Comments on plots for *elec\_heat*

# Electricity Analysis - Mismatch

## Principal Component 1

1. Monopole of whole of Europe
2. Strong daily frequency and semi-strong half-daily frequency
3. Negative peak at noon and positive peak at 18-20 o’clock
4. Large fluctuations in yearly average
5. Primarily wind driven with a partial Solar PV contribution
6. Mostly heat coupling with an additional Storage/Heat Couple covariance
7. Half are wind/heat coupling covariance

## Principal Component 2

1. North-South division between Europe with Italy being the most significance in magnitude
2. Strong daily frequency and semi-strong half-daily frequency
3. Negative peak at noon and positive peak at 18-20 o’clock similar to PC 1
4. Les fluctuations over the yearly average with more stability in the summer months
5. Primarily Solar PV driven with partial Wind and Solar PV/Wind included
6. Mainly storage response with 5 additional components with a significance of 5-10% each
7. Mostly Solar PV/storage covariance

## Principal Component 3

1. East-West division of Europe with France and UK being the most significance in magnitude
2. Semi-strong half-day frequency
3. Minor fluctuation with daily average plot, with minor peaks in morning and afternoon
4. Large fluctuations in yearly average
5. Heavy wind dominated
6. Primary response from heat coupling and Import-Export/Heat Couple and Storage/ Heat Couple covariance.
7. Primarily Wind covariances

## Principal Component 4

1. Tri-pole divided with North and south being positive, while diagonal-central Europe being negative, with France being the most significance in magnitude
2. Semi-strong daily pattern with what is expected to be a two-week frequency as well
3. Very minor fluctuations in daily average pattern
4. Large fluctuations in yearly average with no obvious pattern.
5. Almost entirely Wind contribution
6. Larges response from Heat Couple with 7 additional components with 5-12% significance each
7. Primarily wind covariances

### Principal Component 5

1. Primarily Scandinavian dominance with Poland contributing as well
2. Lot of noise in frequency plot
3. No daily pattern or fluctuations
4. Semi-large fluctuations for yearly average
5. Almost entirely wind driven
6. Larges response Heat Couple with Hydro Reservoir being second largest response.
7. Primarily wind covariances

### Principal Component 6

1. No obvious pattern. Spain being most significant in magnitude (negative) as well as Italy (positive)
2. Strong daily frequency as well as a semi-strong half-daily frequency
3. Daily pattern with peaks in morning hours (6-8) and late afternoon (15-17)
4. No yearly pattern with minor fluctuations
5. Almost entirely Wind and Solar PV driven with a 40/60 distribution
6. Two largest responses from Storage and Heat Couple together with multiple minor response contributors
7. Highest contributors are covariances with Solar PV

# Heating Analysis - Mismatch

## Principal Component 1

1. Monopole across whole of Europe
2. Strong daily frequency and semi-strong half-daily frequency
3. Strong peak in daily average around noon (11-13)
4. Large fluctuations across yearly average with seasonal pattern peaking in summer months
5. Largest contribution from Central-Urban Solar Collectors (34%) with 5 additional contributors each responsible for 8-18%
6. Primary response from storage with two additional response contributors from Electricity Couple and Storage/ElectricityCouple covariance
7. Half are Central-Urban Solar Collector/Storage covariance

## Principal Component 2

1. No obvious pattern, but with France standing out from rest of Europe
2. Two semi-strong frequencies of daily and half-daily
3. Similar daily pattern and peak as PC 1, but with smaller magnitude
4. Low fluctuations with slight season minima at summer months
5. Primary contribution from Central-Urban Solar Collectors, as well as a noteworthy contribution from Load Heat and Load Heat / Load Urban heat covariance
6. Three large responses from Storage, Electricity Couple and Storage/Electricity Couple covariance
7. Half are Central-Urban Solar Collector/Storage covariance

## Principal Component 3

1. East and North Europe division with UK being the single most significant country
2. Strong daily and half-daily frequency
3. Very small peak at early noon (7-11)
4. Very small fluctuations over the yearly average
5. Four medium contributors being Central-Urban Solar Collectors, Load Heat/Load Urban Heat covariance, Load Urban Heat and Load Heat
6. Three large responses from Storage, Electricity Couple and Storage/ Electricity Couple covariance
7. Half are Central-Urban Solar Collector/Storage covariance

# Electricity Analysis - Nodal Prices

## Principal Component 1

1. Monopole across whole of Europe
2. Two semi-weak frequencies at daily and half-daily
3. Daily pattern with peak at noon (11-13)
4. Large fluctuations over the yearly average with seasonal pattern with minima in summer months

## Principal Component 2

1. North-South division of Europe
2. Two semi-strong frequencies at daily and half-daily
3. Daily average pattern with minima at noon, but smaller in amplitude compared to PC 1
4. Large yearly fluctuations over yearly average

## Principal Component 3

1. East-West division of Europe
2. Strong daily frequency and weak half-daily frequency
3. Minor daily pattern with peak at noon (12-14)
4. Large fluctuations over yearly average

## Principal Component 4

1. Central Europe being negative while rest of Europe is positive
2. No obvious dominating frequencies
3. No obvious daily average pattern and peaks
4. Large fluctuations over yearly average

## Principal Component 5

1. No obvious pattern across Europe, but with Spain and Portugal being larges in magnitude
2. Strong daily frequency with semi-strong half-daily frequency
3. Slight average daily peak at late afternoon/early evening
4. Small fluctuations over yearly average

## Principal Component 6

1. No obvious division across Europe
2. No obvious dominating frequencies
3. No obvious average daily pattern
4. No obvious yearly average pattern and with small fluctuations

# Heating Analysis - Nodal Prices

## Principal Component 1

1. Monopole across Europe
2. No dominating frequencies, besides a yearly frequency which is difficult to confirm since the data is only over the course of a single year.
3. Small peaks for daily average plot with peak at noon (11-13)
4. Clear seasonal pattern between winter and summer for the yearly average plot

## Principal Component 2

1. North-South division between Europe
2. No dominant frequency
3. Small daily average fluctuation with a very slight peak at 8-10
4. Large fluctuation in wither months with stagnation during summer months

## Principal Component 3

1. Tri-division of Europe with North and South being negative, while central Europe being positive
2. Weak daily frequency
3. No obvious pattern for daily average plot
4. Large fluctuations during winter months, while stagnant during summer months, for yearly average plot

## Principal Component 4

1. East-West division of Europe
2. Two semi-weak daily and half-daily frequencies
3. No obvious pattern for daily average plot
4. Large fluctuations during winter months, while stagnant during summer months, for yearly average plot

## Principal Component 5

1. No obvious pattern across Europe
2. Semi-weak daily frequency
3. No obvious pattern for daily average plot
4. Large fluctuations during winter months, while stagnant during summer months, for yearly average plot

## Principal Component 6

1. Norway and Sweden being dominant, while no real pattern for rest of Europe
2. No dominant frequencies
3. No obvious pattern for daily average plot
4. Large fluctuations during winter months, while stagnant during summer months, for yearly average plot

# Coherence

## Elec Mismatch (EM) vs Elec NP (ENP)

1. 5 PC with a covariance of more than 0.4, with the maximum covariance of 0.531 between PC1/PC1
2. Only PC1/PC1 coherence significant for coherence method 2
3. High positive coherence between PC2/PC2. While 5 PC have a negative covariance below -0.3

## Heat Mismatch (HM) vs Heat NP (HNP)

1. 4 PC with a covariance of 0.4 or more, with PC1/PC1 and HM PC3/HNP PC2 being the largest of 0.544
2. Only PC1/PC1 coherence being significant for coherence method 2
3. PC1/PC1 being the largest positive coherence of 0.695 while HM PC2 / HNP PC 1 being the most negative of -0.456

## Elec NP (ENP) vs Heat NP (HNP)

1. Strong pattern across diagonal terms
2. Only PC1/PC1 coherence being significant for coherence method 2
3. Strong pattern across diagonal terms with both positive and negative terms, with PC1/PC1 and PC2/PC2 being the most significant