastno krmilno opremo za prilagajanje dobave glede na dejanske potrebe.

Ob začetkih daljinskega ogrevanja so vsi nameščeni sistemi delovali po načelu PUSH, dobava je bila fiksna, prav tako obračunavanje, ki je temeljilo denimo na površini ogrevanega prostora ali nazivni zmogljivosti radiatorja. Sisteme, ki delujejo po tem načelu, še vedno lahko najdemo v vzhodni Evropi in Aziji, predvsem na Kitajskem. Glavni izzivi, ki jih prinašajo sistemi PUSH, so, da so zasnovani za delovanje s konstantnim razmerjem pretokov ter da uporabljajo ročne načine izravnavanja in fiksno obračunavanje. Dobava toplove se regulira s spremenjanjem temperature v toplarni. Zasnova s konstantnim razmerjem pretokov vodi v neskladje med ponudbo in dejanskim povpraševanjem, kar posledično privede do splošne prekomerne ponudbe, fiksno obračunavanje pa običajno pomeni neučinkovito rabo toplove pri odjemalcih, kar se lahko kaže kot reguliranje temperature notranjih prostorov z odpiranjem in zapiranjem oken.

Način obračunavanja vpliva tudi na strategijo krmiljenja, predvsem ker so odjemalci manj motivirani za varčevanje s toploto in uporabo avtomatiziranega krmiljenja, če obračunavanje ne temelji na dejanski porabi. Na ravni stavbe odsotnost avtomatiziranega krmiljenja navadno privede do visokih pretokov, manjše temperaturne razlike med dovedeno toploto in povratnim tokom, večje toplotne izgube na omrežju in manjšega izkoristka toplarne. Poleg tega breme poštene porazdelitve toplove nosijo toplarne. Te v splošnem težavo poskušajo reševati s fiksno pretočno zmogljivostjo na površino ali stavbo. S trenutno dostopno krmilno opremo in načini krmiljenja, ki so načeloma zasnovani za sisteme PULL, je učinkovito upravljanje teh sistemov zahtevna naloga.

Doslej je prevladovalo neskladje med dostopno krmilno opremo in potrebami sistemov PUSH po zagotovitvi ustreznega hidravličnega ravnotežja in poštene porazdelitve v sistemu. Da bi omogočil energetsko učinkovito delovanje sistemov za daljinsko ogrevanje, ki delujejo po načelu PUSH, je Danfoss razvil novo krmilno metodo, ki je prilagojena prav za omrežja daljinskega ogrevanja, ki delujejo po načelu PUSH, in s pametnim krmiljenjem doseže pošteno porazdelitev toplove. Nova krmilna metoda omogoča, da se dobava toplove kadarkoli priladi toplotnim potrebam stavbe, hkrati pa se upošteva skupna dobava toplove in tako prepreči morebitna nezadostna oskrba pri najbolj oddaljenih odjemalcih. Z uporabo te nove krmilne metode za usklajevanje ponudbe toplove z dejanskim povpraševanjem priključenih odjemalcev lahko dosežemo občutne prihranke energije, hkrati pa pri strankah povečamo splošno udobje.

Ključne besede: fiksno obračunavanje, poštena porazdelitev, inovativnost, načelo PUSH, konstantni pretok

HYDRAULIC BALANCING IN DISTRICT HEATING SYSTEMS OPERATED ACCORDING TO THE PUSH PHILOSOPHY

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Historically there are two heat delivery philosophies applied in district heating systems – the PUSH and PULL philosophies. In the PUSH system consumer billing is fixed (independent from heat consumption) and the consumer has limited, or even no, flow control equipment to adjust the supply to their actual demand. In the PULL system consumer billing is based on the heat consumed and consumers have their own flow control equipment to adjust the heat supply to their actual demand.

In the early days of district heating all installed systems were based on the PUSH philosophy, supplied flow was fixed and the billing was fixed and based on, for example, the number of square metres heated or the design radiator capacities. Systems operating under this philosophy can still be found in Eastern Europe and Asia, especially in China. The main challenges with the PUSH systems are that they are designed for constant flow ratio operation applying manual balancing principles and fixed billing. Heat delivery is controlled by varying the supply temperature at the heat plant. The constant flow ratio design leads to a mismatch between the supply and the actual demand, which results in a general oversupply, and the fixed billing typically results in inefficient utilisation of heat by consumers, which can be characterised by opening and closing windows to regulate indoor temperatures.

The method of billing also impacts the control strategy, mainly due to the fact that if billing is not according to consumption, customers are less interested in saving heat and utilising automatic controls. The lack of automatic controls at building level typically results in high flow rates, reduced temperature difference between supply and return, increased network heat loss and reduced heat plant efficiencies. Further, the burden of fair distribution of heat supply is laid on the district heating utilities. In general, the utilities try to solve this issue with fixed flow capacity per area or building. Efficient operation of these systems is difficult with currently available control equipment and control principles, which are generally designed for PULL systems.

Until now there has been a mismatch between the available control equipment and what the PUSH systems need to ensure good hydraulic balance and fair distribution in their systems. To ensure energy efficient operation of PUSH district heating systems, Danfoss has developed a new control method specifically tailored for PUSH district heating networks where fair heat distribution is achieved by intelligent control principles. The new control method ensures that at any given time the heat supply is adapted to a building's heat demand at the same time as the overall heat supply is taken into account to prevent undersupply at the most distant consumers. By utilising this new control method to match the heat supply to the actual heat demand of connected consumers, significant energy savings can be achieved at the same time as increasing overall consumer comfort.

Key Words: fixed billing, fair distribution, innovative, push philosophy, constant flow

INTERNET STVARI V ENERGETSKIH OMREŽJIH

Tomaž Fatur, Gašper Lakota, Marko Šepič, Solvera Lynx

Internet stvari oziroma »Internet of Things« (IoT) je izraz za omrežje raznolikih naprav (stvari), ki zbirajo, sprejemajo in pošiljajo podatke, komunikacija pa poteka preko obstoječega medomrežja. Zahvaljujoč izjemnemu razvoju tehnologij, znižanju cen v elektroniki, izboljšani energetski učinkovitosti naprav in tehnologij za procesiranje podatkov ter povečanju zmogljivosti omrežij, bo področje IoT v prihodnjih letih doživelо izjemен razmah. Izboljšanje brezžičnih komunikacij je omogočilo razvoj ogromnega nabora cenovno dostopnih naprav za uporabo na vseh področjih našega življenja, kot so pametne naprave v domovih, pametne osebne naprave (fitness ure, pametne ure, povezljive kamere ...), upravljanje infrastrukture v industriji, avtomatizacija v tovarnah, robotika, nove naprave v medicini, zdravstvu, pri vključevanju starostnikov v povezano družbo in podobno.

Možnosti za IoT v omrežnih energetskih sistemih, kot so elektroenergetski sistemi, plinovodna omrežja, sistemi daljinskega ogrevanja, pa tudi v drugih sistemih distribucije energentov so velike. Lastniki in operaterji omrežij upravljajo veliko število naprav in objektov, katerih stanje vpliva na nemoteno obratovanje omrežij in s tem posledično na kakovostno in neprekiniteno proizvodnjo ter dobavo energije. Z učinkovitim novimi brezžičnimi tehnologijami, kot je LoRa, se lahko spremišljajo stanje teh naprav in objektov na dolge razdalje in v velikem obsegu. Same naprave za spremljanje stanja in upravljanje so zaradi majhne porabe energije lahko baterijsko napajane, kar pomeni, da jih lahko namesшимo tudi na mestih, kjer bi bilo to prej nemogoče. Na sliki je prikazano povezovalno omrežje, ki temelji na radijskih brezžičnih komunikacijah LoRa in povezuje napajane ali baterijske brezžične senzorje in števce v omrežni strežnik, kjer sistem za upravljanje energije in energetskih podatkov predstavlja platformo, ki omogoča zanesljiv dostop do podatkov preko uporabniškega portala, analizo in poročilni sistem, hkrati pa omogoča razvoj novih storitev, kot je povezovanje alarmnih naprav in podobno.

Pri povezovanju naprav v energetskih omrežjih moramo upoštevati nekatere zakonitoosti področja, ki jih je treba izkoristiti, da bo prihodnji razvoj tako tehnično kot ekonomsko upravičen: interoperabilnost med različnimi sistemi IoT, uporaba podatkov ne le za odkrivanje napak in nadzor, pač pa za optimizacijo in napovedovanje, kjer pričakujemo mnogo večje koristi, aplikacije B2B bodo prinesle več koristi kot naprave, ki so namenjene uporabniku, zato se pri energetskih podjetjih pričakuje povečan razvoj tovrstnih sistemov, večina koristil mora biti namenjena uporabniku.

Povezovanje velikega števila naprav, ki bodo cenovno ugodne in bodo omogočale nove storitve in predvsem koristi za uporabnike, so že danes prisotne v različnih poslovnih modelih. Številna mesta in države so se že odločile za vzpostavitev infrastrukture za brezžična omrežja, ki bodo različnim skupinam uporabnikov omogočala povezljivost in nadgradnjo dosedanjih informacijskih sistemov. In prav energetska podjetja lahko zaradi svojega unikatnega položaja na trgu in dostopa do velikih skupin uporabnikov odločilno prispevajo k prihodnjemu razvoju tovrstnih aktivnosti.

Ključne besede: internet of things, internet stvari, energetska omrežja, pametna omrežja, sistem za upravljanje energije

THE INTERNET OF THINGS IN ENERGY NETWORKS

Tomaž Fatur, Gašper Lakota, Marko Šepič, Solvera Lynx

The Internet of Things (IoT) is a term denoting a network of devices (things) which collect, receive and send data, communicating via the Internet. In the coming years, the field of the IoT is expected to experience rapid growth, driven by a massive surge in technological development, price cuts in electronics, increased energy efficiency of data processing devices and technologies, and increased network capacities. Wireless communication improvements have sparked the development of a wide range of affordable devices in all areas of our lives, such as smart home appliances, smart personal gadgets (fitness trackers, smart watches, Wi-Fi cameras...), infrastructure management in industry, industrial process automation, robotics, new medical and healthcare devices, new devices that help integrate the elderly in a networked society, etc.

The IoT offers ample possibilities in networked energy systems such as electric power systems, gas pipeline networks, district heating systems, and other energy distribution systems. Network owners and operators manage a large number of devices and units, the shape of which affects the smoothness of network operation and subsequently the quality and reliability of energy production and supply. Efficient new wireless technologies such as LoRa enable mass monitoring of these devices and units over long distances. Monitoring and control devices may be powered by batteries to reduce energy consumption, which means they can be installed in locations where this has previously been impossible. The picture shows a connectivity network based on LoRa wireless radio communication, which connects wired or battery-powered wireless sensors and meters with the network server, where the energy and energy data management system is a platform that provides reliable access to data through a user interface, analytics, and a reporting system, while enabling development of new services, such as alarm device connectivity, etc.

When connecting devices in energy networks, certain principles of the field need to be considered and utilised in order to make future development both technically and economically viable: interoperability between various IoT systems, the use of data not only for fault detection and control, but also for optimisation and forecasting, where much bigger benefits are expected. As B2B applications will have much greater advantages than the devices intended for individual users, energy companies are expected to focus their development activities on the former, with most notable benefits for the user.

Various business models of today envision networks of large numbers of affordable connected devices that will bring new services and, most notably, benefits for users. Many cities and countries have already decided to build the infrastructure required for wireless networks which enable connectivity and upgrades of the present information systems for various groups of users. Due to their special position in the market and access to large groups of users, energy companies can play an important role in future development of these activities.

Key Words: internet of things, energy networks, smart grids, energy management system

IZKORIŠČANJE ODPADNE TOPLOTE TRGOVINSKEGA HLADILNEGA SISTEMA ZA DALJINSKO OGREVANJE KOT DEL PAMETNEGA ENERGETSKEGA SISTEMA

Jan Eric Thorsen¹, Torben Green², Torben Funder-Christensen², Danfoss A/S,
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V luči neprestanih zahtev po večji energetski učinkovitosti ter rabi obnovljivih in presežnih virov energije se v pametnem energetskem sistemu uporablja čedalje več novih prilagodljivih virov. Prispevek obravnava rabo odpadne toplote trgovinskega hladilnega sistema v sistemu daljinskega ogrevanja. Dotakne se tudi izkoriščanja prilagodljivosti električne in toplotne energije z vidika razvoja pametnega energetskega sistema, v katerem koncept daljinskega ogrevanja četrte generacije predstavlja pomemben del predvidene energetske infrastrukture.

Supermarket lahko toploto iz hladilnika plina sistema za hlajenje s CO₂ po potrebi uporablja za pripravo tople sanitarne vode in ogrevanje prostora. Poleg tega pa se odpadna toplota navadno odvaja v okolico prek izmenjevalnikov toplote, ki so običajno nameščeni na strehi. V tem prispevku predstavljamo koncept dovajanja te energije v omrežje daljinskega ogrevanja, s čimer jo izkoristimo in preprečimo njeno sproščanje v okolico. Hladilni sistemi v supermarketih navadno proizvedejo več toplote, kot jo potrebujemo za pripravo sanitarne tople vode in ogrevanje prostora, celo kadar jo proizvajajo zgolj na podlagi potreb živil. Zmogljivost hladilnega sistema običajno veliko presega dejanske potrebe za hlajenje živil. To pomeni, da zmogljivost ogrevanja in hlajenja ni popolnoma izkoriščena. Sistem nadalje ponuja možnost izkoriščanja električne energije na prilagodljiv način. Če imamo na voljo tak tip sistema, imamo potrebno energijsko prilagodljivost za pametni energetski sistem prihodnosti, ki prinaša možnost prilaganja odjema in porazdelitve obremenitev. Supermarketi imajo v skupni porabi električne energije približno dvoostotni delež. To pomeni, da obstaja precejšen potencial za izkoriščanje te prilagodljivosti za enakomernejšo obremenitev pri rabi električne in toplotne energije.

Prispevek predstavlja realiziran inovativni sistem rabe toplote iz supermarketeta na jugu Danske. Supermarket ima površino 1000 m², zmogljivost hladilnega sistema pa je 160 kW. Raba odpadne toplote poteka po načelu, da se najprej pokrijejo notranje potrebe po sanitarni topli vodi, nato notranje potrebe po ogrevanju, preostala razpoložljiva toplota pa se nazadnje uporabi v omrežju daljinskega ogrevanja. Povprečna zmogljivost ogrevanja iz omrežja daljinskega ogrevanja je približno 30 kW pri 65 °C. Prodaja odpadne toplote za rabo v omrežju daljinskega ogrevanja je za supermarket zanimiv način povečanja vrednosti investicije.

Ključne besede: pametni energetski sistem, daljinsko ogrevanje četrte generacije, energijska prilagodljivost, supermarket, hlajenje

UTILISING EXCESS HEAT FROM A SUPERMARKET REFRIGERATION SYSTEM IN A DISTRICT HEATING GRID AS PART OF A SMART ENERGY SYSTEM

Jan Eric Thorsen¹, Torben Green², Torben Funder-Christensen², Danfoss A/S,
Danfoss Heating Segment¹, Danfoss Cooling Segment²

In light of the continuous requirements for increased energy efficiency, and utilisation of renewable and surplus sources, more and more new flexible sources are being used in smart energy systems. This presentation focuses on utilisation of excess heat from a supermarket refrigeration system to a district heating system. Furthermore, introduction of electric and thermal energy flexibility is discussed, from a smart energy system development perspective, where the 4th generation district heating (DH) concept is an important part of the envisioned energy infrastructure.

A supermarket can use the heat from the gas cooler of a CO₂ refrigeration system to heat domestic hot water and, when needed, the building itself. Besides this, the excess heat is normally emitted to the surroundings, typically by roof mounted heat exchangers. The concept presented here is to feed energy into the DH network and thus utilise it instead of emitting the energy to the surroundings. Typically, there is more heat available from refrigeration systems in supermarkets than is needed for heating domestic hot water and buildings, even when heat production is only based on the cooling demand of the goods. When looking at the installed capacity of the refrigeration system, the capacity is normally much larger than actually needed for cooling of the goods. This means there is an installed capacity in terms of heating and cooling that is not utilised to the full extent. Further, the system represents the possibility of utilising electricity in a flexible way. This type of system offers the needed energy flexibility in regards to the future smart energy system, opening the possibility for demand response and load shifting. Supermarkets account for approximately 2% of all electricity use. This means there is relevant potential to utilise this flexibility in regards to electric and thermal load shifting.

The presentation includes a realised innovative supermarket heat utilisation system located in the southern part of Denmark. The supermarket floor area is 1000 m² and the system cooling capacity is 160 kW. The excess heat utilisation principle is to firstly prioritise internal domestic hot water needs, then secondly to prioritise internal heat demands, and finally to utilise the remaining available heat for the DH network. On average the heat capacity available for the DH network is approximately 30 kW at 65°C. The utilisation of the excess heat by selling it to the DH network is an interesting value increase for the supermarket.

Key Words: smart energy system, 4th generation district heating, energy flexibility, supermarket, refrigeration

OGLJIČNO NEVTRALNO DALJINSKO OGREVANJE V KÖBENHAVNU Z OKOLICO LETA 2025 – OD VIZIJE DO UKREPOV

Lars Gullev, VEKS, Danska

Leta 2008 so tri največja podjetja za daljinsko ogrevanje v Köbenhavnu z okolico – HOFOR, CTR in VEKS – sklenila do leta 2025 svojim odjemalcem zagotoviti izključno ogljično nevtralno daljinsko ogrevanje. V letih, ki so sledila, je to zahtevalo odločno vizijo in velika prizadevanja. Leta 2008 je samo ena od naprav za soproizvodnjo toplice in električne energije v Köbenhavnu (AVV 2) delovala na lesne pelete – in še ta s 75-odstotno zmogljivostjo.

Kaj se je odtlej zgodilo?

2012 Podjetje VEKS je kupilo enoto za SPTE na lesne sekance (70 MJ/s toplice, 25 MW električne energije). Leta 2014 je bil zgrajen prenosni vod za daljinsko ogrevanje, ki to enoto povezuje z obstoječim prenosnim omrežjem (20 km).

2014 Podjetje VEKS je podpisalo pogodbo z DONG Energy, lastnikom enote za SPTE AVV, za nadgradnjo bloka 2 s 75-odstotne na 100-odstotno rabo biomase (480 MJ/s).

2015 Podjetje HOFOR je posledično sklenilo zgraditi enoto za SPTE na lesne sekance z zmogljivostjo 400 MJ/s (AMV 4), ki naj bi začela obratovati leta 2020. Spomladti tega leta je bila podpisana nova pogodba med podjetjem VEKS in DONG Energy o prenovi bloka AVV 1 (350 MJ/s) do leta 2033 in njegovi nadgradnji na 100-odstotno rabo lesnih peletov do oktobra 2016. Decembra 2015 je VEKS na omrežje priklopil novo enoto za SPTE na bioplín (3 MJ/s toplice in 3 MW električne energije), ki v omrežje pošilja zeleno električno energijo, odpadno toplovo iz bioplinskega motorja pa v omrežje za daljinsko ogrevanje.

Zakaj je podjetje VEKS kupilo enoto za SPTE na biomaso? Da bi zmanjšalo odvisnost od drugih proizvajalcev toplice in stroške proizvodnje toplice.

Zakaj izbrati lesne pelete in ne lesnih sekancev ali nasprotno? Blok 1 enote AVV je bil zasnovan za kurjenje premoga ali nafte, blok 2 pa za premog, zemeljski plin ali nafto. Oba kotla sta bila načrtovana za rabo premogovega prahu. S predelavo za rabo lesnih peletov namesto lesnih sekancev je treba prilagoditi samo mline za premog, da lahko obdelajo tako premog kot lesne pelete. Kotlov ni treba predelovati. Če torej namesto lesnih sekancev uporabljamo lesne pelete, investicijo v predelavo bloka zmanjšamo na minimum. Pri novem kotlu – kakršen je AMV 4 – pa smo se odločili za lesne sekance, saj so ti cenejši od lesnih peletov.

Kako skladiščiti lesne pelete? Lesne pelete je treba skladiščiti v zaprtem prostoru, da ostanejo suhi. V enoti AVV sta bili zgrajeni dve skladiščni cisterni, prva s prostornino 15.000 m³ in druga s prostornino 60.000 m³.

Lesne sekance lahko hranimo na prostem, vendar potrebujejo veliko več prostora kot lesni peleti.

Kako obvladati do 1.100.000 ton lesnih peletov na leto? Lesni peleti prihajajo iz osmih do desetih evropskih držav in ZDA. Iz evropskih držav jih pripeljejo manjše ladje, vsaka po 5000 do 6000 ton. Iz ZDA jih z velikimi ladjami za do 60.000 ton tovora pripeljejo do tranzitnega terminala na zahodu Danske, potem pa z manjšimi ladjami do enot za SPTE.

Zakaj je podjetje VEKS investiralo v motor enote za SPTE, ki deluje na bioplín? Solroed Biogas je edinstven projekt sodelovanja med industrijo, kmetijstvom in energetiko. VEKS uporablja bioplín iz obrata za poganje plinskega motorja, pri čemer proizvedeno zeleno električno energijo oddaja v omrežje, preostanek bioplina pa uporablja za poceni, okolju prijazno daljinsko ogrevanje. Ta koncept je skladen z vizijo, da odjemalcem do leta 2015 zagotovimo ogljično nevtralno daljinsko ogrevanje.

Napredek pri izpustih CO₂: S 50 kg/GJ leta 1990 na 32 kg/GJ leta 2005 oz. 23 kg/GJ leta 2014.

Ključne besede: biomasa, lesni peleti, lesni sekanci, SPTE, bioplín

CO₂-NEUTRAL DISTRICT HEATING IN GREATER COPENHAGEN 2025: FROM VISION TO ACTION.

Lars Gullev, VEKS, Denmark

In 2008 the three large district heating companies in Greater Copenhagen – HOFOR, CTR and VEKS – made the decision that all district heating supplied to customers in 2025 should be CO₂-neutral. This was an ambitious vision requiring a lot of effort in the subsequent years. In 2008 only one of the CHP units in Copenhagen (AVV 2) was wood pellet-fired – and providing only 75% of the capacity of the whole unit.

What has happened since?

- 2012 VEKS bought a wood chip-fired CHP plant (70 MJ/s heat, 25 MW power). In 2014 a district heating transmission line from the plant to the existing transmission network was constructed (20 km).
- 2014 VEKS signed an agreement with DONG Energy, which owns the CHP plant AVV, to upgrade unit 2 from 75% to 100% biomass firing (480 MJ/s).
- 2015 HOFOR subsequently decided to build a 400 MJ/s woodchip-fired CHP plant (AMV 4) for commissioning in 2020. In spring 2015 another agreement was signed between VEKS and DONG Energy for the overhaul of unit AVV 1(350 MJ/s) by 2033, and rebuilding of the unit to 100% wood pellet-firing for commissioning in October 2016. In December 2015 VEKS put a new biogas engine CHP plant (3 MJ/s heat and 3 MW power) into operation where green electricity is supplied to the grid and surplus heat from the biogas engine is supplied to the district heating network.

Why has VEKS bought a biomass fired CHP plant? To reduce the dependence of other heat producers and to reduce heat production costs.

Why choose wood pellets instead of wood chips or vice-versa? Unit 1 of the AVV CHP plant is built for coal/oil-firing and unit 2 for coal/natural gas/oil-firing. Both boilers are constructed for coal dust-firing. By rebuilding to operate using wood pellets instead of wood chips, only the coal mills have to be rebuilt to handle both coal and wood pellets. Boilers do not have to be rebuilt. By using wood pellets instead of wood chips, investments for rebuilding the plant will be minimised.

A new boiler – AMV 4 – will be constructed to operate on wood chips as they are cheaper than wood pellets.

How should wood pellets be stored? Wood pellets must be stored indoors to ensure they are kept dry. Two storage tanks have been built at the AVV CHP plant – one with a volume of 15,000 m³ and the other with a volume of 60,000 m³.

Wood chips can be stored outside but require a far greater storage area than that for wood pellets.

How are up to 1,100,000 tonnes of wood pellets transported annually? The wood pellets are sourced from 8-10 European countries and from the USA. From European countries the wood pellets are carried by small ships – 5-6,000 tonnes each. From the USA the pellets are shipped by large bulk carriers – up to 60,000 to a transit terminal in the western part of Denmark. From here the pellets are transferred by small ships to the CHP plant.

Why has VEKS invested in a CHP engine which can use biogas? Solroed Biogas is a unique co-operation between the industrial, agricultural and energy sectors. VEKS takes biogas from the plant and uses it in a gas engine to produce green electricity to the grid, utilising the surplus for cheap, green, district heating. The concept supports the vision to supply consumers with CO₂ neutral district heating in 2025.

Development of CO₂ emissions: From 50 kg/GJ in 1990 to 32 kg/GJ in 2005 and 23 kg/GJ in 2014.

Key Words: biomass, wood pellets, wood chips, CHP and biogas

ENERGETSKA SAMOOSKRBA LOKALNE SKUPNOSTI DO LETA 2020

Uroš Plik, Energetika Šentrupert

Dejstvi, da v lokalnem okolju 60 % površin predstavlja gozd in da je študija Zavoda za gozdove pokazala, da je v radiju 30 km letno na voljo 50.000 kubikov lesa, sta povzročili, da je model trajnostne rabe obnovljivih virov za proizvodnjo energije, v našem primeru lesne biomase, postal edina logična izbira. Vizija Energetike Šentrupert sledi viziji lokalne samooskrbe Občine Šentrupert. Marca 2014 smo uspešno končali projekt izgradnje kotlovnice na Dobu, s katero je naš največji zaporski kompleks v Sloveniji in hkrati največje naselje v občini prešlo na uporabo obnovljivega vira energije.

Naslednji projekt, ki je uspešno končan in je bil zagnan februarja, je bila elektrarna za soproizvodnjo toplove in električne energije. V nadaljevanju je predvidena še izvedba daljnatega ogrevanja samega naselja Šentrupert. V sodelovanju z zasebnim investitorjem je zasnovan koncept proizvodnje 3000 ton paradižnika. Prostorsko je zagotovljena lokacija za gradnjo 4,5 hektarja steklenjakov, za katere bo Energetika Šentrupert dobavljala vso potrebno toploto. S tem projektom želimo graditi temelje lokalne samooskrbe s hrano.

Pri vseh projektih sledimo načelom »zelene« integralne ekonomije, za katero je ključno zapiranje finančnih tokov znotraj lokalne skupnosti oz. regije. Ravno od tod izhaja tudi dejstvo, da se lesna biomasa pridobiva v lokalnem okolju. Hkrati so vse investicije, ki so izvedene, se izvajajo ali so predvidene, medsebojno povezane. Vsaka nova dopolnjuje prejšnjo in jo hkrati nadgradi. Z vsako novo investicijo se bodo ustvarila nova delovna mesta.

Vsekakor bo imel proces izvedbe energetske samooskrbe, poleg zaposlitvenega potenciala, učinke tudi na zagotavljanje obnovljivega in cenejšega energenta ter pomemben vpliv na to, da bodo finančni tokovi potekali predvsem znotraj lokalne skupnosti.

»Zapiranje finančnih tokov znotraj lokalne skupnosti« in organizirano nastopanje na trgu na področju lesne biomase sta bila glavna vzroka za ustanovitev Lesno gozdarske zadruge Dolenjske. Temeljni namen ustanovitve zadruge je bil dokazati že 130 let znano »resnico«, da interesno povezovanje članom omogoča izboljšanje konkurenčne sposobnosti in hkrati poveča ekonomsko učinkovitost vseh deležnikov s skupnim nastopom na trgu. Hkrati pa je globalna kriza samo še poglobila prepričanje, da je z organiziranim nastopom na trgu mogoče ustrezno slediti spremembam na trgu in blažiti tržna nihanja.

V skladu z vizijo 2020 o energetski samooskrbi občine bomo v prihodnjih letih v lesno-predelovalnem centru v Puščavi zgradili še en obrat kogeneracije za proizvodnjo električne in odvečno toploto porabili za sušilnice lesa. Naslednji projekt, ki sledi zastavljeni viziji, je daljinsko ogrevanje naselja Šentrupert. Izvedli ga bodo s pomočjo evropskega projekta Remida, pri katerem je občina uspešno pridobila nepovratna sredstva v višini dobreih 140.000,00 evrov. Projekt bo voden vzporedno z renovacijo mestnega jedra Šentruperta. To pomeni, da bodo elektrokомуunikacije in kanalizacijski sistemi odprti hkrati in da bo infrastruktura za ogrevanje vgrajena v zemljo. Daljinsko ogrevanje je predvideno v dolžini dobreih 700 metrov. Za prihodnost ostaja želja prenesti te dobre prakse na področje celotne Mirnske doline, kasneje pa na področje jugovzhodne Slovenije. Postati želimo neke vrste »one stop shop« na področju energetskih rešitev.

Ključne besede: energetska samooskrba, lokalna skupnost, zelena integralna ekonomija

ENERGY SELF-SUFFICIENCY OF THE LOCAL COMMUNITY BY 2020

Uroš Pikl, Energetika Šentrupert

Based on the facts that forests take up 60% of the area in local environments, and that according to a Slovenia Forest Service study there are 50,000 cubic metres of wood to be consumed each year within each 30 km radius, the model of sustainable use of renewable energy sources, wood biomass in this case, has become the only logical approach for energy production. In its vision, Energetika Šentrupert follows the local self-sufficiency vision of the Šentrupert municipality. In March 2014 the boiler room construction project in Dob was finalised successfully, enabling the largest Slovenian prison system as well as the biggest town in the municipality to make the transition to renewable energy sources.

Finalised and successfully launched in February, the next project was a combined heat and power unit. A district heating system is also planned to be installed in the town of Šentrupert as a follow-up. A scheme to produce 3,000 tonnes of tomatoes has been devised in co-operation with a private investor. A location extending over 4.5 ha has been chosen for greenhouses to be constructed, which Energetika Šentrupert will supply with the heat required. With this project our aim is to build the foundations for local self-sufficiency in food.

In all our projects, we have been following the principles of integral "green" economy, its key concept being to confine financial flows to the local community or region. This is also the reason why wood biomass originates in the local environment. Furthermore, all the investments that have been, are being, or are planned to be implemented, are mutually related. Each new investment is a complement and an upgrade to a previous one. Each new investment will generate new jobs.

As well as increasing the employment potential, the process of implementing energy self-sufficiency will undoubtedly help provide a renewable and more affordable energy source and, vitally, contribute to confining the financial flows mostly within the local community.

"Confining financial flows to the local community" and organising joint activity in the wood biomass market has led to the establishment of the Dolenjska Wood and Forestry Co-operative. The main purpose of founding it was to prove the "truth" that has been known for 130 years, i.e. that interest grouping brings improved competitive abilities to members, while increasing the economic performance of all the stakeholders participating jointly in the market. The global crisis has also further deepened the belief that an organised participation in the market can facilitate adaptation to changes in the market and alleviate market fluctuations.

In compliance with the 2020 vision on energy self-sufficiency of the municipality, we will be constructing another CHP facility in the Puščava wood-processing centre in the coming years, using its waste heat in wood drying chambers. Our next project working towards the vision set forth will be district heating in the town of Šentrupert. The project will be implemented with the support of the Remida European project, as the municipality has been successful in acquiring a non-refundable grant amounting to more than EUR 140,000.00. The project will be run parallel to the renovation of Šentrupert town centre, meaning that the power and sewerage systems will be put in operation at the same time and that the heating infrastructure will be installed in the ground. The planned length of the district heating system is 700 metres. In future we hope to be able to transfer these examples of good practice to the entire Mirna Valley and, later, further to south-eastern Slovenia. Our aim is to become a "one stop shop" for the field of energy solutions.

Key Words: energy self-sufficiency, local community, integral green economy

PODPOSTAJA DALJINSKEGA OGREVANJA Z ELEKTRIČNIM GRELINKOM ZA PRIPRAVO VODE Z VSTOPNO TEMPERATURO 40 °C

Marek Brand, Danfoss A/S, Oddlek za ogrevanje, Application & Technology, Danska, Christian Holm Christiansen, Danski tehnološki inštitut, Danska, Niels Vilstrup, COWI, Danska, in Lars Overgaard Lisberg, Odder Varmeværk, Danska

Strateški energetski načrti vlad in mestnih oblasti v zadnjih letih namenjajo čedalje več pozornosti daljinski energetiki, saj ta velja za eno glavnih gonilnih sil za zmanjšanje izpussov CO₂ z obsežno rabo virov obnovljive toplotne. A da bi zadostili prihodnjim zahtevam sistemov daljinskega ogrevanja, ki bodo oskrbovali energetsko učinkovite stavbe s toploto iz obnovljivih virov in z industrijsko odpadno toploto z nižjo uporabno vrednostjo, je treba znižati vstopno temperaturo.

Konzorcij partnerjev v projektu, ki ga podpira dansi raziskovalni program EUDP, je razvil in preskusil koncept ultranizkotemperaturnega daljinskega ogrevanja, kjer vstopna temperatura ne presega 40 °C in ki je kombiniran s pretočnim grelnikom vode, ki segreje sanitarno vodo za zadnjih nekaj stopinj. Koncept je bil v mestu Odder na Danskem na preskušu devet mesecev v petih enodružinskih hišah s konca 90. let, ki imajo talno ogrevanje.

Rezultati so pokazali, da koncept in razvite enote zelo dobro delujejo in uporabniku zagotavljajo zadovoljivo raven udobja v smislu temperature in pretoka sanitarne vode. Delež električne energije za pripravo tople vode je v povprečju znašal 30 odstotkov, kar ustreza zgoljtem odstotkom vse energije, potrebne za ogrevanje prostora in pripravo tople vode. Dodatne tekoče stroške električne energije in dodatno investicijo v prilagoditev podpostaje je deloma, vendar ne v celoti uravnotežilo 50-odstotno zmanjšanje izgub pri distribuciji toplotne iz poskusnega omrežja. Glavno prednost koncepta pa je vendarle treba videti v priložnosti za celoletno oskrbo omrežij daljinskega ogrevanja pri temperaturi 40 °C, kar omogoča rabo nizkocenovnih virov toplotne z nižjo uporabno vrednostjo ali povratnega toka obstoječih omrežij daljinskega ogrevanja. Če upoštevamo, da cena toplotne pri temperaturi 40 °C znaša 70 odstotkov običajne cene toplotne, in če povprečna cena električne energije za končne odjemalce ostane na sedanji ravni, se investicija povrne v sedmih letih več kot konvencionalna rešitev za daljinsko ogrevanje. Če pa se cena toplotne pri 40 °C zniža na 50 odstotkov običajne cene toplotne, se preprosta vračilna doba prepelovi na približno tri leta in pol.

Količina razpoložljive industrijske toplotne z nižjo uporabno vrednostjo in toplotne iz obnovljivih virov je ogromna, in ker koncept omogoča uporabo virov toplotne z nižjo uporabno vrednostjo, ki bi sicer ostali neizkorisčeni, velja za zelo obetavnega.

Ključne besede: ultranizkotemperaturno daljinsko ogrevanje, električni grelnik, odpadna toplota z nižjo uporabno vrednostjo

DISTRICT HEATING SUBSTATION WITH AN ELECTRICAL HEAT SUPPLIED BY 40°C DISTRICT HEATING WATER

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For the last couple of years district energy has been drawing increased awareness in energy strategy plans of governments and cities. This is because it is seen as one of the main drivers for reducing CO₂ emissions through implementation of large-scale renewable heat sources. However, to fit the future requirements of district heating systems supplying energy efficient buildings with renewable and low-grade industrial waste heat, the supply temperature should be reduced.

The consortium of partners in the project supported by the Danish research programme EUDP has developed and tested the concept of ultra-low-temperature district heating with a supply temperature as low as 40°C, combined with instantaneous electric heat topping up the last few degrees of domestic hot water heating. The concept was tested in the late 90s in the city of Odder, Denmark, for a period of nine months, in five single-family houses equipped with floor heating.

The results show that the concept and the developed units operate well and end-users are satisfied with the comfort of the temperature and flow rate of domestic hot water. The share of the electricity for domestic hot water preparation accounted on average for 30%, corresponding to only 3% of the total energy needed for heating and domestic hot water. The additional running costs for the electricity, and the additional investment for the modified substation, were partly, but not fully, counteracted by a 50% distribution heat loss reduction from the experimental network. However, the main benefit of the concept should be seen in the opportunity of supplying the district heating networks at 40°C during the whole year, enabling the use of low-cost, low-grade heat sources or the return line of the existing district heating network. Considering the price of the 40°C heat at a level of 70% of the normal heat price, and maintaining the typical end-user price for electricity, the simple payback time is expected to be seven years in addition to the traditional district heating solution. Nevertheless, in the case that the price of 40°C heat is reduced to 50% of the normal heat price the simple payback time is halved to approximately three-and-a-half years.

The amount of available low-grade industrial and renewable heat is huge and the concept is therefore seen as very promising because it allows for the utilisation of low-grade heat sources that would otherwise be lost.

Key Words: ultra-low-temperature district heating, electrical heater, low-grade waste heat

REKONSTRUKCIJA SISTEMOV DALJINSKEGA OGREVANJA V TRANZICIJSKIH DRŽAVAH – VELIK ENERGETSKI IZZIV

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Človeštvo se sooča z največjim izzivom doslej – s prehodom v družbo, ki temelji na trajnostnih načelih. Gre seveda za izjemno resen in zahteven izziv. Številne študije in analize so pokazale, da rekonstrukcija sistemov daljinskega ogrevanja v gospodarstvih v tranziciji zaradi nezadostnega financiranja lokalnih oblasti in mednarodnih finančnih ustanov zahteva sodelovanje zasebnega sektorja. Če želijo energetska podjetja uspešno voditi prehod k trajnostnemu energetskemu sistemu, pa morajo biti sposobna obvladovati družbeno kompleksnost, ki presega njihove poslovne okvire.

Naša trenutna raba energije predstavlja velik del trajnostnega problema. Hiter razvoj trajnostnega energetskega sistema je ključnega pomena za prehod celotne družbe k trajnostnemu načinu delovanja. Strategija trajnostnega razvoja predstavlja temelj za povečanje energetske učinkovitosti, zmanjšanje stroškov ogrevanja in zmanjšanje škodljivih izpustov v okolje. K temu vodijo trije veliki energetski izzivi: zagotavljanje nizkoogljične prihodnosti, varnost s samozadostnostjo in trajnostna energija. Poslednji cilj je razviti strategijo trajnostnega razvoja in optimalni način upravljanja sistema daljinskega ogrevanja. To bo omogočilo optimizacijo celotnega sistema, denimo učinkovitejše upravljanje sistemov (temperatura, tlak ipd.), boljšo uporabo obstoječega procesnega algoritma ter učinkovitejše proizvodnjo električne energije in toplotne za zdravo gospodarsko rast, ki bo hkrati imela čim manjši vpliv na okolje in potrošnikom zagotavljala udobje. Eden najpomembnejših dejavnikov pri izvajanju vseh teh ukrepov in dejavnosti je temeljito poznavanje celotnega sistema, ki je za uvedbo takega koncepta nujno. Brez ustrezne slike sistema v realnem času, ki jo zagotavlja informacijska tehnologija, danes kompleksnega sistema ni mogoče upravljati. IKT-orodja za upravljanje v realnem času (SCADA, Termis ipd.) naj bi omogočila delo v realnem času na podlagi ažurnih podatkov o sistemu daljinskega ogrevanja. Pomembno je tudi, da najdemo pravo ravnotesje med IKT in človeškimi viri. Ustrezna kombinacija rabe sodobnih tehnologij in IKT na eni strani ter človeških virov na drugi je ključ do uspeha. To je osnovni pogoj za povečevanje energetske učinkovitosti in optimizacijo upravljanja sistema.

Da bi predvideli zanesljivost daljinskega ogrevanja v prihodnje, je nujno poznati potrebe odjemalcev, njihove preference in nove tendre, ki poganjajo razvoj sistemov ogrevanja. V prihodnosti potrebujemo nove pametne in prilagodljive rešitve, denimo decentralizirano proizvodnjo, sisteme shranjevanja toplotne, spremljanje v realnem času, optimizacijo, svetovanje pri porabi in nov način oblikovanja cen. Pri povezanih učinkovitih energetskih sistemih je cilj kar najbolj zmanjšati potrebno kakovost vstopne energije za končno rabo, razen če je odpadno energijo mogoče drugje učinkovito porabiti. Tranzicijske države bi se morale pri rekonstrukciji sistemov daljinskega ogrevanja zgledovati po zahodnoevropskih državah, predvsem po danskem sistemu daljinskega ogrevanja. Poleg tega vsak sistem in vsaka tranzicijska država potrebujeta strategijo rekonstrukcije sistema daljinskega ogrevanja. Če želijo energetska podjetja uspešno voditi prehod k trajnostnemu energetskemu sistemu, pa morajo biti sposobna obvladovati družbeno kompleksnost, ki presega njihove poslovne okvire.

Ključne besede: daljinsko ogrevanje, rekonstrukcija, trajnostni razvoj, trajnostni energetski sistemi

DISTRICT HEATING SYSTEM RE-ENGINEERING IN A TRANSITION STATE – A GREAT ENERGY CHALLENGE

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Humanity is facing its greatest challenge ever – to transition society towards sustainability.

This, of course, is extremely serious and challenging. A lot of studies and analysis have shown that rehabilitation of district heating (DH) systems in economies in transition require private sector participation due to insufficiency of resources of local authorities and international financing institutions. Energy companies must be able to handle social complexity beyond them in order to manage a successful transition towards a sustainable energy system.

Our current use of energy is a major part of the sustainability problem. Rapid development of sustainable energy systems is crucial for society's transition towards sustainability. A sustainable development strategy is essential to improve energy efficiency, reduce heating costs and reduce emissions in the environment. To realise this there are three major energy challenges: realising a low-carbon future, security through self-reliance, and sustainable energy. The final goal is to develop a sustainable development strategy and optimal management of the DH system. This will enable optimisation of the systems, such as managing these systems more efficiently (temperature, pressure, etc.), facilitating existing algorithms of processing, more efficient production of electrical and thermal energy to combine sound economic growth with little environmental impact, and customer convenience. One of the most important elements in the implementation of all these measures and activities is in-depth knowledge of the entire system in order to implement a concept such as this. Without knowing the actual picture of the system in real-time, it is impossible nowadays to manage one complex system without IT. Real-time IT management tools (SCADA, Termis, etc.) should enable work in real-time on the basis of the latest data about a district heating system. It is also very important to find a proper combination of IT and human resources. The right usage combination of modern technologies and IT on the one hand, and human resources on the other, is the key to success. This is a basic hypothesis for implementation of energy efficiency measurements and system management optimisation.

To accurately foresee the future of district heating it is necessary to understand customers' needs, preferences and new trends driving the development of heating systems. New smart and flexible solutions, for example decentralised production, heat storing systems, real-time monitoring, optimisation, consumption consulting, and new pricing, are needed in the future. With integrated efficient energy systems, the goal is to minimise the required quality of energy input for each end-user unless the rejected energy can be used efficiently elsewhere. Western European countries' district heating systems, especially that of Denmark, should be the final target of district heating system re-engineering in transition states. Additionally, each system and each country need a distinct rehabilitation strategy for district heating in economies in a state of transition. Energy companies must be able to handle social complexity beyond them to be able to successfully manage the transition towards a sustainable energy system.

Key Words: district heating, re-engineering, sustainable development, sustainable energy systems

OCENA TOPLOTNE UČINKOVITOSTI IN TEHNIČNO-EKONOMSKA ANALIZA

EKONOMIZATORJA TOPLOVODNEGA KOTLA V TOPLARNI KONJARNIK

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Toplarna Konjarnik je s toplotno zmogljivostjo 238 MW tretja največja v beograjskem sistemu daljinskega ogrevanja. Obsega tri toplovodne kotle, ki so z distribucijskim omrežjem povezani posredno prek izmenjevalnikov toplotne. Dimni plini se skozi betonske cevi skupnega ojačenega betonskega dimnika izločijo v ozračje. Da bi izkoristili del odpadne toplotne, je bil leta 2009 zasnovan in zgrajen dodatni (zunanji) gelnik vode – ekonomizator z nazivno izhodno toplotno močjo 6 MW.

Ekonomizator se nahaja na obvodu obstoječe betonske cevi za dimne pline na toplovodnem kotlu z zmogljivostjo 116 MW. Obvod je izdelan iz jeklene cevi dimenzijs 1500 x 3000 mm. Ločen je z loputnim ventilom, v bentonsko cev za dimne pline pa je nameščen zaporni zasun. Proses je v celoti avtomatiziran in krmiljen prek sistemov PLC in SCADA.

Težavo z dodatnim uporom na strani plina, ki se ustvari z namestitvijo ekonomizatorja, se reši z namestitvijo osnega ventilatorja za dimne pline (predmet št. 8). Tega poganja 110kW električni motor, opremljen s frekvenčnim pretvornikom. Ventilator poleg tega regulira tlak dimnih plinov pri izhodu iz kotla.

V zadnjih dveh kurilnih sezонаh je ekonomizator skupaj deloval 5600 ur in na račun hlajenja dimnih plinov proizvedel 15.173 MWh toplotne.

Povprečni letni prihranek pri porabi zemeljskega plina, ki ga dosežemo z namestitvijo ekonomizatorja, lahko izračunamo po tej enačbi:

$$B = \frac{Q_{ekr}}{H_d \cdot \eta_k} = \frac{7586,5 \cdot 10^6}{34000 \cdot 10^3 \cdot 0,9} \cdot 3600 = 892529 \text{ m}^3$$

Kjer velja:

- $Q_{ekr} = 7586,5 \text{ MWh}$ – povprečna letna proizvodnja toplotne s pomočjo ekonomizatorja
- $H_d = 34000 \text{ KJ/m}^3$ – povprečna kurilnost zemeljskega plina
- $\eta_k = 0,9$ – povprečni izkoristek kotla

Izračunani prihranek pri porabi zemeljskega plina obsega približno 5 odstotkov skupne letne porabe zemeljskega plina v toplovodnem kotlu, zato je mogoče skleniti, da se za enak odstotek poveča izkoristek kotla.

Če je cena zemeljskega plina v tem obdobju $C = 40 \text{ RSD/m}^3$, je prihranek pri letnem strošku energije, izražen v monetarnih enotah: $D = C \times B = 40 \times 892529 = 35701160 \text{ RSD}$, kar pomeni D = 297510 EUR.

Če upoštevamo investicijo in obratovalne stroške sistema ter doseženi prihranek, lahko iz rezultatov sklenemo, da je preprosta vračilna doba investicije na ravni dveh let. Glede na to, da je življenska doba ekonomizatorja 15 let, je investicija ekonomsko upravičena in stroškovno učinkovita.

Projekt namestitve ekonomizatorja v toplarni Konjarnik je uspešen primer dobre prakse povečanja energetske učinkovitosti pri proizvodnji toplotne za daljinsko ogrevanje in zmanjšanja izpustov CO₂, zato bi moral prispetati k širši uporabi te tehnologije v drugih toplarnah.

Ključne besede: izkoristek toplovodnega kotla, ekonomizator, tehnično-ekonomska analiza, energetska učinkovitost

THERMAL PERFORMANCE EVALUATION AND TECHNO-ECONOMIC ANALYSIS OF THE HOT WATER BOILER ECONOMISER IN THE KONJARNIK DISTRICT HEATING PLANT

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The Konjarnik heating plant is the third largest in the district heating system of Belgrade with an installed thermal capacity of 238 MW. It accommodates three hot water boilers that are connected to the distribution network indirectly through heat exchangers. Flue gases are extracted in concrete ducts through the common reinforced concrete stack in the atmosphere. In order to partially utilise waste heat, in 2009 an additional (external) water heater – an economiser, with a rated thermal output of 6 MW, was designed and built.

The economiser is located on the bypass of the existing concrete flue-gas duct on the hot water boiler, with a capacity of 116 MW. The bypass line is made of steel duct with dimensions of 1500x3000 mm. The bypass line is separated with a butterfly valve, and a gate valve is installed in the concrete flue gas duct. The process is fully automated and controlled using PLC and SCADA systems.

Additional resistance from the gas side, generated by installation of the economiser, is solved by installation of an axial flue gases fan (item 8). The fan uses a 110 kW electric motor, equipped with a frequency converter. The fan also regulates the set flue gas pressure at the outlet of the boiler.

During the last two heating seasons the economiser has operated for a total of 5,600 hours and produced 15,173 MWh of heat at the expense of cooling the flue gases.

Average annual savings in consumption of natural gas achieved by installing the economiser can be evaluated as follows:

$$B = \frac{Q_{ek}}{H_d \cdot \eta_k} = \frac{7586,5 \cdot 10^6}{34000 \cdot 10^3 \cdot 0,9} \cdot 3600 = 892529 \text{ m}^3$$

Where are:

- Q_{ek} = 7586,5 MWh – average value of heat energy produced in the economiser annually

- H_d = 34000 KJ/m³ – average value of lower heating value of natural gas

- η_k = 0,9 – average value of boiler efficiency

The calculated savings in natural gas consumption comprise approximately 5% of the total annual natural gas consumption of the hot water boiler, thus it can be concluded that boiler efficiency has increased by the same amount.

For the price of natural gas in that period $C = 40 \text{ RSD/m}^3$, the savings in energy costs annually reported in monetary units amount to: $D = C \times B = 40 \times 892529 = 35701160 \text{ RSD}$, i.e. D = 297510 EUR.

From the results, taking into account investment and operating costs for the system and savings achieved, it can be concluded that the simple payback period of investments is at a level of two years. Given that the lifetime of the economiser is 15 years, the investment is justified in economic terms and is cost effective.

The installation project for the economiser in the Konjarnik district heating plant is a successful example of good practice for improving district heat production energy efficiency and reducing CO₂ emissions, and as such should contribute to a wider application of this technology in other district heating plants.

Key Words: hot water boiler efficiency, economiser, techno-economic analysis, energy efficiency

AKTIVNOSTI NA PODROČJU REGULIRANJA CEN TOPLOTE

ZA DALJINSKO OGREVANJE

Tina Štok, Agencija za energijo

Agencija za energijo (v nadaljevanju agencija) je z Energetskim zakonom (EZ-1) zavzana izvajati regulacijo cene toplove za daljinsko ogrevanje, ki jo je do uveljavitve EZ-1 na podlagi Zakona o kontroli cen opravljalo Ministrstvo za gospodarski razvoj in tehnologijo. Z uveljavitvijo splošnega akta o metodologiji za oblikovanje cene toplove za daljinsko ogrevanje je agencija v letu 2015 pripravila nov pravni okvir za oblikovanje izhodiščne cene toplove za daljinsko ogrevanje iz distribucijskih sistemov, katerih distributerji izvajajo gospodarsko javno službo, in cene toplove, ki jo zaračunava regulirani proizvajalec toplove. Na podlagi sprejetega akta so zavezanci za regulacijo v skladu z EZ-1 agenciji do konca leta 2015 posredovali zahtevo za izdajo soglasja k izhodiščni ceni toplove.

V prispevku bodo predstavljene aktivnosti agencije v letu 2016 na področju izdajanja soglasij k izhodiščnim cenam toplove zavezancev za regulacijo. Predstavljen bo način izdajanja soglasij, ki se glede na dosedanji način spreminja. Skladno z določbami EZ-1 pred izdajo soglasja agencije namreč k predlagani izhodiščni ceni toplove ni več potrebno soglasje lokalne skupnosti. Lokalne skupnosti se do predlagane izhodiščne cene toplove sicer lahko opredelijo, pri čemer pa agencija pri izdaji soglasja ni vezana na njihovo mnenje. V prispevku bo predstavljena tudi analiza prejetih in obravnavanih zahtev za izdajo soglasja k izhodiščnim cenam toplove ter pomanjkljivosti in problematika, ki jih agencija zaznava pri pregledu zahtev zavezancev za regulacijo.

Agencija je z izdajo soglasij k izhodiščnim cenam toplove časovno omejena, saj mora o zahtevah za izdajo soglasja k izhodiščnim cenam toplove vseh zavezancev za regulacijo odločiti do junija 2016. Tako potrjene izhodiščne cene toplove bodo začele veljati 1. julija 2016. Predstavljene bodo tudi aktivnosti zavezancev za regulacijo, ki so potrebne po izdaji soglasij k izhodiščnim cenam toplove. Skladno z aktom imajo namreč zavezanci za regulacijo možnost ob določenih pogojih spremenjati tako oblikovano in potrjeno izhodiščno ceno toplove, pri čemer za to spremembo potrebujejo soglasje agencije. Postopek izdaje soglasja k novi izhodiščni ceni toplove je enak kot pri izdaji soglasja k prvič oblikovani izhodiščni ceni toplove. Zavezanci za regulacijo pa lahko zaradi spremembe upravičenih stroškov uveljavljajo spremembo variabilnega oziroma fiksne dela izhodiščne cene toplove. Variabilni del izhodiščne cene toplove lahko oziroma morajo prilagajati spremembam upravičenih stroškov največ enkrat mesečno, fiksni del izhodiščne cene toplove pa največ enkrat letno. Za tovrstno spremembo ne potrebujejo soglasja agencije, ampak agencijo o spremembah samo obvestijo.

Ključne besede: agencija za energijo, daljinska toploplota, regulacija

ACTIVITIES IN PRICE REGULATION OF DISTRICT HEATING

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Under the Energy Act (EZ-1), the Energy Agency, Slovenian National Regulatory Authority (hereinafter referred to as 'the Agency') is obliged to perform the regulation of district heating prices, which until the enforcement of EZ-1 had been performed by the Ministry of Economic Development and Technology under the Price Control Act. As the general Legal Act on the methodology for district heating pricing came into force, in 2015 the Agency devised a new legal framework for district heating pricing in the distribution systems in which distributors perform a public utility service, and for heating pricing for regulated heat producers. Based on the Act adopted, persons liable for regulation under EZ-1 submitted their request for approval of the base price to the Agency by the end of 2015.

The paper presents the Agency's action in 2016 in the field of granting approvals to base heating prices to persons liable for regulation. It discusses the manner of granting approvals, which is different from the method used previously. In compliance with the provisions of EZ-1, local community approval is no longer required before the Agency can grant its approval to the proposed base heating price. Local communities may take a position regarding the proposed base price of heating, yet the Agency shall not be bound to consider their opinion in granting its approval. The article also features an analysis of the received and processed requests for approvals to base heating prices, as well as imperfections and issues identified by the Agency while reviewing the requests submitted by persons liable for regulation.

The Agency has a limited time available to grant approvals to base heating prices, since all requests for approvals to base heating prices submitted by all persons liable for regulation have to be processed by June 2016. All base heating prices so approved shall enter into force on 1 July 2016. The article also specifies all the actions that need to be executed by persons liable for regulation after approvals to base heating prices have been granted. Pursuant to the Act, persons liable for regulation shall be given the opportunity to modify the base heating price so decided and approved under certain conditions, whereas any such change requires the Agency's approval. The procedure for granting approval to the new base heating price is identical to the procedure for granting approval to the original base heating price. Persons liable for regulation can seek changes in the variable or fixed components of the base heating price due to changed eligible costs. They may, or have to, adapt the variable component of the base heating price to changed eligible costs no more than once per month, and the fixed component of the base heating price no more than once per year. Any such changes have to be communicated to the Agency, however, its approval is not required.

Key Words: energy agency, slovenian national regulatory authority, district heating, regulation

PRILOŽNOSTI DECENTRALIZIRANE PROIZVODNJE ELEKTRIKE IN TOPLOTE V STANOVANJSKIH STAVBAH

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Danes večino energije, ki jo potrebujemo v stavbi, proizvedemo iz fosilnih goriv. Zgorevanje fosilnih goriv prispeva k različnim oblikam onesnaževanja zraka in nastajanja ogljikovega dioksida oz. CO₂. Upoštevanje okolijskih in ekonomskih stroškov proizvodnje energije je izhodišče za iskanje novih alternativnih in bolj trajnostnih virov energije. Mednje štejemo tudi sisteme za sočasno proizvodnjo toplotne in električne energije oz. mikro SPTE. Kot izhodišče smo izpostavili lokalno proizvodnjo energije, kjer toplotna in električna energija nastaneta tam, kjer se uporablja, kar pomeni, da ni izgub zaradi njune distribucije. Delovanje sistemov smo modelirali z numeričnim simulacijskim orodjem TRNSYS, ki omogoča povezan (sočasen) dinamični toplotni odziv stavbe in sistema za proizvodnjo električne in toplotne energije v odvisnosti od stanja okolice.

V prispevku je predstavljena primerjalna analiza vključevanja plinskih alternativnih tehnologij za proizvodnjo toplotne in električne energije v stanovanjskih stavbah. Kot izhodiščni sistem smo upoštevali kotlovnico s starejšim tipom generatorja toplotne na ekstra lahko kurično olje. Tega nadomestimo z mikro SPTE, in sicer v prvem primeru s plinskim motorjem in v drugem z gorivno celico. V primerjavo smo vključili dve sicer enaki stavbi z različno rabo energije. Stavba z večjo rabo energije ima specifično rabo toplotne za ogrevanje 110 kWh/m²a (energijski razred E), manj energijsko potratna stavba pa 52 kWh/m²a (energijski razred C). Poleg notranjih toplotnih dobitkov (ljudje in naprave) upoštevamo tudi rabo toplotne za pripravo sanitarnih topel vode. Slednja se preko dneva spreminja in sta odvisna od zasedenosti stavbe, s čimer se približamo realnejšemu toplotnemu odzivu stavbe. Pri analizi smo upoštevali celoletno obdobje s krajšimi časovnimi razmiki. Meteoroške podatke smo povzeli iz baze testnega referenčnega leta za mesto Ljubljana.

Velikosti naprave za soproizvodnjo toplotne in električne energije in prigrajenega hranilnika toplotne smo določili z optimiranjem glede na trenutno potreben toplotno moč za delovanje stavbe. Sistem je priključen na elektroomrežje, saj le na ta način zagotovimo optimalno izkoriščenost proizvodnje električne energije. Ugotovljeno je bilo, da se z vključevanjem takih sistemov raba toplotne energije za delovanje stavbe zmanjša za tretjino. Letna količina proizvedene električne energije pa lahko v nekaterih primerih (v primeru energijsko potratne stavbe) celo preseže vrednost letne povprečne porabe električne energije v enodružinskih stanovanjskih stavbah. Ob tem je treba tudi poudariti, da se z vključevanjem takih sistemov emisije CO₂ praktično prepeljajo.

Na osnovi dobljenih rezultatov želimo prikazati, da lahko z vključevanjem decentraliziranih sodobnih plinskih tehnologij zagotovimo proizvodnjo toplotne in električne energije na mestu porabe in s tem preprečujemo nepotrebne izgube pri prenosu energije.

Ključne besede: mikro spte na zemeljski plin, decentralizirana proizvodnja, toplotna in električna energija, zmanjševanje emisij CO₂

OPPORTUNITIES FOR DECENTRALISED PRODUCTION OF HEAT AND POWER IN RESIDENTIAL BUILDINGS

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The majority of energy used in buildings is currently produced from fossil fuels. Burning fossil fuels contributes to various types of air pollution and production of carbon dioxide (CO_2). In seeking new, alternative and more sustainable energy sources, environmental and economic costs of energy production are the basic factor. Such sources include combined heat and power systems or micro-CHP. As the starting point, we focused on local energy production, meaning that heat and electricity are generated where they are used, so that there are no distribution-related losses. System operation was modelled with TRNSYS numerical simulation software, which enables the simultaneous heat response of the building and the CHP system, depending on the conditions in the surroundings.

The paper presents a comparative analysis of introducing alternative gas-fuelled combined heat and power technologies in residential buildings. A boiler room with an older heat generator using extra light fuel oil was taken as the starting system. It was then replaced with a micro-CHP unit, featuring a gas engine in the first case, and a fuel cell in the second. The comparison is based on two identical buildings with varying energy consumption patterns. Specific heat consumption for heating is 110 kWh/m²a (energy grade E) in the case of the building that consumes more, and 52 kWh/m²a (energy grade C) in the case of the more efficient building. Internal thermal gains (people and appliances) are taken into account, as is heat consumption for household hot water. As both factors change throughout the day, depending on the occupancy of the building, we are approaching a more realistic heat response of the building. The analysis is based on a year-round period with shorter time steps. The meteorological data was taken from the test referential year base for Ljubljana.

The capacities of the combined heat and power unit and the attached heat storage were defined through optimisation based on the heat output currently required for building operation. The system is connected to the power grid in order to ensure the most efficient utilisation of electricity generation. It has been established that by introducing such systems into buildings, their consumption of heat required for their operation is reduced by a third. In some cases (in energy inefficient buildings), the amount of power generated within one year can exceed the average annual electricity needs of single family homes. Very importantly, the introduction of such systems results in almost halved CO_2 emissions.

We wish to use the results to show that by introducing decentralised modern gas technologies we can ensure combined heat and power generation on-premises, thus preventing avoidable losses related to energy transfer.

Key Words: gas-fuelled micro-chp decentralised production, heat and power, cutting CO_2 emissions

EKSERGOEKONOMSKA OPTIMIZACIJA CEVNE MREŽE DALJINSKEGA HLAJENJA

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Hlad lahko proizvajamo na različne načine, zaradi vse večjih potreb po hlajenju pa se vedno bolj uveljavljajo sistemi daljinskega hlajenja. Ti so izvedeni analogno sistemom daljinskega ogrevanja, ki so po svetu in v Sloveniji poznani že dolgo časa. Razlika je le v proizvodnem viru, ki mora v primeru daljinskega hlajenja zagotavljati hlad namesto grelne energije.

Sistemi daljinskega hlajenja imajo pred konvencionalnimi hladilnimi napravami številne prednosti, saj bistveno manj obremenjujejo okolje. Zaradi centralne proizvodnje hladu nastopijo prihranki obsega, veliko prednost pa predstavlja tudi možnost izrabe toplotne kot vzporednega produkta pri kogeneraciji v primeru proizvodnje hladu z absorpcijskimi hladilniki. Po drugi strani pa distribucijska mreža predstavlja dodatne stroške izgradnje, obratovanja ter vzdrževanja, na njej pa nastopajo toplotni dobitki ter tlačni padci. Na upravičenost gradnje sistema daljinskega hlajenja vplivajo tako prednosti centralne priprave hladu kot tudi dodatni investicijski stroški za izgradnjo distribucijske mreže.

Za zagotovitev konkurenčnosti sistemov daljinskega hlajenja v primerjavi s konvencionalnimi hladilnimi tehnologijami je potrebna optimizacija sistema. Pravilno termodinamsko in ekonomsko vrednotenje energetskih proizvodov omogoča uspešno trženje ter minimalno rabo primarne energije. Vendar pa eksjerško optimalen sistem daljinskega hlajenja ne pomeni vedno tudi ekonomsko optimalnega in obratno. Tovrstni sistemi so največkrat grajeni na osnovi ločenih tehničnih in ekonomskev analiz, kar pa nam ne daje pravega optimuma v smislu minimalnega stroška rabe eksjerije, zato je treba obe analizi, eksjerško in ekonomsko, združiti. S tem dosežemo optimalno razmerje med rabo eksjerije in stroški proizvedenega hladu. To nam omogoča eksjergoekonomika.

V prispevku smo se osredotočili predvsem na eksjergoekonomsko optimizacijo cevne mreže sistema daljinskega hlajenja. Preostalih komponent sistema (centralna hladilna postaja za proizvodnjo hladu, interna hladilna postaja na strani porabnika) nismo vključili v optimizacijo. Pri eksjergoekonomski optimizaciji sistema daljinskega hlajenja smo najprej opravili eksjerško analizo sistema, pri kateri smo določili vse eksjerjske tokove, vključujuč eksjerjske izgube zaradi toplotnih dobitkov in tlačnih padcev v cevovodu. Pri ekonomski analizi smo upoštevali investicijske stroške cevne mreže, stroške obratovanja in stroške vzdrževanja. Določili smo ciljno funkcijo, ki je v našem primeru minimalna cena končnega produkta, torej hladu, za različne dimenzije cevovoda ter različne debeline izolacije. Rezultati eksjergoekonomiske optimizacije cevne mreže daljinskega hlajenja bodo zagotovo uporabni pri določitvi ekonomsko in energetsko optimalne investicije.

Ključne besede: eksjergoekonomksa analiza, daljinsko hlajenje, distribucija hladu, cevna mreža

EXERGOECONOMIC OPTIMISATION OF A DISTRICT COOLING PIPELINE NETWORK

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Cooling energy can be produced in various ways, and as demand grows district cooling systems are becoming increasingly common. They are analogous to district heating systems, which have long been used both in Slovenia and worldwide. The only difference between them is that in district cooling, the source should produce cooling energy instead of heat.

Much less damaging to the environment, district cooling systems have a number of advantages over conventional cooling devices. Centralised cooling energy production results in savings of scale, and an additional benefit is the potential to utilise heat, the second product of co-generation, when producing cooling energy by means of an absorption refrigerator. However, a distribution network means there would be additional construction, operation and maintenance costs, leading to thermal gains and pressure drops. When assessing the viability of constructing a district cooling system, considerations include the advantages of producing cooling energy centrally, as well as the additional investment costs of building the distribution network.

To guarantee that district cooling systems can compete with conventional cooling technologies, system optimisation is required. The right thermodynamic and economic assessment of energy products allows for successful marketing and minimisation of primary energy consumption. Nevertheless, the best possible district cooling system in exergy terms is not necessarily the best possible system in economic terms, and vice versa. The development of these systems is usually based on separate technical and economic analyses, but this fails to provide the best solution in terms of minimising the cost of exergy consumption. Therefore, both the exergy and economic analyses need to be combined in order to achieve the perfect balance between exergy consumption and the cost of cooling energy production. Exergoeconomics is what makes this possible.

The paper focuses on the exergoeconomic optimisation of a district cooling pipeline network. No other system component (the central cooling plant for cooling energy production, user stations) was included in the optimisation. To execute the exergoeconomic optimisation of the district cooling system, an exergy analysis of the system was first conducted to identify all exergy flows, including exergy losses arising from thermal gains and pressure drops in the pipeline. The economic analysis considered all costs of investment in the pipeline, its operation, and maintenance. The target function, in our case the minimised cost of the final product, i.e. cooling energy, was established for various values of pipeline dimensions and insulation thickness. The results of the exergoeconomic optimisation of the district cooling pipeline network can be useful in identifying the best possible investment in both economic and energy terms.

Key Words: exergoeconomic analysis, district cooling, cooling energy distribution, pipeline network

DISTRIBUCIJA ZEMELJSKEGA PLINA DEVET LET PO ODPRTJU TRGA

Aleš Žurga, Agencija za energijo

Pred odprtjem trga z zemeljskim plinom so v Sloveniji vse odjemalce na distribucijskih sistemih oskrbovala distribucijska podjetja, ki so izvajala distribucijo, dobavo in meritev porabe kot enovito dejavnost. Vsa ta podjetja so imela istega dobavitelja, podjetje Geoplín. Spremenjen in dopolnjen Energetski zakon je v letu 2004 povzročil pomemben premik v smeri odpiranja trga. Odjemalcem je zagotovil reguliran dostop do omrežja, Agenciji za energijo (v nadaljevanju agencija) pa poleg preostalih nalog naložil odgovornost za pripravo metodologij za določitev in obračunavanje omrežnine. Šele priprava navedenih metodologij je bila prvi korak k dejanskemu odpiranju trga za odjemalce, priključene na distribucijske in prenosni sistem zemeljskega plina. Za ločitev dejavnosti dobave od dejavnosti distribucije je bilo treba ločiti strošek dobave energenta od stroška uporabe omrežja. V skladu z metodologijami so morali operatorji agenciji razkriti upravičene stroške, povezane z dejavnostjo distribucije in izvajanja meritev, ter določiti tarifne postavke za obračunavanje distribucije in meritev glede na velikostni razred odjemalca in značilnost odjema. V letu 2005 zamenjava dobavitelja še ni bila mogoča, ker omrežnine še niso bile določene, ni še bilo podzakonskih aktov, ki bi urejali pravila v zvezi z menjavo dobavitelja, na trgu pa tudi ni bilo novih dobaviteljev. Cene oskrbe so bile v tem obdobju določene s tarifnimi sistemi ter so bile še v celoti v pristojnosti občin. Ne glede na dejstvo, da strošek obračuna oskrbe še ni bil ločen na regulirani in tržni del, so v nekaterih primerih z določili koncesijskih pogodb ali mestnih odlokov uspešno omejevali višino končne cene zemeljskega plina glede na ceno kurilnega olja kot konkurenčnega energenta. V letu 2006 so bile prvič določene distribucijske omrežnine. S 1. julijem 2007 je prišlo do popolnega odprtja trga z zemeljskim plinom. Teoretično je bila s tem tudi gospodinjskim odjemalcem omogočena zamenjava dobavitelja. Določene so bile omrežnine in pripravljena sistemsko obratovalna navodila, pred koncem leta pa je vlada izdala Uredbo o delovanju trga z zemeljskim plinom, s katero so bila med drugim urejena razmerja med udeleženci trga, postopek zamenjave dobavitelja ter delna ureditev varstva potrošnikov. Agencija je v tem letu pripravila tudi generični dokument Splošni pogoji za dobavo zemeljskega plina iz distribucijskega omrežja, ki je operatorjem olajšal pripravo lastnega dokumenta. V letu 2008 so bili tako vzpostavljeni dejanski pogoji za menjavo dobavitelja in v tem letu je 69 odjemalcev na distribucijskih sistemih že zamenjalo svojega dobavitelja.

Prispevek obravnava značilnosti trga z zemeljskim plinom in distribucijskih sistemov ob odpiranju trga leta 2007, širitev in razvoj omrežij, število oskrbovanih odjemalcev, gibanje višine omrežnin in cene zemeljskega plina za značilne tipe odjemalcev, menjave dobavitelja, trenutno stanje trga ter izzive regulacije trga in prihodnje oskrbe s ciljem zagotavljanja pogojev za konkurenčno, varno in zanesljivo oskrbo z energentom ter ekonomsko preživetje operatorjev distribucijskih sistemov.

Ključne besede: distribucija zemeljskega plina, omrežnina, cena zemeljskega plina, agencija za energijo

NATURAL GAS DISTRIBUTION 9 YEARS AFTER MARKET OPENING

Aleš Žurga, Energy Agency, Slovenian National Regulatory Authority

Before opening of the natural gas market all distribution system consumers in Slovenia were supplied by distribution companies, which provided distribution, supply, and consumption metering as a comprehensive service. All these companies were serviced by the same distributor, Geoplin. In 2004, the amended Energy Act was an important milestone in the process towards market opening. Consumers were given regulated access to the network, and the Energy Agency, Slovenian National Regulatory Authority (hereinafter referred to as 'the Agency') was given the additional responsibility of drafting network charge setting and billing methodologies. These methodologies were but the first concrete step towards true market opening for those consumers connected to the natural gas distribution and transmission systems. To unbundle supply from distribution, the cost of energy supply had to be separated from the cost of using the network. In line with the methodologies, operators were obliged to report to the Agency the eligible costs associated with distribution and metering, and set distribution and metering tariff components depending on the size category of the consumer and their consumption pattern.

In 2005 switching one's supplier was still impossible, as network charges had not yet been set. The regulations about the supplier switching process had not yet been adopted, and there were no new distributors in the market. At the time, energy supply pricing was organised by means of tariff systems, and was entirely within the competence of municipalities. Despite the fact that the cost of supply had not yet been split into regulated and market-based components, in some instances the rates of end-use natural gas prices were restricted through provisions in concession agreements or municipal ordinances, and tied to the price of fuel oil as a competitive energy source.

In 2006, distribution network charges were set for the first time. Full natural gas market opening followed on 1 July 2007. Theoretically, this gave household consumers the right to switch their supplier. Network charges were set and the network code was drafted, and before the year end the government adopted the Regulation on the operation of the natural gas market, governing the relations between market participants, the supplier switching process, and, to some degree, consumer protection, etc. That year, the Agency drafted a generic document entitled 'General terms and conditions of natural gas supply from the distribution network', which operators could use in producing their own document. In 2008, when conditions were finally created to enable supplier switching in practice, 69 consumers in distribution systems switched their supplier.

The paper discusses the characteristics of the natural gas market and distribution systems during market opening in 2007, the development and expansion of networks, the number of consumers supplied, movements of network charge and gas price rates for typical consumer groups, supplier switching, the present situation in the market, and challenges concerning market regulation and future supply, in the light of endeavours to create conditions for competitive, secure and reliable energy supply and financial stability of Distribution System Operators.

Key Words: natural gas distribution, network charge, natural gas price, energy agency, slovenian national regulatory authority

NOVI NAČINI PREGLEDOV PLINOVODOV

Marko Kogovšek, Plinovodi

Plinovodi omogočajo prenos plina od virov do trošil. Ključnega pomena je, da je prenos zanesljiv in hkrati varen. Eden od pogojev za omogočanje takšnega prenosa je ustrezno stanje plinovodov. Plinovodi večjih dimenzij in višjih obratovalnih tlakov se zato običajno pregledujejo z napravami za notranji pregled, s katerimi se ugotavlja obstoj morebitnih neustreznosti, ki se pravočasno odpravijo.

Tudi operater prenosnega sistema zemeljskega plina v Republiki Sloveniji družba Plinovodi d.o.o. podobno kot preostali operatorji izvaja periodične preglede svojih plinovodov. Vsebina pregledov je odvisna od vrste dejavnikov, predvsem pa od zmožnosti tehnologij, ki jih ponuja trg. Poseben izviv pa predstavljajo pregledi plinovodov manjših dimenzij in nižjih obratovalnih tlakov, ki ne izpolnjujejo pogojev za uspešen pregled s temi napravami. Družba spremi razvoj novih tehnologij in stalno povečuje obseg in nadgrajuje vsebino pregledov svojih plinovodov. Vse uporabljene tehnologije pregledov morajo biti neporušne.

V preteklem letu je družba Plinovodi d.o.o. z usposobljenimi izvajalci uspešno izvedla pregledne nekaterih plinovodov, ki jih z napravami za notranji pregled ni mogoče pregledati, ko obratujejo. Prvi način pregleda je tako potekal sicer z običajno napravo za notranji pregled, vendar v tekočinskem mediju, drugi pa s pomočjo umetno ustvarjenega magnetnega polja in z nadzemnim ugotavljanjem sprememb oblike tega polja.

Posebnost prvega primera so dodatne aktivnosti, ki jih je treba izvesti pred in po izvedbi notranjega pregleda. Pred izvedbo je treba potrditi ustreznost konfiguracije plinovoda za uspešno izvedbo pregleda.

Zaradi odstranjenega zemeljskega plina iz plinovoda lahko vir zemeljskega plina v času od razplinjanja do ponovnega zaplinjanja plinovoda predstavlja ustrezno postrojenje za nadomestno oskrbo z zemeljskim plinom.

Poznanih je več zemeljskemu plinu alternativnih medijev, s pomočjo katerih se izvaja notranji pregledi plinovodov. Izbira medija je odvisna od vrste dejavnikov. Za uspešen potek notranjega pregleda je treba zagotoviti zadostno količino ustrenega medija, dovolj močne naprave za potiskanje medija in s tem naprave za notranji pregled ter zmoglјiv vir energije za delovanje naprav.

Izpihanje plina iz plinovoda mora biti izvedeno na ustrenem mestu. Tudi izrivanje zemeljskega plina iz plinovoda in polnjenje tega z izbranim alternativnim medijem v zadnji fazi razplinjanja mora biti izvedeno na ustrezni in varen način. Po izvedbi notranjega pregleda so aktivnosti vezane predvsem na izločanje alternativnega medija iz plinovoda in pripravo plinovoda na zaplinjanje in redno obratovanje. Drugi primer je poseben že sam po sebi, saj poteka brez poseganja v pretok zemeljskega plina v plinovodu. Tudi v tem primeru je pred izvedbo pregleda plinovod treba pripraviti na način, da je zagotovljena prehodnost trase plinovoda, saj se pregled izvaja s premikanjem merilne naprave po zemeljski površini vzdolž te trase. Omogočiti je treba tudi priklop naprave, s pomočjo katere se ustvarja magnetno polje. Rezultat analize merjenih vrednosti je lokaliziranje in ovrednotenje resnejših poškodb.

V okviru predstavitve bo prikazana uporabnost obravnavanih načinov pregledov plinovodov in možnost njihove uporabe v prihodnje.

Ključne besede: neporušni pregledi plinovodov

NEW GAS PIPELINE INSPECTION METHODS

Marko Kogovšek, Plinovodi

Plinovodi is a company that enables the transfer of gas from source to consumer. Making this process both reliable and safe is of vital importance. One of the factors in achieving this is maintaining adequate conditions in pipelines. Large gas pipelines with high operating pressures are usually inspected by means of in-line inspection tools to detect possible anomalies and address them in a timely manner.

As with other operators, the natural gas Transmission System Operator in the Republic of Slovenia – Plinovodi d.o.o. – performs periodic inspections of its pipelines. The nature of inspections depends on a number of factors, but above all on the capabilities of the technologies available in the market. A special challenge is to inspect small pipelines with low operating pressures, which fail to meet the conditions for a successful inspection using these tools. The company keeps abreast of the development of new technologies, increasing the frequency and upgrading the nature of inspections of its pipelines. Only non-destructive inspection technologies may be used.

Last year, in collaboration with qualified contractors, Plinovodi d.o.o. successfully performed inspections on some of the pipelines which cannot be inspected with in-line inspection tools when in operation. The first inspection method involved ordinary in-line inspection tools, but in a liquid medium, while the second method used an artificially generated magnetic field and detected anomalies in its shape from above ground.

The first method stands out for the additional activities that need to be implemented before and after the in-line inspection. Before the inspection, the adequacy of pipeline configuration needs to be confirmed for the inspection to succeed.

As natural gas is removed from the pipeline, gas supply during the time from pipeline degassing to its re-gassing can be provided by a suitable replacement facility for natural gas supply.

Several media can serve as an alternative to natural gas when performing in-line pipeline inspections. The choice of the medium depends on a number of factors. For the inspection to succeed, one needs the right quantity of the chosen medium, in-line inspection tools powerful enough to fill the pipeline with the medium, and a high-performance source of energy to power the tools.

Venting gas from the pipeline should be carried out at a suitable location. Replacing natural gas in the pipeline with the chosen alternative medium as the last stage of degassing should also be implemented in an adequate, secure manner. Activities that follow an in-line inspection are mainly associated with extraction of the alternative medium from the pipeline, and preparation of the pipeline for re-gassing and resumed operation.

The second method is special in itself, as it requires no interference with the natural gas flow in the pipeline. Before the inspection, preparatory activities have to ensure the accessibility of the pipeline route as the inspection is performed by following the route with measuring tools above ground. Additionally, a power source is needed to plug in the device used to generate the magnetic field. Results of the analysis of the measured values include localisation and assessment of major defects.

The presentation focuses on the applicability of the pipeline inspection methods discussed in the paper, and the potential for their future use.

Key Words: non-destructive pipeline inspections

MEDSEBOJNI VPLIV ENERGETSKIH OBJEKTOV

Leopold Lovšin, Plinovodi

Plinovodni sistem zemeljskega plina predstavlja sistem povezanih plinovodnih cevi in objektov, ki zagotavljajo transport in distribucijo zemeljskega plina od vstopnih točk do porabnikov.

Umeščanje plinovodov in pripadajočih objektov v prostor je zahtevno z več vidikov. Poleg okoljskih in varnostnih vidikov je umeščanje v prostor skupaj z drugimi infrastrukturnimi objekti zelo pomembno. Infrastrukturi objekti imajo svoje varnostne pasove, v katerih veljajo posebni režimi za posege in zahtevajo določene odmike.

Poleg teh omejitev imajo energetski infrastrukturni objekti interferenčni vpliv drug na drugega. Čeprav je zaradi racionalne izrabe prostora mogoče v iste koridorje umestiti različne infrastrukturne objekte, je treba poznavati in ustrezno obvladovati medsebojne vplive.

Plinovod z električnega vidika predstavlja dolgo galvansko povezavo (električni vodnik), ki je izolirano položen v zemljišče. Plinovod ima pasivno zaščito proti koroziji, npr. polietilenski trak. Kljub temu ni idealno izoliran od zemljišča in je na več mestih v elektrolitskem stiku z njim. Zemljišče omogoča prevajanje tokov na meji med jeklom in elektrolitom. Električni tok v kovini se na fazni meji spremeni v ionskega in povzroča korozijo jeklene cevi.

Plinovod, ki poteka paralelno z visokonapetostnim daljnovodom, se nahaja v magnetnem polju daljnovoda. Zaradi medsebojne induktivnosti se na plinovodu inducira napetost. Ta napetost je posledica normalnega obratovanja daljnovoda, lahko pa tudi nastane kot posledica izklopov oz. vklopov daljnovodov in zaradi enopolnih kratkih stikov. Slednje napetosti se kažejo kot prenapetosti in lahko dosežejo več 100 V ter so nevarne za osebje, ki dela na plinovodu. Maksimalna dovoljena napetost je odvisna od časa trajanja. Inducirana napetost na plinovodu, ki se pojavi pri normalnem obratovanju daljnovoda, pa povzroča t. i. izmenično korozijo.

V Sloveniji in v nekaterih drugih državah imamo elektrificirano železniško progo, kjer je uporabljen enosmerni sistem napajanja napetostnega nivoja 3 kV. Enosmerni napajalni sistem povzroča enosmerne blodeče tokove, ki uhajajo iz tavnice povratnega voda v zemljo. Ti tokovi povzročajo t. i. enosmerno (elektrokemično) korozijo. Blodeči tokovi povzročajo spremembo enosmernega potenciala plinovoda in rušijo zahtevane zaščitne potenciale, ki so potrebni za katodno zaščito jekla.

Pri načrtovanju pa tudi pri samem obratovanju plinovodov je treba izvesti učinkovite zaščitne ukrepe, ki odpravljajo negativne medsebojne vplive. Ti ukrepi ne morejo biti samo problem enega upravljalca energetske infrastrukture, ampak morajo biti v skupnem interesu za varno in zanesljivo obratovanje vseh energetskih vodov.

V nadaljevanju prispevka bodo obdelani medsebojni vplivi elektrificirane železniške vleke in visokonapetostnih daljnovodov na obratovanje plinovoda. Predstavljeni bodo problematika zaščite plinovoda pred blodečimi tokovi železniške elektrovleke, vpliv visokonapetostnih daljnovodov ter nastanek pogojev za korozijo jeklene plinovodne cevi.

Ključne besede: plinovod, korozija, inducirana napetost, blodeči tokovi, prenapetost

INTERACTION BETWEEN ENERGY FACILITIES

Leopold Lovšin, Plinovodi

The natural gas pipeline is a system of interconnected gas pipes and units which enable natural gas transport and distribution from entry points to consumers.

The siting of gas pipelines and associated units is a complex task for several reasons. In addition to environmental and security aspects, other infrastructure should be considered in the siting process. Infrastructure facilities have their own security corridors, where special regimes apply regarding further development in the immediate vicinity.

In addition to these restrictions, energy infrastructure facilities interfere with each other. Even though different infrastructure facilities can be placed in the same corridors to enable rational use of space, possible interactions between them should be identified and addressed adequately.

In electric terms, a gas pipeline is a long galvanic connection (electrical conductor), isolated and placed in the ground. Although it uses passive corrosion protection such as polyethylene tape, it is not ideally isolated from the ground and comes in electrolytic contact with it at several points. The ground enables the conduction of currents at the point where steel comes in contact with the electrolyte. At the phase boundary, the electric current in the metal converts into an ion current, causing corrosion of the steel pipe.

A pipeline built in parallel with a high-voltage power line is in the magnetic field of the power line. This mutual inductance induces voltage in the gas pipeline. The voltage is a result of regular operation of the power line, but could also occur as a result of switching the power line off or on, or line-to-earth short circuits. In the latter cases, the voltage comes as a spike of up to 100V or more, and presents a touch voltage hazard for staff working on the pipeline. The maximum permissible voltage depends on the duration. Meanwhile, the induced voltage in the gas pipeline occurring from regular power line operation causes alternating current corrosion.

As with some other countries, Slovenia has an electrified railway line with a 3kV DC power supply. DC power supply produces stray current, which leaks from the return rails into the ground. This current causes direct (electrochemical) corrosion. Stray current changes the direct potential of the pipeline, negatively affecting the protection potential required for cathodic protection of steel.

When designing and operating a pipeline, effective protective measures should be implemented in order to eliminate negative interaction. These measures should not be the responsibility of one energy infrastructure operator alone; they should be in the common interest of all parties in order to ensure secure and reliable operation of all energy systems.

The paper discusses interaction between railway electric traction or high-voltage power transmission lines and a gas pipeline. It also deals with the issue of pipeline protection against stray current from railway electric traction, the impact of high-voltage power lines, and creation of conditions for corrosion of a steel pipe.

Key Words: gas pipeline, corrosion, induced voltage, stray current, voltage spike

SODELOVANJE DVGW IN GIZ DZP NA PODROČJU TEHNIČNIH PREDPISOV IN IZOBRAŽEVANJA

Aida Bučo-Smajić, DVGW Sarajevo, Urban Odar, GIZ DZP

Nemško strokovno in znanstveno združenje za plin in vodo DVGW že od leta 1859 nudi strokovno in znanstveno podporo nemški industriji plina in vode. Tehnični standardi združenja DVGW so bili temelj za strokovno samoregulacijo pod okriljem nemške industrije plina in vode ter zagotavljajo varno oskrbo s plinom in z vodo, ki dosega najvišje mednarodne standarde. Praktično delo v sektorjih plina in vode temelji na tehničnih pravilih združenja DVGW. Regulativa kot zanesljiv instrument predpisov in ukrepov za večjo učinkovitost podjetjem nudi potreбno varnost pri načrtovanju in pravnih vprašanjih, kar velja celo za najvišje instance. Regulativa združenja DVGW je kot uveljavljen nabor pravil za tehnične zadeve dokumentirana v zakonu o energetiki in uredbi o pitni vodi.

Združenje DVGW tesno sodeluje z Nemškim inštitutom za standardizacijo DIN in je dejavno vključeno v proces oblikovanja evropske zakonodaje. Poleg tega v procesu prilaganja evropski zakonodaji podpira vzhodno- in srednjeevropske države.

Leta 2002 so se plinska združenja, podjetja in inštituti iz držav jugovzhodne Evrope odločili za proaktivno uvedbo edinstvenih tehničnih predpisov za plinsko industrijo svoje regije, ki bodo skladni z energetskimi politikami Evropske unije. V ta namen so sprožili pobudo, poimenovano »Ustavljanje tehničnih predpisov v plinskem sektorju držav jugovzhodne Evrope«. Domači strokovnjaki so ob strokovni podpori DVGW vzpostavili mrežo usposobljenih strokovnjakov, ki sodelujejo v namenskih odborih. V samoorganizaciji in s samofinanciranjem so doslej prevedli več kot 200 tehničnih predpisov DVGW s področij plinske infrastrukture in rabe plina ter jih prilagodili lokalnim razmeram in pripravili za uvedbo. Uveljavljanje tehničnih predpisov se spodbuja z ustreznim izobraževanjem, s strokovnim usposabljanjem, z obnavljanjem znanja in s sledenjem novim tehničnim pravilom. Uveljavljanje na lokalni ravni že kaže občuten prispevek k tehnični varnosti plinske infrastrukture, zanesljivosti plinskega sistema ter prihrankom za plinska podjetja in javnost.

DVGW od leta 2008 bilateralno sodeluje z GIZ DZP na področju tehničnih predpisov in izobraževanja. Zaradi tedanjih razmer na področju varnosti plinskih naprav v Sloveniji so bili v središču pozornosti tehnični predpisi o plinskih napravah in njihovo uveljavljanje v praksi. GIZ DZP je začel prevajati izdajo tehničnih predpisov za plinske naprave DVGW G 600 (TRGI) iz leta 2008 v slovenščino in dokument objavil leta 2010. Pozneje so sledili še drugi tehnični pravilniki, ki so nujni za prenos v praksu.

Tehnični predpisi opredeljujejo pogoste primere iz prakse, ne morejo pa opisati vseh primerov iz vsakodnevnega življenja, zato je izobraževanje nepogrešljivo. Uporabniki morajo razumeti cilje načel zaščite in varnosti, poleg tega pa jih morajo biti sposobni prenesti v svoje vsakodnevne delovne aktivnosti. To dosežemo z izobraževanjem in rednim usposabljanjem.

GIZ DZP je od leta 2010 v sodelovanju z DVGW za svoje člane pripravil več delavnic in izobraževanjskih poudarkov na prenosu znanja in izkušenj z nemških na slovenske strokovnjake na področju plina. Cilj je vzpostaviti sistem ugotavljanja usposobljenosti in strokovnega sistema na področju plinskih naprav, da se tako izboljša tehnična varnost plinskega sistema.

Ključne besede: sodelovanje, tehnični predpisi, izobraževanje

DVGW AND GIZ DZP CO-OPERATION IN THE FIELD OF TECHNICAL REGULATIONS AND EDUCATION

Aida Bučo-Smajić, DVGW Office Sarajevo, Urban Odar, GIZ DZP

The DVGW German Technical and Scientific Association for Gas and Water has been providing technical and scientific support for the German gas and water industry since 1859. Technical standards of the DVGW lay the foundations for technical self-regulation under the responsibility of the German gas and water industry and ensure safe gas and water supplies at the highest international levels. The practical work in the gas and water branch is based on the technical rules of the DVGW. As a reliable instrument for rules and efficiency measures, regulation offers companies the necessary safety for planning and legal matters, even for the highest authorities. As acknowledged rules for technical matters the regulation of the DVGW is documented in the law for energy economy and the decree for drinking-water.

DVGW co-operates closely with the DIN German Institute for Standardisation and actively participates in the creation of European regulations. DVGW also supports Eastern and Central European countries within the process of adjustment to the European regulation system.

In 2002, gas associations, companies and institutes from the countries of Southeast Europe decided on the proactive establishment of unique technical regulations for the gas industry in their region, complying with the energy policies of the European Union. They founded the initiative "Harmonisation of technical regulations in the gas sector of countries of Southeast Europe". Local experts, with the specialist support of the DVGW, have built a competent network of experts who work together in dedicated committees. In self-management and self-financing, to date more than 200 DVGW technical rules in the fields of gas infrastructure and gas utilisation have been translated, adapted to local conditions and prepared for use. The implementation of technical rules is fostered by appropriate education, professional training, renewal of knowledge and the keeping up with new technical rules. Local implementation is already showing a significant contribution to technical safety of gas infrastructure, reliability of the gas system and economic savings for gas companies and the public.

Since 2008 DVGW has been co-operating bilaterally with GIZ DZP in the field of technical regulations and education. Due to the situation at that time in regard to the safety of gas installations in Slovenia, the focus was on technical regulations for gas installation and their implementation in practice. GIZ DZP started with translation of the DVGW G 600 (TRGI) edition 2008 into the Slovenian language, which was published in 2010. Other technical rules essential for implementation in practice followed.

Technical rules define common cases in practice and cannot describe all the cases from everyday life, therefore education is indispensable. Users should understand the objectives of a protection and safety philosophy. In addition, users should be able to apply these objectives in their everyday working activities. This is achieved through education and regular training.

Since 2010 GIZ DZP has organised several workshops and training sessions for its members in co-operation with DVGW, with a focus on the transfer of know-how from German to Slovenian gas experts. The aim is to establish a system of qualification and expert systems in the field of gas installations in order to improve the technical safety of the gas system.

Key Words: co-operation, technical regulations, education

PROBLEMATIKA MERITEV PRETOKA V VROČEVODU

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Pri upravljanju daljinskega vročevodnega omrežja si pomagamo tudi z meritvami tekočinskih pretokov v izpostavljenih delih omrežja. Praviloma pri tem uporabljamo komercialne merilnike pretokov. Predstavili bomo možnost, kako lahko pretoke določimo na podlagi temperaturnih meritev, ki jih prav tako obdelujemo za potrebe omenjenega upravljanja. Temperaturnih meritev je v sistemu relativno veliko. Naša metoda temelji na dejstvu, da je časovni potek temperature v določeni točki odvisen tudi od pretoka. Odvisnost se kaže kot časovni zamik temperaturnih sprememb med posameznimi merilnimi mesti.

Temperaturne meritve na različnih merilnih mestih v omrežju jasno kažejo, da so si časovni poteki temperature na različnih mestih podobni. Zaradi topotnih izgub vzdolž cevi je temperatura na merilnem mestu, ki je bliže uporabniku, nižja. Če se temperaturno nihanje ali motnja pojavi na merilnem mestu bliže izvoru, se s časovnim zamikom pojavi tudi na merilnem mestu, ki je bliže uporabniku. Ta časovni zamik lahko uporabimo za določitev pretoka.

Temperaturni potek v različnih delih cevi opišemo s konvekcijsko-difuzijsko enačbo. Prevajanje topote, ki ga opisuje difuzijski člen, vpliva na temperaturno razliko med obema merilnima mestoma (topotne izgube), zanemarljivo pa vpliva na časovni zamik, ki je posledica masnega toka po cevi (konvekcijski del). Časovni zamik je tako sorazmeren z razdaljo med merilnima mestoma in s presekom cevi, obratno sorazmeren pa je s pretokom.

Če določimo časovni zamik med obema časovnima potekoma temperature, lahko določimo tudi pretok.

Podatke smo zajemali istočasno na dveh merilnih mestih v enakomernih časovnih presledkih. Za določeni časovni interval (časovno okno) vnaprej izbrane dolzine smo izračunali križnokorelačijsko funkcijo med temperaturnima potekoma. Križnokorelačijska funkcija pove, koliko sta si dva signala podobna, če ju zamaknemo za različne čase. Iskani časovni zamik je ravno tam, kjer ima križnokorelačijska funkcija maksimum.

Metoda križne korelacijske ima omejitve. Najbolje deluje, če je temperaturni signal dovolj značilen, da ima križnokorelačijska funkcija dovolj izrazit maksimum. V stacionarnem stanju, ko se temperatura ne spreminja, ali ko se temperatura enakomerno spreminja, s križno korelacijo ni mogoče določiti časovnega zamika. Druga omejitev te metode je, da lahko na ta način določimo le povprečni zamik in s tem le povprečni pretok v izbranem časovnem oknu. Predvidevamo, da bi z naprednejšimi metodami obdelave signalov lahko bolj zanesljivo in natančno določali časovni zamik in posledično pretok.

Model, ki opisuje odvisnost temperaturnega poteka od pretoka, smo preskusili z meritvami temperature na dejanskem omrežju, vročevodnem omrežju Ljubljane, in rezultate preverili z instaliranimi merilniki pretoka.

Ključne besede: pretok, temperaturne meritve, vročevod

MEASURING FLOW IN DISTRICT HEATING PIPELINE

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When managing a district heating pipeline, measuring the rate of flow in exposed parts of the network could be helpful. As a rule, commercial flow meters are used in such cases. The paper discusses a method of determining flows based on temperature measurements, which can also be processed for the purpose of pipeline management. In the system, temperature measurements are quite frequent. Our method is based on the fact that at a given point the time course of temperature also depends on the rate of flow. This dependency shows as a delay in temperature variation between individual measuring points.

Temperature measurements at various measuring points in the network indicate clearly that temperature time courses at various points are similar to each other. Due to heat losses along the pipe, measuring points closer to the user have lower temperatures. If temperature fluctuation or disturbance occurs at a measuring point closer to the source, it then also occurs with a delay at a measuring point closer to the user. This delay can be used to determine the rate of flow.

The time course of temperature in various parts of the pipe can be described with a convection–diffusion equation. Heat conduction as described in the diffusion term influences the temperature difference between the two measuring points (heat losses), while having an insignificant impact on the delay, which results from the mass flow along the pipe (the convection term). The delay is therefore proportional to the distance between the measuring points and the pipe intersection, and inversely proportional to the rate of flow.

Once the delay between the two temperature time courses is determined, we can also determine the rate of flow.

The data was gathered simultaneously at two measuring points at regular intervals. For a given interval (time window) of a predefined length, the cross-correlation function was calculated for the two temperature courses. The cross-correlation function shows the extent to which the two signals are similar when delayed for varying sections of time. The sought delay occurs exactly at the point where the cross-correlation function reaches its maximum.

The cross-correlation method has certain limitations. It works best when the temperature signal is significant enough for the cross-correlation function to have a prominent enough maximum. In the stationary state, when there is no change of temperature or when the temperature changes evenly, the delay cannot be determined by means of cross-correlation. The other limitation of this method originates in the fact that it can only determine the average delay, and subsequently the average rate of flow in the chosen time window. It is expected that more advanced methods of processing signals could determine the delay, and subsequently also the rate of flow, with increased reliability and precision.

The model describing how the temperature time course depends on the rate of flow has been tested by measuring temperatures in the actual network, i.e. the Ljubljana district heating pipeline, and the results have been checked against the installed flow meters.

Key Words: rate of flow, temperature measurements, district heating pipeline

SISTEM SCADA KOT OSNOVA ZA RABO POSLOVNIH INFORMACIJSKIH SISTEMOV JAVNEGA PODJETJA BEOGRADSKE ELEKTRANE

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Posodabljanje beograjskega sistema daljinskega ogrevanja, katerega sedanja zmogljivost je 3000 MW, se je začelo leta 2002 z največjo elektrarno v sistemu. V naslednjih letih so se dejavnosti za posodobitev virov toplove in toplotnih postaj nadaljevale in danes so v napravah, ki skupaj predstavljajo več kot dve tretjini skupne zmogljivosti beograjskega sistema daljinskega ogrevanja, nameščeni sodobni krmilno-kontrolni sistemi (sistemi SCADA) z visoko učinkovito opremo. Poleg tega je bila prenovljena tudi oprema v 95 odstotkih toplotnih postaj.

Konfiguracija sistema: Sistemi SCADA omogočajo krmiljenje, pridobivanje in shranjevanje podatkov o delovanju naprave. Uporabljena rešitev temelji na sistemu S7-400H in aplikativni programske opremi, ki so jo izdelali pri Siemensu. Na ravni aplikacije SCADA je uporabljen način vroče pripravljenosti, kar pomeni, da oba strežnika delujeta neprestano in sinhronizirata podatke v realnem času, pri čemer je aktiven samo eden. To zagotavlja večjo dostopnost sistema in zmanjšuje možnost izgube podatkov.

Arhiviranje v uporabljenem sistemu SCADA: Sistem SCADA uporablja dve bazi podatkov, eno s hitrim dostopom branja in pisanja za arhiviranje alarmov in obdelavo neobdelanih podatkov, drugo pa za arhiviranje procesnih podatkov. V času uvajanja aplikacij SCADA se razvije načrt arhiviranja, s čimer se zagotovi učinkovito upravljanje podatkov in pozneje poveže aplikacije z zunanjimi sistemmi. Prednosti izbranega koncepta arhiviranja so struktura s smotrnou izrabo prostora, preprosto upravljanje arhivov, hitro branje podatkov, hkratni dostop do različnih arhivov in možnost preurejanja baze podatkov, ki ne prekine procesa arhiviranja.

Funkcije poročanja pri uporabljeni rešitvi SCADA: Poročilo se izdela v obliki posebne Excelove datoteke v strojni postaji, pri čemer je Excelov delovni zvezek dinamično povezan z bazo podatkov na strežnikih sistema SCADA. To neposredno omogoča pripravo širšega nabora podatkov o delovanju elektrarne, ki so urejeni v skladu z zahtevami upravljalca.

Uporaba rešitve informacijskega strežnika: modul informacijskega strežnika omogoča izvoz vnaprej določenega nabora podatkov v zunanje baze podatkov. To je pomembna funkcija aplikacij SCADA, s katero zagotovimo razpoložljivost podatkov in njihovo rabo v drugih aplikacijah, pri čemer pa se ohranja varnost sistemov SCADA.

Povezava med informacijskimi sistemi za načrtovanje proizvodnje in sistemom SCADA: Namen poslovnih informacijskih sistemov (PIS) je povezovanje in obdelava podatkov, zanimivih za poslovno načrtovanje, s ciljem učinkovitega poslovnega odločanja, ki bo omogočilo zmanjšanje stroškov poslovanja, delovanje v tržnih razmerah in izpolnjevanje zakonskih obveznosti.

Med pomembnimi vidiki, ki jih je treba upoštevati pri načrtovanju povezovanja aplikacij SCADA z zunanjimi aplikacijami, so sistemi PIS, so obseg podatkov, povezljivost aplikacij in ohranjanje varnosti sistema SCADA. Če je sistem arhiviranja skrbno načrtovan in zahteve za podatke jasno vnaprej določene, je mogoče vzpostaviti skladno povezavo med aplikacijami SCADA in sistemom PIS ter tako ustvariti razmere za izpolnitev ciljev sistema PIS.

Ključne besede: scada

SCADA SYSTEM AS A BASE FOR IMPLEMENTATION OF BUSINESS INFORMATION SYSTEMS OF PUC "BEOGRADSKE ELEKTRANE"

Tatjana Nušić, Dubravka Jovančić, Petar Vasiljević, PUC "Beogradske elektrane", Belgrade, Serbia

Modernisation of Belgrade's district heating system, with a present installed capacity of 3000 MW, began in 2002 at the largest generation plant in the system. In the years that followed, activities on modernisation of heat sources and substations have continued, so today modern control systems (SCADA systems) with highly efficient equipment are installed in plants that, together, have a share of more than two-thirds of the total installed capacity of Belgrade's district heating system. In addition, equipment in 95% of substations has been innovated.

System configuration: SCADA systems provide control, acquisition and storage of plant operation data. The applied SCADA solution is based on the S7-400H system and application software manufactured by SIEMENS. At SCADA application level the redundancy with hot stand-by mode is applied, which implies that both servers operate continuously, synchronising data in real-time, with only one active server. This ensures greater system availability, and reduces the possibility of data loss.

Archiving in the applied SCADA system: The SCADA system uses two databases. One with a fast read and write access to archive alarms and process raw data, while the other is used for archiving processed data. During the implementation of SCADA applications the archive plan will be developed, in order to enable efficient data management, and later to link applications with external systems. The advantages of the applied archiving concept are the structure that rationally uses space, easy management of archives, fast data reading, simultaneous access to different archives and reorganisation of the database which does not interrupt the archiving process.

Reporting functions of the applied SCADA solution: The SCADA report is executed as a special Excel file on the engineer station with a workbook in Excel dynamically linked to the database on SCADA system servers. This directly enables the preparation of a wider range of data on operation of the plant, arranged in line with the requirements of the management.

Use of the Infoserver solution: The Infoserver module enables export of a predefined set of data in external databases. This is an important option for SCADA applications which ensures that data is available and used in other applications, and the security of SCADA systems is preserved.

Correlation between planning of production – information systems and SCADA application: Production information systems (PIS) are aimed at the integration and processing of data which are of interest to business planning in order to achieve efficient business decision-making, to allow a reduction in operating costs, work in market conditions and the fulfillment of legal obligations.

Important aspects that must be taken into account when planning to link SCADA applications with external applications such as PIS systems are the volume of data and the connectivity of applications and preservation of SCADA system security. If an archive system is carefully planned, and the requirements for information are clearly defined in advance, it is possible to create a harmonious connection of SCADA applications with the PIS system, and thus create conditions for fulfillment of PIS system objectives.

Key Words: scada

**UPORABA PROGRAMSKE OPREME ZA ANALIZO TOKOV V CEVNIH SISTEMIH
ZA UGOTAVLJANJE PUŠČANJA VODE V VROČEVODU DALJINSKEGA OGREVANJA**
Matjaž Perpar, Matej Konstantini, Primož Škerl*, Iztok Žun, Univerza v Ljubljani,
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Obravnava je zajemala različne cevovode v delu mreže sistema daljinskega ogrevanja v Ljubljani. S programskim paketom EPANET je bila izvedena enodimensijska numerična analiza puščanja v cevnem sistemu. Izračunane so bile porazdelitve tlaka vzdolž posamičnih cevovodov za več izbranih primerov puščanja pri ustaljenih hidravličnih razmerah. Kot so pokazale že meritve, je stalni padec tlaka, večji od 10 kPa, lahko indikator puščanja. Identifikacija posamičnega cevovoda s puščanjem je mogoča na osnovi spremembe gradiента tlaka, ki povzroči, da je padec tlaka na vstopu v cevovod večji od padca tlaka na izstopu. Izračuni so pokazali, da bi kontinuirani nadzor tlaka na obstoječih merilnih mestih lahko omogočil identifikacijo količine puščanja 10 m³/h ali več pri: višjem obratovalnem tlaku (dovod), nazivnem premeru cevi 250 mm ali manj ter pretoku, večjem od 150 m³/h.

Ključne besede: daljinsko ogrevanje, puščanje vode, padec tlaka

**UTILIZING OF THE PIPELINE FLOW ANALYSIS SOFTWARE FOR THE WATER
LEAKAGE ASSESSMENT IN THE DISTRICT HEATING PIPELINE**

Matjaž Perpar, Matej Konstantini, Primož Škerl*, Iztok Žun, Faculty of Mechanical
Engineering, University of Ljubljana, *Energetika Ljubljana

Different pipelines in a part of Ljubljana district heating network were considered. One dimensional numerical analysis of the leakage in a piping system was performed utilizing EPANET software. Pressure distributions along individual pipelines in steady state hydraulic conditions were calculated for several leakage cases. As already shown by the experiment, a permanent pressure drop larger than 10 kPa can be the leakage indicator. The identification of the leaking pipeline is possible based on the pressure gradient change, causing the pipeline input pressure drop to be larger than output pressure drop. Calculations showed that continuous pressure monitoring at the existing measuring points could enable identifying the leakage amount 10 m³/h or more at: larger operating pressure (supply), nominal pipeline diameter 250 mm or less and flow rate larger than 150 m³/h.

Key Words: district heating, water leakage, pressure drop



Vodilno združenje za daljinsko energetiko v Sloveniji in v jugovzhodni Evropi ter med najbolj dejavnimi v širši regiji

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Ogrevaj pametneje



DALINSKO
OGREVANJE



ZEMELJSKI
PLIN



TOPLARNA
CELJE

Energetika Celje, d.o.o. | Smrekarjeva ulica 1, 3000 Celje | www.energetika-ce.si



OD IDEJE DO IZVEDBE

**IMP, d.d. družba za svetovanje, projektiranje,
inženiring in gradnjo**

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Več kot šest desetletij razvijamo in izvajamo
učinkovite energetske rešitve v stavbah in
industriji.

Z našim znanjem vam zagotavljamo optimizacijo
stroškov gradnje in obratovanja objekta.

IMP ima skupino izkušenih projektantov in
izvajalcev za energetske, klimatske, varnostne,
protipožarne in druge sisteme.



ZAHVALUJUJEMO SE PARTNERJEM IN POKROVITELJEM

