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EVROPSKO TERITORIALNO SODELOVANJE

PMinter

Poročilo o aktivnostih

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December 2013

List of abbreviations

PM10	particulate matter, fine dust; particles with a diameter below 10 micrometres (10 µm = 0.01 mm)
PM2.5	particulate matter with a grain diameter of < 2.5 µm
NO_2	nitrogen dioxide
NOx	nitric oxides (NO_2+NO)
SO_2	sulphur dioxide
O_3	ozone
CO	carbon monoxide
O_2	oxygen
NH_3	ammonia
PM	particulate matter
VOC	volatile organic compounds
Org. C	organic carbon
BC	black carbon
CO_2	carbon dioxide
K	Klagenfurt
LB	Leibnitz
MB	Maribor
TUG	Graz University of Technology
PEZ	Pilot Environmental Zone
AQMP	Air Quality Management Plan
B(a)P	benzo(a)pyrene
SEA	Slovenian Environmental Agency (ARSO (Agencija Republike Slovenije za okolje)
DJF	December, January, February
BAU	business as usual
AMV	annual mean value

Seznam uporabljenih kratic

PM10	Particulate Matter, prašni delci velikosti manj kot 10 mikrometrov (10µm = 0,01 mm) premera
PM2,5	prašni delci s premerom manjšim od 2,5 µm
NO_2	dušikov dioksid.
NOx	dušikov oksid (NO_2+NO)
SO_2	žveplov dioksid
O_3	ozon
CO	ogljikov monoksid
O_2	kisik
NH_3	amonijak
PM	prašni delci
VOC	hlapni ogljikovodiki, volatile organic compounds
Org. C	organski ogljik
BC	črni ogljik, saje
CO_2	ogljikov dioksid
K	Celovec/Klagenfurt
LB	Lipnica/Leibnitz
MB	Maribor
TUG	Technische Universität Graz/Tehniška univerza v Gradcu
PUZ	pilotna okoljska cona
AQMP	Air Quality Management Plan, načrt za kakovost zraka
B(a)P	benzo(a)piren
SEA	Slovenian Environmental Agency, Agencija Republike Slovenije za okolje (ARSO)
DJF	december, januar, februar
BAU	Business as usual / Ravnanje/delovanje kot običajno
LPV	letna povprečna vrednost

Kazalo vsebine
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Mejne vrednosti za PM10 in PM2,5

PM10	50 µg/m³	Povprečna dnevna vrednost PM10 50 µg/m³; v koledarskem letu so dovoljene naslednje prekoračitve: 35
PM10	40 µg/m³	Povprečna letna vrednost
PM2,5	25 µg/m³	Povprečna letna vrednost, veljavna od 1. 1. 2015
PM2,5	20 µg/m³	AEI (Average Exposure Indicator), drseča triletna povprečna vrednost kot povprečna vrednost mestnih merilnih postaj, nameščenih v ozadju, veljavno od 31. 12. 2015, z nadaljnjimi obveznostmi za zmanjšanje

Limit values for PM10 und PM2.5

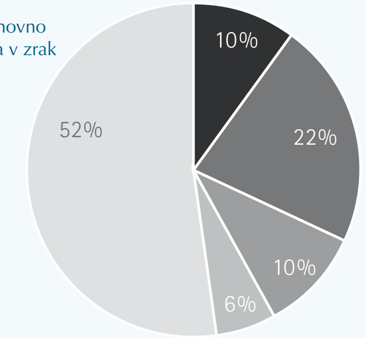
PM10	*50 µg/m³*	*Daily average: per calendar year limit values may be exceeded on 35 days*
PM10	*40 µg/m³*	*Annual average*
PM2.5	*25 µg/m³*	*Annual average – effective from 1/1/2015*
PM2.5	*20 µg/m³*	*AEI (Average Exposure Indicator), sliding three-year average as a mean value from urban background measuring stations, effective from 31/12/2015 with the obligation for further reductions*

Viri onesnaževanja s PM10
na merilni postaji Völkermarkterstraße v Celovcu (23.000 DTV), letna povprečna vrednost 2005.

10%	izpušni plini iz prometa
22%	obraba cestišča in zavor, ponovno dvigovanje delcev iz cestišča v zrak
10%	ogrevanje
6%	industrija
0%	kmetijstvo
52%	ozadje

Contributors to PM10
in percentages at the measuring station Völkermarkterstraße (23,000 DTV) in Klagenfurt, annual average 2005.

10%	*traffic exhaust*
22%	*traffic non-exhaust*
10%	*domestic fuels*
6%	*industries*
0%	*agriculture*
52%	*background*



Uvodna obrazložitev
Background

Prašni delci (delci, PM10, PM2,5), NO_2 (dušikov dioksid) in B(a)P (benzo(a)piren) so trenutno glavna onesnaževala v zraku z negativnimi učinki na zdravje.

Evropske mejne vrednosti za PM10 (40 µg/m³ je mejna letna vrednost, 50 µg/m³ je mejna dnevna vrednost, ki ne sme biti presežena več kot 35-krat v letu; Direktiva 2008/50/ES o kakovosti zunanjega zraka in čistejšem zraku za Evropo) so v številnih slovenskih, avstrijskih in evropskih mestih presežene. Glavna vira onesnaževanja sta promet in mala kurišča. Za več kot polovico onesnaženosti s PM10 pa konkretnega povzročitelja ni možno določiti.

The dominant air contaminants with a negative impact on health are currently particulate matter (fine dust, PM10, PM2.5), NO_2 (nitrogen dioxide) and B(a)P (benzo(a) pyrene), the leading substance for polycyclical aromatic hydrocarbons – PAH).

The European limit values for PM10 (40 µg/m³ annual average, 35 days maximum beyond 50 µg/m³ 24-hour average, Ambient Air Quality Directive EC/50/2008) can no longer be met in many Austrian and other European cities. The main polluters are traffic and domestic heating. Furthermore it has so far been impossible to specify a concrete polluter for more than fifty percent of the PM10 load.

Povzetek
Summary

Project Objectives

Main objective
The priority objective of PMinter is the development of methods and air pollution control plans that facilitate a sustainable improvement of the air quality as well as a reduction of health hazards for the people of Klagenfurt in Lower Carinthia, Leibnitz in Southern Styria and Maribor in Northern Slovenia.

There are four subordinate objectives
- *Clarifying the unknown sources of the high PM10 background load with a special focus on the influence of domestic heating, in particular emissions from woodstove combustion*
- *Establishing a regional and problem-oriented, multi-scale model system for air quality for the border region between Austria and Slovenia*
- *Developing and implementing new AQMPs (Air Quality Management Plans)*
- *Increasing public awareness of the problem*

The influence of possible important measures is to be simulated and evaluated within the project and first measures are to be implemented during the project term.
Ways of meeting the European air quality limit values for PM10 and PM2.5 as early as possible are to be demonstrated.

Project Results
A new measurement method (aethalometer) was used to measure air quality. This method makes the direct determination of wood smoke and diesel soot in the ambient

Cilji projekta

Glavni cilj
Glavni cilj projekta PMinter je razvijanje metod in načrtov za kakovost zraka, ki bodo omogočili trajno izboljšanje kakovosti zraka in zmanjšanje tveganja za zdravje prebivalcev Celovca z avstrijsko Koroško, Lipnice z južno avstrijsko Štajersko in Maribora s severovzhodno Slovenijo.

Ostali cilji projekta so:
- razjasnitev neznanih virov visokega onesnaženja s PM10 s posebnim poudarkom na vplivu malih kurišč, predvsem peči na lesno biomaso,
- vzpostavitev regionalnega modela za kakovost zraka v avstrijsko-slovenskih obmejnih regijah,
- priprava in izvajanje novih načrtov za kakovost zraka (AQMP),
- ozaveščanje javnosti.

Vpliv pomembnejših ukrepov se bo v okviru projekta modeliral in ocenjeval. Prvi ukrepi naj bi bili izvedeni že v času trajanja projekta.
Projekt naj bi nakazal, kako bi bilo mogoče čim prej doseči evropske mejne vrednosti za PM10 in PM2,5.

Rezultat projekta
Pri meritvah kakovosti zraka se je uporabljala nova metoda merjenja (aethalometer, etalometer), ki omogoča neposredno določanje, koliko prispevajo izpusti pri izgorevanju biomase in fosilnih goriv k onesnaženosti zraka. Ta metodologija je bila preverjena s kemijsko analizo filtrov in meritvami 14C.

Kurjenje lesa v malih kuriščih lahko prispeva do 70% k onesnaženju zraka s PM10.

Novi metodološki modelni pristop je bil uspešno razvit in testiran z uporabo visokorazvitega kemijskega modela za promet (WRF-Chem) na regionalni ravni in modelnega sistema GRAMM/GRAL na mikroravni za januar 2010. Bistvene izboljšave so bile dosežene v primerjavi s prejšnjim modelom glede na simulacijo skupnega PM10 in simulacijo posameznih komponent PM10. Rešeno je bilo vprašanje t. i. ozadja. Izkazalo se je, da je anorganski sekundarni PM glavni sestavni del PM na regionalni ravni. Kurjava v gospodinjstvih se je izkazala za drug najpomembnejši vir PM, v Lipnici/avstrijska Štajerska celo kot glavni vir. Te izboljšave temeljijo na boljšem izkoristku obstoječih podatkovnih zbirk o regionalnih emisijah, izboljšanem izračunu emisij iz malih kurišč v gospodinjstvih v Celovcu in Mariboru ter modeliranju prometnih emisij znotraj projektnega območja PMinter. Nov modelni pristop je mogoče uporabiti tudi za ocenjevanje ukrepov oz. obstoječih načrtov za izboljšanje kakovosti zraka (AQMP) na regionalni ravni. Na podlagi novih ugotovitev glede zastopanosti kemijskih elementov v delcih je ta pristop mogoče uporabiti tudi za oceno vpliva na zdravje.

Modeliranje in izkušnje v praksi so pokazali, kateri ukrepi so zelo učinkoviti za zmanjšanje onesnaženosti zraka zaradi kurjenja lesne biomase, ne da bi pri tem zanemarili podnebne cilje:

Vzpostavitev sistema daljinskega ogrevanja na osnovi biomase v urbanih območjih, programi subvencij za zamenjavo starih peči na les, iskanje rešitev za pravilni način ogrevanja s strani dimnikarjev.

Okoljska cona je učinkovita le tedaj, ko se vzpostavi na večji površini s strogimi omejitvami (Euro 4, le redke izjeme) in je podprta z ukrepi za vzpodbujanje uporabe javnega potniškega prometa.

air possible. The method was evaluated by means of chemical filter analyses and ^{14}C measurements, representing the fossil part of the carbon.

The proportion of wood smoke from individual furnaces can amount to up to 70% of PM10 emissions.

A new methodological model approach was developed and tested successfully using a sophisticated chemistry transport model (WRF-Chem) on a regional scale and the GRAMM/GRAL model system on a micro-scale for January 2010. Significant improvements were achieved compared with previous modelling work with regard to simulated total PM10 and simulated PM10 components: The so-called background was resolved. Inorganic secondary PM turned out to be the major PM component at the regional level. Residential heating is the second most abundant PM component and in Leibnitz/Southern Styria it is the major component. These improvements are due to the enhanced exploitation of existing regional emission databases, the improved calculation of domestic heating emissions in Klagenfurt and Maribor and traffic emission modelling within the PMinter program area. The new model approach can also be used for the evaluation of measures or existing AQMPs on the regional level. Given the differentiated representation of PM components, the approach may be used for health impact assessment.

Based on the simulations carried out and the experience gained with the demonstration activities, the following measures proved to be highly efficient in reducing the impact from wood combustion while at the same time pursuing climate protection objectives: establishment of district heating systems on the basis of biomass in urban areas; schemes to promote the replacement of old wood-fired ovens; information about the correct way of heating to be provided by chimney sweeps.

The establishment of an environmental zone will only make sense if it is large in scale, if access is strictly limited (Euro 4, only few exceptions) and if measures to promote the use of public transport are introduced simultaneously.

A significant reduction of ammonia (-30%) from agriculture is particularly helpful in Southern Styria. While speed limits on motorways have an impact on NO_2, their effect on PM10 is not so high.

Because of the Euro 6 standards and the modernisation of the vehicle fleet, further improvement of air quality is to be expected by 2020, which can be increased even further if more e-vehicles are used.

The new air quality management plans take account of the findings of the PMinter project.

Both Klagenfurt and Maribor already succeeded in reaching the EU limit values during the project term. The air quality trend indicates further improvement for the future, both in terms of PM10 and NO_2. Improvements have also been noted in Styria, but a thorough and consistent implementation of the air quality management plan will be required here to remain within the PM10 limit values even in meteorologically unfavourable years in future.

Project Term
01.07.2010 to 31.12.2013

Project Partners
Municipality of the Carinthian capital Klagenfurt am Wörthersee
Municipality of Maribor
Office of the Carinthian Government
Graz University of Technology
Institute for Public Health, Maribor
Office of the Styrian Government
University of Maribor

Očitno zmanjšanje amonijaka (-30%) v kmetijstvu je predvsem smiselno na območju južne avstrijske Štajerske. Omejitve hitrosti na avtocestah učinkujejo na NO_2, manj na PM10.

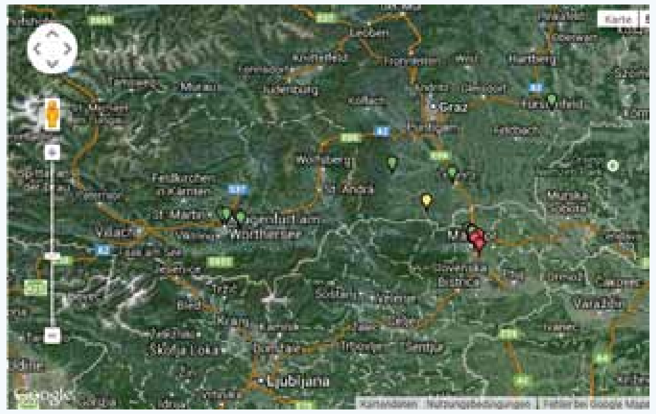
Do leta 2020 je na podlagi normativov Euro 6 in posodobitve flote vozil pričakovati nadaljnje izboljšanje kakovosti zraka, ki se bo s povečanjem e-mobilnosti še izboljšalo.

Spoznanja projekta PMinter so bila upoštevana pri pripravi novih načrtov za kakovost zraka.

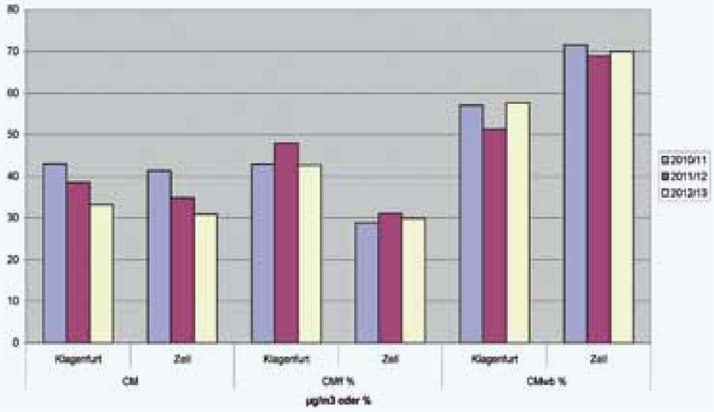
V Celovcu so bile že v času projekta dosežene mejne vrednosti EU, prav tako v Mariboru. V prihodnosti se kaže trend izboljšanja kakovosti zraka tako na področju delcev PM10 kot tudi NO_2. Na avstrijskem Štajerskem je prav tako mogoče prepoznati trend izboljšave, vendar pa bo potrebno izvajanje ukrepov iz načrta za kakovost zraka, da bi lahko v prihodnosti tudi v meteorološko neugodnih letih izmerili vrednosti pod mejnimi, predpisanimi za PM10.

Trajanje projekta:
od 1. 7. 2010 do 31. 12. 2013

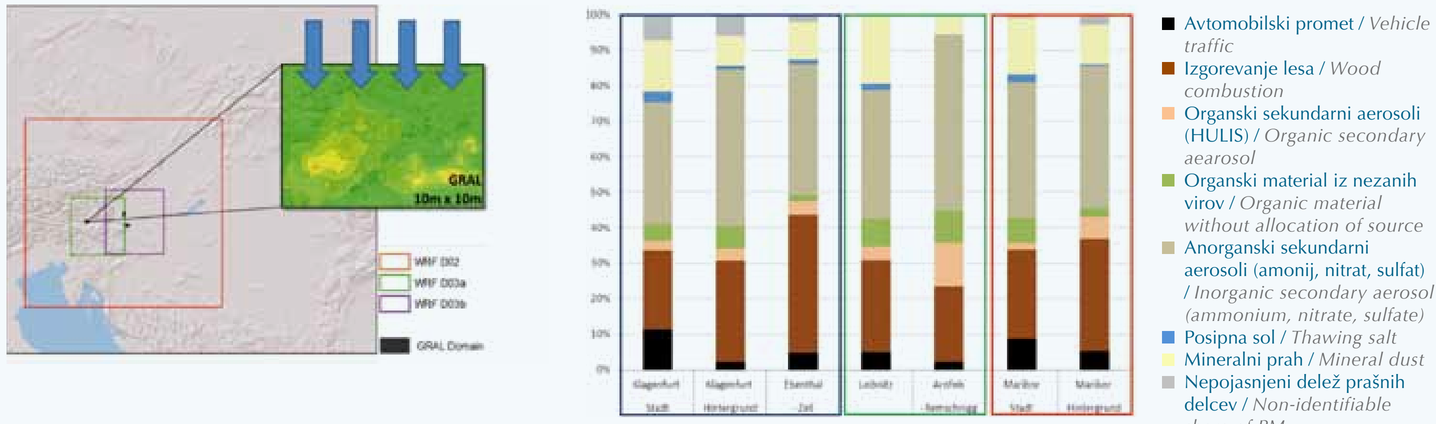
Partnerji projekta
Magistrat deželnega glavnega mesta Celovec ob Vrbskem jezeru
Mestna občina Maribor
Urad koroške deželne vlade
Tehniška univerza v Gradcu
Zavod za zdravstveno varstvo Maribor
Urad štajerske deželne vlade
Univerza v Mariboru, Fakulteta za gradbeništvo



Slika 1: Zemljevid s povezavami do merilnih postaj na avstrijskem Koroškem, Štajerskem in v Sloveniji
Fig. 1: Map with links to measuring stations in Carinthia, Styria and Slovenia



Slika 2: Deleži dizelskih izpuhov v odstotkih (CMff) in izgorevanje lesa (CMwb) pri skupnih ogljikovih aerosolih (CM) v Celovcu in Selah v zimskem polletju 2010-2013
Fig. 2: Share of diesel exhaust gas (CMff) and wood combustion (CMwb) of the overall carbonaceous aerosol (CM) in Klagenfurt and Zell in the 6 winter months 2010-2013 in %



Slika 3: Absolutni in relativni delež, ki ga k PM10 prispevajo posamezni viri onesnaževal, ugotovljen na podlagi kemijskih analiz filtrov
Fig. 3: Absolute and relative share of PM10 polluters as shown by chemical filter analyses

Meritve kakovosti zraka
Air Quality Measurements

Meritve kakovosti zunanjega zraka so bile opravljene z desetimi mobilnimi in stacionarnimi merilnimi postajami v regijah Celovec, Lipnica in Maribor.

Pri tem smo izvajali meritve parametrov PM10, NO_2, NOx, SO_2, O_3 in CO ter opravljali kemijske analize na filtrih z vzorčenimi delci (npr. B(a)P). Dodatno smo v regijah izvajali še meritve amonijaka (NH_3) s pasivnimi vzorčevalniki, meritve z etalometri (črni ogljik) in meritve meteoroloških spremenljivk.

The air quality was measured by means of 10 mobile and stationary measurement stations in the regions of Klagenfurt, Leibnitz and Maribor.

The PM10, NO_2, NOx, SO_2, O_3 and CO parameters were continuously recorded and chemical filter analyses performed (e.g. B(a)P). In addition, ammonia (NH_3) was measured in the region by means of passive samplers, aethalometer measurement and meteorological measurement.

Zbirka podatkov o kakovosti zraka

Rezultati meritev so na voljo na www.pminter.eu (Slika 1). Pri podatkih gre za t. i. surove podatke, ki so bili podvrženi le predhodnemu, avtomatskemu testiranju. Pri končni obdelavi se lahko ti podatki še spremenijo.

Air quality database

The results of the continuous measurement of the 10 measurement points are available online at www.pminter.eu (Fig. 1). These data are raw data that have been subjected to preliminary analysis only and may change in the course of the final verification.

Meritve z etalometri

Namen meritev z etalometri v projektu PMinter je bil merjenje koncentracij črnega ogljika (BC, angl. black carbon), karakterizacija aerosolov in opredelitev povzročiteljev. Črni ogljik (BC) je inertni proizvod nepopolnega izgorevanja in s tem dober pokazatelj primarnih izpustov. Pogosto se uporablja tudi kot pokazatelj učinkovitosti ukrepov za varovanje zraka.

Meritve absorpcije svetlobe na obloženem filtru ob različnih valovnih dolžinah omogočajo karakterizacijo delcev aerosolov. S pomočjo Angstromovega eksponenta imamo možnost razlikovanja med črnim ogljikom iz fosilnih goriv ter izpusti pri izgorevanju biomase.

Aethalometer measurements

The purpose of the aethalometer deployment within the PMinter project is the measurement of black carbon concentrations, aerosol characterization and source apportionment. Aerosolized black carbon is an inert primary product of incomplete combustion and therefore a good indicator of primary emissions. It is often used as an indicator for efficiency of abatement strategies.

Measurements at different wavelengths enable the characterization of sampled aerosol particulate matter. We can qualitatively and quantitatively differentiate between diesel exhaust and smoke from biomass combustion by calculating the aerosol absorption Angstrom exponent.

Aethalometer measurements were taken in Klagenfurt (3 measuring points), Southern Styria (2 measuring points) and the region of Maribor (2 measuring points) in three winter campaigns between 2010 and 2013.

In Klagenfurt (Völkermarkter Str.), the winter black carbon (BC) concentrations are high with an average value of approximately 7.5 µg/m³ compared to around 5 µg/m³ in Zell (rural area). The wood burning contribution to BC was around 15% in Klagenfurt and around 35% in Zell and similar to the Limmersdorfer Strasse background measurement station. The wood burning contribution to carbonaceous matter (CM) was around 55% in Klagenfurt and 70% in Zell (Fig. 2). It is clear that wood burning influences the whole Klagenfurt basin more than traffic, and that any abatement measures on wood combustion need to be carried out in the whole basin rather than just in the municipality of Klagenfurt.

Meritve z etalometri so bile izvedene v treh zimskih obdobjih med letoma 2010 in 2013, in sicer v Celovcu (tri merilne postaje), na južnem avstrijskem Štajerskem (dve merilni postaji) in v Mariboru (dve merilni postaji).

V Celovcu (Völkermarkter Strase) so bile koncentracije črnega ogljika visoke in so dosegle povprečne vrednosti okoli 7,5 µg/m³ v primerjavi z vrednostjo okrog 5 µg/m³ v kraju Zell/Sele (podeželski kraj). Delež črnega oglika iz izgorevanja lesa je v Celovcu znašal okoli 15 % in 35 % v Selah, podobno tudi pri merilni postaji na lokaciji Limmersdorferstrasse. Delež izgorevanja lesa pri delcih iz ogljika (CM, angl. carbonaceous matter) je bil okrog 55 % v Celovcu in 70 % v Selah (Slika 2). Očitno je, da je vpliv izgorevanja lesa na celotno Celovško kotlino večji kot vpliv prometa ter da so potrebni ukrepi za zmanjšanje vpliva izgorevanja lesa v širši Celovški kotlini, in ne le zgolj v mestu Celovec.

Chemical filter analyses

The comprehensive chemical analysis of fine dust samples collected in seven air quality measurement stations in Southern Styria, Lower Carinthia and Northern Slovenia in the winter of 2011 makes it possible to detect the originators of particulate matter. The contributions of the individual source were calculated by means of the Macrotracer model.

The main sources of particulate matter are:

> *The formation from the trace gas ammonia, the nitrogen oxides and sulphur dioxide (inorganic secondary aerosol) in the atmosphere*
> *The burning of wood*
> *Motorised traffic*

The highest share of particulate matter at all measurement points is due to the inorganic secondary aerosol. These compounds result from the trace gases ammonia in combination with nitrogen dioxides and sulphur dioxide in the atmosphere. Since the transformation of the trace gases to dust particles may take several hours, these compounds

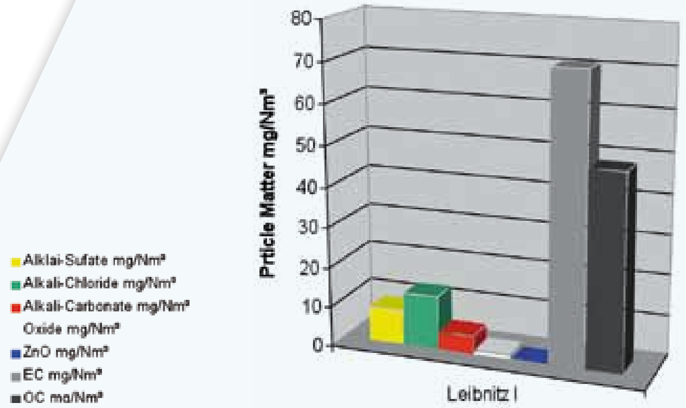
Kemijske analize prašnih delcev

Obsežna kemijska analiza vzorcev prašnih delcev s postaj za meritve kakovosti zunanjega zraka na avstrijskem Štajerskem, spodnjem avstrijskem Koroškem in v severni Sloveniji pozimi 2011 je omogočila identifikacijo onesnaževalcev, nato so bili na podlagi modela Makrotracer določeni prispevki posameznih virov.

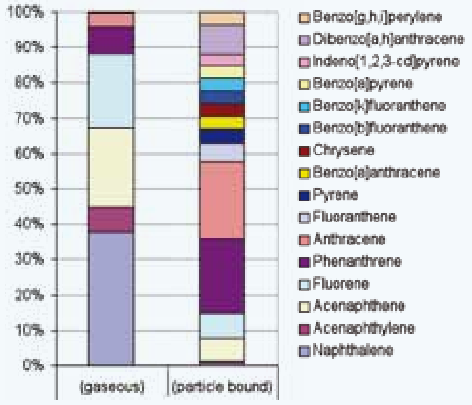
Viri prašnih delcev so večinoma naslednji:

> nastajajo v atmosferi iz amonijaka, dušikovega dioksida in žveplovega dioksida (anorganski sekundarni aerosoli),
> kurjenje lesne biomase,
> avtomobilski promet.

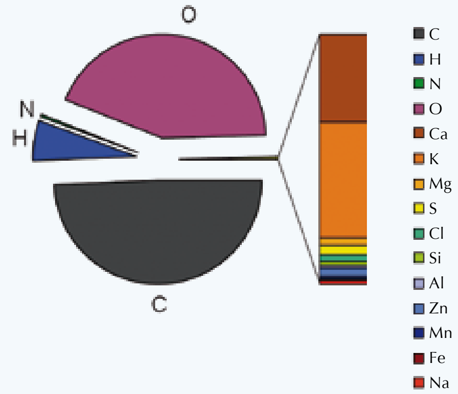
Na vseh merilnih postajah največ k onesnaževanju s prašnimi delci prispevajo anorganski sekundarni aerosoli, ki se pospešeno tvorijo v hladnem in vlažnem letnem času. Ti nastanejo v atmosferi iz amonijaka v povezavi z dušikovimi oksidi in žveplovim dioksidom. Pretvorba izpušnih plinov v prašne delce traja tudi več ur, zato se te spojine lahko razširijo izven regije nastanka.



Slika 4: Prašni delci (rezultat analize v Lipnici)
Fig. 4: Particulate matter (result of analysis Leibnitz)



Slika 5: Policiklični aromatski ogljikovodiki, plini in prašni delci (rezultat analize v Mariboru)
Fig. 5: Polycyclical aromatic hydrobarbons, gaseous and in fine dust particles (analysis result Maribor)



Slika 6: sestava goriva (rezultat analize v Celovcu)
Fig. 6: Fuel mix (analysis result Klagenfurt)

Drugi največji vir onesnaževanja s prašnimi delci je kurjenje lesne biomase. Stare naprave na ročno nalaganje nadpovprečno prispevajo k onesnaženju.

Zaradi intenzivne rabe lesa za ogrevanje na celotnem projektnem območju in širjenja prašnih delcev je vpliv zaznan v celotni regiji. Kurjenju lesne biomase lahko pripišemo tudi deleže organskih sekundarnih aerosolov (HULIS), ki posebej na podeželskih območjih prispevajo k povečanju onesnaženja zaradi ogrevanja na lesno biomaso. Občuten prispevek ogrevanja z lesno biomaso na kakovost zraka so potrdile tudi neodvisne analize za določanje fosilnega in modernega ogljika (14C analize).

Avtomobilski promet povzroča pomemben del emisij. To so tako emisije iz izpušnih plinov kot tudi emisije zaradi obrabe pnevmatik in zavor (vsota teh deležev je opisana na sliki 3 kot avtomobilski promet). Tudi posip cest (del mineralnega prahu) in sol za posipanje spadata k emisijam cestnega prometa.

migrate across regions. The precursor substances, however, are emitted in the area investigated. The inorganic secondary aerosol is mainly formed in the cold and humid season.

Burning of wood accounts for the second highest share of particulate pollution, with old and manually charged ovens causing above-average pollution. Due to the intensive use of wood for heating purposes in the area under investigation and because of the migration of particulate matter, this source of fine dust has a major impact on the entire region. Wood burning also accounts for some of the inorganic secondary aerosol (HULIS) so that the impact of the combustion of wood in rural areas on particulate matter formation is even higher. The significant impact of wood burning on air quality was also confirmed by independent analyses of fossil and modern carbon dating (^{14}C analyses).

Emissions caused by motorised traffic also play an important role. These are emissions from exhaust gases as well as the dust resulting from the abrasion of tyres and brakes (the total of these shares is shown as "motorised traffic" in figure 3). The grit on the streets in winter (share of mineral dust) and thawing salt also fall under motorised traffic.

Osnovni podatki in emisije
Basic Data and Emissions

A comprehensive emission database is an important prerequisite for successfully modelling air quality.

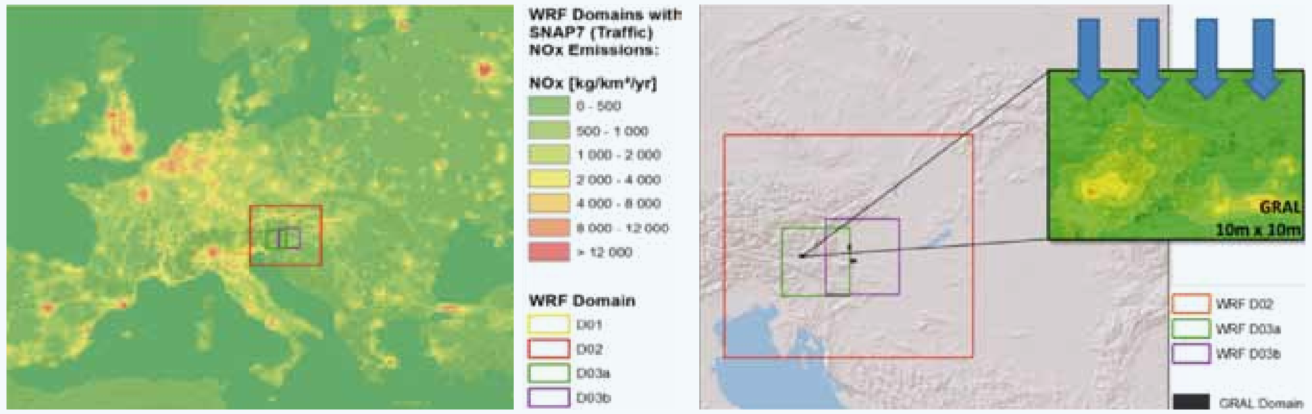
Methodology
A major challenge was the preparation, processing, refinement and harmonisation of emission data so that two different dispersion model systems and concepts can be used and finally complement each other.

On the European scale an emission data set on 7 km x 7 km was used. However, this data set required several corrections in Croatia near the Slovenian border. Slovenian emission data were provided by SEA (Slovenian Environmental Agency). All regional and core area traffic emissions were computed and updated based on road network data and traffic count data for light and heavy vehicles. The TUG emission model NEMO was used to compute PM exhaust and non-exhaust emissions, nitrogen oxide, VOC and CO_2 emissions. Detailed traffic model data which supplement traffic count data were available for Maribor and Klagenfurt. Emissions from regional emission inventories (Styria, Carinthia) for commerce, industry, heat generation and agriculture were processed for the regional modelling on resolutions of 5 km x 5 km and 1 km x 1 km. Emissions from traffic or point sources (stacks) used within the three micro scale core domains were processed and allocated with approximately order 1 m – 10 m accuracy. Emission data for log wood boilers and single stoves measured within PMinter were used for improving the emission database for residential heating. Within the Klagenfurt micro-scale core domain, domestic heating emissions were computed based on various census data available for the majority of individual households. For

Obsežna, celovita podatkovna zbirka emisij je pomemben predpogoj za uspešno modeliranje kakovosti zraka.

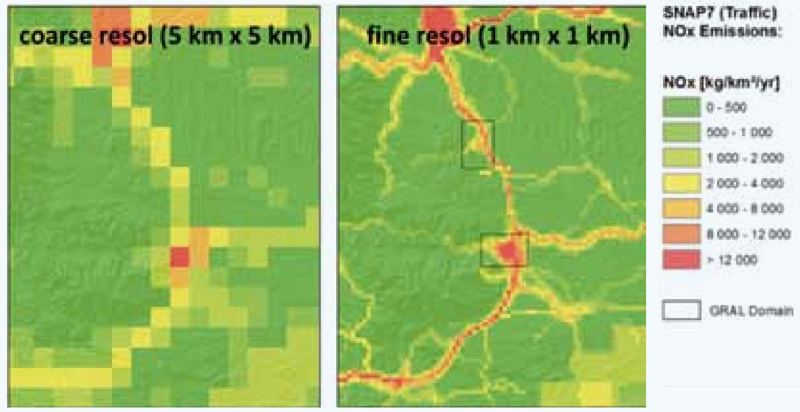
Metodologija
Glavni izziv je bila priprava, procesiranje, čiščenje in usklajevanje podatkov o emisijah s ciljem, da se lahko uporabita dva različna modela in koncepta, ki se na koncu medsebojno dopolnjujeta.

Na evropski ravni so bili uporabljeni emisijski podatki v ločljivosti 7 x 7 km. Za določene podatke so bili potrebni popravki, recimo na Hrvaškem v bližini slovenske meje. Slovenske podatke o emisijah je zagotovila Agencija Republike Slovenije za okolje. Vse regionalne emisije iz prometa z obravnavanega območja so bile vnesene v bazo in posodobljene na podlagi ostalih dosegljivih podatkov (štetja prometa za lahka in težka motorna vozila itd.). Za obdelavo emisij iz cestnega prometa (PM, dušikovi oksidi, VOC in emisij CO_2; ločeno na emisije iz izpuha vozila ter na „neizpušni" del) je bil uporabljen emisijski model NEMO Tehniške univerze v Gradcu (TUG). Natančnejši podatki modela prometa, ki so bili dopolnjeni s podatki iz štetja prometa, so bili na voljo za Maribor in Celovec. Emisije iz regionalnih emisijskih popisov (avstrijska Štajerska, avstrijska Koroška) za trgovino, industrijo, proizvodnjo energije in kmetijstvo so bile obdelane za regionalni izračun z resolucijo 5 km x 5 km in 1 km x 1 km. Emisije iz prometa oz. točkovnih virov (dimniki), uporabljene znotraj treh jedrnih območij na mikroravni, so bile obdelane in razporejene s približno natančnostjo od 1 do 10 m. Emisijski podatki za peči na drva in individualna kurišča, ki so bili pridobljeni v okviru projekta PMinter, so bili uporabljeni za izboljšanje podatkovne zbirke o emisijah iz gospodinjstev.



Slika 7: Področja WRF-Chem & emisije NOx iz prometa za 2010 (levo); shematska kombinacija WRF-Chem z GRAMM/GRAL (desno). Majhna črna kvadratka predstavljata 3 jedrna ciljna območja za K, LB in MB.

Fig. 7: WRF-Chem domains & traffic NOx 2010 emissions (left); schematic combining WRF-Chem with GRAMM/GRAL (right). The small black boxes represent the 3 core target areas for K, LB and MB.



Slika 8: Letne prometne emisije NOx iz grobih podatkov MACC (levo) in obdelanih podrobnih podatkov PMinter za razjasnitev virov emisij v kotlinah in dolinah (desno).

Fig. 8: Yearly NOx traffic emissions from the coarsely resolved European MACC data set (left) and calculated for the PMinter data set with a detailed resolution, which is adequate to locate emission sources in basins and valleys (right).

V okviru celovškega jedrnega območja na mikroravni so bile emisije iz kurjave v gospodinjstvih obdelane na podlagi podatkov iz popisa, ki so bili na voljo iz individualnih gospodinjstev. Za mariborsko območje so bile emisije iz gospodinjskega ogrevanja obdelane na podlagi podatkov o vrsti goriva in porabi goriva za vsako posamezno gospodinjstvo glede na podatke dimnikarjev. Podatki so bili na koncu obdelani za posamezna gospodinjstva in zatem sešteti za območje velikosti 250 m x 250 m in definirani kot območni viri.

Da bi lahko kvantitativno bolje zajeli emisije prašnih delcev iz peči na lesno biomaso, so bile v projektnih regijah izvedene terenske meritve v gospodinjstvih z regijsko značilnimi pečmi na lesno biomaso. Tako pridobljeni emisijski podatki naj bi tvorili boljšo osnovo za izračun širjenja in s tem omogočili natančnejšo določitev povzročiteljev emisij prašnih delcev.

Izvedeni sta bili dve merilni kampanji za območja Celovca, Lipnice in Maribora v kurilnih sezonah 2010/2011 in 2011/2012. Za pridobitev reprezentativih podatkov so posamezni lastniki stanovanja ogrevali na svoj običajen način. Na vsakem testnem objektu so bili izmerjeni naslednji podatki: poraba goriva, količina pepela, temperatura dimnega plina, vlek dimnika, sestava dimnih plinov (O_2, CO_2, CO, org. C) ter emisije prašnih delcev in skupaj emisije prahu. Nadalje so se določile kemijske sestave izbranih vzorcev goriva, pepela in emisij prahu. Z izdelavo masnih in energetskih bilanc za ogrevanje smo iz teh merilnih in analiznih podatkov dobili emisijske faktorje za relevantne komponente škodljivih snovi. Ti rezultati izboljšujejo do sedaj razpoložljive podatkovne sklope in tvorijo nove osnovne podatke, ki se bodo uporabljali za vzorčenje in modeliranje širitve prašnih delcev v projektnih regijah (slika 4, 5, 6).

the Maribor area domestic heating emissions were computed based on the type of fuel and fuel consumption data for individual households according to chimney sweepers' data. Finally, the data were computed for single households and then summed up over areas of 250 m x 250 m and assigned as elevated area sources.

Field measurements in homes with heating installations that are typical for the area were carried out within the project regions to improve the quantity recording of particulate matter emissions from wooden stoves. The emission data collected in this way are to create a better basis for propagation calculations and thus enable a more precise allocation of fine dust emissions to their polluters.

Two measurement campaigns each were conducted in the Klagenfurt, Leibnitz and Maribor areas during the heating seasons 2010/2011 and 2011/2012. To obtain representative data, the operators used their heaters in the usual manner. The following data were recorded for each tested heating installation: fuel consumption, ash produced, exhaust gas temperature, draft performance of chimney, composition of flue gas (O_2, CO_2, CO, org. C) and particulate matter and total dust emissions. The chemical compositions of selected fuel, ash and dust emission samples were determined. By establishing mass and energy balances for heating, emission factors for relevant pollutant components were determined on the basis of these measurement and analysis data. These results have improved the database available so far and in addition have created new fundamental data that were used for simulation of the particulate matter propagation in the project regions (Fig. 4, 5 and 6).

Modeliranje
Modelling

Modelling in PMinter a new holistic approach

To develop and improve local and regional air quality management plans (AQMP), major PM sources, precursors, transport and transformation processes are assessed from Europe down to regions (Carinthia, Styria, and N-Slovenia) and finally down to the three micro-scale core areas LB, K, and MB, typically 8 km x 12 km in extent (Fig. 7).

Methodology

A new multi-scale model approach was developed and implemented for air quality modelling. This combined modelling ensures that transport processes, complex chemical processes, and aerosol dynamics (i.e. secondary PM) can be represented from the European scale down the three core areas. In addition, the models enable to differentiate between health relevant PM components ultra-fine particles, originating from traffic exhaust, residential heating, industrial combustion) and potentially less health relevant components and thus can support the improvement of AQMPs.

Three models were deployed to model the winter season 2010. First, the chemistry transport model WRF-Chem, using a nesting technique for three domains varying in size and resolution: Europe, the eastern alpine region, and two small domains of about 100 km x 100 km extent and a 1 km horizontal resolution. The latter comprise the three micro-scale core investigation areas K, LB, and MB. Second, the meteorological model GRAMM (Graz Mesoscale Model) was applied on horizontal resolutions of 150 m to 250 m to represent complex terrain flows within the micro-scale core investigation areas. Third, the dispersion model GRAL (Graz Lagrangian Model) was used to model air quality in the micro-scale regions. The models, approaches and emissi-

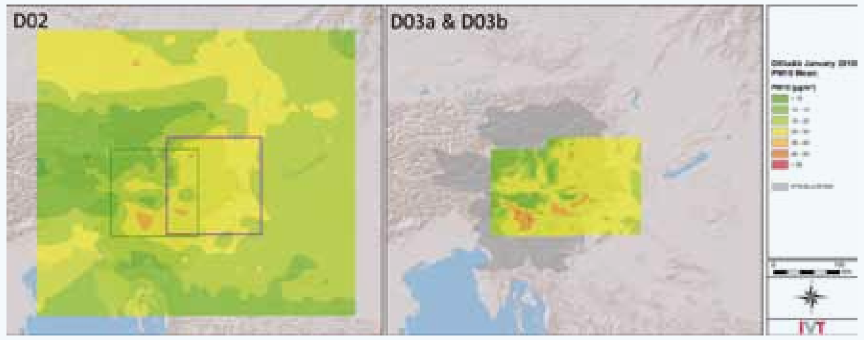
Modeliranje v okviru projekta PMinter – nov holistični pristop

Za pripravo in izboljšanje lokalnih in regionalnih načrtov za kakovost zraka (AQMP) so se glavni viri delcev in predhodniki onesnaževal, upoštevajoč njihov transport in kemijske reakcije v atmosferi, ugotavljali od zgoraj navzdol - od Evrope navzdol do regij (Koroška, Štajerska in severna Slovenija) in vse do treh jedrnih območij na mikroravni LB, K in MB, in sicer z ločljivostjo 8 km x 12 km (slika 7).

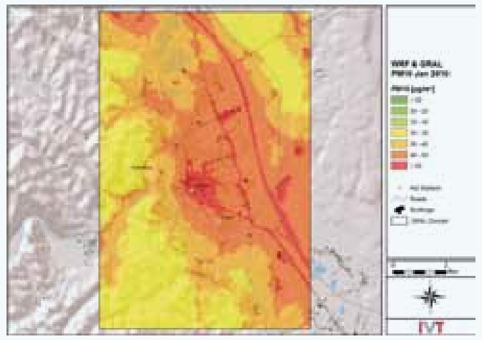
Metodologija

Za modeliranje kakovosti zraka je bil razvit in izveden nov večstopenjski modelni pristop. Kombinirano modeliranje omogoča, da so prenosi onesnaževal, kompleksni kemijski postopki in dinamika aerosolov (tj. sekundarnih delcev) predstavljeni od evropske ravni navzdol vse do treh jedrnih območij. Poleg tega model omogoča razlikovanje delcev med za zdravje relavantnimi snovmi, ki izvirajo iz prometnih izpušnih plinov, ogrevanja v gospodinjstvih, industrijskega izgorevanja in potencialno za zdravje manj relavantnimi snovmi, kar lahko prispeva k izboljšanju načrtov za kakovost zraka.

Za modeliranje zimske sezone 2010 so bili uporabljeni trije modeli. Prvi, kemijski model za promet WRF-Chem, ki uporablja tehniko gnezdenja za tri območja, ki se razlikujejo po velikosti in resoluciji: Evropa, vzhodna alpska regija in dve majhni območji velikosti okoli 100 km x 100 km in 1 km ločljivosti. Zadnja je na mikroravni sestavljena s treh jedrnih preiskovalnih območij K, LB in MB. Drugi, meteorološki model GRAMM (Graz Mesoscale Model), je bil uporabljen na vodoravni resoluciji velikosti 150 m do 250 m z namenom, da predstavi kompleksne terenske pretoke na mikroravni znotraj jedrnih preiskovalnih območij. Tretji, razpršitveni model GRAL (Graz



Slika 9: Natančnejši kot sta resolucija emisij in resolucija modela, natančnejši so podatki o najvišjih in najnižjih koncentracijah. Povprečne koncentracije PM10 za januar 2010, ki temeljijo na emisijskih podatkih MACC v resoluciji 5 km x 5 km (levo) in enako polje koncentracij, ki temeljijo na podrobnih emisijskih podatkih PMinter v resoluciji 1 km x 1 km (desno).
Fig. 9: The more detailed the resolution of emissions and the model resolution the more accurate the presentation of maxima and minima in concentration levels. Mean Jan. 2010 PM10 concentrations based on coarse MACC emission data at 5 km x 5 km resolution (left) and same concentration field based on detailed PMinter emission data at 1 km x 1 km (right).



Slika 10: Kombinacija modeliranja na regionalni in mikroravni omogoča razjasnitev močno lokaliziranih virov (promet, ogrevanje v gospodinjstvu) z ustrezno resolucijo 10 m x 10 m , povprečni PM10 za januar 2010.
Fig. 10: Combining regional & micro-scale modelling enables to resolve strong localized sources (traffic, domestic heating) adequately at 10 m x 10 m resolution, Jan. mean PM10, 2010.

Lagrangian Model), je bil uporabljen za modeliranje kakovosti zraka v regijah na mikroravni. Na podlagi različnih primerjav modelirnih parametrov (vetra ali onesnaževalcev zraka) z nadzorovanimi podatki je bilo mogoče potrditi in še izboljšati modelne pristope in osnove za emisijske podatke. Na koncu so bili rezultati modelov WRF-Chem in GRAL združeni in preverjeni z meritvami na standardnih kontrolnih postajah za merjenje kakovosti zraka in s podatki natančnejših analiz s kemijskimi analizami filtrov (komponente delcev PM).

Proučeni so bili različni scenariji in njihov medregionalni vpliv na koncentracije delcev na regionalni in mikroravni (vpliv okoljskih con, povezava gospodinjstev, ki uporabljajo starejše peči, na daljinsko ogrevanje vpliv zmanjšanja prisotnosti NOx iz prometa ali zmanjšanja prisotnosti amonijaka iz kmetijstva).

Rezultati osnovnih primerov
Izboljšana obdelava emisij zagotavlja bolj realistično predstavitev virov emisij, ki so v kotlinah in dolinah in so obdani s hribovitim ali gorskim terenom (slika 8). Če se uporabijo grobi vneseni emisijski podatki, so ti viri razporejeni na odročnih hribovitih ali gorskih predelih. Zato se je bistvenega pomena izkazala povečana natančnost pri predstavitvi atmosferske kemije in aerosolnih postopkov, ki se večinoma omejujejo na kotline in doline.

Prednost boljše natančnosti v zbirki emisijskih podatkov se odraža v modelnih emisijah. Maksima in minima sta veliko bolje predstavljeni, če se uporablja natančna zbirka emisijskih podatkov v modelu WRF-Chem (slika 9). Kljub temu pa je manjše strukture v imisijah zaradi prometa, gostejše poseljenosti in gospodinjskega ogrevanja mogoče zadovoljivo razložiti s kombiniranjem regionalnega (WRF-Chem) in lokalnega (GRAL) modela (slika 10). Na ta način model zazna kontrolno razliko v višini 40 µg/m³ med LB center in postajo Kogelberg.

Za potrditev modelnega pristopa (prikazano za januar 2010) so bili rezultati primerjani z meritvami (januar 2010) in podatki kemijske analize filtrov z delci, opravljene pri Tehniški univerzi na Dunaju (TUW) za zimsko obdobje 2011. Primerjava

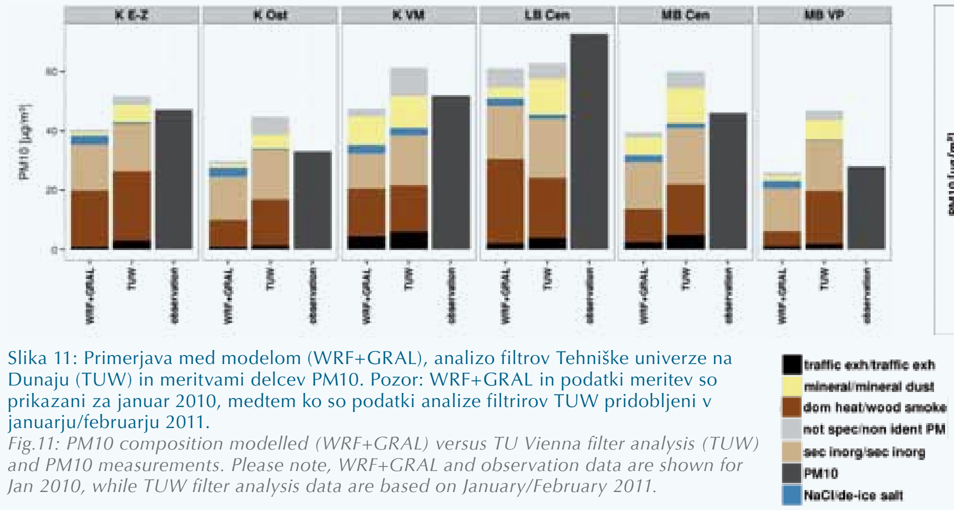
on databases could be validated and further improved based on various comparisons of modelled parameters (e.g. wind or air pollutants) with monitored data. Finally, results from WRF-Chem and GRAL were combined and validated with measurements at standard air quality monitoring stations and data from detailed filter analyses (PM components).

Various scenarios were studied on regional and micro-scale, e.g. the impact of environmental zones, the connection of households using old single stoves to district heating, the impact of traffic related NOx reductions, or the reduction of agricultural ammonia on interregional PM levels.

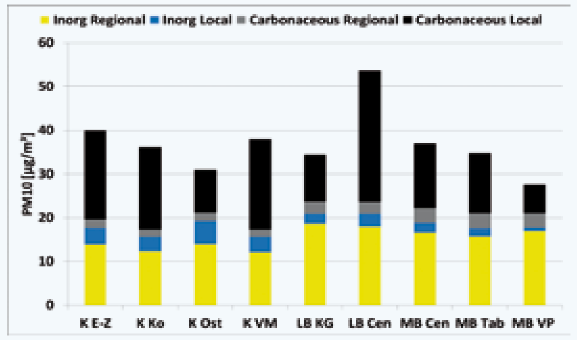
Results Basis Cases
The improved emission processing guarantees a more realistic representation of emission sources, which are mainly located in the main basins and valleys and surrounded by hilly or mountainous terrain (Fig. 8). These sources are blurred to the remote hilly or mountainous terrain, if coarse emission input data are used. Hence, the fine resolution used proved to be essential for representing the atmospheric chemistry and aerosol processes that are mainly confined to basins and valleys.

The advantage of the detailed resolution in the emission database is mirrored in the modelled immissions. Maxima and minima are much better represented if the detailed emission database is used in the WRF-Chem model (Fig. 9). Nonetheless, smaller structures in immissions due to traffic, dense population, and residential heating, can only be resolved satisfactorily by combining the regional (WRF-Chem) and local (GRAL) model (Fig. 10). Thus, the monitored difference of up to 40 µg/m³ between LB centre and the Kogelberg station is captured by the models.

To validate the model approach (shown for January 2010), the results were compared to measurements (January 2010) and data from chemical filter analysis from TU-Vienna (TUW) for the winter period 2011. A generally good agreement between simulated and observed PM10 concentrations was



Slika 11: Primerjava med modelom (WRF+GRAL), analizo filtrov Tehniške univerze na Dunaju (TUW) in meritvami delcev PM10. Pozor: WRF+GRAL in podatki meritev so prikazani za januar 2010, medtem ko so podatki analize filtrirov TUW pridobljeni v januarju/februarju 2011.
Fig.11: PM10 composition modelled (WRF+GRAL) versus TU Vienna filter analysis (TUW) and PM10 measurements. Please note, WRF+GRAL and observation data are shown for Jan 2010, while TUW filter analysis data are based on January/February 2011.



Slika 12: Simulirani „regionalni“ in „lokalni“ prispevki anorganskih in ogljičnih sestavin PM10 iz simulacij WRF-chem + GRAL za 9 PMinter postaj za merjenje kakovosti zraka.
Fig. 12: Simulated "regional" & "local" contributions for inorganic and carbonaceous PM10 components WRF-chem + GRAL simulations at the nine PMinter air quality monitoring stations.

obtained in as good as all the stations considered (shown exemplarily for nine stations in Fig. 11). On average, the simulated results underestimate the measurements by less than 10%. These results indicate that the methodology applied is superior to applying a fixed constant background PM concentration level, as generally implemented for air quality assessments.

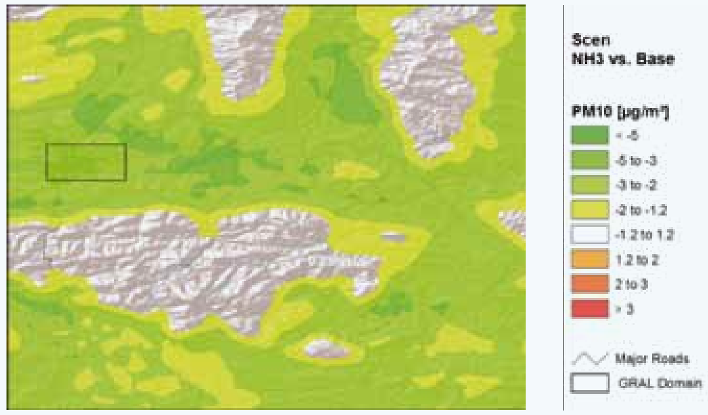
Comparing PM10 composition of simulated data to results obtained from chemical filter analysis (Fig. 11), consistency was achieved in all three micro-scale core domains for traffic related PM (PM exhaust concentrations up to 4.6 µg/m³) and secondary inorganics (up to 19 µg/m³). This secondary PM fraction links different sources from agriculture, traffic and industry. Residential heating related PM proved to be relatively well simulated for K, LB and MB Centre, while it was significantly underestimated by the model for MB Vrbanski Plato, an urban background station.

The combined model approach allows the differentiation between regional and local contributions of PM10 compounds to the total PM10 concentration as added value. The local contributions to inorganic secondary PM at locations of the air quality monitoring stations and the transported contributions to these locations are shown in Fig. 12. The local and transported contributions of carbonaceous PM10 originating mainly from residential heating and traffic exhaust were also analysed and are shown in Fig. 12. Based on these results it can be inferred that AQMP aimed at reducing emissions from residential heating or traffic can be effective acting on the local level. AQMPs which may target the reduction of secondary inorganic PM should act on the regional level.

je pokazala razmeroma dobro razmerje med simuliranimi in opazovanimi koncentracijami delcev PM10 na vseh postajah (prikazano kot primer za 6 postaj na sliki 11). V povprečju so simulirani rezultati prenizko ovrednotili meritve za manj kot 10 %. Ti rezultati kažejo, da je uporabljena metodologija boljša od uporabe fiksne, konstantne stopnje koncentracije delcev PM, ki se navadno uporablja za oceno kakovosti zraka.

Če primerjamo sestavo delcev PM10 simuliranih podatkov z rezultati, pridobljenimi na podlagi kemijske analize filtrov z delci (slika 11), ugotovimo, da je bila konsistenca dosežena na vseh treh jedrnih območjih na mikroravni za delce, ki nastanejo zaradi prometa (PM koncentracije izpušnih plinov do 4,6 µg/m³), in za sekundarne anorganske delce (do 19 µg/m³). Ta sekundarna frakcija delcev PM povezuje različne vire od kmetijstva, prometa do industrije. Delci, povezani z ogrevanjem v gospodinjstvih, so se izkazali za dobro simulirane za K, LB in MB center, medtem ko so bili močno prenizko ocenjeni za lokacijo MB Vrbanski plato, urbano postajo, nameščeno v ozadju.

Pristop kombiniranega modela kot dodana vrednost dopušča razlikovanje med regionalnimi in lokalnimi prispevki zmesi delcev glede na skupno koncentracijo delcev PM10. Lokalni prispevki anorganskim sekundarnim delcem PM na lokacijah kontrolnih postaj za kakovost zraka in preneseni prispevki tem lokacijam so prikazani na sliki 12. Tudi lokalni in transportirani prispevki karbonatnih delcev PM10, ki izvirajo pretežno iz stanovanjskega ogrevanja in prometnih izpušnih plinov, so bili analizirani in so prikazani na sliki 12. Na podlagi teh rezultatov lahko sklepamo, da so načrti AQMP za zniževanje emisij iz ogrevanja v gospodinjstvih ali prometa lahko učinkoviti, če se izvajajo na lokalni ravni. Načrti AQMP, katerih cilj je zniževanje sekundarnih anorganskih delcev, se morajo izvajati na regionalni ravni.



Slika 13: Simulacija sprememb v povprečni vrednosti za delce PM10 v januarju (imisije) zaradi zmanjšanja emisij NH_3 iz kmetijstva za območje D03a (vzhodna Koroška in deli severne Slovenije).
Fig. 13: Simulated changes in January mean PM10 (immission) due to gaseous agricultural NH_3 emission reductions for the domain D03a (E-Carinthia and parts of N-Slovenia).

Slika 14: Simulirane spremembe povprečne letne vrednosti za delce PM10 upoštevajoč Scen2 2016 v primerjavi z letom 2010. Scenarij 2 združuje ukrepe kot okoljska cona, povečan javni potniški promet, P+R in izboljšanje na podlagi posodobitve voznega parka in boljših izpušnih sistemov.
Fig. 14: Simulated changes in annual mean PM10 (immission) Scen2 2016 – Base case 2010. The scenario 2 comprises measures such as the environmental zone, increased public transport and P+R and improvements due to fleet renewal and improved exhaust aftertreatment.

Predstavitev ukrepov

Demonstration of Measures

Da bi lahko preverili učinke ukrepov za zmanjšanje prašnih delcev pred njihovo izvedbo, smo te simulirali z novim modelom.

Analiziranih je bilo 13 različnih scenarijev oz. ukrepov znotraj projekta PMinter in primerjanih z izhodiščnim stanjem oz. scenarjem, ki predvideva ravnanje/delovanje kot običajno (BAU). Glavni rezultati so zbrani v razpredelnici 1-3.

Ocena, uporabljena za predviden vpliv na zdravje

++ močan, pozitiven učinek
\+ pomemben pozitiven učinek
(+) majhen pozitiven učinek
0 nevtralno
(-) majhen negativen učinek
\- pomemben negativen učinek
-- močan negativen učinek

Razpredelnica 1: Povzetek sprememb (razlik) v PM10 in NO_2 (januar 2010), povprečne koncentracije za regionalne scenarije v primerjavi z izhodiščnim letom 2010. Vpliv na zdravje je predviden glede na zmanjšanje koncentracije delcev PM10 in NO_2 in zmanjšane sestavine delcev. Prvi trije scenariji vplivajo le na anorganske sekundarne delce PM, pomemben vpliv na zdravje pa je predviden tako nizko, kot tisti pri karcinogenih sestavinah.

Scenarij:	Učinek PM10 jan. 2010 & širše	Učinek NO_2 jan. 2010 & širše	Predviden vpliv na zdravje
-35% regionalno za emisije NH_3	++ -2 do -4 $\mu g/m^3$ regionalno	++ -1 do -3 $\mu g/m^3$ regionalno	+
-35% regionalno za emisije NOx	(+) < -0,15 $\mu g/m^3$	++ -2 do -3 $\mu g/m^3$ regionalno	+
-35% regionalno za emisije NH_3 & NOx	++ -2 do -4 $\mu g/m^3$ regionalno	++ -2 do -3 $\mu g/m^3$ regionalno	+
Hitrostna omejitev na avtocestah A2 & A9 za avstrijsko Štajersko	(+) < -0,1 $\mu g/m^3$ lokalizirano blizu A2, A9	+ -2 $\mu g/m^3$ lokalizirano blizu A2, A9	+

In order to verify the effectiveness of measures for fine dust reduction before their implementation, the new model was used for simulation.

13 different emission scenarios or measures were analysed within PMinter and compared to base cases or business as usual scenarios. The main results are summarized within the Tables 1-3.

Rating applied for the estimated health impact

++ strong positive effect
+ significant positive effect
(+) small positive effect
0 neutral
(-) small negative effect
- significant negative effect
-- strong negative effect

***Table 1:** Summary of the changes (differences) in PM10 and NO_2 January 2010 mean concentrations for regional scenarios compared with the base case 2010. The health impact is estimated based on the concentration reductions of PM10 and NO_2 and the particle components reduced. The first three scenarios affect only inorganic secondary PM and the related health impact is estimated as lower the one from carcinogenic components.*

Scenario:	*Effect PM10 Jan 2010 & extent*	*Effect NO_2 Jan 2010 & extent*	*Estimated health impact*
-35% regional NH_3 emissions	*++ -2 to -4 $\mu g/m^3$ regional*	*++ -1 to -3 $\mu g/m^3$ regional*	*+*
-35% regional NOx emissions	*(+) < -0.15 $\mu g/m^3$*	*++ -2 to -3 $\mu g/m^3$ regional*	*+*
-35% regional NH_3 & NOx emissions	*++ -2 to -4 $\mu g/m^3$ regional*	*++ -2 to -3 $\mu g/m^3$ regional*	*+*
Speed limit A2 & A9 motorways Styria	*(+) < -0.1 $\mu g/m^3$ localized near A2, A9*	*+ -2 $\mu g/m^3$ localized near A2, A9*	*+*

***Table 2:** Summary of the changes (differences) in PM10 and NOx annual mean concentrations 2010 for "local" scenarios compared with the base case 2010.*

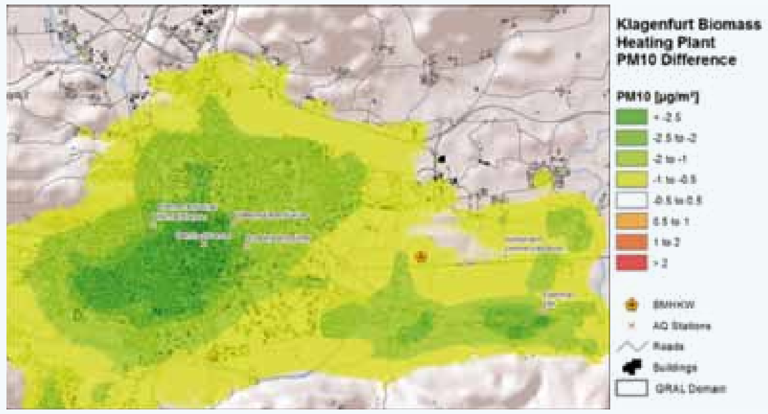
Scenario:	*Effect AMV PM10 vs Base 2010 & extent*	*Effect AMV NOx vs Base 2010 & extent*	*Estimated health impact*
MB Scen1 2014 Env. Zone	*(+) up to -1 $\mu g/m^3$ near roads*	*+ up to -5 $\mu g/m^3$ NOx area wide, main roads up to -10 $\mu g/m^3$*	*+*
MB Scen2 2016 Env. Zone stricter, public transport, P+R	*+ up to -1.5 $\mu g/m^3$ widespread, -3 $\mu g/m^3$ near some roads*	*++ -4 to -8 $\mu g/m^3$ NOx area wide, main roads up to -30 $\mu g/m^3$*	*++*
MB Scen3 2018 Env. Zone stricter, increases public transport & P+R	*+ -1 to -2 $\mu g/m^3$ widespread, -3 $\mu g/m^3$ near some roads*	*++ up to -10 $\mu g/m^3$ NOx area wide, main roads up to -20 $\mu g/m^3$*	*++*
MB traffic BAU 2016	*(+) -1 $\mu g/m^3$ near some main roads*	*not evaluated*	*+*
Klgf - old single stoves replaced by biomass heating	*++ -2 to -3 $\mu g/m^3$ area wide in Klgf during the winter months Dec – Feb*	*not evaluated*	*++*
Klgf traffic BAU (no increase in traffic volume assumed)	*+ up to -2 $\mu g/m^3$ Klgf centre, -3 $\mu g/m^3$ near main roads*	*++ -5 to -10 $\mu g/m^3$ NOx area wide, main roads up to -20 $\mu g/m^3$*	*++**
Klgf 20% E-Mobility light vehicles 2020	*+ up to -2 $\mu g/m^3$ Klgf Centre, -3 $\mu g/m^3$ near main roads*	*++ -5 to -10 $\mu g/m^3$ NOx area wide, main roads up to -20 $\mu g/m^3$*	*++**
Klgf Env. Zone traffic calming Bahnhofstr. opt. 7 + 8	*0 +3 to -3 $\mu g/m^3$ near some roads*	*0 +20 to -20 $\mu g/m^3$ near some roads*	*0*

**The related improvements rely on fleet renewal and improved exhaust after treatment technologies and no further increase in traffic volume.*

Razpredelnica 2: Vsota sprememb (razlik) letnih povprečnih koncentracij PM10 in NOx v letu 2010 za lokalne scenarije v primerjavi z izhodiščnim letom 2010. „BAU" pomeni ravnanje/delovanje kot običajno.

Scenarij:	Učinek AMV PM10 v primerjavi z 2010 & širše	Učinek AMV NOx v primerjavi z 2010 & širše	Predviden vpliv na zdravje
MB Scen1 2014 Okolj. cona	(+) do -1 $\mu g/m^3$ v bližini cest	+ do -5 $\mu g/m^3$ NOx širom območja, ob glavnih cestah do -10 $\mu g/m^3$	+
MB Scen2 2016 Okolj. cona strožje, javni promet, P+R	+ do -1.5 $\mu g/m^3$ široko razširjeno, -3 $\mu g/m^3$ v bližini nekaterih cest	++ -4 do -8 $\mu g/m^3$ NOx širom območja, ob glavnih cestah do -30 $\mu g/m^3$	++
MB Scen3 2018 Okolj. cona strožje, povečan javni promet & P+R	+ -1 do -2 $\mu g/m^3$ široko razširjeno, -3 $\mu g/m^3$ v bližini nekaterih cest	++ do -10 $\mu g/m^3$ NOx širom območja, ob glavnih cestah do -20 $\mu g/m^3$	++
MB promet BAU 2016	(+) -1 $\mu g/m^3$ c bližini nekaterih glavnih cest	ni ocenjeno	+
Celovec, zamenjava starih peči za ogrevanje na biomaso	++ -2 do -3 $\mu g/m^3$ širom območja v Celovcu med zimskimi meseci dec.-feb.	ni ocenjeno	++
Celovec, promet BAU (brez povišanj v predvidenem obsegu prometa)	+ do -2 $\mu g/m^3$ Celovec center, -3 $\mu g/m^3$ v bližini glavnih cest	++ -5 do -10 $\mu g/m^3$ NOx širom območja, ob glavnih cestah do -20 $\mu g/m^3$	++*
Celovec, 20% e-mobilnost lahka vozila 2020	+ do -2 $\mu g/m^3$ Celovec center, -3 $\mu g/m^3$ v bližini glavnih cest	++ -5 do -10 $\mu g/m^3$ NOx širom območja, ob glavnih cestah do -20 $\mu g/m^3$	++*
Celovec, okolj. cona umirjajoč promet na Bahnhofstr. opt. 7 + 8	0 +3 do -3 $\mu g/m^3$ v bližini nekaterih cest	0 +20 do -20 $\mu g/m^3$ v bližini nekaterih cest	0

*Povezane izboljšave so rezultat posodobitve voznega parka in boljših izpušnih sistemov, zahvaljujoč boljšim tehnologijam in nespremenjenemu obsegu prometa.



Slika 15: Simulirane spremembe povprečne vrednosti za delce PM10 (imisije) v zimskem obdobju (DJF). Scenarij v primerjavi z letom 2010. V okviru tega scenarija so gospodinjstva priključena na dodatni sistem daljinskega ogrevanja na biomaso (BMHKW). Glavni vpliv je iz gospodinjstev, ki uporabljajo stare peči in drva.

Fig. 15: Simulated changes in winter (DJF) mean PM10 (immission) Scenario – Base case 2010. Within this scenario households are connected to an additional biomass district heating (BMHKW). The major impact is related to households using old single stoves and wood.

Razpredelnica 3: Vsota sprememb (razlik) letnih povprečnih (AMV) koncentracij PM10 in NOx za lokalne scenarije v primerjavi s scenarijem BAU (2016 za Maribor in 2020 za Celovec).

Scenarij	**Učinek AMV PM10 proti BAU 2016/2020 & širše**	**Učinek AMV NOx proti BAU 2016/2020 & širše**	**Predviden vpliv na zdravje**
MB Scen 2 2016 samo prometne meritve	+ do -1 µg/m³ c četrtih, do -1.5 µg/m³ v bližini cest	ni ocenjeno	+
Celovec 20% e-mobilnost samo lahka vozila 2020	(+) < -0.2 µg/m³	+ -0.5 do -1.5 µg/m³	(+)

***Table 3:** Summary of the changes (differences) in PM10 and NOx annual mean (AMV) concentrations for "local" scenarios compared with the business as usual scenario (2016 for Maribor and 2020 for Klagenfurt).*

Scenario:	***Effect AMV PM10 vs BAU 2016/2020 & extent***	***Effect AMV NOx vs BAU 2016/2020 & extent***	***Estimated health impact***
MB Scen2 2016 traffic measures only	*+ up to -1 µg/m³ in quarters, up to -1.6 µg/m³ near roads*	*not evaluated*	*+*
Klgf 20% E-Mobility light vehicles only 2020	*(+) < -0.2 µg/m³*	*+ -0.5 to -1.5 µg/m³*	*(+)*

V nadaljevanju so na kratko opisani najučinkovitejši scenariji za zmanjšanje delcev PM10.

Za scenarij zmanjšanja NH_3 so se emisije iz kmetijstva, ki je glavni vir onesnaževanja z NH_3 v projektnem območju, zmanjšale za 35%. Rezultat zmanjšanja emisij NH_3 je upad imisij PM10 v primerjavi z osnovnim letom, in sicer za 2 µg/m³ na avstrijskem Štajerskem in v dolini reke Drave, do 3 µg/m³ v bližini Celovca in Celjski kotlini ter do 3 µg/m³ v SV Sloveniji (slika 13). Simulacija za okoljsko cono v Mariboru za leto 2016 (izključitev vozil s starejšimi standardi Euro, izboljšan javni potniški promet, P+R) je pokazala potencial, da se na letni ravni na širšem območju PM10 zmanjša do 2 µg/m³ znotraj okoljske cone (slika 14). Manjši izpusti zaradi pričakovane posodobitve voznega parka prispevajo k zmanjšanju PM10 do 1 µg/m³ v obdobju od leta 2010 do 2016.

Velik potencial za zmanjšanje števila dni s prekoračeno povprečno dnevno vrednostjo PM10 >50 µg/m³ v Celovcu predstavlja priklop tistih gospodinjstev na daljinsko ogrevanje, ki imajo urejena individualna kurišča (slika 15). Seveda pa je zaradi nizke cene lesa v primerjavi z daljinskim ogrevanjem ter v zgradbah s slabo toplotno izolacijo takšne ukrepe težko prenesti v prakso.

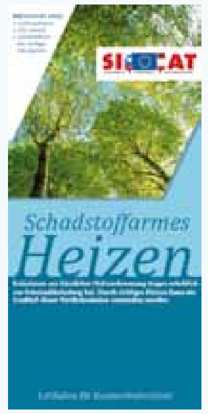
Subsequently, the most effective scenarios reducing PM10 are briefly described.

For the NH_3 reduction scenario, NH_3 emissions from agriculture, the major NH_3 emitter in the program area, were reduced by 35%. The NH_3 emission reduction results in a PM10 immission decrease compared to the base case of about 2 µg/m³ in Styria and in the Drava river basin, of up to 3 µg/m³ near Klagenfurt and the Celje basin, and up to 3 µg/m³ in NE-Slovenia (Fig. 13). Simulations for an environmental zone in Maribor for 2016 (exclusion of vehicles with older Euro standards, enhanced public transport, P+R) revealed a potential of a widespread annual mean PM10 reduction of up to 2 µg/m³ within the environmental zone, see Fig. 14. However, PM10 reductions of up to 1 µg/m³ can be attributed to improved exhaust after treatment technologies with the anticipated fleet renewal from 2010 until 2016.

Connecting households using old single stoves to district heating has a large potential to reduce the days with an annual daily mean PM10 value >50 µg/m³ in Klagenfurt (Fig. 15). However, low fuel costs for wood compared with district heating and buildings with poor thermal insulation are problematic to get such measures into practice.

Tečaj za dimnikarje
Chimney sweep training course

Tečaj za dimnikarje
Chimney sweep training course



Naslovna stran smernic
Cover of the guidelines

Training programme for chimney sweeps

In the course of the project, a training programme for chimney sweeps was developed to deepen their knowledge of wood burning and pollutant emissions from old and new combustion systems and to improve their expertise so that they can provide consulting in matters of environmental protection and energy efficiency.

In Klagenfurt, Leibnitz and Maribor advanced training events on „Fine dust from domestic heating" were organised for the chimney sweeps of the region in autumn 2012. The large number of highly interested participants reflects the increased awareness of the fine dust problem. The participants were given extensive documentation and taught the most important aspects during the training course.

Program usposabljanja za dimnikarje

Program usposabljanja za dimnikarje, ki je bil opravljen v okviru projekta, naj bi poglobil njihovo znanje o ogrevanju na lesno biomaso ter o emisijah škodljivih snovi iz starih in novih peči na lesno biomaso. S tem so dimnikarji pridobili nova znanja za svetovanje pri vprašanjih varstva okolja in energetske učinkovitosti.

Jeseni 2012 je v Celovcu, Lipnici in Mariboru potekala izobraževalna prireditev na temo „Prašni delci iz drobnih kurišč" za dimnikarje iz regij. Številčna udeležba in veliko zanimanje dimnikarjev kažeta povečano ozaveščenost o problematiki prašnih delcev. Udeleženci so prejeli obširno gradivo, vsebina tega gradiva pa jim je bila med usposabljanjem izčrpno predstavljena.

Guidelines for low-pollution heating

Emissions, and particulate matter emissions in particular, from manually charged wooden stoves (fireplaces or ovens), depend to a large degree on the firewood used and the typical heating behaviour of the users. Proper handling can improve the efficiency of an oven and reduce particulate matter emissions. A leaflet was drawn up to inform the owners of wood-fired stoves about low-pollution heating. This guideline is available in the project regions. The communities and chimney sweeps of the regions support the distribution of this leaflet.

The KT1 television station made a contribution in which the "Low-pollution heating" brochure was presented. The report was filmed in a suitable home at Klagenfurt where wood is stored and used for heating. The Austrian Broadcasting Agency aired 10 spots under the slogan "Heizen mit Hirn heißt Feinstaub reduzieren" ("Using your brain when heating will reduce particulate matter").

Priporočila za ogrevanje z nizkimi emisijami škodljivih snovi

Emisije pri pečeh na lesno biomaso, še posebej pri ogrevanju na lesno biomaso (predvsem drva) v klasičnih pečeh z ročnim nalaganjem, so odvisne predvsem od uporabljenega goriva in ravnanja uporabnika. S pravilnim ravnanjem je mogoče povečati učinkovitost peči in zmanjšati emisije prašnih delcev. Da bi uporabnike peči seznanili o ogrevanju z večjo učinkovitostjo in z nizkimi emisijami škodljivih snovi, so bila izdelana navodila v obliki zloženke. Razdeljevanje zloženk podpirajo tudi občine in dimnikarji v regiji.

Televizija KT1 je posnela prispevek, v katerem je med drugim predstavljena zloženka „Ogrevanje z nizkimi emisijami škodljivih snovi", za lokacijo snemanja pa je bilo izbrano gospodinjstvo z drvarnico in s pečjo na drva. Nadalje je bilo na televizijskem kanalu ORF predvajanih deset oglasnih spotov na temo pravilnega kurjenja s sloganom „Ogrevanje po pameti pomeni zmanjšanje prašnih delcev".

Dimnikar z merilno opremo za prašne delce
Chimney sweep with fine dust measuring equipment

Predstavitev za medije (feb. 2012)
P&R press conference (Feb. 2012)

Predstavitev za medije (feb. 2012)
P&R press conference (Feb. 2012)

Rezultati meritev dimnikarjev

Dimnikarjem iz projektnih regij se je ponudila možnost, da sami opravijo meritve emisij prašnih delcev in pridobijo izmerjene podatke na terenu, zato je bila v okviru programa usposabljanja predstavljena nova naprava za merjenje emisij delcev. Zainteresiranim dimnikarjem je bila dana na voljo naprava za opravljanje terenskih meritev v okviru projekta.

Prav tako je bilo zainteresiranim dimnikarjem izročenih deset naprav, projektni partnerji pa so prejeli rezultate meritev v kurilnih napravah, značilnih za posamezno regijo. Ocena rezultatov meritev dimnikarjev je bila opravljena na inštitutu IPPT/TU v Gradcu.

Rezultati meritev so potrdili potrebo po spremembi ogrevalnih navad in uporabi sodobnejših peči na biomaso.

Oglaševalska kampanja Park & Ride

V sodelovanju z mestnimi komunalnimi podjetji v Celovcu je bila februarja 2012 izvedena kampanja ozaveščanja v zvezi s ponudbo Park & Ride v Celovcu, da bi z njo uporabnike spodbudili k uporabi Park & Ride parkirnih mest West in Ost (na zahodu in vzhodu mesta). Hkrati so bile uvedene tudi občutne izboljšave na regionalnem železniškem omrežju, kar pomeni, da so se dnevni vozači v domačem kraju lahko odločili za javni promet. Čeprav je bilo istočasno v središču mesta uvedeno plačljivo parkiranje, je oglaševalska akcija le za kratek čas dosegla povečanje potnikov.

Measurement data collected by chimney sweeps

During the course of the training program, new fine dust measuring equipment was presented and made available to chimney sweeps of the project regions so that they could carry out measurements themselves and collect additional data in the field.

10 measuring devices were handed over to the interested chimney sweeps and in return they supplied fine dust measurement data of wood-burning stoves that are typical of the region. The measurement results were evaluated by the IPPT/Graz University of Technology and used for a comparison of the emission databases for the propagation calculations carried out in the framework of the project.

The results of measurements confirmed the need to change heating habits and to use modern biomass stoves.

Park & Ride advertising campaign

In February 2012, a park & ride image and awareness campaign was carried out in Klagenfurt in cooperation with the Klagenfurt public utility company to motivate more people to use the park & ride provisions in the west and east of the city. User numbers increased only for a brief period, despite the fact that parking fees were introduced simultaneously for a major parking lot in the city centre. At the same time, the local railway connection in the region was significantly improved, giving commuters the opportunity to use public transport for their trips as a matter of principle.

Environmental Pilot Zone in Maribor

The Faculty of Civil Engineering of Maribor University studied the effects of the environmental zone on the quality of the city's ambient air, particularly on PM concentrations. The pilot environmental zone was approved by a majority vote of the Municipality of Maribor City Council. During the implementation of the pilot environmental zone, the administrative and organizational role was played by the Intermunicipal Environmental Protection and Nature Conservation Office. The pilot environmental zone (PEZ) was launched on 1st October 2012 and applied during the heating season until 30th April 2013. Vehicles not meeting Euro 2 standards were prohibited from entering the environmental zone on working days. There was a long list of exceptions, such as residents of the PEZ, buses, all kinds of emergency and other important services. There was also a specified period of time during the day when all vehicles were allowed to enter the PEZ to deliver goods. Figure 16 shows the area of the old city centre on the left bank of Drava River, where the PEZ was implemented (depicted as POC), and the planned expansion of PEZ (shown as Extended zone).

The PEZ covered a small area in order to study the measures and their socio-economic impact and to raise the awareness for environmental problems caused by road traffic. The significant improvement of air quality was not a priority target. The overall PM reduction caused by road traffic was predicted by the HBEFA methodology to be less than 10%. Nevertheless, the pilot project pointed out advantages and disadvantages of traffic measures.

The main PEZ weaknesses were:
a) access restrictions affected a specific group of people only and might therefore be considered discriminatory;
b) relatively small impact on the general air quality if the measures are not strictly implemented and if there are many exceptions and the zone is small, etc.;
c) impact on the business in the city in the initial phase, requiring alternative support.

Pilotna okoljska cona v Mariboru

Fakulteta za gradbeništvo Univerze v Mariboru je proučila učinke okoljske cone na kakovost zunanjega zraka v mestu Maribor. Pripravila je program vzpostavitve pilotne okoljske cone (POC) ter njenega razvoja z ocenami faznih učinkov prometnih ukrepov na znižanje izpustov PM10. Mestni svet Mestne občine Maribor je potrdil program z večino glasov, upravno organizacijsko vlogo pa je prevzel Medobčinski urad za varstvo okolja in ohranjanje narave. POC se je vzpostavila 1.10.2012 in je delovala v času kurilne sezone do 30.4.2013. Ob delovnikih je omejevala promet osebnih, dostavnih in tovornih vozil, ki niso dosegala emisijskih Euro standardov 0 in 1. Omejitve niso veljale za številne izjeme - rezidente POC, osebe z motnjami gibanja, vozila javnega prevoza, intervencijska in servisna vozila, medtem ko so dostavna in tovorna vozila do 3,5 t lahko prosto vstopala v POC med 5:00 in 7:00 uro ter 20:00 in 22:00 uro. Slika 16 prikazuje lego POC na območju starega mestnega jedra na levem bregu Drave in njena fazna razvojna območja.

Obseg POC je bil majhen, da ne bi bila ogrožena splošna dostopnost in gospodarska aktivnost mesta v testni fazi. Zaradi blagih prometnih ukrepov, ki so na podlagi izračunov s programskih orodjem HBEFA povzročila manj kot 10% znižanje izpustov PM10 iz cestnega prometa, večjih učinkov na kakovost zunanjega zraka v mestu ni bilo mogoče pričakovati. Neglede na to, pa je opozoril pilotni projekt na prednosti in slabosti okoljevarstvenega ukrepa, na spremembe starih potovalnih navad in podal smernice za načrtovanje nadaljnjih ukrepov.

Med slabosti bi izpostavili:
a) majhen učinek prometnih ukrepov na kakovost zunanjega zraka, če so omejitve blage in na majhnem območju,
b) omejevanje le določene vrste vozil ima lahko diskriminatorne učinke,
c) vpliv na gospodarstvo v začetni fazi, kar zahteva alternativno podporo.

Rezultati POC so temelj načrta širitve okoljske cone (OC), ki izhaja iz treh scenarijev za prihodnost, imenovanih po obsegu prometnih ukrepov: konservativni, aktivni in optimistični scenarij. V Konservativnem scenariju se okoljska cona geografsko razširi (Slika 16), meja za vstop OC se dvigne na vozila Euro 3, seznam izjem je krajši, ponudba javnega potniškega prometa (JPP) se poveča za 15%, 5% kilometrov, ki jih opravijo vozila, se opravi peš, s kolesom ali JPP, 5% kilometrov, ki jih opravijo vozila v POC, se opravi na območju razširjene cone in 5% voznega parka se obnovi. Zaradi ukrepov Konservativnega scenarija bi se znižali izpusti PM10 iz cestnega prometa na območju OC za okoli 24%, na območju mesta pa za 10%.

Aktivni scenarij je podoben Konservativnemu (slika 16), le da je seznam izjem precej krajši, ponudba JPP se dvigne za 30%, cona za pešce se razširi, več ulic v središču mesta se zapre za promet, število parkirnih mest v mestnem središču se nekoliko zmanjša in parkirnina zviša, na treh do štirih glavnih prometnicah se uredijo parkirišča P&R, 15-50% kilometrov, ki jih opravijo vozila, se opravi peš, s kolesom ali JPP, obsega kilometrov lahkih tovornih vozil se zmanjša za 15%, obseg kilometrov avtobusov se poveča za 30% in 5% voznega parka se obnovi na letni ravni. Učinek navedenih ukrepov na znižanje izpustov PM10 iz cestnega prometa je ocenjen na 60% v OC in na 30% na območju mesta.

V Optimističnem scenariju se dvigne meja za vstop OC na vozila Euro 4, seznam izjem se omeji zgolj na intervencijska vozila in obseg kilometrov avtobusov se poveča za 50%. Učinek navedenih ukrepov na znižanje izpustov PM10 iz cestnega prometa je ocenjen na 82% v OC in na 56% na območju mesta.

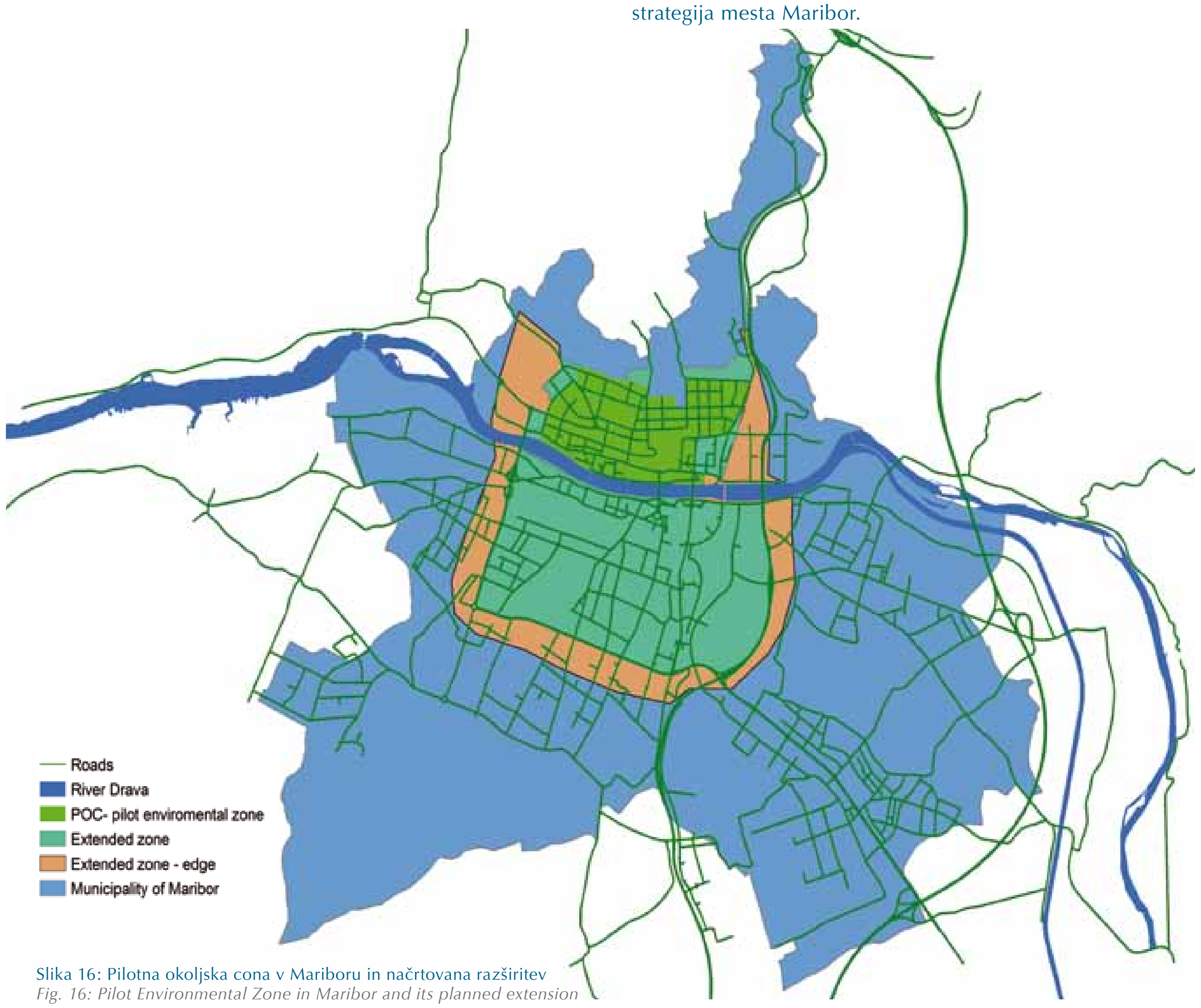
Opisane ukrepe in njihove učinke je možno doseči korakoma, ker je treba občanom ter ponudnikom storitev ter obiskovalcem mesta dopustiti, da se lahko prilagodijo omejitvam. Potrebeni so jasni načrti omejevanja prometa, alternativne prometne ponudbe, alternativne pomoči v obliki subvencij na državnem in lokalnem nivoju, izdaje dovolilnic ter nadzora.

Three future scenarios were developed based on the PEZ results (conservative, active and optimistic scenario).
In the conservative scenario, the environmental zone (EZ) is extended (Fig. 16), entry approval is granted to Euro 3 vehicles, the list of exemptions is slightly shorter, public transport provision is 15% higher, 5% of vehicle kilometres are shifted to public transport, 5% of all vehicle kilometres are shifted to the edge of the extended zone outside the PEZ, 5% of new vehicles replace old ones each year. The described measures would cause a reduction of PM emissions by 24% in the EZ and by approximately 10% in the city area.

The active scenario is similar to the conservative one (Fig. 16), but the list of exceptions is much shorter, public transport provision is increased by 30%, the pedestrian zone is extended, several roads in the city centre are closed for traffic, the number of parking spaces in the city centre is slightly reduced and parking fees are increased; P&R parking lots are established on three to four arterial roads, 15% – 50% of private vehicle kilometres are shifted to public transport or other modes of transport, light-duty vehicle kilometres are reduced by 15%, bus kilometres increased by 30%, and 5% of old vehicles are replaced by new ones every year. These measures would bring down PM emissions by 60% in the EZ and by approx. 30% in the city as a whole.

In the optimistic scenario, only Euro 4 vehicles are allowed to enter the environmental zone, the list of exemptions is reduced to emergency vehicles and the public transport is extended by 50%. The measures would lead to a reduction of PM emissions by 82% in the EZ and approximately 56% in the city as a whole.

The results presented here are mainly intended to support decision-makers in their decisions. A significant impact of the EZ on the quality of air could only be reached in the short term, if the measures were to be extended to a larger zone, the Euro limit was higher and the list of exemptions shorter than expected by the citizens. These might cause severe social and economic problems. The environmental zone will only be accepted if accompanying measures are taken, such as offering more public transport.



Slika 16: Pilotna okoljska cona v Mariboru in načrtovana razširitev
Fig. 16: Pilot Environmental Zone in Maribor and its planned extension

Rezultati raziskave so pripravljeni v podporo nosilcem odločanja na področju prometa in okolja. Vključeni so v dva strateška dokumenta MOM: a) Načrt za kakovost zraka na območju Mestne občine Maribor in b) Celostna prometna strategija mesta Maribor.

Načrti za kakovost zraka

Air Quality Management Plans

Ukrepi, ki so se pri modeliranju in v praksi izkazali za učinkovite, so bili vključeni v načrte za kakovost zraka.

Načrt za kakovost zraka v Celovcu

V Celovcu dela interdisciplinarna delovna skupina že od leta 2003 na načrtu za kakovost zraka z namenom zmanjševanja delcev PM10 v zraku. Prvi sveženj ukrepov je bil sprejet 13. 5. 2003, ki se je sproti ažuriral, 21. 2. 2006 pa je bil v načrt za kakovost zraka dodan tudi NO_2.

Deželni glavar avstrijske Koroške je ukrepe za omejitev prometa predpisal z uredbo o ukrepih za NO_2 za Celovec in v programu ukrepov za PM10 za Celovec z dne 24. 11. 2009.

Dne 12. 7. 2012 je potekala 9. delavnica za oceno, obdelavo in aktualiziranje svežnja ukrepov, pri čemer so bili upoštevani rezultati PMinter.

Aktualni sveženj ukrepov za znižanje prašnih delcev (PM10) in dušikovega dioksida (NO_2), sprejet dne 25. 1. 2013 obsega skupno 24 ukrepov z 290 izvedbenimi koraki na štirih področjih delovanja:

- > vzdrževanje cest, vozni park, grabišča;
- > kurjava, daljinsko ogrevanje;
- > upravljanje prometa, načrtovanje prometa, prostorsko načrtovanje;
- > inovativni ukrepi in stiki z javnostjo.

Dežela avstrijska Koroška bo ta sveženj ukrepov po javni obravnavi na začetku leta 2014 razglasila kot „Skupni program ukrepov za PM10 in NO_2 skladno z 9. a-členom IG-L za Celovec ob Vrbskem jezeru“.

The effective measures resulting from simulation and demonstration were included in the regional air quality management plans.

Klagenfurt Air Quality Management Plan

An interdisciplinary working group has been in charge of Klagenfurt's Air Quality Management Plan to reduce PM10. The first set of measures was adopted by the City Senate on 13th May 2003 and has been updated continuously since then. On 21st February 2006, NO_2 was added to the Air Quality Management Plan upon a decision of the Senate.

The Governor of Carinthia ordered traffic-limited measures in the NO_2 Measures Ordinance for Klagenfurt and the PM10 Set of Measures for Klagenfurt of 24th November 2009.

The ninth evaluation workshop was held on 12th July 2012, the set of measures was revised and updated taking the PMinter results into account.

The current set of measures to reduce PM10 and nitrogen dioxide (NO_2) was adopted on 25th January 2013 and includes 24 measures and 290 steps to be taken in four areas of action

- *> Road/street maintenance / vehicle fleet / construction sites*
- *> Domestic heating / district heating plant*
- *> Traffic control / traffic planning / regional development planning*
- *> Innovative measures and PR work*

Carinthia will publish this set of measures after public appraisal under the title "Joint set of measures for PM10 and NO_2 pursuant to Sect. 9 a Pollution Control Act (IG-L) for Klagenfurt am Wörthersee" in early 2014.

Air Quality Management Scheme Styria 2011

The Air Quality Management Programme for Styria was adopted in October 2011. It includes 10 core measures, 5 supporting measures and 30 additional measures taking account of engine technology, winter service, industry and trade, agriculture, domestic heating and energy, traffic/mobility, legal aspects and regional development planning. More than 20 million euros from the Environmental Department's budget have been invested in air pollution control in the years 2011-2014. The regional focus in 2011 and 2012 was on Greater Graz and the technical focus was on reducing emissions from domestic heating (enforcing grid-bound energy carriers, replacement of old boilers) and bringing down industrial emissions (driving bans for old trucks and taxis, support granted for the acquisition of new vehicles). Over the next two years the focus will be on projects in Eastern and Western Styria and on improving the public transport provisions.

The implementation of measures (successes and obstacles) is revised and monitored in short intervals.
(Download: http://www.umwelt.steiermark.at/cms/beitrag/11563390/19222537/)

AQMP in Maribor

The general regulation specifying outdoor air quality is the Ordinance on Outside Air (Official Gazette RS no. 9/2011) adopted according to Directive 2008/50/EC of the European Parliament and the Council of 21th May 2008 on ambient air quality and clean air for Europe (Office Journal L 152, 11.6.2008, no. 1-44). Based on the Directive, the Ministry for the Environment adopted an ordinance on the specification of the area and the structuring of areas, agglomerations and sub-regions in terms of ambient air pollution (Official Law Gazette RS no. 50/2011). The city of Maribor is part of agglomeration SIM for which pollution degree I is typical (PM10 particles and ozone values are above the threshold or target value). The communities in the environment are classified as SI1 with pollution degree II (only the ozone value

Program za kakovost zraka na avstrijskem Štajerskem 2011

Oktobra 2011 je bil sprejet načrt za kakovost zraka za avstrijsko Štajersko 2011. Vsebuje deset osnovnih ukrepov, pet spremljajočih ukrepov ter 30 dodatnih ukrepov, ki upoštevajo področja motorne tehnike, zimske službe, industrije in obrti, kmetijstva, kurjave in energije, prometa/mobilnosti, pravnih vidikov ter prostorskega načrtovanja. V letih 2011-2014 je bilo samo iz proračunskih sredstev okoljskega resorja v ukrepe za kakovost zraka vloženih več kot 20 milijonov evrov. V letih 2011 in 2012 je bilo regionalno težišče na širšem območju Gradca in strokovni poudarek na zmanjšanju emisij iz individualnih kurišč (npr. menjava starih ogrevalnih kotlov) ter prometa (prepoved vožnje za stara tovorna vozila in taksije, programi subvencij za posodobitev voznega parka). V obeh naslednjih letih naj bi se okrepljeno izvajali projekti na vzhodnem in zahodnem avstrijskem Štajerskem ter izboljšala ponudba javnega potniškega prometa.

Izvajanje ukrepov (uspehi in ovire) se bo preverjalo v krajših časovnih razmikih.
(Prenos datoteke je možen na: http://www.umwelt.steiermark.at/cms/beitrag/11563390/19222537/)

Načrt za kakovost zraka v Mariboru

Krovni predpis, ki določa področje kakovosti zunanjega zraka, je Uredba o kakovosti zunanjega zraka (Ur. l. RS, št. 9/2011), ki je bila sprejeta v skladu z Direktivo 2008/50/ES Evropskega parlamenta in Sveta z dne 21.5.2008 o kakovosti zunanjega zraka in čistejšem zraku za Evropo (UL L, 152, 11.6.2008, str. 1-44). Na podlagi omenjene uredbe pa je pristojno ministrstvo za okolje izdalo Odredbo o določitvi območja in razvrstitvi območij, aglomeracij in podobmočij glede na onesnaženost zunanjega zraka (Ur. l. RS, št. 50/2011). Območje Mestne občine Maribor tako sodi v aglomeracijo SIM, za katero je značilna I. stopnja onesnaženosti (nad mejno ali ciljno vrednostjo so delci PM10 in ozon), okoliške občine pa v območje SI1, za katero je določena II. stopnja onesnaženosti (nad mejno in ciljno vrednostjo je le ozon). Zaradi tega mora Vlada RS za aglomeracijo SIM sprejeti načrt za kakovost zraka.

Na državnem nivoju je novembra 2011 začela delovati delovna skupina za pripravo načrta, katerega nosilec je Ministrstvo za kmetijstvo in okolje. Februarja 2012 je bila na lokalnem nivoju ustanovljena delovna skupina za pripravo načrta, ki deluje v dveh podskupinah – ena za promet in prostorsko načrtovanje ter druga za učinkovito rabo energije in obnovljive vire energije. Člani prihajajo iz občinskih in drugih gospodarskih javnih služb (Energetska agencija za Podravje, Marprom, Energetika Maribor, Plinarna Maribor, Mariborska razvojna agencija).

Pravzaprav sta sestavna dela Odloka o načrtu za kakovost zraka na območju Mestne občine Maribor dva: odlok kot normativni del in načrt v prilogi. Mariborski mestni svet se je na seji 21.10.2013 seznanil z odlokom in soglašal z nalogami občine. Načrt namreč vsebuje nabor ukrepov in pristojne organe za izvajanje le teh. Ukrepi sodijo v tri večje skupine, in sicer s področij učinkovite rabe energije in obnovljivih virov energije, prometa in drugih področij (kamor sodita na primer informiranje in ozaveščanje). Predvidoma v začetku novembra bo odlok obravnavala tudi vlada. Na podlagi sprejetega odloka se bo pripravil triletni program ukrepov za zmanjšanje onesnaženosti zraka, ki bo tudi finančno ovrednoten.

Za izboljšanje kakovosti zraka bomo največ naredili, če bomo posodobili ogrevalne sisteme. V novem načrtu je kot ukrep zato predvideno tudi subvencioniranje priklopa na toplovodno in plinovodno omrežje. Tam, kjer ti omrežji še nista razvejani, pa bodo na voljo spodbude za prehod na sodobne kurilne naprave na biomaso in toplotne črpalke. Precej pa lahko za izboljšanje situacije naredimo z ukrepi, ki ne stanejo nič oziroma s katerimi celo prihranimo – mednje sodijo upoštevanje navodil za pravilno kurjenje drv, omejevanje števila kresov, prepoved ognjemetov in uporabe drugih pirotehničnih sredstev.

exceeds the limit and/or target value). The Government of the Republic of Slovenia must thus decide on an air quality management plan for agglomeration SIM.

A working group of the Ministry of Agriculture and Environment began to draft the plan in November 2011. In February 2012, a working group was established at local level to develop the plan. The working group was subdivided into two sub-groups. One sub-group is in charge of traffic and regional development planning, and the second one of efficient use of energy and renewable energies. The members of the working groups are public servants and legal officers from the community and national levels (Energy Service for Podravje, Marprom, Energetika Maribor, Plinarna Maribor and Maribor Development Agency).

The Ordinance on the Air Quality Management Plan for the municipality of Maribor is comprised of two parts: the ordinance as the normative part, and the plan in the enclosure. The ordinance was introduced to the Maribor City Senate in its session of 21st October 2013 and the tasks to be fulfilled by the community were approved. The plan contains a number of measures and lists those bodies which are responsible for implementing them. The measures are broken down to three large groups: efficient energy use and renewable energy sources; transport; and other areas (such as information and awareness creation). It is expected that the Government will confirm the ordinance by the end of 2013. Based on the adopted ordinance a three-year action programme for the improvement of ambient air will be drawn up which will also be assessed from the financial point of view.

The biggest contribution to improving air quality can be achieved by the modernisation of heating systems. In the light of this fact the new plan includes incentives for connection to the district heating network (water or gas). In areas where these networks are not sufficiently developed, there will be incentives for the installation of modern heating systems using biomass and heat pumps. There are several measures

that do not cost anything but save large sums of money and contribute significantly to an improvement of the situation. Correct use of wood for heating is one such measure; another one is a restriction of traditional bonfires, or the prohibition of fireworks and the use of other pyrotechnics.

In the field of transport, measures geared at sustainable mobility are planned, which means that the use of public transport and bicycles as well as walking are to be promoted to reduce the kilometres driven by car. The plan also includes the transition to clean fuels for vehicles, such as natural gas and electricity.

Na področju prometa se načrtujejo ukrepi v smeri trajnostne mobilnosti, kar pomeni spodbujanje uporabe javnega potniškega prometa, kolesarjenja in hoje na račun zmanjšanja števila prevoženih kilometrov z avtomobili. Načrt predvideva tudi prehod na čistejše energente za pogon vozil, kot sta na primer stisnjen zemeljski plin (CNG) in elektrika.

Informativni dan o mobilnosti v Celovcu
Mobility information day in Klagenfurt

Informativni dan o mobilnosti v Celovcu
Mobility information day in Klagenfurt

Stiki z javnostjo
PR Work

V okviru projekta so potekali aktivni stiki z javnostjo, da bi s tem dvignili ozaveščenost o težavah zaradi prašnih delcev, javnost seznanili z evropskim projektom PMinter in z njegovimi ukrepi ter razširili rezultate projekta v strokovnih krogih širom Evrope. Tako so bile natisnjene in razdeljene zloženke, izdelana je bila spletna stran projekta (www.pminter.eu), poslane so bile novice, organizirana so bila strokovna predavanja, objavljene publikacije, organizirane novinarske konference, narejeni radijski in televizijski prispevki, organizirani informativni dnevi ter zaključna konferenca skupaj z razstavljavci in še veliko več.

The project was accompanied by pro-active PR work to create awareness for the fine dust issue and the EU project PMinter and its measures and to propagate the project findings among experts in Europe. Folders were printed and distributed, a website was established (www.pminter.eu), newsletters were dispatched, lectures held, publications were made and a press conferences was organised. There were reports on radio and TV, information days and a concluding conference with exhibitor forum plus many other additional supporting events.

Mednarodna konferenca PMinter v Mariboru

Mednarodna zaključna konferenca projekta PMinter je potekala 18. in 19. septembra 2013 v Mariboru. Na konferenci so sodelujoči partnerji iz Slovenije in Avstrije predstavili rezultate svojega dela. Posamezne teme s področja varstva zraka so predstavili tudi vabljeni strokovnjaki iz drugih evropskih držav. Konferenca je potekala v treh jezikih: v slovenščini, nemščini in angleščini; zagotovljeno je bilo simultano tolmačenje. Skupno se je konference udeležilo 178 slušateljev iz Slovenije, Avstrije, Hrvaške, Češke in Nemčije. Udeležba na konferenci je bila brezplačna. Vsi udeleženci so prejeli biltene s povzetki predavanj v vseh treh jezikih. Predstavitve so na voljo na spletni strani projekta PMinter.

Pred zaključno konferenco projekta PMinter je bila organizirana tudi tiskovna konferenca, na kateri sta predstavnik vodilnega partnerja iz Celovca in predstavnica Mestne občine Maribor novinarjem predstavila projekt PMinter in njegove rezultate. Na to temo sta bila objavljena dva članka v časopisih Delo in Večer. Novica je bila posredovana me-

International PMinter Conference in Maribor

The concluding international conference of the PMinter project was held on 18th and 19th September 2013 in Maribor. The project partners from Slovenia and Austria presented the outcome of their work. Experts from other European countries held lectures on specific aspects, such as air pollution and impacts on health. Slovene, English and German were the three conference languages and simultaneous interpreting services were provided. 178 participants from Slovenia, Austria, Croatia, the Czech Republic and Germany attended the conference. Attendance was free of charge. All participants received summaries of the lectures in all three languages. The presentations are also available online on the PMinter website.

The press conference prior to the concluding conference of the PMinter project was attended by a representative of the lead partner from Klagenfurt and a representative of the Municipality of Maribor who introduced the PMinter project and its outcome to the journalists. The Slovene newspapers Delo and Večer published two articles on the topic, and

Dan mobilnosti v Lipnici
Mobility day in Leibnitz

Dan mobilnosti v Lipnici
Mobility day in Leibnitz

Informativni dan in novinarska konferenca v Mariboru
Information day and press conference in Maribor

Informativni dan in novinarska konferenca v Mariboru
Information day and press conference in Maribor

Otvoritev pilotne okoljske cone v Mariboru
Opening of the Pilot Environmental Zone in Maribor

Otvoritev pilotne okoljske cone v Mariboru
Opening of the Pilot Environmental Zone in Maribor

Oglaševanje Park & Ride v Celovcu
Park & Ride advertising in Klagenfurt

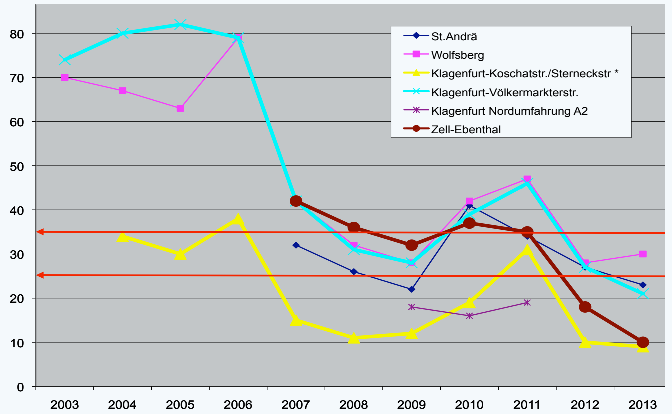
Informativna točka v Mariboru
Info point in Maribor

Fotografije z mednarodne zaključne konference v Mariboru
International conference in Maribor

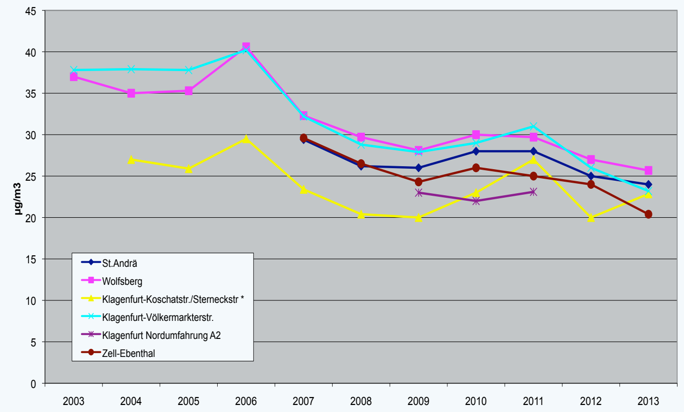
Fotografije z mednarodne zaključne konference v Mariboru
International conference in Maribor

dijem tudi preko Slovenske tiskovne agencije. Na avstrijski televiziji ORF 2 je bil v trojezični oddaji Servus, Srečno, Ciao (19. 10. 2013), objavljen sedemminutni prispevek o zaključni konferenci v Mariboru.

the Slovene press agency distributed a press release to the media. Austrian television ORF2 broadcast a trilingual programme under the title of "Servus, Srečno, Ciao" on 19th October 2013, covering the final conference in Maribor in a seven minute report.



Slika 17: Število dni z dnevnimi prekoračitvami PM10 (> 50µg/m³) v letih 2003 do 2013 na izbranih merilnih postajah na avstrijskem Koroškem in v Celovcu.
Fig. 17: Number of days with PM10 limit values exceeded (> 50µg/m³) in the years 2003-2013 at selected points of measurement in Carinthia and Klagenfurt.



Slika 18: Letna povprečna vrednost za PM10 med letoma 2003 in 2013 na izbranih merilnih postajah na avstrijskem Koroškem in v Celovcu.
Fig. 18: Annual PM10 mean in the years 2003-2013 at selected points of measurement in Carinthia and Klagenfurt.

Obeti
Outlook

Air quality trend in Klagenfurt

In Klagenfurt, the EU limit values for NO_2 and PM10 have been complied with since 2012 not least as a result of the measures taken so far. The trend of improved air quality will continue thanks to the renewal of the vehicle fleet (Euro 6) that is to be expected and due to other traffic-related measures (e-mobility, public transport) and the reduction of domestic wood heating (new district heating plant, expansion of the district heating network, sanitation of buildings). (Fig. 17 and 18)

Trendi kakovosti zraka v Celovcu

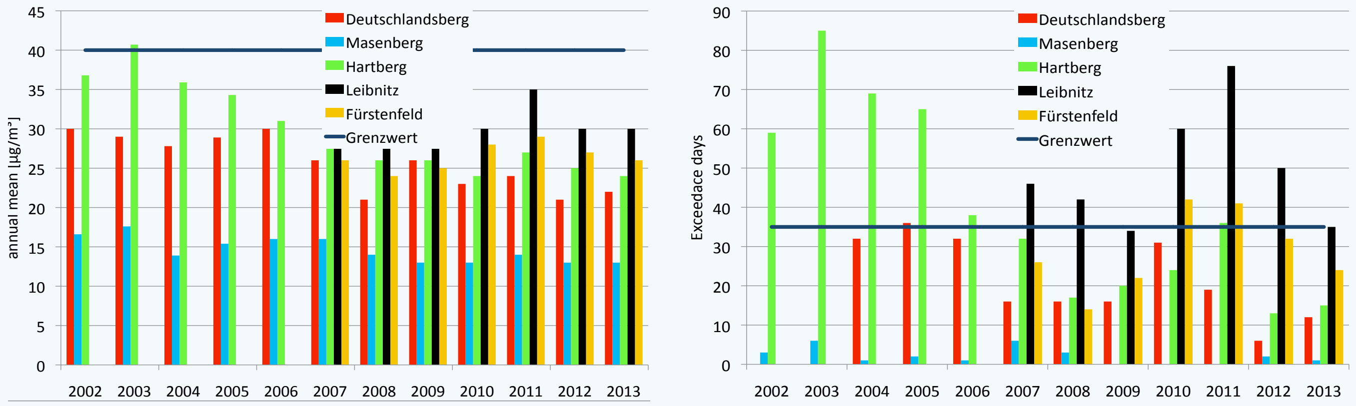
V Celovcu so od leta 2012 naprej dosežene EU mejne vrednosti za NO_2 in PM10, kar je najbrž posledica že izvedenih ukrepov. Na podlagi pričakovane posodobitve voznega parka (Euro 6) in dodatnih ukrepov na prometnem področju (e-mobilnost, javni promet) ter zmanjšanja ogrevanja gospodinjstev na lesno biomaso (razširitev daljinskega ogrevanja, izgradnja daljinskega omrežja, sanacija zgradb) se bo trend izboljšave kakovosti zraka še nadaljeval (slika 17, 18).

PM10 trends in the project region in Styria

Figure 19 depicts trends in annual mean PM10 concentrations and days on which limit values are exceeded as observed in the Styrian project region of PMinter. Note that data from 2013 has not yet been checked and the data was available only until 21st November 2013 with the result that the whole year is not covered. While at some stations (Hartberg, Deutschlandsberg) a clear downward trend is visible since 2002, at other monitoring stations (Leibnitz, Fürstenfeld) there is no clear trend towards lower concentrations. After a minimum in concentrations in 2009, PM10 levels increased significantly in 2011 and dropped again in 2012. Such behaviour is most likely due to varying dispersion conditions in the various years, but may also be influenced by changing emissions (e.g. domestic heating emissions increase during strong winters). It can be concluded that the European air quality standard for the annual mean PM10 concentration of 40 µg/m³ has not been violated at any monitoring station in the past decade. On the other hand the air quality standard for the number of days above 50 µg/m³ of 35 days is commonly exceeded at the monitoring stations Leibnitz

Trendi koncentracij PM10 v projektni regiji avstrijske Štajerske

Slika 19 kaže trende letnih povprečnih koncentracij PM10 in dneve prekoračitev v projektni regiji PMinter avstrijske Štajerske. Pri tem je treba opozoriti, da podatki za leto 2013 še niso bili preverjeni in da so bili na voljo le do 21. novembra 2013, tako da ni pokrito celotno leto. Medtem ko je na določenih postajah (Hartberg, Deutschlandsberg) mogoče zaznati jasen trend padanja koncentracij od leta 2002, na drugih postajah (Lipnica, Fürstenfeld) ni zaznati jasnega trenda zniževanja koncentracij. Po najnižjih koncentracijah v letu 2009 so se koncentracije delcev PM10 občutno povečale v letu 2011 in ponovno padle v letu 2012. Razlog za takšno obnašanje se verjetno skriva v spreminjajočih se pogojih razpršitve v različnih letih, lahko pa tudi v spreminjajočih se emisijah (npr. emisije iz ogrevanja se močno povečajo med hudo zimo). Zaključimo lahko, da v zadnjem desetletju evropski standard za kakovost zraka z letno povprečno koncentracijo PM10 v višini 40 µg/m³ na nobenem merilnem mestu ni bil prekoračen. Po drugi strani pa je standard za kakovost zraka za število dni nad 50 µg/m³ s 35 dnevi na splošno prekoračen na kontrolnih postajah



Slika 19: Trendi letnih stopenj PM10 (levo) in prekoračenih dni (desno) v projektni regiji na avstrijskem Štajerskem
Fig. 19: Trends of annual PM10 levels (left) and exceedance days (right) in the project region in Styria

Lipnica in Fürstenfeld v letih s slabimi pogoji za razpršitev. Na podlagi analize, izvedene v okviru projekta PMinter, sta glavna vira ogrevanje v gospodinjstvih in sekundarni aerosoli.

V naslednjih letih je pričakovati padajoči trend, potrebno pa bo veliko prizadevanj in posledično izvajanje načrta za kakovost zraka, da se bo v naslednjih letih lahko zagotovilo upoštevanje zakonskih standardov za celotno območje, tudi ob neugodnih meteoroloških pogojih.

Trendi koncentracij delcev PM10 v Mariboru

Na merilni postaji Maribor center je jasno viden trend zniževanja koncentracij delcev PM10 (diagrama 20 in 21), tudi letno število prekoračitev mejne dnevne koncentracije se zmanjšuje (pod 35 v letih 2009 in 2012). Od leta 2009 naprej je zaznan rahel nasprotni trend (razlog za to je mogoče v večji rabi lesne biomase za kurjavo zaradi višjih cen energije), toda v letu 2012 je število prekoračitev bilo spet pod dovoljeno mejo (35).

Napovedovanje koncentracij delcev je zaradi meteoroloških razmer in drugih dejavnikov zelo nezanesljivo, toda se na splošno pričakuje, da bo trend zniževanja prisoten tudi v prihodnje (še posebej po in zaradi izvedbe načrta za kakovost zraka, posodobitve voznega parka, modernizacije naprav za ogrevanje, izvajanja politike energetske učinkovitosti - toplotna izolacija zgradb ipd.).

V letu 2013 je bil položaj podoben tistemu v letu 2012 - število prekoračitev delcev PM10 je bilo 36, kar je sicer rahlo nad dovoljenim številom preseganj mejne dnevne koncentracije.

and Fürstenfeld in years with bad dispersion conditions. The major sources are, according to the analyses carried out in the PMinter project, domestic heating and secondary aerosols.

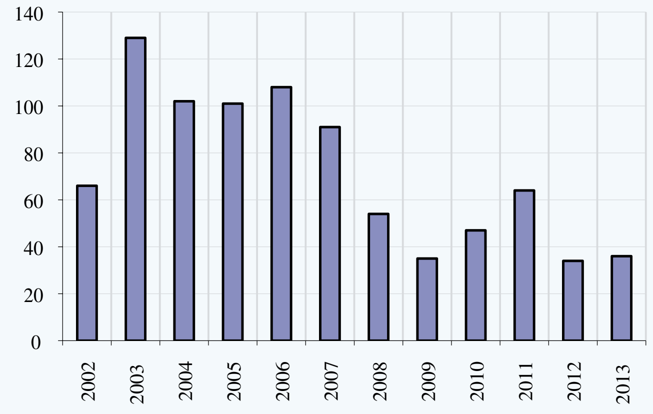
A decreasing tendency can be expected for the next few years, but great efforts and a stringent implementation of the air quality management plan will be required to ensure Styria-wide compliance with legal standards also under unfavourable meteorological conditions over the next few years.

Trends for PM10 for Maribor

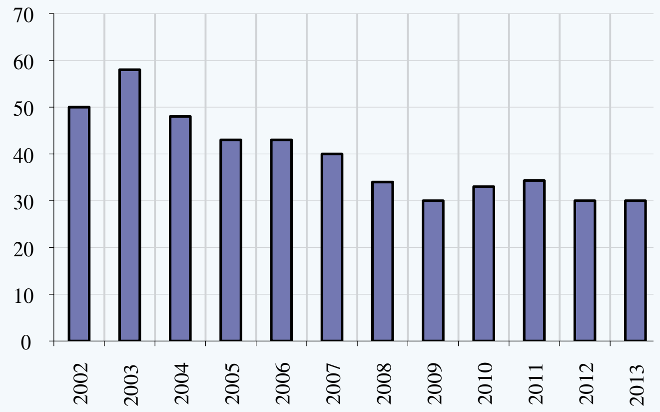
A trend of dropping concentrations of PM10 (Fig. 20 and 21) is seen in measuring location Maribor Center; and the number of days on which limit values are exceeded is decreasing (below 35 in years 2009 and 2012). Furthermore a slight opposite trend is notable from 2009 (the reason for this could be more wood burning due to higher energy prices), but in 2012 number of exceedances was again below the limit of 35.

Forecasting of PM concentrations is very unreliable (meteorological situation and other influencing factors), but we expect in general the trend to lower values will also be continued in future (especially after and because of the implementation of AQMP, natural renewal of car fleet, modernization of heat devices, implementation of energy efficiency policy – thermal insulation of buildings etc.).

In 2013, the situation was similar to that of 2012. The limit value was only slightly exceeded.



Slika 20: Prekoračitve mejne dnevne vrednosti
Fig. 20: PM10-exceedances of daily mean value – Maribor



Slika 21: PM10-letna povprečna vrednost (µg/m³)
Fig. 21: PM10-yearly mean value (µg/m³) – Maribor

Zaključna beseda in zahvala
Concluding Remarks

The excellent cooperation within the international team extending over a period of nearly four years has shown that effective air quality management measures can be implemented on local and regional level and that a future without particulate matter is not a utopian fantasy. I would like to thank all project partners and their colleagues, contractors, politicians, sponsors and the innumerable voluntary helpers most warmly for their extraordinary commitment and for having made PMinter a success.

Their contributions and energy have created the basis for continued interregional cooperation and follow-up projects for clean air.

Wolfgang Hafner
Project Manager

Skoraj štiriletno odlično sodelovanje v mednarodni delovni skupini je dokazalo, da je učinkovite ukrepe za kakovost zraka mogoče izvajati na lokalni in regionalni ravni in da prihodnost brez drobnih prašnih delcev ni nikakršna utopija. Vsem partnerjem v projektu in njihovim sodelavcem, kolegom, izvajalcem, politikom, podpornikom in številnim prostovoljnim pomočnikom se prisrčno zahvaljujem za to, da so s svojo zagnanostjo in požrtvovalnim delom omogočili uspeh projekta PMinter.

S tem je bil ustvarjen tudi predpogoj za nadaljnje mednarodno sodelovanje, ki bo živelo v obliki novih projektov za izboljšanje kakovosti zraka.

Wolfgang Hafner
vodja projekta

Podatki o projektu
Project Data

Operativni program Slovenija-Avstrija 2007-2013, projekt Interreg

PMinter
Medregijski vpliv ukrepov za varstvo zunanjega zraka pred onesnaževanjem z delci iz cestnega prometa in malih kurišč v slovensko-avstrijskem obmejnem prostoru.
Trajanje projekta: 1. 7. 2010 - 31. 12. 2013
Celotni stroški: pribl. 2,5 mio. EUR - od tega: 85% sredstev Evropske skupnosti iz Evropskega sklada za regionalni razvoj 15% lastnih sredstev SLO: 10% sredstev, nacionalno javno sofinanciranje, 5% lastnih sredstev

Operational Programme Slovenia-Austria 2007-2013, Interreg Project

PMinter
The interregional interaction of measures to reduce residential heating and traffic related measures with the PM-levels in the Slovenian-Austrian border region
Project term: *01.07.2010-31.12.2013*
Project budget: *approx. € 2.5 million – of which 85% community financed by the European Fund for Regional Development (EFRD) 15% own funds SLO: 10% national public financing (SVLR), 5% own funds*

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