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# Report

# P350 Load Flow Modelling Service

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# 1    CONTENT

## 2    PROJECT OBJECTIVES AND INTRODUCTION

Siemens PTI has been commissioned to assist ELEXON and P350 Modification Group in the assessment procedure of the BSC (Balancing and Settlement Code) Modification Proposal P350 ('Introduction of a seasonal Zonal Transmission Losses scheme').

This section presents the key summary elements of the Modification Proposal P350 and presents the P350 Load Flow Modelling Service objectives.

### 2.1    Modification Proposal P350 – key summary elements

Modification Proposal No 350 (P350), 'Introduction of a seasonal Zonal Transmission Losses scheme' was raised on 04 July 2016 by National Grid Electricity Transmission plc (the Proposer).

_Description of Proposed Modification_

This modification relates to the CMA (Competition and Market Authority) Energy Market investigation[1] and proposes to apply the same solution as that proposed under P229. A high-level description of P229 is provided in italics below.

_P229 was raised by RWE Npower on 28 November 2008._

_It seeks to allocate transmission loss costs more cost reflectively across generators and demand customers on the GB transmission system. Under the current BSC arrangements, losses are allocated to Parties in proportion to their metered energy volumes, with a uniform allocation of 45% of losses to production accounts and 55% to consumption accounts. The current BSC losses arrangements do not consider the geographic location of generators and customers._

_P229 proposes to change the Transmission Losses arrangements in the BSC so a Transmission Loss Factor (TLF) for each BSC Season is calculated for each 'TLF Zone'. TLFs would be calculated annually for the following year using historical data._

_The P229 Proposed solution is essentially the same as that proposed by P203 'Introduction of a seasonal Zonal Transmission Losses scheme', except that it includes provision for offshore nodes._

It's worth noting that, subsequent to P229, P278 set TLMs to 1 for all I/C BM Units, which may require consideration as this mod progresses[2]. Similarly, this new modification may require consideration of onshore HVDC circuits as these were not considered under P229.

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[1]    See paragraph 6.144c of the CMA Energy Investigation Final Report (https://assets.publishing.service.gov.uk/media/5773de34e5274a0da3000113/final-report-energy-market-investigation.pdf).

*Description of Issue or Defect that Modification Proposal Seeks to Address*

The defect that this modification seeks to address is that the current treatment of transmission losses (i.e. allocated to BSC parties on a non-locational basis)[3] does not follow the principles that are to be set out in the electricity transmission licence as a result of the CMA Energy Market Investigation Order referenced in paragraph 6.143 of the CMA Energy Investigation Final Report (the report).

This specifically relates to the CMA AEC (Adverse Impact on Competition) that the absence of locational pricing for transmission losses is likely to distort competition between generators, raise bills to customers and to have both short- and long-run effects on generation and demand:

- In the short run, costs will be higher than would otherwise be the case, because cross-subsidisation will lead to some plants generating when it would be less costly for them not to generate, and other plants, which it would be more efficient to use, not generating.
- In the long run, the absence of locational pricing may lead to inefficient investment in generation, including inefficient decisions over the extension or closure of plant. There could also be inefficiency in the location of demand.

The remedy that the CMA has adopted, as set out in paragraph 6.113 of the report, is to "introduce locational charging for transmission losses in Great Britain".

This paragraph also states that "the design of the remedy will be identical in its technical aspects to the P229 code modification previously assessed in 2011, including notably the use of semi-marginal (rather than full marginal) transmission loss factors (for the avoidance of doubt, any reference to the P229 code modification proposal relates to the original proposal raised by RWE – referred to as the Proposed Solution in the P229 Assessment Report – and not to any alternative proposals considered within the context of the modification process)".

*Justification for Proposed Modification with Reference to Applicable BSC Objectives*

This proposal will better facilitate Applicable BSC Objective A as the current arrangements are in direct contradiction to the principles which will be set out in the electricity transmission licence as a result of the CMA Energy Investigation Order detailed in para 6.143 of the report. For ease of reference, this states that:

"at all times, imbalance charges (and specifically the estimated volumes of an imbalance) are calculated such as to be locationally sensitive to transmission losses".

In conjunction with this, the report specifies (in para 6.144) that the required changes need to be in place by April 2018 and (in para 6.145) that "the order will also provide for the modification of the Transmission Standard Licence Conditions" to give effect to this.

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2   This is clarified in paragraph 6.121 of the CMA Energy Investigation Final Report

3   All transmission system losses are allocated to BSC parties in proportion to metered energy, whether production or consumption, on a uniform allocation basis (45% to production accounts, 55% to consumption accounts) taking no account of location.

The CMA has also clearly demonstrated in the report (e.g. in the AEC referenced in the section above) that there are benefits under objectives B and C.

Finally, the proposal appears neutral on Applicable BSC Objective E as it not incompatible with the EU Target Model and implementing this solution would not preclude a move further toward this design at a later point in the future.

## 2.2  P350 Load Flow Modelling Service objectives

Specifically, PTI has been tasked to:

- perform calculations of TLFs for a specified number of Sample Settlement Periods (SSPs) for Modification Proposal P350;
- present the results in a form suitable for the assessment procedure; and
- draw attention to any potential issues with the fundamentals of the scaled marginal approach proposed (P350) arising from the exercise.

The modelling tasks were:

*Task 1: Baseline Transmission Loss Factor values*

This task is to produce a set of baseline Adjusted Seasonal Zonal Transmission Loss Factor values. It is to illustrate the likely patterns of loss allocation under P350, to provide Parties with an indication of the likely impacts of P350 on them in its first year. It is also to provide a baseline against which further sensitivity scenarios can be considered.

*Task 2: Baseline Transmission Loss Factor values with Interconnector flows excluded from the Zonal average*

Interconnector BM Units are exempt from the allocation of transmission losses following European legislation treating them as part of the Transmission System (as implemented in the BSC through P278).  As this rule change occurred after P229, the P350 Workgroup needs to decide how best to account for this in the final P350 methodology.

So that the Workgroup can consider the sensitivity of the Adjusted Seasonal Zonal Transmission Loss Factor values in this area, Task 2 is to recalculate the baseline values from Task 1 based on a scenario in which Interconnector power flows are excluded from the zonal averaging.

*Task 3: Inclusion of the HVDC Western Link*

The High Voltage Direct Current (HVDC) Western Link is expected to become operational in 2017. Task 3 is to recalculate the baseline values from Task 1 based on a scenario in which the HVDC Western Link is operational, and to consider the sensitivity of the resulting values to different approaches to including this in the model. Since no HVDC links have been in operation historically, such circuits will not be included in the input data provided for Tasks 1 and 2. The P229 methodology did not

cater for HVDC transmission circuits as, at the time it was progressed, the introduction of such circuits was still many years in the future. Task 3 is therefore to support the P350 Workgroup's consideration of how the final P350 methodology should account for HVDC transmission circuits.

Therefore, this task is to calculate Adjusted Seasonal Zonal Transmission Loss Factor values as per Task 1 but with the HVDC Western Link to be included in the model. There were two options for including the HVDC Western Link, and thus separate sets of Adjusted Seasonal Zonal Transmission Loss Factors to be calculated:

- Option A: The HVDC Western Link to be modelled as a point of generation at one of the corresponding Nodes and as a point of demand at the other Node.
- Option B: The HVDC Western Link to be modelled as an AC connection between the two relevant Nodes in a manner that is consistent with the legal text for the P229 Proposed Modification

## 2.3  Introductory notes

A large number of load flow calculations, marginal TLF calculations and post processing calculations were performed.  All results from these calculations as well as the input data received from ELEXON and used in the calculations were delivered to ELEXON in electronic format.

TLMs presented in this report were provided by ELEXON on the basis of the MP350 Load Flow Modelling results (i.e. TLFs) Siemens PTI submitted to ELEXON.

This report presents a suitable selection of the project results.   Section 3 presents the methodological approach and software tools used in the Load Flow Modelling exercise in this project.  Section 4 presents the input data received from ELEXON for the Load Flow Modelling exercise in this project.  Section 5 presents the zones as applied in the Load Flow Modelling exercise.  Section 6 presents the results from the modelling calculations for the Modification Proposal P350.  Section 7 outlines some observations made during the Load Flow Modelling exercise that are related to HVDC Western Link.  The report does not have conclusions as they will arise from the P350 Modification Group assessment procedure.

## 3   MODELLING APPROACH

P350 is the same as P229 (2008).  P229 was very much based on P203 (2006).  P203 was about 'Introduction of a seasonal Zonal Transmission Losses scheme', except that P229 included provision for the offshore nodes.  And there were other predecessor modification proposals.

Under this solution, 14 Transmission Loss Factor Zones would be created based on the existing 14 Grid Supply Point (GSP) Groups. A Network Mapping Statement will be established to document the allocation of BM Units to Zones. One Transmission Loss Factor value will be calculated per zone per BSC Season. These values would be published three months prior to the start of each BSC Year, and would be based on historical data from a preceding 12 month period (the Reference Year). The Transmission Loss Factor for a given Zone would be applied to all non-Interconnector BM Units allocated to that Zone for all Settlement Periods in the relevant BSC Season. A new BSC Agent, the Transmission Loss Factor Agent (TLFA), would be created to perform these calculations, and the calculation would be documented in a Load Flow Model Specification document.

Transmission Loss Factor values would only be used to allocate variable losses. A scaling factor of 0.5 would be applied to the marginal Transmission Loss Factor values, which would have the effect of ensuring that the volume of losses allocated through the Transmission Loss Factor mechanism is approximately equal to the total volume of variable losses. Fixed losses would continue to be allocated via the Transmission Losses Adjustment values, and the calculation and application of these values, including the value of $\alpha$, would remain unchanged from currently.

P350 recognises that, since the progression of P229, P278 'Treatment of Transmission Losses for Interconnector Users' has exempted Interconnector BM Units from the allocation of transmission losses. Interconnector BM Units will therefore continue to be allocated a Transmission Loss Multiplier of 1 in all Settlement Periods under P350.

Key elements:

- Ex-ante

- Use of SSPs  (Sample Settlement Periods) from preceding, 'reference' year

- TLFs are based on 'scaled marginal' methodology

- Use of Zonal TLFs

- Zones are to be set by the Panel (based on 14 GSPGs)

- Use of Seasonal Zonal TLFs

- First the Nodal (raw) TLFs for each SSP are averaged for each zone, using a 'volume-weighted' averaging

- Then Zonal TLFs are averaged across a season using SSPs scheme for a 'time-weighted' averaging

- Seasonal Average Zonal TLFs are adjusted using a scaling factor (0.5)

- Fixed losses would be allocated as done in the past

- The existing overall 45% production / 55% consumption allocation of total transmission losses would also be retained

## 3.1  Method

The adopted method for calculation of Transmission Loss Factors (TLFs) was that of "DC" calculations as described in ELEXON's document:

"Load Flow Model Specification for the Calculation of Nodal Transmission Loss Factors" (June 2003, version 1.0, Author CVA Programme)

The above document is related to calculation of Nodal TLFs.  The Adjusted Seasonal Zonal TLFs were calculated by the methodology described in ELEXON's document:

'P229 Proposed Modification legal text' (2010)' (that was based on "Transmission Loss Factor Agent Service Description", Version 2.0, September 2003)

Metered Volumes for a SSP are turned into Nodal Power Flows.  With such Nodal Power Flows the considered total generation is equal to the considered total demand – i.e. difference between Delivery and Off-take Metered Volumes is eliminated, and this difference accounts for:

- Heating (variable) losses
- Fixed losses
- Inaccuracies in Metered Volumes

This is suitable for "DC" load flow calculations.  Together with introduction of Nodal Power Flows it is also assumed that they are constant over the considered SSP (i.e. they are average power over 1/2h).

Linear, "DC" Load Flow Model was used.  This is an approximation of the AC load flow that converts the nonlinear power flows equations into a linear circuit analysis problem. Only real power flows are computed, reactive flows are neglected.

Main advantages of "DC" Load Flow:

- Computations are typically 40 to 50 times faster than AC
- Its linearity (particularly with regard to the issue of the slack node) plays well in calculating TLMs (see next page)

Main disadvantages of "DC" Load Flow:

- Voltage effects are neglected
- In principle it is less accurate than AC

*A well developed and defined methodology was at hand*

Table 1: Adjusted TLF Values - Task 1 (Autumn) - Heysham vs. Cowley

| GSP Group | TLF Zone | Order on Graph | Name | Heysham | Cowley | Difference |
|---|---|---|---|---|---|---|
| P | 14 | 1 | North Scotland | -0.01546 | -0.0321 | 0.01664 |
| N | 13 | 2 | South Scotland | -0.00905 | -0.02569 | 0.01664 |
| F | 6 | 3 | Northern | -0.00024 | -0.01688 | 0.01664 |
| G | 7 | 4 | North Western | 0.00352 | -0.01312 | 0.01664 |
| M | 12 | 5 | Yorkshire | 0.0019 | -0.01474 | 0.01664 |
| D | 4 | 6 | Merseyside and North Wales | 0.00898 | -0.00766 | 0.01664 |
| B | 2 | 7 | East Midlands | 0.00738 | -0.00926 | 0.01664 |
| E | 5 | 8 | Midlands | 0.01672 | 0.00008 | 0.01664 |
| A | 1 | 9 | Eastern | 0.00993 | -0.00671 | 0.01664 |
| K | 10 | 10 | South Wales | 0.00945 | -0.00719 | 0.01664 |
| J | 9 | 11 | South Eastern | 0.00969 | -0.00695 | 0.01664 |
| C | 3 | 12 | London | 0.02087 | 0.00423 | 0.01664 |
| H | 8 | 13 | Southern | 0.01907 | 0.00243 | 0.01664 |
| L | 11 | 14 | South Western | 0.01773 | 0.00109 | 0.01664 |

TLF values are sensitive to choice of the slack node in the Network Model. However, when using "DC" Load Flow the differences in TLFs for each Zone are the same (see the Table 1 and Figure 1) Consequentially the choice of the slack node does not have an impact on TLMs.
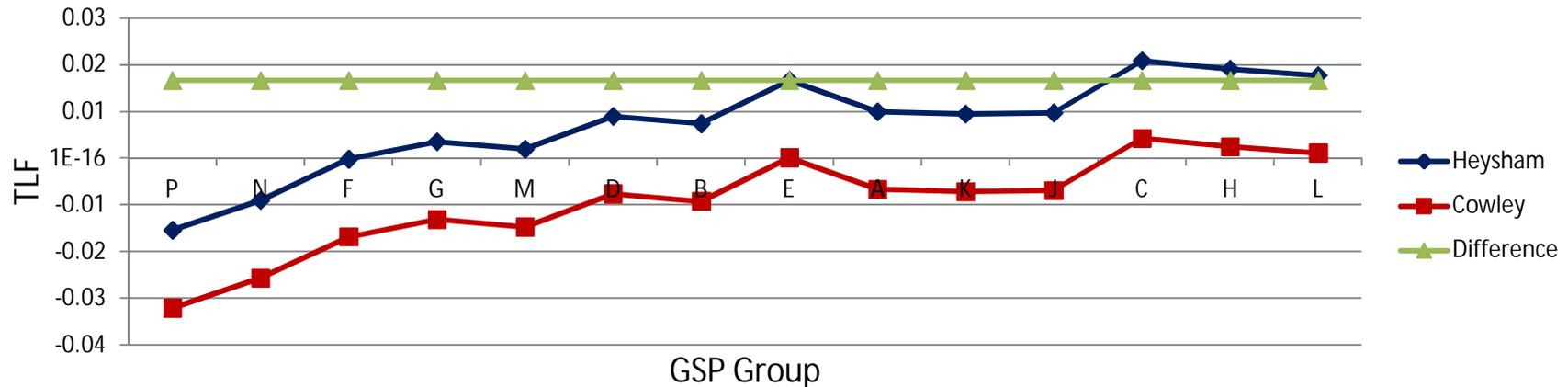


Figure 1: Adjusted TLF Values - Task 1 (Autumn) - Heysham vs. Cowley

Calculation of <u>Zonal TLFs</u> for an SSP is "volume-weighted" averaging. For each SSP the Zonal TLF (TLFZj) for each Zone is determined as:

$$TLFZj = \Sigma N (TLFNj * QMNj) / \Sigma N \, QMNj$$

where for that SSP, and for each Node in that Zone:

TLFNj    is the value of Nodal TLF; and

QMNj    is the absolute value of the nodal power flow;

and where $\Sigma N$ is summation by Nodes in a Zone

Calculation of <u>Seasonal Average Zonal TLFs</u> is "time-weighted" averaging. Seasonal Average Zonal TLF (TLFZs) for each Zone is determined as:

$$TLFZs = \Sigma p ((\Sigma s \, TLFZj / Sp) * Jp) / \Sigma p \, Jp$$

Sp    is the number of Sample Settlement Periods for a Load Period

Jp    is the total number of SPs falling within the Load Period

$\Sigma s$    is summation by Sample Settlement Periods within a Load Period

$\Sigma p$    is summation by Load Period within the Reference Season.

<u>Adjusted Seasonal Average Zonal TLF</u> (ATLFZs) for each Zone is determined as: $\quad ATLFZs = TLFZs / 2$

## 3.2  Software tools

Siemens PTI utilised LFM System Software, which originates from our engagement as TLF Agent in period 2003-04. LFM System Software consists of two components:

- LFM Core Software, and
- LFM Operational Software.

LFM Core Software is Siemens PTI's proprietary software tool called PSS®E. LFM Operational Software is a software component that Siemens PTI developed for BSCCo and that works on the basis of the LFM Core Software. LFM Operational Software is BSCCo's property. LFM System Software was thoroughly tested in 2003. During the P350 Load flow Modelling Project a variant of the LFM Operational Software was utilised in order to produce the results for Task 2, while the core of the code remained intact.

Input data (see Section 4) and most of output data were in the format described in ELEXON's document "TLFA User Requirements Specification" (17th October 2003, Issue 3.0, Version 1.0; section 5 "Interface Requirements and Definitions").

*The intention was to employ well defined methodology and maximally utilise the existing, well tested software*

# 4   INPUT DATA FOR THE MODELLING

## 4.1  Sample Settlement Periods (SSPs)

There were 630 Sample Settlement Periods (SSPs) representing period June 2015 to May 2016.  These 630 SSPs were split into 4 seasons as for the baseline input data set.  Seasons and SSPs numbers per season were:

- Summer:        June 2015 – August 2015              156 SSPs
- Autumn:        September 2015 – November 2015       157 SSPs
- Winter:        December 2015 – February 2016        156 SSPs
- Spring:        March 2016 – May 2016                161 SSPs

These 630 SSPs were used across all 3 Tasks

## 4.2  Metered Volumes

The Base Metered Volumes for the selected 630 SSPs (and grouped into seasons) were used for:

- Task 1
- Task 2, and
- Task 3, Option B (HVDC Western Link as AC line)

Modified Metered Volumes (derived from the base Metered Volumes) were used for

- Task 3, Option A

    1/3 of Scotland to England flow was modelled on the HVDC Western Link subject to respecting its minimal/maximal capacity

## 4.3 Network Mapping Statement (NMS)

Base Network Mapping Statement was used for

- Task 1
- Task 2, and
- Task 3, Option B (HVDC Western Link as AC line)

Extended Network Mapping Statement was used for

- Task 3, Option A

## 4.4 Network Data

Network Data were provided by the National Grid Electricity Transmission plc.  Only the intact network was used.  The modelled network

- included all network elements that belong to the GB transmission system;
- excluded the generators' transformers, due to the existing metering arrangements

Base Network Data were used for

- Task 1
- Task 2, and
- Task 3, Option A

Modified Network Data were used for

- Task 3, Option B (HVDC Western Link as an AC line)
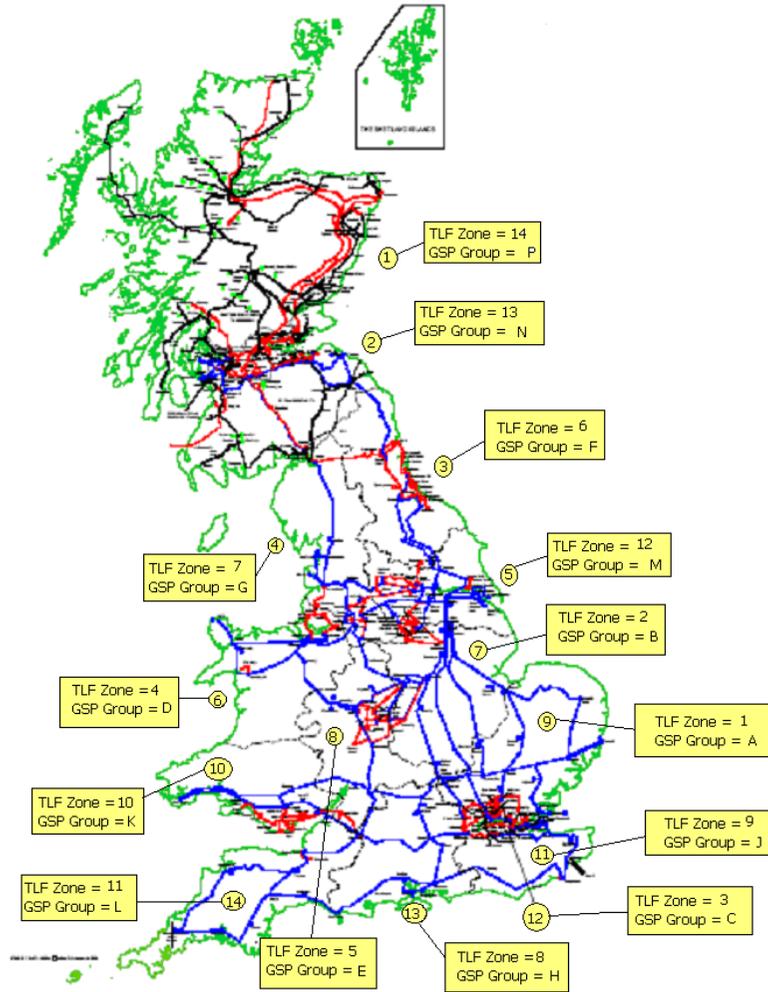
# 5   ZONES AS APPLIED IN THIS PROJECT



TLF Zone = 14
GSP Group = P

TLF Zone = 13
GSP Group = N

TLF Zone = 6
GSP Group = F

TLF Zone = 12
GSP Group = M

TLF Zone = 7
GSP Group = G

TLF Zone = 2
GSP Group = B

TLF Zone = 4
GSP Group = D

TLF Zone = 1
GSP Group = A

TLF Zone = 10
GSP Group = K

TLF Zone = 9
GSP Group = J

TLF Zone = 11
GSP Group = L

TLF Zone = 3
GSP Group = C

TLF Zone = 5
GSP Group = E

TLF Zone = 8
GSP Group = H

Figure 2: Guidance for the Zones as applied in the Project

P350 is based on P229 and it suggests that "the applicable onshore zones would be the geographical area defined by a GSP Group. For offshore nodes connected to the GB transmission system"…"the relevant onshore GSP Group in which the network is connected would be used as the basis for the applicable zone subject to Panel determination using specific criteria." This indicated unique zones for both generation and demand.

The Network Mapping Statement, input data provided by ELEXON and National Grid, maps the network nodes of relevance to the zones. Figure 2 can be used as for an approximate guidance for the zones as applied in the Project. Zone area numbers (1 to 14) in Figure 2 served a convenient sorting of the results in a geographical perspective. TLF Zone numbers in Figure 2 correspond to GSP Group ordered letters (i.e. 1 corresponds to A, 2 to B, etc). The Key to zones is presented in Table 2.

### Table 2: Key to Zone numbers and codes

| No. on picture | GSP Group's area name | GSP Group code | TLF Zone Number |
|---|---|---|---|
| 1 | North Scotland | GSPG-P | 14 |
| 2 | South Scotland | GSPG-N | 13 |
| 3 | Northern | GSPG-F | 6 |
| 4 | North Western | GSPG-G | 7 |
| 5 | Yorkshire | GSPG-M | 12 |
| 6 | Merseyside and North Wales | GSPG-D | 4 |
| 7 | East Midlands | GSPG-B | 2 |
| 8 | Midlands | GSPG-E | 5 |
| 9 | Eastern | GSPG-A | 1 |
| 10 | South Wales | GSPG-K | 10 |
| 11 | South Eastern | GSPG-J | 9 |
| 12 | London | GSPG-C | 3 |
| 13 | Southern | GSPG-H | 8 |
| 14 | South Western | GSPG-L | 11 |

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# 6    PROJECT RESULTS

## 6.1  Task 1: Baseline Transmission Loss Factor values
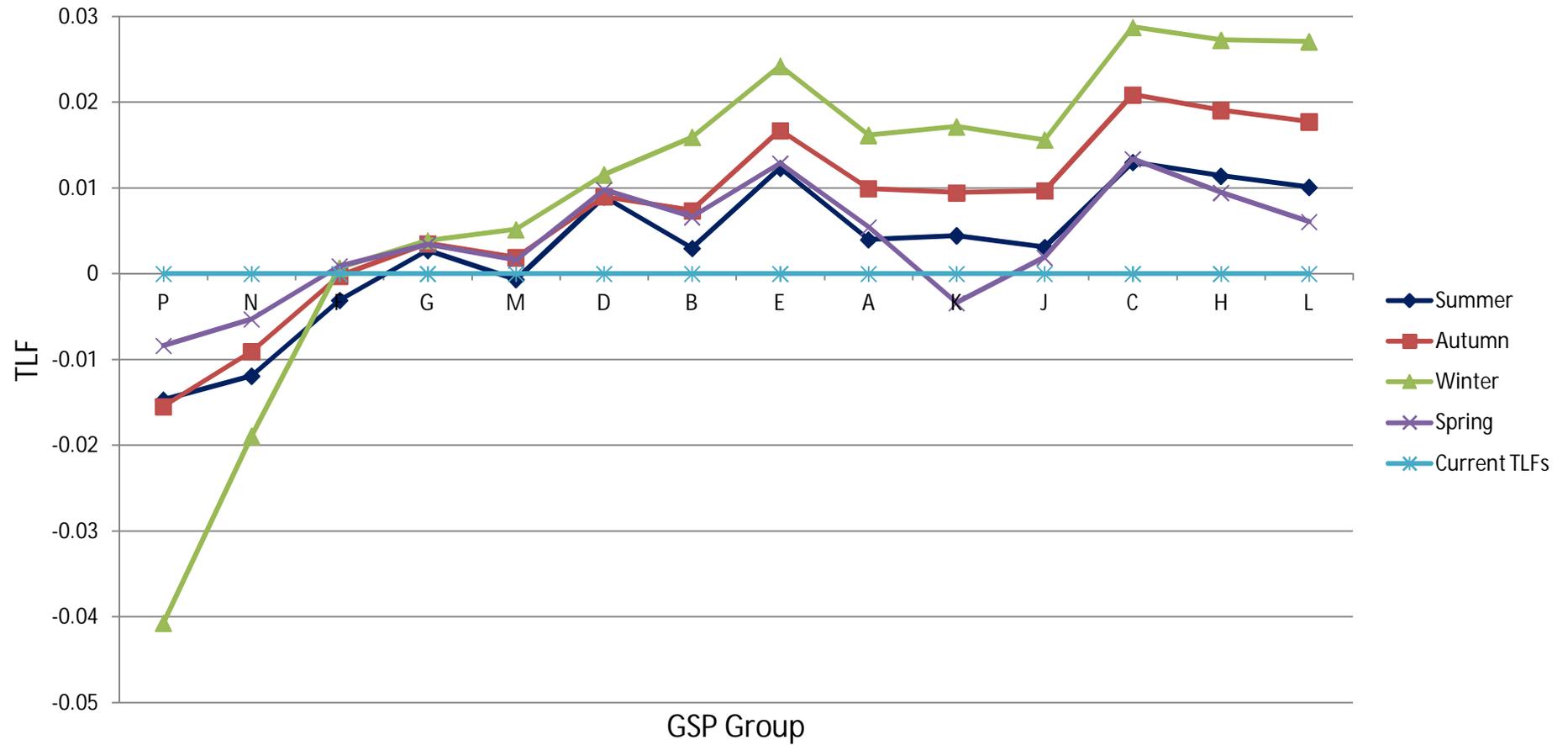


Figure 3: Task 1 Baseline Adjusted Seasonal Average Zonal TLFs vs. current TLFs that are equal to zero

Table 3: Task 1 Baseline Adjusted Seasonal Average Zonal TLFs

| GSP Group | TLF Zone | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|---|
| P | 14 | -0.01471 | -0.01546 | -0.04071 | -0.00839 |
| N | 13 | -0.01192 | -0.00905 | -0.01892 | -0.0053 |
| F | 6 | -0.00308 | -0.00024 | 0.00069 | 0.00088 |
| G | 7 | 0.00273 | 0.00352 | 0.00388 | 0.00341 |
| M | 12 | -0.00065 | 0.0019 | 0.00516 | 0.00161 |
| D | 4 | 0.00899 | 0.00898 | 0.01156 | 0.00978 |
| B | 2 | 0.00297 | 0.00738 | 0.01593 | 0.00661 |
| E | 5 | 0.01233 | 0.01672 | 0.02423 | 0.01289 |
| A | 1 | 0.00399 | 0.00993 | 0.01617 | 0.00544 |
| K | 10 | 0.00446 | 0.00945 | 0.01716 | -0.00338 |
| J | 9 | 0.0031 | 0.00969 | 0.01563 | 0.00188 |
| C | 3 | 0.01299 | 0.02087 | 0.02876 | 0.01339 |
| H | 8 | 0.01141 | 0.01907 | 0.02725 | 0.00945 |
| L | 11 | 0.01009 | 0.01773 | 0.02708 | 0.00606 |

Currently the BSC calculates TLMs with TLFs set to zero. P350 proposes Adjusted Seasonal Average Zonal TLFs that will vary geographically, reflecting the contribution to variable heating system losses by the generation and demand.

For calculation of the baseline Adjusted Seasonal Average Zonal TLFs ELEXON selected 630 Sample Settlement Period (SSPs) from the period June 2015 to May 2016 inclusively. The use of 630 SSPs is similar in size and structure to what could be the sample for live calculations of the Adjusted Seasonal Average Zonal TLFs for use in the settlement procedure.

Therefore, the Metered Volumes used in calculations were selected from ELEXON's past records and coupled with the intact transmission systems network, provided by National Grid from their practice.

Figure 3 presents the calculated baseline Adjusted Seasonal Average Zonal TLFs as put against TLFs currently used in the settlement procedure.

Table 3 presents numerical values of the calculated baseline Adjusted Seasonal Average Zonal TLFs.

The meaning of specially arranged signs of the Adjusted Seasonal Average Zonal TLFs in Figure 3 and Table 3 should be noted: a negative Adjusted Seasonal Average Zonal TLFs indicates that generation in that zone contributes to increasing variable heating system losses and should be charged accordingly. Demand in that same zone contributes to decreasing and should be credited accordingly.

The baseline Adjusted Seasonal Average Zonal TLFs in Figure 3 are obtained by two tier averaging process. In the first step, for a particular SSP and particular Zone, Zonal TLF was produced by weighted averaging Nodal TLFs in that Zone and for that SSP, weighted by unadjusted nodal power flows (that reflect the Metered Volumes). Then SSP Zonal TLFs were averaged across all SSPs for that season using a time weighted averaging.

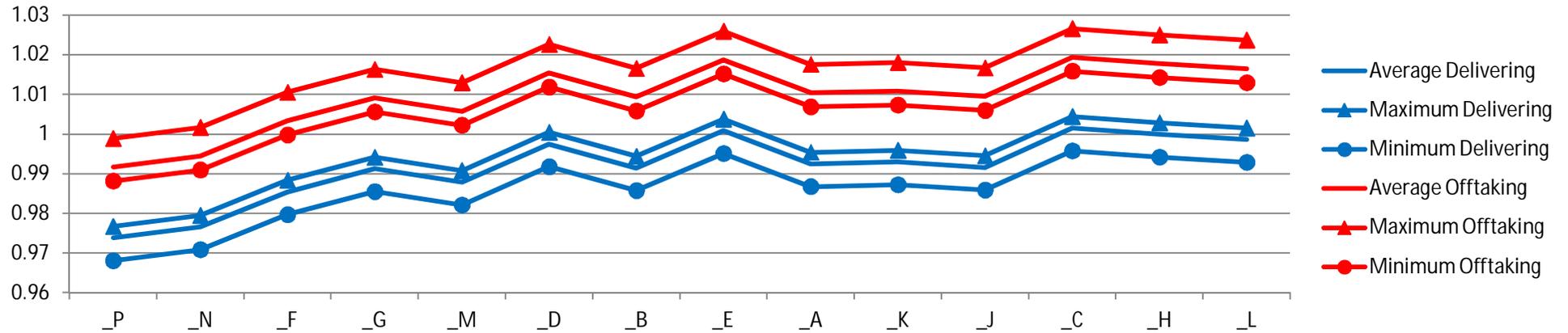## 6.2 Task 1: Baseline TLMs


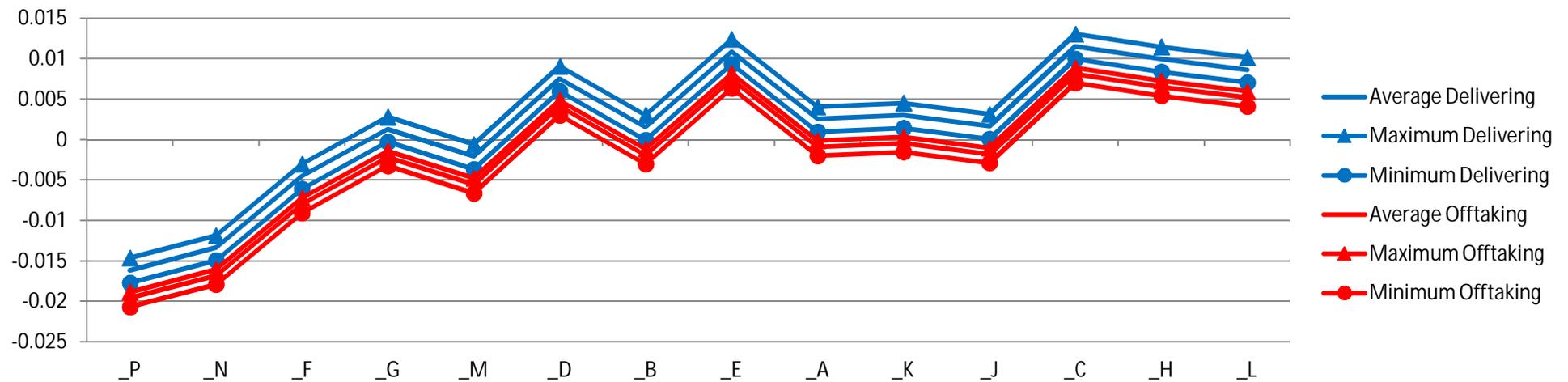
Figure 4: Task 1 Summer TLM values



Figure 5: Task 1 Summer TLM - Changes from current (pre-P350) values
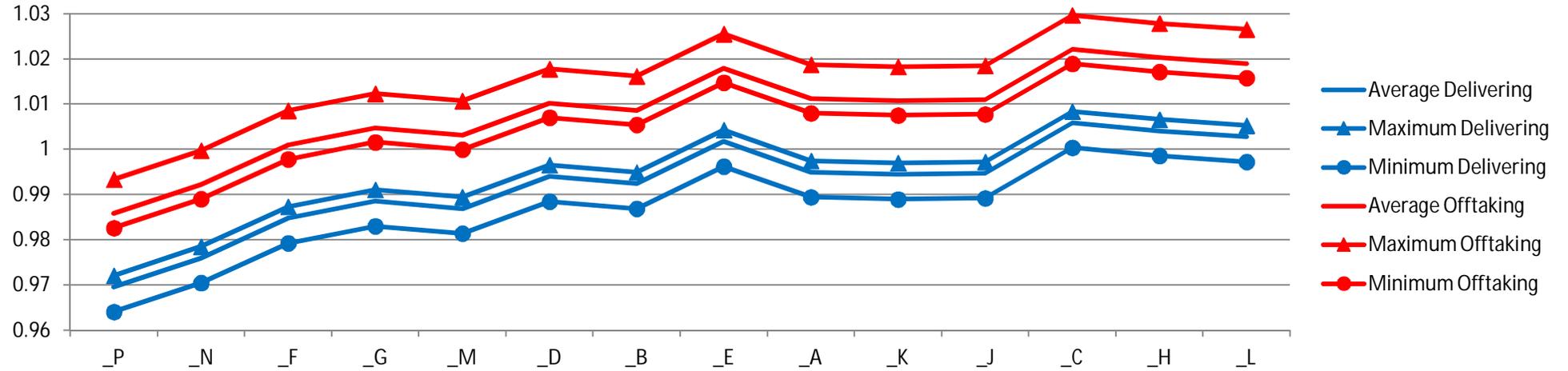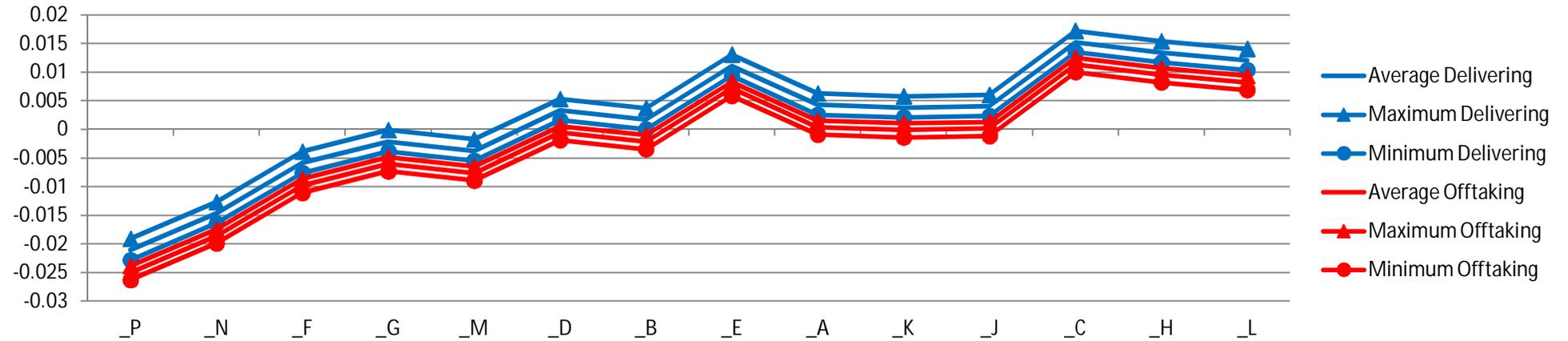
Figure 6: Task 1 Autumn TLM values



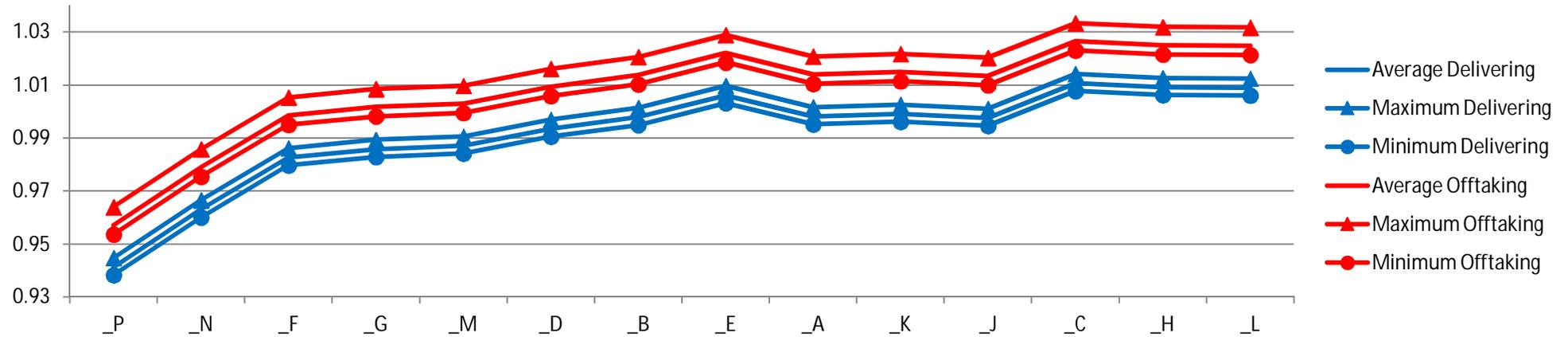Figure 7: Task 1 Autumn TLM - Changes from current (pre-P350) values

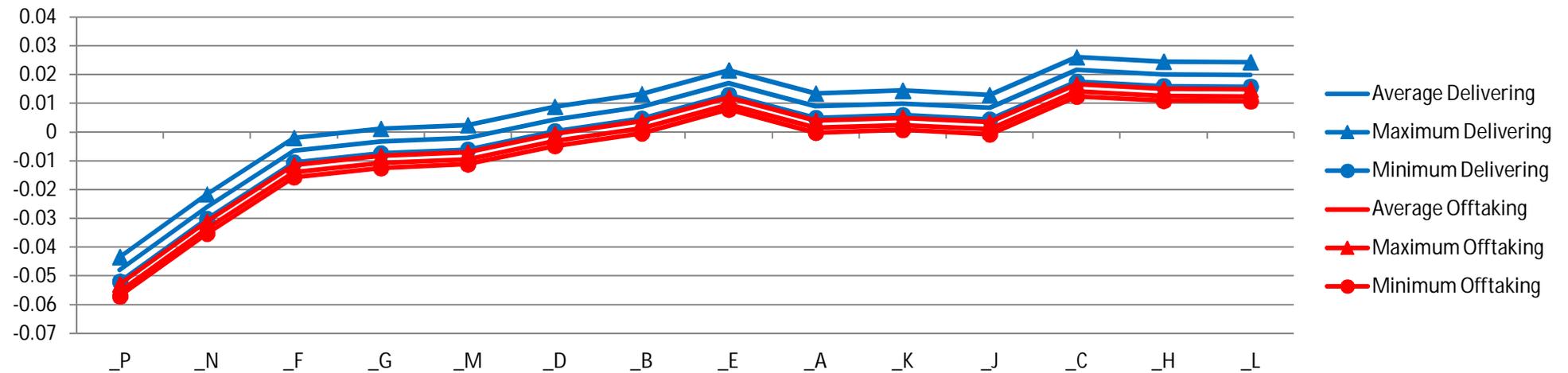Figure 8: Task 1 Winter TLM values



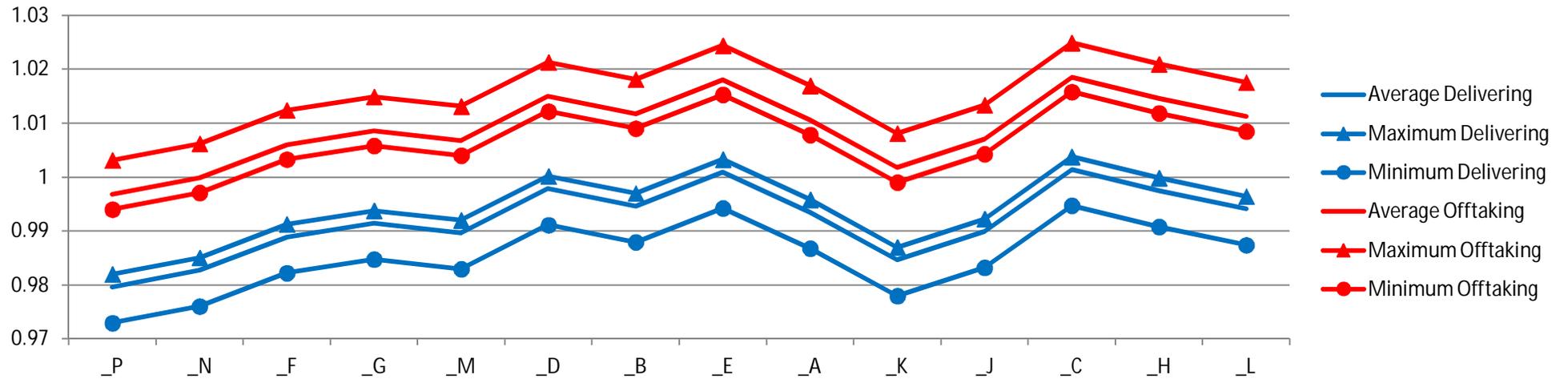Figure 9: Task 1 Winter TLM - Changes from current (pre-P350) values
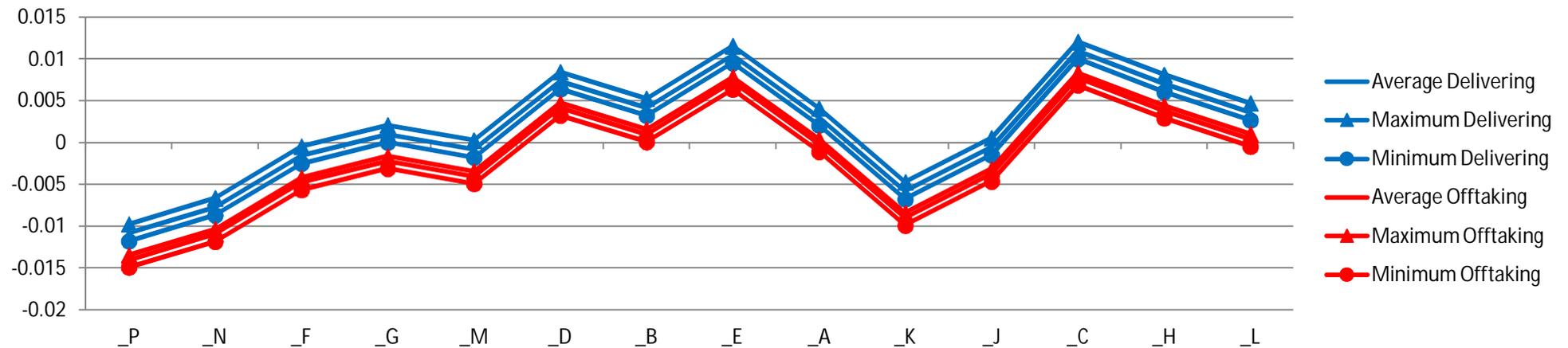
Figure 10: Task 1 Spring TLM values



Figure 11: Task 1 Spring TLM - Changes from current (pre-P350) values

## 6.3 Task 2: Baseline TLF values with Interconnector flows excluded from the Zonal average
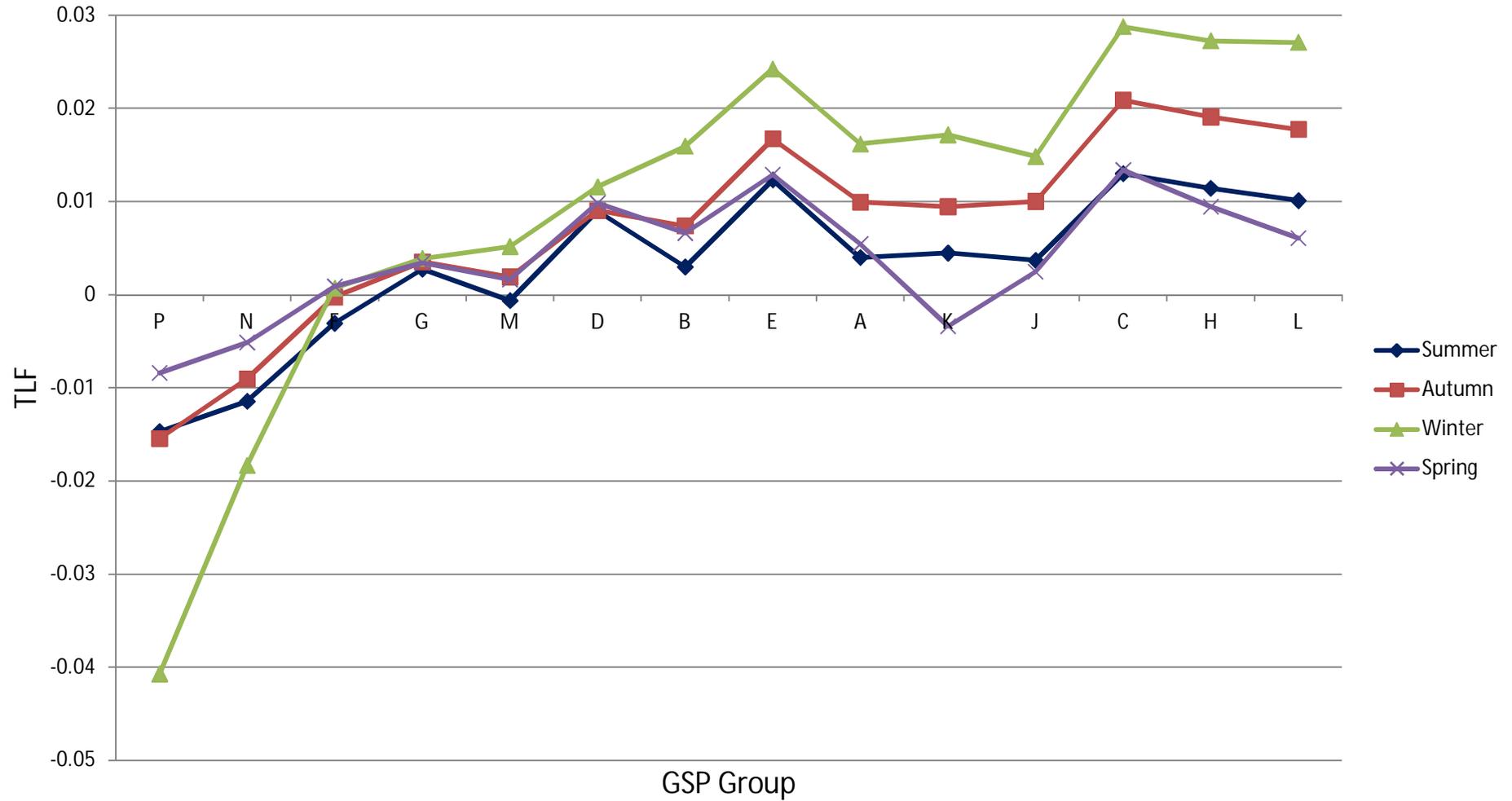


Figure 12: Task 2 Adjusted Seasonal Average Zonal TLFs

Table 4: Task 2 Adjusted Seasonal Average Zonal TLFs

| GSP Group | TLF Zone | Summer | Autumn | Winter | Spring |
|-----------|----------|--------|--------|--------|--------|
| P | 14 | -0.01471 | -0.01546 | -0.04071 | -0.00839 |
| N | 13 | -0.01146 | -0.00905 | -0.01834 | -0.00515 |
| F | 6 | -0.00308 | -0.00024 | 0.00069 | 0.00088 |
| G | 7 | 0.00273 | 0.00352 | 0.00388 | 0.00341 |
| M | 12 | -0.00065 | 0.0019 | 0.00516 | 0.00161 |
| D | 4 | 0.00901 | 0.00904 | 0.01157 | 0.00981 |
| B | 2 | 0.00297 | 0.00738 | 0.01593 | 0.00661 |
| E | 5 | 0.01233 | 0.01672 | 0.02423 | 0.01289 |
| A | 1 | 0.00399 | 0.00993 | 0.01617 | 0.00544 |
| K | 10 | 0.00446 | 0.00945 | 0.01716 | -0.00338 |
| J | 9 | 0.00367 | 0.01 | 0.01483 | 0.00247 |
| C | 3 | 0.01299 | 0.02087 | 0.02876 | 0.01339 |
| H | 8 | 0.01141 | 0.01907 | 0.02725 | 0.00945 |
| L | 11 | 0.01009 | 0.01773 | 0.02708 | 0.00606 |

The Task 2 results are presented in Figure 12 and figures are given in Table 4.

As expected, Task 2 altered averaging for Zonal TLFs resulted in changes only for the Zones of GSP Groups N, D and J, where there are interconnectors. Adjusted Seasonal Average Zonal TLFs values for other Zones are exactly the same as in Task 1.

Differences in Adjusted Seasonal Average Zonal TLFs between Task 1 and Task 2 may appear small, but this could only be judged when applied in real financial allocation of losses by the affected parties.
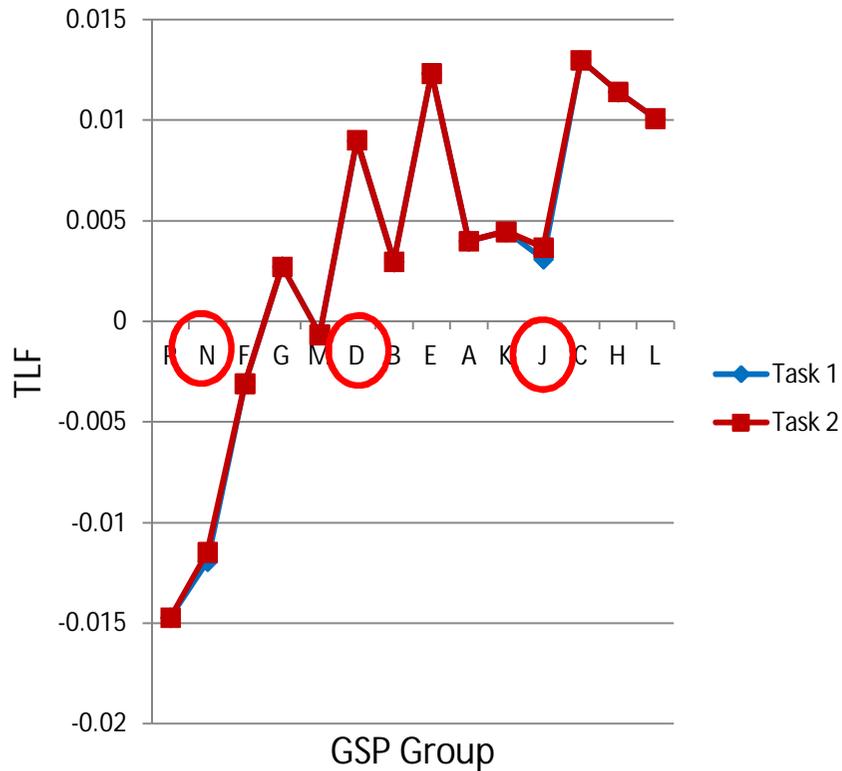
Figure 13: Summer Adjusted Seasonal Average Zonal
TLFs: Task 1 vs. Task 2
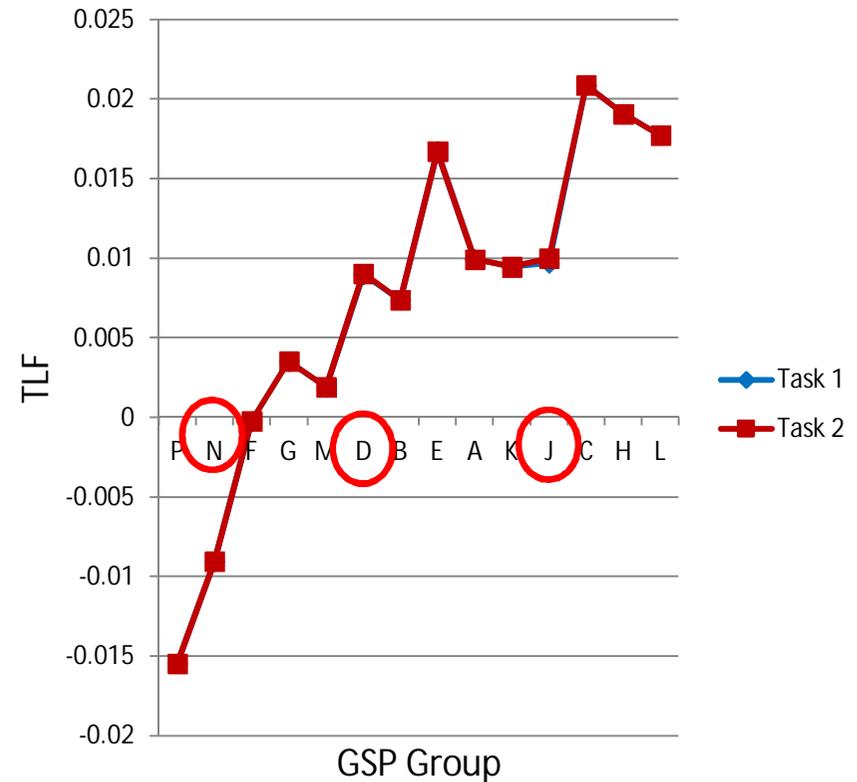


Figure 14: Autumn Adjusted Seasonal Average Zonal TLFs:
Task 1 vs. Task 2

Figure 13 and Figure 14 present comparison of Adjusted Seasonal Average Zonal TLFs from Task 1 versus those from Task 2 for summer and autumn respectively. Task 1 versus Task 2 Adjusted Seasonal Average Zonal TLFs numerical values are given in Table 5 and Table 6 for summer and autumn respectively.

`

Table 5: Summer Adjusted Seasonal Average Zonal TLFs: Task 1 vs. Task 2

| GSP Group | TLF Zone | Task 1 | Task 2 |
|---|---|---|---|
| P | 14 | -0.01471 | -0.01471 |
| N | 13 | -0.01192 | -0.01146 |
| F | 6 | -0.00308 | -0.00308 |
| G | 7 | 0.00273 | 0.00273 |
| M | 12 | -0.00065 | -0.00065 |
| D | 4 | 0.00899 | 0.00901 |
| B | 2 | 0.00297 | 0.00297 |
| E | 5 | 0.01233 | 0.01233 |
| A | 1 | 0.00399 | 0.00399 |
| K | 10 | 0.00446 | 0.00446 |
| J | 9 | 0.0031 | 0.00367 |
| C | 3 | 0.01299 | 0.01299 |
| H | 8 | 0.01141 | 0.01141 |
| L | 11 | 0.01009 | 0.01009 |

Table 6: Autumn Adjusted Seasonal Average Zonal TLFs: Task 1 vs. Task 2

| GSP Group | TLF Zone | Task 1 | Task 2 |
|---|---|---|---|
| P | 14 | -0.01546 | -0.01546 |
| N | 13 | -0.00905 | -0.00905 |
| F | 6 | -0.00024 | -0.00024 |
| G | 7 | 0.00352 | 0.00352 |
| M | 12 | 0.0019 | 0.0019 |
| D | 4 | 0.00898 | 0.00904 |
| B | 2 | 0.00738 | 0.00738 |
| E | 5 | 0.01672 | 0.01672 |
| A | 1 | 0.00993 | 0.00993 |
| K | 10 | 0.00945 | 0.00945 |
| J | 9 | 0.00969 | 0.01 |
| C | 3 | 0.02087 | 0.02087 |
| H | 8 | 0.01907 | 0.01907 |
| L | 11 | 0.01773 | 0.01773 |
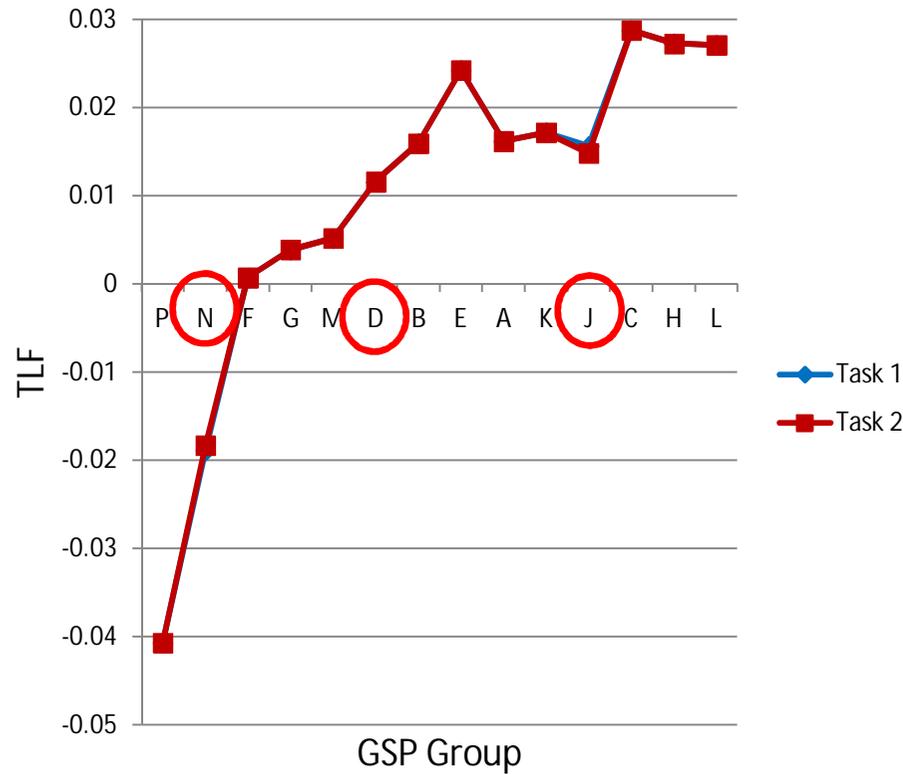
Figure 15: Winter Adjusted Seasonal Average Zonal TLFs:
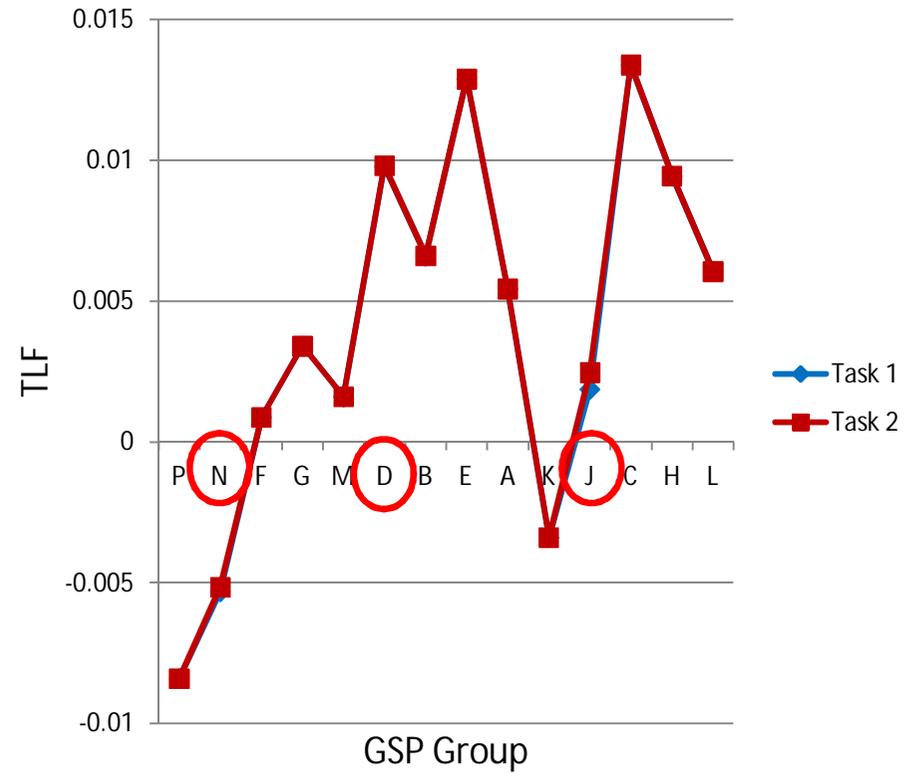Task 1 vs. Task 2



Figure 16: Spring Adjusted Seasonal Average Zonal TLFs:
Task 1 vs. Task 2

Figure 15 and Figure 16 present comparison of Adjusted Seasonal Average Zonal TLFs from Task 1 versus those from Task 2 for summer and autumn respectively.
Task 1 versus Task 2 Adjusted Seasonal Average Zonal TLFs numerical values are given in Table 7 and Table 8 for summer and autumn respectively.

`

Table 7: Winter Adjusted Seasonal Average Zonal TLFs:
Task 1 vs. Task 2

| GSP Group | TLF Zone | Task 1 | Task 2 |
|---|---|---|---|
| P | 14 | -0.04071 | -0.04071 |
| N | 13 | -0.01892 | -0.01834 |
| F | 6 | 0.00069 | 0.00069 |
| G | 7 | 0.00388 | 0.00388 |
| M | 12 | 0.00516 | 0.00516 |
| D | 4 | 0.01156 | 0.01157 |
| B | 2 | 0.01593 | 0.01593 |
| E | 5 | 0.02423 | 0.02423 |
| A | 1 | 0.01617 | 0.01617 |
| K | 10 | 0.01716 | 0.01716 |
| J | 9 | 0.01563 | 0.01483 |
| C | 3 | 0.02876 | 0.02876 |
| H | 8 | 0.02725 | 0.02725 |
| L | 11 | 0.02708 | 0.02708 |

Table 8: Spring Adjusted Seasonal Average Zonal TLFs:
Task 1 vs. Task 2

| GSP Group | TLF Zone | Task 1 | Task 2 |
|---|---|---|---|
| P | 14 | -0.00839 | -0.00839 |
| N | 13 | -0.0053 | -0.00515 |
| F | 6 | 0.00088 | 0.00088 |
| G | 7 | 0.00341 | 0.00341 |
| M | 12 | 0.00161 | 0.00161 |
| D | 4 | 0.00978 | 0.00981 |
| B | 2 | 0.00661 | 0.00661 |
| E | 5 | 0.01289 | 0.01289 |
| A | 1 | 0.00544 | 0.00544 |
| K | 10 | -0.00338 | -0.00338 |
| J | 9 | 0.00188 | 0.00247 |
| C | 3 | 0.01339 | 0.01339 |
| H | 8 | 0.00945 | 0.00945 |
| L | 11 | 0.00606 | 0.00606 |

Figure 17: Summer Adjusted Seasonal Nodal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T2 for GSPG-J



Figure 18: Autumn Adjusted Seasonal Nodal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T2 for GSPG-J

In the context of Task 2 considerations the P350 Modification Group expressed interest in the composition of Adjusted Seasonal Average Zonal TLFs for GSP Group J (South Eastern) with respect to the Adjusted Seasonal Nodal TLFs in this GSP Group J.  Figure 17, Figure 18, Figure 19, and Figure 20 present Adjusted Seasonal Nodal TLFs (Task 1) versus Adjusted Seasonal Average Zonal TLFs (Task 1) versus Adjusted Seasonal Average Zonal TLFs (Task 2) for GSPG-J, for summer, autumn, winter and spring respectively.
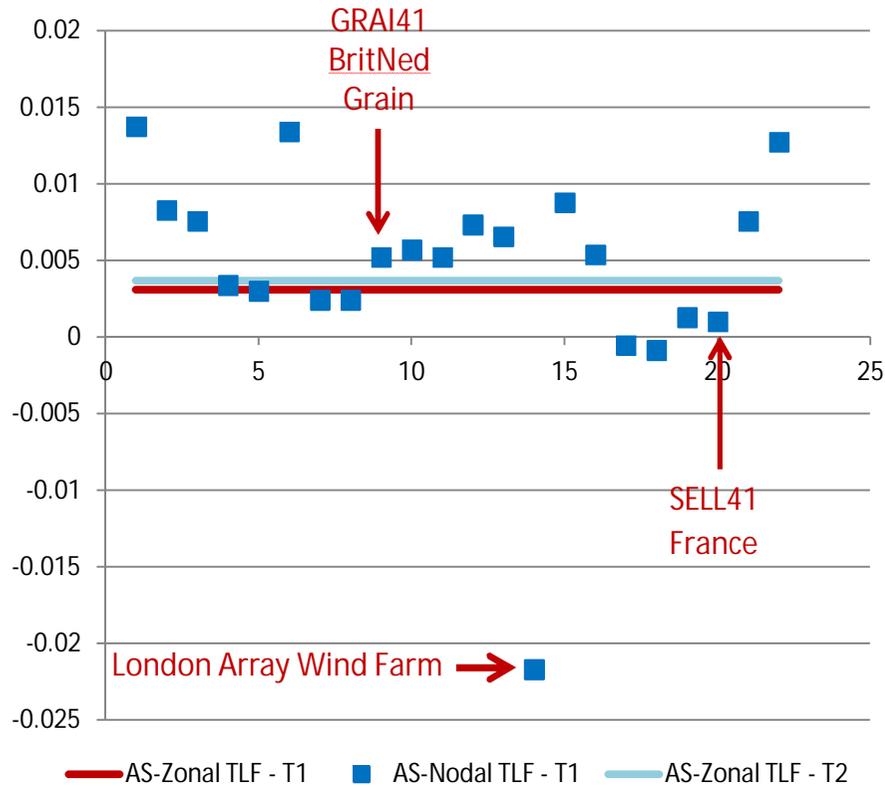
Figure 19: Winter Adjusted Seasonal Nodal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T2 for GSPG-J
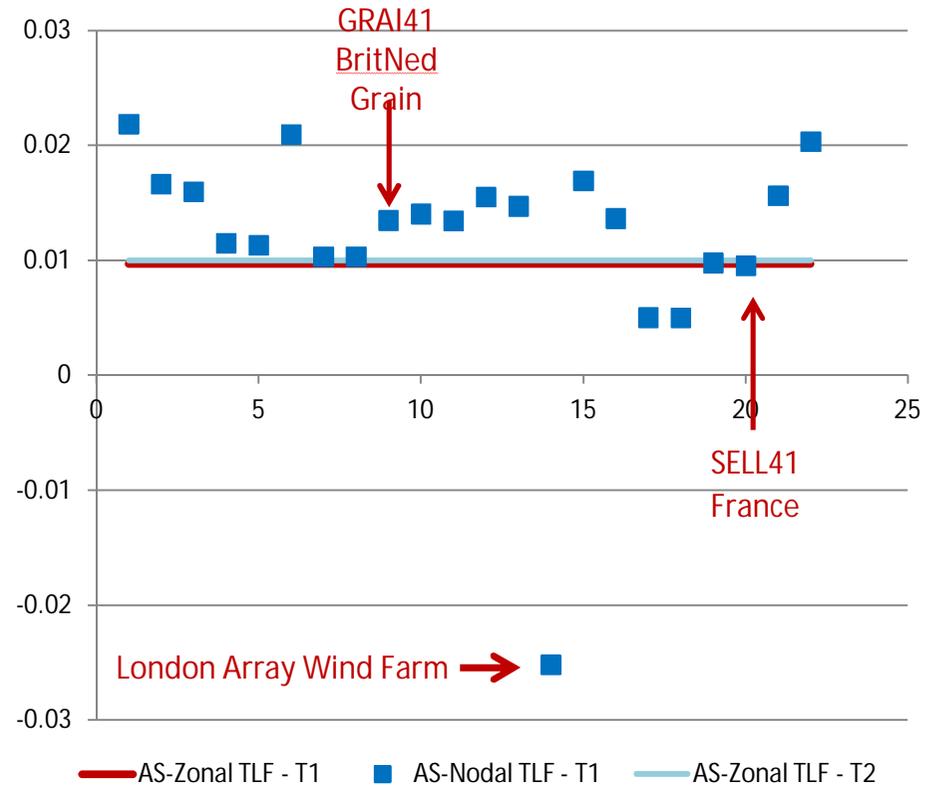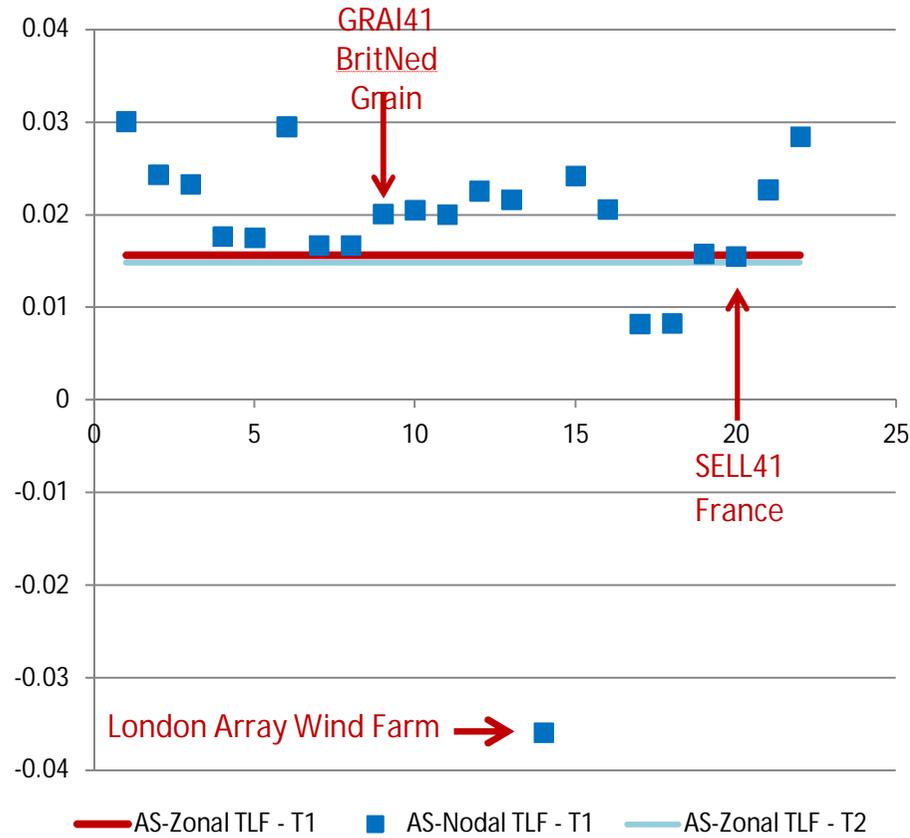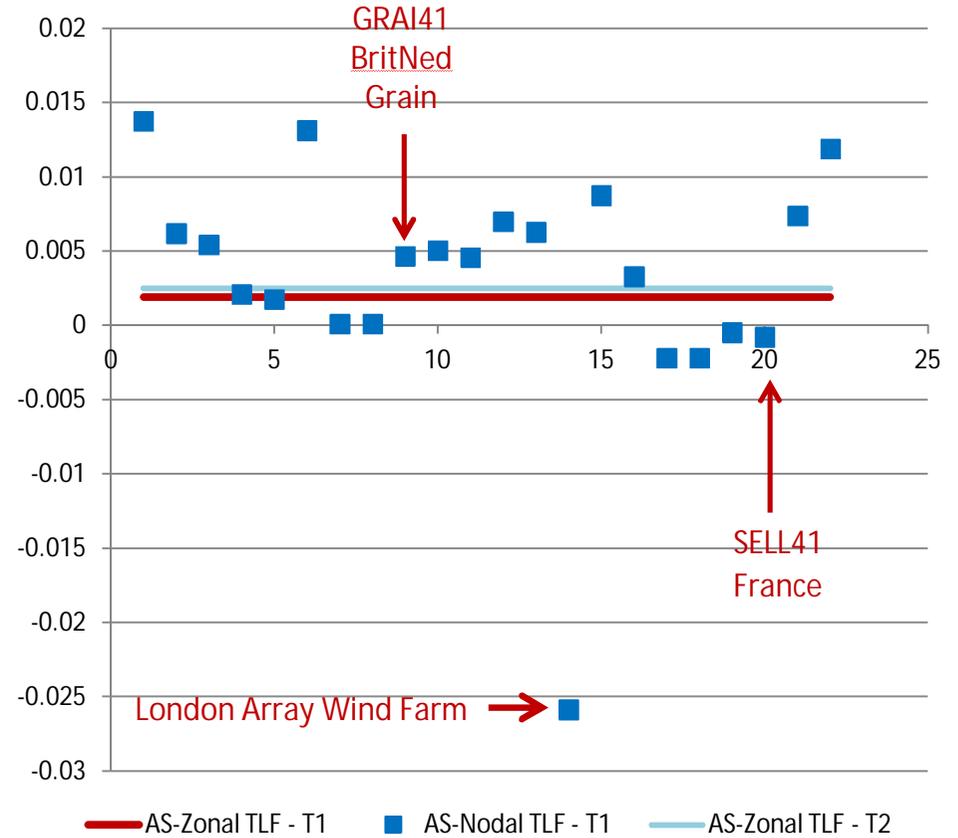


Figure 20: Spring Adjusted Seasonal Nodal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T1 vs. Adjusted Seasonal Average Zonal TLFs T2 for GSPG-J

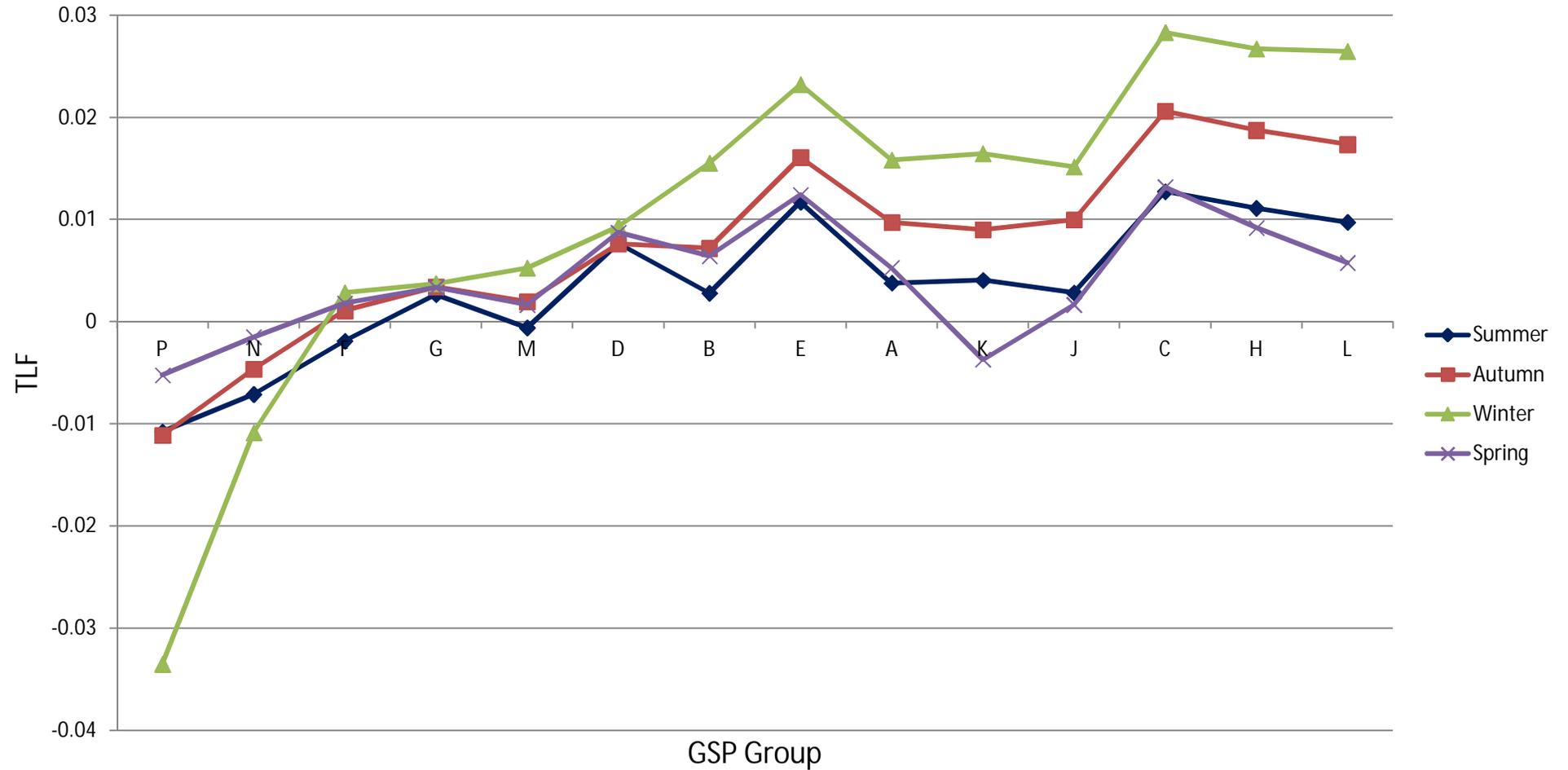## 6.4 Task 3: Inclusion of the HVDC Western Link – Option A



Figure 21: Task 3 Option A – Adjusted Seasonal Average Zonal TLFs

Table 9: Task 3 Option A – Adjusted Seasonal Average Zonal TLFs

| GSP Group | TLF Zone | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|---|
| P | 14 | -0.01077 | -0.01113 | -0.03351 | -0.00524 |
| N | 13 | -0.00712 | -0.00465 | -0.01086 | -0.00151 |
| F | 6 | -0.00189 | 0.00108 | 0.00284 | 0.00179 |
| G | 7 | 0.00265 | 0.00342 | 0.00373 | 0.00335 |
| M | 12 | -0.00059 | 0.00196 | 0.00527 | 0.00166 |
| D | 4 | 0.00766 | 0.00763 | 0.00933 | 0.00872 |
| B | 2 | 0.00279 | 0.00718 | 0.01553 | 0.00643 |
| E | 5 | 0.01173 | 0.01608 | 0.0232 | 0.01243 |
| A | 1 | 0.00378 | 0.00971 | 0.01582 | 0.00527 |
| K | 10 | 0.00405 | 0.00901 | 0.01644 | -0.00371 |
| J | 9 | 0.00282 | 0.00997 | 0.01515 | 0.00166 |
| C | 3 | 0.01273 | 0.0206 | 0.02831 | 0.01318 |
| H | 8 | 0.0111 | 0.01873 | 0.0267 | 0.00919 |
| L | 11 | 0.00973 | 0.01734 | 0.02644 | 0.00576 |

In Option A of Task 3 the HVDC Western Link was modelled as a point of generation at one of the corresponding Nodes and as a point of demand at the other Node.

The network model used in Task 3 Option A was the same as for Task 1.

Network Mapping Statement was extended for these two points (a point of generation at one of the corresponding Nodes and as a point of demand at the other Node).

Metered Volumes were extended to provide for the two above mentioned points so to model 1/3 of Scotland to England flow over the HVDC Western Link, subject to its minimal and maximal carrying capacity and accounting for the losses on the link.

Figure 21 graphically presents the Adjusted Seasonal Average Zonal TLFs as calculated for Task 3 Option A.

Table 9 provides numerical values for the Adjusted Seasonal Average Zonal TLFs as calculated for Task 3 Option A.

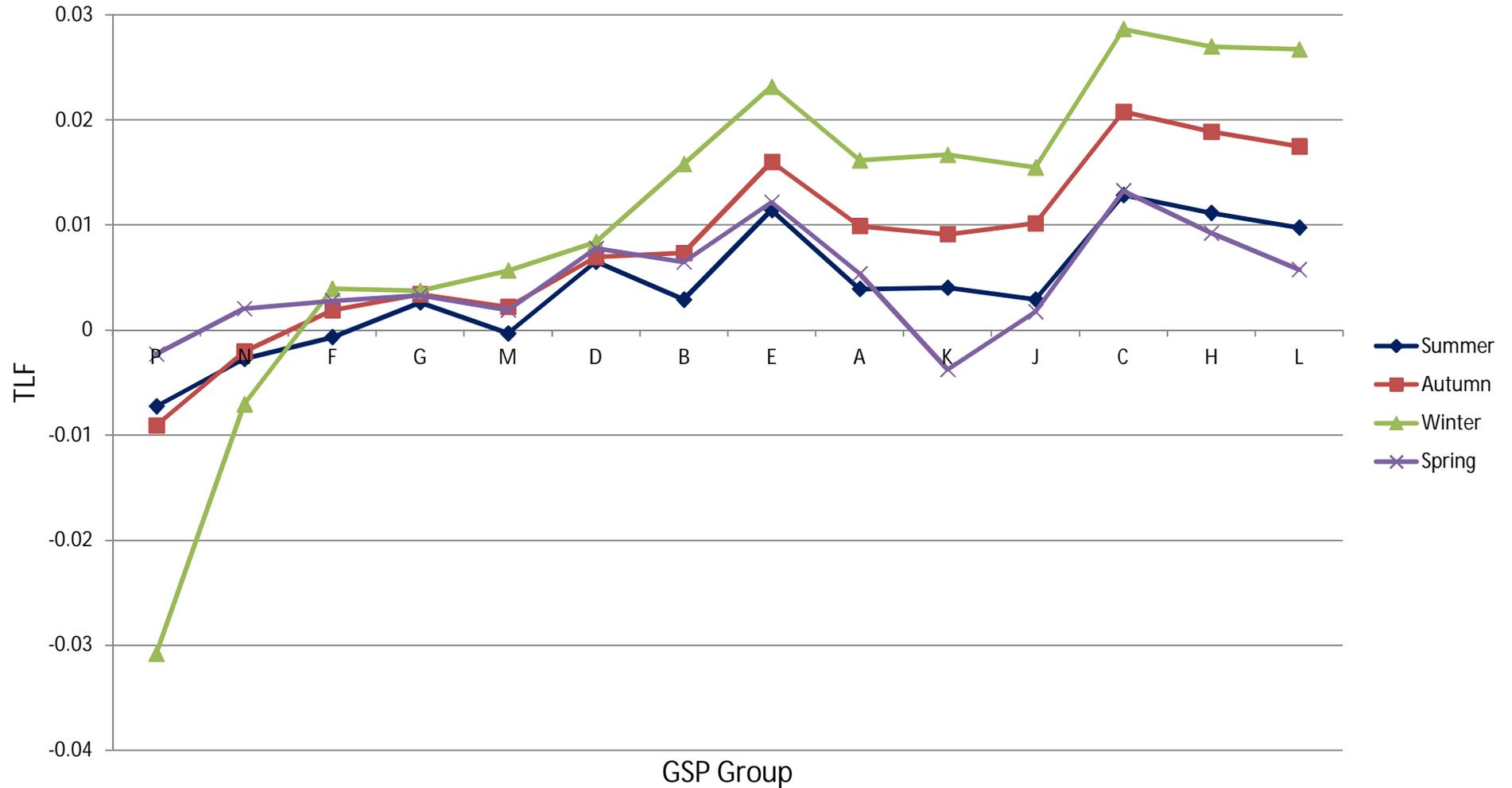## 6.5 Task 3: Inclusion of the HVDC Western Link – Option B



Figure 22: Task 3 Option B – Adjusted Seasonal Average Zonal TLFs

Table 10: Task 3 Option B – Adjusted Seasonal Average Zonal TLFs

| GSP Group | TLF Zone | Summer | Autumn | Winter | Spring |
|-----------|----------|---------|---------|---------|---------|
| P | 14 | -0.00725 | -0.00909 | -0.03079 | -0.00228 |
| N | 13 | -0.00274 | -0.00205 | -0.00706 | 0.00204 |
| F | 6 | -0.00067 | 0.00187 | 0.00393 | 0.00279 |
| G | 7 | 0.00261 | 0.00341 | 0.00376 | 0.00332 |
| M | 12 | -0.00032 | 0.0022 | 0.00566 | 0.00188 |
| D | 4 | 0.0065 | 0.00696 | 0.00839 | 0.00776 |
| B | 2 | 0.0029 | 0.00734 | 0.01579 | 0.00648 |
| E | 5 | 0.01142 | 0.016 | 0.02316 | 0.01218 |
| A | 1 | 0.00391 | 0.0099 | 0.01614 | 0.00536 |
| K | 10 | 0.00403 | 0.00912 | 0.01667 | -0.00375 |
| J | 9 | 0.00292 | 0.01015 | 0.01548 | 0.00173 |
| C | 3 | 0.01284 | 0.02078 | 0.02864 | 0.01326 |
| H | 8 | 0.01116 | 0.01888 | 0.02699 | 0.00923 |
| L | 11 | 0.00975 | 0.01748 | 0.02671 | 0.00576 |

In Option B of Task 3 the HVDC Western Link was modelled as an AC connection between the two relevant Nodes in a manner that is consistent with the legal text for the P229 Proposed Modification.

With reference to Task 1 network model, the network model used for Task 3 Option B was altered so to include this AC line representing the HVDC Western Link in an equivalent manner. The link was modelled with an AC equivalent at peak demand and high transfer from north to south (R = 0.11% and X = 0.613%).

Network Mapping Statement used for Task 3 Option B was the same as in Task 1.

Metered Volumes used for Task 3 Option B was the same as in Task 1.

Figure 22 graphically presents the Adjusted Seasonal Average Zonal TLFs as calculated for Task 3 Option B.

Table 10 provides numerical values for the Adjusted Seasonal Average Zonal TLFs as calculated for Task 3 Option B.

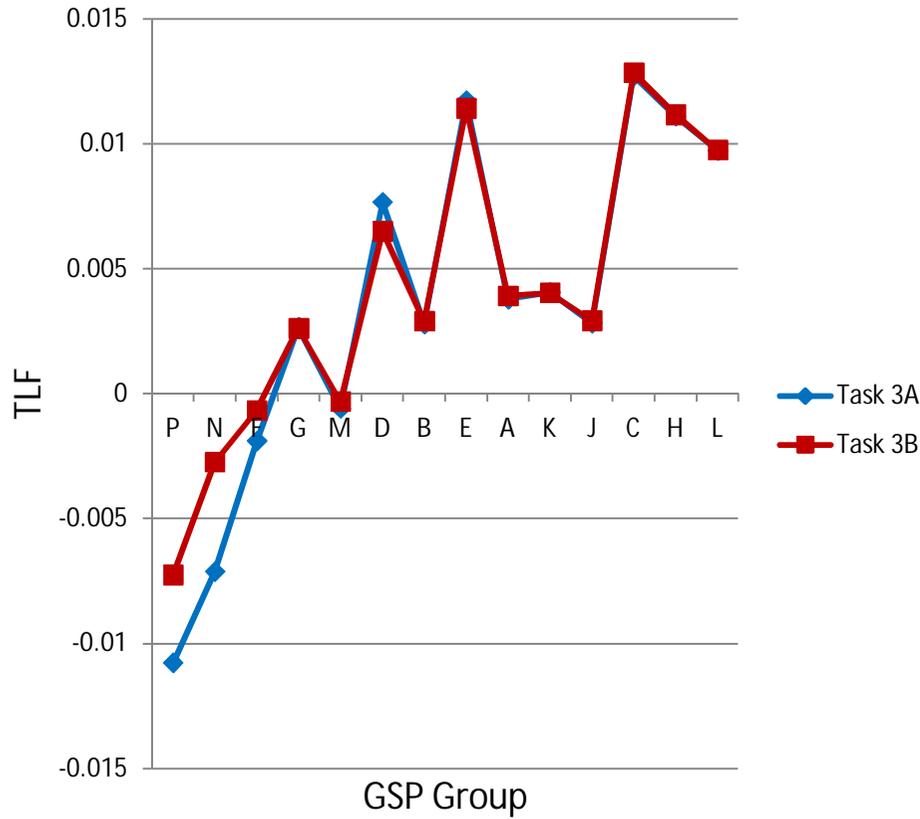## 6.6 Task 3: Comparisons between Option A and Option B



Figure 23: Task 3 - Summer Adjusted Seasonal Average
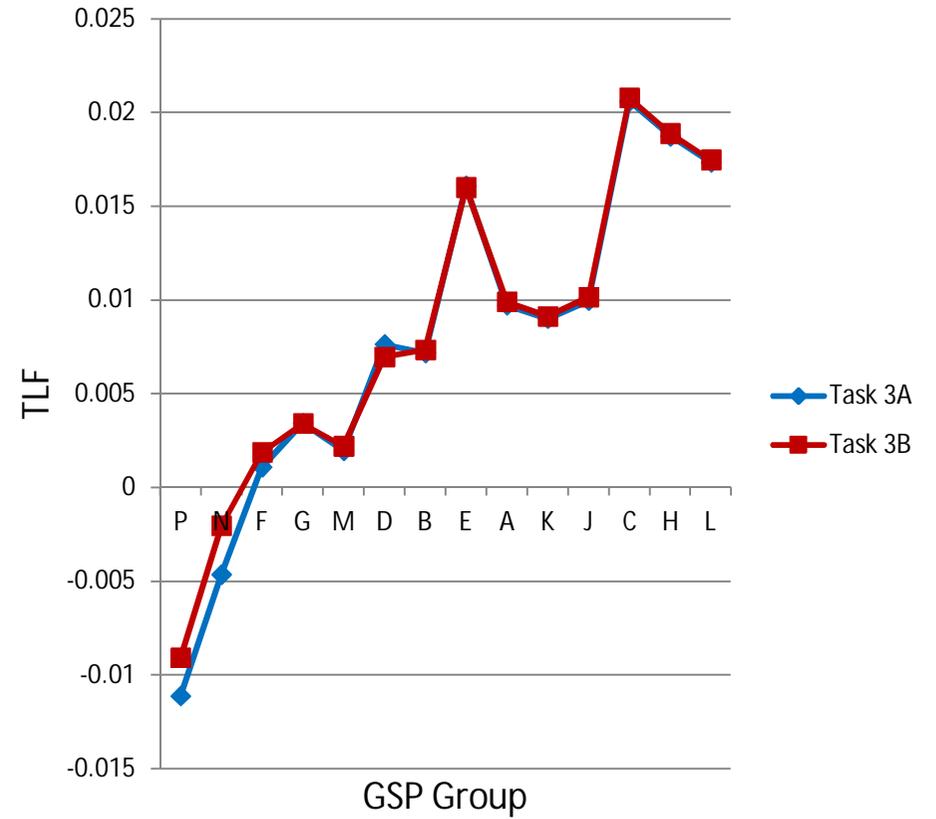Zonal TLFs: Option A vs. Option B



Figure 24: Task 3 - Autumn Adjusted Seasonal Average
Zonal TLFs: Option A vs. Option B

Table 11: Task 3 - Summer Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B

| GSP Group | TLF Zone | Task 3 Option A | Task 3 Option B |
|---|---|---|---|
| P | 14 | -0.01077 | -0.00725 |
| N | 13 | -0.00712 | -0.00274 |
| F | 6 | -0.00189 | -0.00067 |
| G | 7 | 0.00265 | 0.00261 |
| M | 12 | -0.00059 | -0.00032 |
| D | 4 | 0.00766 | 0.0065 |
| B | 2 | 0.00279 | 0.0029 |
| E | 5 | 0.01173 | 0.01142 |
| A | 1 | 0.00378 | 0.00391 |
| K | 10 | 0.00405 | 0.00403 |
| J | 9 | 0.00282 | 0.00292 |
| C | 3 | 0.01273 | 0.01284 |
| H | 8 | 0.0111 | 0.01116 |
| L | 11 | 0.00973 | 0.00975 |

Table 12: Task 3 - Autumn Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B

| GSP Group | TLF Zone | Task 3 Option A | Task 3 Option B |
|---|---|---|---|
| P | 14 | -0.01113 | -0.00909 |
| N | 13 | -0.00465 | -0.00205 |
| F | 6 | 0.00108 | 0.00187 |
| G | 7 | 0.00342 | 0.00341 |
| M | 12 | 0.00196 | 0.0022 |
| D | 4 | 0.00763 | 0.00696 |
| B | 2 | 0.00718 | 0.00734 |
| E | 5 | 0.01608 | 0.016 |
| A | 1 | 0.00971 | 0.0099 |
| K | 10 | 0.00901 | 0.00912 |
| J | 9 | 0.00997 | 0.01015 |
| C | 3 | 0.0206 | 0.02078 |
| H | 8 | 0.01873 | 0.01888 |
| L | 11 | 0.01734 | 0.01748 |

Figure 23 and Figure 24 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 3 Option B for summer and autumn respectively.

Table 11 and Table 12 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 3 Option B for summer and autumn respectively.
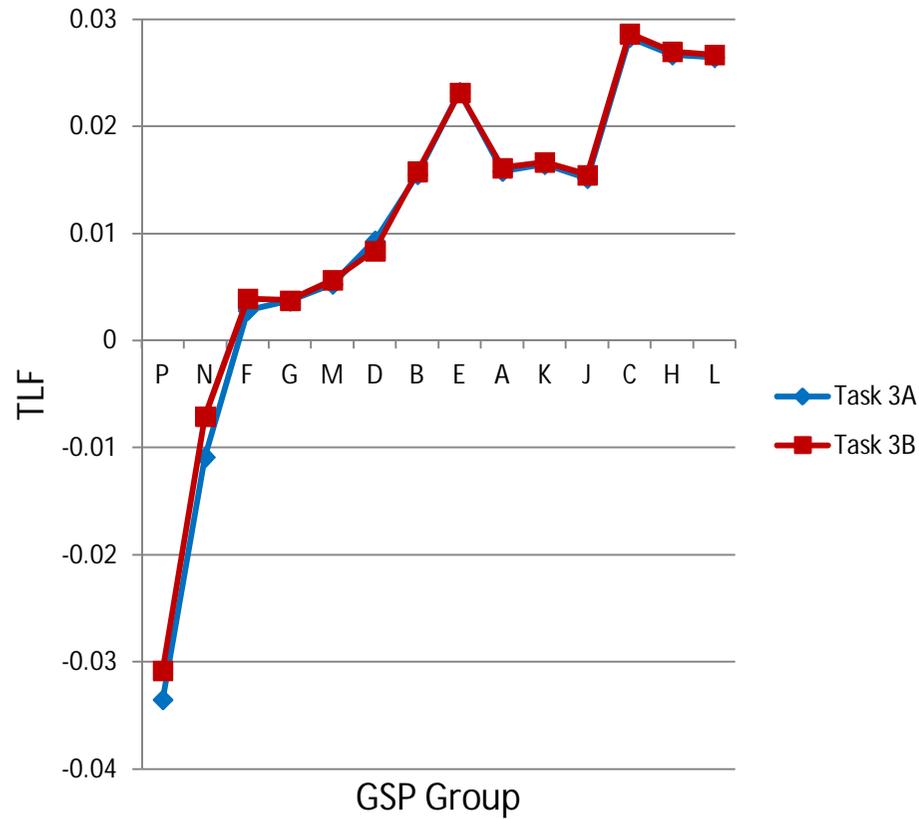
Figure 25: Task 3 - Winter Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B
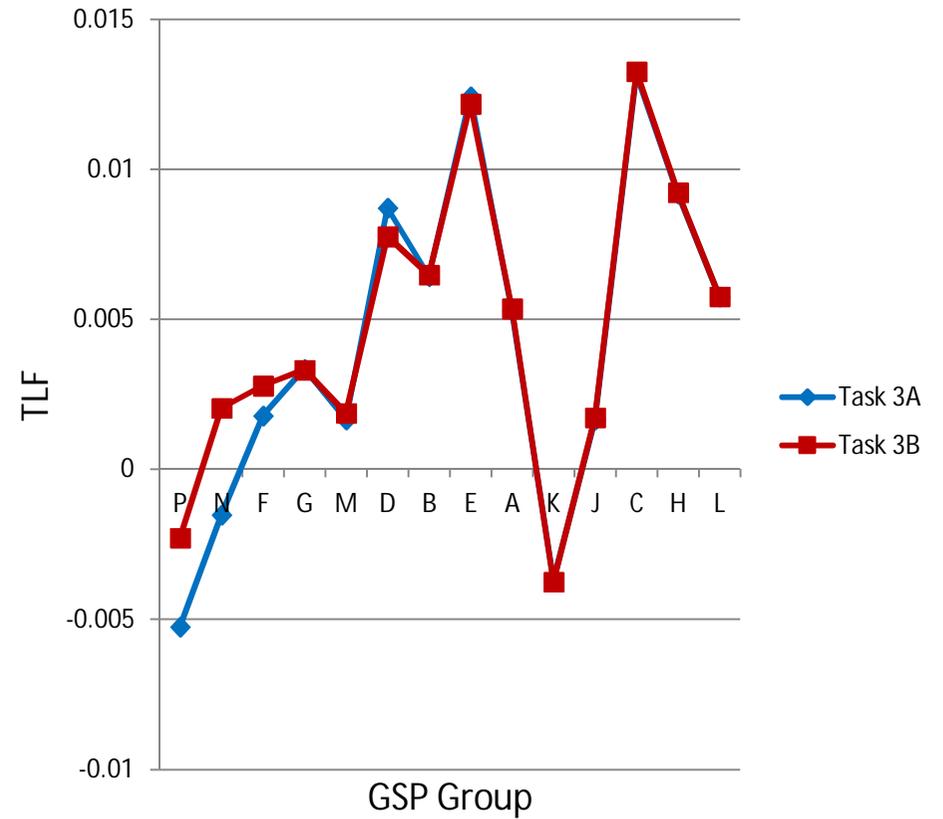
Figure 26: Task 3 - Spring Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B

Table 13: Task 3 - Winter Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B

| GSP Group | TLF Zone | Task 3 Option A | Task 3 Option B |
|-----------|----------|-----------------|-----------------|
| P | 14 | -0.03351 | -0.03079 |
| N | 13 | -0.01086 | -0.00706 |
| F | 6 | 0.00284 | 0.00393 |
| G | 7 | 0.00373 | 0.00376 |
| M | 12 | 0.00527 | 0.00566 |
| D | 4 | 0.00933 | 0.00839 |
| B | 2 | 0.01553 | 0.01579 |
| E | 5 | 0.0232 | 0.02316 |
| A | 1 | 0.01582 | 0.01614 |
| K | 10 | 0.01644 | 0.01667 |
| J | 9 | 0.01515 | 0.01548 |
| C | 3 | 0.02831 | 0.02864 |
| H | 8 | 0.0267 | 0.02699 |
| L | 11 | 0.02644 | 0.02671 |

Table 14: Task 3 - Spring Adjusted Seasonal Average Zonal TLFs: Option A vs. Option B

| GSP Group | TLF Zone | Task 3 Option A | Task 3 Option B |
|-----------|----------|-----------------|-----------------|
| P | 14 | -0.00524 | -0.00228 |
| N | 13 | -0.00151 | 0.00204 |
| F | 6 | 0.00179 | 0.00279 |
| G | 7 | 0.00335 | 0.00332 |
| M | 12 | 0.00166 | 0.00188 |
| D | 4 | 0.00872 | 0.00776 |
| B | 2 | 0.00643 | 0.00648 |
| E | 5 | 0.01243 | 0.01218 |
| A | 1 | 0.00527 | 0.00536 |
| K | 10 | -0.00371 | -0.00375 |
| J | 9 | 0.00166 | 0.00173 |
| C | 3 | 0.01318 | 0.01326 |
| H | 8 | 0.00919 | 0.00923 |
| L | 11 | 0.00576 | 0.00576 |

Figure 25 and Figure 26 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 3 Option B for winter and spring respectively.

Table 13 and Table 14 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 3 Option B for winter and spring respectively.

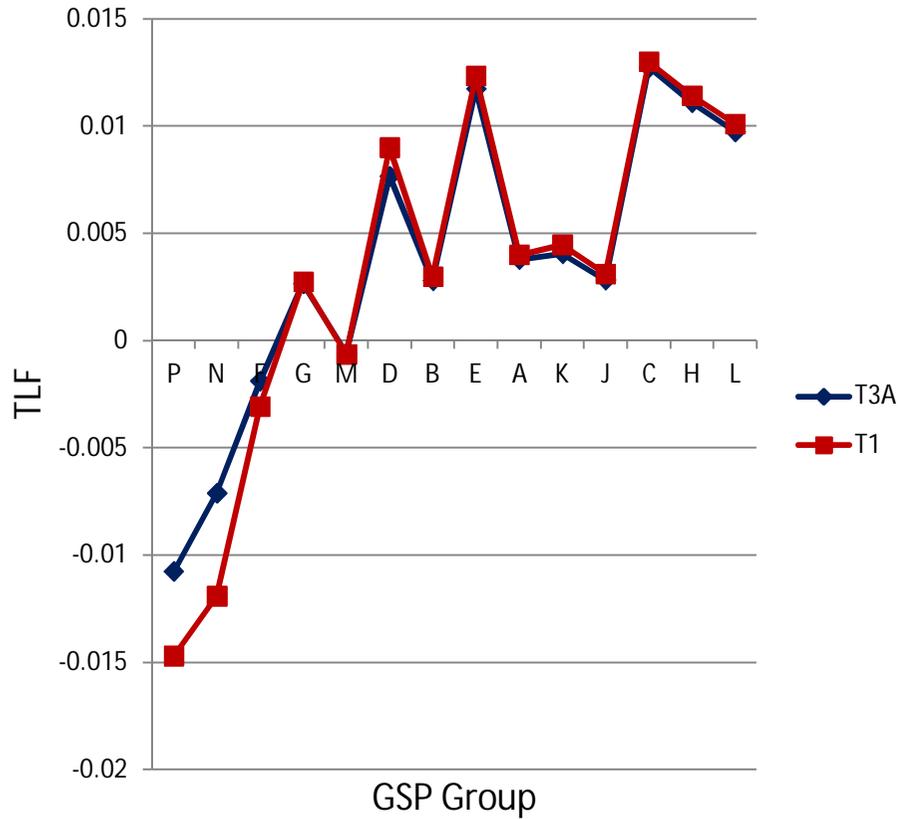## 6.7 Comparisons between Task 3 Option A and Task 1



Figure 27: Summer Adjusted Seasonal Average Zonal TLFs:
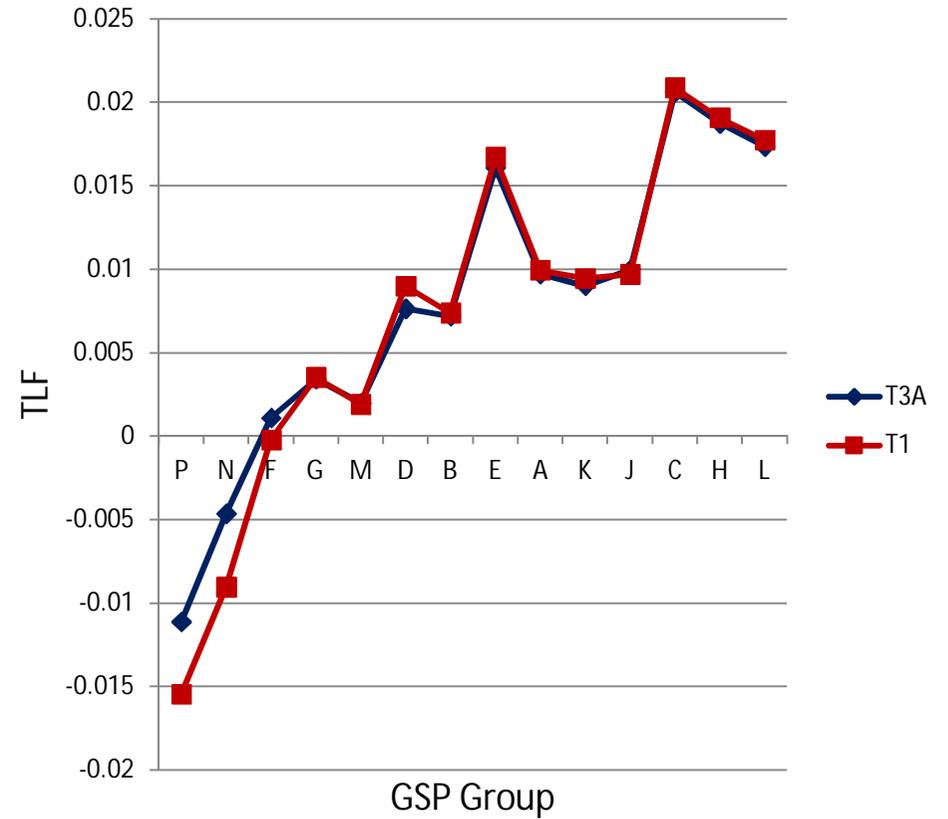Task 3 Option A vs. Task 1

Figure 28: Autumn Adjusted Seasonal Average Zonal TLFs:
Task 3 Option A vs. Task 1

Table 15: Summer Adjusted Seasonal Average Zonal TLFs: Task 3 Option A vs. Task 1

| GSP Group | TLF Zone | Task 3 Option A | Task 1 |
|---|---|---|---|
| P | 14 | -0.01077 | -0.01471 |
| N | 13 | -0.00712 | -0.01192 |
| F | 6 | -0.00189 | -0.00308 |
| G | 7 | 0.00265 | 0.00273 |
| M | 12 | -0.00059 | -0.00065 |
| D | 4 | 0.00766 | 0.00899 |
| B | 2 | 0.00279 | 0.00297 |
| E | 5 | 0.01173 | 0.01233 |
| A | 1 | 0.00378 | 0.00399 |
| K | 10 | 0.00405 | 0.00446 |
| J | 9 | 0.00282 | 0.0031 |
| C | 3 | 0.01273 | 0.01299 |
| H | 8 | 0.0111 | 0.01141 |
| L | 11 | 0.00973 | 0.01009 |

Table 16: Autumn Adjusted Seasonal Average Zonal TLFs: Task 3 Option A vs. Task 1

| GSP Group | TLF Zone | Task 3 Option A | Task 1 |
|---|---|---|---|
| P | 14 | -0.01113 | -0.01546 |
| N | 13 | -0.00465 | -0.00905 |
| F | 6 | 0.00108 | -0.00024 |
| G | 7 | 0.00342 | 0.00352 |
| M | 12 | 0.00196 | 0.0019 |
| D | 4 | 0.00763 | 0.00898 |
| B | 2 | 0.00718 | 0.00738 |
| E | 5 | 0.01608 | 0.01672 |
| A | 1 | 0.00971 | 0.00993 |
| K | 10 | 0.00901 | 0.00945 |
| J | 9 | 0.00997 | 0.00969 |
| C | 3 | 0.0206 | 0.02087 |
| H | 8 | 0.01873 | 0.01907 |
| L | 11 | 0.01734 | 0.01773 |

Figure 27 and Figure 28 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 1 for summer and autumn respectively.

Table 15 and Table 16 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 1 for summer and autumn respectively.
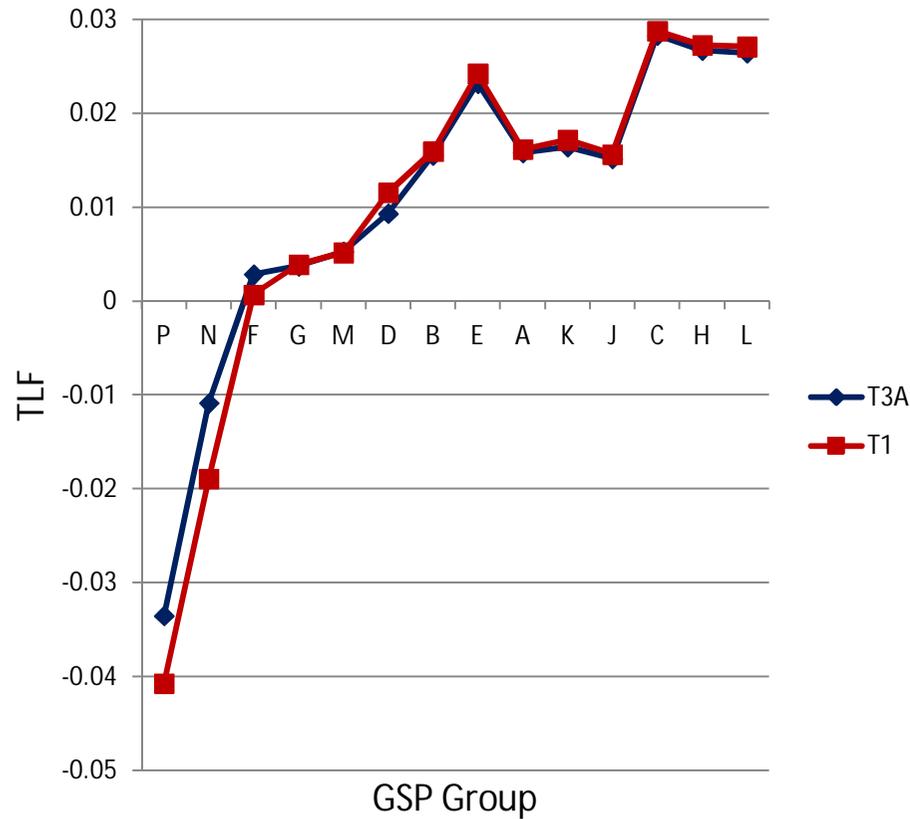
Figure 29: Winter Adjusted Seasonal Average Zonal TLFs:
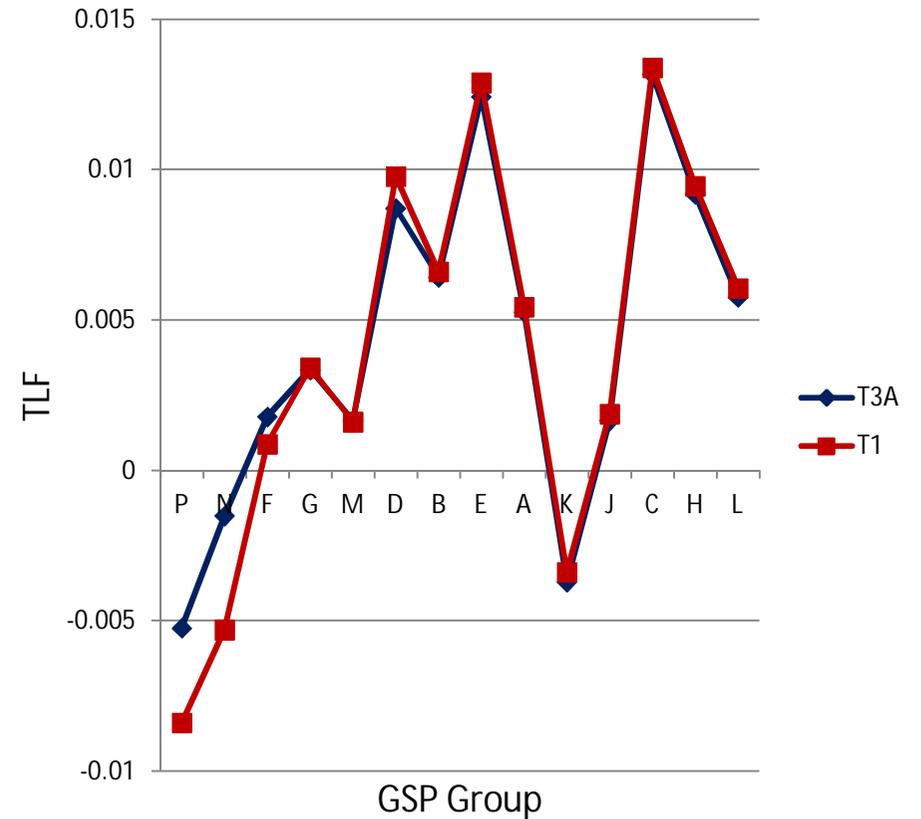Task 3 Option A vs. Task 1

Figure 30: Spring Adjusted Seasonal Average Zonal TLFs:
Task 3 Option A vs. Task 1

Table 17: Winter Adjusted Seasonal Average Zonal TLFs:
Task 3 Option A vs. Task 1

| GSP Group | TLF Zone | Task 3 Option A | Task 1 |
|---|---|---|---|
| P | 14 | -0.03351 | -0.04071 |
| N | 13 | -0.01086 | -0.01892 |
| F | 6 | 0.00284 | 0.00069 |
| G | 7 | 0.00373 | 0.00388 |
| M | 12 | 0.00527 | 0.00516 |
| D | 4 | 0.00933 | 0.01156 |
| B | 2 | 0.01553 | 0.01593 |
| E | 5 | 0.0232 | 0.02423 |
| A | 1 | 0.01582 | 0.01617 |
| K | 10 | 0.01644 | 0.01716 |
| J | 9 | 0.01515 | 0.01563 |
| C | 3 | 0.02831 | 0.02876 |
| H | 8 | 0.0267 | 0.02725 |
| L | 11 | 0.02644 | 0.02708 |

Table 18: Spring Adjusted Seasonal Average Zonal TLFs:
Task 3 Option A vs. Task 1

| GSP Group | TLF Zone | Task 3 Option A | Task 1 |
|---|---|---|---|
| P | 14 | -0.00524 | -0.00839 |
| N | 13 | -0.00151 | -0.0053 |
| F | 6 | 0.00179 | 0.00088 |
| G | 7 | 0.00335 | 0.00341 |
| M | 12 | 0.00166 | 0.00161 |
| D | 4 | 0.00872 | 0.00978 |
| B | 2 | 0.00643 | 0.00661 |
| E | 5 | 0.01243 | 0.01289 |
| A | 1 | 0.00527 | 0.00544 |
| K | 10 | -0.00371 | -0.00338 |
| J | 9 | 0.00166 | 0.00188 |
| C | 3 | 0.01318 | 0.01339 |
| H | 8 | 0.00919 | 0.00945 |
| L | 11 | 0.00576 | 0.00606 |

Figure 29 and Figure 30 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 1 for winter and spring respectively.

Table 17 and Table 18 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option A and Task 1 for winter and spring respectively.

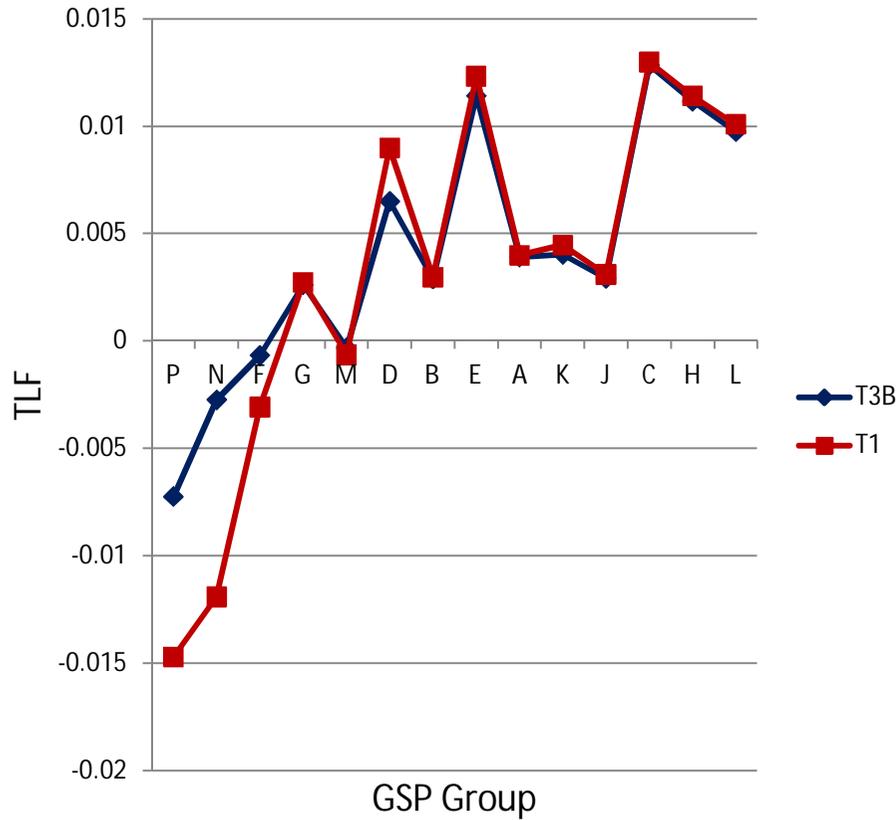## 6.8  Comparisons between Task 3 Option B and Task 1



Figure 31: Summer Adjusted Seasonal Average Zonal TLFs:
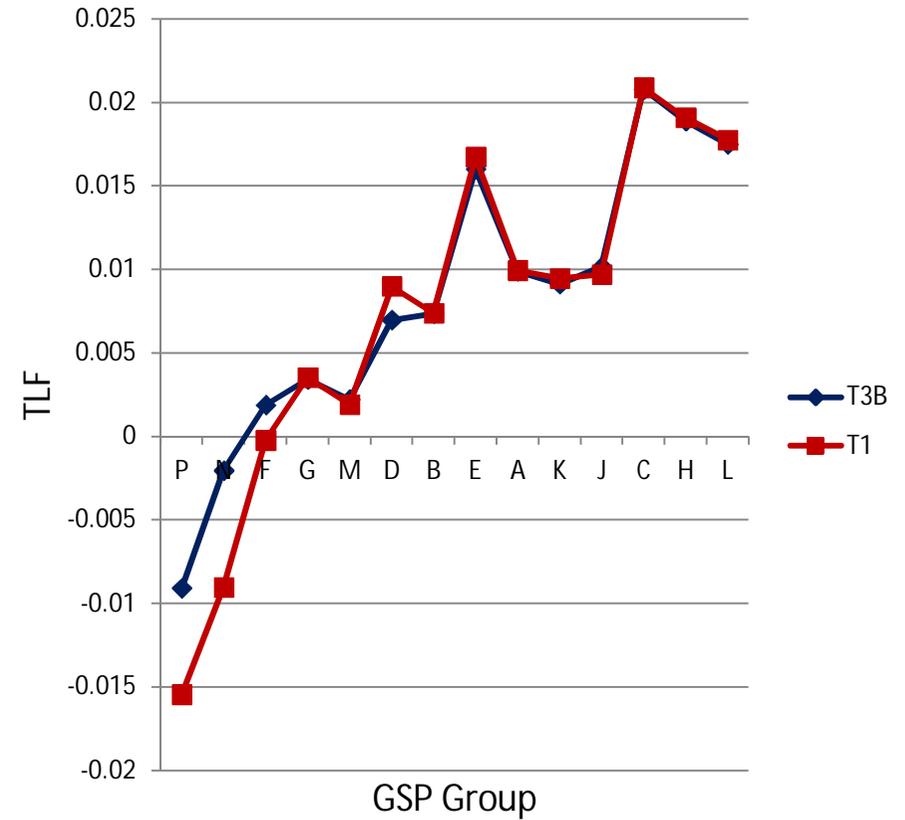Task 3 Option B vs. Task 1



Figure 32: Autumn Adjusted Seasonal Average Zonal TLFs:
Task 3 Option B vs. Task 1

Table 19: Summer Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

| GSP Group | TLF Zone | Task 3 Option B | Task 1 |
|---|---|---|---|
| P | 14 | -0.00725 | -0.01471 |
| N | 13 | -0.00274 | -0.01192 |
| F | 6 | -0.00067 | -0.00308 |
| G | 7 | 0.00261 | 0.00273 |
| M | 12 | -0.00032 | -0.00065 |
| D | 4 | 0.0065 | 0.00899 |
| B | 2 | 0.0029 | 0.00297 |
| E | 5 | 0.01142 | 0.01233 |
| A | 1 | 0.00391 | 0.00399 |
| K | 10 | 0.00403 | 0.00446 |
| J | 9 | 0.00292 | 0.0031 |
| C | 3 | 0.01284 | 0.01299 |
| H | 8 | 0.01116 | 0.01141 |
| L | 11 | 0.00975 | 0.01009 |

Table 20: Autumn Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

| GSP Group | TLF Zone | Task 3 Option B | Task 1 |
|---|---|---|---|
| P | 14 | -0.00909 | -0.01546 |
| N | 13 | -0.00205 | -0.00905 |
| F | 6 | 0.00187 | -0.00024 |
| G | 7 | 0.00341 | 0.00352 |
| M | 12 | 0.0022 | 0.0019 |
| D | 4 | 0.00696 | 0.00898 |
| B | 2 | 0.00734 | 0.00738 |
| E | 5 | 0.016 | 0.01672 |
| A | 1 | 0.0099 | 0.00993 |
| K | 10 | 0.00912 | 0.00945 |
| J | 9 | 0.01015 | 0.00969 |
| C | 3 | 0.02078 | 0.02087 |
| H | 8 | 0.01888 | 0.01907 |
| L | 11 | 0.01748 | 0.01773 |

Figure 31 and Figure 32 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option B and Task 1 for summer and autumn respectively.

Table 19 and Table 20 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option B and Task 1 for summer and autumn respectively.
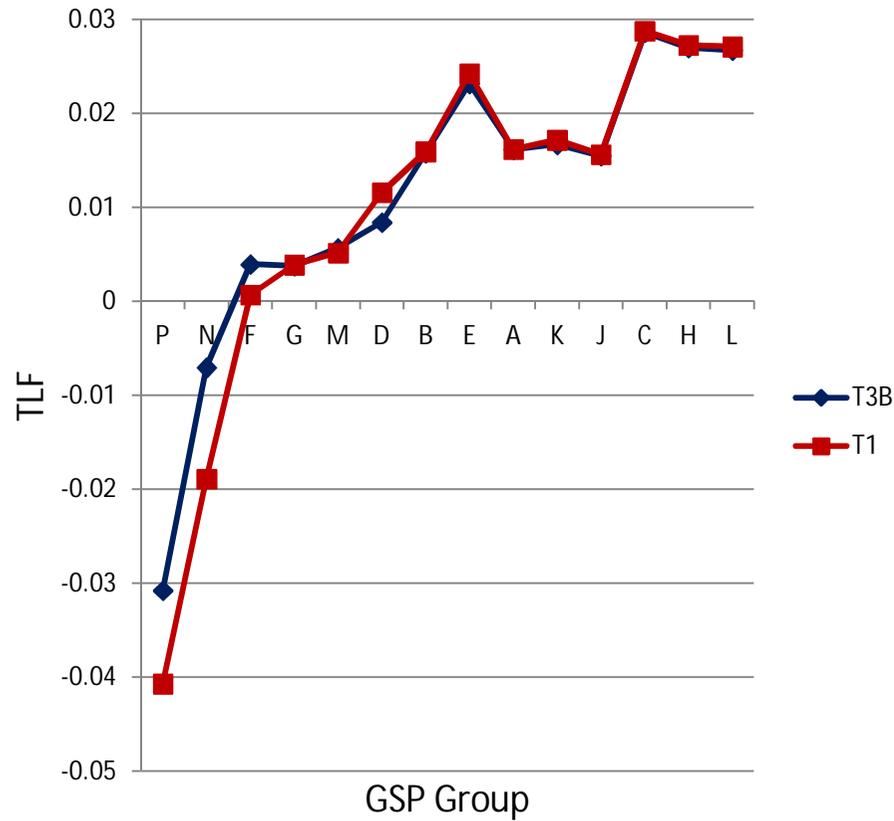
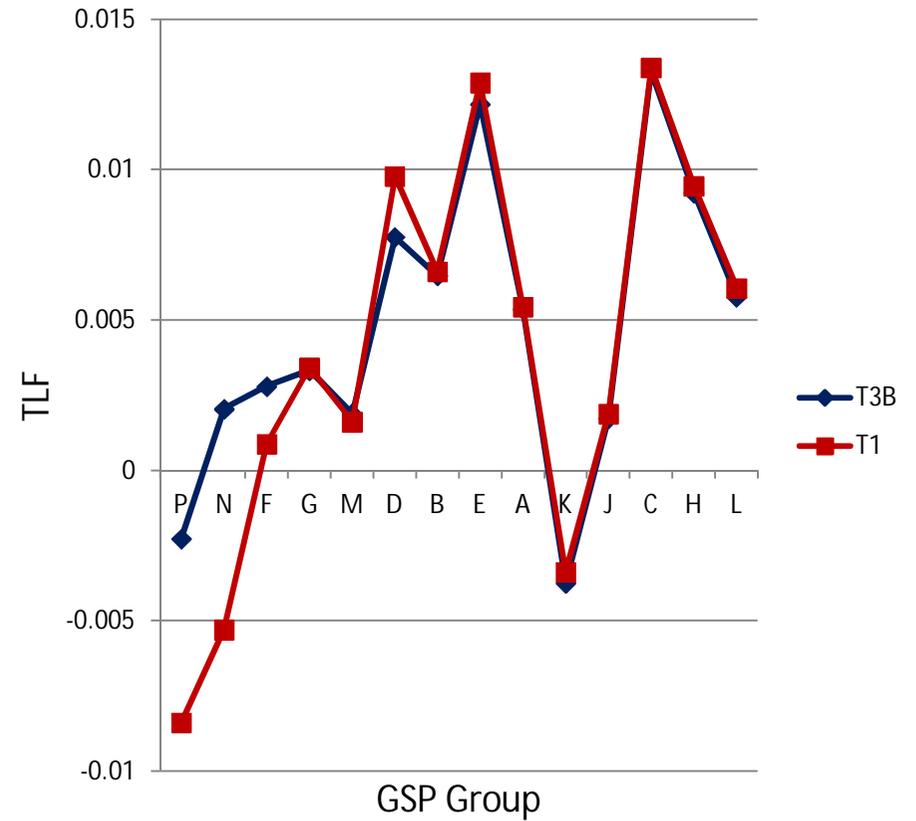Figure 33: Winter Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

Figure 34: Spring Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

Table 21: Winter Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

| GSP Group | TLF Zone | Task 3 Option B | Task 1 |
|---|---|---|---|
| P | 14 | -0.03079 | -0.04071 |
| N | 13 | -0.00706 | -0.01892 |
| F | 6 | 0.00393 | 0.00069 |
| G | 7 | 0.00376 | 0.00388 |
| M | 12 | 0.00566 | 0.00516 |
| D | 4 | 0.00839 | 0.01156 |
| B | 2 | 0.01579 | 0.01593 |
| E | 5 | 0.02316 | 0.02423 |
| A | 1 | 0.01614 | 0.01617 |
| K | 10 | 0.01667 | 0.01716 |
| J | 9 | 0.01548 | 0.01563 |
| C | 3 | 0.02864 | 0.02876 |
| H | 8 | 0.02699 | 0.02725 |
| L | 11 | 0.02671 | 0.02708 |

Table 22: Spring Adjusted Seasonal Average Zonal TLFs: Task 3 Option B vs. Task 1

| GSP Group | TLF Zone | Task 3 Option B | Task 1 |
|---|---|---|---|
| P | 14 | -0.00228 | -0.00839 |
| N | 13 | 0.00204 | -0.0053 |
| F | 6 | 0.00279 | 0.00088 |
| G | 7 | 0.00332 | 0.00341 |
| M | 12 | 0.00188 | 0.00161 |
| D | 4 | 0.00776 | 0.00978 |
| B | 2 | 0.00648 | 0.00661 |
| E | 5 | 0.01218 | 0.01289 |
| A | 1 | 0.00536 | 0.00544 |
| K | 10 | -0.00375 | -0.00338 |
| J | 9 | 0.00173 | 0.00188 |
| C | 3 | 0.01326 | 0.01339 |
| H | 8 | 0.00923 | 0.00945 |
| L | 11 | 0.00576 | 0.00606 |

Figure 33 and Figure 34 present comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option B and Task 1 for summer and autumn respectively.

Table 21 and Table 22 provide numerical values for comparison of Adjusted Seasonal Average Zonal TLFs between Task 3 Option B and Task 1 for summer and autumn respectively.

# 7 OPEN ISSUES – HVDC WESTERN LINK

## 7.1 Option A

In Option A of Task 3 the HVDC Western Link was modelled as a point of generation at one of the corresponding Nodes and as a point of demand at the other corresponding Node.

This is an approach that has a potential to reflect the impact of HVDC Western Link on the load flows in the rest of the network.

Metered Volumes were extended to provide for the two above mentioned points so to model 1/3 of Scotland to England flow over the HVDC Western Link, subject to its minimal and maximal carrying capacity and accounting for the losses on the link. The information received was indicating that:

- HVDC Western Link transfer capability is 100MW up to 2200MW;
- Losses range from 20MW at minimal transfer to 50MW at maximal transfer.

## 7.2 Option B

In Option B of Task 3 the HVDC Western Link was modelled as an AC connection between the two relevant Nodes in a manner that is consistent with the legal text for the P229 Proposed Modification.

Therefore, the network model used for Task 3 Option B was altered so to include this AC line representing the HVDC Western Link in an equivalent manner. The link was modelled with an AC equivalent at peak demand and high transfer from north to south (R = 0.11% and X = 0.613%).

From load flow perspective this is a good equivalent for such an SSP, but debatable one for other SSPs (potentially tangibly erroneous, causing flows significantly different from real ones and thus distorted TLFs). Also, for this reason, the following unusual load flows on the HVDC Western Link were possible to observe:

| SSP | | AC equivalent end nodes | | Flow | |
|---|---|---|---|---|---|
| 20150715 | 25 | HUER4- | CONQ40 | -5.83 | MW |
| 20160128 | 11 | HUER4- | CONQ40 | 2232.08 | MW |

## 7.3  Some comparative observations on Option A and Option B

The following few spot samples (from calculated SSPs) signify differences between Load Flow Modelling for Task 3 Option A and for Task 3 Option B:

| SSP | | Task 3 Option B Load Flow | | | Task 3 Option A Nodal Flows (from used Metered Volumes) | | | |
|---|---|---|---|---|---|---|---|---|
| | | AC equivalent end nodes | | Load Flow [MW] | | In [MW] | | Out [MW] |
| 20160112 | 2 | HUER4- | CONQ40 | 1600.01 | HUER4- | -804.39 | CONQ40 | 774.33 |
| 20160112 | 27 | HUER4- | CONQ40 | 977.45 | HUER4- | -446.48 | CONQ40 | 421.53 |
| 20150708 | 1 | HUER4- | CONQ40 | 1300.72 | HUER4- | -564.90 | CONQ40 | 538.26 |
| 20150709 | 25 | HUER4- | CONQ40 | 173.70 | HUER4- | 0.00 | CONQ40 | 0.00 |

The differences certainly reflect characteristics of the two Load Flow Modelling option approaches.  However, there are further, more general observations:

- It does not look practical to work with 630 different AC equivalents (one for each SSP) to achieve adequate level of modelling and thus the adequate calculation accuracy
- In the two Load Flow Modelling exercise, in Task 3 Option B the flow on the HVDC Western Link was accidental to the equivalent used and particular SSP's deliveries and off-takes
- In Task 3 Option A the nodal flows related to the HVDC Western Link end nodes were deliberate, but in future implementation of P350 they could be accurately matching actually recorded such nodal flows