R-tools

Ran at 2015-02-23 15:21:52

```
> wiki_username <- "Jouni"
> server <- TRUE
> ### THIS CODE IS FROM PAGE [[Climate change policies and health in Kuopio]] (Op_en5461, code_name = "")
> # Siirrä Kuopion-datat kässäristä linkin taakse Opasnettiin
> # KÄssäriin vain yhteenvetotaulukko joka kaupungista.
> # Mieti mitä sanotaan sisäilmasta. Perusmalli toimii ilmankin, ja Matin nostama miljoonan sisäilman hankaluus pitäisi lähinnä keskustella. Käytetäänkä ylileveitä jakaumia?
> # Onko järkeä yhdistää kaupungit? Silloin tulisi NA:ta eri päätösten kohdalle, ja tämä pitäisi huomioida kuvissa (muutenkin kannattaisi slaissata data ennen kuvien piirtämistä).
> # Tarkista iF jota käytetään: Mikä on iF-summary?
> library(OpasnetUtils)
> library(ggplot2)
> library(rgdal)
> library(maptools)
> library(RColorBrewer)
> library(classInt)
> library(OpasnetUtilsExt)
> library(RgoogleMaps)
> suomenna <- function(ova) {
+ d <- ova@output
+ if("Trait" %in% colnames(d)) {
+ levels(d$Trait)[levels(d$Trait) == "Cancer"] <- "Syöpä"
+ levels(d$Trait)[levels(d$Trait) == "CHD2"] <- "Sydänkuolema"
+ levels(d$Trait)[levels(d$Trait) == "Stroke"] <- "Aivohalvaus"
+ levels(d$Trait)[levels(d$Trait) == "Child's IQ"] <- "Lapsen ÄO"
+ levels(d$Trait)[levels(d$Trait) == "Tooth defect"] <- "Hammasvaurio"
+ levels(d$Trait)[levels(d$Trait) == "Dental defect"] <- "Hammasvaurio"
+ levels(d$Trait)[levels(d$Trait) == "Vitamin D recommendation"] <- "D-vitamiinin saantisuositus"
+ levels(d$Trait)[levels(d$Trait) == "Dioxin recommendation"] <- "Dioksiinin saantisuositus"
+ }
+ if("Exposure_agent" %in% colnames(ova@output)) {
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "Vitamin_D"] <- "D-vitamiini"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "EPA"] <- "EPA"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "DHA"] <- "DHA"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "Omega3"] <- "Omega3"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "PCDDF"] <- "Dioksiini"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "PCB"] <- "PCB"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "TEQ"] <- "TEQ"
+ levels(d$Exposure_agent)[levels(d$Exposure_agent) == "MeHg"] <- "Metyylielohopea"
+ }
+ if("Hedelm" %in% colnames(d)) {
+ levels(d$Hedelm)[levels(d$Hedelm) == FALSE] <- "Ei"
+ levels(d$Hedelm)[levels(d$Hedelm) == TRUE] <- "Kyllä"
+ }
+
+ colnames(d)[colnames(d) == "Age"] <- "Ikäryhmä"
+ colnames(d)[colnames(d) == "Exposure_agent"] <- "Altiste"
+ colnames(d)[colnames(d) == "Trait"] <- "Vaste"
+ colnames(d)[colnames(d) == "IkÃ¤"] <- "Ikä"
+ colnames(d)[colnames(d) == "SilakkamÃ¤Ã¤rÃ¤"] <- "Silakkamäärä"
+
+ return(d)
+ }
> openv.setN(0) # use medians instead of whole sampled distributions
> objects.latest("Op_en6007", code_name = "answer") # [[OpasnetUtils/Drafts]] findrest
> obstime <- data.frame(Startyear = (192:205) * 10) # Observation years must be defined for an assessment.
> ## Additional index needed in followup of ovariables efficiencyShares and stockBuildings
> year <- Ovariable("year", data = data.frame(
+ Constructed = factor(
+ c("1799-1899", "1900-1909", "1910-1919", "1920-1929", "1930-1939", "1940-1949",
+ "1950-1959", "1960-1969", "1970-1979", "1980-1989", "1990-1999",
+ "2000-2010", "2011-2019", "2020-2029", "2030-2039", "2040-2049"
+ ),
+ ordered = TRUE
+ ),
+ Time = c(1880, 1905 + 0:14 * 10),
+ Result = 1
+ ))
> BS <- 24
> heating_before <- FALSE
> efficiency_before <- TRUE
> allfigures <- TRUE
> ###################### Decisions
> decisions <- opbase.data('Op_en5461', subset = "Decisions") # [[Climate change policies and health in Kuopio]]
> DecisionTableParser(decisions)
> # Remove previous decisions, if any.
```

```
> rm(
+ "buildings",
+ "stockBuildings",
+ "changeBuildings",
+ "efficiencyShares",
+ "energyUse",
+ "heatingShares",
+ "renovationShares",
+ "renovationRate",
+ "fuelShares",
+ "year",
+ envir = openv
+ )
> ############################## City-specific data
> ####!----------------------------------------------
> objects.latest("Op_en5417", code_name = "initiate") # [[Population of Kuopio]]
> # population: City_area
> objects.latest("Op_en5932", code_name = "initiate") # [[Building stock in Kuopio]] Building ovariables:
> # buildingStock: Building, Constructed, City_area
> # rateBuildings: Age, (RenovationPolicy)
> # renovationShares: Renovation
> # construction: Building
> # constructionAreas: City_area
> # buildingTypes: Building, Building2
> # heatingShares: Building, Heating, Eventyear
> # heatingSharesNew: Building2, Heating
> # eventyear: Constructed, Eventyear
> # efficiencyShares: Time, Efficiency
> renovationRate <- EvalOutput(renovationRate) * 10 # Rates for 10-year periods
> ##################### Energy use (needed for buildings submodel)
> ####!----------------------------------------------
> objects.latest("Op_en5488", code_name = "initiate") # [[Energy use of buildings]]
> # energyUse: Building, Heating
> # efficiencyShares: Efficiency, Constructed
> # renovationRatio: Efficiency, Building2, Renovation
> ####i----------------------------------------------
> ###################### Actual building model
> # The building stock is measured as m^2 floor area.
> ####!----------------------------------------------
> objects.latest("Op_en6289", code_name = "initiate") # [[Building model]] # Generic building model.
> # buildings: formula-based
> # heatingEnergy: formula-based
> ####i----------------------------------------------
> buildings <- EvalOutput(buildings)
> buildings@output$RenovationPolicy <- factor(
+ buildings@output$RenovationPolicy,
+ levels = c("BAU", "Active renovation", "Effective renovation"),
+ ordered = TRUE
+ )
> buildings@output$EfficiencyPolicy <- factor(
+ buildings@output$EfficiencyPolicy,
+ levels = c("BAU", "Active efficiency"),
+ ordered = TRUE
+ )
> bui <- oapply(buildings * 1E-6, cols = c("City_area", "buildingsSource"), FUN = sum)@output
> ggplot(subset(bui, RenovationPolicy == "BAU" & EfficiencyPolicy == "BAU"), aes(x = Time, weight = buildingsResult, fill = Heating)) +
geom_bar(binwidth = 5) +
+ theme_gray(base_size = BS) +
+ labs(
+ title = "Building stock in Kuopio",
+ x = "Time",
+ y = "Floor area (M m2)"
+ )
> ggplot(subset(bui, EfficiencyPolicy == "BAU"), aes(x = Time, weight = buildingsResult, fill = Renovation)) +
+ geom_bar(binwidth = 5) +
+ facet_grid(. ~ RenovationPolicy) + theme_gray(base_size = BS) +
+ labs(
+ title = "Building stock in Kuopio by renovation policy",
+ x = "Time",
+ y = "Floor area (M m2)"
+ )
> if(allfigures) {
+
+ ggplot(subset(bui, RenovationPolicy == "BAU"), aes(x = Time, weight = buildingsResult, fill = Efficiency)) + geom_bar(binwidth = 5) +
+ facet_grid(. ~ EfficiencyPolicy) + theme_gray(base_size = BS) +
+ labs(
+ title = "Building stock in Kuopio by efficiency policy",
+ x = "Time",
+ y = "Floor area (M m2)"
+ )
+
+ ggplot(subset(bui, RenovationPolicy == "BAU" & EfficiencyPolicy == "BAU"), aes(x = Time, weight = buildingsResult, fill = Building)) +
geom_bar(binwidth = 5) +
```

```
 + theme_gray(base_size = BS) +
 + labs(
 + title = "Building stock in Kuopio",
 + x = "Time",
 + y = "Floor area (M m2)"
 + )
 + }
 > ######################## Energy and emissions
 > ####!-----------------------------------------------
 > objects.latest("Op_en2791", code_name = "initiate") # [[Emission factors for burning processes]]
 > # emissionFactors: Burner, Fuel, Pollutant
 > # fuelShares: Heating, Burner, Fuel
 > ####i-----------------------------------------------
 > heatingEnergy <- EvalOutput(heatingEnergy)
 > ################# Transport and fate
 > ####!-----------------------------------------------
 > iF <- Ovariable("iF", ddata = "Op_en3435", subset = "Intake fractions of PM")
 > # [[Exposure to PM2.5 in Finland]] Humbert et al 2011 data
 > emissionLocations <- Ovariable("emissionLocations", ddata = "Op_en3435", subset = "Emission locations")
 > ####i-----------------------------------------------
 > colnames(iF@data) <- gsub("[ \\.]", "_", colnames(iF@data))
 > iF@data$iFResult <- iF@data$iFResult * 1E-6
 > colnames(emissionLocations@data) <- gsub("[ \\.]", "_", colnames(emissionLocations@data))
 > emissionLocations@data$emissionLocationsResult <- 1
 > emissions <- EvalOutput(emissions)
 > emissions@output$Time <- as.numeric(as.character(emissions@output$Time))
 > # Plot energy need and emissions
 > ggplot(subset(heatingEnergy@output, EfficiencyPolicy == "BAU"), aes(x = Time, weight = heatingEnergyResult * 1E-6, fill = Heating)) +
geom_bar(binwidth = 5) +
 + facet_wrap( ~ RenovationPolicy) + theme_gray(base_size = BS) +
 + labs(
 + title = "Energy used in heating in Kuopio",
 + x = "Time",
 + y = "Heating energy (GWh /a)"
 + )
 > emis <- truncateIndex(emissions, cols = "Emission_site", bins = 5)@output
 > ggplot(subset(emis, EfficiencyPolicy == "BAU" & RenovationPolicy == "BAU"), aes(x = Time, weight = emissionsResult, fill = Fuel)) +
geom_bar(binwidth = 5) +
 + facet_grid(Pollutant ~ FuelPolicy, scale = "free_y") + theme_gray(base_size = BS) +
 + labs(
 + title = "Emissions from heating in Kuopio",
 + x = "Time",
 + y = "Emissions (ton /a)"
 + )
 > if(allfigures) {
 +
 + ggplot(heatingEnergy@output, aes(x = Time, weight = heatingEnergyResult * 1E-6, fill = Heating)) + geom_bar(binwidth = 5) +
 + facet_grid(EfficiencyPolicy ~ RenovationPolicy) + theme_gray(base_size = BS) +
 + labs(
 + title = "Energy used in heating in Kuopio",
 + x = "Time",
 + y = "Heating energy (GWh /a)"
 + )
 +
 + ggplot(subset(emis, EfficiencyPolicy == "BAU" & RenovationPolicy == "BAU"), aes(x = Time, weight = emissionsResult, fill = Fuel)) +
geom_bar(binwidth = 5) +
 + facet_grid(Pollutant ~ FuelPolicy, scale = "free_y") + theme_gray(base_size = BS) +
 + labs(
 + title = "Emissions from heating in Kuopio",
 + x = "Time",
 + y = "Emissions (ton /a)"
 + )
 +
 + ggplot(subset(emis, EfficiencyPolicy == "BAU" & FuelPolicy == "BAU"), aes(x = Time, weight = emissionsResult, fill = Emission_site)) +
geom_bar(binwidth = 5) +
 + facet_grid(Pollutant ~ RenovationPolicy, scale = "free_y") + theme_gray(base_size = BS) +
 + labs(
 + title = "Emissions from heating in Kuopio",
 + x = "Time",
 + y = "Emissions (ton /a)"
 + )
 +
 + ggplot(subset(emis, EfficiencyPolicy == "BAU" & FuelPolicy == "BAU"), aes(x = Time, weight = emissionsResult, fill = Fuel)) + geom_bar(binwidth = 5)
 +
 + facet_grid(Pollutant ~ RenovationPolicy, scale = "free_y") + theme_gray(base_size = BS) +
 + labs(
 + title = "Emissions from heating in Kuopio",
 + x = "Time",
 + y = "Emissions (ton /a)"
 + )
 + }
 > ######################## Health assessment
```

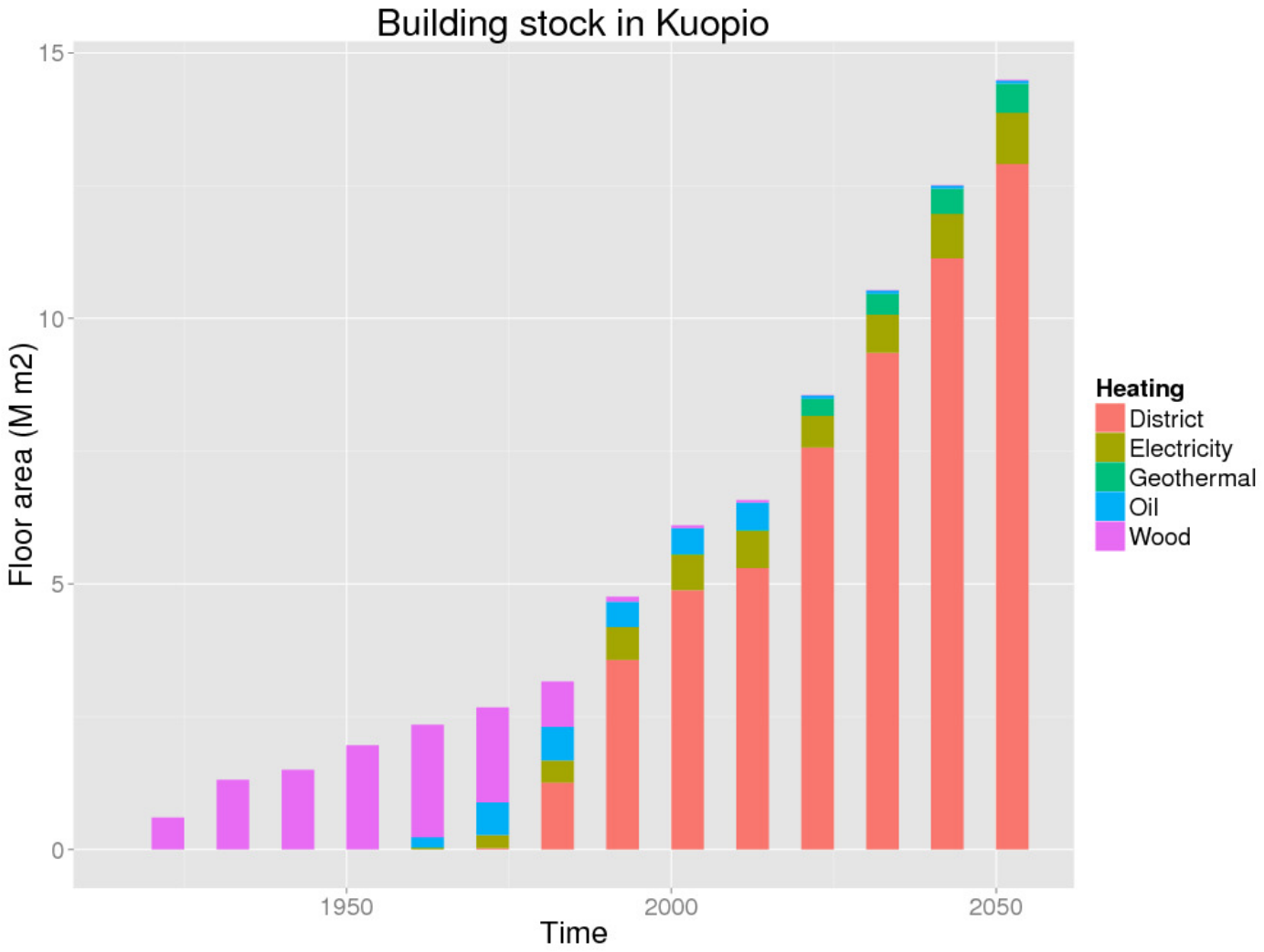
```
> ####!----------------------------------------------
> objects.latest('Op_en2261', code_name = 'initiate') # [[Health impact assessment]] dose, RR, totcases.
> objects.latest('Op_en5917', code_name = 'initiate') # [[Disease risk]] disincidence
> objects.latest('Op_en5827', code_name = 'initiate') # [[ERFs of environmental pollutants]] ERF, threshold
> #objects.latest('Op_en5453', code_name = 'initiate') # [[Burden of disease in Finland]] BoD
> directs <- tidy(opbase.data("Op_en5461", subset = "Direct inputs"), direction = "wide") # [[Climate change policies and health in Kuopio]]
> ####i----------------------------------------------
> colnames(directs) <- gsub(" ", "_", colnames(directs))
> ### Use these population and iF values in health impact assessment. Why?
> frexposed <- 1 # fraction of population that is exposed
> bgexposure <- 0 # Background exposure to an agent (a level below which you cannot get in practice)
> BW <- 70 # Body weight (is needed for RR calculations although it is irrelevant for PM2.5)
> population <- 5E+5
> exposure <- EvalOutput(exposure, verbose = TRUE)
Evaluating exposure ... - Evaluating iF ... done(0 secs)! - Checking iF marginals ... Pollutant, Emission_height, Area, iFSource recognized as marginal(s).
done(0.91 secs)! Checking exposure marginals ... Time, EfficiencyPolicy, RenovationPolicy, Heating, Fuel, FuelPolicy, Exposure_agent, Emission_site,
Emission_height, Area, exposureSource recognized as marginal(s).

> if(allfigures) {
+
+ ggplot(subset(exposure@output, RenovationPolicy == "BAU" & EfficiencyPolicy == "BAU" & FuelPolicy == "BAU"), aes(x = Time, weight =
exposureResult, fill = Heating)) +
+ geom_bar(binwidth = 5) + facet_grid(Area ~ Emission_height) + theme_gray(base_size = BS) +
+ labs(
+ title = "Exposure to PM2.5 from heating in Kuopio",
+ x = "Time",
+ y = "Average PM2.5 (µg/m3)"
+ )
+ }
> exposure@output <- exposure@output[exposure@output$Area == "Average" , ] # Kuopio is an average area,
> # rather than rural or urban.
> ggplot(subset(exposure@output, EfficiencyPolicy == "BAU"), aes(x = Time, weight = exposureResult, fill = Heating)) + geom_bar(binwidth = 5) +
facet_grid(FuelPolicy ~ RenovationPolicy) + theme_gray(base_size = BS) +
+ labs(
+ title = "Exposure to PM2.5 from heating in Kuopio",
+ x = "Time",
+ y = "Average PM2.5 (µg/m3)"
+ )
> totcases <- EvalOutput(totcases)
> totcases@output$Time <- as.numeric(as.character(totcases@output$Time))
> totcases <- oapply(totcases, cols = c("Age", "Sex"), FUN = sum)
> ggplot(subset(totcases@output, EfficiencyPolicy == "BAU" & FuelPolicy == "BAU"), aes(x = Time, weight = totcasesResult, fill =
Heating))+geom_bar(binwidth = 5) +
+ facet_grid(Trait ~ RenovationPolicy) +
+ theme_gray(base_size = BS) +
+ labs(
+ title = "Health effects of PM2.5 from heating in Kuopio",
+ x = "Time",
+ y = "Health effects (deaths /a)"
+ )
> DW <- Ovariable("DW", data = data.frame(directs["Trait"], Result = directs$DW))
> L <- Ovariable("L", data = data.frame(directs["Trait"], Result = directs$L))
> DALYs <- totcases * DW * L
> cat("Total DALYs/a by different combinations of policy options.\n")
Total DALYs/a by different combinations of policy options.

> temp <- DALYs
> temp@output <- subset(temp@output, as.character(Time) %in% c("2010", "2030"))
> oprint(oapply(temp, INDEX = c("Time", "EfficiencyPolicy", "RenovationPolicy", "FuelPolicy"), FUN = sum)@output)
```

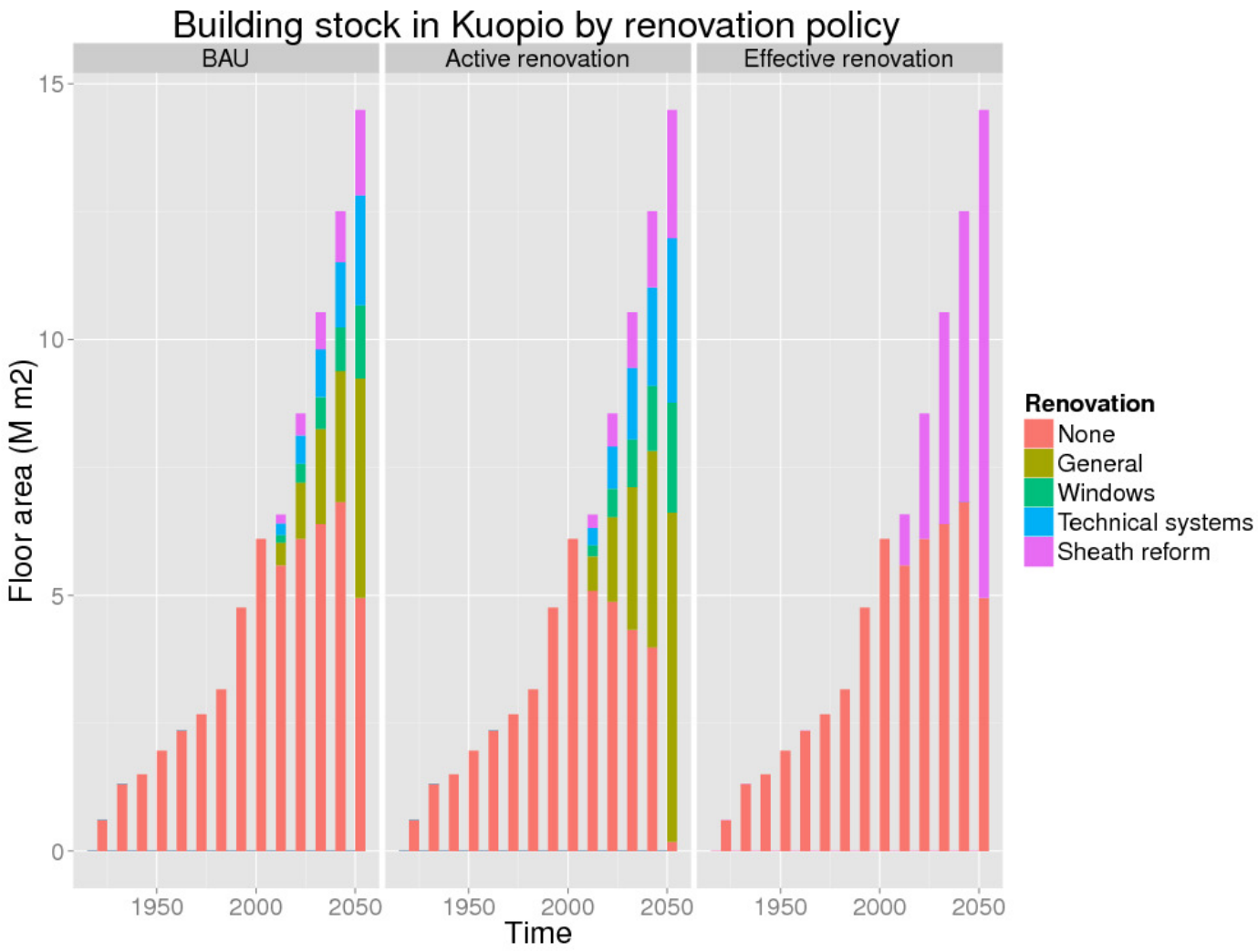
	Time	EfficiencyPolicy	RenovationPolicy	FuelPolicy	Result
1	2010.00	BAU	BAU	BAU	46.68
2	2030.00	BAU	BAU	BAU	35.75
3	2010.00	Active efficiency	BAU	BAU	46.68
4	2030.00	Active efficiency	BAU	BAU	35.32
5	2010.00	BAU	Active renovation	BAU	45.30
6	2030.00	BAU	Active renovation	BAU	32.17
7	2010.00	Active efficiency	Active renovation	BAU	45.30
8	2030.00	Active efficiency	Active renovation	BAU	31.74
9	2010.00	BAU	Effective renovation	BAU	43.76
10	2030.00	BAU	Effective renovation	BAU	28.19
11	2010.00	Active efficiency	Effective renovation	BAU	43.76
12	2030.00	Active efficiency	Effective renovation	BAU	27.76
13	2010.00	BAU	BAU	Biofuel increase	46.68
14	2030.00	BAU	BAU	Biofuel increase	34.49
15	2010.00	Active efficiency	BAU	Biofuel increase	46.68
16	2030.00	Active efficiency	BAU	Biofuel increase	34.08
17	2010.00	BAU	Active renovation	Biofuel increase	45.30
18	2030.00	BAU	Active renovation	Biofuel increase	31.04
19	2010.00	Active efficiency	Active renovation	Biofuel increase	45.30
20	2030.00	Active efficiency	Active renovation	Biofuel increase	30.63
21	2010.00	BAU	Effective renovation	Biofuel increase	43.76
22	2030.00	BAU	Effective renovation	Biofuel increase	27.21
23	2010.00	Active efficiency	Effective renovation	Biofuel increase	43.76
24	2030.00	Active efficiency	Effective renovation	Biofuel increase	26.80

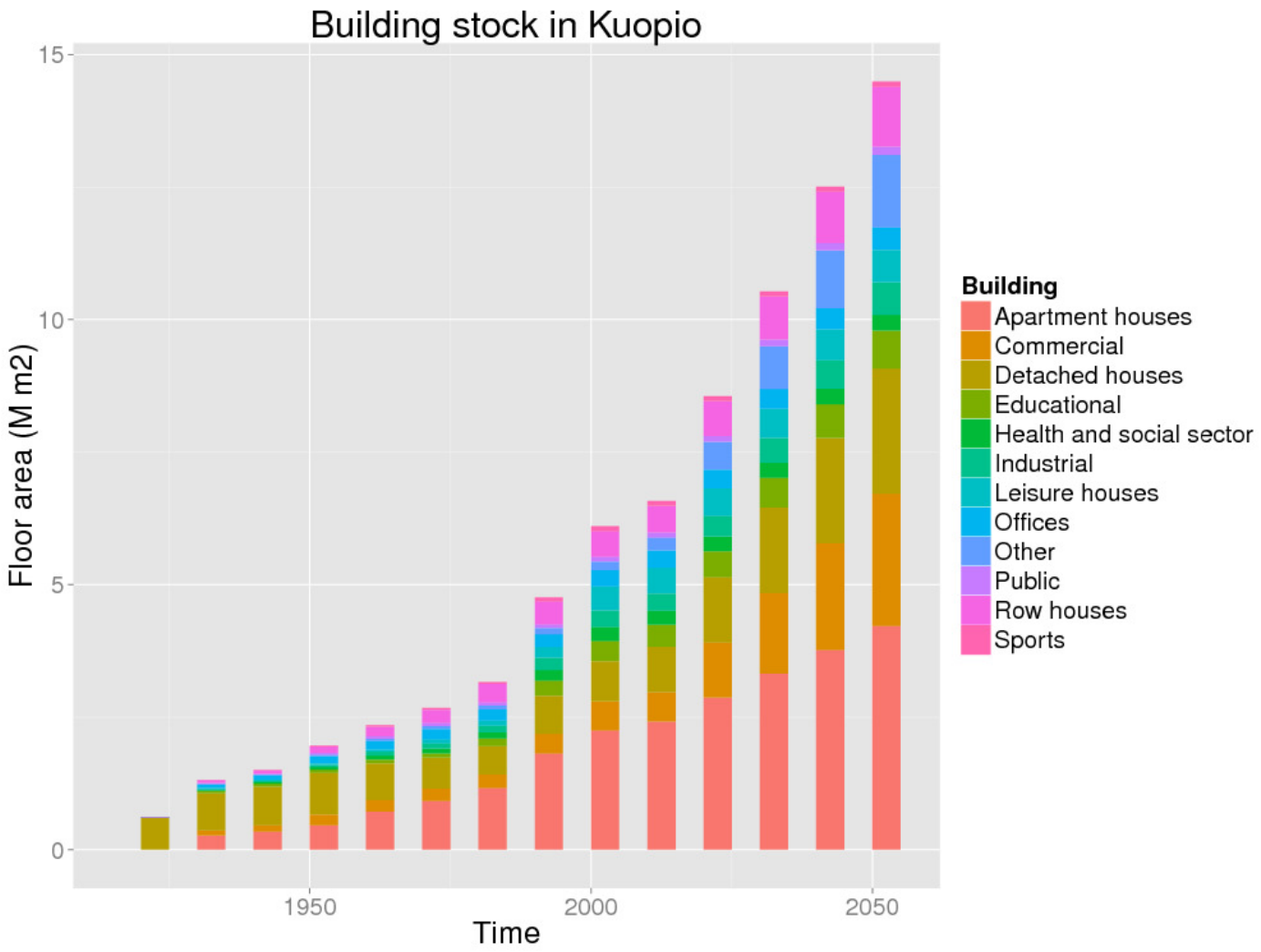
```
> if(allfigures) {
+
+ ggplot(subset(DALYs@output, FuelPolicy == "BAU" & Trait == "Total mortality"), aes(x = Time, weight = Result, fill = Heating))+geom_bar(binwidth =
5) +
+ facet_grid(EfficiencyPolicy ~ RenovationPolicy) +
+ theme_gray(base_size = BS) +
+ labs(
+ title = "Health effects in DALYs of PM2.5 from heating in Kuopio",
+ x = "Time",
+ y = "Health effects (DALY /a)"
+ )
+
+ }
>
> ggplot(subset(DALYs@output, Time == 2020 & Trait == "Total mortality"), aes(x = FuelPolicy, weight = Result, fill = Heating))+geom_bar() +
+ facet_grid(EfficiencyPolicy ~ RenovationPolicy) +
+ theme_gray(base_size = BS) +
+ labs(
+ title = "Health effects in DALYs of PM2.5 from heating in Kuopio",
+ x = "Biofuel policy in district heating",
+ y = "Health effects (DALY /a)"
+ )
> ############################## Old graphs
> if(FALSE) {
+ BS <- 24
+
+ ######## Buildings in Kuopio on map
+
+ if(exists("server")) # The following code only works from Opasnet server.
+ {
+ # Calculate locations for Kuopio districts
+
+ ####!-----------------------------------------------
+ districts <- tidy(opbase.data("Op_en3435.kuopio_city_districts"), widecol = "Location") # [[Exposure to PM2.5 in Finland]]
+ ####i-----------------------------------------------
+
+ colnames(districts) <- gsub("\\.", "_", colnames(districts))
+ districts <- Ovariable("districts", data = data.frame(districts, Result = 1))
+
+ temp <- buildings * districts
+ temp@output <- temp@output[temp@output$Year == 2040 , ]
+ temp <- unkeep(temp, sources = TRUE, prevresults = TRUE)
+ temp@output <- dropall(temp@output)
+ temp <- oapply(temp, cols = c("Building", "Heating", "Efficiency", "Renovation"), FUN = "sum", na.rm = TRUE)
+
```

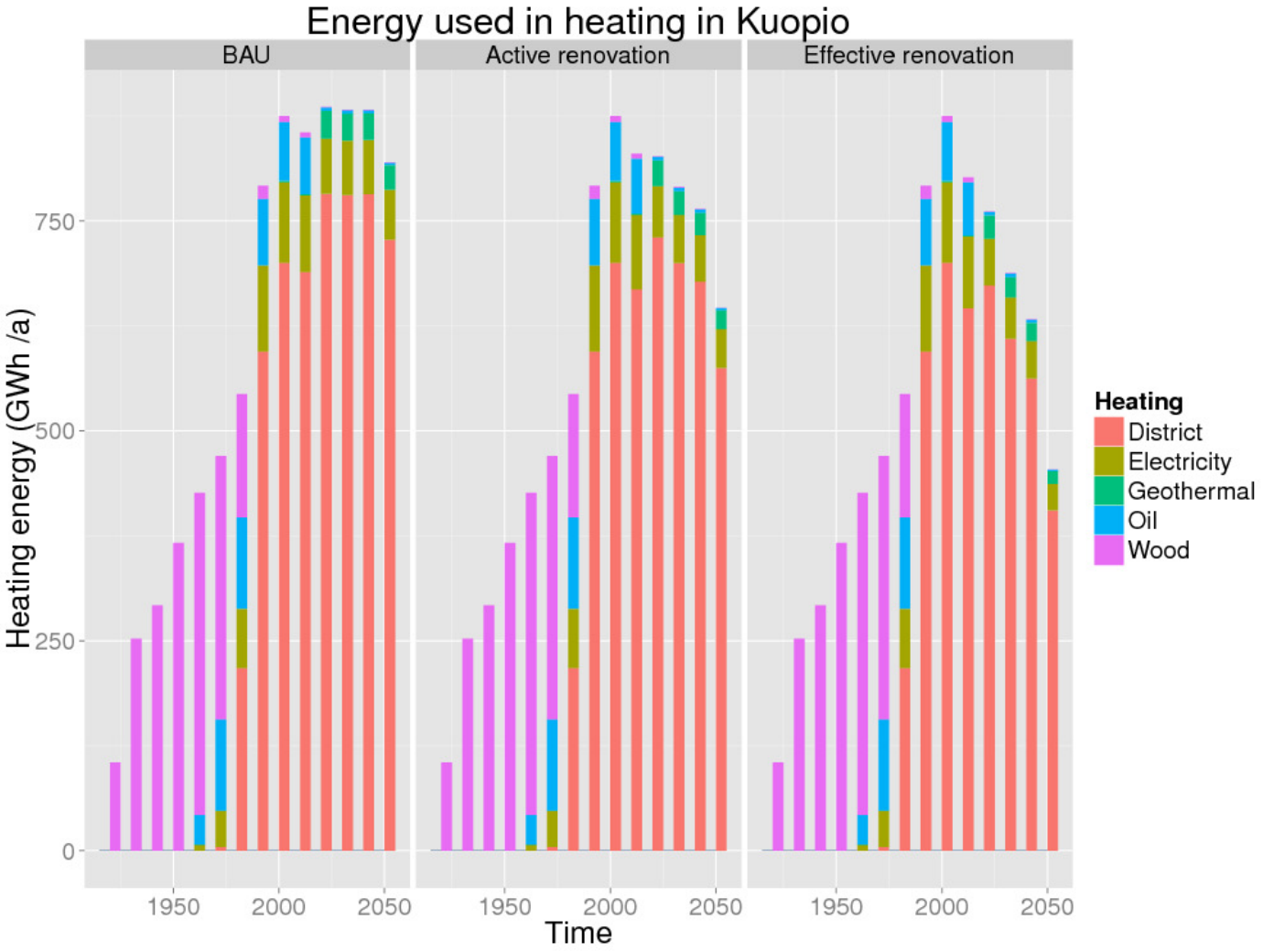
```
+ MyRmap(
+ ova2spat(temp, coord = c("E", "N"), proj4string = "+init=epsg:3067"), # National Land Survey uses EPSG:3067 (ETRS-TM35FIN)
+ plotvar = "Result", legend_title = "Floor area", numbins = 8, pch = 19, cex = 2
+ )
+ }
+
+ if(exists("server")) # The following code only works from Opasnet server.
+ {
+ if(language == "EN") lege2 <- "Age of building" else lege2 <- "Rakennuksen ikä"
+
+ shp <- readOGR('PG:host=localhost user=postgres dbname=spatial_db','kuopio_house')
+ proj4string(shp) <- ("+init=epsg:3067") # The map projection of NLS Finland.
+
+ epsg4326String <- CRS("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
+ shp2 <- spTransform(shp,epsg4326String) # Convert to longitude-latitude projection.
+
+ MyRmap(shp2, plotvar = "ika", legend_title = lege2, numbins = 8, pch = 19, cex = 0.3) # Draw the map.
+ }
+
+ if(exists("server")) BS <- 24 else BS <- 12
+
+ ### Impact graphs in ENGLISH
+
+ ggplot(buildings@output) + geom_bar(binwidth = 5) + theme_gray(base_size = BS) +
+ aes(x = Building, weight = buildingsResult/1000000, fill = Heating) + labs(y = "Floor area (M m2)", title = "Building impacts of renovation policy") +
coord_flip() # + facet_grid(. ~ RenovationPolicy)
+
+ plo <- ggplot(buildings@output) + geom_bar(binwidth = 5) + facet_grid(. ~ RenovationPolicy) + theme_gray(base_size = BS) +
+ aes(x = Year, weight = buildingsResult/1000000, fill = Renovation) + labs(y = "Floor area (M m2)",
+ title = "Building impacts of renovation policy")
+
+ print(plo)
+
+ ggplot(heatingEnergy@output) + geom_bar(binwidth = 5) + theme_gray(base_size = BS) + labs(title = "Energy impacts of renovation policy") +
+ aes(x = Building, weight = heatingEnergyResult/1E+6, fill = Heating) + labs(y = "Heating energy need (GWh /a)") + coord_flip() # + facet_grid(. ~
RenovationPolicy)
+
+ plo <- ggplot(heatingEnergy@output) + geom_bar(binwidth = 5) + facet_grid(. ~ RenovationPolicy) + theme_gray(base_size = BS) +
+ labs(title = "Energy impacts of renovation policy", y = "Heating energy need (GWh /a)") +
+ aes(x = Year, weight = heatingEnergyResult/1E+6, fill = Heating)
+
+ print(plo)
+
+ emis@output <- emis@output[emis@output$Renovation == "BAU" , ]
+
+ ggplot(emis@output) + geom_bar(binwidth = 5) + facet_grid(Pollutant ~ . , scales = "free_y") + theme_gray(base_size = BS) + labs(title = "Emission
impacts of biofuel policy") +
+ aes(x = Heating, weight = Result, fill = Fuel) + labs(y = "Emissions to air (ton /a)") + theme(axis.text.x = element_text(angle = 90, hjust = 1))
+
+ plo <- ggplot(emis@output) + geom_bar(binwidth = 5) + facet_grid(Pollutant ~ FuelPolicy, scales = "free_y") + theme_gray(base_size = BS) +
+ labs(title = "Emission impacts of biofuel policy", y = "Emissions to air (ton /a)") +
+ aes(x = Year, weight = Result, fill = Fuel)
+
+ print(plo)
+
+ ggplot(emissions@output, aes(x = Year, weight = Result, fill = Emission_site)) + geom_bar(binwidth = 5) + facet_grid( Pollutant ~ ., scales = "free_y")
+
+ colnames(exposure@output)[colnames(exposure@output) == "Pollutant"] <- "Exposure_agent"
+ ggplot(exposure@output, aes(x = Year, weight = exposureResult)) + geom_bar(binwidth = 5) + facet_grid(Exposure_agent ~ FuelPolicy, scales = "free_y")
+
+ # plo <- ggplot(health@output) + geom_bar(binwidth = 5) + facet_grid(FuelPolicy ~ RenovationPolicy) + theme_gray(base_size = BS) +
+ # labs(title = "Health impacts of fuel and renovation policy", y = "Premature deaths (# /a)") +
+ # aes(x = Year, weight = Result, fill = Heating)
+ #
+ # print(plo)
+
+
+
+ #ggplot(health@output) + geom_bar(binwidth = 5) + theme_gray(base_size = BS) + labs(title = "Health impacts of fuel and renovation policy") +
+ #aes(x = Year, weight = Result, fill = Heating) + labs(y = "Premature deaths (# /a)") # + facet_grid(FuelPolicy ~ RenovationPolicy)
+
+ #ggplot(cases@output[cases@output$Causes == "PM2.5+" , ], aes(x = Year, weight = Result/10, fill = Disease)) + geom_bar() + facet_grid(FuelPolicy ~
RenovationPolicy, scale = "free_y")
+
+ #ggplot(DALYs@output[DALYs@output$Causes == "PM2.5+" , ], aes(x = Year, weight = Result/10, fill = Response.metric)) + geom_bar(binwidth = 5) +
facet_grid(FuelPolicy ~ RenovationPolicy, scale = "free_y")
+ ggplot(DALYs@output, aes(x = Year, weight = Result, fill = Trait)) + geom_bar(binwidth = 5) + facet_grid(RenovationPolicy ~ FuelPolicy)
+
+ ### Impact graphs in FINNISH
+
+ if(FALSE) {
+
+ plo <- ggplot(buildings@output) + geom_bar(binwidth = 5) + facet_grid(. ~ Remonttipolitiikka) + theme_gray(base_size = BS) +
```

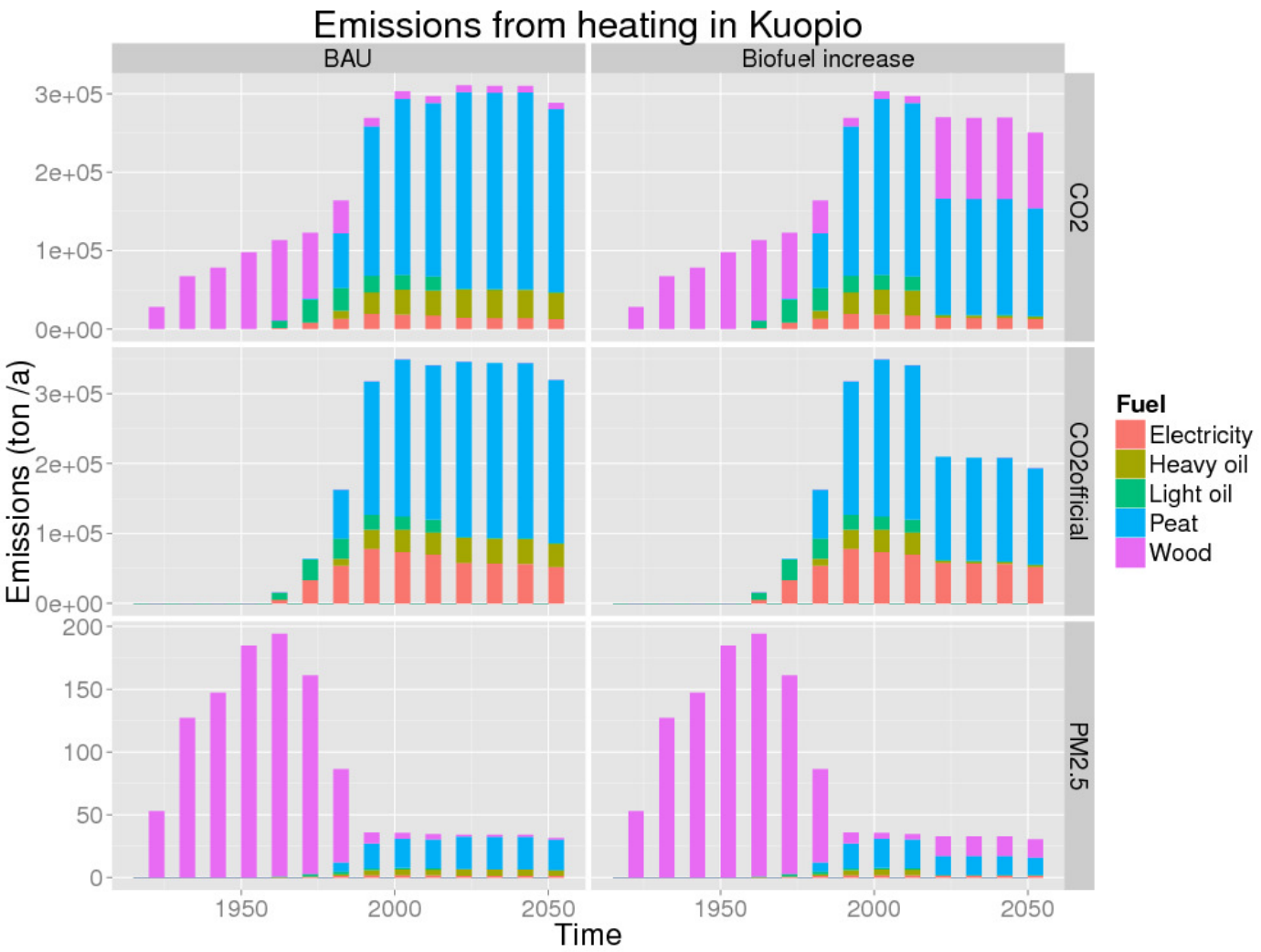
```
+ aes(x = Year, weight = buildingsResult/1000000, fill = Renovation) + labs(y = "Rakennuspinta-ala (M m2)",
+ title = "Remonttipolitiikan vaikutus rakennuskantaan")
+
+ print(plo)
+
+ plo <- ggplot(heatingEnergy@output) + geom_bar(binwidth = 5) + facet_grid(. ~ Remonttipolitiikka) + theme_gray(base_size = BS) +
+ labs(title = "Remonttipolitiikan vaikutus energiankulutukseen", y = "Lämmitysenergian tarve (GWh /a)") +
+ aes(x = Year, weight = heatingEnergyResult/1E+6, fill = Heating)
+
+ print(plo)
+
+ emis@output <- emis@output[emis@output$Remonttipolitiikka == "BAU" , ]
+
+ plo <- ggplot(emis@output) + geom_bar(binwidth = 5) + facet_grid(Pollutant ~ Bioenergiapolitiikka, scales = "free_y") +
+ theme_gray(base_size = BS) + labs(title = "Bioenergiapolitiikan päästövaikutukset", y = "Päästöt ilmaan (ton /a)") +
+ aes(x = Year, weight = Result, fill = Fuel)
+
+ print(plo)
+
+ # plo <- ggplot(health@output) + geom_bar(binwidth = 5) + facet_grid(Bioenergiapolitiikka ~ Remonttipolitiikka) + theme_gray(base_size = BS) +
+ # labs(title = "Remontti- ja bioenergiapolitiikan terveysvaikutukset", y = "Ennenaikaisia kuolemia (# /a)") +
+ # aes(x = Year, weight = Result, fill = Heating)
+ #
+ # print(plo)
+ }
+
+ ggplot(dose@output, aes(x = Year, y = doseResult, colour = RenovationPolicy)) + geom_point() + facet_grid(. ~ FuelPolicy)
+
+ ggplot(totcases@output, aes(x = Year, y = totcasesResult, colour = Trait)) + geom_point() + facet_grid(Trait ~ FuelPolicy)
+
+ ggplot(RR@output, aes(x = RRResult, colour = Trait)) + geom_density()
+
+ #ggplot(cases@output, aes(x = Year, weight = Result, fill = Trait)) + geom_bar(binwidth = 5) + facet_grid(RenovationPolicy ~ #FuelPolicy)
+
+ ggplot(health@output[ter@output$Tehokkuuspolitiikka == "BAU" , ], aes(x = Year, weight = Result/get("N", envir=openv),
+ fill = Lämmitys)) + geom_bar(binwidth = 5) + facet_grid(Remonttipolitiikka ~ Bioenergiapolitiikka) +
+ labs(y = "Pienhiukkasten terveyshaitta")
+
+ ggplot(cases@output, aes(x = Year, weight = totcasesResult, fill = Trait)) + geom_bar(binwidth = 5) + facet_grid(RenovationPolicy ~ FuelPolicy)
+
+ ggplot(DALYs@output, aes(x = Year, weight = Result, fill = Trait)) + geom_bar(binwidth = 5) + facet_grid(RenovationPolicy ~ FuelPolicy)
+ } # END if(FALSE)
```

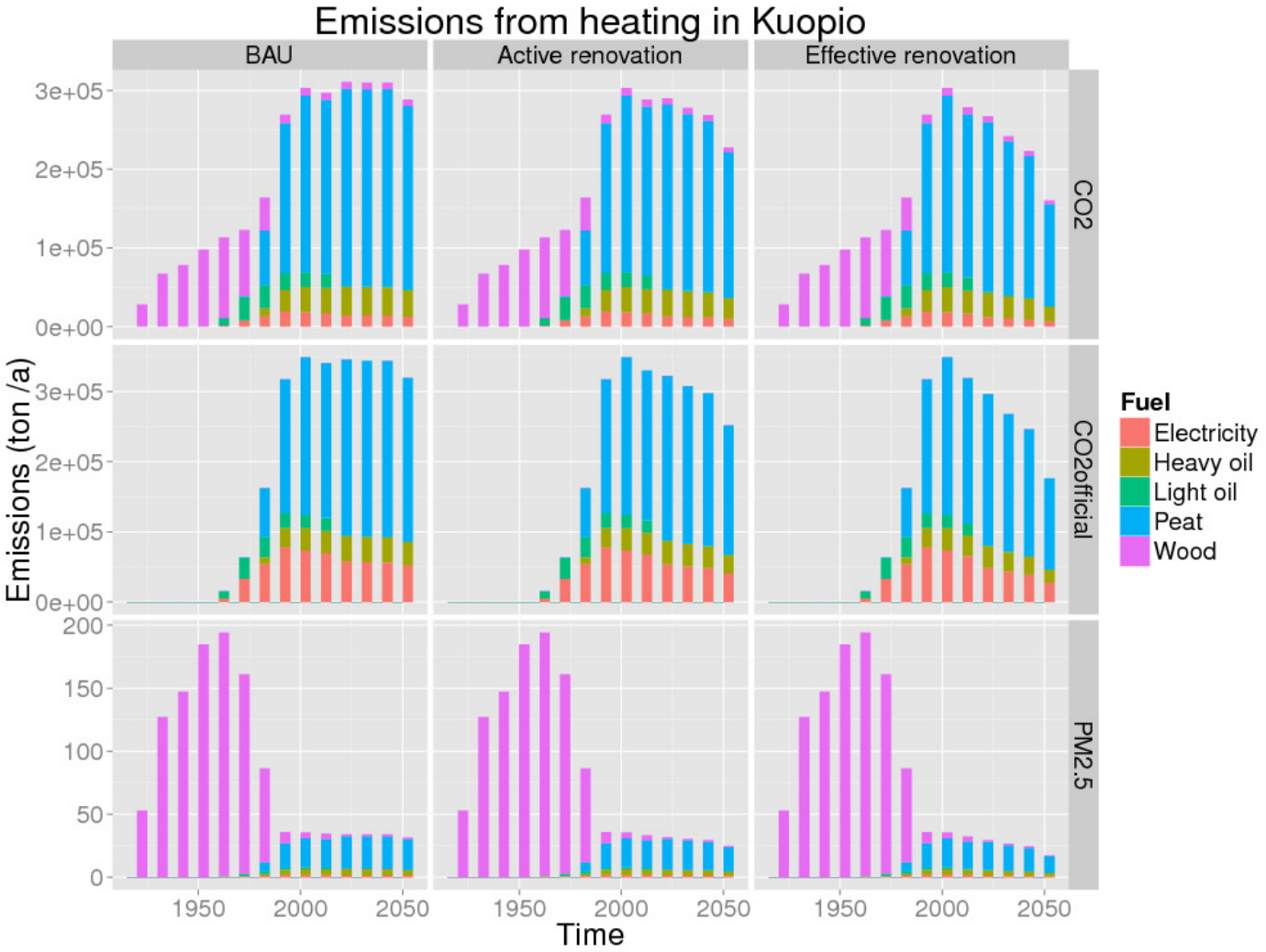

Building stock in Kuopio
Floor area (M m2)
15
10
5
0
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood

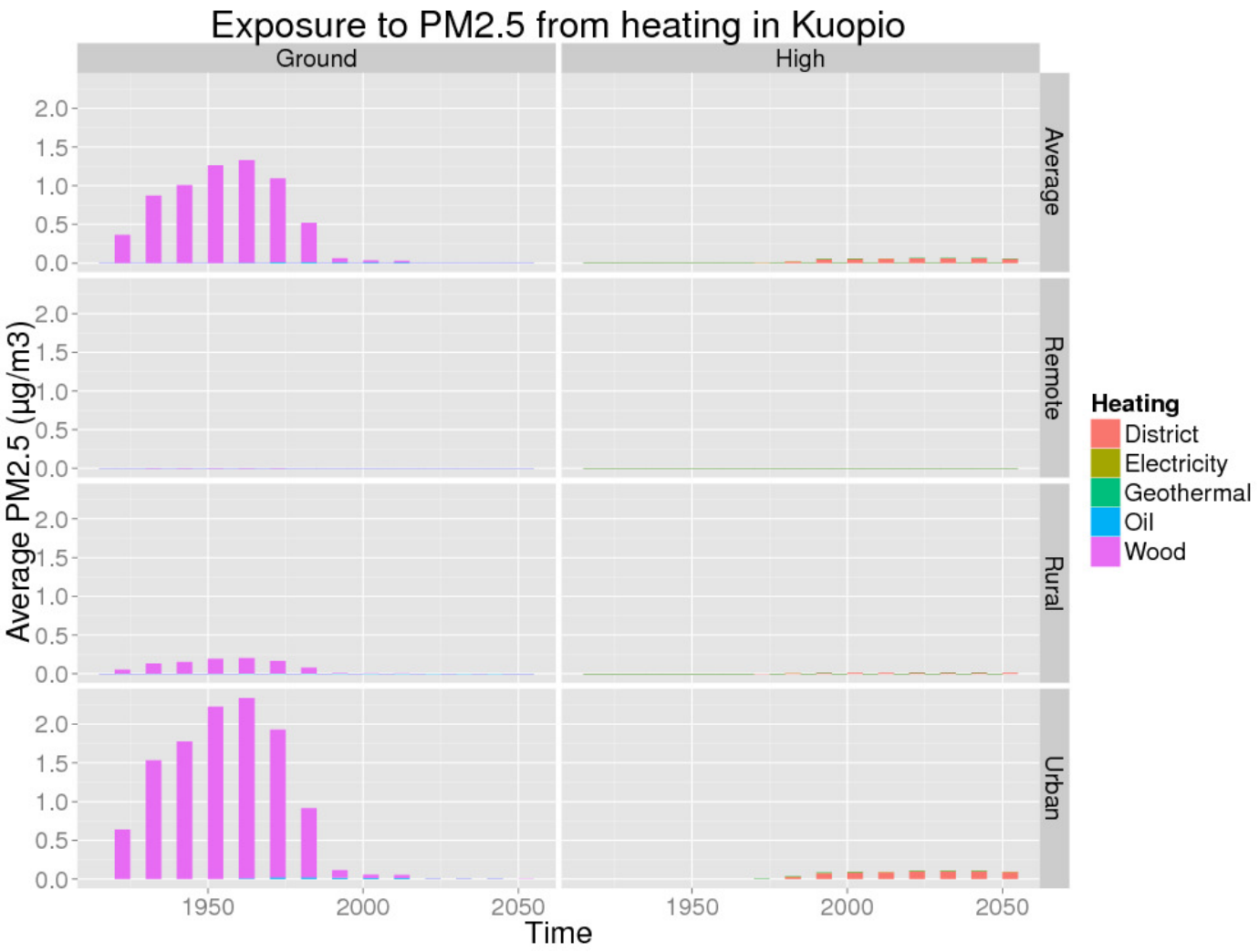

Building stock in Kuopio by renovation policy
BAU
Active renovation
Effective renovation
Floor area (M m2)
15
10
5
0
1950
2000
2050
Time
Renovation
None
General
Windows
Technical systems
Sheath reform

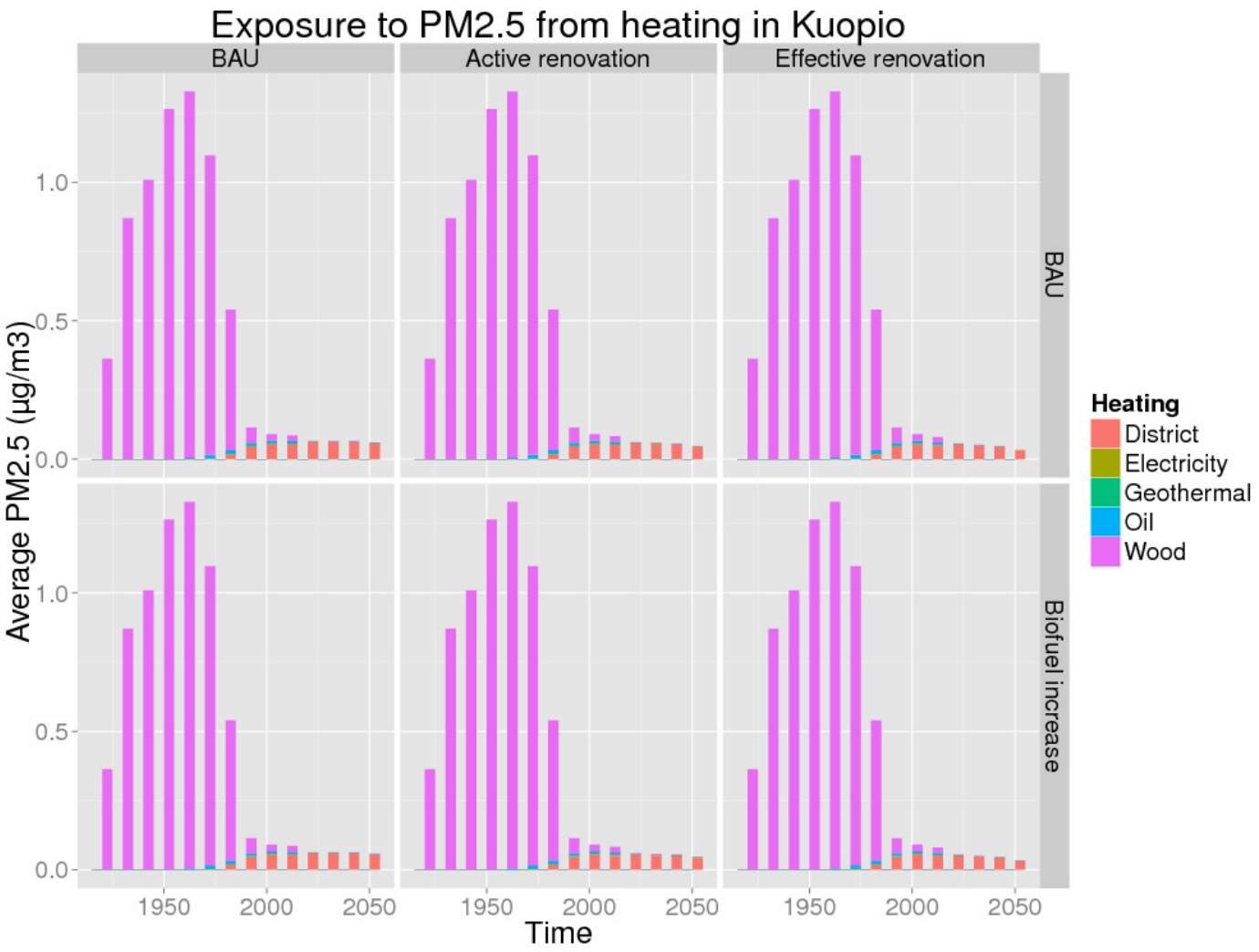

Building stock in Kuopio
Floor area (M m2)
15
10
5
0
1950
2000
2050
Time
Building
Apartment houses
Commercial
Detached houses
Educational
Health and social sector
Industrial
Leisure houses
Offices
Other
Public
Row houses
Sports

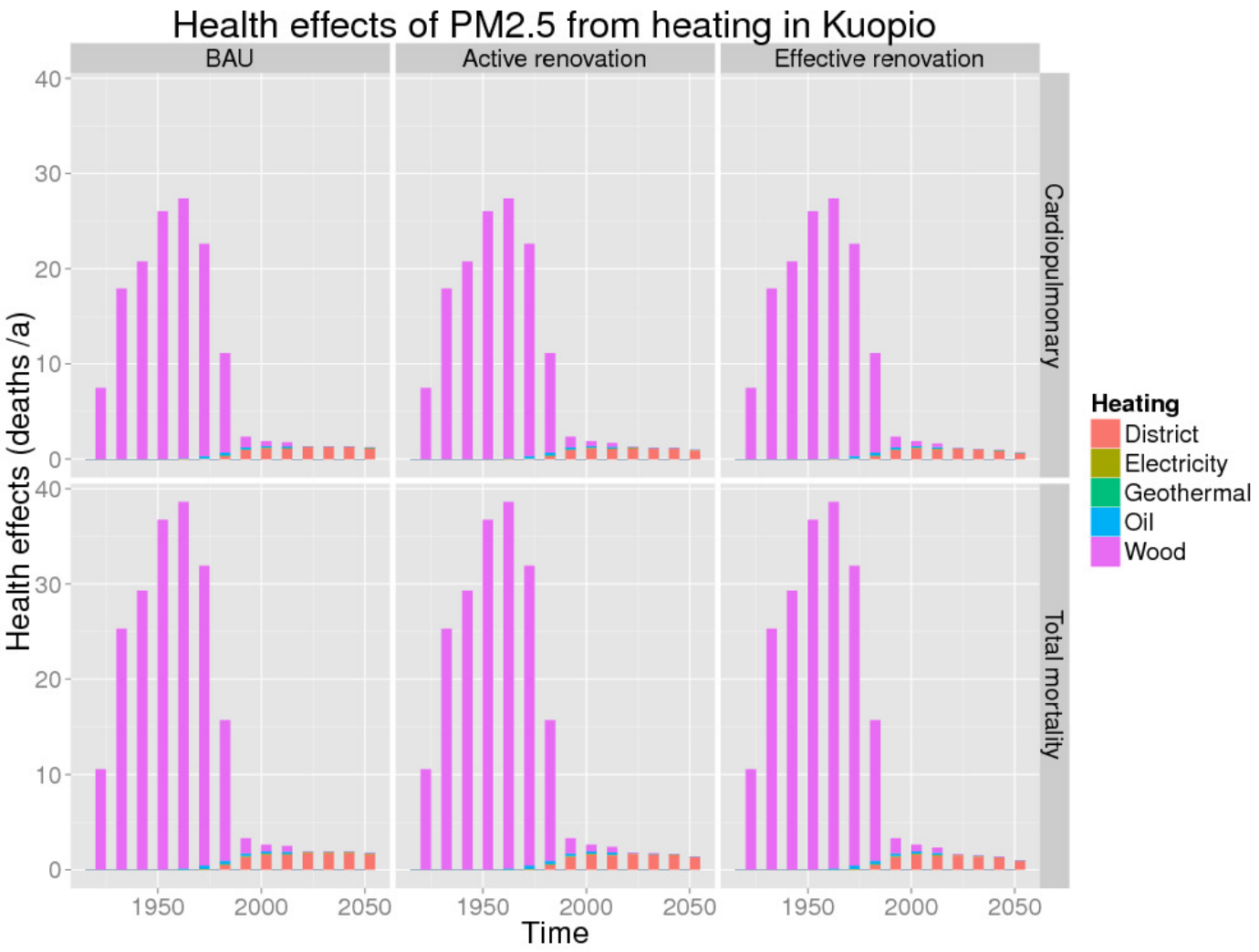

Energy used in heating in Kuopio
BAU
Active renovation
Effective renovation
Heating energy (GWh /a)
0
250
500
750
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood

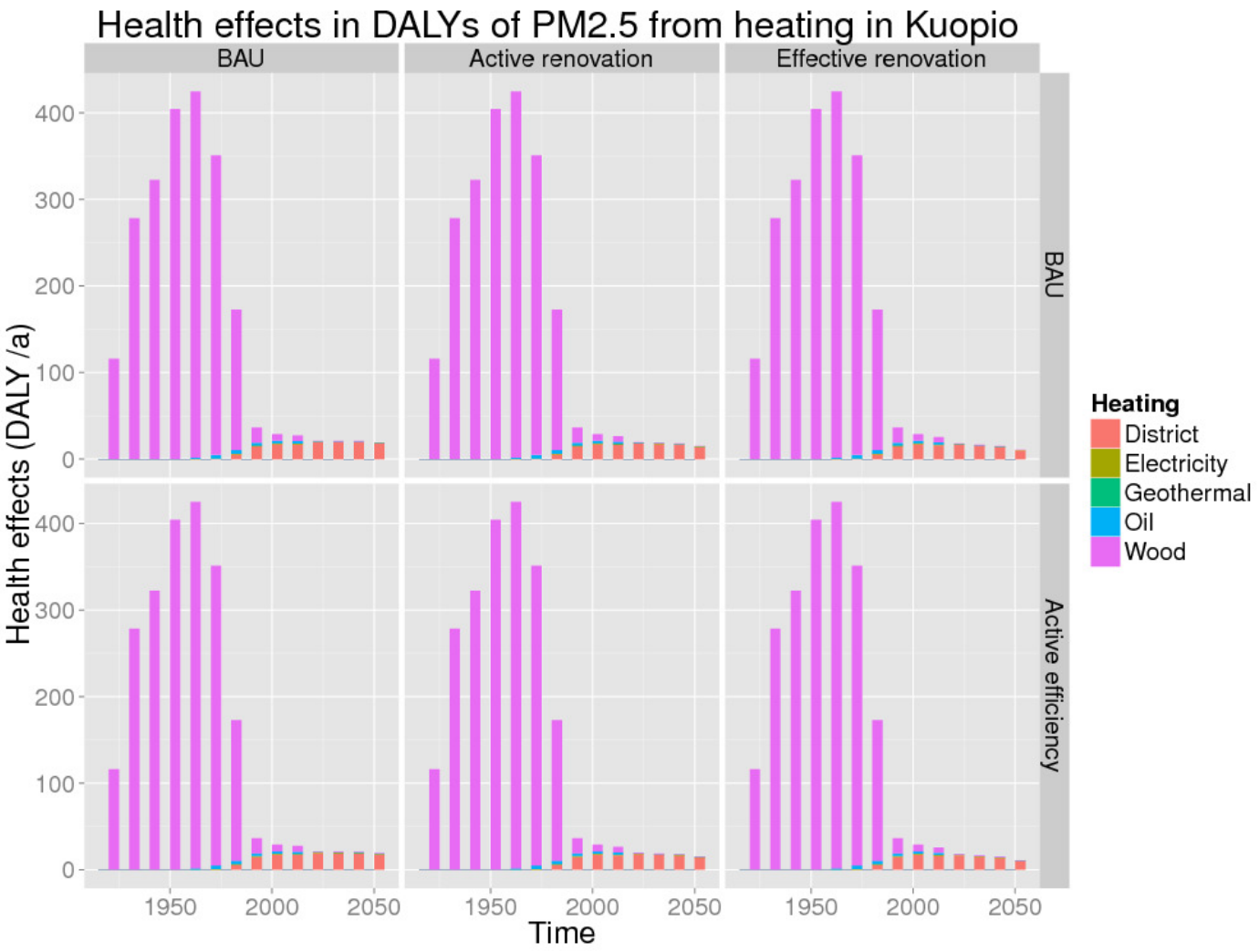

Emissions from heating in Kuopio
BAU
Biofuel increase
CO2
CO2official
PM2.5
Emissions (ton /a)
3e+05
2e+05
1e+05
0e+00
200
150
100
50
0
1950
2000
2050
Time
Fuel
Electricity
Heavy oil
Light oil
Peat
Wood

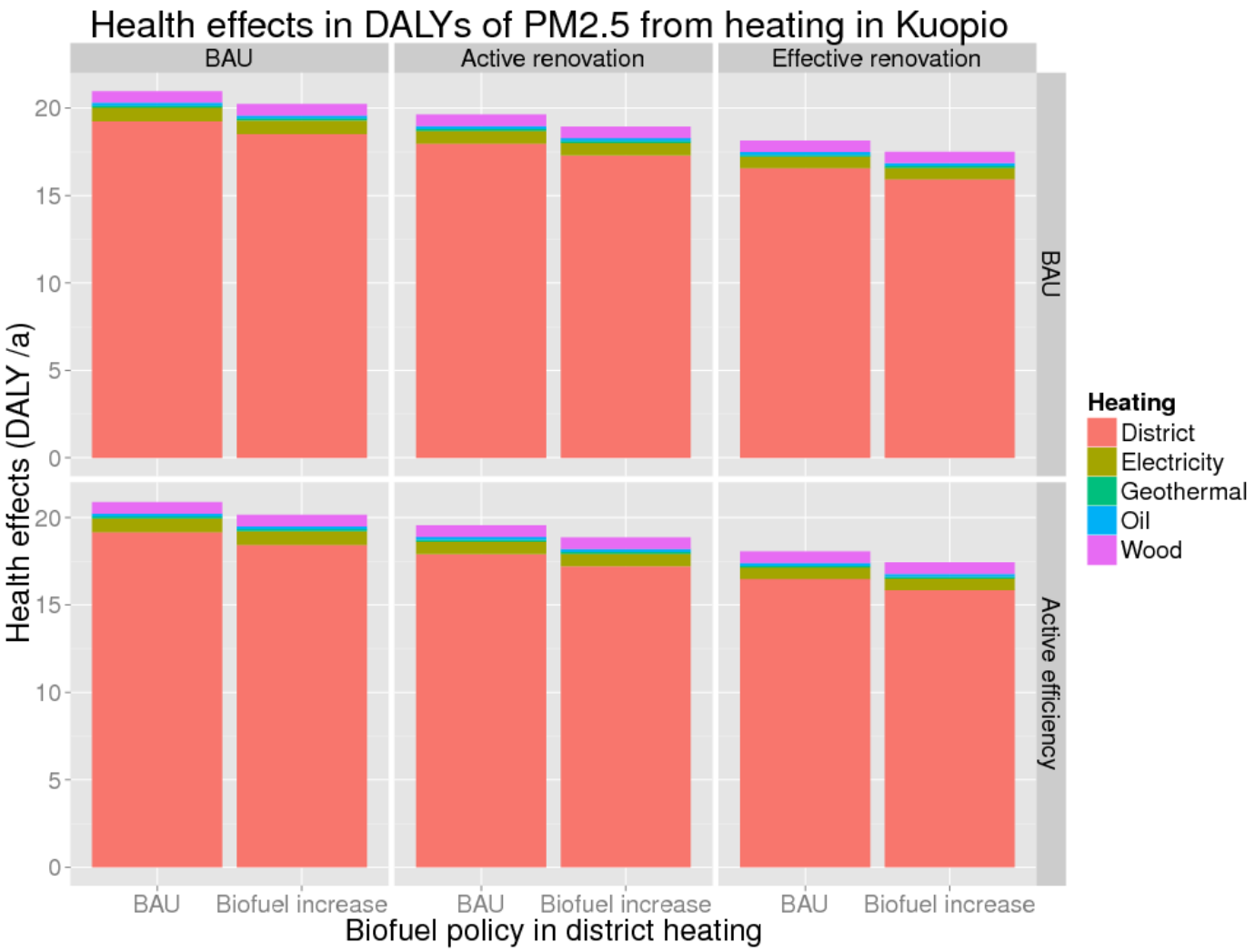

Emissions from heating in Kuopio
BAU
Active renovation
Effective renovation
CO2
CO2official
PM2.5
Emissions (ton /a)
3e+05
2e+05
1e+05
0e+00
200
150
100
50
0
1950
2000
2050
Time
Fuel
Electricity
Heavy oil
Light oil
Peat
Wood


Exposure to PM2.5 from heating in Kuopio
Ground
High
Average
Remote
Rural
Urban
Average PM2.5 (µg/m3)
0.0
0.5
1.0
1.5
2.0
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood


Exposure to PM2.5 from heating in Kuopio
BAU
Active renovation
Effective renovation
BAU
Biofuel increase
Average PM2.5 (µg/m3)
0.0
0.5
1.0
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood


Health effects of PM2.5 from heating in Kuopio
BAU
Active renovation
Effective renovation
Cardiopulmonary
Total mortality
Health effects (deaths /a)
0
10
20
30
40
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood


Health effects in DALYs of PM2.5 from heating in Kuopio
BAU
Active renovation
Effective renovation
BAU
Active efficiency
Health effects (DALY /a)
0
100
200
300
400
1950
2000
2050
Time
Heating
District
Electricity
Geothermal
Oil
Wood


Health effects in DALYs of PM2.5 from heating in Kuopio
BAU
Active renovation
Effective renovation
BAU
Active efficiency
Health effects (DALY /a)
0
5
10
15
20
BAU
Biofuel increase
Biofuel policy in district heating
Heating
District
Electricity
Geothermal
Oil
Wood