Comments on plots for *elec\_heat\_v2g50*

# Electricity Analysis - Mismatch

## Principal Component 1

1. Monopole across whole of Europe
2. Strong daily frequency and semi-strong half-daily frequency
3. Clear daily pattern with peak at noon (11-13)
4. Large fluctuations during yearly average, with increased amplitudes in winter months
5. Primary contribution from Solar PV, with Wind and Solar PV /Load Electricity being the two second largest influencers
6. Primary response from Transport Couple with a minor response from Storage/Transport Couple covariance and Heat couple
7. Large covariance between Solar PV/Transport Couple

## Principal Component 2

1. North-South dipole split of Europe
2. Strong daily frequency and semi-strong half-daily frequency
3. Clear daily pattern with peaks at noon (11-13), but with lower amplitude compared to PC1
4. Large fluctuations for yearly average, with increased amplitude in winter months
5. Primary contribution from Wind together with a medium contribution from Solar PV and Solar PV/Wind covariance
6. Primary response with Heating Couple, and 6 additional sub-responses in range between 5-10% significance each
7. Half are Wind/Heat Couple covariance

## Principal Component 3

1. East-West dipole split of Europe
2. Strong daily frequency
3. Semi-weak average daily pattern with maxima in the morning (7-9) and minima in the evening (14-16)
4. Large fluctuations over yearly average
5. Primary contribution from Wind only
6. Response from Heat Couple and Transport Couple with several small coherence responses as well
7. Mainly Wind/Heat Couple covariance with Wind/Transport Couple covariance as second most

## Principal Component 4

1. No obvious pattern across Europe, but with France standing out
2. Weak daily frequency and what is assumed 14-day frequency
3. No real pattern from average daily plot
4. Large fluctuations over the yearly average with minor peak during summer months
5. Primary response from Wind
6. 4 almost equally sized responses from Heat Couple, Import-Export, Transport couple/Heat Couple covariance and Transport Couple
7. Mainly Wind covariances contributing

## Principal Component 5

1. Monopole of Europe with the exception of Germany
2. Weak half-daily and daily frequency
3. No real pattern from daily average
4. Large fluctuations across yearly average
5. Primary contribution from Wind with small Solar PV contribution as well
6. Primary response from Heat Couple with small Transport Couple response as well
7. High Wind/Heat Couple covariance with other wind covariances contributing as well

## Principal Component 6

1. No real pattern across Europe with Spain and Italy being the two largest in amplitude, but with opposite sign
2. Strong daily and half-daily frequency
3. Clear pattern across daily average with minima in the morning (7-9) and maxima in the evening (15-17)
4. Lower fluctuations across the yearly average plot, compared to previous PC’s
5. Primary contribution from Solar PV with notable contribution from Wind as well
6. Primary response from Transport Couple with multiple minor responses as well
7. High Solar PV/Transport Couple covariance with Solar PV/Storage as second contribution

# Heating Analysis - Mismatch

## Principal Component 1

1. Monopole across Europe with France and Germany being the largest in amplitude
2. Strong daily frequency as well as semi-strong half-daily frequency
3. Strong daily pattern with maxima in the noon (11-13)
4. Strong yearly pattern with seasonal maxima during summer months
5. Multiple notable contribution from Central-Urban Solar Collector, Load Heat/Load Urban Heat covariance and more
6. Primary response from Storage and notable response from Electricity Couple
7. Highest contribution from Central-Urban Solar Collector/Storage

## Principal Component 2

1. No clear division of Europe, but with France and Germany again being largest in amplitude, but with different signs
2. Semi-strong half-daily and daily frequency
3. Clear daily pattern with minima at noon (11-13) and opposite of PC 1
4. Weak yearly pattern across yearly average plot with small fluctuations
5. Primary contribution from Central-Urban Solar Collector and notable contribution from Load Heat/Load Urban Heat covariance
6. Three primary responses from Storage, Electricity Couple and Storage/Electricity Couple covariance
7. Highest contribution from Central-Urban Solar Collector/Storage

## Principal Component 3

1. East-West dipole division of Europe with Italy being the largest in amplitude
2. Strong half-daily and daily frequency
3. Weak daily pattern with minor maxima at morning ( 7-9) and minor minima at afternoon (14-16)
4. No obvious pattern across yearly average, with low fluctuations
5. Multiple notable contributions from Central-Urban Solar Collector, Solar Collector, Load Heat/Load Urban Heat covariance and more
6. Primary response from storage with two notable responses from Electricity Couple and Storage/Electricity Couple covariance
7. Largest contribution from Central-Urban Solar Collector/Storage with Solar Collector/Storage as secound

# Transport Analysis - Mismatch

## Principal Component 1

1. Monopole across whole of Europe
2. Strong daily frequency
3. Clear daily pattern with maxima at 2-4 in the night and global minima at 15-17 in the afternoon. Additional local minima at 7-9 in the morning
4. Minor pattern across yearly average with peaks during summer months. Very clear (daily) fluctuations

## Principal Component 2

1. Monopole across whole of Europe with except from UK and Portugal.
2. Strong daily frequency
3. Minor daily pattern with minima at the morning (5-7) and maxima at the evening (18-20)
4. No clear pattern across yearly average

# Electricity Analysis – Nodal Price

## Principal Component 1

1. Monopole across Europe
2. Small daily frequency and a high peak at the year mark
3. Clear daily pattern with positive from 5 am to 3 pm
4. Large fluctuations throughout the year with more positive values at summer. Very large negative spike at the beginning of the year

## Principal Component 2

1. North-South bipolar Europa with UK being of largest magnitude (negative)
2. Slight daily frequency
3. Small daily pattern opposite of PC1
4. Large fluctuations over the year

## Principal Component 3

1. East-West bipolar Europa with UK and Finland being of largest magnitude
2. Not much of a frequency
3. No daily pattern
4. Fluctuations across the year without a pattern

## Principal Component 4

1. Tripolar Europa with east central Europa being negative
2. No frequency of significance. A spike near the year that might be of interest
3. No daily pattern
4. Smaller frequencies. Larger spikes at the winter months

## Principal Component 5

1. Tripolar Europa (diagonal top left to bottom right) with Greece being of largest magnitude (negative)
2. Semi-strong daily frequency with additional disturbances
3. Low daily pattern for daily average with minor maxima at 3-5 in the night and minima at 15-17 in the evening
4. Semi-large fluctuations during the year for the yearly average, with no obvious pattern

## Principal Component 6

1. Vague tripolar division of Europe with East-Central-West division
2. Semi-weak daily frequency with additional disturbances
3. Very minor daily pattern for daily average with minor maxima at 3-5 in the night and minima at 15-17 in the evening
4. Semi-large fluctuations during the year for the yearly average, with no obvious pattern

# Heating Analysis – Nodal Price

## Principal Component 1

1. Monopole across whole of Europe
2. No obvious frequency besides yearly, but can not be confirmed due to the data only spanning over the course of a single year
3. Weak pattern for daily average with maxima at early noon (10-12)
4. Clear seasonal pattern for yearly average with maxima during summer months and minima during winter months

## Principal Component 2

1. North-South division of Europe
2. No clear dominating frequencies
3. No clear pattern for daily average
4. Larger fluctuations for yearly average during winter months compared to summer months

## Principal Component 3

1. Central Europe being positive, while rest of Europe being negative. Almost like a tripolar division of Europe
2. No clear dominant frequencies
3. No clear pattern for daily average
4. Larger fluctuations for yearly average during winter months compared to summer months

## Principal Component 4

1. Mid-Eastern Europe being negative, while rest of Europe is positive
2. No clear dominant frequencies
3. No clear pattern for daily average
4. Larger fluctuations for yearly average during winter months compared to summer months

## Principal Component 5

1. No obvious pattern for Europe
2. No clear dominant frequencies
3. No clear pattern for daily average
4. Larger fluctuations for yearly average during winter months compared to summer months

## Principal Component 6

1. Norway standing out as the single most negative country, with no real pattern for whole of Europe
2. No clear dominant frequencies
3. No clear pattern for daily average
4. Larger fluctuations for yearly average during winter months compared to summer months

# Transport Analysis – Nodal Price

## Principal Component 1

1. Monopole across whole of Europe
2. Weak daily frequency
3. Clear pattern for daily average with a minimum spanning from 4 to 14
4. Clear pattern for yearly average with minima during summer months, and additional large fluctuations across the whole year

## Principal Component 2

1. North-South division of Europe
2. Medium dominant daily frequency
3. Clear pattern for daily average with a minimum spanning from 4 to 14, similar to PC 1 but with lower amplitude
4. Weak pattern for yearly average with minimums during the summer months and greater fluctuations during winter months

## Principal Component 3

1. East-West division of Europe
2. No obvious dominating frequencies
3. Very minor pattern for daily average with a maxima period spanning from 4 to 14
4. No obvious pattern for yearly average

## Principal Component 4

1. Central of Europe being positive, while rest of Europe is negative
2. Minor dominating daily frequency
3. Very minor pattern for daily average with a maxima period spanning from 4 to 14, lower amplitude than PC 3
4. No obvious pattern for yearly average

## Principal Component 5

1. No obvious pattern across Europe
2. No clear dominating frequency
3. Minor pattern for daily average with maxima in the morning (3-4) and minima during evening (15-16)
4. No obvious pattern for yearly average

## Principal Component 6

1. No obvious pattern across Europe
2. No clear dominating frequency
3. Minor pattern for daily average with maxima in the morning (3-4) and minima during evening (15-16) similar to PC 5
4. No obvious pattern for yearly average

# Coherence Analysis

## Electricity Mismatch (EM) and Electricity Nodal Prices (ENP)

1. Strong correlation between PC1/PC1 and PC2/PC2
2. Only strong correlation between PC1/PC1
3. Strong positive correlation between PC2/PC2, with most negative correlation being between PC3/PC3

## Heating Mismatch (HM) and Heating Nodal Prices (HNP)

1. Strong correlation between PC1/PC1 and PC3HM/PC2HNP
2. Only strong correlation between PC1/PC1
3. Strong positive correlation between PC1/PC1 and PC2HM/PC1HNP

## Transport Mismatch (TM) and Transport Nodal Prices (TNP)

1. Multiple strong correlation, but most noteworthy is PC1/PC1 and PC4/PC4
2. Only strong correlation between PC1/PC1
3. Only noteworthy negative correlation between PC3TM/PC1TNP

## Electricity Nodal Prices (ENP) and Heating Nodal Prices (HNP)

1. Strong diagonal correlation between ENP and HNP
2. Only strong correlation between PC1/PC1
3. Strong diagonal correlation with PC1/PC1 and PC4/PC4 being positive, while PC2/PC2 and PC3/PC3 being negative

## Electricity Nodal Prices (ENP) and Transport Nodal Prices (TNP)

1. Very strong diagonal correlation
2. Only strong correlation between PC1/PC1
3. Very strong diagonal correlation with switching positive and negative terms every two PC

## Heating Nodal Prices (HNP) and Transport Nodal Prices (TNP)

1. Strong diagonal correlation (and tendency for diagonality)
2. Only strong correlation between PC1/PC1
3. Strong negative correlation between diagonal terms ranging from PC1 to PC4