ENV 790.30 - Time Series Analysis for Energy Data | Spring 2021

Assignment 2 - Due date 01/26/22

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Submission Instructions

You should open the .rmd file corresponding to this assignment on RStudio. The file is available on our class repository on Github.

Once you have the file open on your local machine the first thing you will do is change "Student Name" on line 4 with your name. Then you will start working through the assignment by **creating code and output** that answer each question. Be sure to use this assignment document. Your report should contain the answer to each question and any plots/tables you obtained (when applicable).

When you have completed the assignment, **Knit** the text and code into a single PDF file. Rename the pdf file such that it includes your first and last name (e.g., "LuanaLima_TSA_A02_Sp22.Rmd"). Submit this pdf using Sakai.

R packages

R packages needed for this assignment:"forecast","tseries", and "dplyr". Install these packages, if you haven't done yet. Do not forget to load them before running your script, since they are NOT default packages.\

Data set information

Consider the data provided in the spreadsheet "Table_10.1_Renewable_Energy_Production_and_Consumption_by_Source on our **Data** folder. The data comes from the US Energy Information and Administration and corresponds to the January 2022 Monthly Energy Review. The spreadsheet is ready to be used. Use the command *read.table()* to import the data in R or *panda.read_excel()* in Python (note that you will need to import pandas package). }

```
#Importing data set
energy_data <- read_xlsx(path="./Data/Table_10.1_Renewable_Energy_Production_and_Consumption_by_Source.
```

Question 1

You will work only with the following columns: Total Biomass Energy Production, Total Renewable Energy Production, Hydroelectric Power Consumption. Create a data frame structure with these three time series only. Use the command head() to verify your data.

```
energy_data <- energy_data[-c(1),4:6]
head(energy_data)
```

```
## # A tibble: 6 x 3
##   `Total Biomass Energy Production` `Total Renewable Ener~ `Hydroelectric Power~
##   <chr>                             <chr>                   <chr>
## 1 129.787                           403.981                 272.703
## 2 117.338                           360.9                   242.199
## 3 129.938                           400.161                 268.81
## 4 125.636                           380.47                  253.185
## 5 129.834                           392.141                 260.77
## 6 125.611                           377.232                 249.859
```

Question 2

Transform your data frame in a time series object and specify the starting point and frequency of the time series using the function ts().

```
ts_energy_data <- ts(energy_data[,1:3])
ts_energy_data
```

```
## Time Series:
## Start = 1
## End = 585
## Frequency = 1
##     Total Biomass Energy Production Total Renewable Energy Production
##   1                              23                                 73
##   2                               2                                 38
##   3                              27                                 68
##   4                               9                                 52
##   5                              25                                 57
##   6                               8                                 47
##   7                              23                                 39
##   8                              26                                 33
##   9                              11                                 20
##  10                              28                                 21
##  11                              10                                 26
##  12                              24                                 76
##  13                              35                                121
##  14                               3                                 66
##  15                              31                                 97
##  16                              13                                 94
##  17                              34                                106
##  18                              14                                 81
##  19                              32                                 82
##  20                              33                                 54
##  21                              15                                 34
##  22                              30                                 29
##  23                              12                                 32
##  24                              29                                 46
##  25                              17                                 59
##  26                               1                                 41
##  27                              16                                 98
##  28                               4                                 75
##  29                              20                                 91
##  30                               7                                 86
```

```
##  31  19  65
##  32  22  40
##  33   6  28
##  34  21  42
##  35   5  53
##  36  18  72
##  37  43  93
##  38  36  60
##  39  44 105
##  40  37  62
##  41  42  88
##  42  38  85
##  43  45  92
##  44  46  64
##  45  39  36
##  46  47  44
##  47  40  31
##  48  48  37
##  49  59  48
##  50  41  19
##  51  58  43
##  52  52  30
##  53  57  35
##  54  51  24
##  55  53  25
##  56  55  23
##  57  50  22
##  58  56  27
##  59  49  45
##  60  54  67
##  61  69 123
##  62  60  56
##  63  70 112
##  64  63 115
##  65  67 190
##  66  62 111
##  67  66 109
##  68  72  79
##  69  64  58
##  70  71  51
##  71  65  50
##  72  68  78
##  73  78 137
##  74  61  55
##  75  84 156
##  76  74 132
##  77  82 230
##  78  73 125
##  79  79 100
##  80  83  80
##  81  75  49
##  82  80  63
##  83  76  87
##  84  81 101
```

```
##  85 111 202
##  86  89  99
##  87 110 174
##  88  96 197
##  89 104 294
##  90  94 247
##  91 105 179
##  92 107 108
##  93  97  69
##  94 108  71
##  95  98  83
##  96 106 139
##  97 146 164
##  98  92 104
##  99 148 129
## 100 123 122
## 101 142 206
## 102 121 244
## 103 140 235
## 104 141 147
## 105 124  77
## 106 147  89
## 107 122  90
## 108 143 195
## 109 164 287
## 110  99 234
## 111 160 355
## 112 132 293
## 113 159 313
## 114 133 296
## 115 162 298
## 116 161 214
## 117 134 114
## 118 166 124
## 119 135 176
## 120 163 302
## 121 250 390
## 122 152 303
## 123 251 410
## 124 205 387
## 125 252 415
## 126 206 405
## 127 253 367
## 128 254 320
## 129 207 192
## 130 255 185
## 131 208 265
## 132 256 419
## 133 291 406
## 134 191 339
## 135 293 413
## 136 227 396
## 137 290 423
## 138 228 372
```

```
## 139 295 362
## 140 296 305
## 141 230 178
## 142 298 205
## 143 235 221
## 144 300 331
## 145 326 375
## 146 186 276
## 147 327 309
## 148 266 279
## 149 321 353
## 150 267 266
## 151 322 233
## 152 325 191
## 153 268 148
## 154 323 187
## 155 269 254
## 156 324 337
## 157 278 220
## 158 154 203
## 159 274 382
## 160 216 347
## 161 273 356
## 162 217 317
## 163 276 283
## 164 277 211
## 165 220 180
## 166 275 207
## 167 221 239
## 168 279 330
## 169 238 299
## 170 144 145
## 171 240 250
## 172 197 198
## 173 233 269
## 174 200 167
## 175 242 169
## 176 244 141
## 177 199 118
## 178 234 127
## 179 198  96
## 180 237 188
## 181 312 243
## 182 209 134
## 183 315 173
## 184 259 153
## 185 311 222
## 186 264 146
## 187 318 126
## 188 320 119
## 189 265 103
## 190 316  95
## 191 258 140
## 192 313 181
```

## 193	364	271
## 194	232	162
## 195	371	332
## 196	297	324
## 197	222	391
## 198	271	360
## 199	339	310
## 200	392	280
## 201	359	225
## 202	389	274
## 203	391	300
## 204	399	336
## 205	202	275
## 206	165	268
## 207	241	400
## 208	188	325
## 209	113	312
## 210	77	261
## 211	137	252
## 212	246	246
## 213	213	136
## 214	193	160
## 215	139	159
## 216	247	322
## 217	375	404
## 218	100	166
## 219	128	297
## 220	86	241
## 221	102	348
## 222	109	284
## 223	112	253
## 224	287	277
## 225	368	238
## 226	280	168
## 227	223	170
## 228	365	321
## 229	396	340
## 230	180	142
## 231	149	210
## 232	114	133
## 233	87	150
## 234	184	248
## 235	282	223
## 236	377	236
## 237	292	157
## 238	376	182
## 239	354	249
## 240	351	358
## 241	384	394
## 242	219	196
## 243	349	354
## 244	168	318
## 245	88	343
## 246	90	264

## 247	119	237
## 248	346	258
## 249	285	163
## 250	331	172
## 251	345	208
## 252	356	295
## 253	419	359
## 254	245	186
## 255	342	326
## 256	195	291
## 257	93	242
## 258	130	245
## 259	385	345
## 260	294	216
## 261	210	113
## 262	380	193
## 263	341	213
## 264	347	278
## 265	229	292
## 266	103	201
## 267	211	366
## 268	366	341
## 269	171	335
## 270	169	385
## 271	407	433
## 272	416	416
## 273	374	251
## 274	406	381
## 275	367	374
## 276	348	418
## 277	382	437
## 278	158	408
## 279	333	450
## 280	101	377
## 281	185	427
## 282	304	439
## 283	397	441
## 284	409	426
## 285	334	282
## 286	420	403
## 287	411	386
## 288	360	430
## 289	388	453
## 290	167	392
## 291	288	452
## 292	299	434
## 293	372	455
## 294	187	440
## 295	335	443
## 296	355	398
## 297	286	281
## 298	418	414
## 299	357	315
## 300	329	349

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## 301 394 421
## 302 117 338
## 303 218 417
## 304 215 365
## 305 283 436
## 306  85 346
## 307 249 395
## 308 305 344
## 309 270 224
## 310 369 219
## 311 181 154
## 312 383 373
## 313 381 428
## 314 145 333
## 315 116 393
## 316 281 368
## 317 404 442
## 318 196 409
## 319 353 424
## 320 332 361
## 321 239 209
## 322 174 155
## 323 303 240
## 324 192 289
## 325 151 263
## 326 248 255
## 327 350 380
## 328 307 401
## 329 308 383
## 330 172 270
## 331 314 314
## 332 310 262
## 333 214 128
## 334 378 171
## 335 340 212
## 336 309 199
## 337 176 130
## 338  95  74
## 339 136 151
## 340 125 102
## 341 115 116
## 342 126 149
## 343 150 117
## 344 157 138
## 345 127  61
## 346 170  84
## 347 138  70
## 348 155 143
## 349 175 194
## 350  91 107
## 351 131 158
## 352 120 227
## 353 156 319
## 354 129 334
```

```
## 355 194 311
## 356 153 175
## 357 182 110
## 358 231 131
## 359 179 152
## 360 224 228
## 361 204 177
## 362 118 120
## 363 189 267
## 364 177 272
## 365 178 379
## 366 173 364
## 367 225 308
## 368 212 257
## 369 183 135
## 370 203 144
## 371 190 161
## 372 289 307
## 373 317 285
## 374 201 184
## 375 272 273
## 376 260 229
## 377 243 301
## 378 236 328
## 379 330 304
## 380 306 259
## 381 226 204
## 382 302 183
## 383 263 217
## 384 352 378
## 385 358 342
## 386 261 232
## 387 336 306
## 388 257 286
## 389 319 399
## 390 301 384
## 391 363 388
## 392 362 288
## 393 314 165
## 394 337 189
## 395 328 218
## 396 373 316
## 397 390 420
## 398 262 323
## 399 361 371
## 400 284 412
## 401 338 444
## 402 344 431
## 403 386 402
## 404 393 327
## 405 370 200
## 406 387 231
## 407 379 290
## 408 400 350
```

```
## 409 405 422
## 410 343 226
## 411 401 411
## 412 395 397
## 413 402 425
## 414 398 376
## 415 412 389
## 416 410 351
## 417 403 215
## 418 414 256
## 419 413 260
## 420 421 363
## 421 435 429
## 422 415 352
## 423 428 435
## 424 423 438
## 425 431 462
## 426 422 463
## 427 434 458
## 428 438 432
## 429 425 329
## 430 433 370
## 431 432 369
## 432 430 445
## 433 424 449
## 434 408 357
## 435 427 448
## 436 417 460
## 437 426 472
## 438 429 468
## 439 439 457
## 440 443 446
## 441 437 407
## 442 440 451
## 443 442 456
## 444 447 471
## 445 458 467
## 446 441 447
## 447 465 475
## 448 451 464
## 449 457 484
## 450 453 494
## 451 468 479
## 452 476 465
## 453 459 454
## 454 472 461
## 455 471 474
## 456 492 485
## 457 490 492
## 458 446 480
## 459 481 518
## 460 455 515
## 461 467 532
## 462 477 527
```

## 463	489	510
## 464	496	491
## 465	473	470
## 466	486	481
## 467	491	487
## 468	529	504
## 469	488	499
## 470	454	473
## 471	475	508
## 472	452	497
## 473	474	512
## 474	460	503
## 475	461	488
## 476	470	482
## 477	449	459
## 478	456	466
## 479	450	469
## 480	464	496
## 481	478	509
## 482	445	477
## 483	485	502
## 484	469	519
## 485	498	537
## 486	493	524
## 487	524	516
## 488	510	490
## 489	482	476
## 490	518	489
## 491	515	495
## 492	558	511
## 493	528	523
## 494	462	478
## 495	534	536
## 496	503	543
## 497	526	540
## 498	531	538
## 499	562	526
## 500	551	493
## 501	507	483
## 502	538	500
## 503	525	513
## 504	573	528
## 505	542	522
## 506	466	498
## 507	519	531
## 508	497	525
## 509	530	521
## 510	523	507
## 511	557	514
## 512	552	506
## 513	504	486
## 514	520	501
## 515	521	520
## 516	559	549

```
## 517  544  545
## 518  499  535
## 519  546  565
## 520  487  551
## 521  533  553
## 522  536  534
## 523  555  542
## 524  568  517
## 525  517  505
## 526  537  529
## 527  545  530
## 528  583  566
## 529  565  562
## 530  483  544
## 531  560    8
## 532  502    1
## 533  541   14
## 534  532  581
## 535  556  561
## 536  572  541
## 537  516  533
## 538  554  552
## 539  563  550
## 540  579  560
## 541  577  575
## 542  508  558
## 543  576    5
## 544  535    7
## 545  570   15
## 546  561    9
## 547  580  567
## 548  582  572
## 549  539  539
## 550  575  554
## 551  566  557
## 552  581  569
## 553  569  571
## 554  494  547
## 555  553  585
## 556  527   12
## 557  564   16
## 558  550    4
## 559  574  584
## 560  571  570
## 561  512  556
## 562  549  564
## 563  547  555
## 564  578  568
## 565  567  577
## 566  506  579
## 567  522  583
## 568  436  559
## 569  448    6
## 570  463   13
```

```
## 571                                495                                582
## 572                                500                                573
## 573                                479                                548
## 574                                501                                563
## 575                                505                                576
## 576                                540                                578
## 577                                509                                  2
## 578                                444                                546
## 579                                511                                 17
## 580                                480                                 11
## 581                                543                                 18
## 582                                514                                 10
## 583                                548                                580
## 584                                513                                  3
## 585                                484                                574
##     Hydroelectric Power Consumption
##   1                             460
##   2                             334
##   3                             449
##   4                             383
##   5                             419
##   6                             362
##   7                             307
##   8                             245
##   9                              56
##  10                              97
##  11                             185
##  12                             469
##  13                             548
##  14                             483
##  15                             506
##  16                             518
##  17                             523
##  18                             485
##  19                             473
##  20                             382
##  21                             262
##  22                             187
##  23                             250
##  24                             340
##  25                             430
##  26                             368
##  27                             521
##  28                             482
##  29                             512
##  30                             495
##  31                             445
##  32                             314
##  33                             214
##  34                             317
##  35                             400
##  36                             463
##  37                             466
##  38                             404
```

```
##  39                          477
##  40                          387
##  41                          442
##  42                          446
##  43                          464
##  44                          361
##  45                          200
##  46                          240
##  47                          172
##  48                          196
##  49                          226
##  50                           18
##  51                          182
##  52                          118
##  53                          120
##  54                           67
##  55                           51
##  56                           48
##  57                           41
##  58                           66
##  59                          215
##  60                          328
##  61                          425
##  62                          295
##  63                          409
##  64                          435
##  65                          538
##  66                          429
##  67                          398
##  68                          292
##  69                          244
##  70                          154
##  71                          175
##  72                          289
##  73                          423
##  74                          253
##  75                          454
##  76                          438
##  77                          543
##  78                          421
##  79                          318
##  80                          248
##  81                          126
##  82                          190
##  83                          300
##  84                          316
##  85                          436
##  86                          259
##  87                          395
##  88                          450
##  89                          544
##  90                          507
##  91                          403
##  92                          209
```

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##  93                          106
##  94                           82
##  95                          145
##  96                          299
##  97                          311
##  98                          254
##  99                          223
## 100                          230
## 101                          392
## 102                          478
## 103                          437
## 104                          274
## 105                           85
## 106                           94
## 107                          136
## 108                          373
## 109                          493
## 110                          488
## 111                          558
## 112                          524
## 113                          527
## 114                          526
## 115                          502
## 116                          375
## 117                          184
## 118                          174
## 119                          355
## 120                          516
## 121                          552
## 122                          529
## 123                          565
## 124                          563
## 125                          576
## 126                          569
## 127                          532
## 128                          468
## 129                          287
## 130                          235
## 131                          422
## 132                          578
## 133                          557
## 134                          519
## 135                          564
## 136                          559
## 137                          577
## 138                          546
## 139                          505
## 140                          434
## 141                          237
## 142                          234
## 143                          304
## 144                          457
## 145                          510
## 146                          465
```

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## 147 418
## 148 411
## 149 479
## 150 377
## 151 263
## 152 188
## 153 124
## 154 191
## 155 332
## 156 441
## 157 267
## 158 351
## 159 535
## 160 508
## 161 501
## 162 476
## 163 389
## 164 256
## 165 251
## 166 261
## 167 343
## 168 467
## 169 444
## 170 255
## 171 350
## 172 293
## 173 394
## 174 238
## 175 199
## 176 107
## 177  96
## 178  88
## 179  52
## 180 246
## 181 284
## 182 130
## 183 157
## 184 134
## 185 249
## 186 121
## 187  50
## 188  37
## 189  34
## 190  14
## 191 101
## 192 171
## 193 257
## 194 127
## 195 335
## 196 408
## 197 534
## 198 474
## 199 337
## 200 218
```

```
## 201 147
## 202 210
## 203 270
## 204 297
## 205 384
## 206 426
## 207 539
## 208 472
## 209 514
## 210 533
## 211 407
## 212 283
## 213  79
## 214 149
## 215 227
## 216 432
## 217 484
## 218 326
## 219 490
## 220 487
## 221 551
## 222 486
## 223 439
## 224 313
## 225 144
## 226 103
## 227 146
## 228 325
## 229 308
## 230 115
## 231 315
## 232 197
## 233 336
## 234 347
## 235 205
## 236 125
## 237  70
## 238  60
## 239 193
## 240 415
## 241 448
## 242 222
## 243 385
## 244 471
## 245 560
## 246 500
## 247 391
## 248 220
## 249  83
## 250  81
## 251 112
## 252 290
## 253 233
## 254 186
```

```
## 255 339
## 256 390
## 257 440
## 258 410
## 259 329
## 260 179
## 261  36
## 262  63
## 263 119
## 264 281
## 265 399
## 266 412
## 267 522
## 268 386
## 269 497
## 270 553
## 271 492
## 272 369
## 273 166
## 274 319
## 275 431
## 276 537
## 277 562
## 278 572
## 279 583
## 280 573
## 281 581
## 282 575
## 283 531
## 284 455
## 285 276
## 286 298
## 287 342
## 288 556
## 289 579
## 290 566
## 291 585
## 292 570
## 293 582
## 294 584
## 295 568
## 296 470
## 297 322
## 298 379
## 299 333
## 300 433
## 301 520
## 302 550
## 303 567
## 304 513
## 305 580
## 306 574
## 307 515
## 308 397
```

```
## 309 195
## 310 100
## 311 155
## 312 401
## 313 540
## 314 517
## 315 571
## 316 480
## 317 528
## 318 555
## 319 545
## 320 428
## 321 202
## 322 151
## 323 221
## 324 393
## 325 413
## 326 279
## 327 458
## 328 509
## 329 481
## 330 402
## 331 356
## 332 258
## 333  65
## 334  46
## 335 111
## 336 138
## 337 108
## 338  61
## 339 192
## 340  74
## 341 123
## 342 204
## 343  77
## 344 110
## 345  13
## 346  11
## 347  15
## 348 131
## 349 243
## 350 161
## 351 203
## 352 358
## 353 452
## 354 498
## 355 414
## 356 207
## 357  42
## 358  45
## 359 137
## 360 236
## 361 173
## 362 133
```

```
## 363 348
## 364 366
## 365 530
## 366 504
## 367 371
## 368 294
## 369  78
## 370  76
## 371 129
## 372 341
## 373 282
## 374 181
## 375 280
## 376 178
## 377 327
## 378 381
## 379 296
## 380 219
## 381 163
## 382  87
## 383 183
## 384 424
## 385 338
## 386 217
## 387 278
## 388 285
## 389 461
## 390 443
## 391 416
## 392 213
## 393  39
## 394  58
## 395 104
## 396 241
## 397 456
## 398 353
## 399 344
## 400 491
## 401 549
## 402 525
## 403 376
## 404 212
## 405  35
## 406  32
## 407 142
## 408 206
## 409 405
## 410  71
## 411 320
## 412 309
## 413 406
## 414 264
## 415 247
## 416 117
```

```
## 417   1
## 418   2
## 419   9
## 420  64
## 421 158
## 422  73
## 423 201
## 424 228
## 425 447
## 426 499
## 427 372
## 428 177
## 429  16
## 430   5
## 431   7
## 432 162
## 433 277
## 434  43
## 435 198
## 436 370
## 437 503
## 438 496
## 439 273
## 440  93
## 441  33
## 442  98
## 443 160
## 444 330
## 445 224
## 446 139
## 447 153
## 448  75
## 449 345
## 450 511
## 451 323
## 452 116
## 453  29
## 454  38
## 455  92
## 456 265
## 457 360
## 458 301
## 459 541
## 460 542
## 461 561
## 462 554
## 463 547
## 464 365
## 465 169
## 466  99
## 467 140
## 468 286
## 469 231
## 470 102
```

```
## 471 357
## 472 364
## 473 459
## 474 388
## 475 374
## 476 229
## 477  28
## 478  10
## 479  55
## 480 225
## 481 312
## 482 109
## 483 114
## 484 324
## 485 453
## 486 420
## 487 417
## 488 165
## 489  19
## 490  24
## 491  31
## 492 143
## 493 164
## 494  27
## 495 288
## 496 331
## 497 378
## 498 346
## 499 291
## 500  84
## 501   6
## 502  22
## 503  49
## 504 194
## 505 260
## 506 168
## 507 266
## 508 180
## 509  80
## 510  91
## 511 113
## 512  54
## 513   3
## 514   8
## 515  59
## 516 216
## 517 310
## 518 252
## 519 380
## 520 321
## 521 305
## 522 208
## 523 122
## 524  62
```

```
## 525   4
## 526  17
## 527  40
## 528 170
## 529 352
## 530 232
## 531 462
## 532 451
## 533 536
## 534 489
## 535 349
## 536 148
## 537  47
## 538  21
## 539  68
## 540 159
## 541 272
## 542 269
## 543 306
## 544 396
## 545 475
## 546 367
## 547 275
## 548 135
## 549  44
## 550  53
## 551 128
## 552 167
## 553 239
## 554 152
## 555 302
## 556 359
## 557 494
## 558 363
## 559 242
## 560 141
## 561  25
## 562  20
## 563  57
## 564  95
## 565 211
## 566 271
## 567 176
## 568 150
## 569 427
## 570 354
## 571 303
## 572 156
## 573  23
## 574  26
## 575  69
## 576  86
## 577 268
## 578  90
```

```
## 579                              89
## 580                              30
## 581                             132
## 582                             189
## 583                             105
## 584                              72
## 585                              12
```

Question 3

Compute mean and standard deviation for these three series.

```
mean(ts_energy_data[,1])
```

```
## [1] 291.5778
```

```
mean(ts_energy_data[,2])
```

```
## [1] 293
```

```
mean(ts_energy_data[,3])
```

```
## [1] 293
```

```
sd(ts_energy_data[,1])
```

```
## [1] 168.5232
```

```
sd(ts_energy_data[,2])
```

```
## [1] 169.0192
```

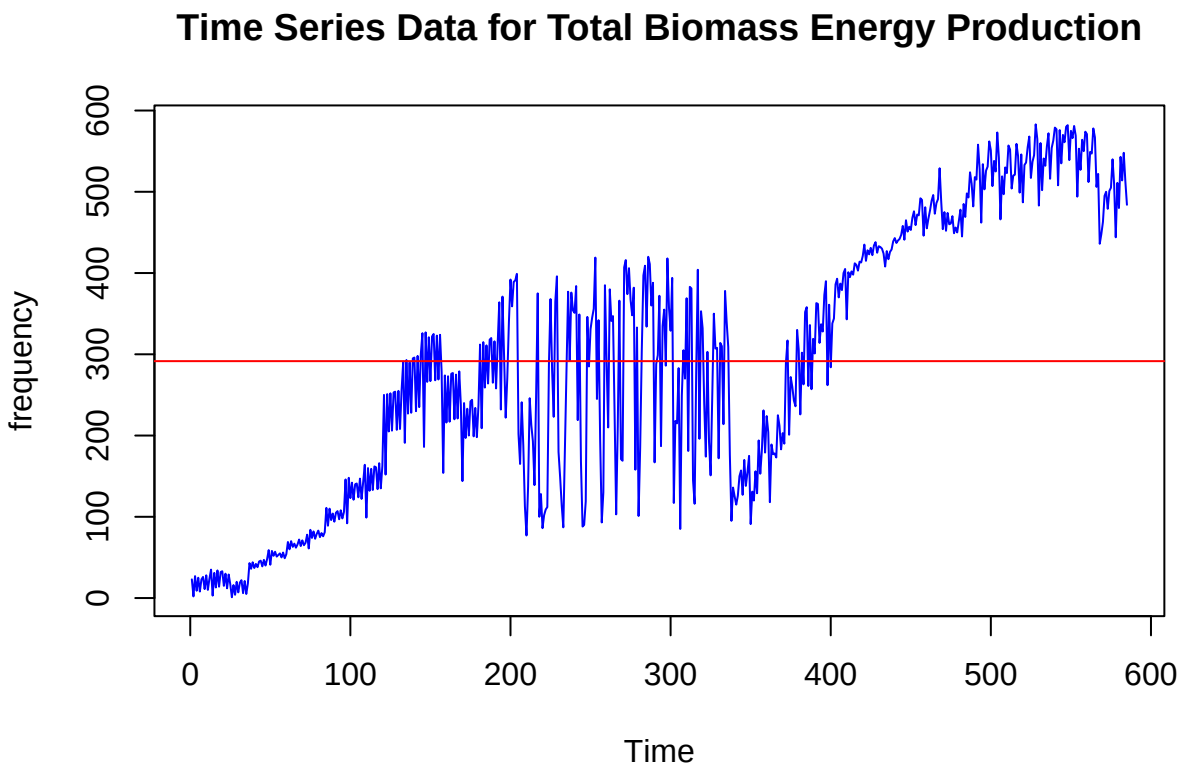
```
sd(ts_energy_data[,3])
```

```
## [1] 169.0192
```

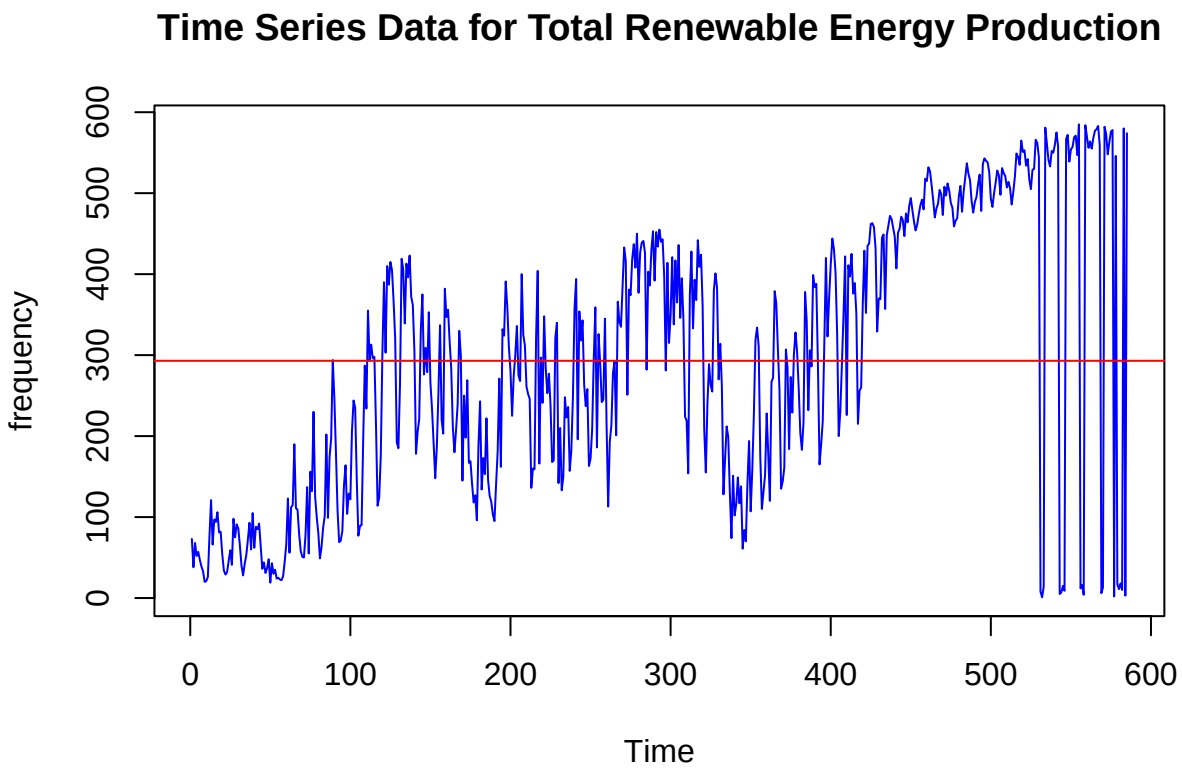
Question 4

Display and interpret the time series plot for each of these variables. Try to make your plot as informative as possible by writing titles, labels, etc. For each plot add a horizontal line at the mean of each series in a different color.

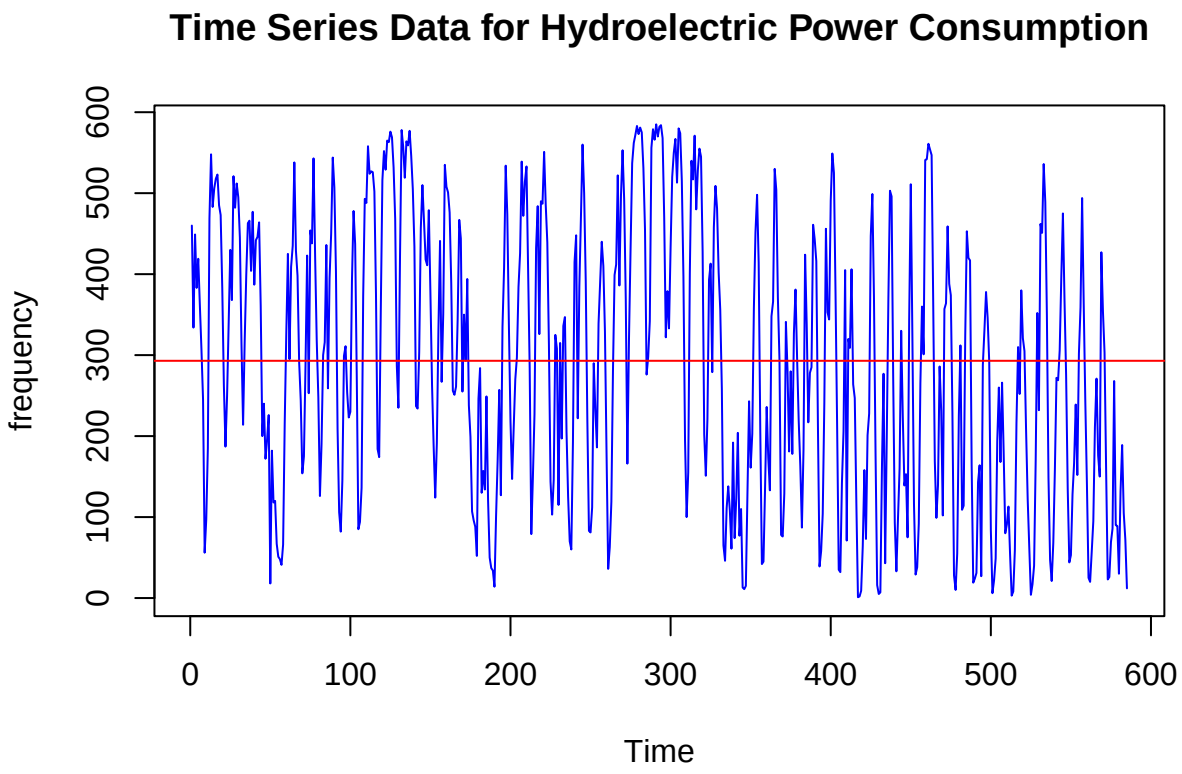
```
plot(ts_energy_data[,1],col="blue",ylab="frequency",main="Time Series Data for Total Biomass Energy Pro
abline(h=mean(ts_energy_data[,1]),col="red")
```




```
plot(ts_energy_data[,2],col="blue",ylab="frequency",main="Time Series Data for Total Renewable Energy P
abline(h=mean(ts_energy_data[,2]),col="red")
```




```
plot(ts_energy_data[,3],col="blue",ylab="frequency",main="Time Series Data for Hydroelectric Power Consu
abline(h=mean(ts_energy_data[,3]),col="red")
```



Question 5

Compute the correlation between these three series. Are they significantly correlated? Explain your answer. None of the three series are signifacntly correlated as the probability value for each correlation is above the absolute value of 0.5

```
cor(ts_energy_data[,1],ts_energy_data[,2])
```

```
## [1] 0.7325836
```

```
cor(ts_energy_data[,1],ts_energy_data[,3])
```

```
## [1] -0.2724661
```

```
cor(ts_energy_data[,2],ts_energy_data[,3])
```

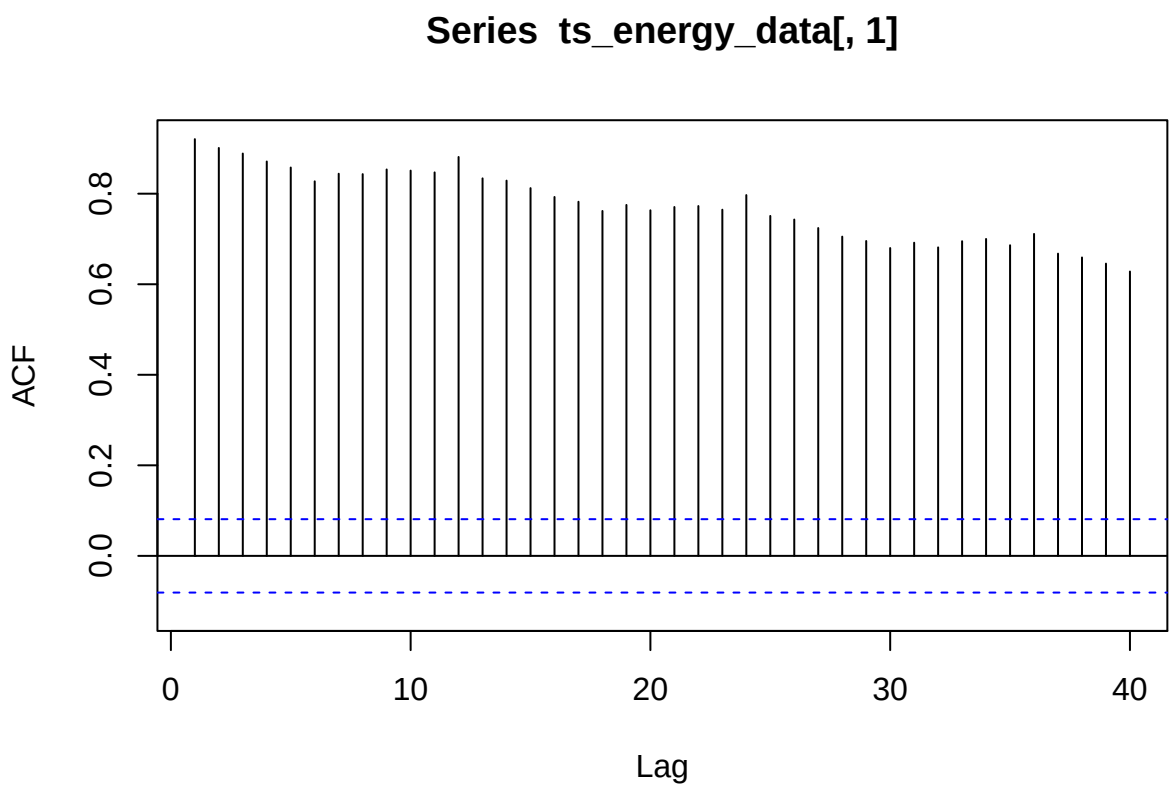
```
## [1] 0.06868406
```

Question 6

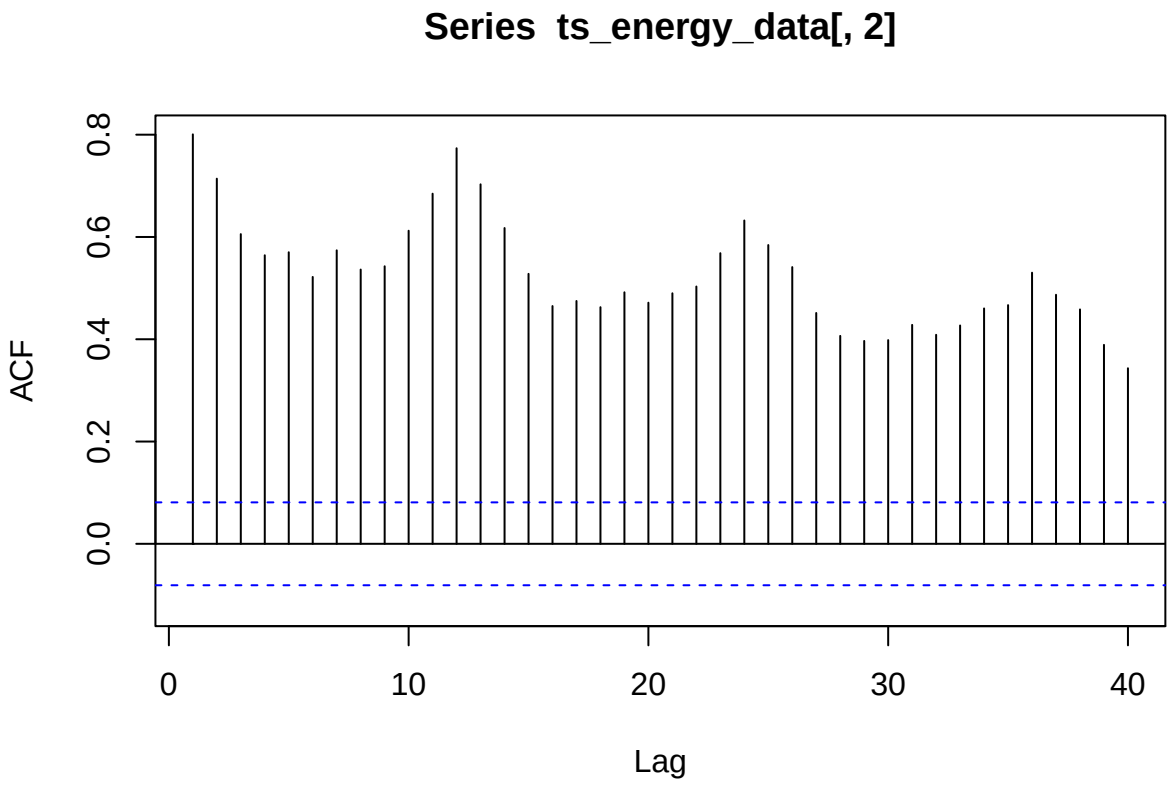
Compute the autocorrelation function from lag 1 up to lag 40 for these three variables. What can you say about these plots? Do the three of them have the same behavior? All three of these plots show some form of

seasonality. The first graph has the least amount of seasonality, the second has a little more, and the third graph has the most seasonality.

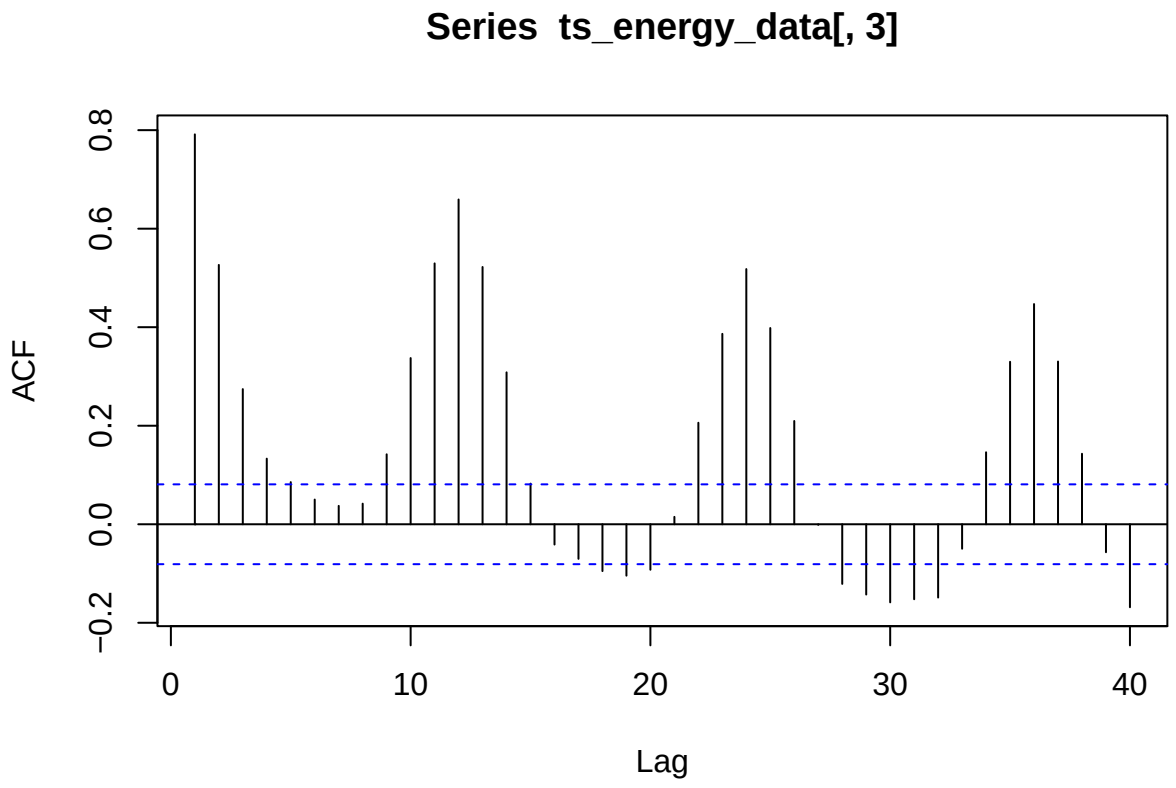
```
TBEP_acf=Acf(ts_energy_data[,1],lag.max=40, type="correlation", plot=TRUE)
```




```
TREP_acf=Acf(ts_energy_data[,2],lag.max=40, type="correlation", plot=TRUE)
```



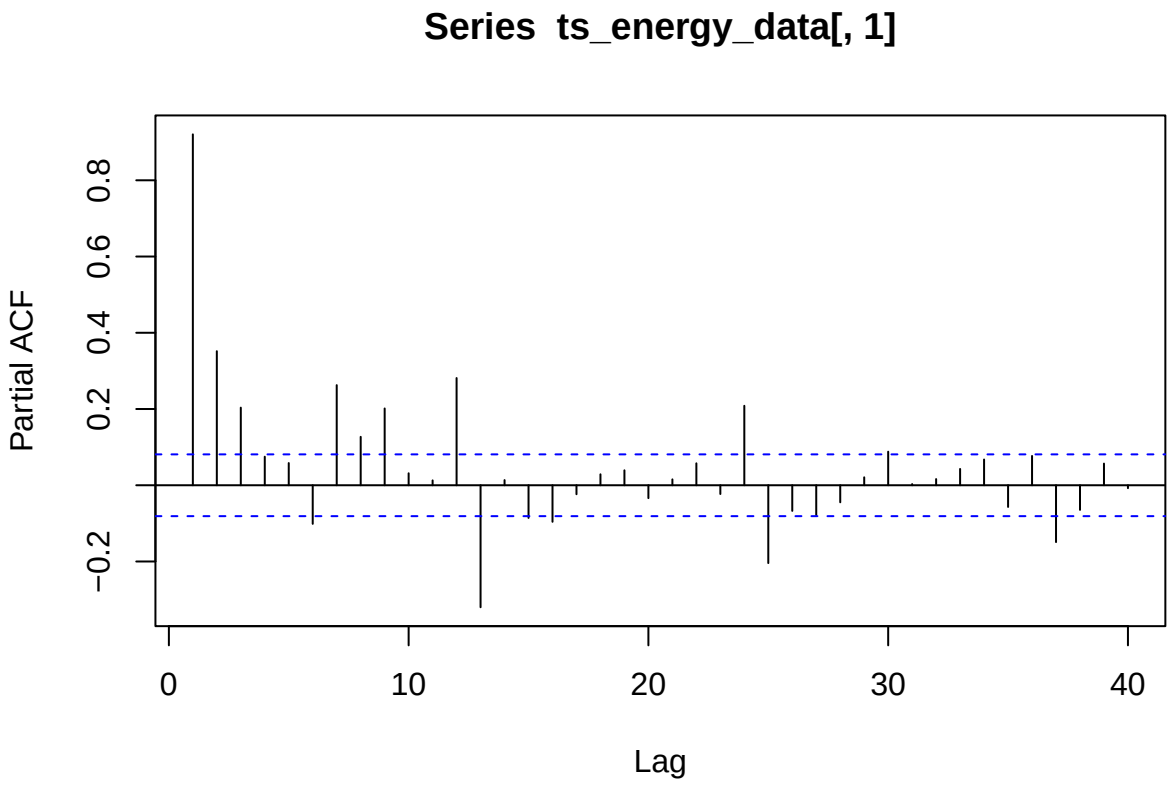

```
HPC_acf=Acf(ts_energy_data[,3],lag.max=40, type="correlation", plot=TRUE)
```



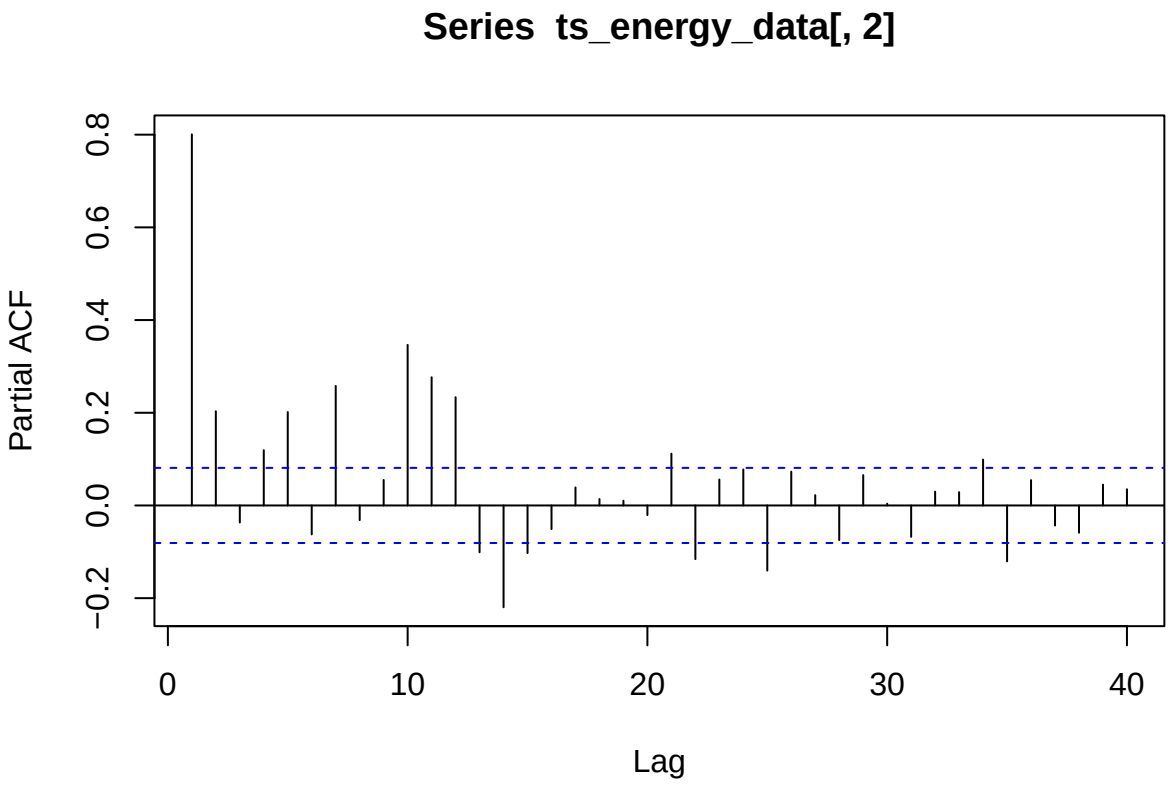
Question 7

Compute the partial autocorrelation function from lag 1 to lag 40 for these three variables. How these plots differ from the ones in Q6? Since the PACF graph looks to remove the seasonality from the graphs in Q6, you can see that there is less of a seasonal distribution in the below graphs across each three variables.

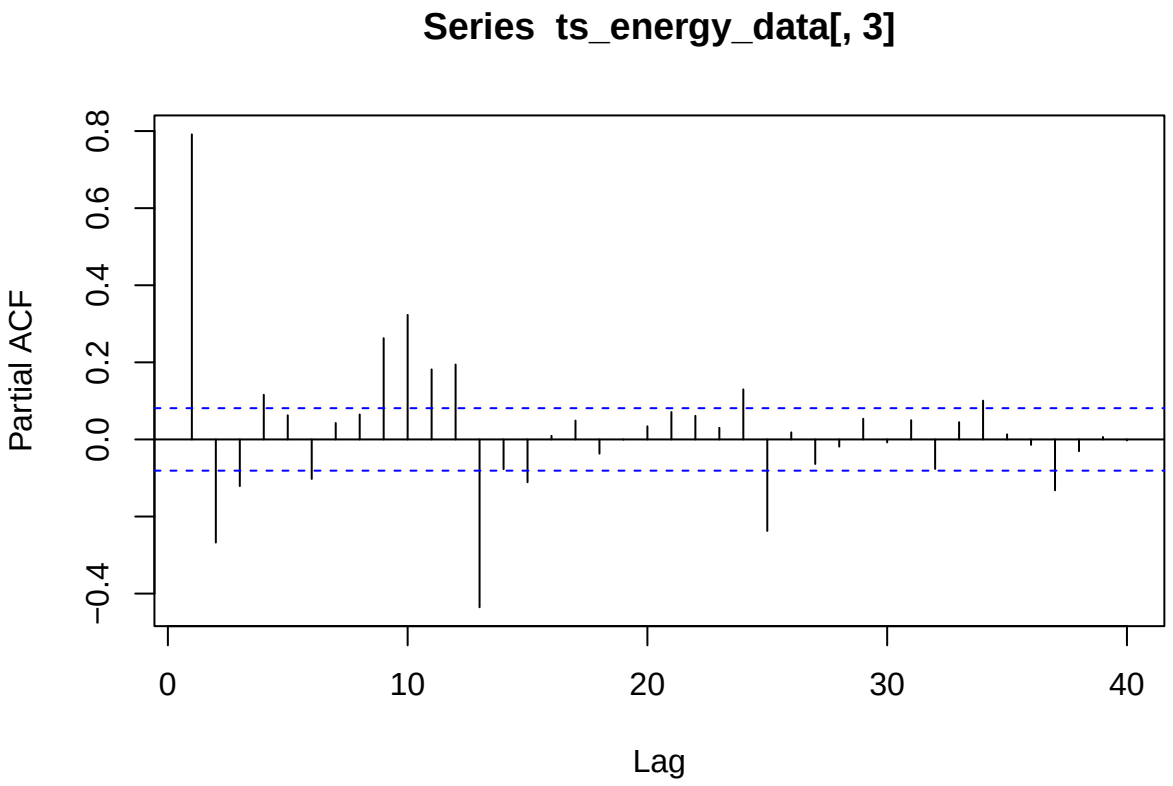
```
TBEP_pacf=Pacf(ts_energy_data[,1],lag.max=40, plot=TRUE)
```




```
TREP_pacf=Pacf(ts_energy_data[,2],lag.max=40, plot=TRUE)
```




```
HPC_pacf=Pacf(ts_energy_data[,3],lag.max=40, plot=TRUE)
```


Series ts_energy_data[, 3]
Partial ACF
0.8
0.6
0.4
0.2
0.0
−0.4
0
10
20
30
40
Lag