Evaluation of changes required in the transmission system to facilitate the developments of smart grids

MSc Thesis project

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The work for thesis has been carried out at TenneT TSO B.V Arnhem

from November 2010 to August 2011

“The stone age did not end due to lack of stone”

-Sheikh Zaki Yamani, former Saudi minister for Oil

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Preface

In the world we inhabit basic commodities such as water, food and habitable surroundings are no longer the basic requirements. We live in perhaps one of the most important times in human history-when sustainable practices need to be desperately implemented to ensure a future for all mankind.

Almost everything we touch in our lives today requires fossil fuels to manufacture or operate. Fossil fuels are becoming increasingly difficult to extract, acquire and transport to the point of their intended use. Even after their use, fossil fuels leave behind traces in the atmosphere- effects of which are becoming increasingly apparent after two centuries of their continued use in the form of global warming and other forms of environmental pollution. Electricity is thus added to the list of basic amenities for human survival. Renewable energy resources can provide clean, green and affordable energy-but their large scale implementation faces difficult challenges- mostly due to the inconsistency of the sources of energy they rely on to produce energy.

Smart grids hold a promising answer to the challenges posed toward implementing sustainable energy resources, and in particular renewable resources of energy into large scale energy transmission. This work is a study into the expected effects of incorporating renewable resources of energy and storage sources into the electricity grid and attempts to answer some of the technical aspects which are likely to arise in the process.

This work is not the result of a single person's work. I would like to thank my supervisors Frank Koers and Prof. Marjan Popov for their incredible support in guiding me in the thesis at every step and providing avenues for such a deep and timely research subject. My special thanks go to Ernst Wierenga for his inputs and directions. I would like to thank all my friends and my loving family for supporting me in my hours of most need. Last but not the least I would like to thank Hema for her continued understanding and support throughout the process of this work.

Arvind Kumar Srinivasan

Summary

The energy industry today is in the precipice of great changes. As the changes in the energy supply into the Netherlands are expected to change over the coming years the nature of the HV grid is also expected to change drastically in the coming years.

It becomes necessary to develop models for the future scenarios in which the different patterns of energy flow are taken into account. This was the focus of the vision 2030 document by TenneT in 2008. The study gives an overview of the expected load flows under the different development scenarios. With the nature of generation and load varying between the years 2010 and 2030, it becomes necessary to study the dynamic behavior of the grid in addition to the load flows.

In this study the dynamic aspects of the network under the different scenarios are studied. It was seen that the contribution of the wind power is expected to increase most under the sustainable transition scenario (with contribution at the Ijmuiden generation bus reached 60% of its production value) and least under the money rules scenario(at a 1% of total production). Effects of faults at different locations in the network were studied. It was seen that the fault levels in the network determine the voltage sags during the fault event. The voltage sags were found to be the highest in the new strongholds scenario and lowest in the money rules scenario. It was further observed that even in the worst case scenario, a fault in the distribution network with generation from photovoltaic, μ-CHP and electric vehicle sources did not exceed 70% of the prefault voltage levels at the 150KV bus. The worst location in the network was found to be at the 150KV bus which acts as the focal point for all power generation under all the scenarios.

It was further seen that the recovery time after a fault event and the settling time for the voltage, frequency and the active and reactive powers were dependent on both the power generation contributions at the generation bus as well as the nature of the grid itself, characterized using the grid inertia time constant. It was observed that the oscillations in voltage and frequency were highest in the

sustainable transition scenario. The increased contribution from wind power production and complete focus of all the power plants at Ijmuiden 150KV bus are reasons for this phenomenon. The scenario with the lowest oscillation in the parameters was found to be the new strongholds scenario. However in this case fault levels were quite high and larges fault impedance had to be utilized for the system convergence in calculations.

It was found that distributed power generation resources such as rooftop Photovoltaic systems and electric vehicles with vehicle to grid capabilities are indeed capable of supplying power to the grid and participating in applications such as frequency regulation. However the impact of the power electronic converters is clearly visible in their integration with the grid.

Methods were proposed to mitigate the effects of the worst case faults in the network. It was found that fast switching mechanisms and use of fault current limiting devices would mitigate the effects of transients in the HV grid to a very large extent.

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Glossary of abbreviations

µ-CHP: Micro Combined Heat and Power

PV system: Photo Voltaic system

EV: Electric Vehicle

HV: High Voltage

MV: Medium voltage

KV: Kilo Volts

MW: MegaWatt

GW: GigaWatt

Hz: Hertz

p.u: per unit

KA: Kilo Amperes

MVA: Mega Volt-Ampere

pf: power factor

V2G: Vehicle to Grid

R/X: Resistance to reactance ratio

GR: Green Revolution scenario

NS/Nstr: New strongholds scenario

SX: Sustainable transition scenario

MR: Money rules scenario

Chapter 1

Introduction

1.0 Introduction

The turn of the century has bought about profound changes in the energy industry. With severe variations in the prices of fossil fuels, environmental challenges, logistical challenges in the exploration, extraction and transportation from source to point of use continuously influencing availability of cheap and clean energy, increased focus has been given towards development and integration of “Renewable energy sources”.

While the Electric grids around the world continue to be based on conventional technologies renewable energy resources such as photovoltaic power systems, Wind energy, Electric vehicles and CHP plants increasingly rely on power electronic devices and converters to transfer the produced electric power to the electric grid. One of the chief benefits of using the power electronic converters is the high degree of control which can be used to control the behavior of the electricity grid during disturbances and switching conditions. A minor drawback is ascertaining the nature of interactions between the fast-acting power electronic components-based renewable energy resources and the slower reacting conventional electric grid.

This project deals with analyzing the nature of the interactions between the high voltage grid and the smart grids of the future. To analyze the above it is useful to get pointers regarding the growth trends for renewable energy resources and their expected assimilation into the networks of the future. Even though the developments of the smart grids entities such as PV systems, Electric vehicles etc. are dependent to a very large extent on the developments in these individual fields in the future, their incorporation into the grids in the years to come depends to a large extent on the growth policies adopted in the future. These policies in turn would be motivated by the ease of logistics in procuring a steady and reliable source of fossil fuels (coal, petroleum and natural gas) in the years to come. This is the backdrop of the future growth scenarios adopted by TenneT to formulate its vision for the electricity grid in the year 2030 in the “Vision 2030” document [1]. In this document the various scenarios are analyzed. Regions of the grid to be reinforced and the resulting load flow characteristics for the Netherlands (also accounting for the international power exchange under different scenarios) are analyzed.

For a balancing authority of electric power in the Netherlands, it becomes very necessary to analyze the interaction between the smart grid networks and the conventional electric grid setups in this case. The electric grid in the years to come would be faced with an increased amount of distributed generation, higher use of power electronic converters and systems with lower inertia. The fundamental goal is to investigate the nature of the system parameters such as voltage, frequency and dynamic power flows between the grid (modeled as a combination of 400KV and 150 KV buses) and the downstream distribution systems during fault conditions and dynamic load conditions. Variation in these parameters has a profound effect on the stability of the system. Hence the system stability in terms of the individual parameters is studied. In conclusion, methods to reduce and alleviate the results of system disturbances are recommended. The studies are performed on the DIgSILENT PowerFactory ver.14 software.

1.1 Research Objectives

The research objectives of this report are detailed as follows:

1) What is the nature of the behavior of system parameters such as voltage, frequency, active and reactive power flow during system disturbances and dynamic load conditions in the future scenario networks foreseen under the “Vision 2030” document, when smart grid entities such as Photovoltaic power production systems, wind energy and electric vehicles are taken into account?
2) What is the nature of the short circuits at different locations in the network under different scenarios, which locations and conditions represent the worst case fault scenario for the HV grid?

3) What steps can be taken to ensure a steady operation of the system under above conditions?

1.2 Expected results

Various scenarios foreseen for the network in the years 2020 and 2030 have different network characteristics. However the system behavior for voltage, frequency and the resultant dynamic variations in real and reactive power at the HV buses would follow common patterns (albeit at different magnitudes).

1.2.1 Green Revolution scenario

This scenario is highlighted for an increased reliance on nuclear, CHP, wind power and photovoltaic power systems. While there is no variation in nuclear power production based on seasonal variations, CHP, wind and PV power production rely heavily on environmental setup under which the network is being investigated. During this period the grid is expected to function solely based on power production through nuclear and CHP resources in addition to international power exchanges. It is thus expected that system behavior is largely dependent on the conventional power production setup. Voltage and frequency deviations during both disturbances and load variation conditions can be controlled by conventional means. The voltage at the 150 KV bus can vary to a maximum of 10% between loading conditions and the frequency deviations would be limited to 2% of nominal frequency. Furthermore, transient oscillations in power would be reduced considering the relatively increased inertia of the system.

1.2.2 New strongholds scenario

In this scenario the system behavior is dominated by large inertia generators which contribute the majority of the power. The system behavior is thus expected to resemble the conventional setup with large generators dominating the nature of voltage, frequency and power flow patterns. The oscillations in the above parameters would be largely determined by the action of the controllers. The effect of the grid inertia would be to supply a very high amount of store rotational energy into the system in case of disturbances and the system is expected to recover quickly from the disturbed state.

1.2.3 Sustainable transition scenario

In this scenario the increased reliance on renewable energy resources leads to a major portion of the generation capacity being fulfilled by these forms of power production. The overall grid behavior would thus be defined by the increased oscillations in the network brought about by a large amount of wind power being supplied to the grid. It is expected that the voltage sags would be increased in this scenario in terms of recovery time and settling time. The magnitude of the voltage sag would however be reduced owing to the intermediate generation capacity and the low fault current supplying capability of wind power networks. Use of efficient controllers can however be used to mitigate the effect of load variations in the network under this scenario.

1.2.4 Money rules scenario

As a conventional network with very high amount of conventional (i.e. thermal, nuclear, CHP and gas turbine based) power production the scenario is one with the strongest possibilities for recovery time and system restoring time after a fault event. The transients in the power system would be reduced owing to the lower contributions from low inertia power generation methods. The voltage sag magnitudes would however be high due to the higher fault current levels in the grid.

1.3 Research methodology

The research methodology in this work is focused on describing the behavior of the network under different scenarios envisaged in the vision 2030 document by TenneT [1].For this, the generation and load capacities at each of the generation centers is first calculated using the data available from the existing grid model from TenneT and the vision 2030 document.

Breakup of the power production between different methods of power production is then arrived at using the above information. With this step completed the network grid inertia time constant is calculated. Basic models of the generation methods were developed for PV and EV systems and an available model was used for the simulation of wind farms. The results of the short circuit are first analyzed using a voltage sag table which provides information about the voltage sags in the 150KV bus when faults occur at different locations in the network. From this, the worst case scenario is taken for the simulation of the short circuits in the network. In the dynamic load variations, the network is analyzed for the effects of varying load at the 150KV bus and electric vehicle load (in the distribution network). The results are analyzed based on the generation capacity, load capacity, inertia constant of the grid and the distribution of generation in the network.

1.4 Structure

In this work the different scenarios are evaluated for their effects on the voltage, frequency, power flows and system stability at the 150 KV and 400 KV electricity grids. For this purpose, the electricity grid and the downstream distribution networks need to be modeled.

However since the study focuses on the major generation centers the analysis is carried out at the four major production centers identified under the Vision 2030 document. Also since the analysis covers a period of years from 2010 to 2030 the grids are modeled for the increased generation and expected load values for three different years. Each of the production centers is associated with a particular growth scenario, hence the patterns for production and load growth over the period of time from 2010 to 2030 is analyzed under the expected growth rates predicted under the vision 2030 document.

In accordance with the variation in the high voltage grids, the distribution network production and load patterns also change. For this simulation,

distribution system loads are simulated in according to the expected load increase at the four production centers in the Netherlands in the future years.
In addition to the above changes, wind power, CHP, Photovoltaic power and a possible future Electric vehicle load on the grid are analyzed. The process of arriving at these parameters is discussed in chapters 2&3.This report is organized into 7 chapters. The chapters are described below in brief as a small pointer:

Chapter 1 deals with introduction to the subject and presents the fundamental groundwork for this study. Research questions are posed and the answers are sought for in the report. This section also deals with the expected results and the research methodology used for the study. Exclusions from the report are presented in this chapter.
Chapter 2 deals with a brief description of the development scenarios and summarizes the planned extensions in the Dutch grid under different scenarios.

Chapter 3 provides a description of the networks formed in PowerFactory software and the parameters of the networks .In addition the network validation method is presented.
Chapter 4 describes the power flows in the network in terms of generation and load capacities seen at each of the individual power production centers in different scenarios. The breakup of power generation between different methods of power production is described in this chapter. Finally the chapter calculates the grid inertia time constant for different scenarios to account for the different contributions from power generation methods.
Chapter 5 describes the results for short circuits and dynamic load variations in the different scenarios.
Chapter 6 describes the conclusions of the report.
Chapter 7 describes the recommendations and scope for further work.

1.5 Exclusions from the report

Aspects of the analysis of the influences of the smart grids on the transmission network are many. However this study limits itself to certain domains and excludes the other subjects from the scope of the study. These aspects are given as follows:

1) Detailed modeling of the TenneT grid: The study does not cover a detailed model of the TenneT grid at the substations being analyzed. The modeling is done in a way so as to completely reflect the situation at a substation in the simplest possible manner.
2) Detailed modeling of Smart grid entities: The study does not cover detailed models of the smart grid entities. Models are only adequate to reflect the basic parameters of the system.
3) Telecommunication architecture: While this study is absolutely critical to analyze the impacts of smart grids in the HV network this study excludes telecommunication infrastructure from its scope of study.
4) Storage systems, network protection systems, smart grid control systems and market mechanisms: These aspects are excluded from the scope of this report.

Chapter 2

Development scenarios

2.0 Introduction

The four development scenarios are a tool to forecast the expected generation and load patterns in the Netherlands in the future years according to different scenarios of energy flow. The energy flows are based on the following dimensions:

-The environmental dimension: Focus provided to development of sustainable energy practices on one end of the scale and focus on continued reliance on fossil fuels on the other;

-Market dimensions: Increased focus on a “global free market” on one end of the scale and regulations and regional focus on another end of the scale.

The four scenarios are expressed in the following pictorial representation:

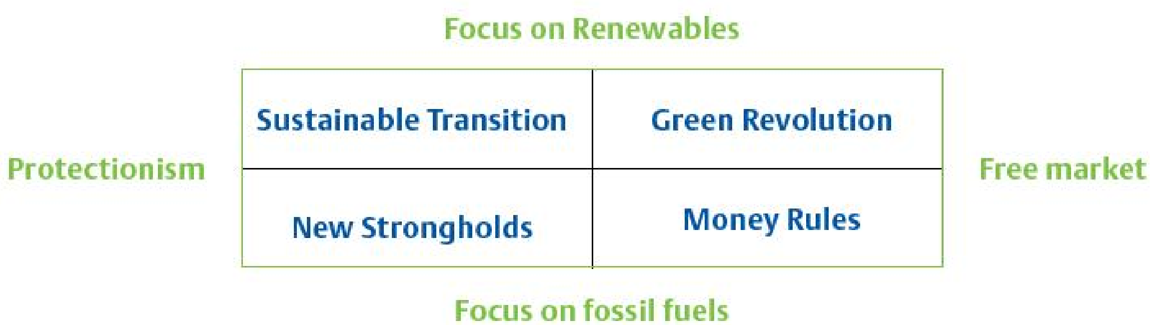

Fig 2.0 Four development scenarios

Based on the above scenarios generation capacities and location of generation vary. Also the estimated load capacities vary and the rate of growth of loads at the “focus areas” varies. A summary extract of the scenario philosophy is presented in this section. As a conclusion to this section, a summary table is presented detailing the expected installed capacities for various resources in the year 2030 based on the vision 2030 document. These values are used for calculations in sections 4.1 & 4.2. The scenarios are described in brief in the following sections.

2.1 The Green revolution scenario

In this scenario the social and political agenda is dominated by free-market principles. Globalization remains a dynamic trend, with removal of trade barrier and exchange of knowledge and technology between industrialized and developing countries.

Under this scenario the energy industry is united in a global effort to tackle the greenhouse effect and the depletion of oil stocks. This brings about a strong shift towards sustainability. Amount of electricity produced from biomass, photovoltaic and wind energy increases. Since wind-powered capacity and photovoltaic capacity are both dependent on the unpredictable availability of solar energy and wind energy; storage systems are constructed so that these production modes can be accommodated. The Netherlands develops further connections to Denmark, Norway and Germany.

Energy conservation is heavily focused on in this scenario. Major advances are made in energy savings in the process industries. The shortage of oil leads to the development of cars powered by fuel cells and fully electric vehicles. As a result, the gas and electricity infrastructures become closely interrelated.

2.2 Sustainable transition scenario

The central characteristic of this scenario is the decreasing consumerism, individualism and competition between governments and private entities especially in regard to the energy and electricity sectors. Quality of immediate surroundings receives an increased priority in this scenario.

Bio-oil becomes the dominant sustainable source of energy used in the Netherlands, both for electricity generation and transport. Higher environmental focus is given in the power production by means of increased investments in high efficiency CHP units and widespread usage of solar panels, especially in residential and commercial buildings. New interconnections are created with Scandinavia, to facilitate the import of sustainable hydro-electricity resources from these countries.

2.3 New Strongholds scenario

In this scenario, wealth inequalities between the western world and other regions are expected to increase. Traditional ties between the old EU-member states and North America are strengthened, leading to the formation of a powerful cultural and trading block. A new service-based economy arises in the western world based on developments in the ICT. These conditions are expected to lead to a further shift towards geopolitical tensions.

As a result the supply of oil and gas from the Middle East and Russia is severely threatened. The importance of western countries' local fossil fuel reserves increases considerably. In this scenario, the Netherlands becomes an electricity exporter because of the availability of coastal production sites where it is easy to deliver coal and cooling water is readily available, and because of its good gas infrastructure.

Under this scenario, reducing coal stocks decommissioning of nuclear power plants causes Germany becomes a net importer of electricity. The emphasis on energy conservation also implies that there is no growth in electricity consumption. Energy savings are achieved mainly by the process industries. Renewable energy sources are developed only in situations where they can contribute to self-sufficiency.

2.4 Money Rules Scenario

This scenario is characterized by continued globalization, liberalization, and the dominance of free-market principles. Social and environmental considerations are afforded a relatively low priority.

Under this scenario, economic growth in developing countries such as China, India and Indonesia leads to a considerable rise in the demand for energy. Precarious supply in oil and gas stocks result in much greater reliance on coal. In addition, the use of nuclear power is increased substantially in order to satisfy the growing domestic energy demand. Oil and gas shortages also mean that alternative sources are utilized to a greater extent. In this scenario, the Netherlands becomes a major electricity importer of electricity.

Table 2.0: Expected installed capacities power production in 2030

Expected installed capacity of various power generation methods	**Green revolution scenario**	**New strongholds scenario**	**Sustainable transition scenario**	**Money rules scenario**
Photovoltaic systems	4	2	4	
CHP/μ-CHP	5	5	2	
Wind power	10	2	7	5
Conventional generation(nuclear, thermal and gas)	11	5	11	10
Consumption growth rate	2	0	1	3
Total Generation capacity	30			16
All values in GW				

From the above table, it is seen that the four development scenarios lead to very different make up in the energy flow into and out of the Netherlands in the future years. As a result of the above scenarios, different cases arise in the supply of energy into Europe. The breakup of generation is further analyzed under each scenario in the section to arrive at the generation capacities to be connected at the power production centers.

Chapter 3

Model description and validation

3.0 Introduction

This section describes the model adopted for the simulation. A basic model of a power system with a generator with local generation is also described for cross reference on the expected results. The network consists of the high voltage grid rated at 400 KV connected to the rest of the network. The grid upstream of the bus selected for each scenario is represented by means of an infinite grid. This bus in turn connected to the 150 KV bus and the other downstream networks. Since the structure of the substations in question varies throughout, the substations are modeled based on the structure of the individual substation chosen in the vision2030 document as the focus for the scenario in question. These are as follows:

Green Revolution scenario: Borselle

New Strongholds: Masvlakte

Sustainable Transition: Ijmuiden

Money Rules: Eemshaven

Description of the HV network

The network setup is different in each of the development scenarios. In this section each of the networks is described in detail with notes on the selection of the parameters. To simplify simulations and ease a comparison between different years, the structure of the grid is maintained with generation and load capacities varied in the individual elements. The Short circuit power capacities were obtained from the TenneT 2010 grid models. The value of R/X ratio was assumed to be 0.1 in all the years. The calculation of the grid inertia time constants for all the networks is discussed in section 4.2. To implement the primary and secondary grid control bias, it was assumed that the total ENTSO-e power capacity of 25000MW/Hz is used as a basis for the primary control. The Netherlands has 8 interconnections to the ENTSO-e grid, thus the primary grid bias was calculated to be 3125 MW/Hz in all the scenarios [2]. The Smart grid entities are modeled in terms of their capacity and production at a DC bus with converters which provide the DC charging. The power electronic components are the heaviest components in the electric vehicle and grid power transfer system. It is thus assumed that the system consists of a source (modeled as a current source and voltage stabilizer in shunt with a load) connected to a converter system. The AC voltage after the converter stage is then stepped up before the power can be transported to the distribution grid.

3.1 Network description for Green Revolution scenario

The high voltage network is represented as shown in fig.3.1. The network represents the setup at the Borselle 400 KV and 150 KV buses derived from the actual Zuid-Holland network. Interconnections to the 400KV network are represented as infinite grids. The total short circuit symmetrical current is about 17.5 KA with an in-feed of 5514.566 MVA short circuit power capacity.

The generation capacity at Borselle is chiefly from nuclear power capacity rated at 900MW. An additional 125 MW is produced by the wind power production facilities at Borselle (this is inclusive of the wind parks which provide in feed at Borselle) It is assumed that the wind farms are connected to the 150 KV network so as to enable a better analysis of the voltage profile and the power flows at this bus. The national grid code [3] stipulates that units above 100MVA capacity be connected directly to the 150 KV and above, hence an additional generator is simulated at the 150 KV bus to account for a future new 900MW of nuclear and CHP power which is expected to be set up in Borselle in future years. The international connection to Belgium from Borselle is represented as a static load rated at 550 MW. It is assumed in the calculations that this line is used to export electricity. For the above model the generators were chosen from the models available from TenneT in an earlier work simulating the Dutch grid. The governor and AVR controllers were chosen from the standard library models available in Powerfactory software. The chosen generators have a nominal rating of 620 MW. The same generators are used across different scenarios, with different active power settings to reflect the required power production capacity in a particular scenario. Details of the generator and the associated governor and AVR controllers are provided in the Appendix A.

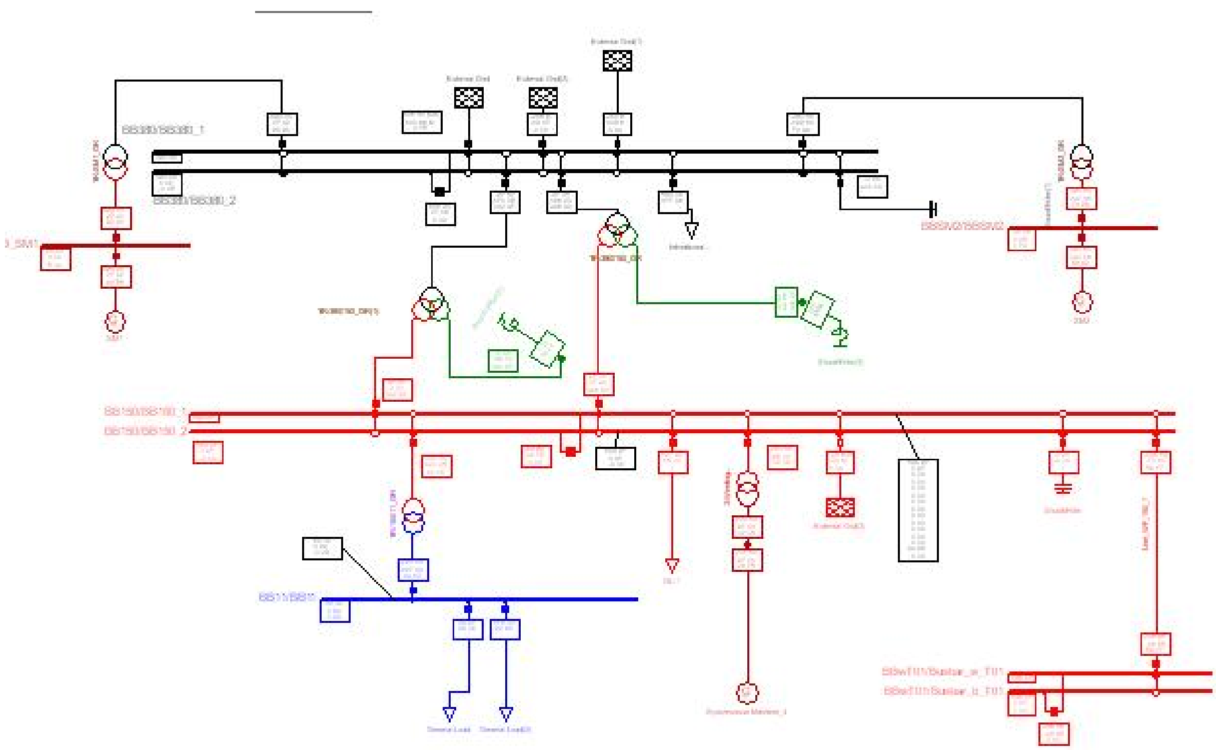

Fig.3.1 Network setup for Green Revolution scenario

3.1.1 Network model for wind farms

The network is fed additionally by a wind farm power production facility connected to the 150 KV network. This wind farm model was adapted from an existing model available with TenneT in an earlier work [2]. The model is shown in fig.3.1.1.The model describes the wind farm in terms of its generation from squirrel cage, DFIG and direct drive wind turbines. Since the study deals with a time span of seconds, the incident wind velocity and hence the produced power is not expected to vary during the window period of simulations. It is also noticed that in the original model the three different types of wind turbines have been chosen so as to account for the increased market penetration of the DFIG and direct drive turbine systems while the contribution of squirrel cage wind turbines decreased. In this study, this aspect is not covered. The wind farm model contributions are set to DFIG generator supplying the largest fraction of the total power production, which is the approx situation today.

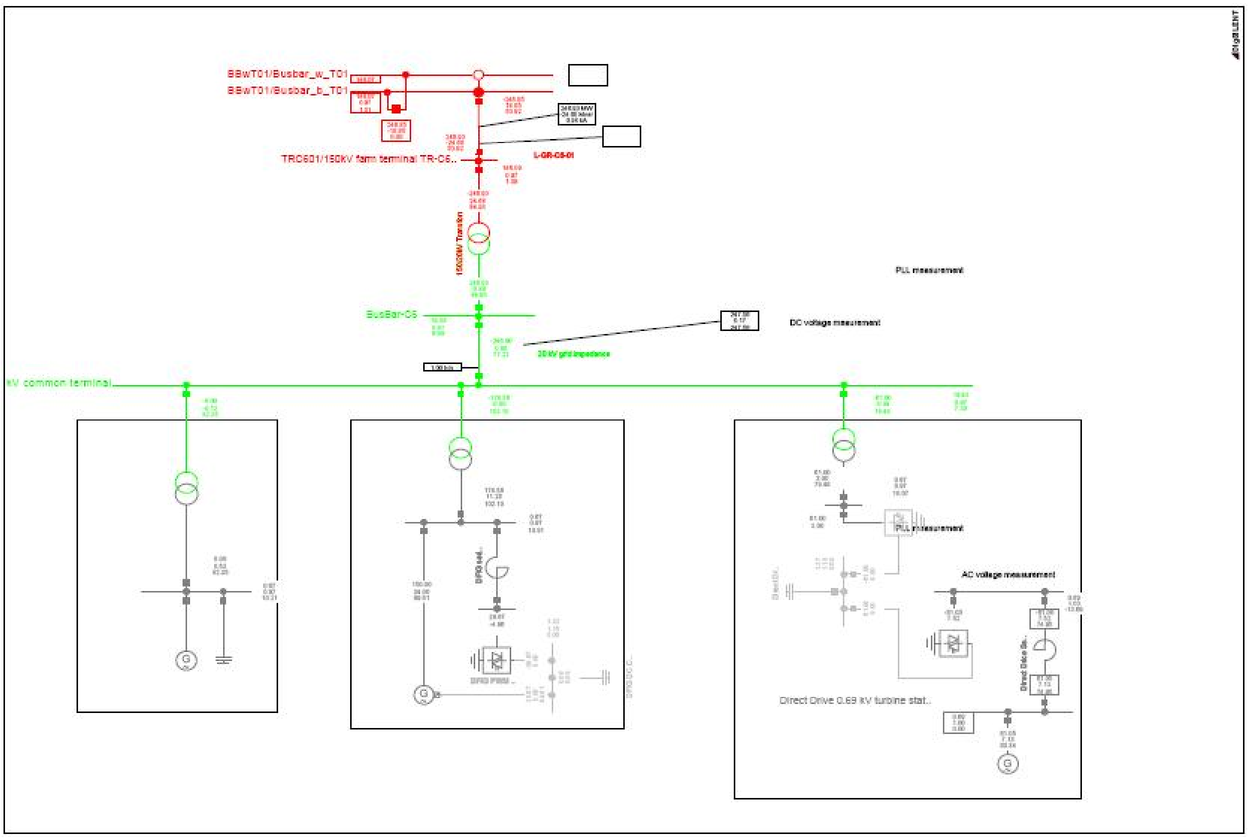

Fig.3.1.1 Wind farm model network

3.1.2 Network model for 11KV networks

The networks downstream to the 150 are represented by an 11KV network which further connects to separate buses for distribution system loads, small capacity conventional generation connected to the 11KV network, photovoltaic systems, µ-CHP facilities and electric vehicle systems. The network model for the 11KV bus is shown in the fig. 3.1.2.

It should be noted here that the loads represented in the study are represented as 100% static loads, with constant impedance. This yields that in case of a voltage drop; the load current will drop equally, thus causing a quadratic power drop. All the connections from the 11KV bus to the individual buses in the 11KV system are via cables. The cables used in this network are form the 11/15KV cable models made available from TenneT in a simulation of the Dutch electric grid.

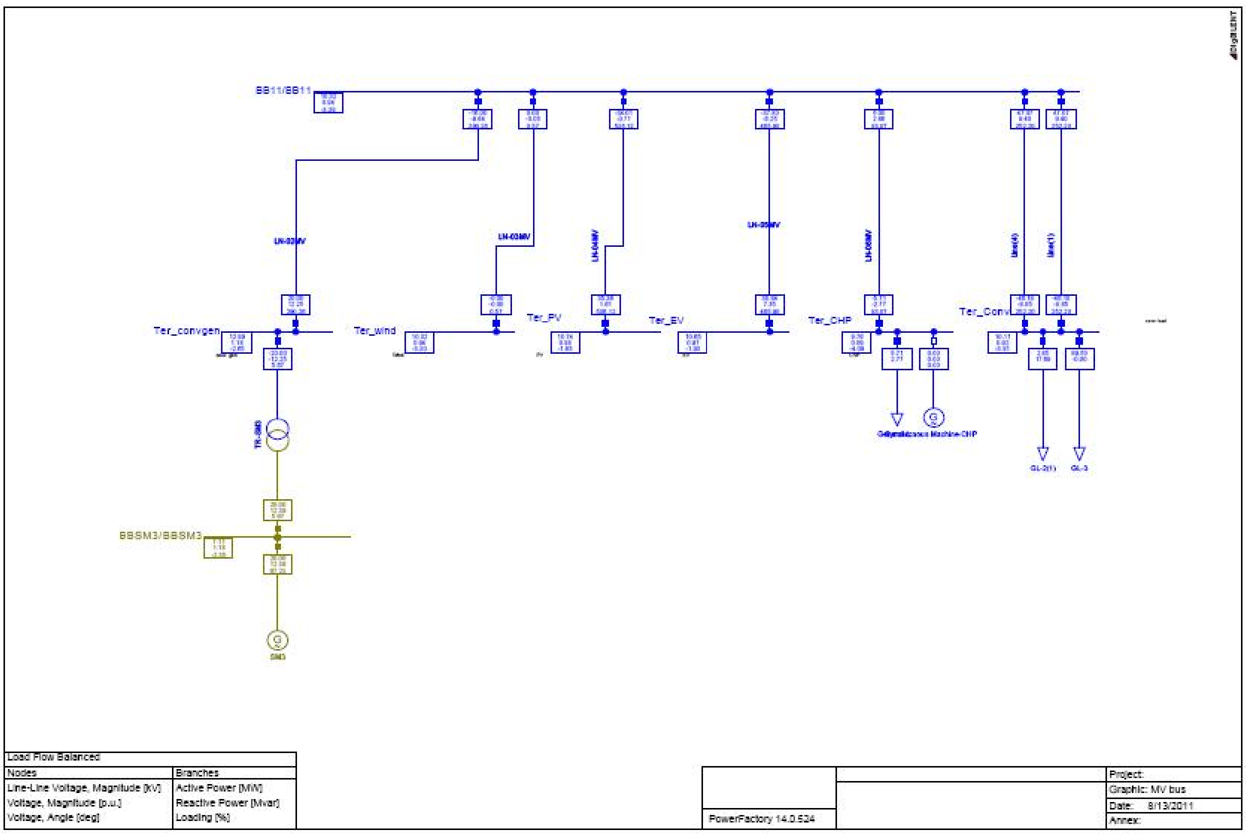

Fig.3.1.2 Network model for MV (11KV) network

For the years 2020 and 2030 the makeup of the power production at the grid changes considerably. By 2030 an additional capacity of 3000MW is built at Borselle to supply the increased consumption in these years. It is assumed that this production will be coal/biomass fired. The above value also represents the planned extension of the nuclear production capability at Borselle. The increased production capacity at this bus is accounted for in the network model, where the coal/biomass fired plants and the nuclear power plants are grouped together and represented by three generators, each with higher generation capability.

3.1.3 Network model for photovoltaic systems

In the green revolution scenario it is assumed that the photovoltaic systems (PV) would assume a much larger production capacity. It is also to be noted however that a significant portion of this power would be made available from rooftop PV systems incorporated into residential and commercial buildings. Thus it is important to note that the network used to simulate the PV systems should also include an AC load together with it to represent the local distribution system loads which are always connected to the system. The model used to simulate the PV systems and their behavior when connected to grids was derived from similar studies in [4] & [5].The network used to simulate the PV system is shown in fig.3.1.3.

The model includes a voltage source in parallel to a current source. The function of this element is to function as a battery system which maintains the voltage of the DC bus at 1pu.It should be noted here that while the models used are simplistic in nature, the network aspects of load flow and voltage profile are adequately simulated via this model. The DC bus for the PV systems was simulated at 0.4 KV while the AC load bus is simulated at 1KV. The rating of the converters is based on the scenario in question, since the power production through the PV systems is based on the scenario in question. The values of PV production in different scenarios for years 2010-2030 are discussed in section 4.1.

3.1.4 Electric vehicle systems

Electric vehicles (EV's) are being increasingly recognized as being a solution to mitigating the increase in domestic and distribution load levels [6]. This is chiefly due to the fact that the stored energy in the battery systems in electric vehicles is utilized to only up to 17-20% of its full capacity [6].

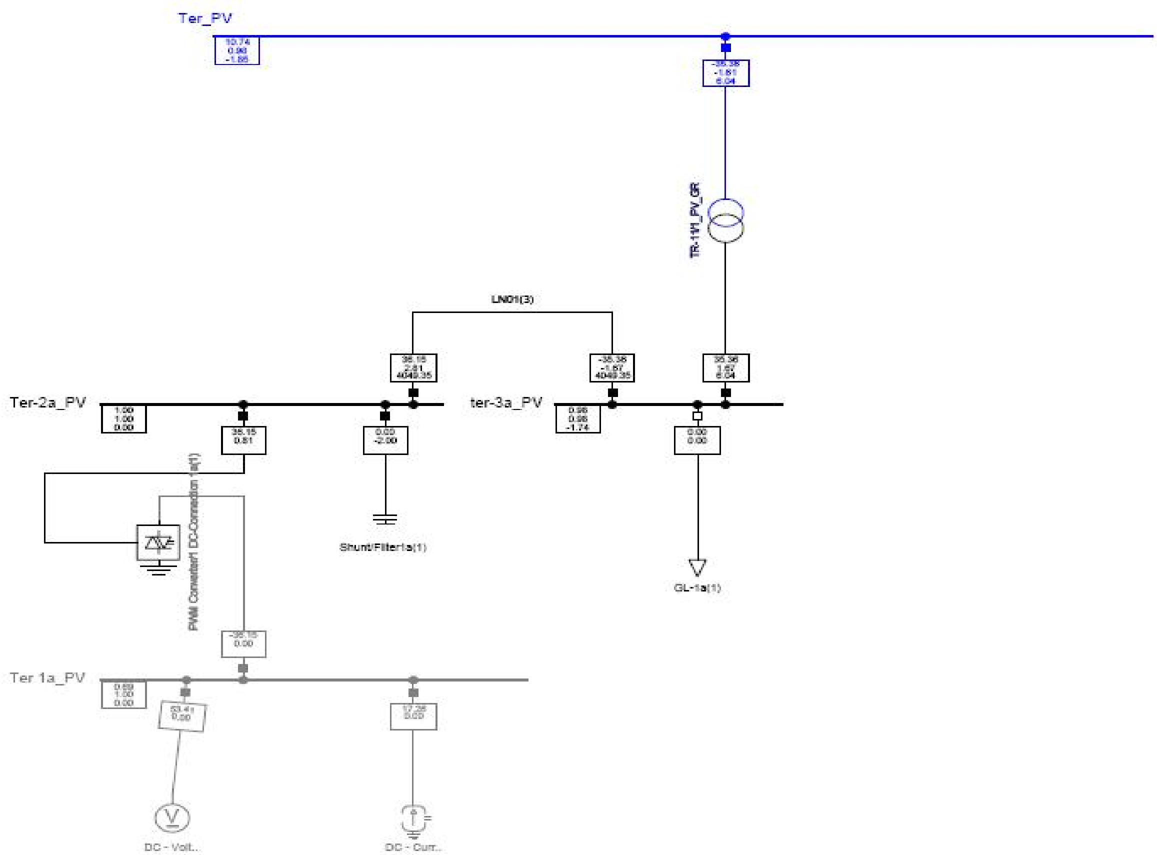

Fig 3.1.3 Network for simulation of PV systems connected to the grid

The remaining charge is not utilized in an everyday commute (expected to span 80 to 100KM for an average electric vehicle). In their work Kempton et al. [7] propose the possibility of a Vehicle to Grid (V2G) network application for electric vehicles by means of which stored power (accounting for up to 80% of the stored battery capacity) in the electric vehicles becomes available to the grid. The system involves a commercial model based on remuneration to customers based on time of charging and V2G supply and the best market for the electric vehicles is the frequency regulation market [8]. Further the time of charging is also a critical component in the load capacity of the electric vehicles while in charging state [9].

In this study the both the aspects of electric vehicle charging and V2G applications are studied. The EV network is essentially simulated similar to the PV network with the difference of DC loads being simulated. To simulate the

DC loads in EV's a DC load is added to the DC bus in fig.3.1.4. The residential and domestic loads connected to the 11KV network are represented by a static load in the AC bus after the converter. The network is shown in Fig.3.1.4.

In this case the EV bus was simulated at 0.4 KV and the AC bus was simulated at 1KV. The converter system rating again varies according to the scenario in question. The EV network load and V2G power production capabilities across scenarios and for the years 2010-2030 are discussed in section 4.1.

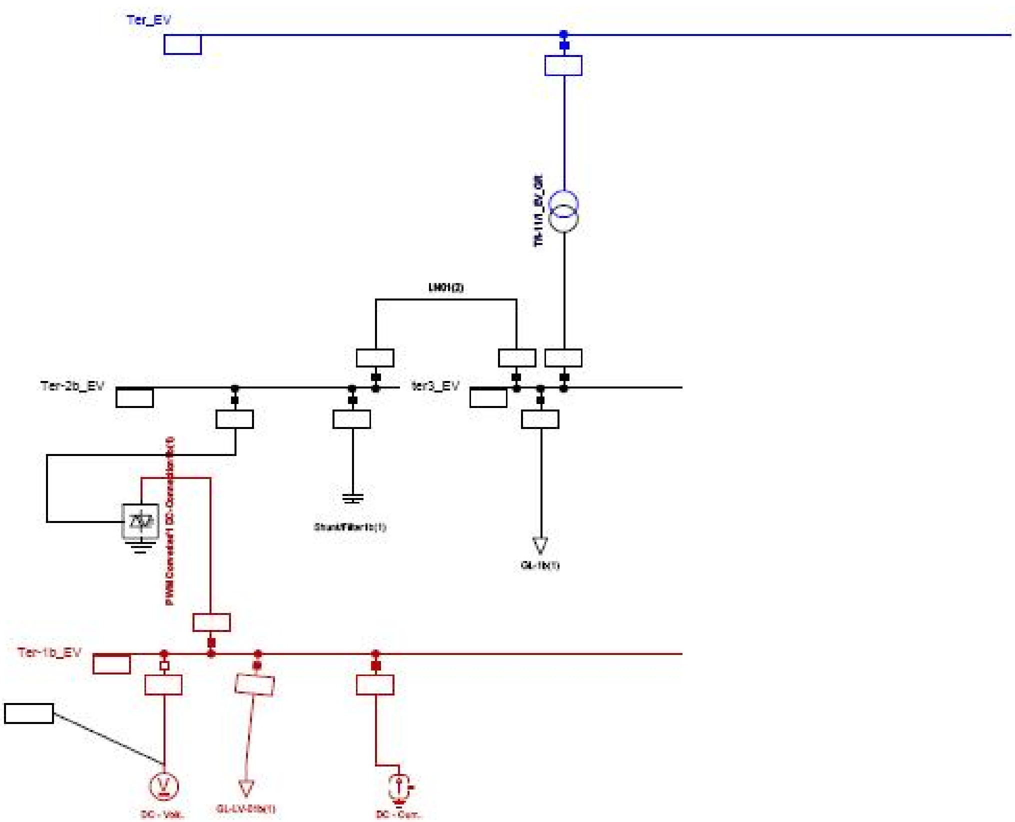

Fig 3.1.4 network for simulation of electric vehicles connected to grid

The networks simulated for the 11KV network, wind farms, PV systems and EV systems remain the same in all the scenarios. The associated loads and generation capacities for these networks are described in the section 4.1. In the remaining part of this section only the HV network is described for the different scenarios.

3.2 Network model for Sustainable transition scenario

In this scenario the focal point for the study is the 150 KV bus at Ijmuiden. The network simulated for this study is as shown in the Fig.3.2. In this scenario the major production is centered at the 150KV bus. This reflects the actual scenario in the Ijmuiden substation. The 150 KV bus has interconnections to the rest of the network at two points (represented as infinite grids in the network). The 400KV network simulated in the scenario is the 400KV substation at Beverwijk.

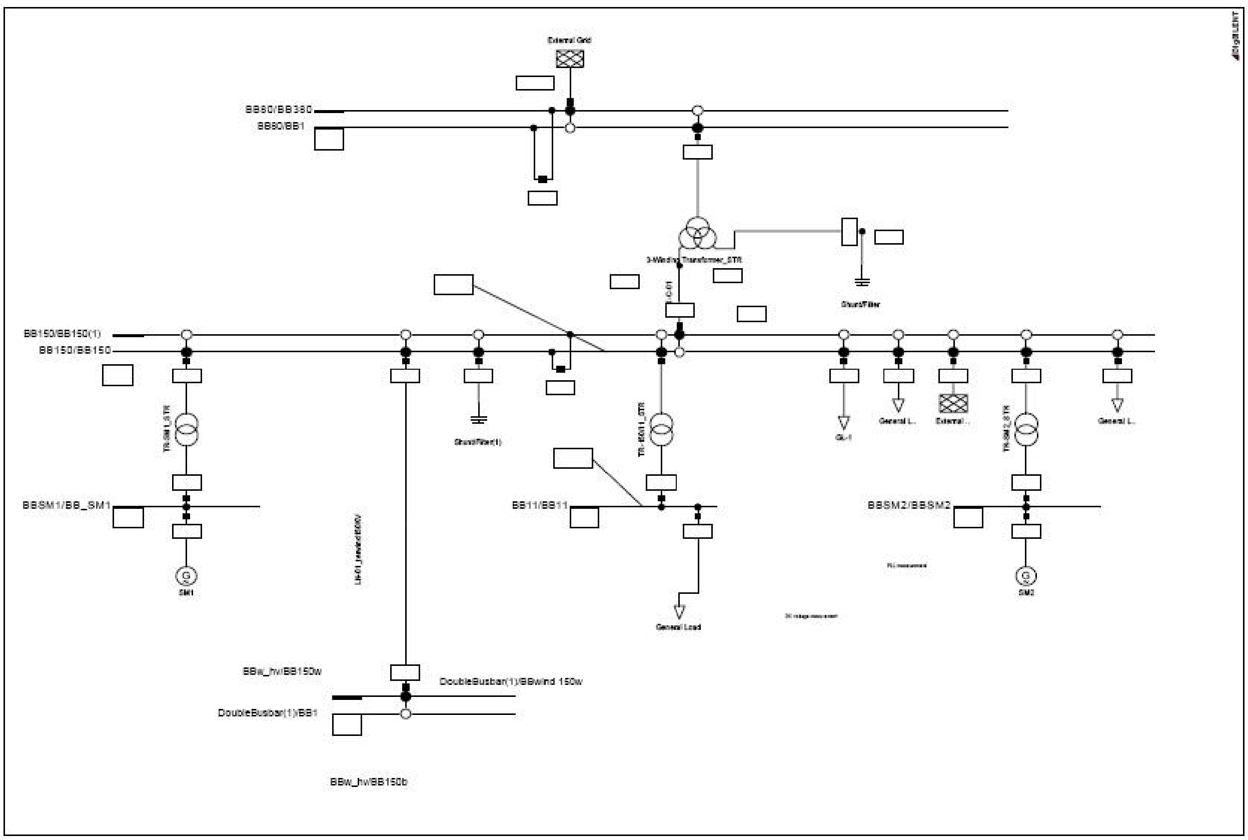

Fig. 3.2: Network model for Sustainable transition scenario

As before the 150KV network is fed by conventional generation at Ijmuiden connected via 2 step up transformers. The 150 and 400KV networks are connected via a three winding transformer, the third winding of which is used for reactive power compensation. The 150 KV bus is also the landing point for offshore wind power. The offshore wind farm is represented here as a bus connected to the 150 KV network through cables. The total short circuit current is calculated to be 45.77 KA fed in from all the interconnections in the year 2010.The short circuit capacity is calculated to be 3142.6 MVA. As before, the models used to simulate the 11KV, PV system, EV system and micro-CHP power production remain the same. The details of the power production and load capacity are discussed in section 4.1.

3.3 Network model for new strongholds scenario

In this scenario the Maasvlakte substation is the focal point for the Simulations. The 400KV substation is connected to the rest of the network

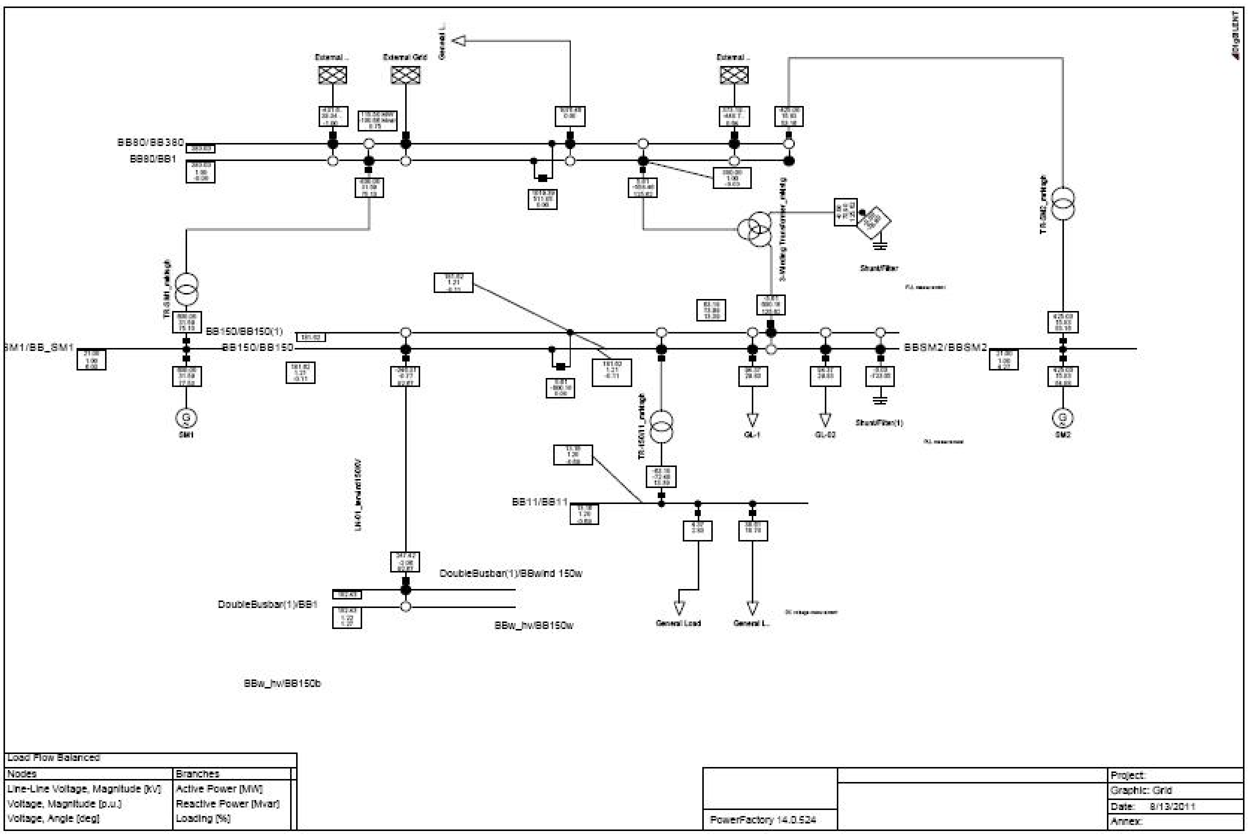

Fig.3.3: Network model for new strongholds scenario

through three interconnections, represented in the above network by 3 infinite grids. Power production at Maasvlakte is connected to the 400KV grid, shown by two generators connected to the 400KV network through step up transformers. The BritNed HVDC connection is shown connected to the 400KV bus. In this study it is assumed that power is being exported via this connection to UK. The BritNed connection is thus represented as a static load. The 150 KV substation is also an in feed point for the wind power production at Maasvlakte.

The short circuit level at the Maasvlakte substation is calculated to be 21.23 KA with a short circuit capacity of 4989.67.Finally the 11KV network is shown connected to the 150KV bus by means of a step down transformer. The PV, EV and wind farm networks remain the same as the ones shown in the section 3.1.

3.4 Network model for Money rules scenario

The network for the money rules scenario is shown in fig. 3.4.

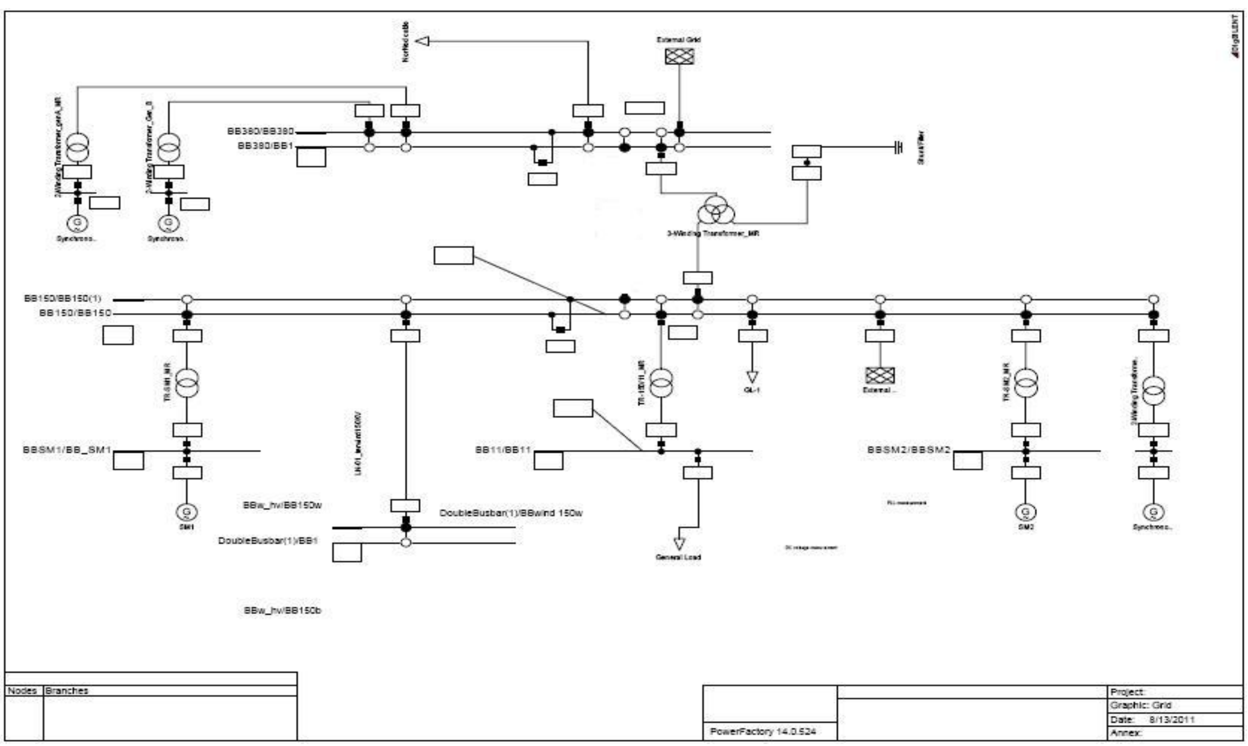

Fig.3.4: Network for Money rules scenario

In this scenario the Eemshaven substation is simulated. The Eemshaven substation is connected to the rest of the grid through two interconnections, one at the 400KV network and another at the 220KV substation. However for simplicity the 220KV substation has been simulated as a 150KV substation. Since this study does not involve simulation of protection systems, this change does not affect the parameters being studied. The generation at Eemshaven is distributed between the 400KV and 150KV substations, represented in the above network by generators supplying power to both the buses. In addition to the interconnection to Norway via the NorNed HVDC cable. For the simulations it is assumed that power is being exported to Norway, thus the HVDC connection is represented as a static load at the 400KV bus. The fault level at the Eemshaven 400KV substation is calculated to be 21.5 KA with a short circuit capacity of 5476.25 MVA.

In addition to being the connection point for the NorNed cable, Eemshaven is also a major connection point to the offshore wind farms in the North Sea. This wind power production is simulated in the network by means of a 150 wind farm terminal connected to the 150 KV bus.

3.5 Model validation

For the purpose of validation the load flow and short circuit studies are carried out at the four production centers. The total generation capacity and connected load at each of the production centers in the year 2010 was recorded from the network models available with TenneT. This range of data for the year 2010 was used as the base values for the calculation of the generation and load curves mention in the section 4.1. In the network validation, the four scenarios were simulated for the year 2010 to emulate the load flows and short circuit at each of the generation buses. Thus the short circuit capacities and the load flows were matched for the year 2010 which serves as a base reference in this study. To investigate the behavior during short circuits and dynamic load variations a model described in [19] was used to ascertain the behavior of the voltage, frequency and power flows during a short circuit condition. The network performance of the models in DIgSILENT Powerfactory under similar conditions was found compliant to this study.

Chapter 4

Network analysis of growth scenarios

4.0 Introduction

The vision 2030 document estimates the power flows under different scenarios in good detail for a range of situations. In this section the power flows in the different scenarios are analyzed. With the present day production and load values made available in the TenneT Dutch grid model and the estimated values available for power production at the four coastal production centers the values for the year 2020 are interpolated. This procedure is also used to estimate the wind power production connected to these substations in the years 2020 and 2030. For the loads connected to the 400 and 150KV substations, the growth rates for electric loads given in the vision 2030 document is used to project values for the years 2020 and 2030. From the available data we also arrive at the grid time constant. This is an important factor in analyzing the behavior of parameters in the simulations.

The table 4.0 shows the estimated power production from the four coastal power production centers for the year 2030.

Table 4.0: Estimated power production for growth scenarios year 2030

	Green Revolution			Sustainable Transition			New Strongholds			Money Rules		
	Conv.	Wind	Total	Conv.	Wind	Total	Conv.	Wind	Total	Conv.	Wind	Total
Borssele	5,7	1,0	6,7	0,9	0,0	0,9	1,5	0,0	1,5	3,7	1,0	4,7
Maasvlakte	2,9	2,5	5,4	3,0	1,0	4,0	7,6	1,0	8,6	4,6	0,5	5,1
IJmuiden	0,0	2,5	2,5	4,0	2,5	6,5	0,0	0,0	0,0	1,0	0,5	1,5
Eemshaven	0,0	0,0	0,0	0,9	0,0	0,9	1,4	0,0	1,4	5,0	0,0	5,0
Total	8,6	6,0	14,6	8,8	3,5	12,3	10,5	1,0	11,5	14,3	2,0	16,3

From the above table we get an estimate about the total expected productions at the individual production centers and the sum total of all power production for the four scenarios. The Total of the power productions is also shown in the table 4.0.1 given below.

Table 4.0.1: Estimated power production for growth scenarios year 2030

Scenario	Load growth	Situation	Total from 4 coastal locations (GW)	Production at primary location (GW)
Green Revolution	2%	Windy, cloudy day	14,5	Borssele = 6,7
		Windless, sunny summer's day	8,5	Borssele = 5,5
Sustainable Transition	1%	Windy, cloudy winter's day	12,3	IJmuiden = 6,5
		Windless, sunny summer's day	8,8	IJmuiden = 4,0
New Strongholds	0%	Windy day	11,5	Maasvlakte = 8,6
Money Rules	3%	Windy day	15,0	Eemshaven = 5,0

From the above tables it is seen that most power production is expected under the Money rules scenario and the Green revolution scenarios, at approximately 15 GW of power. In addition to the above, international power exchange is also estimated in the vision 2030 document. This is shown in the table 4.0.3.

Table 4.0.3: International power exchange under different scenarios

	Green Revolution	Sustainable Transition	New Strongholds	Money Rules
DC Maasvlakte	1,3	-1,3	1,3	1,3
DC IJmuiden	0,0	0,0	0,0	1,3
DC Eemshaven	-3,3	3,3	0,7	2,0
AC imports	2,9	0,0	-5,7	7,1

From the above data and the data available from the load flow models for 2010 available from the TenneT grid model we can summarize the power production and connected load at the individual production centers.

The total connected loads are shown in the table 4.0.4. From the expected rate of load growth available in the Vision 2030 document we can calculate the values of expected connected loads for years 2020 and 2030.

With the above growth rates the following trends become available for the growth of load across the different scenarios. The results are presented in the fig. 4.0.1 till fig 4.0.4.

Table 4.0.4: Expected connected load at production centers in future years

Production centre	Annual growth rate for scenario (in %)	Load in 2010 (MW)	Load in 2020 (MW)	Load in 2030 (MW)
Borselle	2	343.78	419.07	510.84
Maasvlakte	0	227.35	227.35	227.35
Ijmuiden	1	624.16	689.46	761.59
Eemshaven	3	661.40	888.92	1194.63

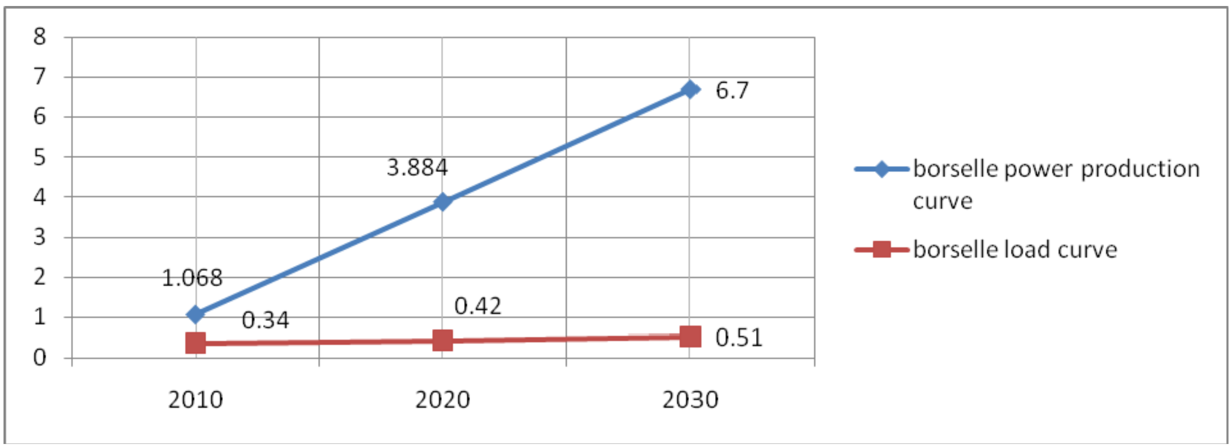

Fig.4.0.1: Estimated production and loads in GW, Borselle (Green revolution scenario)

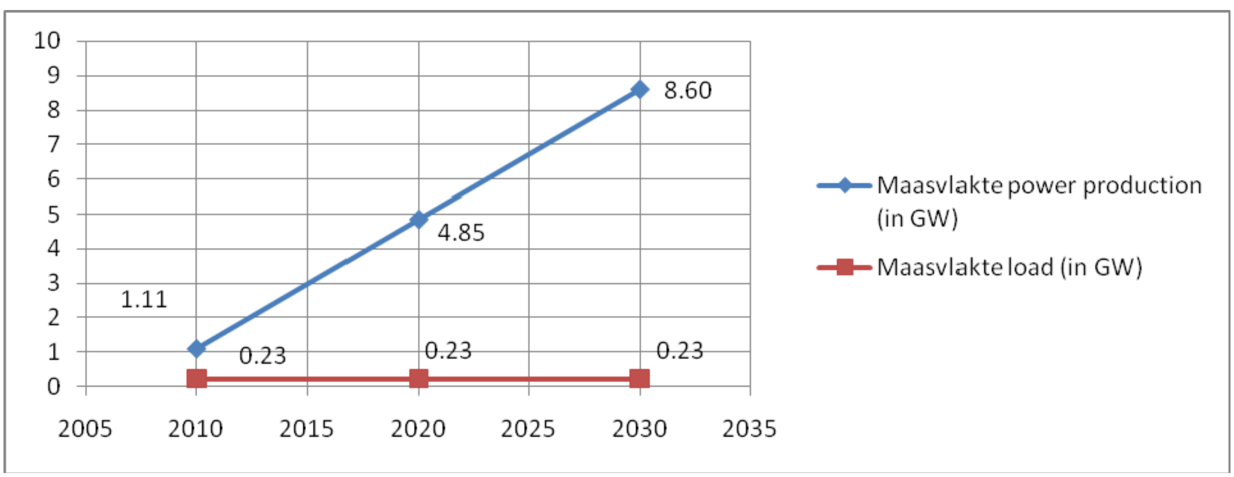

Fig.4.0.2: Estimated production and loads in GW, Maasvlakte (New strongholds scenario)

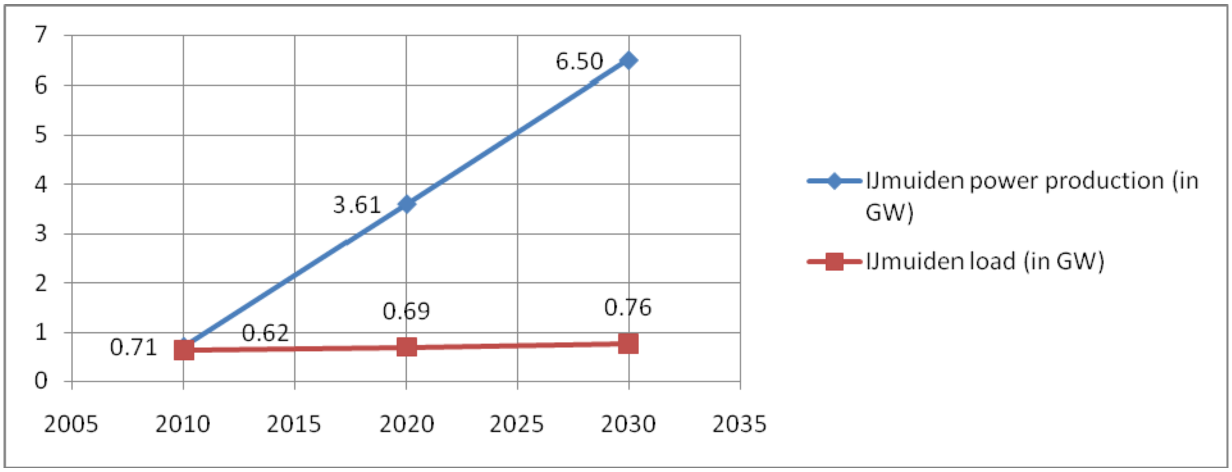

Fig.4.0.3: Estimated production and loads in GW, IJmuiden (Sustainable transition scenario)

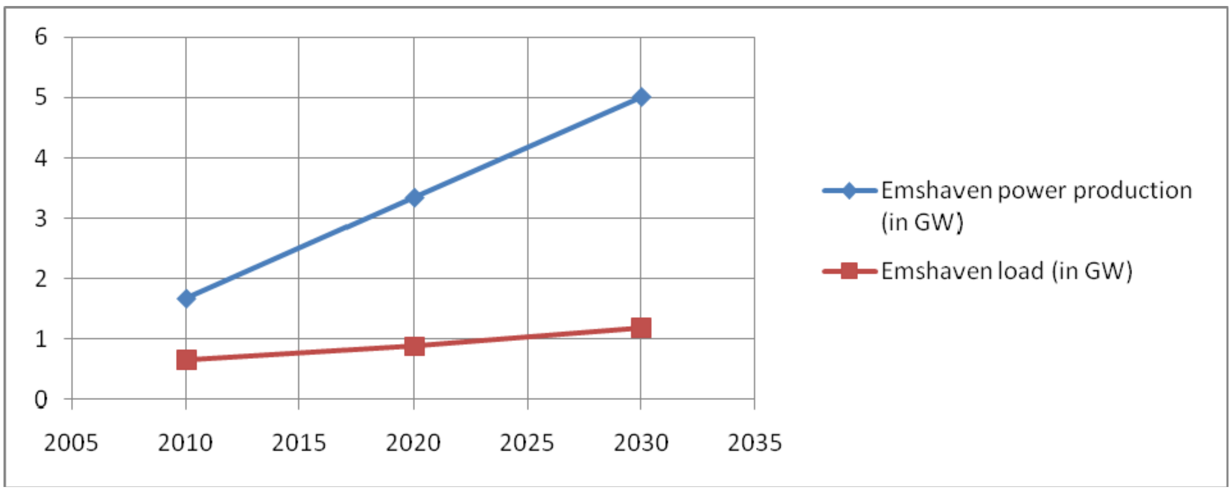

Fig.4.0.4: Estimated production and loads in GW, Eemshaven (Money rules scenario)

4.1 Distribution of power production under growth scenarios

The values in the above table are taken as the total production and load values in the scenarios for different years in the simulations. To estimate the individual contribution of wind power, conventional power production (thermal and nuclear),CHP and photovoltaic values provided in the vision 2030 document[1] were used as references in combination with the data available from [2],[10] on wind power production. To estimate the possible contribution of V2G resources of power to the individual scenarios, the total number of vehicles in the Netherlands in the years 2020 and 2030 was estimated based on [11]. From estimates in [12] and [13], 25% of vehicles in the Netherlands are estimated to be fully electrical (i.e. with V2G) capabilities. Also, the average charging time is estimated to be 4.5 hours [6] [9] with an average consumption of 120KW per vehicle [6]. The V2G power production capability was estimated based on an average availability of 80% battery power being available for transfer to the grid [6][18].The detailed calculations are available in Appendix B. The V2G production capability at each production centre was calculated based on the assumption of all the electric vehicles in a province being available at a single distribution bus feeding to the 11KV network.(Data from [11])

With the above data we can calculate the internal contributions of the various power production methods at each of the power production centers.

The contributions from different methods for the green revolution scenario are provided in fig.4.2.1 till fig 4.2.4 for years 2010, 2020 and 2030.

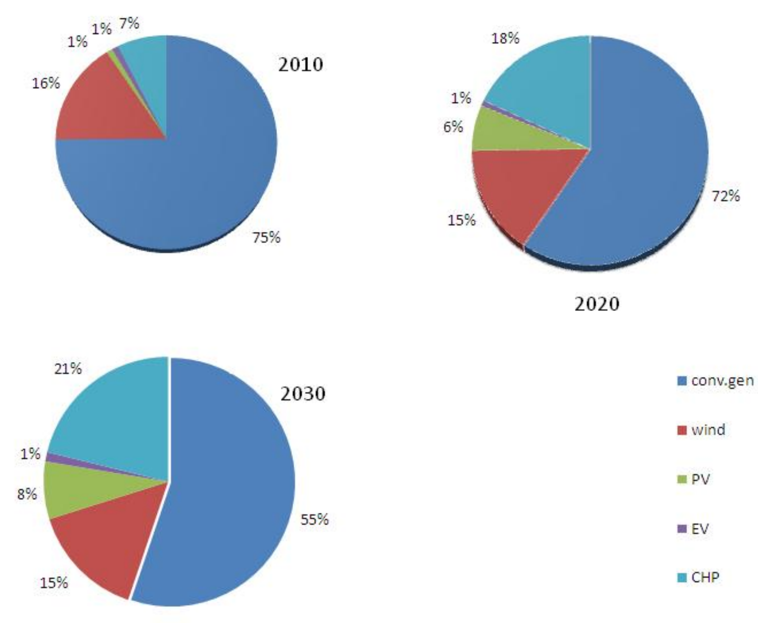

Fig.4.2.1.: Distribution of power production under Green revolution scenario

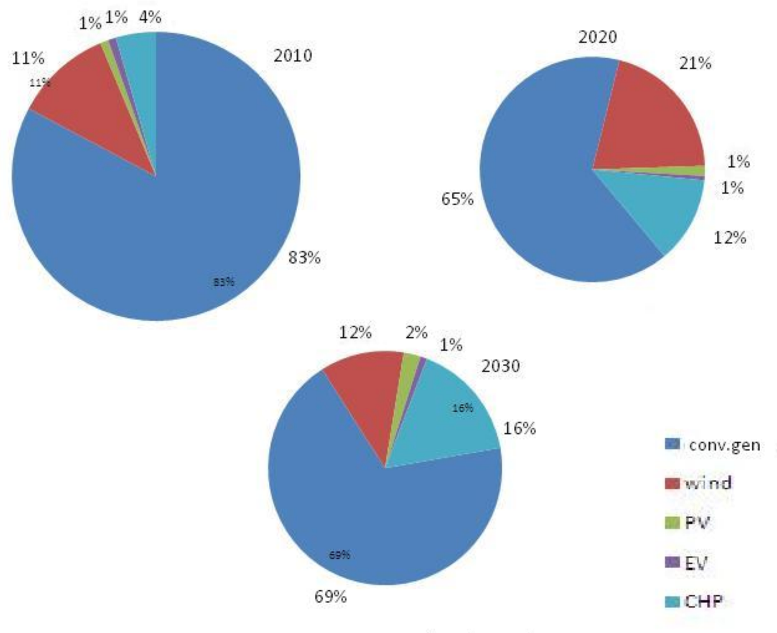

Fig.4.2.2: Distribution of power production under New Strongholds scenario

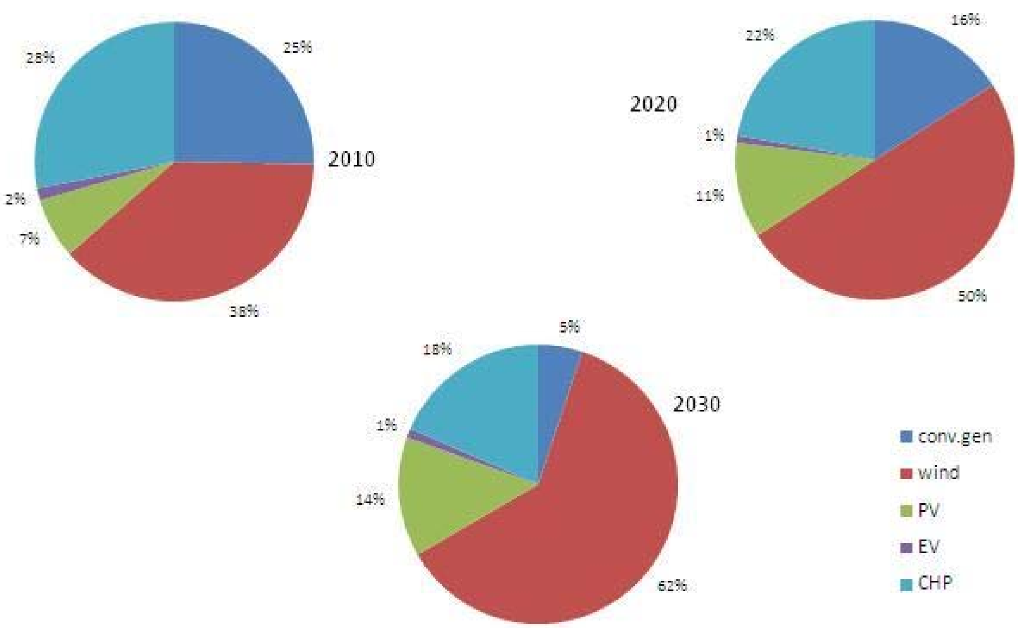

Fig.4.2.3: Distribution of power production under New Strongholds scenario

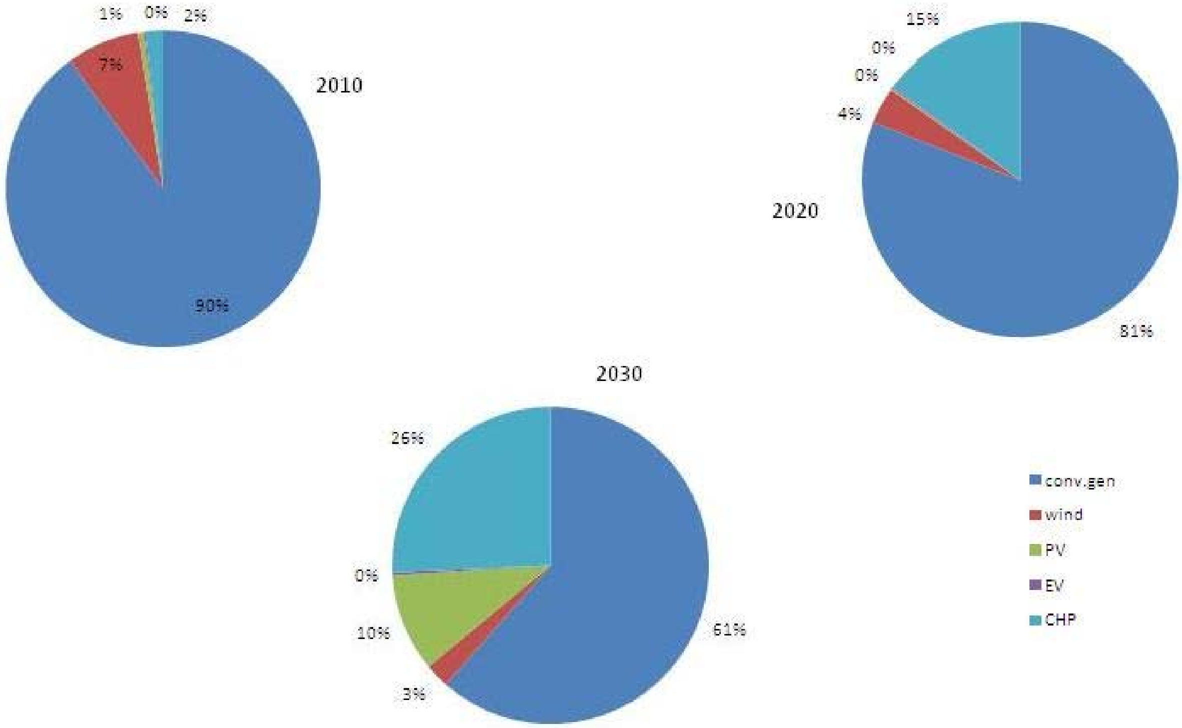

Fig.4.2.4: Distribution of power production under Money rules scenario

4.2 Calculation of grid acceleration time constant

From the above discussion it is clear that the constitution of the HV grid changes in the span of every 10 years and in every growth scenario. For these changes to become clear in the simulations it is necessary to quantify the properties of the grid for different scenarios and different years. One of the most significant way in which the grid influences the network is by means of the equivalent system acceleration time constant, H_{eq}. The acceleration constant (also the inertia constant of the system) is defined as [14]:

$$H = \frac{\text{stored energy at rated speed in MW}\cdot\text{s}}{\text{MVA rating}}$$

… (1.1)

The system average inertia constant and equivalent inertia times constant are defined as [2] [14]

$$H_{av} = \frac{1}{2}\frac{J_{tot}(2\pi f)^2}{S_k''} \quad \text{... (1.2)}$$

$$H_{eq} = \frac{1}{2}\frac{J_{tot}(2\pi f)^2}{S''_{ktot}} \quad \text{... (1.3)}$$

Where

H_{av} Average inertia of the units in the grid

J_{tot} Total moment of inertia of the grid

S_k'' Installed capacity of the grid

H_{eq} Average inertia of the units in the grid

S''_{ktot} Total short circuit MVA capacity at interconnection points (400KV bus)

The Installed capacity of the grid is calculated from the data available in the vision 2030 document. The value of H_{av} is assumed to be the average inertia time constant of all the generators in the network. However, to account for the increasing wind power production in the new strongholds and sustainable transition scenarios it becomes necessary to recalculate this value. It is assumed that the average inertia time constant of DFIG and direct-drive turbines is 2 seconds and that for conventional thermal and gas turbine is 3.5 seconds. The new H_{av} is thus calculated based on the expected percentages of power production from wind turbines and conventional generators. Following these methods and using equations (1.2) and (1.3) above we arrive at values of H_{eq} which has a correlation to the composition of the electric grid. The data collected is shown in the table 4.2.0.

Table 4.2.0: Calculation of H_{eq} for different scenarios in year 2030

Scenario / Parameter	Green revolution	New Strongholds	Sustainable transition	Money Rules
S''_k (GVA)	35	14	25	40
Wind power contribution to total installed capacity (in %)	28.57	16	28	12.5
H_{av} (sec)	3.4286	3.68	3.44	3.75
J_{tot} (Kg-m/s^2)	2.43E+06	1.04E+06	1.74E+06	3.04E+06
S_{ktot}'' (GVA)	5.51E+09	4.99E+09	3.14E+09	5.48E+09
H_{eq} (sec)	21.76	10.33	27.37	27.39

The values of H_{eq} calculated in the table are used as grid inertia time constants for the year 2030. For the years 2010 and 2020 the grid time constants were halved to show the reduced installed capacity (assuming a linear increase in the installed capacity).It is also noted here that the short circuit powers indicated are from the 2010 values (from the TenneT grid model for 2010).With the increased use of fault current limiters it is assumed that the short circuit power capacities will remain the same in the future years.

Chapter 5

Results

5.0 Introduction

This section investigates the effect of short circuits at different point on the network and their effects on the voltage, frequency and power flows at the 150KV bus. The research methodology for this section is to first investigate the voltage dips imposed at the 150KV bus due to faults at different points in the network and then proceed to identify the worst case fault location in each of the scenarios across the years 2010 till 2030. Following this methodology the effects of the system generation and loading pattern become apparent. The results are then analyzed in terms of their voltage dip, recovery times, settling times and the maximum deviations from the nominal values of these parameters. The selection to study the 150 KV network is due to the study being a method to quantify the reliability of the 150KV network, for which an analysis of the system parameters' variation is a good input. It is also noted that since the 150KV network is not directly connected to the generation in most cases the variation in frequency effects are more apparent in the 150KV network when compared with the 400KV network.

To begin the exercise we first investigate the voltage sag plot for each of the networks and analyze the effects of voltage sags at the 150 KV network when different faults occur at different buses and cables in the network. The voltage sag table is a steady state calculation, i.e. the parameters of the network influencing the duration and recovery of the fault such as generator inertia and R/X ratios are not accounted for. The data available indicates the lowest voltage caused at the 150KV bus during the fault event before the fault is cleared. The calculation provides the data about the per phase voltage sag at the 150KV bus for a definite fault period and fault impedance for 3 phase symmetrical faults and unsymmetrical faults (single line to ground fault, line to line fault and double line to ground fault).In addition to the above data the positive, negative and zero sequence impedance data is made available in the report. For all the calculations, it was assumed that the fault impedance is set at 0.1 ohm and faults were calculated for 100ms.The 100ms fault clearing time was carried out in line with the TBD specifications [15][16] which stipulate the maximum time for clearing of faults for the 110,150,220 and 400KV networks. Since the fault clearing time is selected to be 100ms the voltage sags inherently represent a worst case scenario. Under the first scenario, the fault is expected to occur for 100 ms and clear at the end of this time period. In the second scenario the short is cleared by operation of the relevant upstream circuit breaker. Following the study a choice of the worst case fault condition is made by finding the lowest fault voltage (i.e. voltage sags which cause a lowest dip).The methodology followed in [17] to assess the worst case voltage sag is followed in this study.

5.1.1 Analysis of the Voltage sag table

The system is investigated for various short circuits at all the busbars and cables (in case of cables at 50% of cable span). The effects of the faults at different points are shown in the figures below in terms of the range of voltage sags imposed by shorts occurring at the 11KV, 21KV, 150 and 380KV.The plots are made in terms of a comparison across scenarios so as to enable a direct comparison across scenarios for faults at a particular voltage level in the electricity network. It is noted that the simulated network contains other buses rated at 0.4, 0.69,1,20 and 66KV.However the worst case voltage sags due to faults at these buses are in range of +/-5% of nominal voltage of 150KV.The faults at these buses are thus not compared in this section. The complete voltage sag tables are available in Appendix C.

5.1.1.1 Faults occurring in 11KV network

The fig.5.1.1 shows the range of voltage sags at the 150 KV bus due to the faults occurring at different buses and cables in the range of 11KV.From the plot it is seen that the faults occurring at different point in the buses and cables rated at 11KV in the green revolution scenario cause voltage sag in the range of 83 to 96% of nominal voltage during the fault condition. This range moves to approx 84% to 98% of nominal voltage during a fault event in the year 2020.Faults simulated for in 11kV voltage level in the year 2030 indicate that in the condition of the worst fault occurring at the worst case location, the voltage to drop at the 150 KV bus is 85% of the pre fault voltage. From the plot it is seen that the lowest drops in voltage are caused in the sustainable transition scenario. This explanation for this is that in the money rules scenario most of the generation is centered at the 380KV and 150KV networks and the 11KV bus chiefly functions as a distribution bus. Since the fault impedance between the sources and the fault point is quite high the voltage sags are limited to a low range of values. Faults occurring in the 11KV network under the money rules scenario create voltage drops in the range of 10% to 0% (drop recorded from prefault voltage).The explanation for this is similar to the one for sustainable transition scenario.

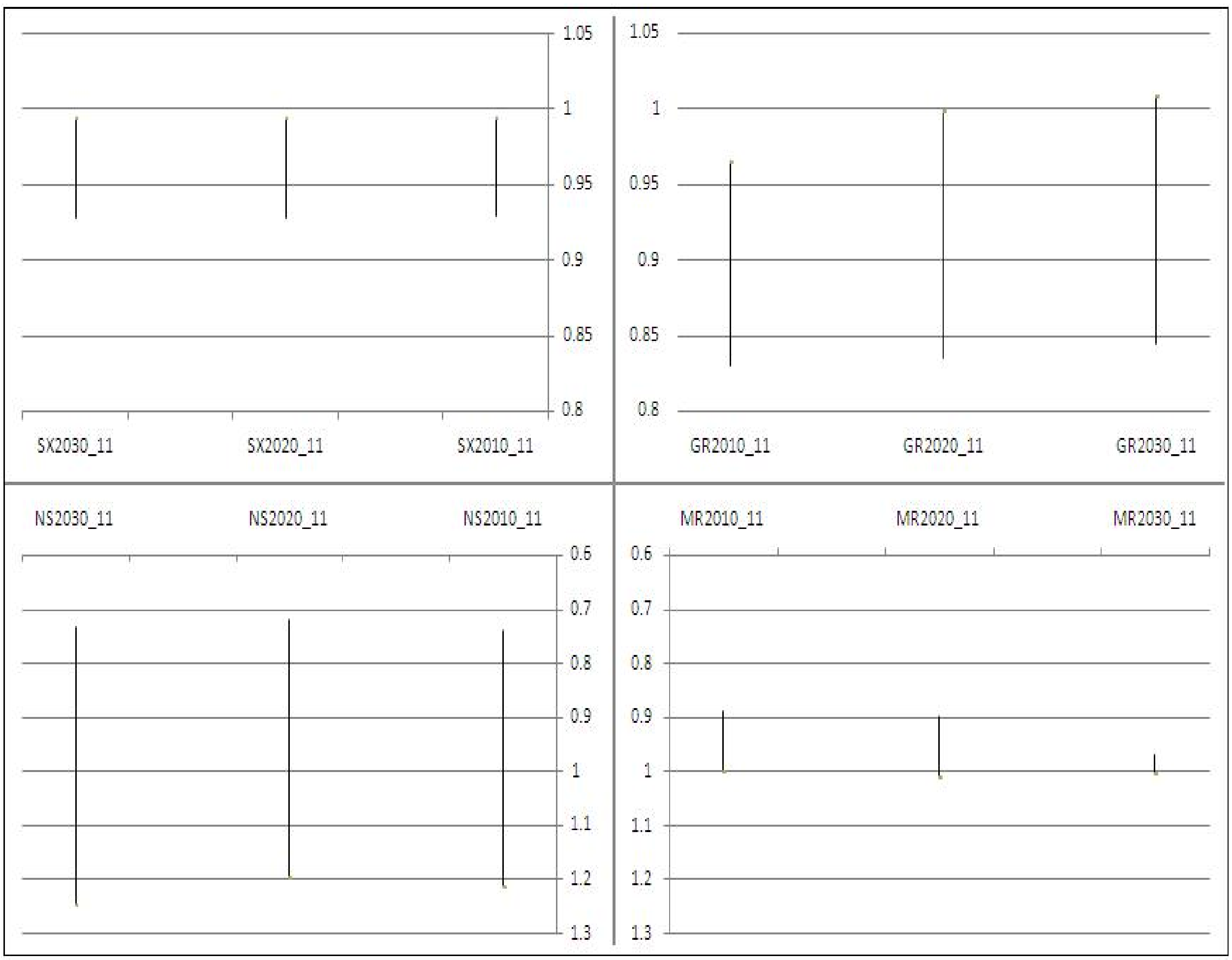

Fig. 5.1.1: Range of fault voltages at 150KV bus due to faults in 11KV network.

5.1.1.2 Faults occurring in 21 KV network:

The 21KV network buses are the generator buses (buses before the generator step up transformer).This simulation is necessary to visualize the effect of different faults at the generator buses across scenarios. It is seen that the worst case voltage sag occurs in the green revolution scenario (in all years).It is seen that the voltage sags have a general tendency to be very close to 1pu prefault voltage level, with the extreme case in the new strongholds scenario when the voltage reaches approx 1.2 pu of prefault voltages. While the over voltages represent the unsymmetrical faults, these are the lowest of all the phase voltages.

The explanation for this can be sought in the aspect of total power production in the new strongholds scenario being the highest of all scenarios. Since the system has a higher fault current supplying capacity the fault currents cause a voltage rise at the faulted bus. As a result even the lowest phase voltage drop is higher than 1 p.u at the generation buses.

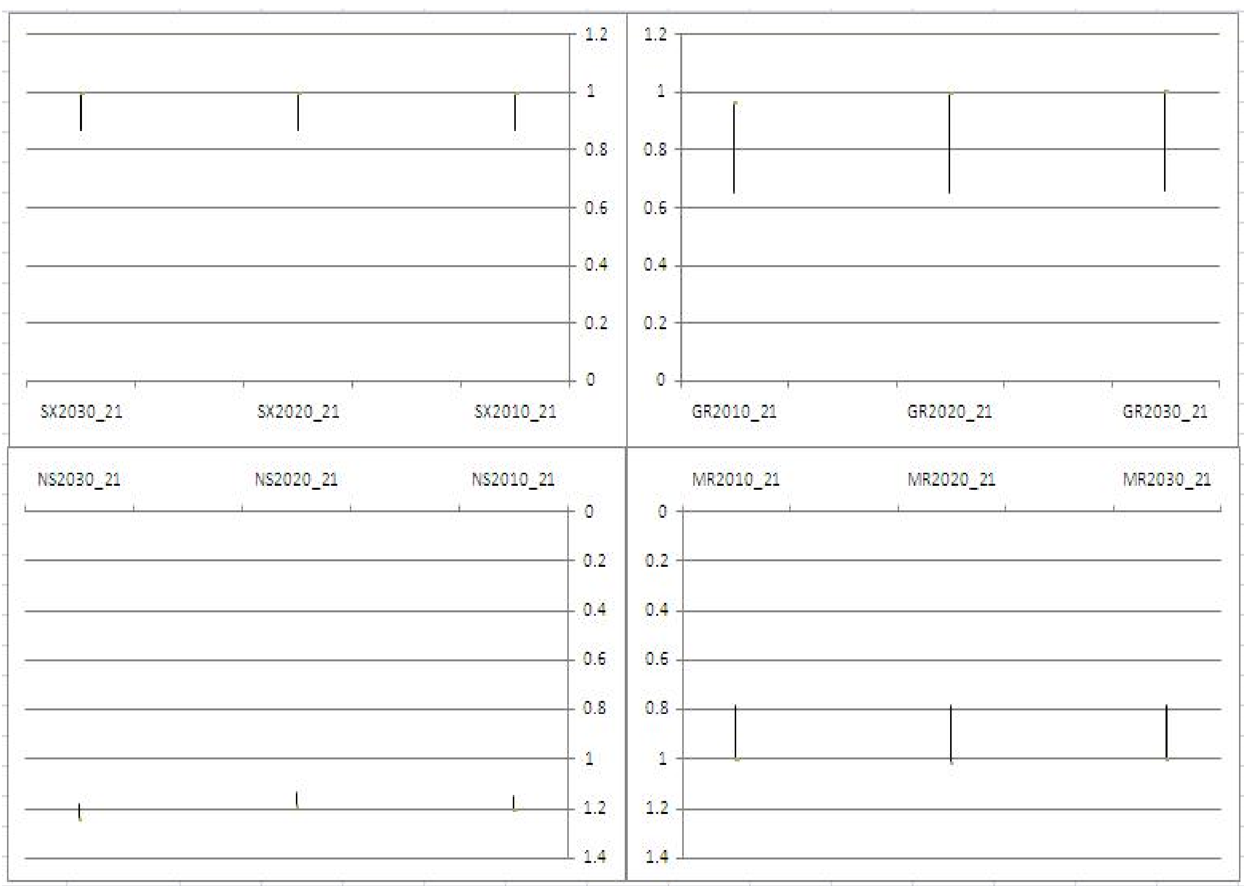

Fig. 5.1.2: Range of fault voltages at 150KV bus due to faults in 21KV network.

5.1.1.3 Faults occurring in 150KV network

The faults occurring at the 150KV network represent the worst case scenario for the voltage sag across all the growth scenarios. This is shown in the fig 5.1.3. It is noted here that the voltage at the 150 bus does not fall to 0 volts despite the 3 phase short circuit fault event at the 150KV bus. This is due to the fault impedance of 0.1 ohm being present at the fault which leads to a calculated voltage drop at the 150KV bus. From this scenario it becomes clear that the worst case fault conditions occur during the faults in the 150KV network. Thus the networks shall be simulated for faults occurring at major buses in the 150KV network. From a detailed analysis of the voltage sag tables it is seen that the worst case locations are the 150KV bus, the 150 KV wind-farm terminals and the interconnecting networks between the 150KV bus and the rest of the system. These faults shall be analyzed for all the scenarios.

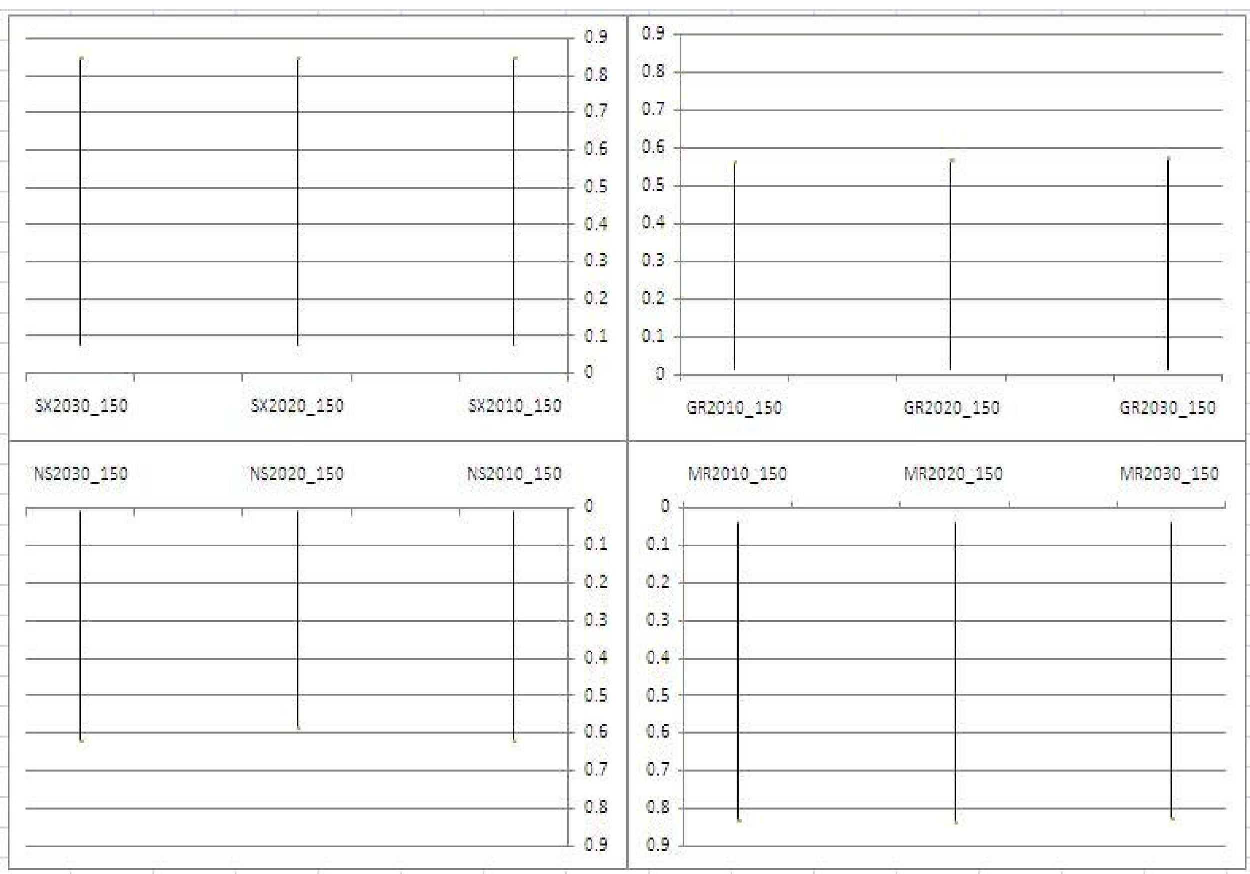

Fig. 5.1.3: Range of fault voltages at 150KV bus due to faults in 150KV network.

5.1.1.4 Faults occurring in 380KV network

For faults occurring at the 380 KV networks the worst case scenario occurs in the general pattern of the worst case voltage sag being present in the new strongholds scenario is repeated. This is followed by the second worst case scenario in the green revolution scenario followed by the sustainable transitions scenario followed in the end by the money rules scenario. This is seen in Fig 5.1.4.

The fig.5.1.5 shows the voltage sag against the positive sequence impedance for the four scenarios for 3 phase symmetrical faults occurring in the 150KV network. The positive sequence impedance is between the fault point (identified individually in the voltage sag report) and the equivalent source for the reminder of the network. It is noted that the magnitude of voltage sag is highest in the new strongholds scenario, followed by the green revolution scenario, sustainable transition scenario and the money rules scenario. Since all the generation feeds into the 150 KV network the magnitude of short circuits is highest at this bus. It is noted here that as the produced power increases the voltage sag is expected to increase (on account of more generation sources being available to feed the fault in the network).In the New strongholds scenario, 8.6 GW of power is in fed at the primary production centre at the Maasvlakte substation. This is the largest power production of all the four scenarios in 2030; hence the magnitude of voltage sag is the highest in this scenario. This is followed by green revolution scenario (at 6.7GW), sustainable transition (at 6.5GW) and finally money rules scenario (at 5 GW).

5.1.5 Summary of voltage sag table

The results from the voltage sag table can be summarized as follows:

1) The larger the generated power in the network, the higher the fault levels at the 150KV bus, consequently the larger voltage sag, if the fault impedance and network parameters remain the same.
2) The worst faults in the system are caused by the faults occurring in the 150KV network.

3) Faults occurring at generation (21KV) and distribution buses (11KV) have variable effect on the voltage at the 150KV bus. While faults in the 21KV network increase the voltage at the 150KV bus those at the 1KV bus cause voltage sags based on the corresponding impedance between the equivalent source and the location of the fault in the network.

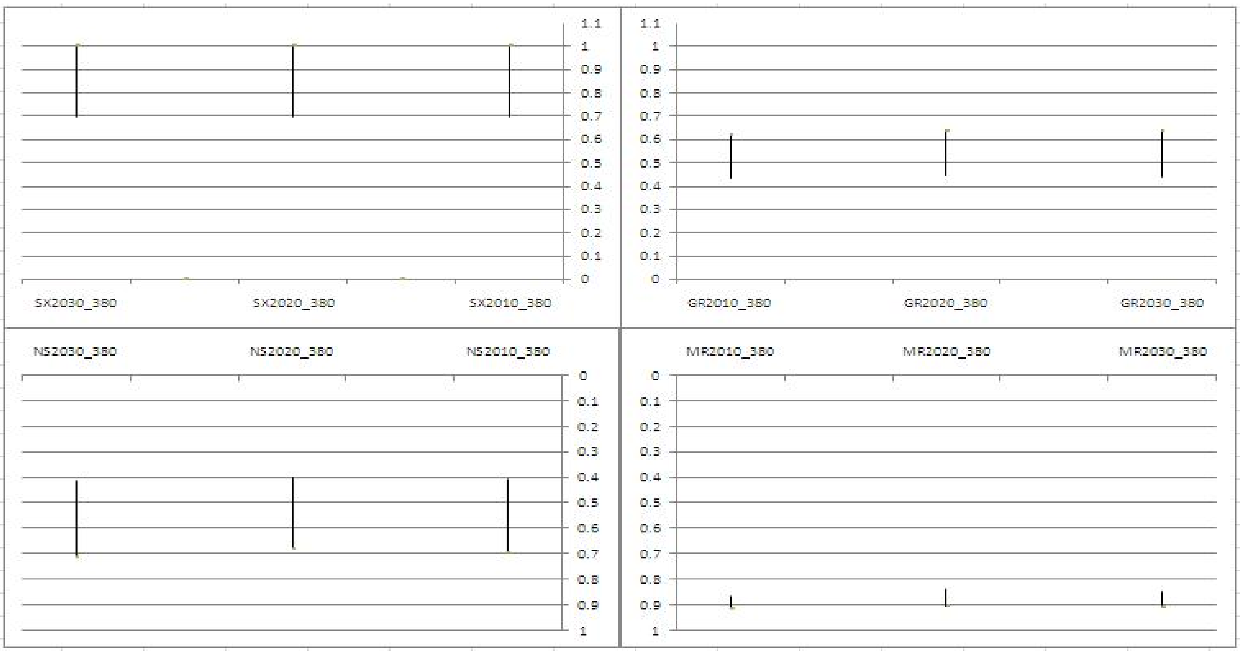

Fig. 5.1.4: Range of fault voltages at 150KV bus due to faults in 380KV network.

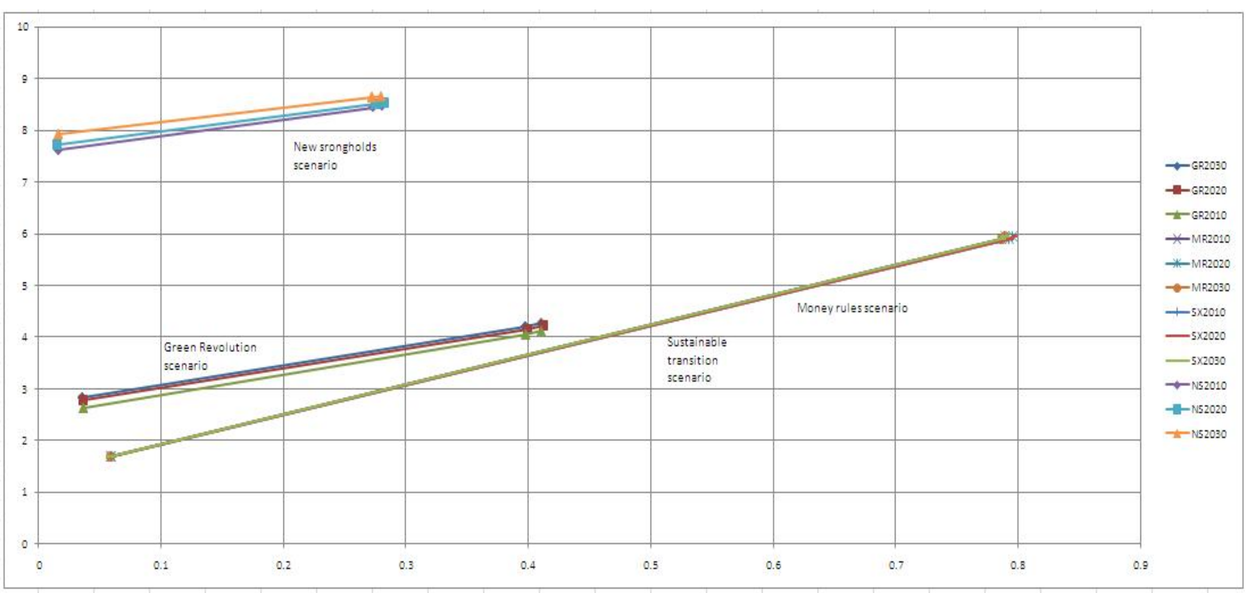

Fig. 5.1.5 positive sequence impedance against voltage sag magnitude

5.2 Results for short circuit calculations

As the grid short circuit capacity decreases the ability of the system to sustain faults at different points in the network decreases and the system begins to become increasingly unstable. For the short circuit conditions in the 150 KV networks the faults are simulated at the 150KV bus, 150KV wind farm terminals and the interconnecting cables between the 150KV bus and the wind farm terminal. To notice the effect of increasing system inertia time constant the results for the years 2010, 2020 and 2030 are presented in the same plot. The simulation plots in addition to the short circuit simulations at buses not discussed in this section are made available in the Appendix D. It should be noted here that the nature (i.e. the contribution to power generation and the average inertia) of the gird as well as the power produced at the focal production center for each scenario undergo transformations between years and scenarios. Thus the effects would need to be analyzed not only on the basis of the nature of power production at the production center, but also the behavior of the rest of the network and also the distribution of the generation between the 380 and 150KV buses.

Case 1: 3 phase symmetrical short circuit at 150KV bus;

Case 2: 3 phase symmetrical short circuit at 150 KV wind farm terminal;

Case 3: 3 phase symmetrical short circuit at 150KV wind farm interconnecting cable

5.2.1 Short Circuit analysis under the Green Revolution scenario

In this section the worst case fault cases for the Green revolution scenario are analyzed. The fig.5.2.1.1 shows the condition for a three phase symmetrical fault at the 150KV terminal. The results for the system voltage, frequency, active and reactive powers are presented in the plot. It is seen that the fault voltage is the same across all the years. This may be due to the basic assumption that in the years 2020 and 2030, the fault levels at the 380 and 150KV networks will be limited by means of fault current limiting devices. It is further seen that the recovery of the post fault voltage becomes progressively better in the years 2020 and 2030. This can be explained using the fact that the system inertia constant is assumed to linearly increase from the year 2010 till 2030. The grid inertia time constant of the system indicates the capability of the system to store rotational kinetic energy, measured with the available generation capacity as a base value. As this value increases the grid attains a better capability to recover faster from short circuits.

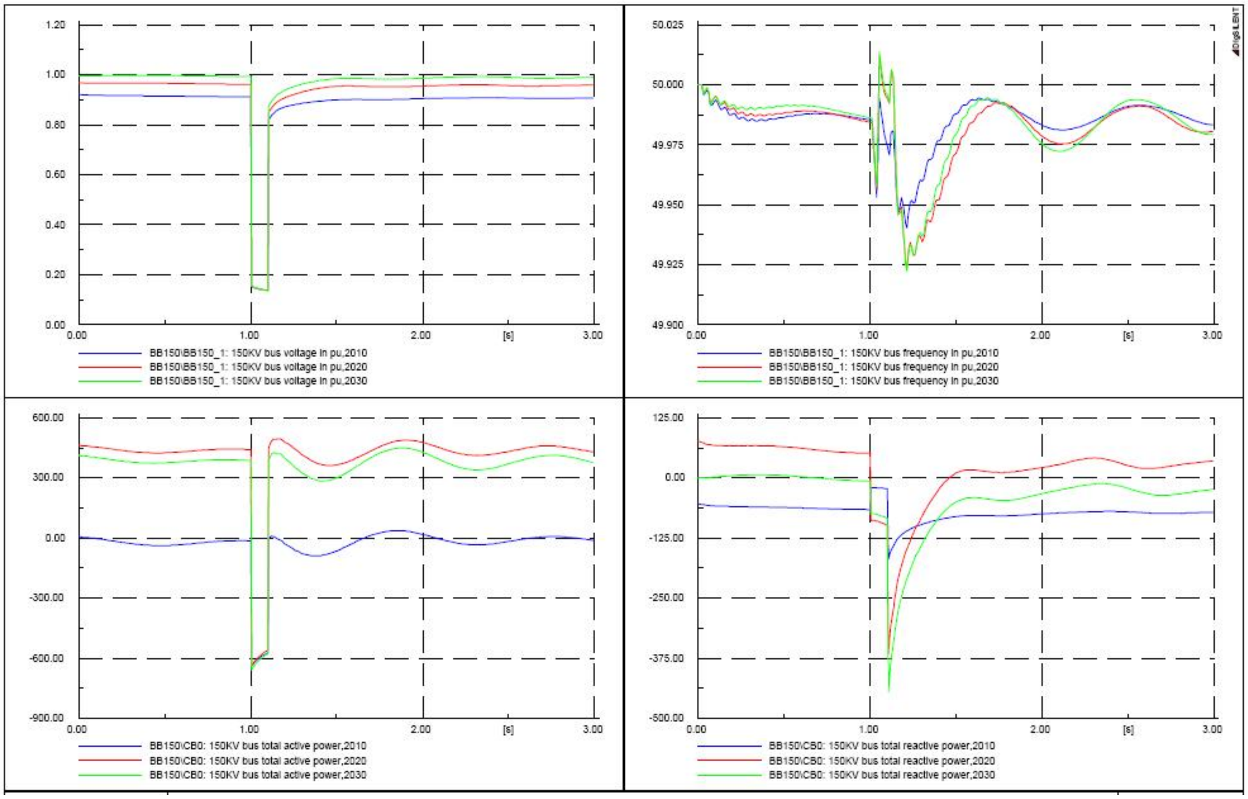

Fig.5.2.1.1: Three phase symmetrical short circuit at 150KV bus,GR

In the fig 5.2.1.2 the simulation results for a short circuit at the 150KV wind farm terminal are presented. It is seen that the Pattern of voltage recovery after the fault event is followed in this short circuit event as well. In addition the reactive power flow through the 150KV terminal reverses in orientation, which means that the 150KV bus feeds reactive power into the fault.

In the fig 5.2.1.3 the simulation results for a short circuit at the 150KV wind farm interconnection cable are presented. While this scenario is a best case scenario (three phase faults on cables leads to its disconnection due to no auto reclosure possibilities), this case is studied for the impact of faults on cable systems. It is seen that the pattern of voltage recovery after the fault event is followed in this short circuit event as well. The recovery of the reactive power flow at the 150KV bus is fastest in the year 2010 and the time of recovery continues to increase for the years 2020 and 2030. The larger fluctuation in reactive power in case of the cables is due to their impedance being largely capacitive.

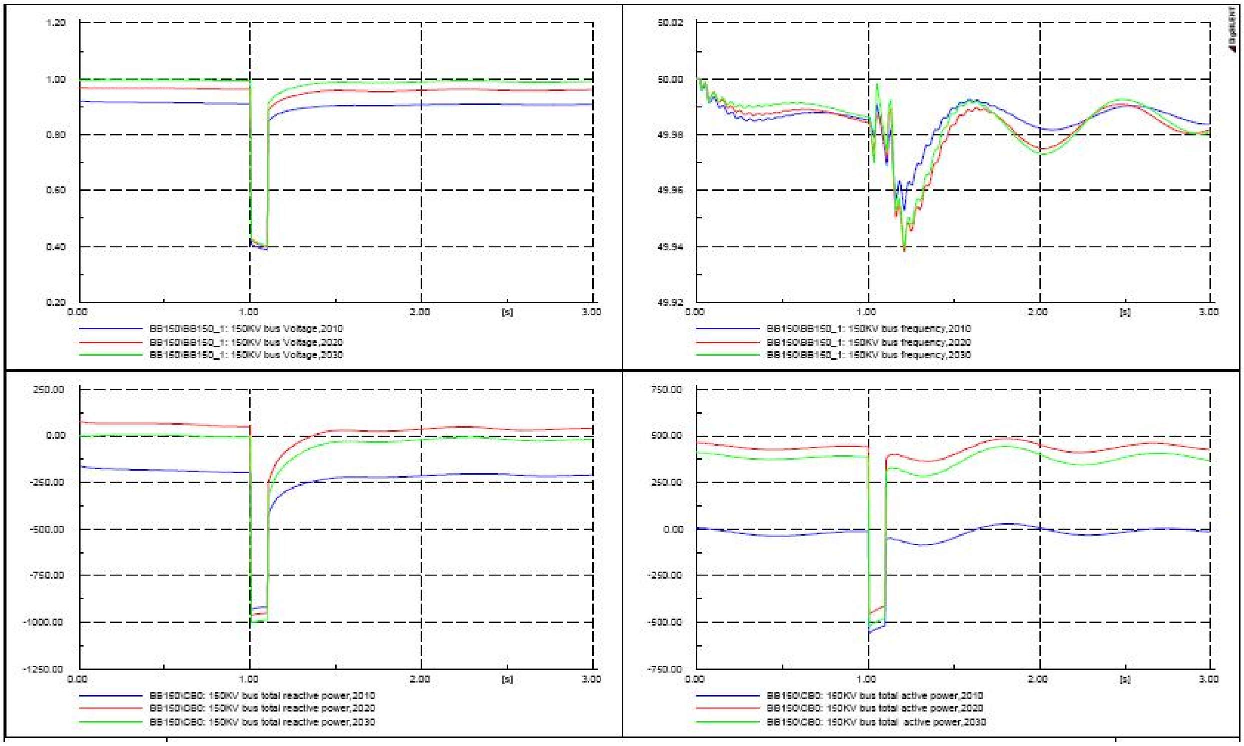

fig.5.2.1.2: Three phase symmetrical short circuit at 150KV wind farm terminal, GR

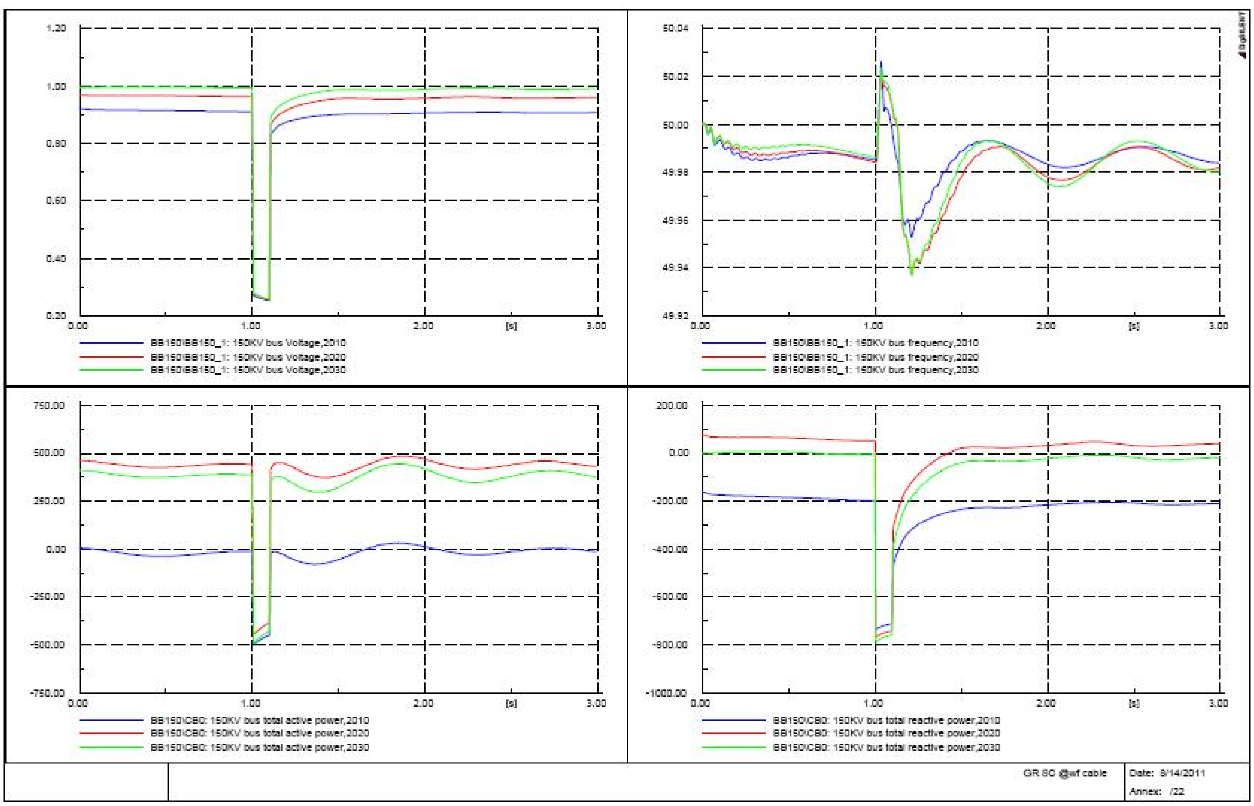

Fig.5.2.1.3: Three phase symmetrical short circuit at 150KV wind farm interconnection cable, GR

5.2.2 Short circuit calculations for the new strongholds scenario

In this scenario the fault levels are the highest owing to the highest power production of all the scenarios. To simulate the fault events the fault impedance values need to be increased continuously to converge the network simulations. In effect this means that the system is inherently instable under a fault condition.

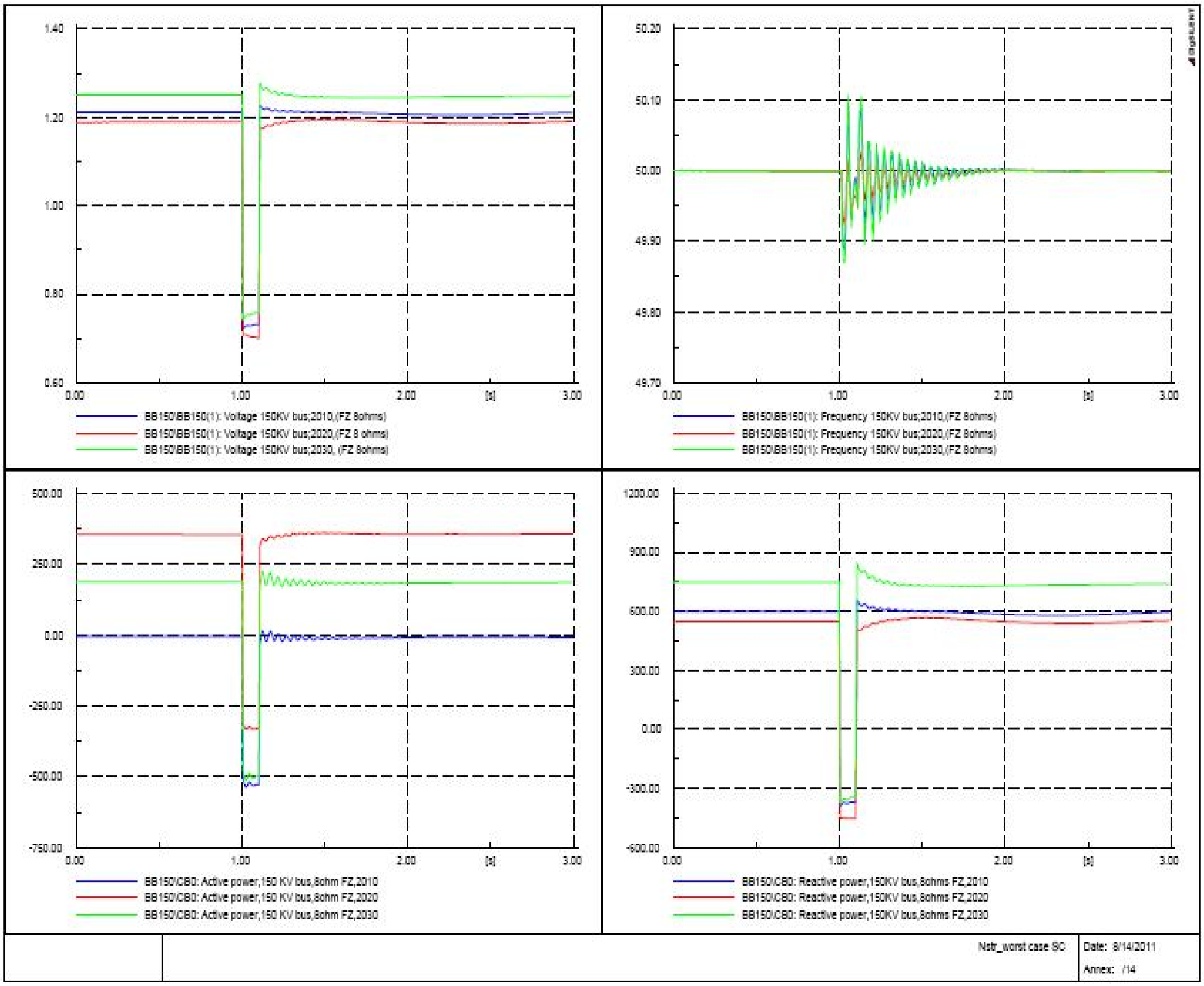

Fig.5.2.2.1: Three phase symmetrical short circuit at 150KV bus, NStr

It is noticed that the fluctuations in all the parameters increases from the years 2010 to 2030 (for fault at 150KV bus, fig.5.2.2.1).The deviations in voltage and frequency fade in about 300ms with maximum overshoots of 4%. This could be explained on basis of larger generation capacity of the system and the heavy damping provided by the network (due to fault impedances). The fluctuations in frequency are the highest in the year 2030 followed by the years 2020 and

2010.This leads to a conclusion between scenarios that a larger grid time constant, while enabling a higher stored energy to flow into the fault, also leads to higher oscillations in the system. It should also be noted at this point that in this scenario, an average 11% of power production is through the wind generation, thus reducing the effect of fluctuations due to low inertia machines being connected to the 150KV bus.

The plot in fig.5.2.2.3 shows the 3 phase symmetrical fault scenario in the wind farm interconnection cable. As in the green revolution scenario, the reactive power is provided by the 150KV bus into the fault. The oscillations in the network are reduced due to the larger fault impedance in the network; however the overshoots are of the order of 20% of prefault values in the system for voltage and reactive power. It is also observed that while the parameters for years 2010 and 2030 show overshoots, the parameters for the year 2020 show undershoots and critical damping. This is because of a better balance between the generated power and load.

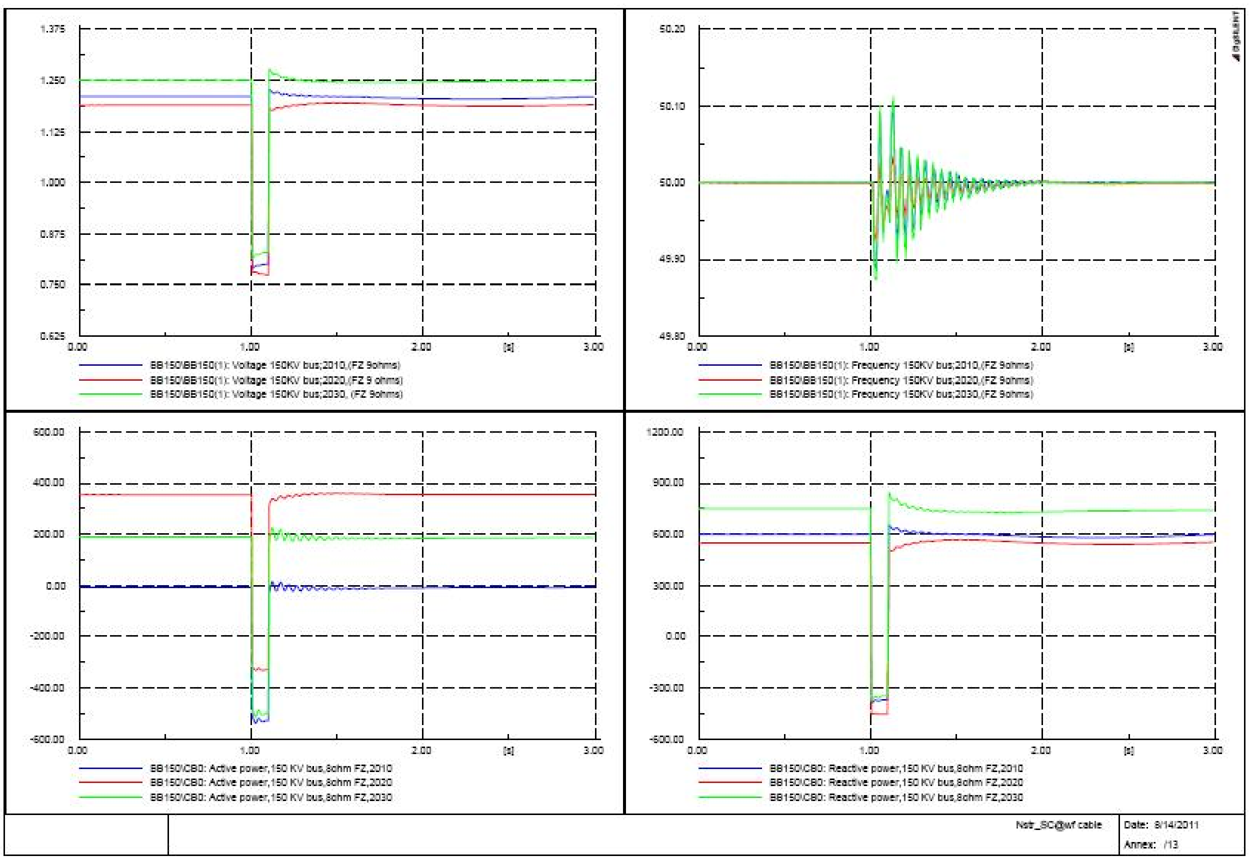

Fig. 5.2.2.2.: Three phase symmetrical short circuit at 150KV wind farm terminal, Nstr

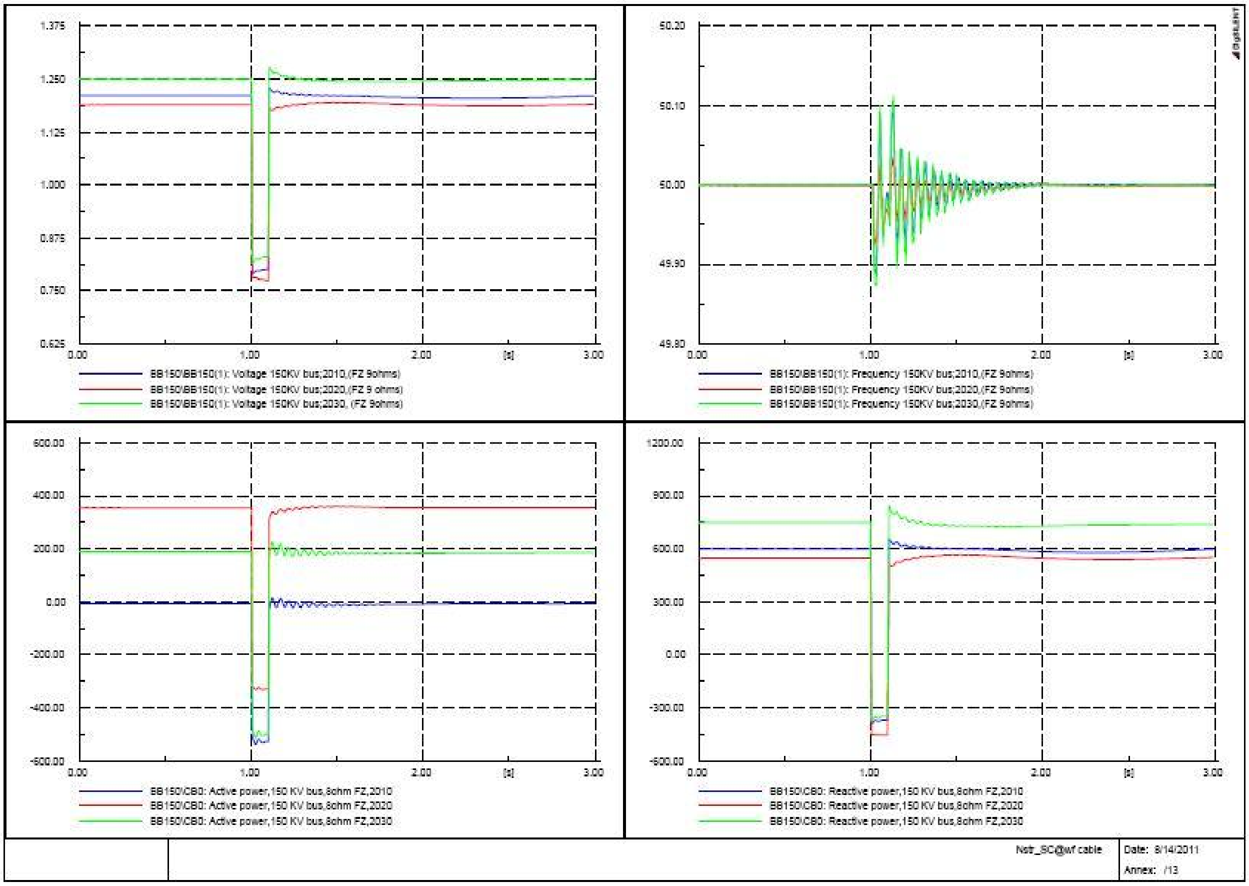

Fig.5.2.2.3: Three phase symmetrical short circuit at wind farm interconnection cable, Nstr

5.2.3 Short circuit analysis: Sustainable transition scenario

In this scenario the generation is focused at the 150KV bus. As a result the oscillations in the active and reactive power are very high for this scenario. The pattern of higher settling time for voltage and frequencies in the networks for years 2020 and 2030 is observed again in fig.5.2.3.1. However it is also noted in this scenario that the voltage overshoots are limited and the overshoots in the frequency are very high. This can be explained in terms of the aspects that firstly, most of the generation capacity at IJmuiden is connected to the 150KV bus. Secondly, the percentage of power production from wind power increases from 38% to 61 % between years 2010 and 2030.Thus disturbance in the network in the 150KV network cause severe oscillations in the voltage, frequency and power flows at the 150KV bus. The use of fault current limiters and voltage management methods can mitigate this problem by smoothening the variations in voltage and frequency.

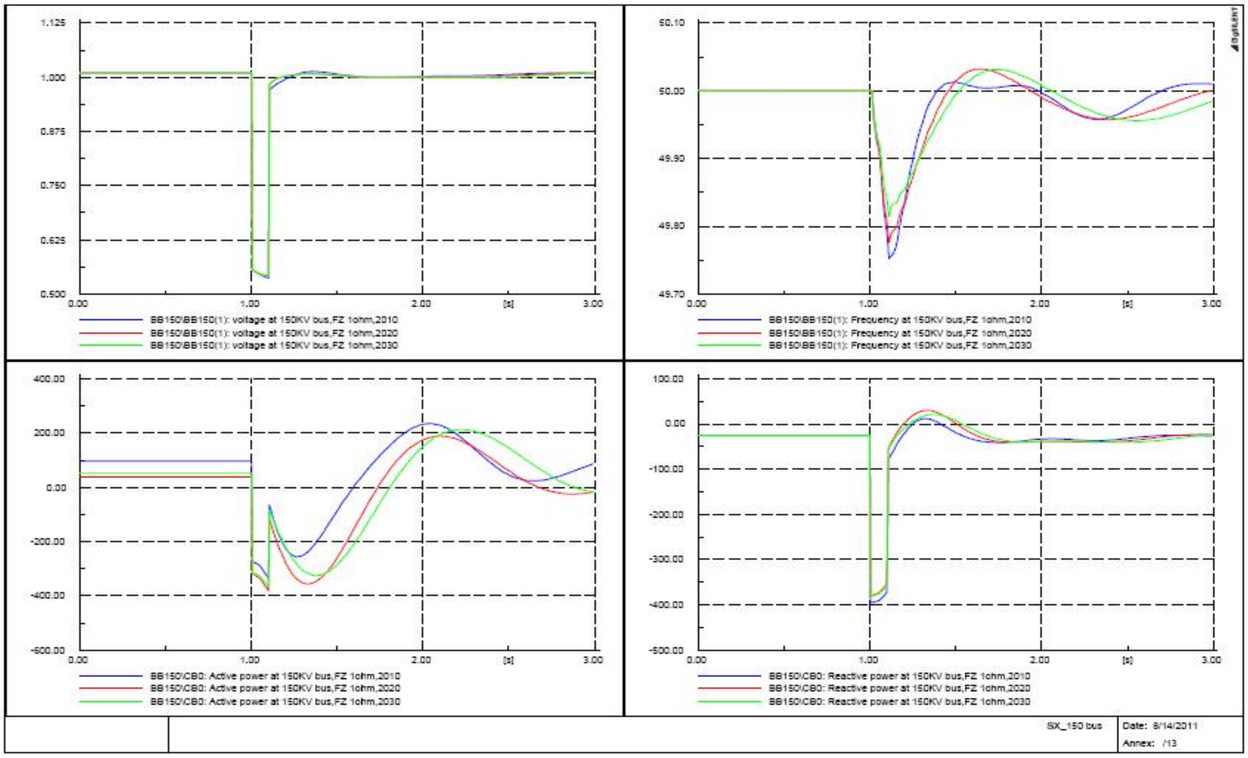

Fig.5.2.3.1: Three phase symmetrical short circuit at 150KV bus, SX

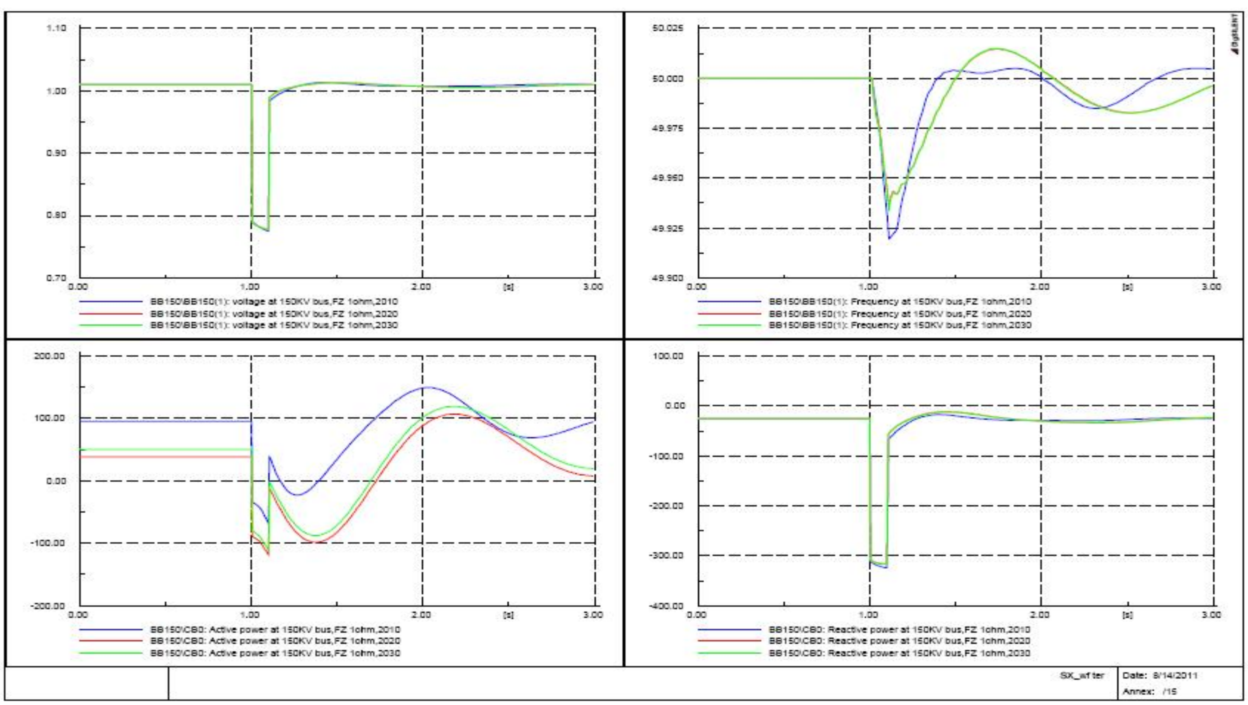

Fig.5.2.3.2: Three phase symmetrical short circuit at wind farm terminal, SX

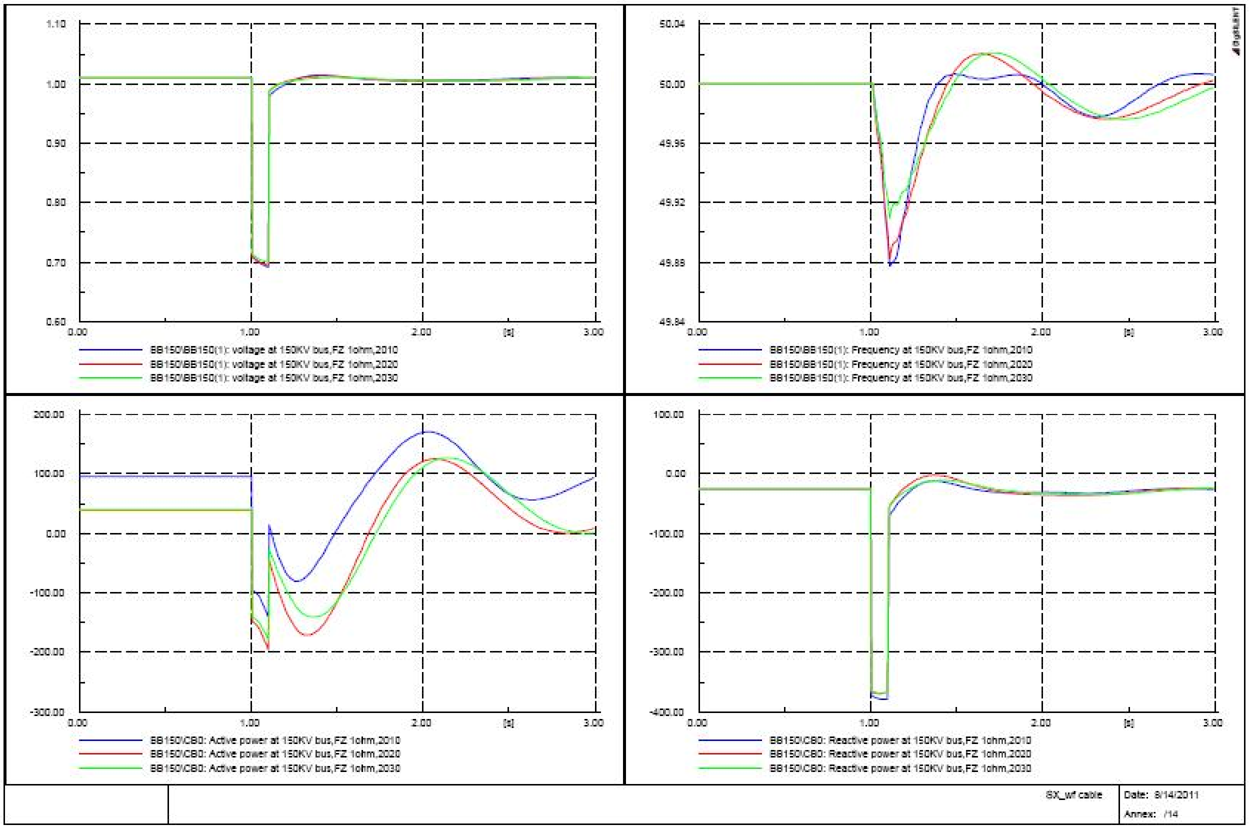

Fig.5.2.3.3: Three phase symmetrical short circuit at wind farm interconnection cable, SX

5.2.4 Short circuit analysis: Money rules scenario

The behavior of the parameters in the money rules scenario is similar to those of the sustainable transition scenario (fig.5.2.4.1). The explanation for this could be in the similar levels of power production and system inertia time constant. However, since power production in the money rules scenario is divided between the 380 and 150 KV buses the overshoots in active and reactive power are lower. The settling times for the parameters are lower. This can be explained in terms of generation capacity being distributed between the 380KV and 150KV bus, which damps the oscillations from the generators connected on the 380 KV bus. Also since the contribution of wind power to the production capacity at the production centre is limited (between 20 to 25% of total production), the variations in frequency are lower than those of the sustainable transition scenario, but higher when compared to the scenarios with lower contribution from wind power.

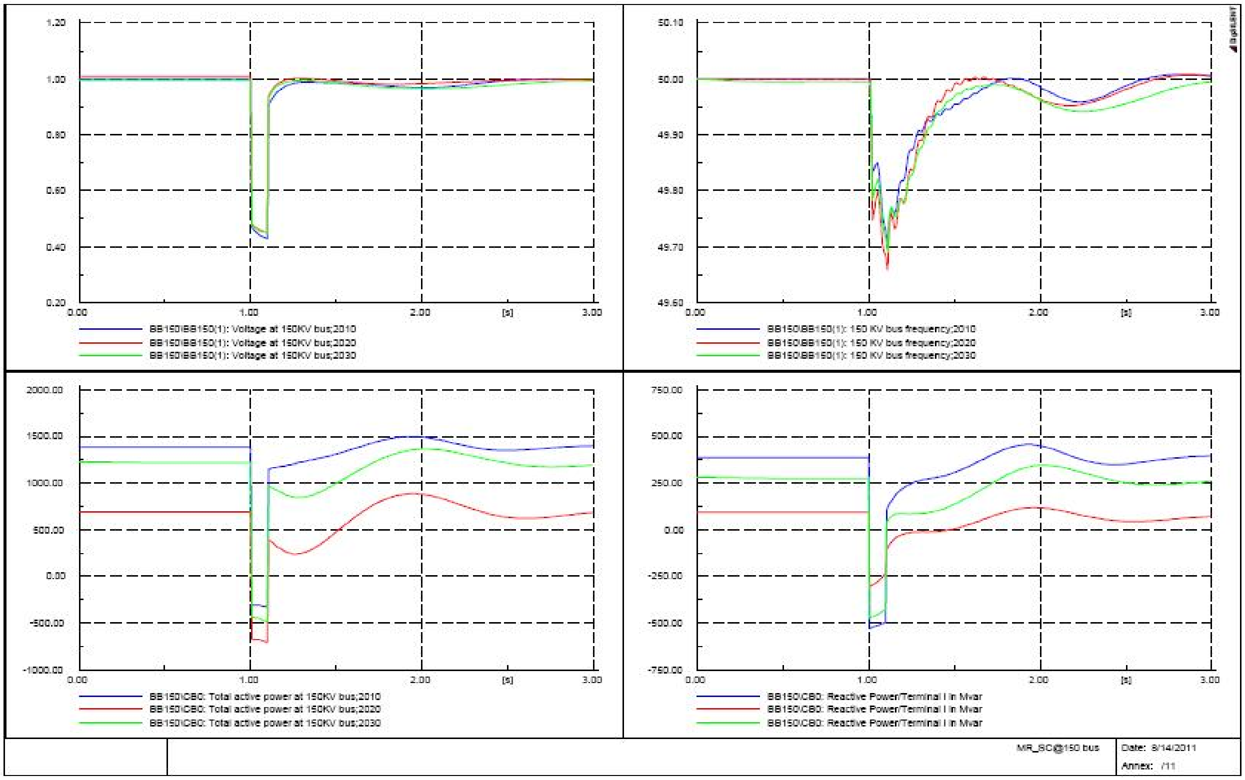

Fig.5.2.4.1: Three phase symmetrical short circuit at 150KV bus, MR

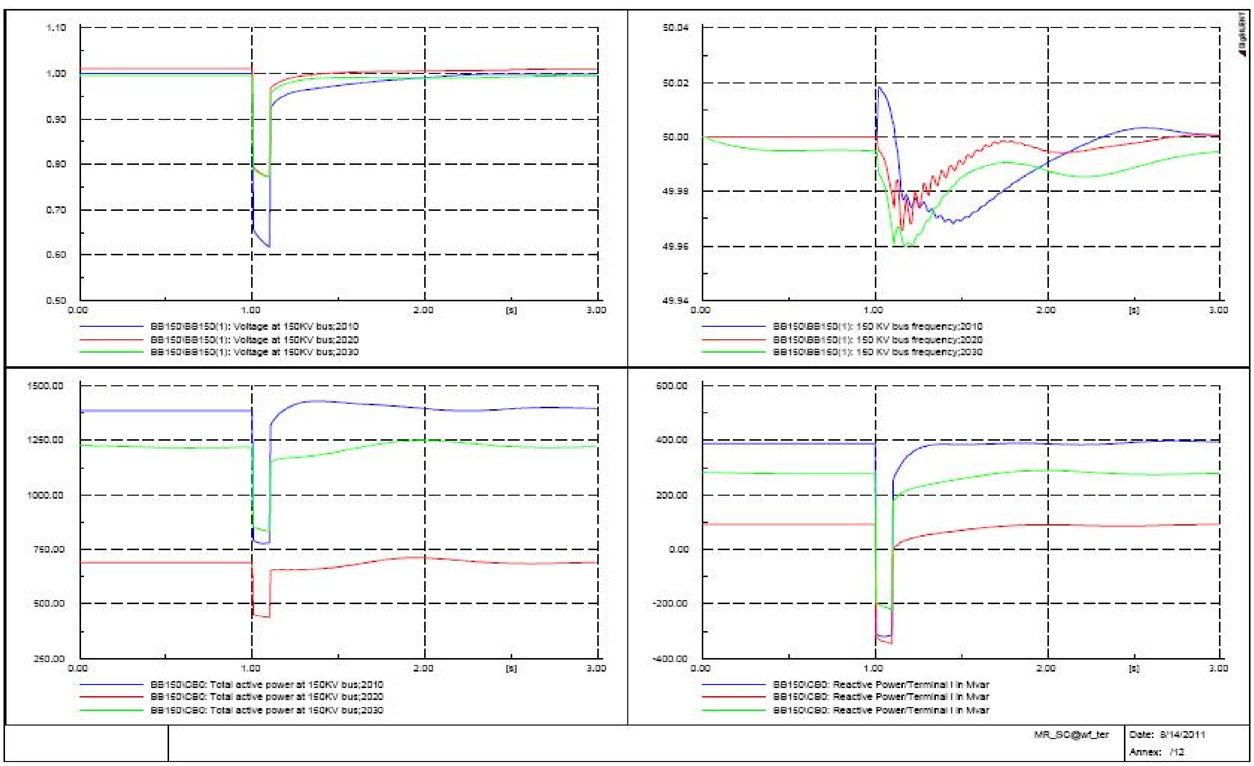

Fig.5.2.4.2: Three phase symmetrical short circuit at wind farm terminal, MR

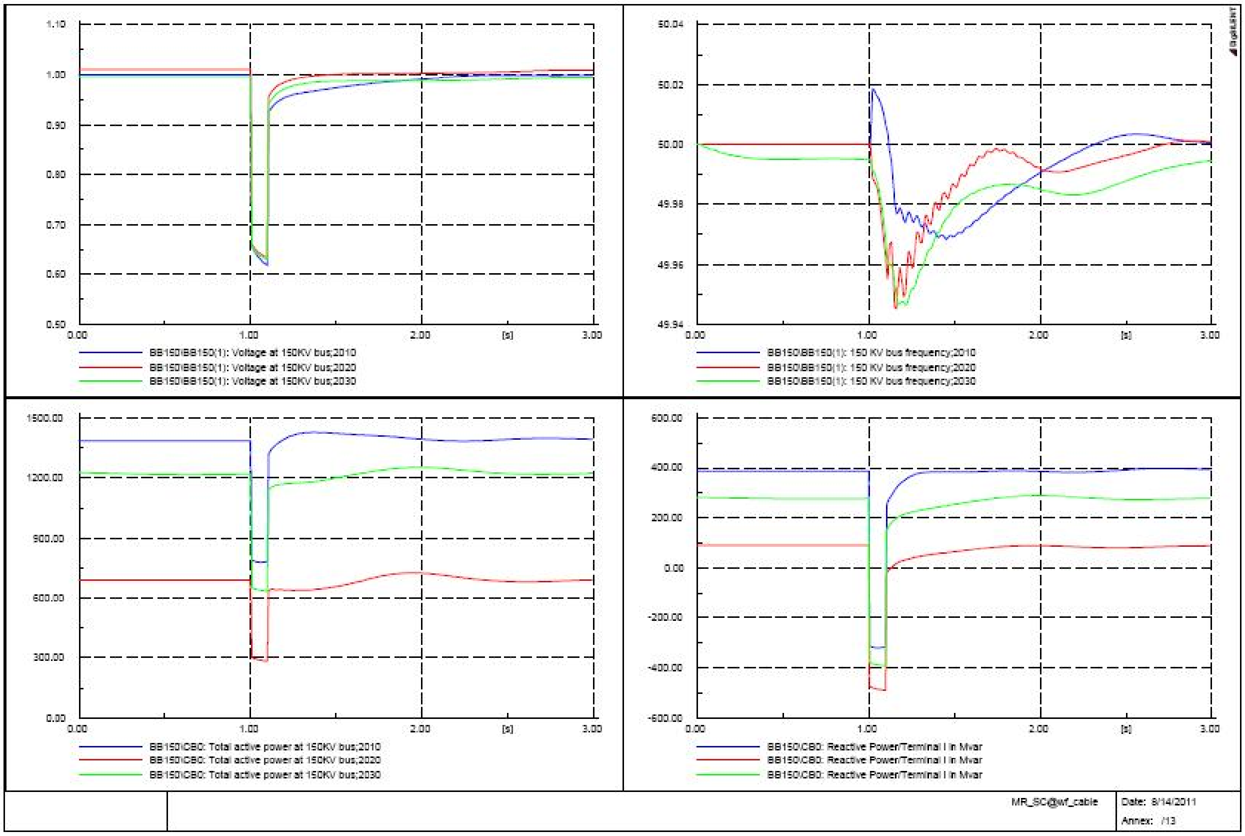

Fig.5.2.4.3: Three phase symmetrical short circuit at wind farm interconnection cable , MR

5.3 Behavior under dynamic load conditions

The effects of the network behavior under dynamic load conditions are studied in this section. Dynamic changes in load are the essential components of the electrical system at every voltage level. In this study focus is given to the changes in the load at the 150 KV voltage level. The changes in loads are expected to occur under periods of load changes in the network, for example during the different time spans in a day when load change. The loads studied in this section are those connected directly to the 150 KV bus. As a special case variation in load is also simulated for electric vehicle loads .The load variations are simulated under the following conditions:

1) Load changes under increasing load conditions
2) Load changes under decreasing load conditions

Load changes for electric vehicles are simulated under the following conditions:

1) Charging periods for electric vehicles
2) V2G operating conditions for electric vehicles

5.3.1 System behavior for varying load conditions at 150KV bus

In this section the effects of increasing load at the 150 KV is studied. For the simulation at the 150 KV it is assumed that the loads are balanced three phase loads. The network load variation is simulated as a step change for the load "GL-01", wherein a step change of 10% variation is studied. The resulting voltage profile at the 150 KV bus and 380 KV bus and the resulting frequency variations are studied. Since the load is rated at a large value, a variation in load is a large value the settling time and the final settling value for the voltage is of particular interest in this case. As before, the conventional generation units with capacity above 100 MVA are equipped with governor and AVR controls. Additionally, a frequency control and voltage control mechanism is implemented at the 150 KV bus.

5.3.1.1 Load variation in the Green revolution scenario

In the fig.5.3.1.1 it is seen that as the load increases the voltage settles down to a lower new value. The frequency also decreases according to the increased load condition. During a reducing load condition the grid frequency and bus voltage parameters increase. The frequency behavior at the 150 KV bus is heavily dependent on the primary and secondary controller bias in the attached girds. The controller bias increases the grid's ability to recover faster to a new stable state of system.

In case of the decreasing load condition (fig.5.3.1.2) the load is increased by 10% at t=1sec.The frequency and the voltage of the 150KV bus increase marginally. It is seen that the variations in load do not affect the frequency in the 150KV bus to a very large extent. This can be attributed to the governor action of the generators. During a decreasing load scenario presented in figure the frequency and voltage increase and the system settles at a new state.

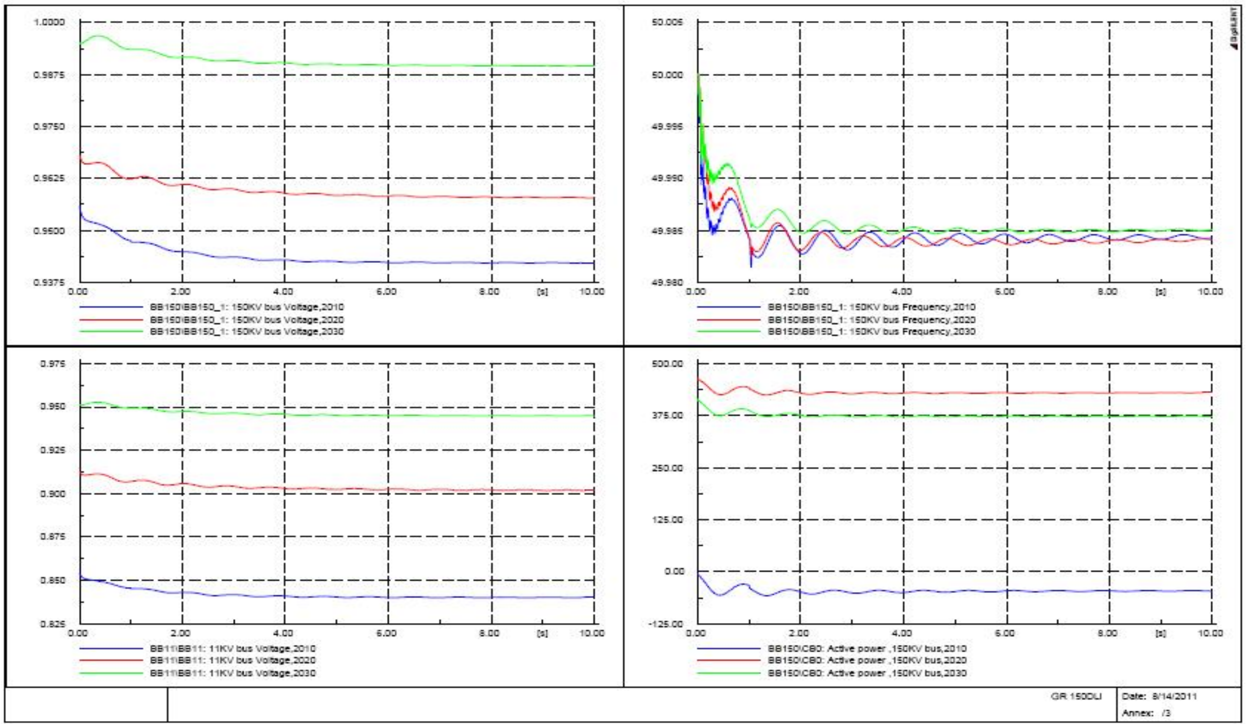

Fig.5.3.1.1: Increase in load at 150 KV terminal, green revolution scenario

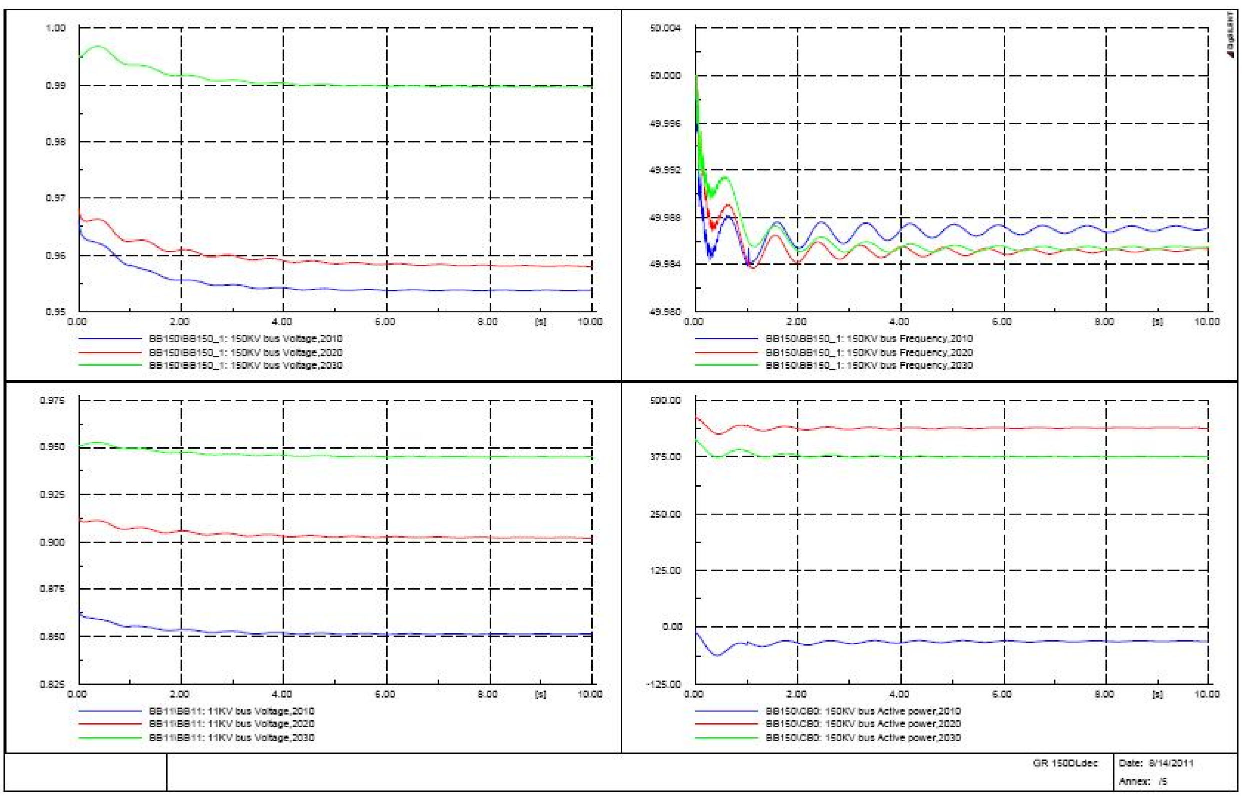

Fig.5.3.1.2: Decrease in load at 150 KV terminal, green revolution scenario

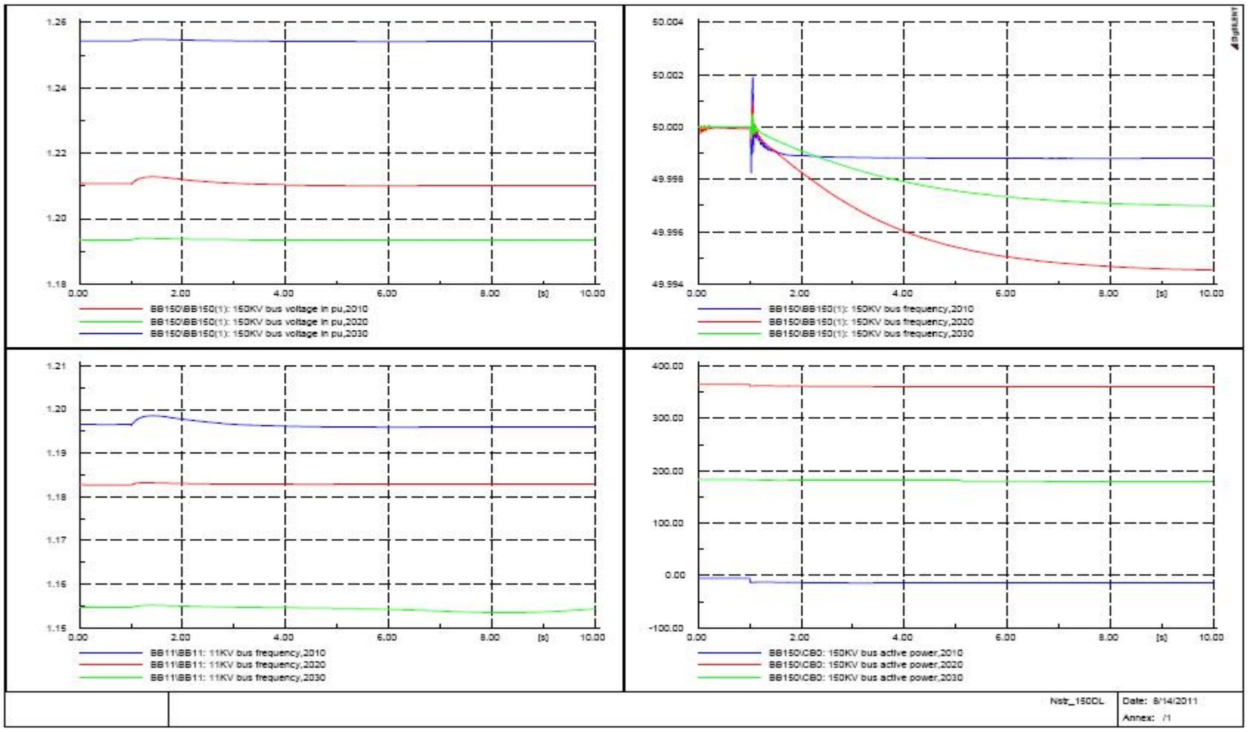

Fig.5.3.1.3: Increase in load at 150 KV terminal, New strongholds scenario

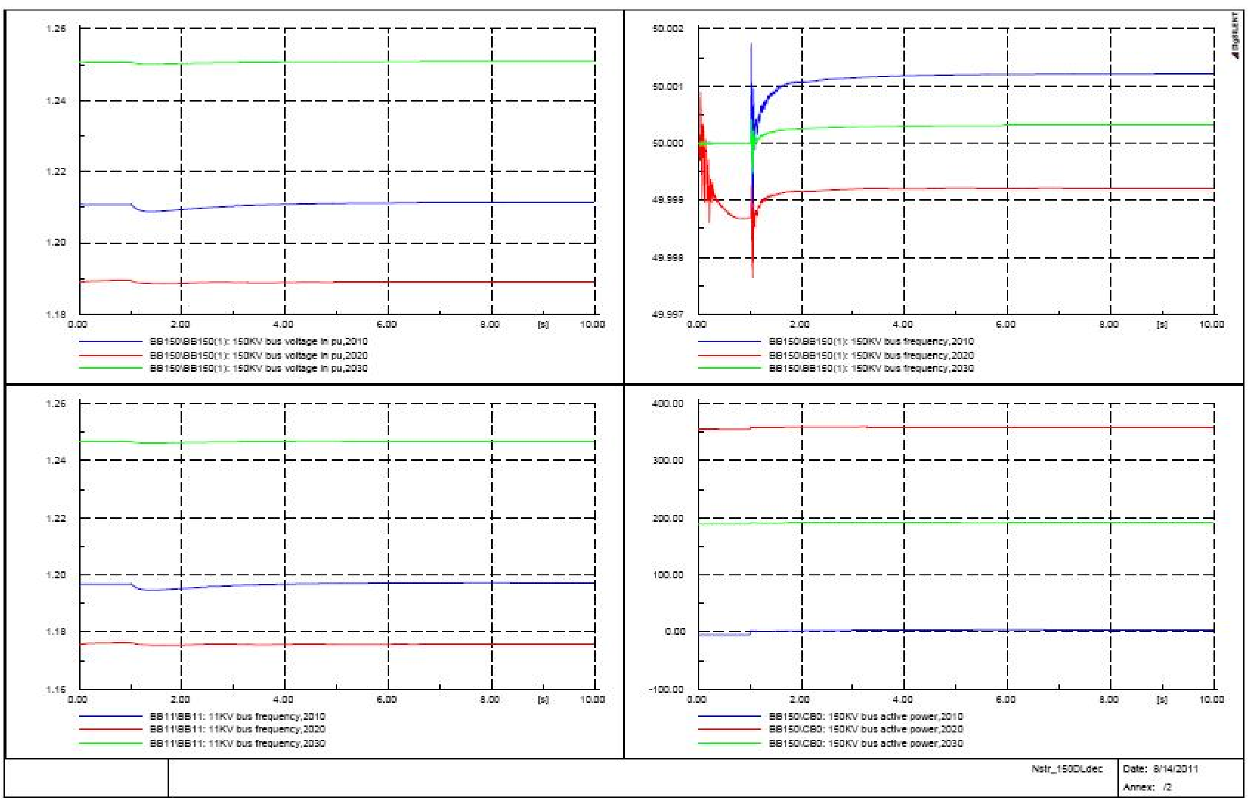

Fig.5.3.1.4: Decrease in load at 150 KV terminal, New strongholds scenario

5.3.1.2 Load variation in the new strongholds scenario

In the New strongholds scenario the simulations show (fig 5.3.1.3 and fig 5.3.1.4) that as the generation capacity increases the system settles at a higher value of frequency and voltage. The overshoot in the voltage at 150KV bus decreases as the system exports more power to the 380 KV network.

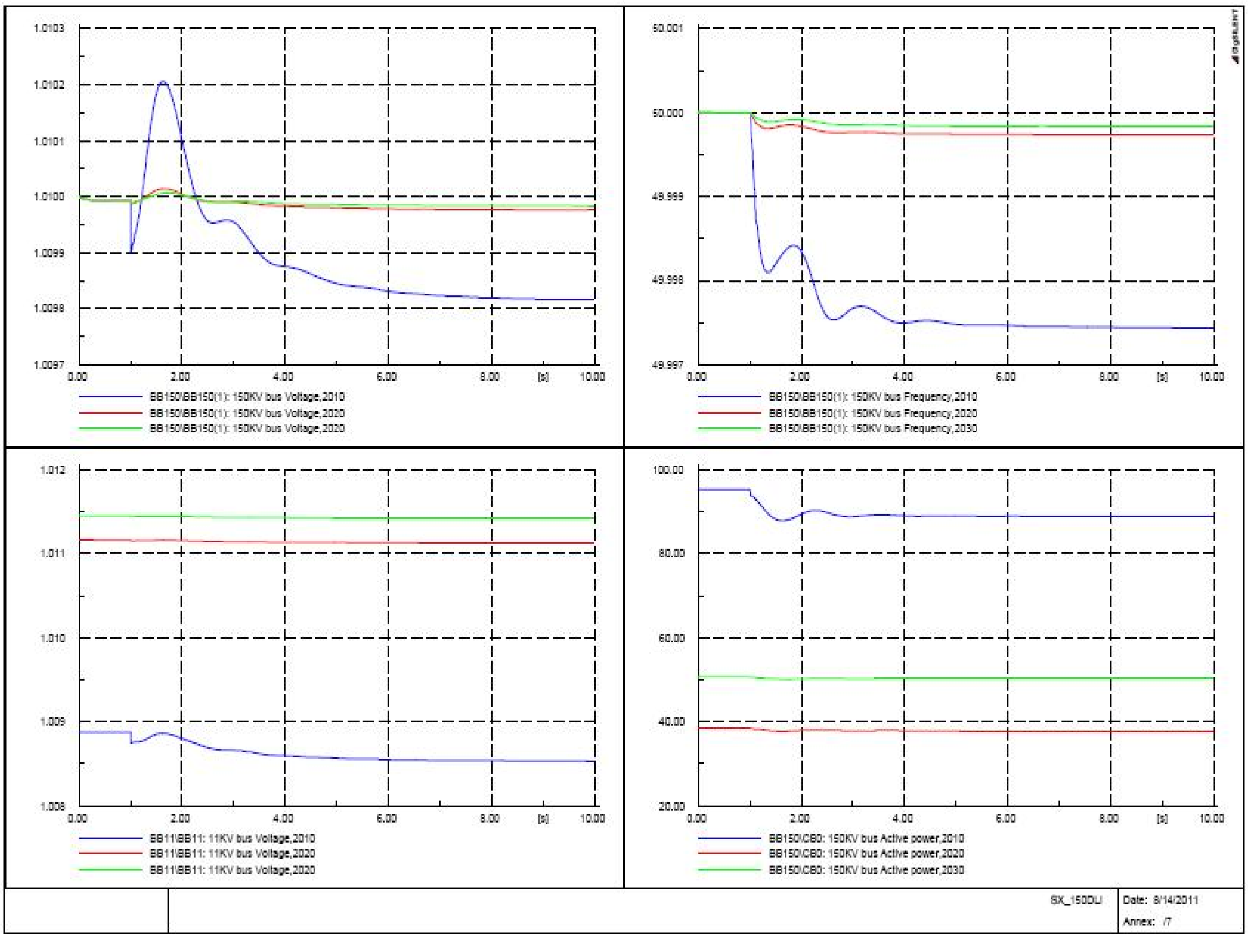

Fig.5.3.1.5: Increase in load at 150 KV terminal, sustainable transition scenario

5.3.1.3 Load variation in the Sustainable transition scenario

In the sustainable transition scenario the 150KV bus is the also the generation terminal. A similar pattern of voltage and frequency behavior is seen in this scenario (fig.5.3.1.5, fig.5.3.1.6). However the decrease or increase in frequency in this scenario is very small (of the order of 10^{-3} Hz). This is due to the governor action. Also it is seen that the final settling value of the system frequency decreases under decreasing load conditions from the years 2010 to 2030. This is an indication about the nature of the loading of the system. As the connected load increases the variations in one of the loads has smaller influence on the frequency and voltage behavior at the 150KV grid. However the oscillations in the parameters and settling times also increase, this can be attributed to the increased contribution by wind power production toward the total production at the production center.

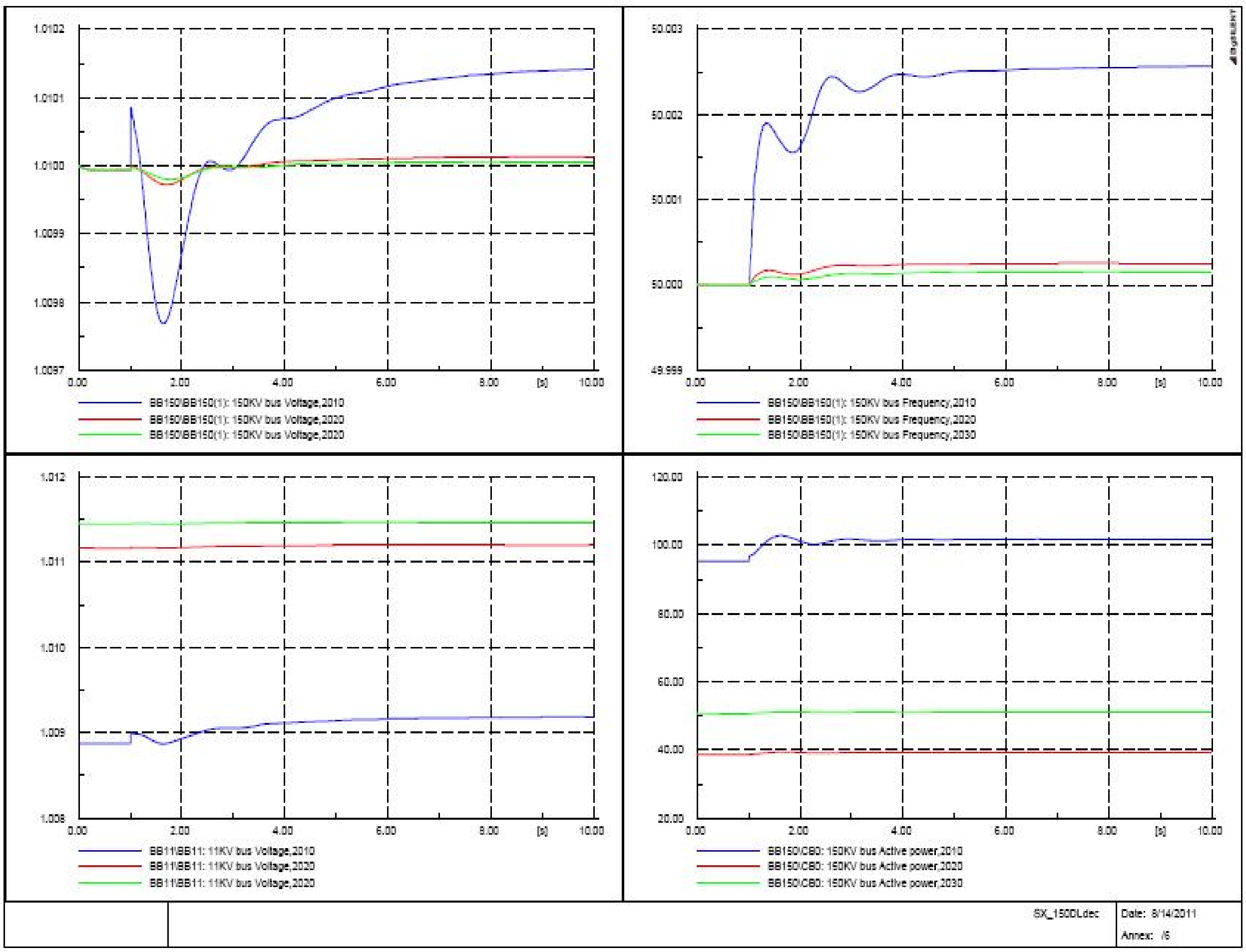

Fig.5.3.1.6: Decrease in load at 150 KV terminal, sustainable transition scenario

5.3.1.4 Load variation in the Money rules scenario

In the money rules scenario it is seen that the system voltage and frequency have the highest damping and that the overshoots reduce over the years 2010 to 2030. This is due to the increasing load in the system over the years 2010 till 2030.It is also observed that the final settling time of the voltage and frequency decreases over the same time span. This is also due to the increased load in the system.

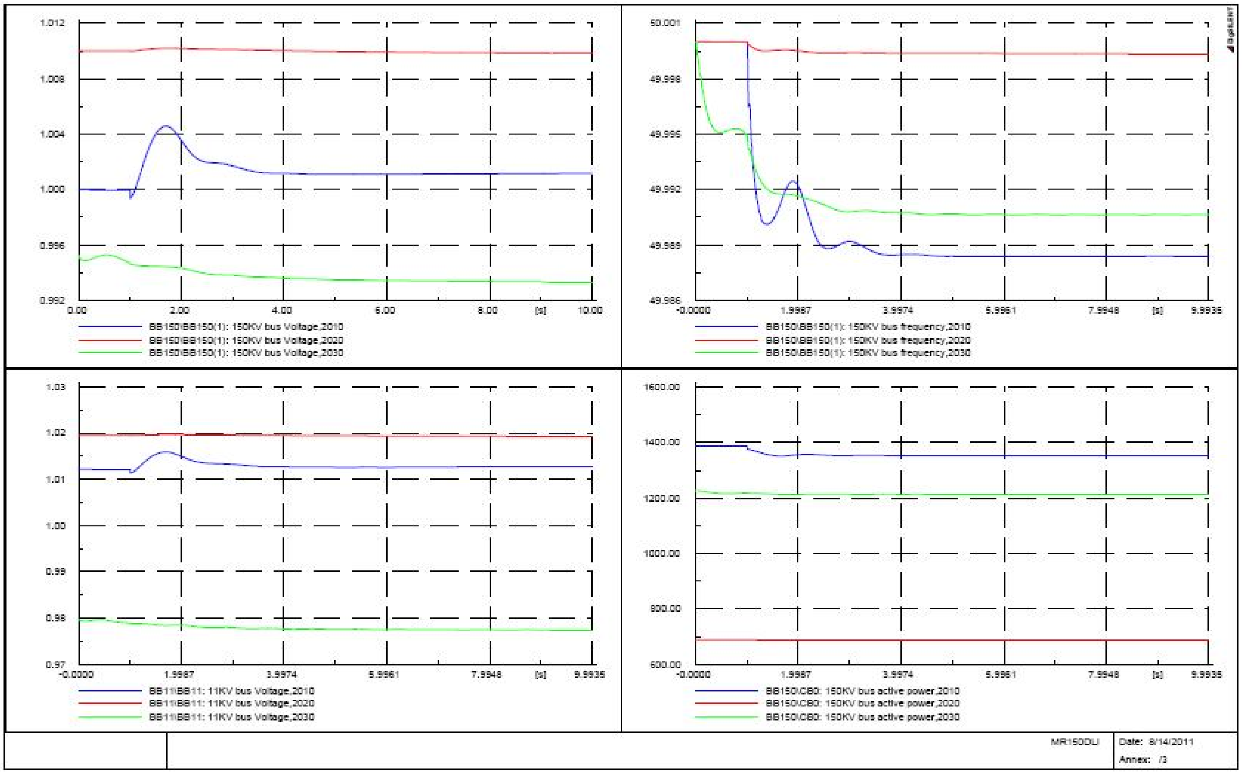

Fig.5.3.1.7: Increase in load at 150 KV terminal, Money rules scenario

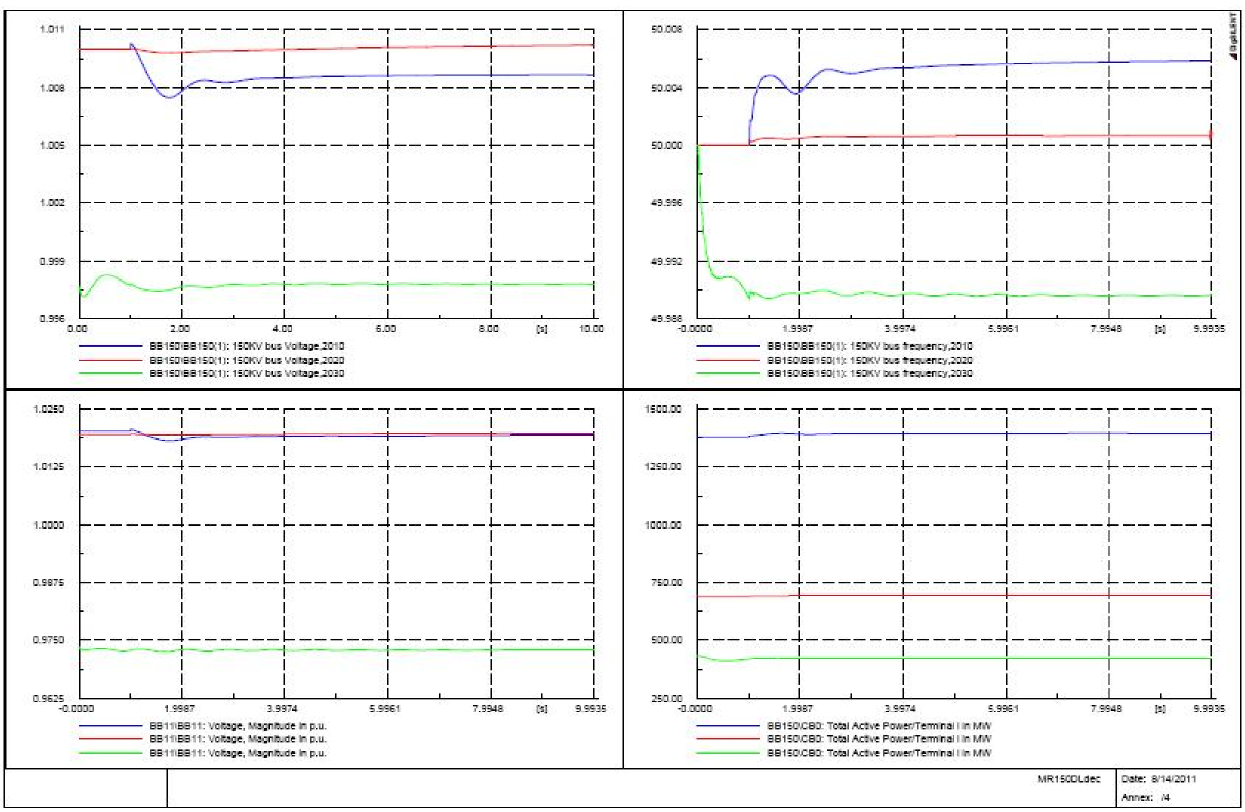

Fig.5.3.1.8: Decrease in load at 150 KV terminal, money rules scenario

5.3.2 System behavior for increasing load at the EV bus

In this section the effect of a variation in the DC load posed by electric vehicles is studied. From the figures we see that the variation of the DC load in the network at the distribution bus does not affect the parameters in the 150KV bus to a very large extent. The effect of a 10% variation in load is thus too small and is supplied by the power production in the distribution network. An interesting observation here however is the fluctuations during the increasing load conditions seen in fig. 5.3.2.2 and fig 5.3.2.3. These fluctuations only last for about 100ms but are visible in the new strongholds and sustainable transition scenarios. This is due to the harmonics in the power electronic converters which supply the DC loads. As the capacity of the electric vehicles increases in the future the amount of transient spikes in the system brought about by increasing use of power electronic devices increases. However the variations in frequency, voltage and power flows at the 150KV bus are very minimal.

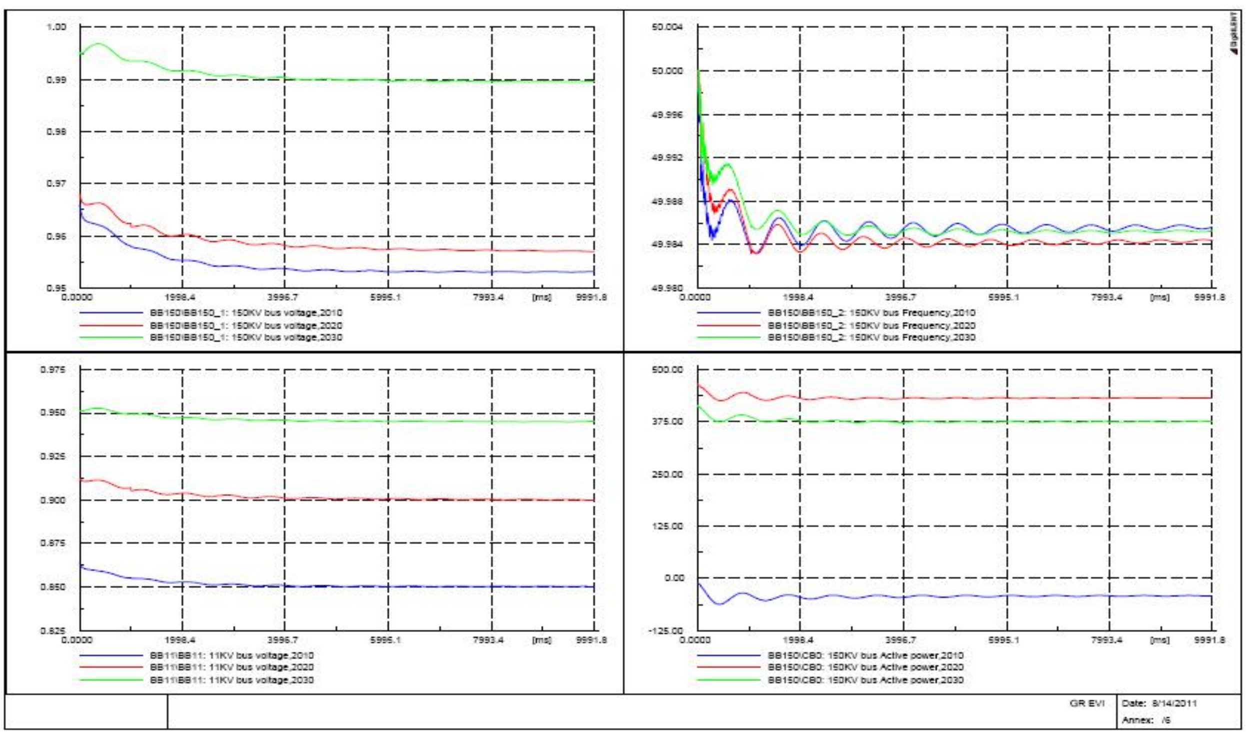

Fig 5.3.2.1: Increase in load at electric vehicle DC load, green revolution scenario

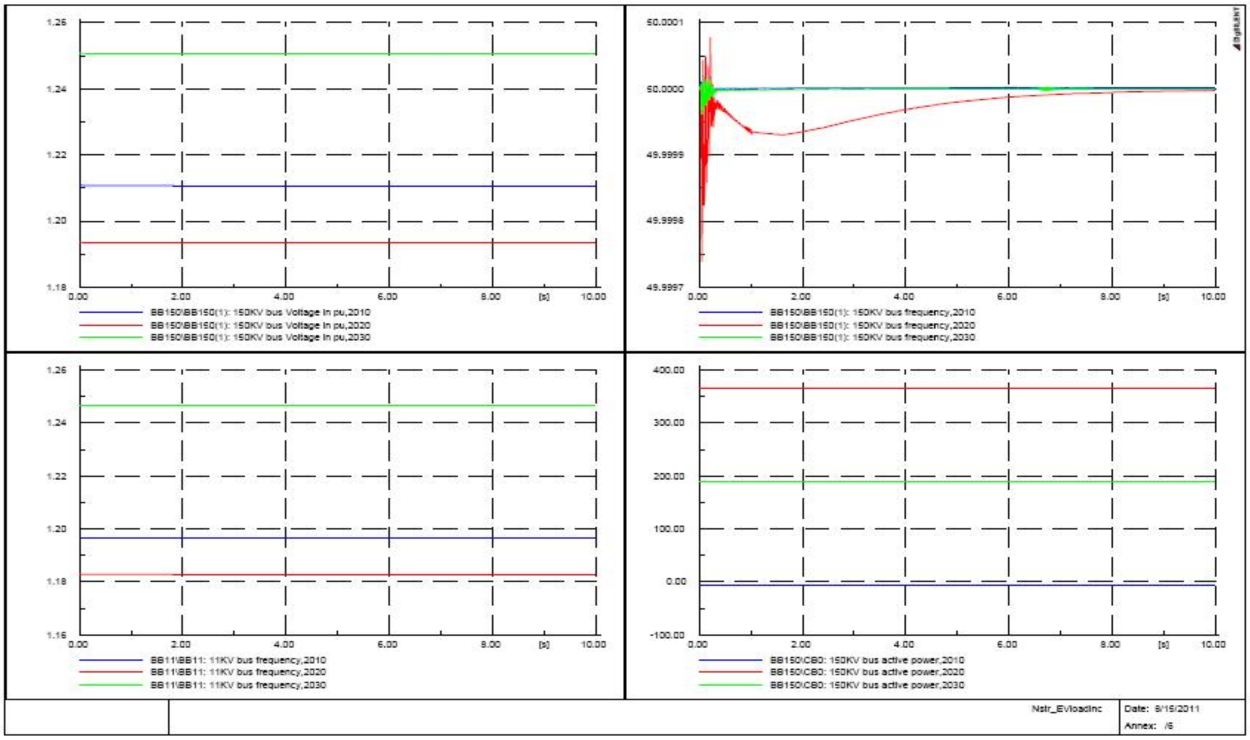

Fig 5.3.2.2: Increase in load at electric vehicle DC load, new strongholds scenario

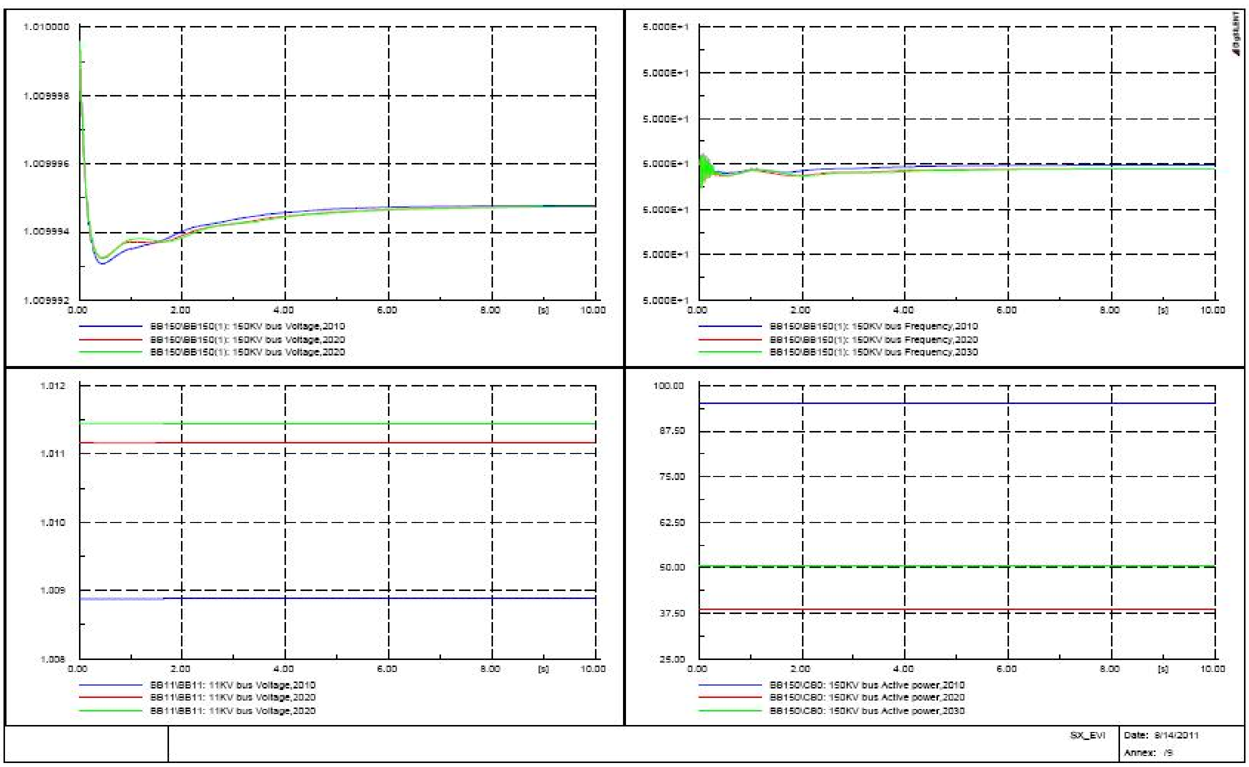

Fig 5.3.2.3: Increase in load at electric vehicle DC load, Sustainable transitions scenario

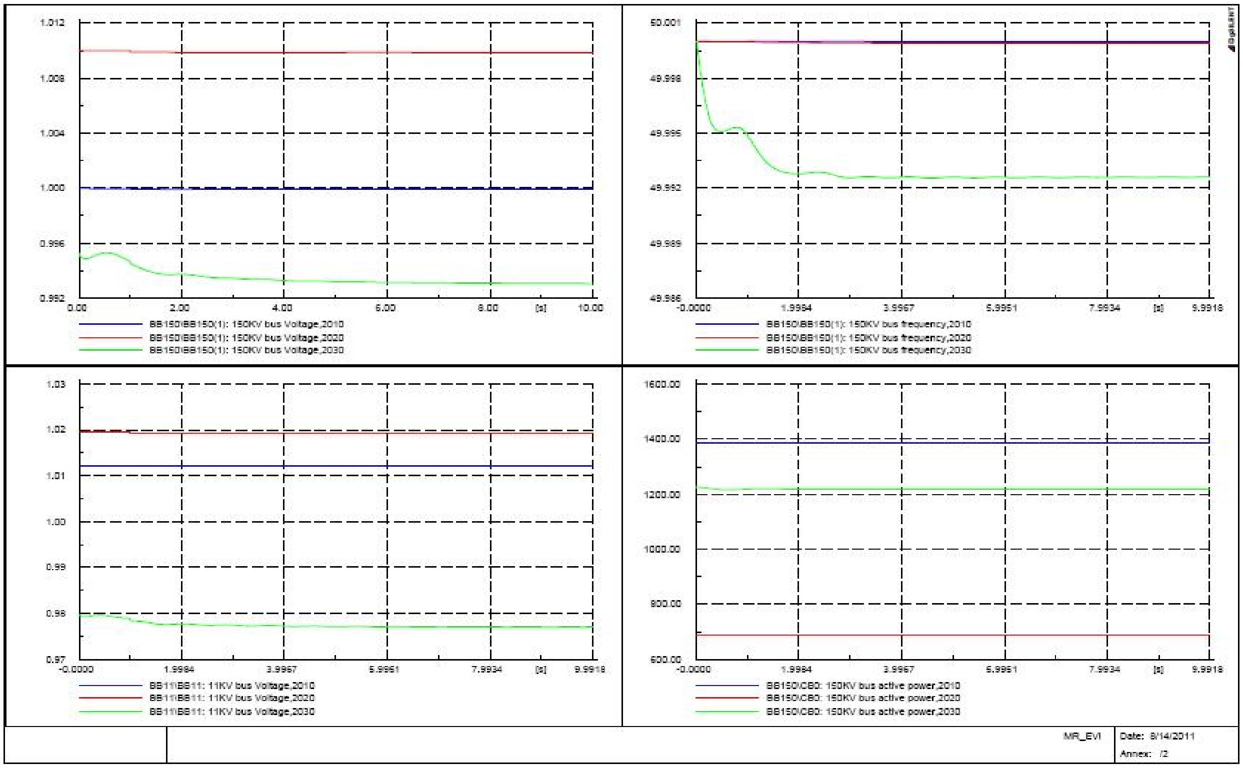

Fig 5.3.2.4: Increase in load at electric vehicle DC load, Money rules scenario

5.4 Impact of V2G on system frequency regulation

It has been proposed that in the future, V2G action by electric vehicles can be most profitably used for the frequency regulation operations in the network. In the fig.5.4 this action is studied.

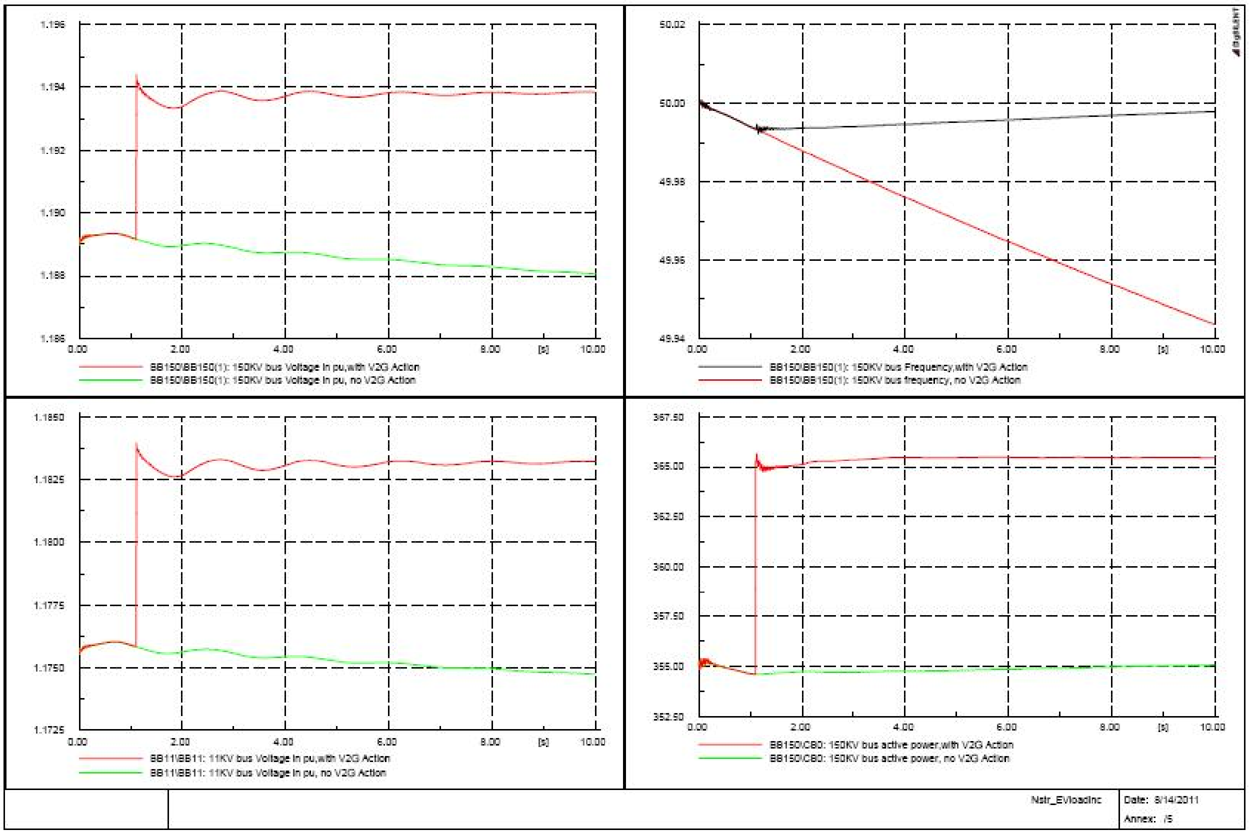

Fig5.4: impact of V2G action on frequency regulation

In this case the secondary controls in the network are disabled to better observe the effects of frequency regulation by V2G applications. The local AC system load at the 1KV bus was varied by 10MW and the in feed from the EV bus was increased by 10MW to meet this demand. The events occur at t=1 sec. It is seen that the V2G application does indeed have a regulation impact on the frequency of the 11KV and 150KV buses. Also the increased power demand is met locally the system voltage at the 150KV bus increases to 1.19 p.u. This action is however due to the voltage and frequency controllers at the 150KV bus being disabled.

5.5 Suggested mitigation methods

5.5.1 Methods for short circuit conditions

The increased generation capacity increases the fault level in all the parts of the network. However this effect can be countered by means of the following mechanisms:

1) Fast switching action-As the time required to clear the fault decreases the system is restored faster to its pre fault state. This is shown in the fig.5.5.1 below wherein a fault at the 380 KV bus is cleared in 85ms, thus enabling a faster recovery of the voltage, frequency and power flows at this bus.
2) Fault current limiting devices- As the impedance offered to the fault increases the system fault current levels decrease. This aspect can be utilized to incorporate fault current limiting devices in the future grids to faster restore the system to its pre fault state.

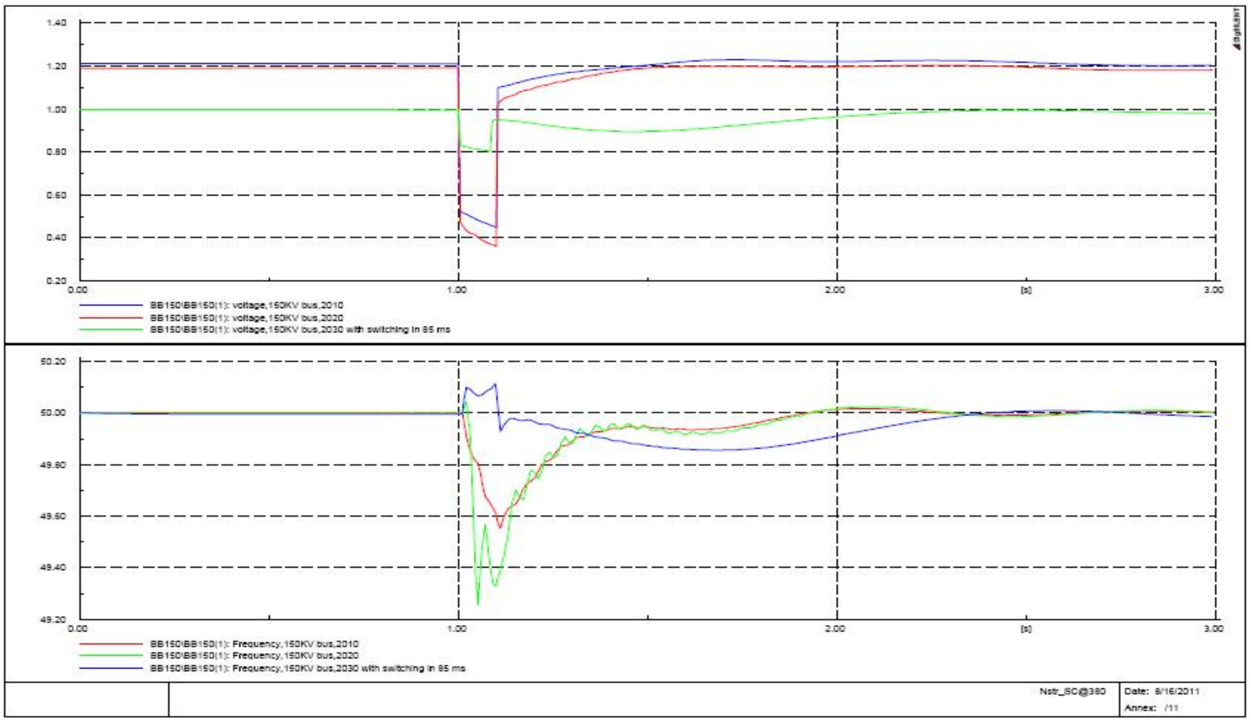

Fig 5.5.1: simulation of fast switching at 380KV bus (in 85 ms)

5.5.2 Methods for Dynamic load variation

For the dynamic load it is seen that the action of the distributed power production is indeed capable of handling the variations in local loads. It can thus be proposed that as the generation capacity in the distribution network increases, the power flow, voltage and frequency parameters in the high voltage network are lesser influenced by the events in the distribution network. In this work it is seen that in the best case, the changes in the load at the 150KV network causes a frequency deviation of the order of 10^{-3} Hz, which is very a very small deviation and is restored quickly by the generation in the distribution system. The variations in load at the 150KV bus can be handled effectively by the governor and AVR action, while power-frequency control and voltage stabilization controls at the 150KV bus can be used for management of the voltage profile and frequency at the 150 KV bus. Faster controller action in this case would bring the system to a new steady state at a faster rate. These methods can be investigated in further works.

Chapter 6

Conclusions

The conclusions of this study are as follows:

1) As the generation capacity in the network increases the fault levels increase at all the buses. The scenario with higher generation capacity has the higher fault level at the same bus. Thus the highest fault levels are observed in the new strongholds scenario and the lowest are observed in the money rules scenario.
2) Increased fault currents in the future can however be mitigated using fault current limiting devices. By using these devices the voltage sags during faults at different buses can be contained within acceptable limits. The transient overshoots in voltage, frequency and power flows are greatly reduced and the system recovers faster to its pre fault state.
3) The worst case faults and fault locations in the network were identified and simulated to see the effects of these faults on the behavior of voltage, frequency and power flows in the network. It was seen that the worst faults occurred in the buses with the highest power flows. In this study the effects of the faults were observed to be the worst at the 150KV bus when faults occurred at the 150KV network (including buses, wind farm terminals and cables).
4) As the level of wind power production in the system increases the oscillations in transient phase increase. Higher offshoots in voltage and frequency accompanied by higher settling times are observed. The grid inertia constant was found to increase with a reduction in the contribution of wind power toward total power production at a production centre. This is due to the fact that the lower inertia of wind turbines causes the system parameters to be more vulnerable to disturbances. Scenarios with larger contributions from conventional generator-turbine systems (thermal, gas and nuclear) showed more conventional behavior.

5) Distributed generation is capable of handling increase in loads in the network. This aspect can be used to schedule generation in the future years wherein the high voltage network acts a balancing point for the power flows in the network. The generation and distribution systems are meshed into a single network which is capable of using generator scheduling not only for conventional generation but also for PV and EV based power production.
6) During the process of electricity supply from the smart grid entities it is observed that the transient spikes in the system increase and high frequency oscillations in voltage and frequency occur in the network. This may be due to the effect of the electronic converters operating in the network. While the effects of the electronic converters (primarily harmonic distortion) are not visible at the 150KV level, an increasing amount of power generation from these sources from different locations in the network can become apparent at very large levels of production based on these resources.

Chapter 7

Recommendations for future work

1) Fault current limiting devices

Fault current limiters are power electronic devices which provide high impedance to the network on the occurrence of a fault event. Different types of fault current limiters are available today, however in this study the fault impedance was assumed to be a part of the fault itself. Since the worst case simulations covered only 3 phase symmetrical faults, this was a safe assumption. Further studies can thus investigate the advantages and disadvantages of different fault current limiting methods.

2) Fast fault clearing methods

As the time required to clear the fault reduces the network is restored faster to its pre fault state. This however requires a investigation in both ICT technologies and circuit breaker design for faster detection and faster switching. Phasor measurement techniques can be utilized for this application as the complete grid is monitored at a single point and the real time data is available for the analysis of the type of disturbance.

3) Investigation on impact of harmonics in the high voltage network transients

As the amount of distributed generation is expected to increase in the future years it becomes necessary to study the impact of harmonics and switching on the high voltage network. From this study it is seen that the high frequency transients appear in the network in the case of V2G action; however a detailed model of the PV and EV systems is required to study this phenomenon in detail.

4) Influence of distance on distributed generation capacity in the distribution network and its impacts on the HV grid

As the distance between the generation source and the 150 KV bus increases it was seen that the voltage sag at the 150KV bus reduces. However this effect was only studied for wind farms in this study. The influence of distance between the remote source in a distribution network and the high voltage grid needs detailed modeling of the interconnection systems between the HV bus and the distribution network. This investigation is very necessary to understand the behavior of smart grid entities in the future since it is expected that there are multiple points of generation (in particular from photovoltaic and electric vehicles) all connected to the 11KV bus.

Bibliography

[1] *Vision 2030, TenneT TSO B.V, Arnhem 2008*

[2*]"Connection of large scale wind power generation to the Dutch electrical power system and its impact on dynamic behavior", MSc. Thesis, J.A.Bos Technical University of Delft, Delft, Netherlands*

[3] "Network Code", Office of Energy Regulation (DTe), NMa report (Informal Translation), Network Code as of 4 September 2007

[4] "Dynamic Simulation of a Photovoltaic Installation", Ramos Hernanz, J.A., et al. International Conference on Renewable Energies and Power Quality (ICREPQ'09)

[5] "Development, verification and application of a battery inverter model for the network analysis tool Powerfactory", Martin Braun, Thomas Degner, International Journal of Distributed Energy resources July 2005

[6] "The impact of electric vehicles on the energy industry, a part of the Austrian Climate Research Programme", Bernhard Haider, PricewaterhouseCoopers Report.

[7] "Vehicle-to-Grid power fundamentals: Calculating Capacity and net revenues", W. Kempton, J. Tomic, Journal of Power Sources 144, 268-279, 1 June 2005;

[8] "The V2G Concept: A New Model for Power? Connecting utility infrastructure and automobiles", Steven E. Letendre, Willett Kempton, Public Utilities Fortnightly, February 15, 2002

[9] "Impact of widespread electric vehicle adoption on the electric utility business-threats and opportunities "Nicholas DeForest, et.al, Centre for entrepreneurship and technology technical brief, Aug 2009

[10] CertiQ Netherlands, www.certiq.nl

[11] Statistics Netherlands, http://www.cbs.nl/

[12] “Group’s goal: 26% of cars in Netherlands EVs by 2025”, www.autoobserver.com

[13] “The green vehicle trend: Electric, Plug in hybrid or hydrogen fuel cell?” Fangzhu Zhang and Philip Cooke, centre for advanced studies, Cardiff University, UK

[14] Power system stability and control, P.Kundur, McGraw Hill Inc., page 132

[15] “TAMS STANDAARD Beveiligingsconcept”, TAMS 09.07.17.01, NOVEMBER- 2006, Versie 1.0, TENNET, Arnhem

[16] “Protection of a flexible grid connection” A.K.Srinivasan, Internship technical report, TenneT TSO B.V, Arnhem, Netherlands

[17] “Stochastic Assessment of voltage dips caused by faults in large transmission system” Gabriel Olguin, MSc thesis, Chalmers institute of technology, Goteborg, Sweden

[18] “Consequences of a large amount of electric vehicles on distribution networks”, A.k.Srinivasan, TU Delft,Delft,Netherlands

[19] “Power systems dynamics report”, Betelem Tashoma, Line Bergfjord,TU Delft, Delft, Netherlands

Appendix A

Details of equipments and device data

The AVR and governor models used for generators above 100MVA are as follows:

AVR model:1968 IEEET1 AVR			
Tr	0.02	Measurement delay(s)	s
Ka	175	Controller gain	pu
Ta	0.03	Controller time constant	s
Ke	1	Exciter constant	pu
Te	0.2	Exciter time constant	s
Kf	0.05	stabilization path gain	pu
Tf	1.5	stablization path time constant	s
E1	3.9	saturation factor 1	pu
Se1	0.1	saturation factor 2	pu
E2	5.2	saturation factor 3	pu
Se2	0.5	saturation factor 4	pu
Vrmin	-10	Vrmin controller output minimum	pu
Vrmax	10	Vrmax controller output maximum	pu
Governor model:govBBGOV1 (European governor model)			
T3	6	Turbine delay time constant	pu
T2	2	Turbine derivative time constant	pu
At	1	Turbine power coefficient	pu
Dt	0	Frictional losses factor	pu
Pturb	0	Turbine rated power	MW
R	0.1	Controller droop	pu
T1	0.5	Governor time constant	s
Vmin	0.125	Minimum gate limit	Pu
Vmax	2	Maximum gate limit	Pu

The AVR model and the governor model used are given in fig.A.01 and A.02 respectively:

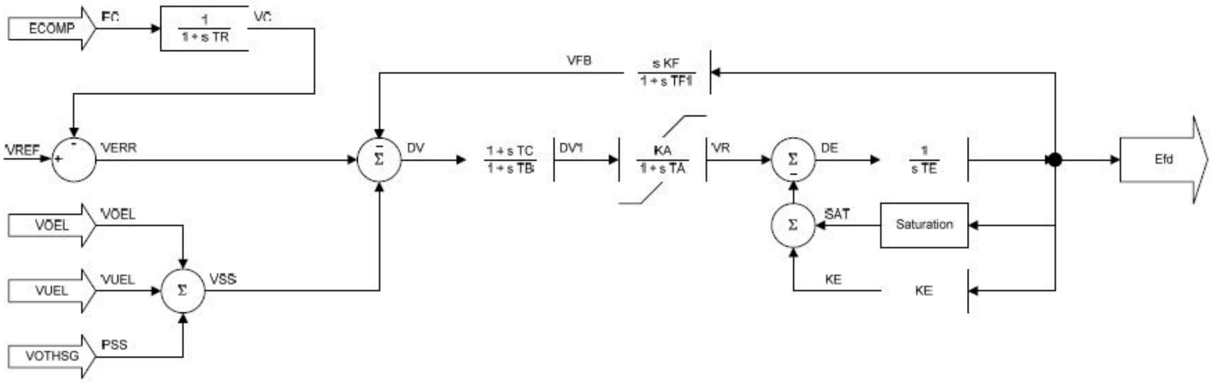

Fig A.01: Exciter system model for IEEE T1

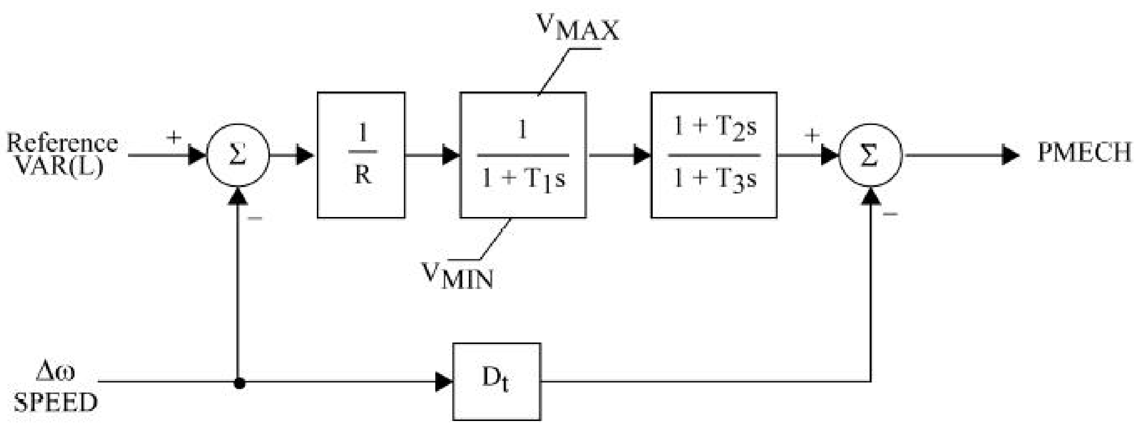

Fig.A 02: governor controller model

The parameters of the generator model used were as follows:

Nominal apparent power: 775MVA

Nominal voltage 21KV

power factor 0.8

Connection-Y

For the three winding transformer the following parameters were used:

Capacity: 550MVA Yn0Y0D0

Primary voltage: 380KV

Secondary voltage: 150KV

Tertiary voltage: 66KV

Impedance: HV-MV: 20%

MV-LV: 12.5% LV-HV: 12.5%

Appendix B

Calculation of Electric Vehicle (EV's) load and V2G production capability in Netherlands for growth scenarios

For this data the number of fully electric vehicles in the Netherlands (inclusive of two wheelers, cars and light transport vehicles) was determined using the statistics Netherlands [11] as a source. The values from this source are shown in the Fig.B01 in Blue data points. Table B.01 shows the values for 2010, 2020, 2025 and 2030.

The number was then used to formulate a data curve. This curve was then extrapolated to calculate the values in the future years (from 2010 till 2030).

Vehicles chosen for the calculation are assumed to have a consumption of 70KWh with an average charging time period of 5 hours during charging and it is assumed that 17% of the energy is consumed by the vehicles [6][7].Based on this the V2G capability of the EV's was calculated. The load capacity of charging EV's and V2G capacities of EV's connected to the grid are shown in Table B.01.To calculate the number of vehicles connected to a single substation the data available on the number of vehicles in the province was used(Shown in Fig. B.02). It was assumed that 25% of the vehicles in every province would be electric by the year 2030 and that the growth of vehicles in the Netherlands would be proportional to the present day distribution of vehicles in the provinces. This was followed by the assumption of 100% compliance to market stimulus for V2G applications (i.e. for a given tariff period for electric vehicle charging and V2G, all consumers adhere to the schedule). The values for the expected load from EV's and the possible V2G power generation were thus calculated. These values are shown in the table B.01.

Year	Total number of driven electric vehicles	EV load (in MW)				V2G capability (MW)			
Scenario		GR	NS	SX	MR	GR	NS	SX	MR
% of total cars feeding to production location		16.3	19	14.6	3.3	16.3	19	14.6	3.3
2010	241194	13.76	16.04	12.33	2.79	11.01	12.83	9.86	2.23
2020	684074	39.03	45.49	34.96	7.90	31.22	36.39	27.96	6.32
2025	1128114	64.36	75.02	57.65	13.03	51.49	60.02	46.12	10.42
2030	1720554	98.16	114.42	87.92	19.87	78.53	91.53	70.34	15.90

GR:Green revolution scenario
NS:New strongholds scenario
SX: Sustainable transition scenario
MR: Money rules scenario

Table B.01: Expected EV loads and V2G Production capabilities

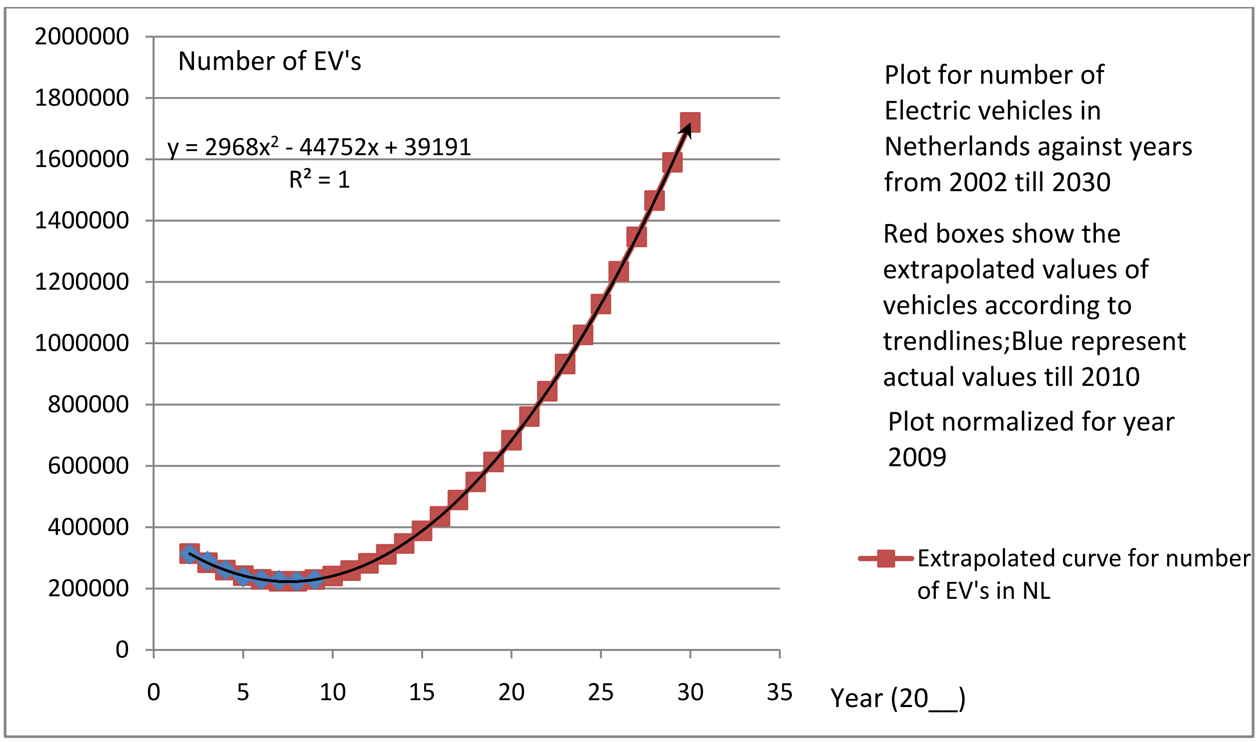

Fig B.01: EV’s in Netherlands between years 2002 and 2009(blue); extrapolated values till 2030 (red)

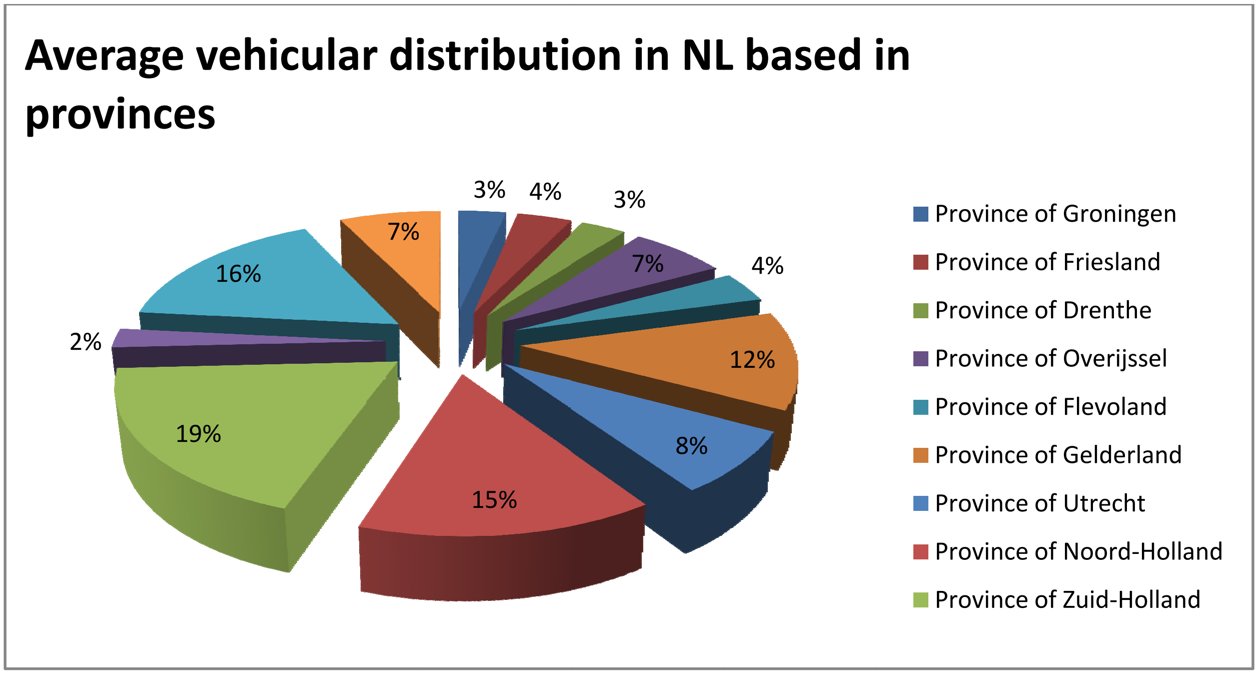

Fig B.02: Distribution of vehicles in the Netherlands (2009)(Data from cbs.nl)

APPENDIX C

Voltage sag Table results for growth scenarios (years 2010,2020 and 2030)

Voltage sag table for 150KV bus,Green revolution scenario 2010

Voltage Sags	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment		Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	BB150_2	BB150_2		BB150_2	BB150_2		BB150_2	BB150_2		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part in Ohm	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	Minimum of phase voltages
3	0	0	0	0.1	150	0.265856	2.61672	2.630190672	#INF	#INF	#INF	#INF	0.005065	-0.03623	0.036578	0.005065	-0.03623	0.03657837	0.005065	-0.036226	0.03657837	0.036578372
-2	0	0	0	0.1	150	0.265856	2.61672	2.630190672	#INF	#INF	#INF	#INF	0.005065	-0.03623	0.036578	0.005065	-0.03623	0.03657837	0.005065	-0.036226	0.03657837	0.036578372
-7	0	0	0	0.1	150	0.515788	4.019181	4.052141801	#INF	#INF	#INF	#INF	0.39461	-0.05175	0.397989	0.39461	-0.05175	0.39798884	0.39461	-0.05175	0.39798884	0.397988837
-10	0	0	0	0.1	150	0.515788	4.019181	4.052141801	#INF	#INF	#INF	#INF	0.39461	-0.05175	0.397989	0.39461	-0.05175	0.39798897	0.39461	-0.051751	0.39798897	0.397988967
-11	0	0	0	0.1	150	0.521314	4.088437	4.121539202	#INF	#INF	#INF	#INF	0.407492	-0.05108	0.410681	0.407492	-0.05108	0.41068139	0.407492	-0.051083	0.41068139	0.410681389
2	0	0	0	0.1	380	0.373026	3.565968	3.585425522	#INF	#INF	#INF	#INF	0.43189	0.043826	0.434108	0.43189	0.043826	0.43410792	0.43189	0.043826	0.43410792	0.434107925
-9	1	0	0	0.1	21	0.002166	0.066997	0.067032004	0.001802	0.0636	0.000512	7.63509	0.826825	-0.28566	0.874779	-0.35198	-0.54657	0.65009478	-0.47485	0.83222	0.9581586	0.650094777
-9	2	0	0	0.1	21	0.002166	0.066997	0.067032004	0.001802	0.0636	0.000512	7.63509	0.938497	-0.21653	0.963151	-0.46269	-0.61745	0.77157347	-0.47581	0.833976	0.96016104	0.771573466
-1	0	0	0	0.1	380	0.373026	3.565968	3.585425522	#INF	#INF	#INF	#INF	0.43189	0.043826	0.434108	0.43189	0.043826	0.43410792	0.43189	0.043826	0.43410792	0.434107925
-8	1	0	0	0.1	11	0.008321	0.031203	0.03229344	0.008237	0.031083	0.000001	0.61262	0.923731	-0.13406	0.933408	-0.44163	-0.70238	0.8296814	-0.4821	0.836431	0.96541975	0.829681403
-9	0	0	0	0.1	21	0.002175	0.067066	0.067101259	#INF	#INF	#INF	#INF	0.810547	-0.20612	0.836345	0.810547	-0.20612	0.83634535	0.810547	-0.206124	0.83634535	0.836345349
-12	0	0	0	0.1	20	0.005601	0.109683	0.109825915	#INF	#INF	#INF	#INF	0.855501	-0.11076	0.862641	0.855501	-0.11076	0.86264063	0.855501	-0.110756	0.86264063	0.862640628
-13	0	0	0	0.1	20	0.005011	0.108612	0.108727534	#INF	#INF	#INF	#INF	0.863375	-0.10876	0.870199	0.863375	-0.10876	0.8701987	0.863375	-0.108763	0.8701987	0.870198702
-8	0	0	0	0.1	11	0.008336	0.031232	0.032325326	#INF	#INF	#INF	#INF	0.910573	-0.07848	0.913948	0.910573	-0.07848	0.91394848	0.910573	-0.078477	0.91394848	0.913948482
-6	0	0	0	0.1	21	0.000472	0.059757	0.059758864	#INF	#INF	#INF	#INF	0.948496	-0.02283	0.948771	0.948496	-0.02283	0.94877067	0.948496	-0.022828	0.94877067	0.948770668
-5	0	0	0	0.1	21	0.000472	0.059757	0.059758864	#INF	#INF	#INF	#INF	0.949967	-0.02221	0.950227	0.949967	-0.02221	0.9502265	0.949967	-0.022206	0.9502265	0.950226503
-4	0	0	0	0.1	66	0.007193	6.139693	6.139697214	#INF	#INF	#INF	#INF	0.951204	0.001585	0.951205	0.951204	0.001585	0.95120532	0.951204	0.001585	0.95120532	0.951205321
-3	0	0	0	0.1	66	0.004397	4.789624	4.789626018	#INF	#INF	#INF	#INF	0.954504	0.00119	0.954505	0.954504	0.00119	0.95450474	0.954504	0.00119	0.95450474	0.954504742
-17	0	50	0	0.123	150	0.408429	3.363437	3.388144433	#INF	#INF	#INF	#INF	0.249614	-0.04859	0.254299	0.249614	-0.04859	0.25429892	0.249614	-0.048588	0.25429892	0.254298924
-18	0	50	0	0.123	150	0.518594	4.053976	4.087011273	#INF	#INF	#INF	#INF	0.401124	-0.05141	0.404405	0.401124	-0.05141	0.40440519	0.401124	-0.051411	0.40440519	0.404405186
-19	0	50	0	0.123	20	0.005353	0.109208	0.109339114	#INF	#INF	#INF	#INF	0.859473	-0.10972	0.866449	0.859473	-0.10972	0.86644861	0.859473	-0.109724	0.86644861	0.86644861
2	3	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.62318	0.020008	0.623501	-0.31097	-0.84403	0.89949596	-0.31221	0.824024	0.88118706	0.623501109
2	1	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.546915	-0.18899	0.578646	-0.06518	-0.64281	0.6461098	-0.48174	0.8318	0.96122981	0.578646133
2	2	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.510322	-0.12117	0.524509	-0.10664	-0.56342	0.57342635	-0.40368	0.684588	0.79474466	0.524508819
3	3	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.005575	-0.01304	0.014177	-1.09255	-0.73794	1.31841748	-1.09204	0.932754	1.43617052	0.014177159
3	1	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.249806	-0.42788	0.495459	0.23056	-0.40217	0.46357246	-0.48037	0.830046	0.95902443	0.463572461
3	2	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.017306	-0.02886	0.033651	-0.02203	0.021658	0.03089249	-0.63566	1.17111	1.33249987	0.030892488
-1	3	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.62318	0.020008	0.623501	-0.31097	-0.84403	0.89949596	-0.31221	0.824024	0.88118706	0.623501109
-1	1	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.546915	-0.18899	0.578646	-0.06518	-0.64281	0.6461098	-0.48174	0.8318	0.96122981	0.578646133
-1	2	0	0	0.1	380	0.372797	3.565243	3.584680635	0.366877	3.544823	0.657688	3.83104	0.510322	-0.12117	0.524509	-0.10664	-0.56342	0.57342635	-0.40368	0.684588	0.79474466	0.524508819
-2	3	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.005575	-0.01304	0.014177	-1.09255	-0.73794	1.31841748	-1.09204	0.932754	1.43617052	0.014177159
-2	1	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.249806	-0.42788	0.495459	0.23056	-0.40217	0.46357246	-0.48037	0.830046	0.95902443	0.463572461
-2	2	0	0	0.1	150	0.264756	2.607716	2.621121607	0.254704	2.568471	7.223299	13.6273	0.017306	-0.02886	0.033652	-0.02203	0.021658	0.03089249	-0.63566	1.17111	1.33249987	0.030892488
-3	3	0	0	0.1	66	0.004395	4.789505	4.789507016	0.004245	4.788983	7.19E+08	-5.0105	0.96647	0	0.96647	-0.48324	-0.83699	0.9664695	-0.48324	0.836987	0.9664695	0.966469505

-3	1	0	0	0.1	66	0.004395	4.789505	4.789507016	0.004245	4.788983	7.19E+08	-5.0105	0.957034	-0.00411	0.957043	-0.47382	-0.83279	0.95814493	-0.48321	0.836895	0.96637733	0.957042821
-3	2	0	0	0.1	66	0.004395	4.789505	4.789507016	0.004245	4.788983	7.19E+08	-5.0105	0.957079	-0.00421	0.957088	-0.47387	-0.83269	0.95808337	-0.48321	0.836895	0.96637683	0.957088246
-4	3	0	0	0.1	66	0.00713	6.139517	6.13952114	0.006922	6.138631	7.19E+08	-5.481	0.96647	0	0.96647	-0.48324	-0.83699	0.9664695	-0.48324	0.836987	0.9664695	0.966469505
-4	1	0	0	0.1	66	0.00713	6.139517	6.13952114	0.006922	6.138631	7.19E+08	-5.481	0.954416	-0.00522	0.95443	-0.47121	-0.83165	0.95586739	-0.4832	0.83687	0.96635268	0.954430275
-4	2	0	0	0.1	66	0.00713	6.139517	6.13952114	0.006922	6.138631	7.19E+08	-5.481	0.95446	-0.00532	0.954475	-0.47126	-0.83155	0.95580481	-0.4832	0.83687	0.96635218	0.95447481
-6	1	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.000044	2.22701	0.949433	-0.03259	0.949992	-0.46737	-0.80369	0.92970601	-0.48206	0.836282	0.96527268	0.929706011
-5	1	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.001973	0.03337	0.951118	-0.03148	0.951639	-0.46902	-0.80487	0.93155613	-0.4821	0.836347	0.96534748	0.931556129
-6	2	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.000044	2.22701	0.962653	-0.02383	0.962948	-0.48062	-0.81232	0.94385793	-0.48203	0.83615	0.96514284	0.943857928
-5	2	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.001973	0.03337	0.958836	-0.02341	0.959122	-0.48588	-0.81365	0.94767941	-0.47296	0.837051	0.9614289	0.947679414
-15	0	0	0	0.1	0.69	0	0	0	#INF	#INF	#INF	#INF	0.96647	0	0.96647	0.96647	0	0.96647	0.96647	0	0.96647	0.96647
-16	0	0	0	0.1	0.69	0.000058	0.002378	0.002378707	#INF	#INF	#INF	#INF	0.96648	-0.00022	0.96648	0.96648	-0.00022	0.96648002	0.96648	-0.000217	0.96648002	0.966480024
-7	3	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.155763	-0.02863	0.158372	-0.94698	-0.82277	1.25448041	-0.94708	0.848063	1.27128655	0.158371769
-7	1	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.556523	-0.27934	0.622696	-0.07524	-0.55363	0.55871789	-0.48129	0.832972	0.96201797	0.558717886
-7	2	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.322435	0.105766	0.339339	-0.31728	-0.15932	0.35503668	-0.64312	1.123404	1.2944636	0.339338733
-20	1	0	0	0.1	11	0.02888	0.043434	0.052159052	0.028798	0.043321	0.082729	0.6692	0.933529	-0.09345	0.938194	-0.45108	-0.74312	0.86931534	-0.48245	0.836572	0.96571572	0.869315335
-8	2	0	0	0.1	11	0.008321	0.031203	0.03229344	0.008237	0.031083	0.000001	0.61262	0.956633	-0.07836	0.959837	-0.47756	-0.75089	0.88988796	-0.47908	0.829252	0.95769234	0.889887958
-20	2	0	0	0.1	11	0.02888	0.043434	0.052159052	0.028798	0.043321	0.082729	0.6692	0.954217	-0.0617	0.956209	-0.47498	-0.769	0.90385939	-0.47924	0.830691	0.95901756	0.903859391
-5	3	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.001973	0.03337	0.956646	-0.01565	0.956774	-0.47874	-0.82885	0.95717627	-0.47791	0.844507	0.97035513	0.956774068
-9	3	0	0	0.1	21	0.002166	0.066997	0.067032004	0.001802	0.0636	0.000512	7.63509	0.958578	0.000202	0.958578	-0.47927	-0.83691	0.96442679	-0.47931	0.836708	0.9642694	0.958578021
-6	3	0	0	0.1	21	0.000472	0.059756	0.059757864	0.000309	0.057025	0.000044	2.22701	0.963694	0.000001	0.963694	-0.48184	-0.83691	0.96570739	-0.48185	0.83691	0.96571252	0.963694
-10	3	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.155763	-0.02863	0.158372	-0.94698	-0.82277	1.25448041	-0.94708	0.848063	1.27128655	0.158371769
-10	1	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.556523	-0.27934	0.622696	-0.07524	-0.55363	0.55871789	-0.48129	0.832972	0.96201797	0.558717886
-10	2	0	0	0.1	150	0.510446	3.993824	4.02631162	0.503255	3.961143	2.196681	11.4995	0.322435	0.105766	0.339339	-0.31728	-0.15932	0.35503668	-0.64312	1.123404	1.2944636	0.339338733
-14	0	0	0	0.1	0.69	0.000009	0.000196	0.000196207	#INF	#INF	#INF	#INF	0.966487	-0.00021	0.966487	0.966487	-0.00021	0.96648702	0.966487	-0.000205	0.96648702	0.966487022
-22	1	0	0	0.1	11	0.039967	0.066724	0.077778231	0.039947	0.066674	0.301664	0.93939	0.95039	-0.04958	0.951682	-0.46758	-0.7872	0.91559162	-0.48282	0.836779	0.96607941	0.915591616
-23	1	0	0	0.1	11	0.048505	0.059187	0.076523434	0.048499	0.059154	0.496089	0.95194	0.961417	-0.03993	0.962246	-0.47853	-0.79697	0.92959407	-0.48289	0.83689	0.96621103	0.929594067
-22	2	0	0	0.1	11	0.039967	0.066724	0.077778231	0.039947	0.066674	0.301664	0.93939	0.960837	-0.03628	0.961522	-0.48012	-0.7984	0.93164354	-0.48071	0.834681	0.9632125	0.931643545
-8	3	0	0	0.1	11	0.008321	0.031203	0.03229344	0.008237	0.031083	0.000001	0.61262	0.937796	-0.00292	0.937801	-0.46889	-0.83533	0.95793293	-0.46891	0.838254	0.96049179	0.937800552
-23	2	0	0	0.1	11	0.048505	0.059187	0.076523434	0.048499	0.059154	0.496089	0.95194	0.966541	-0.02833	0.966956	-0.48548	-0.80745	0.94215857	-0.48106	0.83578	0.96433906	0.942158573
-20	3	0	0	0.1	11	0.02888	0.043434	0.052159052	0.028798	0.043321	0.082729	0.6692	0.943268	-0.00404	0.943277	-0.47164	-0.83481	0.95882574	-0.47163	0.838849	0.96234269	0.943276656
-24	1	0	0	0.1	11	0.308914	0.565333	0.644227646	0.30883	0.565213	1.203815	2.75048	0.956285	-0.00944	0.956332	-0.47312	-0.82744	0.95315326	-0.48316	0.836884	0.9663448	0.953153263
-24	2	0	0	0.1	11	0.308914	0.565333	0.644227646	0.30883	0.565213	1.203815	2.75048	0.956773	-0.00901	0.956815	-0.47457	-0.82662	0.95315864	-0.4822	0.835628	0.9647771	0.953158644
-22	3	0	0	0.1	11	0.039967	0.066724	0.077778231	0.039947	0.066674	0.301664	0.93939	0.95658	-0.00385	0.956588	-0.47831	-0.83499	0.96228235	-0.47827	0.838843	0.96561048	0.956587748
-21	1	0	0	0.1	11	0.671327	0.558996	0.873588272	0.671249	0.558891	2.786075	2.89991	0.962067	-0.00797	0.9621	-0.4789	-0.82897	0.95735761	-0.48317	0.836938	0.96639457	0.957357612
-21	2	0	0	0.1	11	0.671327	0.558996	0.873588272	0.671249	0.558891	2.786075	2.89991	0.962064	-0.00747	0.962093	-0.47975	-0.82887	0.95770005	-0.48231	0.836337	0.96544421	0.957700046
-25	1	0	0	0.1	11	0.163668	0.522857	0.547874672	0.163681	0.522842	4.909641	3.92696	0.964019	-0.00726	0.964046	-0.48085	-0.82969	0.95895951	-0.48317	0.836956	0.96641166	0.958959514
-25	2	0	0	0.1	11	0.163668	0.522857	0.547874672	0.163681	0.522842	4.909641	3.92696	0.964482	-0.00721	0.964509	-0.48168	-0.82982	0.95948904	-0.4828	0.837029	0.96628946	0.959489036
-23	3	0	0	0.1	11	0.048505	0.059187	0.076523434	0.048499	0.059154	0.496089	0.95194	0.960105	-0.00427	0.960115	-0.48008	-0.8348	0.96300038	-0.48003	0.839077	0.96668455	0.960114509
-24	3	0	0	0.1	11	0.308914	0.565333	0.644227646	0.30883	0.565213	1.203815	2.75048	0.961675	-0.00079	0.961675	-0.48084	-0.83656	0.96490301	-0.48084	0.837349	0.96558664	0.961675324
-21	3	0	0	0.1	11	0.671327	0.558996	0.873588272	0.671249	0.558891	2.786075	2.89991	0.963607	-0.00145	0.963608	-0.48181	-0.83624	0.96511133	-0.4818	0.837693	0.96636274	0.963608094
-25	3	0	0	0.1	11	0.163668	0.522857	0.547874672	0.163681	0.522842	4.909641	3.92696	0.965954	-0.00124	0.965955	-0.48299	-0.83636	0.96580324	-0.48297	0.837604	0.96687099	0.965803244
-11	3	0	0	0.1	150	0.515726	4.061893	4.094502174	0.508671	4.029595	2.109227	10.9872	0.166133	-0.02917	0.168675	-0.93193	-0.82215	1.24274682	-0.93203	0.848647	1.26050775	0.168674601
-11	1	0	0	0.1	150	0.515726	4.061893	4.094502174	0.508671	4.029595	2.109227	10.9872	0.566089	-0.27347	0.628682	-0.08476	-0.5596	0.56598033	-0.48133	0.833065	0.9621185	0.565980334
-11	2	0	0	0.1	150	0.515726	4.061893	4.094502174	0.508671	4.029595	2.109227	10.9872	0.332219	0.110113	0.349992	-0.32624	-0.16714	0.36656022	-0.64016	1.118974	1.28915096	0.34999191
-12	3	0	0	0.1	20	0.005539	0.106478	0.106621972	0.005492	0.106294	0.036737	0.15186	0.655304	-0.24509	0.699637	-0.69742	-0.98529	1.207141	-0.69669	0.687688	0.97892519	0.699637364
-12	1	0	0	0.1	20	0.005539	0.106478	0.106621972	0.005492	0.106294	0.036737	0.15186	0.879426	-0.14119	0.890687	-0.39733	-0.69484	0.80042421	-0.48209	0.836027	0.96506675	0.800424211
-12	2	0	0	0.1	20	0.005539	0.106478	0.106621972	0.005492	0.106294	0.036737	0.15186	0.662923	-0.0083	0.662975	-0.72136	-0.5871	0.93007758	-0.69314	0.939828	1.16778292	0.66297492
-13	3	0	0	0.1	20	0.004849	0.105104	0.105215795	0.004813	0.104939	0.000329	0.13956	0.702298	-0.28431	0.757662	-0.64757	-1.02359	1.21123102	-0.64684	0.649365	0.9165592	0.757662071
-13	1	0	0	0.1	20	0.004849	0.105104	0.105215795	0.004813	0.104939	0.000329	0.13956	0.886767	-0.13738	0.897345	-0.40465	-0.69872	0.80743809	-0.48212	0.836098	0.96514075	0.807438086
-13	2	0	0	0.1	20	0.004849	0.105104	0.105215795	0.004813	0.104939	0.000329	0.13956	0.646162	-0.04381	0.647645	-0.74838	-0.63253	0.9798859	-0.71156	0.895116	1.14347854	0.647645193
-14	3	0	0	0.1	0.69	0.000009	0.00018	0.000180225	0.000009	0.000179	0	0.00024	0.966573	-0.00065	0.966573	-0.48315	-0.83745	0.96682962	-0.48315	0.836521	0.96602145	0.966021449
-14	1	0	0	0.1	0.69	0.000009	0.00018	0.000180225	0.000009	0.000179	0	0.00024	0.966652	-0.00027	0.966652	-0.48342	-0.83672	0.96633169	-0.48323	0.836989	0.96646974	0.966331686

-14	2	0	0	0.1	0.69	0.000009	0.00018	0.000180225	0.000009	0.000179	0	0.00024	0.966125	-0.0005	0.966125	-0.48377	-0.83722	0.96693289	-0.48359	0.836679	0.96638188	0.966125127
-15	3	0	0	0.1	0.69	0	0	0	0	0	0	0	0.96647	0	0.96647	-0.48324	-0.83699	0.9664695	-0.48324	0.836987	0.9664695	0.966469505
-15	1	0	0	0.1	0.69	0	0	0	0	0	0	0	0.96647	0	0.96647	-0.48324	-0.83699	0.9664695	-0.48324	0.836987	0.9664695	0.966469505
-15	2	0	0	0.1	0.69	0	0	0	0	0	0	0	0.96647	0	0.96647	-0.48324	-0.83699	0.9664695	-0.48324	0.836987	0.9664695	0.966469505
-16	3	0	0	0.1	0.69	0.000058	0.002375	0.002375708	0.000058	0.002375	0.000028	0.00122	0.966529	-0.00056	0.966529	-0.48319	-0.83734	0.96675297	-0.48319	0.836633	0.96613794	0.966137941
-16	1	0	0	0.1	0.69	0.000058	0.002375	0.002375708	0.000058	0.002375	0.000028	0.00122	0.966656	-0.00031	0.966656	-0.48342	-0.83668	0.96629905	-0.48323	0.836989	0.96646974	0.966299053
-16	2	0	0	0.1	0.69	0.000058	0.002375	0.002375708	0.000058	0.002375	0.000028	0.00122	0.966198	-0.00043	0.966198	-0.4837	-0.83711	0.96681355	-0.48352	0.836767	0.96641954	0.966198096
-26	3	50	0	0.123	15	0.023846	0.040968	0.047402624	0.023763	0.040852	0.062046	0.65506	0.941836	-0.00401	0.941845	-0.47092	-0.83481	0.95847712	-0.47092	0.838825	0.96197155	0.941844545
-27	3	50	0	0.123	15	0.023846	0.040968	0.047402624	0.023763	0.040852	0.062046	0.65506	0.941836	-0.00401	0.941845	-0.47092	-0.83481	0.95847712	-0.47092	0.838825	0.96197155	0.941844545
-17	3	50	0	0.123	150	0.405548	3.347249	3.371727309	0.396937	3.311281	4.776796	12.5784	0.082755	-0.0138	0.083898	-1.01542	-0.77213	1.27564541	-1.01521	0.898612	1.3557872	0.083898065
-18	3	50	0	0.123	150	0.51313	4.028029	4.060581242	0.506007	3.99554	2.152986	11.2435	0.160902	-0.0289	0.163478	-0.93953	-0.82247	1.24866663	-0.93963	0.848345	1.26593519	0.163477506
-18	1	50	0	0.123	150	0.51313	4.028029	4.060581242	0.506007	3.99554	2.152986	11.2435	0.56136	-0.27637	0.625704	-0.08005	-0.55665	0.562375	-0.48131	0.833019	0.96206867	0.562374998
-18	2	50	0	0.123	150	0.51313	4.028029	4.060581242	0.506007	3.99554	2.152986	11.2435	0.32737	0.107991	0.344722	-0.32182	-0.16325	0.36086183	-0.64167	1.121231	1.29186086	0.344721878
-19	3	50	0	0.123	20	0.005242	0.105853	0.105982716	0.0052	0.105679	0.01853	0.14572	0.678252	-0.26355	0.727657	-0.67314	-1.00331	1.20819355	-0.67241	0.669662	0.94898949	0.727657134

Fault Impedance=0.1 ohm

Voltage sag table for 150KV bus,Green revolution scenario 2020

Voltage Sags	Voltage sag table assessment												BB150_2	BB150_2		BB150_2	BB150_2		BB150_2	BB150_2		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part in Ohm	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	Minimum of phase voltages
2	0	0	0	0.1	380	0.329071	3.59987	3.61487922	#INF	#INF	#INF	#INF	0.441061	0.071258	0.44678	0.441061	0.071258	0.44678	0.441061	0.071258	0.44678	0.446780157
3	0	0	0	0.1	150	0.138887	2.769958	2.77343774	#INF	#INF	#INF	#INF	0.00309	-0.03584	0.035968	0.00309	-0.03584	0.035968	0.00309	-0.03584	0.03597	0.035967976
-1	0	0	0	0.1	380	0.329071	3.59987	3.61487922	#INF	#INF	#INF	#INF	0.441061	0.071258	0.44678	0.441061	0.071258	0.44678	0.441061	0.071258	0.44678	0.446780157
-2	0	0	0	0.1	150	0.138887	2.769958	2.77343774	#INF	#INF	#INF	#INF	0.00309	-0.03584	0.035968	0.00309	-0.03584	0.035968	0.00309	-0.03584	0.03597	0.035967976
-3	0	0	0	0.1	66	0.002744	4.791619	4.79161979	#INF	#INF	#INF	#INF	0.987179	0.001203	0.98718	0.987179	0.001203	0.98718	0.987179	0.001203	0.98718	0.987179733
-4	0	0	0	0.1	66	0.004489	6.142957	6.14295864	#INF	#INF	#INF	#INF	0.983644	0.001607	0.983645	0.983644	0.001607	0.983645	0.983644	0.001607	0.98365	0.983645313
-5	0	0	0	0.1	21	0.000432	0.059788	0.05978956	#INF	#INF	#INF	#INF	0.980318	-0.02341	0.980597	0.980318	-0.02341	0.980597	0.980318	-0.02341	0.9806	0.980597452
-6	0	0	0	0.1	21	0.000432	0.059788	0.05978956	#INF	#INF	#INF	#INF	0.980587	-0.02314	0.98086	0.980587	-0.02314	0.98086	0.980587	-0.02314	0.98086	0.980859992
-7	0	0	0	0.1	150	0.406113	4.142924	4.16278117	#INF	#INF	#INF	#INF	0.393284	-0.06659	0.398881	0.393284	-0.06659	0.398881	0.393284	-0.06659	0.39888	0.398881435
-8	1	0	0	0.1	11	0.003975	0.037467	0.03767727	0.003919	0.037277	0.000001	0.612617	0.963309	-0.17165	0.978483	-0.4649	-0.69387	0.835216	-0.49841	0.865525	0.99877	0.835215694
-9	0	0	0	0.1	21	0.001211	0.068237	0.06824774	#INF	#INF	#INF	#INF	0.842357	-0.23972	0.875803	0.842357	-0.23972	0.875803	0.842357	-0.23972	0.8758	0.875802783
-10	0	0	0	0.1	150	0.406113	4.142924	4.16278117	#INF	#INF	#INF	#INF	0.393284	-0.06659	0.398881	0.393284	-0.06659	0.398881	0.393284	-0.06659	0.39888	0.398881435
-11	0	0	0	0.1	150	0.412743	4.210571	4.23075229	#INF	#INF	#INF	#INF	0.40656	-0.06611	0.4119	0.40656	-0.06611	0.4119	0.40656	-0.06611	0.4119	0.411899625
-12	0	0	0	0.1	20	0.004976	0.11044	0.11055204	#INF	#INF	#INF	#INF	0.88341	-0.12522	0.892241	0.88341	-0.12522	0.892241	0.88341	-0.12522	0.89224	0.892240734
-13	0	0	0	0.1	20	0.004427	0.109268	0.10935764	#INF	#INF	#INF	#INF	0.891916	-0.12276	0.900325	0.891916	-0.12276	0.900325	0.891916	-0.12276	0.90032	0.900324752
-14	0	50	0	0.123	150	0.290046	3.501922	3.51391297	#INF	#INF	#INF	#INF	0.245532	-0.05966	0.252677	0.245532	-0.05966	0.252677	0.245532	-0.05966	0.25268	0.252676705
-15	0	50	0	0.123	150	0.409472	4.176915	4.19693772	#INF	#INF	#INF	#INF	0.399995	-0.06635	0.40546	0.399995	-0.06635	0.40546	0.399995	-0.06635	0.40546	0.405460139
2	3	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.639632	0.039271	0.640836	-0.31911	-0.88242	0.938342	-0.32053	0.843144	0.90201	0.640836412
2	1	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.550889	-0.17811	0.578967	-0.05251	-0.68223	0.684248	-0.49838	0.860343	0.99427	0.578967124
2	2	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.516048	-0.10431	0.526485	-0.09161	-0.59595	0.602946	-0.42444	0.700256	0.81885	0.526484874
3	3	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.005493	-0.01346	0.01454	-1.11894	-0.74549	1.344539	-1.11805	0.982887	1.48866	0.014540475
3	1	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.257042	-0.44241	0.511661	0.239451	-0.41621	0.48017	-0.49649	0.858614	0.99183	0.480170161
3	2	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.015565	-0.02953	0.033385	-0.02048	0.022131	0.030153	-0.64899	1.212045	1.37486	0.030153135
-1	3	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.639632	0.039271	0.640836	-0.31911	-0.88242	0.938342	-0.32053	0.843144	0.90201	0.640836412
-1	1	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.550889	-0.17811	0.578967	-0.05251	-0.68223	0.684248	-0.49838	0.860343	0.99427	0.578967124
-1	2	0	0	0.1	380	0.328914	3.599033	3.6140314	0.323634	3.577694	0.552822	3.833256	0.516048	-0.10431	0.526485	-0.09161	-0.59595	0.602946	-0.42444	0.700256	0.81885	0.526484874
-2	3	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.005493	-0.01346	0.01454	-1.11894	-0.74549	1.344539	-1.11805	0.982887	1.48866	0.014540475
-2	1	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.257042	-0.44241	0.511661	0.239451	-0.41621	0.48017	-0.49649	0.858614	0.99183	0.480170161
-2	2	0	0	0.1	150	0.138691	2.759876	2.7633586	0.132004	2.71538	7.223299	13.6273	0.015565	-0.02953	0.033385	-0.02048	0.022131	0.030153	-0.64899	1.212045	1.37486	0.030153135
-3	3	0	0	0.1	66	0.002696	4.791514	4.79151476	0.00261	4.790861	7.19E+08	-2.76369	1	0	1	-0.5	-0.86603	1	-0.5	0.866025	1	0.99999965
-3	1	0	0	0.1	66	0.002696	4.791514	4.79151476	0.00261	4.790861	7.19E+08	-2.76369	0.989921	-0.00445	0.989931	-0.48996	-0.86148	0.991058	-0.49997	0.865923	0.99989	0.989930989
-3	2	0	0	0.1	66	0.002696	4.791514	4.79151476	0.00261	4.790861	7.19E+08	-2.76369	0.98997	-0.00455	0.98998	-0.49	-0.86137	0.990993	-0.49997	0.865924	0.99989	0.989980461
-4	3	0	0	0.1	66	0.004481	6.142752	6.14275363	0.004307	6.141758	7.19E+08	3.501729	1	0	1	-0.5	-0.86603	1	-0.5	0.866025	1	0.99999965
-4	1	0	0	0.1	66	0.004481	6.142752	6.14275363	0.004307	6.141758	7.19E+08	3.501729	0.987125	-0.00565	0.987141	-0.48717	-0.86025	0.988614	-0.49996	0.865895	0.99987	0.987141152

-4	2	0	0	0.1	66	0.004481	6.142752	6.14275363	0.004307	6.141758	7.19E+08	3.501729	0.987173	-0.00575	0.98719	-0.48722	-0.86014	0.988548	-0.49996	0.865895	0.99987	0.987189752
-5	3	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.001658	0.033372	0.988107	-0.01662	0.988247	-0.4945	-0.85735	0.989739	-0.49361	0.873966	1.00373	0.988246681
-5	1	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.001658	0.033372	0.980949	-0.03367	0.981527	-0.48218	-0.83157	0.961257	-0.49876	0.865247	0.99871	0.961257023
-5	2	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.001658	0.033372	0.990005	-0.02531	0.990328	-0.50137	-0.84011	0.978343	-0.48863	0.865411	0.99383	0.978342811
-6	3	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.000044	2.227006	0.997118	0.000091	0.997118	-0.49855	-0.86599	0.999246	-0.49857	0.865899	0.99917	0.997118004
-6	1	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.000044	2.227006	0.98122	-0.03328	0.981784	-0.48244	-0.83198	0.961739	-0.49878	0.865258	0.99873	0.961739397
-6	2	0	0	0.1	21	0.000432	0.059788	0.05978956	0.000273	0.057053	0.000044	2.227006	0.995247	-0.02462	0.995551	-0.49649	-0.84051	0.97619	-0.49876	0.865125	0.9986	0.976189536
-7	3	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.158046	-0.03141	0.161137	-0.96942	-0.83752	1.281104	-0.96923	0.890958	1.31651	0.161137175
-7	1	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.570093	-0.30507	0.646587	-0.07259	-0.55662	0.561335	-0.49751	0.861693	0.995	0.561334818
-7	2	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.328216	0.093788	0.341353	-0.32258	-0.14809	0.35495	-0.65597	1.161311	1.33377	0.341353089
-16	1	0	0	0.1	11	0.024643	0.051592	0.05717527	0.024587	0.051402	0.082729	0.669203	0.97365	-0.12427	0.981549	-0.4748	-0.74139	0.880397	-0.49885	0.865665	0.99911	0.880397157
-8	2	0	0	0.1	11	0.003975	0.037467	0.03767727	0.003919	0.037277	0.000001	0.612617	1.002123	-0.10006	1.007106	-0.50919	-0.75767	0.912877	-0.49293	0.857739	0.98929	0.912876961
-16	2	0	0	0.1	11	0.024643	0.051592	0.05717527	0.024587	0.051402	0.082729	0.669203	0.997192	-0.08211	1.000567	-0.50407	-0.77717	0.926325	-0.49312	0.859277	0.99072	0.926324821
-9	3	0	0	0.1	21	0.001209	0.06816	0.06817072	0.000934	0.064639	0.000512	7.635088	0.991267	-0.00045	0.991267	-0.49563	-0.8656	0.997451	-0.49564	0.86605	0.99785	0.991267104
-9	1	0	0	0.1	21	0.001209	0.06816	0.06817072	0.000934	0.064639	0.000512	7.635088	0.865243	-0.3242	0.923985	-0.37504	-0.53721	0.655166	-0.49021	0.8614	0.99112	0.655166172
-9	2	0	0	0.1	21	0.001209	0.06816	0.06817072	0.000934	0.064639	0.000512	7.635088	0.984797	-0.24182	1.014051	-0.49339	-0.62153	0.793558	-0.4914	0.863344	0.9934	0.793558249
-10	3	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.158046	-0.03141	0.161137	-0.96942	-0.83752	1.281104	-0.96923	0.890958	1.31651	0.161137175
-10	1	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.570093	-0.30507	0.646587	-0.07259	-0.55662	0.561335	-0.49751	0.861693	0.995	0.561334818
-10	2	0	0	0.1	150	0.402082	4.11588	4.13547314	0.397817	4.078959	2.196681	11.49949	0.328216	0.093788	0.341353	-0.32258	-0.14809	0.35495	-0.65597	1.161311	1.33377	0.341353089
-18	1	0	0	0.1	11	0.037859	0.068601	0.07835433	0.037855	0.068528	0.301664	0.939389	0.990826	-0.06232	0.992784	-0.49141	-0.80357	0.941913	-0.49942	0.865883	0.99959	0.941912831
-19	1	0	0	0.1	11	0.128492	0.122241	0.17735009	0.128435	0.122051	0.496089	0.951936	0.988913	-0.05225	0.990293	-0.4894	-0.81362	0.949465	-0.49952	0.865874	0.99963	0.949465282
-8	0	0	0	0.1	11	0.003982	0.037511	0.03772176	#INF	#INF	#INF	#INF	0.944774	-0.10858	0.950993	0.944774	-0.10858	0.950993	0.944774	-0.10858	0.95099	0.950992574
-19	2	0	0	0.1	11	0.128492	0.122241	0.17735009	0.128435	0.122051	0.496089	0.951936	0.993252	-0.04296	0.99418	-0.49822	-0.82011	0.959583	-0.49503	0.863063	0.99495	0.959582912
-18	2	0	0	0.1	11	0.037859	0.068601	0.07835433	0.037855	0.068528	0.301664	0.939389	1.000941	-0.04449	1.001929	-0.50447	-0.81941	0.962246	-0.49647	0.863893	0.99639	0.962246036
-8	3	0	0	0.1	11	0.003975	0.037467	0.03767727	0.003919	0.037277	0.000001	0.612617	0.966214	-0.01036	0.96627	-0.48316	-0.8606	0.98695	-0.48306	0.870959	0.99595	0.966269529
-16	3	0	0	0.1	11	0.024643	0.051592	0.05717527	0.024587	0.051402	0.082729	0.669203	0.972142	-0.01133	0.972208	-0.48613	-0.86016	0.988023	-0.48601	0.871486	0.99784	0.972208033
-20	1	0	0	0.1	11	0.304568	0.5716	0.64767911	0.304512	0.57141	1.203815	2.750475	0.990039	-0.01394	0.990137	-0.49016	-0.85198	0.982917	-0.49988	0.865919	0.99985	0.982917098
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-19	3	0	0	0.1	11	0.128492	0.122241	0.17735009	0.128435	0.122051	0.496089	0.951936	0.986121	-0.00937	0.986166	-0.49312	-0.86123	0.992415	-0.493	0.870608	1.00051	0.986165553
-17	1	0	0	0.1	11	0.692669	0.600813	0.91693326	0.692613	0.600627	2.786075	2.899907	0.99661	-0.01133	0.996674	-0.49671	-0.85466	0.988514	-0.4999	0.865983	0.99991	0.988514382
-17	2	0	0	0.1	11	0.692669	0.600813	0.91693326	0.692613	0.600627	2.786075	2.899907	0.996424	-0.01072	0.996482	-0.49785	-0.85474	0.989157	-0.49858	0.865462	0.9988	0.989157269
-18	3	0	0	0.1	11	0.037859	0.068601	0.07835433	0.037855	0.068528	0.301664	0.939389	0.989191	-0.00677	0.989214	-0.49464	-0.86256	0.994322	-0.49456	0.869327	1.00016	0.989214139
-21	1	0	0	0.1	11	0.162693	0.522486	0.54722996	0.162716	0.522473	4.909641	3.926959	0.998932	-0.00926	0.998975	-0.49902	-0.85675	0.991482	-0.49991	0.866007	0.99994	0.99148177
-21	2	0	0	0.1	11	0.162693	0.522486	0.54722996	0.162716	0.522473	4.909641	3.926959	0.999469	-0.00908	0.99951	-0.49998	-0.85711	0.99228	-0.49949	0.866189	0.99989	0.992280049
-20	3	0	0	0.1	11	0.304568	0.5716	0.64767911	0.304512	0.57141	1.203815	2.750475	0.994404	-0.00219	0.994406	-0.49721	-0.86489	0.997624	-0.49719	0.86708	0.99951	0.994406416
-17	3	0	0	0.1	11	0.692669	0.600813	0.91693326	0.692613	0.600627	2.786075	2.899907	0.996708	-0.00277	0.996712	-0.49837	-0.86462	0.997966	-0.49834	0.867384	1.00035	0.996711841
-21	3	0	0	0.1	11	0.162693	0.522486	0.54722996	0.162716	0.522473	4.909641	3.926959	0.999705	-0.00161	0.999706	-0.49986	-0.86522	0.999234	-0.49984	0.866825	1.00061	0.999233675
-11	3	0	0	0.1	150	0.408489	4.182313	4.20221433	0.404331	4.14583	2.109227	10.98724	0.16857	-0.03217	0.171611	-0.95391	-0.83691	1.268999	-0.95371	0.891527	1.30552	0.171611282
-11	1	0	0	0.1	150	0.408489	4.182313	4.20221433	0.404331	4.14583	2.109227	10.98724	0.580033	-0.29917	0.652642	-0.08248	-0.56262	0.568635	-0.49755	0.861792	0.99511	0.568635472
-11	2	0	0	0.1	150	0.408489	4.182313	4.20221433	0.404331	4.14583	2.109227	10.98724	0.338381	0.098142	0.352326	-0.33191	-0.15598	0.366731	-0.65269	1.156734	1.32817	0.352325919
-12	3	0	0	0.1	20	0.004952	0.107193	0.10730732	0.00492	0.106985	0.036737	0.151863	0.674857	-0.25701	0.722139	-0.72358	-1.01341	1.245214	-0.72265	0.71758	1.0184	0.722138884
-12	1	0	0	0.1	20	0.004952	0.107193	0.10730732	0.00492	0.106985	0.036737	0.151863	0.91074	-0.15691	0.924158	-0.41214	-0.70813	0.819338	-0.4986	0.865042	0.99845	0.819337516
-12	2	0	0	0.1	20	0.004952	0.107193	0.10730732	0.00492	0.106985	0.036737	0.151863	0.688806	-0.01501	0.688969	-0.75016	-0.59697	0.958704	-0.71332	0.976242	1.20908	0.688969416
-13	3	0	0	0.1	20	0.004303	0.105719	0.10580653	0.004281	0.105533	0.000329	0.139561	0.722892	-0.29818	0.781973	-0.67245	-1.0535	1.249822	-0.67151	0.677456	0.95387	0.781972617
-13	1	0	0	0.1	20	0.004303	0.105719	0.10580653	0.004281	0.105533	0.000329	0.139561	0.918564	-0.15255	0.931145	-0.41993	-0.71257	0.827103	-0.49863	0.865119	0.99853	0.827102554
-13	2	0	0	0.1	20	0.004303	0.105719	0.10580653	0.004281	0.105533	0.000329	0.139561	0.671102	-0.05095	0.673033	-0.77868	-0.6441	1.010546	-0.73249	0.930208	1.18399	0.673033432
-22	3	0	0	0.1	0.69	0.000009	0.00018	0.00018022	0.000009	0.00018	0	0.000237	1.000105	-0.00068	1.000105	-0.49992	-0.86651	1.000376	-0.49992	0.865545	0.99954	0.999542972
-22	1	0	0	0.1	0.69	0.000009	0.00018	0.00018022	0.000009	0.00018	0	0.000237	1.00021	-0.00029	1.00021	-0.50021	-0.86574	0.999861	-0.5	0.866027	1	0.999861118
-22	2	0	0	0.1	0.69	0.000009	0.00018	0.00018022	0.000009	0.00018	0	0.000237	0.999648	-0.00051	0.999648	-0.50056	-0.86626	1.000481	-0.50037	0.865716	0.99992	0.999648132
-23	3	0	0	0.1	0.69	0	0	0	0	0	0	0	1	0	1	-0.5	-0.86603	1	-0.5	0.866025	1	0.99999965
-23	1	0	0	0.1	0.69	0	0	0	0	0	0	0	1	0	1	-0.5	-0.86603	1	-0.5	0.866025	1	0.99999965

-23	2	0	0	0.1	0.69	0	0	0	0	0	0	0	1	0	1	-0.5	-0.86603	1	-0.5	0.866025	1	0.99999965
-24	3	0	0	0.1	0.69	0.000057	0.002376	0.00237668	0.000057	0.002375	0.000028	0.001215	1.000063	-0.00059	1.000063	-0.49996	-0.86639	1.000296	-0.49996	0.86566	0.99966	0.999662062
-24	1	0	0	0.1	0.69	0.000057	0.002376	0.00237668	0.000057	0.002375	0.000028	0.001215	1.000217	-0.00033	1.000217	-0.50022	-0.8657	0.999827	-0.5	0.866027	1	0.999827389
-24	2	0	0	0.1	0.69	0.000057	0.002376	0.00237668	0.000057	0.002375	0.000028	0.001215	0.999726	-0.00045	0.999726	-0.5005	-0.86615	1.000358	-0.50029	0.865806	0.99996	0.9997261
-25	3	50	0	0.123	15	0.019476	0.048065	0.05186096	0.019421	0.047874	0.062046	0.655057	0.970818	-0.01121	0.970883	-0.48547	-0.86021	0.987743	-0.48535	0.871415	0.99746	0.970882695
-26	3	50	0	0.123	15	0.019476	0.048065	0.05186096	0.019421	0.047874	0.062046	0.655057	0.970818	-0.01121	0.970883	-0.48547	-0.86021	0.987743	-0.48535	0.871415	0.99746	0.970882695
-14	3	50	0	0.123	150	0.288282	3.484328	3.49623342	0.282819	3.443615	4.776796	12.57835	0.0841	-0.01545	0.085506	-1.03954	-0.78319	1.301546	-1.03899	0.945221	1.40461	0.085506479
-15	3	50	0	0.123	150	0.405329	4.149267	4.16901766	0.401118	4.112565	2.152986	11.24349	0.163261	-0.03179	0.166327	-0.96174	-0.83722	1.275106	-0.96154	0.891234	1.31105	0.166327454
-15	1	50	0	0.123	150	0.405329	4.149267	4.16901766	0.401118	4.112565	2.152986	11.24349	0.575119	-0.30209	0.64963	-0.07759	-0.55965	0.565007	-0.49753	0.861743	0.99506	0.565006635
-15	2	50	0	0.123	150	0.405329	4.149267	4.16901766	0.401118	4.112565	2.152986	11.24349	0.333343	0.096013	0.346895	-0.32731	-0.15205	0.360904	-0.65437	1.159066	1.33103	0.346894871
-27	3	50	0	0.123	20	0.004675	0.106517	0.10661954	0.004649	0.10632	0.01853	0.14572	0.698327	-0.27639	0.751035	-0.69866	-1.03227	1.246478	-0.69773	0.698702	0.98742	0.751034711

Fault Impedance=0.1 ohm

Voltage sag table for 150 KV bus,green revolution scenario 2030

Voltage Sags	Voltage sag table assessment												BB150_2	BB150_2		BB150_2	BB150_2		BB150_2	BB150_2		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	Minimum of phase voltages
2	**0**	**0**	**0**	**0.1**	**150**	**0.173018**	**2.815328**	**2.820639**	**#INF**	**#INF**	**#INF**	**#INF**	**0.003447**	**-0.03554**	**0.035708**	**0.003447**	**-0.03554**	**0.035708**	**0.003447**	**-0.03554**	**0.035708**	**0.035707765**
-1	0	0	0	0.1	150	0.173018	2.815328	2.820639	#INF	#INF	#INF	#INF	0.003447	-0.03554	0.035708	0.003447	-0.03554	0.035708	0.003447	-0.03554	0.035708	0.035707765
-2	0	0	0	0.1	150	0.433202	4.181544	4.203924	#INF	#INF	#INF	#INF	0.392516	-0.06374	0.397657	0.392516	-0.06374	0.397657	0.392516	-0.06374	0.397657	0.397656838
-3	1	0	0	0.1	11	0.005633	0.03768	0.038099	0.00556	0.03749	0.000001	0.612617	0.967655	-0.16897	0.982297	-0.464232	-0.70514	0.844232	-0.50342	0.874107	1.00871	0.844232272
-4	0	0	0	0.1	21	0.001472	0.068581	0.068597	#INF	#INF	#INF	#INF	0.845523	-0.23729	0.878188	0.845523	-0.23729	0.878188	0.845523	-0.23729	0.878188	0.878187787
-5	0	0	0	0.1	380	0.335304	3.583312	3.598966	#INF	#INF	#INF	#INF	0.431322	0.070027	0.43697	0.431322	0.070027	0.43697	0.431322	0.070027	0.43697	0.43696962
-6	0	0	0	0.1	66	0.015484	10.64909	10.6491	#INF	#INF	#INF	#INF	0.981447	0.003073	0.981452	0.981447	0.003073	0.981452	0.981447	0.003073	0.981452	0.981451811
-7	0	0	0	0.1	66	0.015484	10.64909	10.6491	#INF	#INF	#INF	#INF	0.981447	0.003073	0.981452	0.981447	0.003073	0.981452	0.981447	0.003073	0.981452	0.981451811
-8	0	0	0	0.1	150	0.433202	4.181544	4.203924	#INF	#INF	#INF	#INF	0.392516	-0.06374	0.397657	0.392516	-0.06374	0.397657	0.392516	-0.06374	0.397657	0.397656838
-9	0	0	0	0.1	380	0.335304	3.583312	3.598966	#INF	#INF	#INF	#INF	0.431322	0.070027	0.43697	0.431322	0.070027	0.43697	0.431322	0.070027	0.43697	0.43696962
-10	0	0	0	0.1	21	0.000438	0.059773	0.059775	#INF	#INF	#INF	#INF	0.989934	-0.02338	0.99021	0.989934	-0.02338	0.99021	0.989934	-0.02338	0.99021	0.990210029
-11	0	0	0	0.1	21	0.000438	0.059773	0.059775	#INF	#INF	#INF	#INF	0.989934	-0.02338	0.99021	0.989934	-0.02338	0.99021	0.989934	-0.02338	0.99021	0.990210029
-12	0	0	0	0.1	150	0.439459	4.248778	4.271445	#INF	#INF	#INF	#INF	0.405848	-0.06324	0.410746	0.405848	-0.06324	0.410746	0.405848	-0.06324	0.410746	0.410745846
-13	0	0	0	0.1	20	0.005145	0.110664	0.110784	#INF	#INF	#INF	#INF	0.888674	-0.12677	0.89767	0.888674	-0.12677	0.89767	0.888674	-0.12677	0.89767	0.897670098
-14	0	0	0	0.1	20	0.004571	0.109474	0.109569	#INF	#INF	#INF	#INF	0.897393	-0.12436	0.905969	0.897393	-0.12436	0.905969	0.897393	-0.12436	0.905969	0.905969289
-15	0	50	0	0.12	150	0.32065	3.543933	3.558409	#INF	#INF	#INF	#INF	0.244582	-0.05723	0.251188	0.244582	-0.05723	0.251188	0.244582	-0.05723	0.251188	0.251187975
-16	0	50	0	0.12	150	0.436374	4.215328	4.237855	#INF	#INF	#INF	#INF	0.399255	-0.06349	0.404271	0.399255	-0.06349	0.404271	0.399255	-0.06349	0.404271	0.404270982
2	3	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.005538	-0.01352	0.01461	-1.124418	-0.75503	1.354393	-1.12357	0.990511	1.49784	0.014610265
2	1	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.259618	-0.44643	0.516433	0.241867	-0.4206	0.485183	-0.50149	0.867031	1.001614	0.485182773
2	2	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.015687	-0.02919	0.033142	-0.020639	0.021727	0.029967	-0.65483	1.221746	1.386168	0.029967163
-1	3	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.005538	-0.01352	0.01461	-1.124418	-0.75503	1.354393	-1.12357	0.990511	1.49784	0.014610265
-1	1	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.259618	-0.44643	0.516433	0.241867	-0.4206	0.485183	-0.50149	0.867031	1.001614	0.485182773
-1	2	0	0	0.1	150	0.17258	2.804907	2.810211	0.16464	2.75905	7.223299	13.6273	0.015687	-0.02919	0.033142	-0.020639	0.021727	0.029967	-0.65483	1.221746	1.386168	0.029967163
-2	3	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.158541	-0.0307	0.161487	-0.974856	-0.84775	1.291907	-0.97473	0.897904	1.325265	0.161486793
-2	1	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.570807	-0.30746	0.648347	-0.068307	-0.5627	0.566827	-0.5025	0.870158	1.004829	0.566826812
-2	2	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.326661	0.095581	0.340357	-0.320601	-0.1499	0.353914	-0.66219	1.170398	1.34474	0.340357366
-17	1	0	0	0.1	11	0.026301	0.051787	0.058083	0.02623	0.05159	0.082729	0.669203	0.978995	-0.12296	0.986686	-0.475143	-0.7513	0.888942	-0.50385	0.874262	1.009059	0.888942389
-3	2	0	0	0.1	11	0.005633	0.03768	0.038099	0.00556	0.03749	0.000001	0.612617	1.007768	-0.1	1.012718	-0.509552	-0.76595	0.91996	-0.49822	0.865956	0.999049	0.919959622
-17	2	0	0	0.1	11	0.026301	0.051787	0.058083	0.02623	0.05159	0.082729	0.669203	1.003606	-0.08207	1.006956	-0.505267	-0.78545	0.933934	-0.49834	0.867526	1.000471	0.933934006
-4	3	0	0	0.1	21	0.001469	0.068502	0.068518	0.00117	0.06495	0.000512	7.635088	1.001177	-0.00026	1.001177	-0.500581	-0.87435	1.007509	-0.5006	0.874608	1.007738	1.001177032
-4	1	0	0	0.1	21	0.001469	0.068502	0.068518	0.00117	0.06495	0.000512	7.635088	0.867098	-0.32243	0.925105	-0.371859	-0.54732	0.661694	-0.49524	0.869751	1.000863	0.661694335
-4	2	0	0	0.1	21	0.001469	0.068502	0.068518	0.00117	0.06495	0.000512	7.635088	0.988783	-0.24288	1.018175	-0.492407	-0.62887	0.79871	-0.49638	0.871741	1.003156	0.798709647
-5	3	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.637607	0.038412	0.638763	-0.318052	-0.8905	0.945596	-0.31955	0.85209	0.91004	0.638762998
-5	1	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.546658	-0.18718	0.577817	-0.043335	-0.68155	0.682928	-0.50332	0.868735	1.004009	0.577816964
-5	2	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.510372	-0.11129	0.522364	-0.084133	-0.59275	0.598693	-0.42624	0.704037	0.823011	0.52236379
-6	3	0	0	0.1	66	0.015407	10.64847	10.64848	0.01485	10.6455	7.19E+08	2.474703	1.01	0	1.01	-0.505	-0.87469	1.01	-0.505	0.874686	1.01	1.01
-6	1	0	0	0.1	66	0.015407	10.64847	10.64848	0.01485	10.6455	7.19E+08	2.474703	0.987451	-0.00974	0.987499	-0.482523	-0.86472	0.990233	-0.50493	0.874453	1.009763	0.987499006

-6	2	0	0	0.1	66	0.015407	10.64847	10.64848	0.01485	10.6455	7.19E+08	2.474703	0.987498	-0.00984	0.987547	-0.482571	-0.86461	0.990164	-0.50493	0.874453	1.009762	0.987547044
-7	3	0	0	0.1	66	0.015487	10.64847	10.64848	0.01485	10.6454	7.19E+08	-0.6879	1.01	0	1.01	-0.505	-0.87469	1.01	-0.505	0.874686	1.01	1.01
-7	1	0	0	0.1	66	0.015487	10.64847	10.64848	0.01485	10.6454	7.19E+08	-0.6879	0.987451	-0.00974	0.987499	-0.482523	-0.86472	0.990233	-0.50493	0.874453	1.009763	0.987499006
-7	2	0	0	0.1	66	0.015487	10.64847	10.64848	0.01485	10.6454	7.19E+08	-0.6879	0.987498	-0.00984	0.987547	-0.482571	-0.86461	0.990164	-0.50493	0.874453	1.009762	0.987547044
-8	3	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.158541	-0.0307	0.161487	-0.974856	-0.84775	1.291907	-0.97473	0.897904	1.325265	0.161486793
-8	1	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.570807	-0.30746	0.648347	-0.068307	-0.5627	0.566827	-0.5025	0.870158	1.004829	0.566826812
-8	2	0	0	0.1	150	0.428788	4.154011	4.176083	0.42352	4.11593	2.196681	11.49949	0.326661	0.095581	0.340357	-0.320601	-0.1499	0.353914	-0.66219	1.170398	1.34474	0.340357366
-19	1	0	0	0.1	11	0.080911	0.113423	0.139325	0.08084	0.11324	0.301664	0.939389	0.985396	-0.05868	0.987142	-0.480934	-0.81571	0.946929	-0.50446	0.87439	1.009475	0.946929471
-3	0	0	0	0.1	11	0.005644	0.037725	0.038145	#INF	#INF	#INF	#INF	0.950121	-0.10611	0.956028	0.950121	-0.10611	0.956028	0.950121	-0.10611	0.956028	0.956028292
-19	2	0	0	0.1	11	0.080911	0.113423	0.139325	0.08084	0.11324	0.301664	0.939389	0.995533	-0.04808	0.996693	-0.495028	-0.82236	0.959861	-0.50051	0.870445	1.004082	0.959861253
-20	1	0	0	0.1	11	0.047359	0.06022	0.076612	0.04736	0.06017	0.496089	0.951936	1.013776	-0.04943	1.01498	-0.509254	-0.82525	0.969727	-0.50452	0.874671	1.009748	0.969727073
-3	3	0	0	0.1	11	0.005633	0.03768	0.038099	0.00556	0.03749	0.000001	0.612617	0.975377	-0.00903	0.975419	-0.487725	-0.86992	0.997312	-0.48765	0.878942	1.005158	0.975418753
-17	3	0	0	0.1	11	0.026301	0.051787	0.058083	0.02623	0.05159	0.082729	0.669203	0.98133	-0.01024	0.981383	-0.490716	-0.86935	0.998288	-0.49062	0.879589	1.007164	0.981383373
-20	2	0	0	0.1	11	0.047359	0.06022	0.076612	0.04736	0.06017	0.496089	0.951936	1.017239	-0.03417	1.017813	-0.515182	-0.83965	0.985104	-0.50206	0.873819	1.007781	0.98510388
-21	1	0	0	0.1	11	0.306227	0.571813	0.648649	0.30615	0.57162	1.203815	2.750475	0.99929	-0.01366	0.999383	-0.49441	-0.86091	0.992775	-0.50488	0.874569	1.009839	0.992774955
-19	3	0	0	0.1	11	0.080911	0.113423	0.139325	0.08084	0.11324	0.301664	0.939389	0.993023	-0.00673	0.993046	-0.496546	-0.87119	1.002763	-0.49648	0.877925	1.008584	0.993045826
-21	2	0	0	0.1	11	0.306227	0.571813	0.648649	0.30615	0.57162	1.203815	2.750475	0.999791	-0.01305	0.999876	-0.496361	-0.86017	0.993108	-0.50343	0.873213	1.007939	0.993107865
-18	1	0	0	0.1	11	0.691237	0.596522	0.913043	0.69116	0.59633	2.786075	2.899907	1.006057	-0.01124	1.00612	-0.501161	-0.8634	0.998305	-0.5049	0.874636	1.009905	0.998305201
-18	2	0	0	0.1	11	0.691237	0.596522	0.913043	0.69116	0.59633	2.786075	2.899907	1.005902	-0.01062	1.005958	-0.502304	-0.86343	0.998908	-0.5036	0.874049	1.008749	0.998908014
-22	1	0	0	0.1	11	0.162719	0.522714	0.547455	0.16274	0.5227	4.909641	3.926959	1.008567	-0.00854	1.008603	-0.503648	-0.86613	1.001915	-0.50492	0.874663	1.00994	1.001915078
-22	2	0	0	0.1	11	0.162719	0.522714	0.547455	0.16274	0.5227	4.909641	3.926959	1.009074	-0.00839	1.009109	-0.504555	-0.86642	1.002625	-0.50452	0.874812	1.00987	1.002624505
-20	3	0	0	0.1	11	0.047359	0.06022	0.076612	0.04736	0.06017	0.496089	0.951936	1.003477	-0.00678	1.0035	-0.501782	-0.87125	1.005413	-0.5017	0.878021	1.011246	1.003499871
-21	3	0	0	0.1	11	0.306227	0.571813	0.648649	0.30615	0.57162	1.203815	2.750475	1.004228	-0.00196	1.00423	-0.502123	-0.87366	1.007676	-0.50211	0.875624	1.00937	1.004229917
-18	3	0	0	0.1	11	0.691237	0.596522	0.913043	0.69116	0.59633	2.786075	2.899907	1.006561	-0.00262	1.006564	-0.503297	-0.87335	1.007992	-0.50327	0.875968	1.010245	1.006564405
-22	3	0	0	0.1	11	0.162719	0.522714	0.547455	0.16274	0.5227	4.909641	3.926959	1.00965	-0.00148	1.009651	-0.504835	-0.87394	1.009275	-0.50482	0.87542	1.010544	1.009275231
-9	3	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.637607	0.038412	0.638763	-0.318052	-0.8905	0.945596	-0.31955	0.85209	0.91004	0.638762998
-9	1	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.546658	-0.18718	0.577817	-0.043335	-0.68155	0.682928	-0.50332	0.868735	1.004009	0.577816964
-9	2	0	0	0.1	380	0.335117	3.582427	3.598067	0.32964	3.56108	0.552822	3.833256	0.510372	-0.11129	0.522364	-0.084133	-0.59275	0.598693	-0.42624	0.704037	0.823011	0.52236379
-10	3	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.001658	0.033372	0.997853	-0.01661	0.997991	-0.499373	-0.866	0.999667	-0.49848	0.882616	1.013653	0.997991283
-10	1	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.001658	0.033372	0.990471	-0.03372	0.991045	-0.48671	-0.84016	0.970956	-0.50376	0.873883	1.008686	0.970955946
-10	2	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.001658	0.033372	0.999675	-0.02538	0.999997	-0.506121	-0.84856	0.988038	-0.49355	0.873948	1.003684	0.988038121
-11	3	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.000044	2.227006	1.007062	0.000126	1.007062	-0.503522	-0.87467	1.009245	-0.50354	0.87454	1.009145	1.007062008
-11	1	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.000044	2.227006	0.990471	-0.03372	0.991045	-0.48671	-0.84016	0.970956	-0.50376	0.873883	1.008686	0.970955946
-11	2	0	0	0.1	21	0.000438	0.059772	0.059774	0.00028	0.05704	0.000044	2.227006	1.004872	-0.02505	1.005184	-0.501128	-0.8487	0.985605	-0.50374	0.87375	1.008562	0.985605178
-12	3	0	0	0.1	150	0.434816	4.220023	4.242365	0.42967	4.18239	2.109227	10.98724	0.169087	-0.03141	0.17198	-0.959205	-0.84711	1.279715	-0.95907	0.898493	1.314194	0.171979655
-12	1	0	0	0.1	150	0.434816	4.220023	4.242365	0.42967	4.18239	2.109227	10.98724	0.580785	-0.30153	0.654393	-0.078238	-0.56873	0.574089	-0.50255	0.87026	1.004941	0.5740892
-12	2	0	0	0.1	150	0.434816	4.220023	4.242365	0.42967	4.18239	2.109227	10.98724	0.336876	0.09997	0.351396	-0.329951	-0.15782	0.365753	-0.65886	1.165723	1.339033	0.351396415
-13	3	0	0	0.1	20	0.005112	0.107403	0.107525	0.00507	0.10719	0.036737	0.151863	0.679261	-0.25905	0.72698	-0.730006	-1.02264	1.25646	-0.72906	0.7256	1.028604	0.726980286
-13	1	0	0	0.1	20	0.005112	0.107403	0.107525	0.00507	0.10719	0.036737	0.151863	0.916409	-0.15962	0.930206	-0.412844	-0.71401	0.824769	-0.50357	0.873625	1.008364	0.824768639
-13	2	0	0	0.1	20	0.005112	0.107403	0.107525	0.00507	0.10719	0.036737	0.151863	0.693277	-0.01593	0.69346	-0.755166	-0.60019	0.964624	-0.7195	0.985747	1.220399	0.69346004
-14	3	0	0	0.1	20	0.004437	0.105911	0.106004	0.00441	0.10572	0.000329	0.139561	0.727558	-0.30066	0.787233	-0.678507	-1.0632	1.261258	-0.67756	0.685	0.963486	0.787233051
-14	1	0	0	0.1	20	0.004437	0.105911	0.106004	0.00441	0.10572	0.000329	0.139561	0.924434	-0.15526	0.937381	-0.420836	-0.71845	0.832627	-0.5036	0.873706	1.008451	0.832626924
-14	2	0	0	0.1	20	0.004437	0.105911	0.106004	0.00441	0.10572	0.000329	0.139561	0.675457	-0.05211	0.677464	-0.784171	-0.64765	1.017041	-0.73893	0.939254	1.195079	0.677463872
-23	3	0	0	0.1	0.69	0.000009	0.00018	0.00018	9E-06	0.00018	0	0.000237	1.010102	-0.00069	1.010102	-0.50492	-0.87517	1.01038	-0.50492	0.874201	1.009539	1.009539289
-23	1	0	0	0.1	0.69	0.000009	0.00018	0.00018	9E-06	0.00018	0	0.000237	1.010211	-0.0003	1.010211	-0.505214	-0.87439	1.009853	-0.505	0.874687	1.01	1.009852739
-23	2	0	0	0.1	0.69	0.000009	0.00018	0.00018	9E-06	0.00018	0	0.000237	1.009642	-0.00052	1.009642	-0.505572	-0.87491	1.010482	-0.50538	0.874374	1.009919	1.009642135
-24	3	0	0	0.1	0.69	0	0	0	0	0	0	0	1.01	0	1.01	-0.505	-0.87469	1.01	-0.505	0.874686	1.01	1.01
-24	1	0	0	0.1	0.69	0	0	0	0	0	0	0	1.01	0	1.01	-0.505	-0.87469	1.01	-0.505	0.874686	1.01	1.01
-24	2	0	0	0.1	0.69	0	0	0	0	0	0	0	1.01	0	1.01	-0.505	-0.87469	1.01	-0.505	0.874686	1.01	1.01
-25	3	0	0	0.1	0.69	0.000058	0.002376	0.002377	5.8E-05	0.00238	0.000028	0.001215	1.01006	-0.0006	1.01006	-0.504959	-0.87505	1.010298	-0.50496	0.874318	1.00966	1.00966011
-25	1	0	0	0.1	0.69	0.000058	0.002376	0.002377	5.8E-05	0.00238	0.000028	0.001215	1.010218	-0.00034	1.010218	-0.505221	-0.87435	1.009817	-0.505	0.874687	1.01	1.009817278
-25	2	0	0	0.1	0.69	0.000058	0.002376	0.002377	5.8E-05	0.00238	0.000028	0.001215	1.00972	-0.00046	1.00972	-0.505508	-0.87481	1.010358	-0.5053	0.874465	1.009956	1.009720103
-26	3	50	0	0.12	15	0.021135	0.048269	0.052693	0.02106	0.04808	0.062046	0.655057	0.997972	0.010324	0.998025	-0.516688	-0.86406	1.006756	-0.48128	0.853731	0.980046	0.980046381
-27	3	50	0	0.12	15	0.021135	0.048269	0.052693	0.02106	0.04808	0.062046	0.655057	0.997972	0.010324	0.998025	-0.516688	-0.86406	1.006756	-0.48128	0.853731	0.980046	0.980046381

-15	3	50	0	0.12	150	0.318569	3.525922	3.540284	0.31198	3.48394	4.776796	12.57835	1.209269	-0.50849	1.311829	-0.302688	-1.38085	1.413632	-0.02908	0.080565	0.085652	0.085651908
-16	3	50	0	0.12	150	0.431846	4.187188	4.209398	0.42664	4.14933	2.152986	11.24349	1.217458	-0.41382	1.285866	-0.294367	-1.28652	1.319769	-0.05498	0.157357	0.166687	0.166686729
-16	1	50	0	0.12	150	0.431846	4.187188	4.209398	0.42664	4.14933	2.152986	11.24349	0.526615	0.21937	0.570479	-0.502362	-0.8703	1.004886	-0.02425	0.650933	0.651385	0.570479233
-16	2	50	0	0.12	150	0.431846	4.187188	4.209398	0.42664	4.14933	2.152986	11.24349	0.295933	-0.20481	0.359896	-0.681327	-1.15612	1.341944	-0.25063	0.238446	0.345933	0.345932632
-28	3	50	0	0.12	20	0.004822	0.106718	0.106827	0.00479	0.10652	0.01853	0.14572	1.25461	-0.08961	1.257806	-0.259868	-0.96289	0.997345	-0.11012	0.748017	0.75608	0.756079696

Voltage sag table for 150KV bus,Sustainable transition scenario 2010

Voltage Sags	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment		Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.145807	1.250158	1.258632	#INF	#INF	#INF	#INF	0.019255	-0.0769	0.079272	0.019255	-0.0769	0.079272	0.019255	-0.0769	0.079272	0.079272
-1	0	0	0	0.1	21	0.001007	0.063856	0.063864	#INF	#INF	#INF	#INF	0.950021	-0.04905	0.951287	0.950021	-0.04905	0.951287	0.950021	-0.04905	0.951287	0.951287
-2	1	0	0	0.1	11	0.00324	0.030689	0.03086	0.003214	0.030633	0.044116	0.574418	0.996014	-0.0335	0.996577	-0.44744	-0.81403	0.928895	-0.54857	0.847523	1.009566	0.928895
-3	0	0	0	0.1	21	0.001007	0.063856	0.063864	#INF	#INF	#INF	#INF	0.947092	-0.04386	0.948107	0.947092	-0.04386	0.948107	0.947092	-0.04386	0.948107	0.948107
-4	0	0	0	0.1	150	0.145807	1.250158	1.258632	#INF	#INF	#INF	#INF	0.019255	-0.0769	0.079272	0.019255	-0.0769	0.079272	0.019255	-0.0769	0.079272	0.079272
-5	0	0	0	0.1	150	0.52225	3.70862	3.745211	#INF	#INF	#INF	#INF	0.72023	0.005633	0.720252	0.72023	0.005633	0.720252	0.72023	0.005633	0.720252	0.720252
-6	0	0	0	0.1	380	0.935758	26.07323	26.09002	#INF	#INF	#INF	#INF	0.696119	0.059571	0.698663	0.696119	0.059571	0.698663	0.696119	0.059571	0.698663	0.698663
-7	0	0	0	0.1	150	0.368609	3.162394	3.183804	#INF	#INF	#INF	#INF	0.710168	0.018202	0.710401	0.710168	0.018202	0.710401	0.710168	0.018202	0.710401	0.710401
-8	0	0	0	0.1	150	0.52225	3.70862	3.745211	#INF	#INF	#INF	#INF	0.72023	0.005633	0.720252	0.72023	0.005633	0.720252	0.72023	0.005633	0.720252	0.720252
-9	0	0	0	0.1	380	0.484655	4.95698	4.980617	#INF	#INF	#INF	#INF	0.905472	0.056511	0.907234	0.905472	0.056511	0.907234	0.905472	0.056511	0.907234	0.907234
-10	0	0	0	0.1	66	0.041149	13.26939	13.26945	#INF	#INF	#INF	#INF	0.997122	0.052276	0.998491	0.997122	0.052276	0.998491	0.997122	0.052276	0.998491	0.998491
-11	0	0	0	0.1	150	0.528152	3.781522	3.818226	#INF	#INF	#INF	#INF	0.727365	0.006668	0.727396	0.727365	0.006668	0.727396	0.727365	0.006668	0.727396	0.727396
-12	0	0	0	0.1	20	0.005574	0.107839	0.107983	#INF	#INF	#INF	#INF	0.958897	-0.00373	0.958904	0.958897	-0.00373	0.958904	0.958897	-0.00373	0.958904	0.958904
-13	0	50	0	0.123	150	0.525244	3.745236	3.781888	#INF	#INF	#INF	#INF	0.723843	0.006158	0.723869	0.723843	0.006158	0.723869	0.723843	0.006158	0.723869	0.723869
-14	0	50	0	0.123	150	0.31345	2.381526	2.402065	#INF	#INF	#INF	#INF	0.550312	-0.00296	0.55032	0.550312	-0.00296	0.55032	0.550312	-0.00296	0.55032	0.55032
-15	0	50	0	0.123	150	0.368188	2.583569	2.609673	#INF	#INF	#INF	#INF	0.561903	-0.0122	0.562035	0.561903	-0.0122	0.562035	0.561903	-0.0122	0.562035	0.562035
2	3	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.018888	-0.08018	0.082379	-0.42656	-0.90857	1.003719	-0.51641	0.831803	0.979067	0.082379
2	1	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.296512	-0.44724	0.536605	0.250117	-0.39535	0.467822	-0.54663	0.842589	1.00437	0.467822
2	2	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.016756	-0.07815	0.079922	-0.07919	0.02104	0.081935	-0.54124	0.806996	0.971688	0.079922
-1	3	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	0.997414	0.049805	0.998657	-0.45397	-0.89817	1.006376	-0.54345	0.848364	1.0075	0.998657
-1	1	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	0.960159	-0.08561	0.963968	-0.41536	-0.7603	0.866359	-0.5448	0.845904	1.006161	0.866359
-1	2	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	1.007066	-0.04588	1.00811	-0.46284	-0.7992	0.923549	-0.54423	0.845081	1.005161	0.923549
-2	2	0	0	0.1	11	0.00324	0.030689	0.03086	0.003214	0.030633	0.044116	0.574418	1.011311	0.004619	1.011322	-0.46569	-0.84852	0.967913	-0.54562	0.843904	1.004928	0.967913
-2	0	0	0	0.1	11	0.003242	0.030697	0.030868	#INF	#INF	#INF	#INF	0.98458	-0.00012	0.98458	0.98458	-0.00012	0.98458	0.98458	-0.00012	0.98458	0.98458
-2	3	0	0	0.1	11	0.00324	0.030689	0.03086	0.003214	0.030633	0.044116	0.574418	0.99291	0.045783	0.993965	-0.4517	-0.89635	1.003732	-0.54121	0.850567	1.008151	0.993965
-3	3	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	0.997622	0.050351	0.998892	-0.45406	-0.89845	1.006666	-0.54357	0.848097	1.007339	0.998892
-3	1	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	0.955357	-0.07992	0.958694	-0.41037	-0.76585	0.868861	-0.54499	0.84576	1.006143	0.868861
-3	2	0	0	0.1	21	0.001005	0.063845	0.063853	0.000766	0.060714	0.000044	2.227006	1.002804	-0.04328	1.003738	-0.45833	-0.80165	0.923423	-0.54447	0.844933	1.005167	0.923423
-4	3	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.018888	-0.08018	0.082379	-0.42656	-0.90857	1.003719	-0.51641	0.831803	0.979067	0.082379
-4	1	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.296512	-0.44724	0.536605	0.250117	-0.39535	0.467822	-0.54663	0.842589	1.00437	0.467822
-4	2	0	0	0.1	150	0.145548	1.248324	1.25678	0.141678	1.234749	0.071742	1.135542	0.016756	-0.07815	0.079922	-0.07919	0.02104	0.081935	-0.54124	0.806996	0.971688	0.079922
-5	3	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.806472	0.016589	0.806643	-0.42159	-0.89312	0.987624	-0.51112	0.852372	0.993872	0.806643
-5	1	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.810354	-0.10429	0.817037	-0.26205	-0.74196	0.78688	-0.54831	0.846254	1.008358	0.78688
-5	2	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.766021	-0.05225	0.767801	-0.31094	-0.68514	0.752394	-0.52775	0.820486	0.975562	0.752394
-6	3	0	0	0.1	380	0.934097	26.0611	26.07783	0.909619	25.97435	2.62E+10	-36.0996	1.008676	0.051693	1.01	-0.45957	-0.89939	1.01	-0.54911	0.847693	1.01	1.01
-6	1	0	0	0.1	380	0.934097	26.0611	26.07783	0.909619	25.97435	2.62E+10	-36.0996	0.771517	-0.07595	0.775246	-0.22299	-0.77008	0.801718	-0.54853	0.846033	1.008294	0.775246
-6	2	0	0	0.1	380	0.934097	26.0611	26.07783	0.909619	25.97435	2.62E+10	-36.0996	0.77178	-0.0764	0.775552	-0.22325	-0.76964	0.801365	-0.54853	0.846034	1.008293	0.775552
-7	3	0	0	0.1	150	0.368553	3.16134	3.182751	0.367027	3.153444	1.924957	12.30684	0.84774	0.031246	0.848316	-0.46992	-0.90069	1.015907	-0.55949	0.8454	1.013773	0.848316
-7	1	0	0	0.1	150	0.368553	3.16134	3.182751	0.367027	3.153444	1.924957	12.30684	0.79738	-0.09836	0.803423	-0.24902	-0.74782	0.788192	-0.54836	0.846176	1.008321	0.788192

-7	2	0	0	0.1	150	0.368553	3.16134	3.182751	0.367027	3.153444	1.924957	12.30684	0.764796	-0.05555	0.76681	-0.28702	-0.69905	0.75568	-0.55287	0.851583	1.015312	0.75568
-8	3	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.806472	0.016589	0.806643	-0.42159	-0.89312	0.987624	-0.51112	0.852372	0.993872	0.806643
-8	1	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.810354	-0.10429	0.817037	-0.26205	-0.74196	0.78688	-0.54831	0.846254	1.008358	0.78688
-8	2	0	0	0.1	150	0.517155	3.687067	3.723159	0.514769	3.676984	0.980731	5.808361	0.766021	-0.05225	0.767801	-0.31094	-0.68514	0.752394	-0.52775	0.820486	0.975562	0.752394
-9	3	0	0	0.1	380	0.484644	4.956933	4.980569	0.484509	4.956589	0	433.2	1.006395	0.052062	1.007741	-0.45843	-0.89956	1.009634	-0.54797	0.847498	1.009218	1.007741
-9	1	0	0	0.1	380	0.484644	4.956933	4.980569	0.484509	4.956589	0	433.2	0.929198	0.011849	0.929274	-0.38027	-0.85899	0.939396	-0.54893	0.84714	1.009441	0.929274
-9	2	0	0	0.1	380	0.484644	4.956933	4.980569	0.484509	4.956589	0	433.2	0.929581	0.01138	0.929651	-0.38086	-0.85797	0.938708	-0.54872	0.846592	1.008865	0.929651
-10	3	0	0	0.1	66	0.041075	13.26928	13.26934	0.040975	13.26862	7.19E+08	3.027266	1.008676	0.051693	1.01	-0.45957	-0.89939	1.01	-0.54911	0.847693	1.01	1.01
-10	1	0	0	0.1	66	0.041075	13.26928	13.26934	0.040975	13.26862	7.19E+08	3.027266	0.997203	0.052304	0.998574	-0.45382	-0.89964	1.007622	-0.54338	0.847332	1.006595	0.998574
-10	2	0	0	0.1	66	0.041075	13.26928	13.26934	0.040975	13.26862	7.19E+08	3.027266	0.997202	0.052261	0.99857	-0.45382	-0.89962	1.007601	-0.54338	0.847354	1.006613	0.99857
-11	3	0	0	0.1	150	0.522811	3.75885	3.795034	0.52047	3.748886	0.98087	5.770256	0.810807	0.017146	0.810988	-0.42063	-0.89278	0.986903	-0.51015	0.852736	0.993687	0.810988
-11	1	0	0	0.1	150	0.522811	3.75885	3.795034	0.52047	3.748886	0.98087	5.770256	0.815362	-0.10054	0.821538	-0.26704	-0.74575	0.792116	-0.54833	0.84629	1.008398	0.792116
-11	2	0	0	0.1	150	0.522811	3.75885	3.795034	0.52047	3.748886	0.98087	5.770256	0.771987	-0.04979	0.773591	-0.31475	-0.69039	0.758756	-0.52689	0.819764	0.97449	0.758756
-12	3	0	0	0.1	20	0.005511	0.104739	0.104884	0.005495	0.104682	0.018601	0.094955	0.967249	0.000835	0.967249	-0.45542	-0.89367	1.003018	-0.54464	0.853057	1.012094	0.967249
-12	1	0	0	0.1	20	0.005511	0.104739	0.104884	0.005495	0.104682	0.018601	0.094955	0.970734	-0.01796	0.9709	-0.42204	-0.82942	0.930618	-0.5487	0.847376	1.009511	0.930618
-12	2	0	0	0.1	20	0.005511	0.104739	0.104884	0.005495	0.104682	0.018601	0.094955	0.967427	-0.00674	0.96745	-0.47638	-0.83343	0.959972	-0.54179	0.846837	1.005318	0.959972
-13	3	50	0	0.123	150	0.520027	3.723127	3.759269	0.517663	3.713104	0.981176	5.791814	0.808689	0.016875	0.808865	-0.42112	-0.89295	0.987267	-0.51064	0.852554	0.993782	0.808865
-13	1	50	0	0.123	150	0.520027	3.723127	3.759269	0.517663	3.713104	0.981176	5.791814	0.812889	-0.10239	0.819312	-0.26458	-0.74388	0.78953	-0.54832	0.846273	1.008379	0.78953
-13	2	50	0	0.123	150	0.520027	3.723127	3.759269	0.517663	3.713104	0.981176	5.791814	0.76905	-0.05101	0.77074	-0.31286	-0.68781	0.75562	-0.52733	0.820134	0.975037	0.75562
-14	3	50	0	0.123	150	0.313304	2.380108	2.40064	0.310717	2.369556	0.997859	6.720019	0.721459	0.015575	0.721627	-0.46278	-0.90213	1.013907	-0.5524	0.843084	1.007937	0.721627
-14	1	50	0	0.123	150	0.313304	2.380108	2.40064	0.310717	2.369556	0.997859	6.720019	0.683616	-0.18006	0.706932	-0.13567	-0.6653	0.678989	-0.54795	0.84536	1.007413	0.678989
-14	2	50	0	0.123	150	0.313304	2.380108	2.40064	0.310717	2.369556	0.997859	6.720019	0.62448	-0.10196	0.632748	-0.20625	-0.57542	0.611264	-0.55139	0.846107	1.009913	0.611264
-15	3	50	0	0.123	150	0.366257	2.574573	2.600494	0.363166	2.562806	0.745628	4.80822	0.694552	0.003892	0.694563	-0.42841	-0.8972	0.994235	-0.51799	0.847602	0.993348	0.694563
-15	1	50	0	0.123	150	0.366257	2.574573	2.600494	0.363166	2.562806	0.745628	4.80822	0.696366	-0.18297	0.720002	-0.14845	-0.66247	0.678902	-0.54792	0.845439	1.007462	0.678902
-15	2	50	0	0.123	150	0.366257	2.574573	2.600494	0.363166	2.562806	0.745628	4.80822	0.627611	-0.09778	0.635183	-0.22773	-0.56692	0.610944	-0.53449	0.823911	0.982092	0.610944

Voltage sag table for 150KV bus,Sustainable transition scenario 2020

Voltage Sags	Voltage sag table assessment								Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.113449	1.272913	1.277959	#INF	#INF	#INF	#INF	0.014562	-0.07689	0.078253	0.014562	-0.07689	0.078253	0.014562	-0.07689	0.078252852	0.078253
-1	0	0	0	0.1	21	0.000816	0.063991	0.063996	#INF	#INF	#INF	#INF	0.943608	-0.07122	0.946292	0.943608	-0.07122	0.946292	0.943608	-0.07122	0.946291667	0.946292
-2	1	0	0	0.1	11	0.002929	0.030968	0.031106	0.002907	0.030908	0.044116	0.574418	0.997179	-0.06601	0.999361	-0.47446	-0.7977	0.928136	-0.52272	0.863712	1.009573573	0.928136
-3	0	0	0	0.1	21	0.000816	0.063991	0.063996	#INF	#INF	#INF	#INF	0.943608	-0.07122	0.946292	0.943608	-0.07122	0.946292	0.943608	-0.07122	0.946291667	0.946292
-4	0	0	0	0.1	150	0.113449	1.272913	1.277959	#INF	#INF	#INF	#INF	0.014562	-0.07689	0.078253	0.014562	-0.07689	0.078253	0.014562	-0.07689	0.078252852	0.078253
-5	0	0	0	0.1	150	0.497562	3.72439	3.757479	#INF	#INF	#INF	#INF	0.717343	-0.02243	0.717694	0.717343	-0.02243	0.717694	0.717343	-0.02243	0.717693556	0.717694
-6	0	0	0	0.1	380	0.728091	26.21927	26.22938	#INF	#INF	#INF	#INF	0.694204	0.032698	0.694974	0.694204	0.032698	0.694974	0.694204	0.032698	0.694973635	0.694974
-7	0	0	0	0.1	150	0.349117	3.173709	3.192853	#INF	#INF	#INF	#INF	0.707034	-0.01226	0.70714	0.707034	-0.01226	0.70714	0.707034	-0.01226	0.707140304	0.70714
-8	0	0	0	0.1	150	0.497562	3.72439	3.757479	#INF	#INF	#INF	#INF	0.717343	-0.02243	0.717694	0.717343	-0.02243	0.717694	0.717343	-0.02243	0.717693556	0.717694
-9	0	0	0	0.1	380	0.48387	4.957654	4.981211	#INF	#INF	#INF	#INF	0.904906	0.0233	0.905206	0.904906	0.0233	0.905206	0.904906	0.0233	0.905205921	0.905206
-10	0	0	0	0.1	66	0.039465	13.2704	13.27046	#INF	#INF	#INF	#INF	0.998028	0.021648	0.998263	0.998028	0.021648	0.998263	0.998028	0.021648	0.998262753	0.998263
-11	0	0	0	0.1	150	0.50373	3.797072	3.830339	#INF	#INF	#INF	#INF	0.724559	-0.02152	0.724879	0.724559	-0.02152	0.724879	0.724559	-0.02152	0.72487854	0.724879
-12	0	0	0	0.1	20	0.005431	0.107938	0.108075	#INF	#INF	#INF	#INF	0.958994	-0.03484	0.959627	0.958994	-0.03484	0.959627	0.958994	-0.03484	0.959626546	0.959627
-13	0	50	0	0.123	150	0.500689	3.760897	3.794079	#INF	#INF	#INF	#INF	0.720996	-0.02197	0.721331	0.720996	-0.02197	0.721331	0.720996	-0.02197	0.721330624	0.721331
-14	0	50	0	0.123	150	0.287909	2.398097	2.415318	#INF	#INF	#INF	#INF	0.54583	-0.02914	0.546607	0.54583	-0.02914	0.546607	0.54583	-0.02914	0.546607449	0.546607
-15	0	50	0	0.123	150	0.339785	2.602685	2.624771	#INF	#INF	#INF	#INF	0.55763	-0.03659	0.558829	0.55763	-0.03659	0.558829	0.55763	-0.03659	0.558828911	0.558829
2	3	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.014782	-0.08029	0.08164	-0.45002	-0.88605	0.993782	-0.4871	0.856084	0.984961496	0.08164
2	1	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.281757	-0.4562	0.536195	0.23903	-0.40247	0.468103	-0.52079	0.858674	1.004260991	0.468103
2	2	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.012258	-0.07877	0.079718	-0.07662	0.024481	0.080432	-0.50594	0.824049	0.966972116	0.079718
-1	3	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.998681	0.020425	0.99889	-0.48095	-0.88444	1.006746	-0.51774	0.864012	1.007256803	0.99889
-1	1	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.949996	-0.10749	0.956058	-0.43075	-0.75426	0.868595	-0.51925	0.861751	1.006098043	0.868595
-1	2	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.999276	-0.07334	1.001964	-0.4805	-0.78756	0.92257	-0.51878	0.860907	1.005131534	0.92257
-2	2	0	0	0.1	11	0.002929	0.030968	0.031106	0.002907	0.030908	0.044116	0.574418	1.012823	-0.02693	1.013181	-0.49314	-0.83312	0.968129	-0.51968	0.860046	1.004863464	0.968129
-2	0	0	0	0.1	11	0.002931	0.030977	0.031115	#INF	#INF	#INF	#INF	0.985513	-0.03198	0.986032	0.985513	-0.03198	0.986032	0.985513	-0.03198	0.986031741	0.986032
-2	3	0	0	0.1	11	0.002929	0.030968	0.031106	0.002907	0.030908	0.044116	0.574418	0.993736	0.015055	0.99385	-0.47849	-0.88194	1.003377	-0.51525	0.866882	1.008445245	0.99385
-3	3	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.998681	0.020425	0.99889	-0.48095	-0.88444	1.006746	-0.51774	0.864012	1.007256803	0.99889
-3	1	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.949996	-0.10749	0.956058	-0.43075	-0.75426	0.868595	-0.51925	0.861751	1.006098043	0.868595
-3	2	0	0	0.1	21	0.000815	0.063979	0.063984	0.000595	0.060833	0.000044	2.227006	0.999276	-0.07334	1.001964	-0.4805	-0.78756	0.92257	-0.51878	0.860907	1.005131534	0.92257
-4	3	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.014782	-0.08029	0.08164	-0.45002	-0.88605	0.993782	-0.4871	0.856084	0.984961496	0.08164
-4	1	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.281757	-0.4562	0.536195	0.23903	-0.40247	0.468103	-0.52079	0.858674	1.004260991	0.468103
-4	2	0	0	0.1	150	0.113286	1.27101	1.276049	0.110058	1.256824	0.071742	1.135542	0.012258	-0.07877	0.079718	-0.07662	0.024481	0.080432	-0.50594	0.824049	0.966972116	0.079718
-5	3	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.80503	-0.01163	0.805114	-0.44753	-0.87776	0.985268	-0.48428	0.869587	0.995345439	0.805114
-5	1	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.807442	-0.13458	0.81858	-0.285	-0.72783	0.781639	-0.52244	0.862406	1.008308791	0.781639
-5	2	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.763811	-0.08137	0.768133	-0.33315	-0.66969	0.747984	-0.50059	0.836382	0.974744171	0.747984
-6	3	0	0	0.1	380	0.727041	26.20669	26.21678	0.706692	26.11602	2.62E+10	-36.0996	1.009777	0.021243	1.01	-0.48649	-0.88511	1.01	-0.52329	0.863871	1.010000146	1.01
-6	1	0	0	0.1	380	0.727041	26.20669	26.21678	0.706692	26.11602	2.62E+10	-36.0996	0.768813	-0.10498	0.775947	-0.24615	-0.7572	0.796202	-0.52267	0.862178	1.008231966	0.775947
-6	2	0	0	0.1	380	0.727041	26.20669	26.21678	0.706692	26.11602	2.62E+10	-36.0996	0.769069	-0.10543	0.776262	-0.24641	-0.75675	0.795854	-0.52266	0.86218	1.008232121	0.776262
-7	3	0	0	0.1	150	0.349119	3.172621	3.191772	0.347989	3.164409	1.924957	12.30684	0.847094	0.001808	0.847096	-0.49629	-0.88469	1.01439	-0.53309	0.863271	1.014606344	0.847096
-7	1	0	0	0.1	150	0.349119	3.172621	3.191772	0.347989	3.164409	1.924957	12.30684	0.795293	-0.13054	0.805935	-0.27282	-0.73179	0.78099	-0.52248	0.86233	1.008262961	0.78099
-7	2	0	0	0.1	150	0.349119	3.172621	3.191772	0.347989	3.164409	1.924957	12.30684	0.763218	-0.08701	0.768162	-0.31031	-0.68219	0.749449	-0.52582	0.867985	1.014831281	0.749449
-8	3	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.80503	-0.01163	0.805114	-0.44753	-0.87776	0.985268	-0.48428	0.869587	0.995345439	0.805114

-8	1	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.807442	-0.13458	0.81858	-0.285	-0.72783	0.781639	-0.52244	0.862406	1.008308791	0.781639
-8	2	0	0	0.1	150	0.492741	3.702626	3.735269	0.490848	3.692116	0.980731	5.808361	0.763811	-0.08137	0.768133	-0.33315	-0.66969	0.747984	-0.50059	0.836382	0.974744171	0.747984
-9	3	0	0	0.1	380	0.483861	4.957605	4.981161	0.483741	4.957243	0	433.2	1.007451	0.021555	1.007682	-0.48533	-0.88526	1.009565	-0.52213	0.863703	1.009256376	1.007682
-9	1	0	0	0.1	380	0.483861	4.957605	4.981161	0.483741	4.957243	0	433.2	0.930205	-0.02135	0.93045	-0.40713	-0.84196	0.935225	-0.52308	0.863311	1.009412373	0.93045
-9	2	0	0	0.1	380	0.483861	4.957605	4.981161	0.483741	4.957243	0	433.2	0.930606	-0.02182	0.930862	-0.40776	-0.84094	0.934587	-0.52284	0.862762	1.008823135	0.930862
-10	3	0	0	0.1	66	0.039395	13.27029	13.27035	0.03933	13.2696	7.19E+08	1.902961	1.009777	0.021243	1.01	-0.48649	-0.88511	1.01	-0.52329	0.863871	1.010000146	1.01
-10	1	0	0	0.1	66	0.039395	13.27029	13.27035	0.03933	13.2696	7.19E+08	1.902961	0.998112	0.02168	0.998347	-0.48065	-0.88528	1.007341	-0.51746	0.863595	1.006759296	0.998347
-10	2	0	0	0.1	66	0.039395	13.27029	13.27035	0.03933	13.2696	7.19E+08	1.902961	0.998111	0.021636	0.998345	-0.48065	-0.88525	1.007321	-0.51746	0.863617	1.006778168	0.998345
-11	3	0	0	0.1	150	0.49867	3.774185	3.806986	0.496815	3.7638	0.98087	5.770256	0.809402	-0.01117	0.809479	-0.44657	-0.87748	0.984583	-0.48332	0.869889	0.995141713	0.809479
-11	1	0	0	0.1	150	0.49867	3.774185	3.806986	0.496815	3.7638	0.98087	5.770256	0.812563	-0.1309	0.823038	-0.2901	-0.73155	0.786971	-0.52246	0.862443	1.0083508	0.786971
-11	2	0	0	0.1	150	0.49867	3.774185	3.806986	0.496815	3.7638	0.98087	5.770256	0.769852	-0.079	0.773895	-0.33712	-0.67492	0.754433	-0.49977	0.835636	0.973682483	0.754433
-12	3	0	0	0.1	20	0.005376	0.104832	0.10497	0.005363	0.104773	0.018601	0.094955	0.967328	-0.02973	0.967785	-0.48244	-0.87882	1.002537	-0.51891	0.869804	1.012828415	0.967785
-12	1	0	0	0.1	20	0.005376	0.104832	0.10497	0.005363	0.104773	0.018601	0.094955	0.970939	-0.04929	0.972189	-0.44808	-0.81427	0.929413	-0.52286	0.863554	1.009506765	0.929413
-12	2	0	0	0.1	20	0.005376	0.104832	0.10497	0.005363	0.104773	0.018601	0.094955	0.967965	-0.03752	0.968692	-0.50296	-0.81767	0.959978	-0.51552	0.863405	1.005599884	0.959978
-13	3	50	0	0.123	150	0.495749	3.738574	3.7713	0.493875	3.728127	0.981176	5.791814	0.807266	-0.01139	0.807346	-0.44706	-0.87763	0.98493	-0.48381	0.869737	0.995245982	0.807346
-13	1	50	0	0.123	150	0.495749	3.738574	3.7713	0.493875	3.728127	0.981176	5.791814	0.810035	-0.13271	0.820835	-0.28759	-0.72971	0.784337	-0.52245	0.862425	1.008330223	0.784337
-13	2	50	0	0.123	150	0.495749	3.738574	3.7713	0.493875	3.728127	0.981176	5.791814	0.766877	-0.08018	0.771057	-0.33515	-0.67235	0.751255	-0.50019	0.836018	0.974224888	0.751255
-14	3	50	0	0.123	150	0.287838	2.396629	2.413852	0.285763	2.385626	0.997859	6.720019	0.719594	-0.01138	0.719684	-0.48863	-0.88501	1.01094	-0.52548	0.862059	1.009589395	0.719684
-14	1	50	0	0.123	150	0.287838	2.396629	2.413852	0.285763	2.385626	0.997859	6.720019	0.678773	-0.20952	0.710375	-0.15671	-0.65197	0.670542	-0.52206	0.861496	1.007333588	0.670542
-14	2	50	0	0.123	150	0.287838	2.396629	2.413852	0.285763	2.385626	0.997859	6.720019	0.620853	-0.12994	0.634304	-0.22589	-0.56027	0.604095	-0.52334	0.86258	1.008922606	0.604095
-15	3	50	0	0.123	150	0.338045	2.593542	2.61548	0.335519	2.581259	0.745628	4.80822	0.692212	-0.02173	0.692553	-0.45403	-0.88069	0.990833	-0.49083	0.865962	0.995392997	0.692553
-15	1	50	0	0.123	150	0.338045	2.593542	2.61548	0.335519	2.581259	0.745628	4.80822	0.690918	-0.211	0.722418	-0.16888	-0.65058	0.67214	-0.52204	0.861575	1.007390787	0.67214
-15	2	50	0	0.123	150	0.338045	2.593542	2.61548	0.335519	2.581259	0.745628	4.80822	0.623664	-0.12392	0.635856	-0.24642	-0.55278	0.605216	-0.50641	0.84004	0.980876803	0.605216

Voltage sag table for 150KV bus,Sustainable transition scenario 2030

Voltage Sags	Voltage sag table assessment												BB150	BB150		BB150	BB150		BB150	BB150		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part in Ohm	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	Minimum of phase voltages
2	0	0	0	0.1	150	0.110428	1.274324	1.2791	#INF	#INF	#INF	#INF	0.014856	-0.07678	0.078199	0.014856	-0.07678	0.078199	0.014856	-0.07678	0.078199	0.078199
-1	0	0	0	0.1	21	0.000799	0.063999	0.064004	#INF	#INF	#INF	#INF	0.943191	-0.06546	0.945459	0.943191	-0.06546	0.945459	0.943191	-0.06546	0.945459	0.945459
-2	1	0	0	0.1	11	0.00292	0.030974	0.031111	0.002898	0.030914	0.044116	0.574418	0.997702	-0.0597	0.999487	-0.46942	-0.80063	0.928093	-0.52828	0.860324	1.009574	0.928093
-3	0	0	0	0.1	21	0.000799	0.063999	0.064004	#INF	#INF	#INF	#INF	0.944763	-0.06451	0.946963	0.944763	-0.06451	0.946963	0.944763	-0.06451	0.946963	0.946963
-4	0	0	0	0.1	150	0.110428	1.274324	1.2791	#INF	#INF	#INF	#INF	0.014856	-0.07678	0.078199	0.014856	-0.07678	0.078199	0.014856	-0.07678	0.078199	0.078199
-5	0	0	0	0.1	150	0.495281	3.725335	3.758114	#INF	#INF	#INF	#INF	0.717339	-0.01837	0.717574	0.717339	-0.01837	0.717574	0.717339	-0.01837	0.717574	0.717574
-6	0	0	0	0.1	380	0.708701	26.22833	26.2379	#INF	#INF	#INF	#INF	0.693783	0.036643	0.69475	0.693783	0.036643	0.69475	0.693783	0.036643	0.69475	0.69475
-7	0	0	0	0.1	150	0.347333	3.17436	3.193306	#INF	#INF	#INF	#INF	0.706951	-0.00777	0.706994	0.706951	-0.00777	0.706994	0.706951	-0.00777	0.706994	0.706994
-8	0	0	0	0.1	150	0.495281	3.725335	3.758114	#INF	#INF	#INF	#INF	0.717339	-0.01837	0.717574	0.717339	-0.01837	0.717574	0.717339	-0.01837	0.717574	0.717574
-9	0	0	0	0.1	380	0.483795	4.957698	4.981248	#INF	#INF	#INF	#INF	0.90465	0.029559	0.905133	0.90465	0.029559	0.905133	0.90465	0.029559	0.905133	0.905133
-10	0	0	0	0.1	66	0.03931	13.27046	13.27052	#INF	#INF	#INF	#INF	0.99786	0.028104	0.998256	0.99786	0.028104	0.998256	0.99786	0.028104	0.998256	0.998256
-11	0	0	0	0.1	150	0.501474	3.798002	3.830965	#INF	#INF	#INF	#INF	0.724552	-0.0174	0.724761	0.724552	-0.0174	0.724761	0.724552	-0.0174	0.724761	0.724761
-12	0	0	0	0.1	20	0.005417	0.107944	0.10808	#INF	#INF	#INF	#INF	0.959285	-0.02882	0.959718	0.959285	-0.02882	0.959718	0.959285	-0.02882	0.959718	0.959718
-13	0	50	0	0.123	150	0.49842	3.761834	3.794709	#INF	#INF	#INF	#INF	0.720991	-0.01788	0.721213	0.720991	-0.01788	0.721213	0.720991	-0.01788	0.721213	0.721213
-14	0	50	0	0.123	150	0.285544	2.399096	2.416029	#INF	#INF	#INF	#INF	0.545803	-0.02591	0.546418	0.545803	-0.02591	0.546418	0.545803	-0.02591	0.546418	0.546418
-15	0	50	0	0.123	150	0.337145	2.603852	2.625588	#INF	#INF	#INF	#INF	0.557658	-0.03366	0.558673	0.557658	-0.03366	0.558673	0.557658	-0.03366	0.558673	0.558673
2	3	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.015156	-0.08018	0.081601	-0.44411	-0.88812	0.992974	-0.49241	0.853726	0.985552	0.081601
2	1	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.284604	-0.45441	0.536176	0.241696	-0.40089	0.468115	-0.5263	0.855298	1.004254	0.468115
2	2	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.012591	-0.07873	0.079729	-0.07663	0.024098	0.08033	-0.51038	0.821012	0.96672	0.079729
-1	3	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.998451	0.026908	0.998814	-0.47519	-0.88754	1.006745	-0.52326	0.860631	1.007217	0.998814
-1	1	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.949682	-0.10195	0.955138	-0.42491	-0.75641	0.867581	-0.52478	0.858353	1.006061	0.867581
-1	2	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.999234	-0.06749	1.00151	-0.47493	-0.79002	0.921788	-0.5243	0.857505	1.00509	0.921788
-2	2	0	0	0.1	11	0.00292	0.030974	0.031111	0.002898	0.030914	0.044116	0.574418	1.013057	-0.02045	1.013263	-0.48785	-0.83623	0.968132	-0.52521	0.856678	1.004859	0.968132
-2	0	0	0	0.1	11	0.002922	0.030982	0.031119	#INF	#INF	#INF	#INF	0.985756	-0.02573	0.986092	0.985756	-0.02573	0.986092	0.985756	-0.02573	0.986092	0.986092
-2	3	0	0	0.1	11	0.00292	0.030974	0.031111	0.002898	0.030914	0.044116	0.574418	0.99361	0.021431	0.993841	-0.47279	-0.88499	1.003361	-0.52082	0.863557	1.008457	0.993841
-3	3	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.99862	0.026849	0.998981	-0.47528	-0.88751	1.006762	-0.52334	0.860665	1.00729	0.998981
-3	1	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.951393	-0.10043	0.956679	-0.42657	-0.75798	0.869771	-0.52482	0.85841	1.006134	0.869771
-3	2	0	0	0.1	21	0.000798	0.063988	0.063993	0.000579	0.060841	0.000044	2.227006	0.999997	-0.06615	1.002183	-0.47565	-0.79142	0.923359	-0.52435	0.857578	1.005177	0.923359
-4	3	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.015156	-0.08018	0.081601	-0.44411	-0.88812	0.992974	-0.49241	0.853726	0.985552	0.081601
-4	1	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.284604	-0.45441	0.536176	0.241696	-0.40089	0.468115	-0.5263	0.855298	1.004254	0.468115
-4	2	0	0	0.1	150	0.110273	1.272417	1.277186	0.107109	1.25819	0.071742	1.135542	0.012591	-0.07873	0.079729	-0.07663	0.024098	0.08033	-0.51038	0.821012	0.96672	0.079729
-5	3	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.805016	-0.00678	0.805045	-0.44183	-0.88044	0.985076	-0.48984	0.866639	0.995494	0.805045
-5	1	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.808429	-0.12985	0.81879	-0.28045	-0.72917	0.781246	-0.52798	0.85902	1.008306	0.781246
-5	2	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.764385	-0.07695	0.768248	-0.32905	-0.67138	0.747677	-0.5058	0.833197	0.974706	0.747677
-6	3	0	0	0.1	380	0.707705	26.21572	26.22527	0.687765	26.12479	2.62E+10	-36.0996	1.009619	0.027756	1.01	-0.48077	-0.88823	1.01	-0.52885	0.860477	1.009999	1.009999
-6	1	0	0	0.1	380	0.707705	26.21572	26.22527	0.687765	26.12479	2.62E+10	-36.0996	0.769553	-0.1005	0.776087	-0.24134	-0.75829	0.795772	-0.52821	0.858789	1.008228	0.776087
-6	2	0	0	0.1	380	0.707705	26.21572	26.22527	0.687765	26.12479	2.62E+10	-36.0996	0.769812	-0.10095	0.776403	-0.24161	-0.75784	0.795424	-0.52821	0.858791	1.008228	0.776403
-7	3	0	0	0.1	150	0.347339	3.17327	3.192223	0.346247	3.165039	1.924957	12.30684	0.847018	0.007327	0.84705	-0.49054	-0.88773	1.014245	-0.53862	0.859962	1.014714	0.84705
-7	1	0	0	0.1	150	0.347339	3.17327	3.192223	0.346247	3.165039	1.924957	12.30684	0.796035	-0.12552	0.80587	-0.26801	-0.73343	0.780861	-0.52802	0.858942	1.00826	0.780861
-7	2	0	0	0.1	150	0.347339	3.17327	3.192223	0.346247	3.165039	1.924957	12.30684	0.76373	-0.08217	0.768137	-0.30578	-0.68403	0.749262	-0.5313	0.864607	1.014805	0.749262
-8	3	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.805016	-0.00678	0.805045	-0.44183	-0.88044	0.985076	-0.48984	0.866639	0.995494	0.805045
-8	1	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.808429	-0.12985	0.81879	-0.28045	-0.72917	0.781246	-0.52798	0.85902	1.008306	0.781246
-8	2	0	0	0.1	150	0.490485	3.703557	3.735895	0.48864	3.69302	0.980731	5.808361	0.764385	-0.07695	0.768248	-0.32905	-0.67138	0.747677	-0.5058	0.833197	0.974706	0.747677
-9	3	0	0	0.1	380	0.483786	4.957649	4.981198	0.483668	4.957286	0	433.2	1.00729	0.028062	1.007681	-0.47961	-0.88838	1.00957	-0.52769	0.860313	1.009252	1.007681
-9	1	0	0	0.1	380	0.483786	4.957649	4.981198	0.483668	4.957286	0	433.2	0.930079	-0.01507	0.930201	-0.40145	-0.84485	0.935374	-0.52863	0.859918	1.009412	0.930201
-9	2	0	0	0.1	380	0.483786	4.957649	4.981198	0.483668	4.957286	0	433.2	0.930482	-0.01554	0.930612	-0.40208	-0.84383	0.934731	-0.5284	0.859369	1.008822	0.930612

-10	3	0	0	0.1	66	0.039241	13.27035	13.2704	0.039179	13.26966	7.19E+08	1.902907	1.009619	0.027756	1.01	-0.48077	-0.88823	1.01	-0.52885	0.860477	1.009999	1.009999
-10	1	0	0	0.1	66	0.039241	13.27035	13.2704	0.039179	13.26966	7.19E+08	1.902907	0.997944	0.028137	0.998341	-0.47493	-0.88837	1.007348	-0.52302	0.86023	1.006749	0.998341
-10	2	0	0	0.1	66	0.039241	13.27035	13.2704	0.039179	13.26966	7.19E+08	1.902907	0.997943	0.028093	0.998338	-0.47493	-0.88835	1.007328	-0.52302	0.860251	1.006767	0.998338
-11	3	0	0	0.1	150	0.49644	3.775102	3.807604	0.494632	3.764689	0.98087	5.770256	0.809386	-0.00629	0.80941	-0.44087	-0.88015	0.984394	-0.48888	0.866945	0.995289	0.80941
-11	1	0	0	0.1	150	0.49644	3.775102	3.807604	0.494632	3.764689	0.98087	5.770256	0.813525	-0.12612	0.823244	-0.28552	-0.73293	0.786584	-0.528	0.859056	1.008347	0.786584
-11	2	0	0	0.1	150	0.49644	3.775102	3.807604	0.494632	3.764689	0.98087	5.770256	0.770409	-0.07453	0.774006	-0.33298	-0.67664	0.754134	-0.50498	0.832457	0.973645	0.754134
-12	3	0	0	0.1	20	0.005363	0.104838	0.104975	0.005351	0.104779	0.018601	0.094955	0.967562	-0.0236	0.96785	-0.4768	-0.88186	1.002505	-0.52454	0.866494	1.012891	0.96785
-12	1	0	0	0.1	20	0.005363	0.104838	0.104975	0.005351	0.104779	0.018601	0.094955	0.971366	-0.04318	0.972325	-0.44295	-0.81699	0.929344	-0.52841	0.860165	1.009507	0.929344
-12	2	0	0	0.1	20	0.005363	0.104838	0.104975	0.005351	0.104779	0.018601	0.094955	0.96831	-0.03139	0.968819	-0.49783	-0.82084	0.960006	-0.52105	0.86012	1.005634	0.960006
-13	3	50	0	0.123	150	0.493506	3.739498	3.771922	0.49168	3.729023	0.981176	5.791814	0.807251	-0.00653	0.807277	-0.44135	-0.8803	0.98474	-0.48937	0.866791	0.995393	0.807277
-13	1	50	0	0.123	150	0.493506	3.739498	3.771922	0.49168	3.729023	0.981176	5.791814	0.811009	-0.12796	0.821042	-0.28302	-0.73108	0.783947	-0.52799	0.859039	1.008328	0.783947
-13	2	50	0	0.123	150	0.493506	3.739498	3.771922	0.49168	3.729023	0.981176	5.791814	0.767443	-0.07573	0.771171	-0.33103	-0.67405	0.750951	-0.5054	0.832836	0.974187	0.750951
-14	3	50	0	0.123	150	0.28548	2.397625	2.414561	0.283456	2.386592	0.997859	6.720019	0.719562	-0.00685	0.719595	-0.48286	-0.88789	1.010697	-0.53096	0.858897	1.009766	0.719595
-14	1	50	0	0.123	150	0.28548	2.397625	2.414561	0.283456	2.386592	0.997859	6.720019	0.68008	-0.20544	0.710433	-0.15249	-0.65267	0.670246	-0.5276	0.858112	1.00733	0.670246
-14	2	50	0	0.123	150	0.28548	2.397625	2.414561	0.283456	2.386592	0.997859	6.720019	0.621658	-0.12621	0.63434	-0.22223	-0.56139	0.603779	-0.52871	0.85924	1.008872	0.603779
-15	3	50	0	0.123	150	0.335423	2.5947	2.616291	0.332953	2.582383	0.745628	4.80822	0.692229	-0.01769	0.692455	-0.44829	-0.88331	0.990556	-0.49634	0.863057	0.995602	0.692455
-15	1	50	0	0.123	150	0.335423	2.5947	2.616291	0.332953	2.582383	0.745628	4.80822	0.692397	-0.20712	0.722711	-0.16482	-0.65107	0.671612	-0.52757	0.858191	1.007386	0.671612
-15	2	50	0	0.123	150	0.335423	2.5947	2.616291	0.332953	2.582383	0.745628	4.80822	0.624494	-0.1205	0.636014	-0.24309	-0.5538	0.604805	-0.51158	0.836833	0.980817	0.604805

Voltage sag table for 150KV bus,New strong holds scenario 2010

Voltage Sags	Voltage sag table assessment												BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.772202	7.584528	7.623737	#INF	#INF	#INF	#INF	0.001783	-0.01576	0.01586	0.001783	-0.01576	0.01586	0.001783	-0.01576	0.01586	0.01586
-1	0	0	0	0.1	150	0.777403	8.415639	8.451469	#INF	#INF	#INF	#INF	0.268868	-0.04632	0.272829	0.268868	-0.04632	0.272829	0.268868	-0.04632	0.272829	0.272829
-2	0	0	0	0.1	150	0.772202	7.584528	7.623737	#INF	#INF	#INF	#INF	0.001783	-0.01576	0.01586	0.001783	-0.01576	0.01586	0.001783	-0.01576	0.01586	0.01586
-3	1	0	0	0.1	11	0.006655	0.066307	0.06664	0.006586	0.066298	0.000001	0.612386	0.992604	-0.42239	1.078737	-0.38908	-0.62704	0.737939	-0.60353	1.049423	1.210593	0.737939
-4	0	0	0	0.1	150	0.777403	8.415639	8.451469	#INF	#INF	#INF	#INF	0.268868	-0.04632	0.272829	0.268868	-0.04632	0.272829	0.268868	-0.04632	0.272829	0.272829
-5	0	0	0	0.1	380	0.395374	3.332782	3.356152	#INF	#INF	#INF	#INF	0.401617	0.048418	0.404525	0.401617	0.048418	0.404525	0.401617	0.048418	0.404525	0.404525
-6	0	0	0	0.1	66	0.063208	12.43853	12.43869	#INF	#INF	#INF	#INF	1.121843	0.006256	1.12186	1.121843	0.006256	1.12186	1.121843	0.006256	1.12186	1.12186
-7	0	0	0	0.1	150	0.773471	8.433794	8.469188	#INF	#INF	#INF	#INF	0.276288	-0.04684	0.28023	0.276288	-0.04684	0.28023	0.276288	-0.04684	0.28023	0.28023
-8	0	0	0	0.1	380	0.395374	3.332782	3.356152	#INF	#INF	#INF	#INF	0.401617	0.048418	0.404525	0.401617	0.048418	0.404525	0.401617	0.048418	0.404525	0.404525
-9	0	0	0	0.1	21	0.000558	0.051637	0.05164	#INF	#INF	#INF	#INF	1.185764	-0.0404	1.186452	1.185764	-0.0404	1.186452	1.185764	-0.0404	1.186452	1.186452
-10	0	0	0	0.1	21	0.000558	0.051637	0.05164	#INF	#INF	#INF	#INF	1.184602	-0.03961	1.185264	1.184602	-0.03961	1.185264	1.184602	-0.03961	1.185264	1.185264
-11	0	0	0	0.1	20	0.008074	0.135718	0.135958	#INF	#INF	#INF	#INF	0.837862	-0.2917	0.887188	0.837862	-0.2917	0.887188	0.837862	-0.2917	0.887188	0.887188
-12	0	0	0	0.1	20	0.006364	0.131973	0.132126	#INF	#INF	#INF	#INF	0.857332	-0.29331	0.906117	0.857332	-0.29331	0.906117	0.857332	-0.29331	0.906117	0.906117
-13	0	50	0	0.123	150	0.797798	8.07587	8.115181	#INF	#INF	#INF	#INF	0.152041	-0.03364	0.155719	0.152041	-0.03364	0.155719	0.152041	-0.03364	0.155719	0.155719
-14	0	50	0	0.123	150	0.775445	8.424771	8.460383	#INF	#INF	#INF	#INF	0.272571	-0.04657	0.276521	0.272571	-0.04657	0.276521	0.272571	-0.04657	0.276521	0.276521
2	3	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.001438	-0.00954	0.009649	-1.08845	-1.01933	1.491225	-1.08485	1.077751	1.529201	0.009649
2	1	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.305952	-0.53029	0.612224	0.297787	-0.51908	0.598434	-0.60374	1.049376	1.210657	0.598434
2	2	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.00557	-0.01335	0.014461	-0.0109	0.008953	0.014102	-0.7635	1.354988	1.555288	0.014102
-1	3	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.159423	-0.03817	0.163928	-0.81347	-1.0146	1.300443	-0.80991	1.082444	1.351904	0.163928
-1	1	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.520665	-0.43937	0.681274	0.083007	-0.61008	0.6157	-0.60367	1.049445	1.210684	0.6157
-1	2	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.223353	0.042118	0.227289	-0.22032	-0.12094	0.251336	-0.67643	1.224488	1.398904	0.227289
-2	3	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.001438	-0.00954	0.009649	-1.08845	-1.01933	1.491225	-1.08485	1.077751	1.529201	0.009649
-2	1	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.305952	-0.53029	0.612224	0.297787	-0.51908	0.598434	-0.60374	1.049376	1.210657	0.598434
-2	2	0	0	0.1	150	0.764744	7.517484	7.556282	0.759607	7.515917	3.856543	22.18157	0.00557	-0.01335	0.014461	-0.0109	0.008953	0.014102	-0.7635	1.354988	1.555288	0.014102
-3	2	0	0	0.1	11	0.006655	0.066307	0.06664	0.006586	0.066298	0.000001	0.612386	1.144342	-0.31154	1.185992	-0.56172	-0.7087	0.904312	-0.58263	1.020243	1.174883	0.904312
-17	1	0	0	0.1	11	0.081045	0.146262	0.167215	0.080977	0.146254	0.301664	0.939158	1.119695	-0.18937	1.135595	-0.5162	-0.86022	1.003217	-0.6035	1.049589	1.210722	1.003217
-3	0	0	0	0.1	11	0.006711	0.066651	0.066988	#INF	#INF	#INF	#INF	0.965217	-0.29534	1.009392	0.965217	-0.29534	1.009392	0.965217	-0.29534	1.009392	1.009392
-4	3	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.159423	-0.03817	0.163928	-0.81347	-1.0146	1.300443	-0.80991	1.082444	1.351904	0.163928
-4	1	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.520665	-0.43937	0.681274	0.083007	-0.61008	0.6157	-0.60367	1.049445	1.210684	0.6157
-4	2	0	0	0.1	150	0.762169	8.304734	8.339635	0.758454	8.303414	1.992841	10.98217	0.223353	0.042118	0.227289	-0.22032	-0.12094	0.251336	-0.67643	1.224488	1.398904	0.227289
-5	3	0	0	0.1	380	0.39494	3.331505	3.354833	0.389249	3.312176	0.34624	3.614577	0.690832	0.034575	0.691697	-0.3469	-1.06457	1.119669	-0.34393	1.029999	1.085902	0.691697
-5	1	0	0	0.1	380	0.39494	3.331505	3.354833	0.389249	3.312176	0.34624	3.614577	0.581377	-0.3024	0.655319	0.021627	-0.74489	0.745202	-0.603	1.047284	1.208477	0.655319
-5	2	0	0	0.1	380	0.39494	3.331505	3.354833	0.389249	3.312176	0.34624	3.614577	0.532663	-0.19681	0.567858	-0.03864	-0.62222	0.623416	-0.49403	0.819024	0.956484	0.567858
-6	3	0	0	0.1	66	0.062692	12.43388	12.43404	0.062137	12.43326	7.19E+08	-2.45861	1.210824	-0.00223	1.210826	-0.60734	-1.04749	1.210826	-0.60348	1.04972	1.210826	1.210826
-6	1	0	0	0.1	66	0.062692	12.43388	12.43404	0.062137	12.43326	7.19E+08	-2.45861	1.14092	-0.03384	1.141422	-0.53742	-1.01584	1.149239	-0.6035	1.049683	1.210804	1.141422
-6	2	0	0	0.1	66	0.062692	12.43388	12.43404	0.062137	12.43326	7.19E+08	-2.45861	1.14105	-0.03412	1.14156	-0.53755	-1.01556	1.149052	-0.6035	1.049683	1.210804	1.14156
-17	2	0	0	0.1	11	0.081045	0.146262	0.167215	0.080977	0.146254	0.301664	0.939158	1.152381	-0.16339	1.163907	-0.56452	-0.87222	1.038962	-0.58787	1.035612	1.190831	1.038962
-18	1	0	0	0.1	11	0.128272	0.149326	0.196855	0.128205	0.149317	0.496089	0.951705	1.157923	-0.16939	1.170247	-0.55444	-0.88022	1.040284	-0.60348	1.049608	1.210729	1.040284
-15	1	0	0	0.1	11	0.129422	0.147026	0.195874	0.129355	0.147018	0.496089	0.951705	1.158133	-0.16627	1.170008	-0.55465	-0.88334	1.043037	-0.60348	1.04961	1.210731	1.043037
-18	2	0	0	0.1	11	0.128272	0.149326	0.196855	0.128205	0.149317	0.496089	0.951705	1.174891	-0.14393	1.183674	-0.58726	-0.89545	1.070839	-0.58763	1.039376	1.193992	1.070839
-15	2	0	0	0.1	11	0.129422	0.147026	0.195874	0.129355	0.147018	0.496089	0.951705	1.174819	-0.14101	1.183251	-0.58674	-0.89835	1.072982	-0.58808	1.039356	1.194196	1.072982
-3	3	0	0	0.1	11	0.006655	0.066307	0.06664	0.006586	0.066298	0.000001	0.612386	1.09678	-0.03251	1.097262	-0.55028	-1.03232	1.169824	-0.54651	1.064827	1.196881	1.097262
-17	3	0	0	0.1	11	0.081045	0.146262	0.167215	0.080977	0.146254	0.301664	0.939158	1.151303	-0.02872	1.151661	-0.57756	-1.03423	1.184567	-0.57374	1.062942	1.207902	1.151661

-18	3	0	0	0.1	11	0.128272	0.149326	0.196855	0.128205	0.149317	0.496089	0.951705	1.162221	-0.03318	1.162695	-0.58303	-1.03199	1.185295	-0.5792	1.065175	1.212463	1.162695
-15	3	0	0	0.1	11	0.129422	0.147026	0.195874	0.129355	0.147018	0.496089	0.951705	1.162756	-0.03203	1.163197	-0.58329	-1.03257	1.185931	-0.57946	1.064597	1.212083	1.163197
-16	1	0	0	0.1	11	0.700983	0.638014	0.94786	0.700914	0.638006	2.786074	2.899675	1.197625	-0.04202	1.198362	-0.59415	-1.00767	1.169788	-0.60348	1.049693	1.210803	1.169788
-19	1	0	0	0.1	11	0.771992	0.505981	0.923032	0.771923	0.505972	3.066289	2.369886	1.203692	-0.04442	1.204511	-0.60022	-1.00528	1.170829	-0.60348	1.049693	1.210801	1.170829
-16	2	0	0	0.1	11	0.700983	0.638014	0.94786	0.700914	0.638006	2.786074	2.899675	1.19694	-0.03992	1.197605	-0.59826	-1.0078	1.171995	-0.59868	1.047718	1.206704	1.171995
-19	2	0	0	0.1	11	0.771992	0.505981	0.923032	0.771923	0.505972	3.066289	2.369886	1.202449	-0.04214	1.203187	-0.60417	-1.00626	1.173703	-0.59828	1.048396	1.207094	1.173703
-20	1	0	0	0.1	11	0.0165	0.171679	0.17247	0.021998	0.202434	4.909641	3.926728	1.219883	-0.0227	1.220094	-0.61436	-1.0264	1.196221	-0.60552	1.049099	1.211307	1.196221
-16	3	0	0	0.1	11	0.700983	0.638014	0.94786	0.700914	0.638006	2.786074	2.899675	1.198737	-0.01204	1.198797	-0.6013	-1.04258	1.203546	-0.59744	1.05462	1.212089	1.198797
-19	3	0	0	0.1	11	0.771992	0.505981	0.923032	0.771923	0.505972	3.066289	2.369886	1.200008	-0.01402	1.20009	-0.60193	-1.04159	1.203007	-0.59808	1.055608	1.213261	1.20009
-20	2	0	0	0.1	11	0.0165	0.171679	0.17247	0.021998	0.202434	4.909641	3.926728	1.222552	-0.01865	1.222694	-0.61765	-1.03048	1.201402	-0.60491	1.049125	1.211023	1.201402
-20	3	0	0	0.1	11	0.0165	0.171679	0.17247	0.021998	0.202434	4.909641	3.926728	1.211378	-0.00364	1.211383	-0.60752	-1.04675	1.210276	-0.60386	1.050391	1.211598	1.210276
-7	3	0	0	0.1	150	0.757974	8.321107	8.355558	0.754307	8.319796	1.921077	10.51324	0.166815	-0.03889	0.171288	-0.79759	-1.01385	1.289979	-0.79404	1.083193	1.343057	0.171288
-7	1	0	0	0.1	150	0.757974	8.321107	8.355558	0.754307	8.319796	1.921077	10.51324	0.526483	-0.43658	0.683949	0.077187	-0.61287	0.617709	-0.60367	1.049447	1.210684	0.617709
-7	2	0	0	0.1	150	0.757974	8.321107	8.355558	0.754307	8.319796	1.921077	10.51324	0.229837	0.042812	0.23379	-0.22542	-0.1259	0.258194	-0.66942	1.214955	1.387167	0.23379
-8	3	0	0	0.1	380	0.394939	3.331505	3.354833	0.389249	3.312176	0.346239	3.614577	0.690832	0.034575	0.691697	-0.3469	-1.06457	1.119669	-0.34393	1.029999	1.085902	0.691697
-8	1	0	0	0.1	380	0.394939	3.331505	3.354833	0.389249	3.312176	0.346239	3.614577	0.581377	-0.3024	0.655319	0.021627	-0.74489	0.745202	-0.603	1.047284	1.208477	0.655319
-8	2	0	0	0.1	380	0.394939	3.331505	3.354833	0.389249	3.312176	0.346239	3.614577	0.532663	-0.19681	0.567858	-0.03864	-0.62222	0.623416	-0.49403	0.819024	0.956484	0.567858
-9	3	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.205262	-0.00258	1.205265	-0.60456	-1.04721	1.209189	-0.6007	1.049791	1.209505	1.205265
-9	1	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.188321	-0.0585	1.18976	-0.58622	-0.99056	1.151028	-0.6021	1.049066	1.209573	1.151028
-9	2	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.208125	-0.04002	1.208788	-0.60631	-1.00829	1.176546	-0.60182	1.048315	1.208781	1.176546
-10	3	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.205254	-0.00241	1.205256	-0.60455	-1.04729	1.209259	-0.6007	1.049706	1.20943	1.205256
-10	1	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.186601	-0.05779	1.188007	-0.58448	-0.99124	1.150725	-0.60212	1.049024	1.209547	1.150725
-10	2	0	0	0.1	21	0.000558	0.051635	0.051638	0.000422	0.049581	0.000025	1.670263	1.206964	-0.03992	1.207624	-0.6051	-1.00834	1.175969	-0.60186	1.048265	1.208759	1.175969
-11	3	0	0	0.1	20	0.0079	0.130842	0.13108	0.007878	0.130836	0.034136	0.146783	0.697085	-0.37269	0.790459	-0.78287	-1.13572	1.3794	-0.77909	0.961329	1.23739	0.790459
-11	1	0	0	0.1	20	0.0079	0.130842	0.13108	0.007878	0.130836	0.034136	0.146783	0.924022	-0.38444	1.000806	-0.32049	-0.66509	0.738279	-0.60353	1.04953	1.210685	0.738279
-11	2	0	0	0.1	20	0.0079	0.130842	0.13108	0.007878	0.130836	0.034136	0.146783	0.710016	-0.20966	0.740325	-0.81596	-0.50324	0.958669	-0.76096	1.149226	1.378325	0.740325
-12	3	0	0	0.1	20	0.006105	0.12683	0.126977	0.006086	0.126824	0.000305	0.135006	0.743737	-0.42175	0.854995	-0.72784	-1.182	1.388117	-0.72406	0.915048	1.166866	0.854995
-12	1	0	0	0.1	20	0.006105	0.12683	0.126977	0.006086	0.126824	0.000305	0.135006	0.940292	-0.38124	1.014639	-0.33677	-0.66829	0.748351	-0.60352	1.049533	1.210685	0.748351
-12	2	0	0	0.1	20	0.006105	0.12683	0.126977	0.006086	0.126824	0.000305	0.135006	0.698294	-0.24783	0.740968	-0.85953	-0.5565	1.02395	-0.77855	1.089807	1.339334	0.740968
-21	3	0	0	0.1	0.69	0.000011	0.000193	0.000193	0.000011	0.000193	0	0.000232	1.210918	-0.00329	1.210922	-0.60727	-1.04791	1.211148	-0.6034	1.049301	1.210424	1.210424
-21	1	0	0	0.1	0.69	0.000011	0.000193	0.000193	0.000011	0.000193	0	0.000232	1.2114	-0.00318	1.211404	-0.60792	-1.04654	1.210294	-0.60348	1.04972	1.210826	1.210294
-21	2	0	0	0.1	0.69	0.000011	0.000193	0.000193	0.000011	0.000193	0	0.000232	1.210516	-0.00315	1.21052	-0.60823	-1.04746	1.211245	-0.6038	1.049442	1.210746	1.21052
-22	3	0	0	0.1	0.69	0	0	0	0	0	0	0	1.210824	-0.00223	1.210826	-0.60734	-1.04749	1.210826	-0.60348	1.04972	1.210826	1.210826
-22	1	0	0	0.1	0.69	0	0	0	0	0	0	0	1.210824	-0.00223	1.210826	-0.60734	-1.04749	1.210826	-0.60348	1.04972	1.210826	1.210826
-22	2	0	0	0.1	0.69	0	0	0	0	0	0	0	1.210824	-0.00223	1.210826	-0.60734	-1.04749	1.210826	-0.60348	1.04972	1.210826	1.210826
-23	3	0	0	0.1	0.69	0.00006	0.002392	0.002393	0.00006	0.002392	0.000028	0.001212	1.210868	-0.00322	1.210872	-0.6073	-1.04776	1.211039	-0.60344	1.049448	1.210569	1.210569
-23	1	0	0	0.1	0.69	0.00006	0.002392	0.002393	0.00006	0.002392	0.000028	0.001212	1.211418	-0.00333	1.211423	-0.60794	-1.04639	1.210176	-0.60348	1.049719	1.210825	1.210176
-23	2	0	0	0.1	0.69	0.00006	0.002392	0.002393	0.00006	0.002392	0.000028	0.001212	1.21061	-0.00313	1.210614	-0.60818	-1.0473	1.211084	-0.60369	1.049546	1.210781	1.210614
-13	3	50	0	0.123	150	0.786761	7.988247	8.026897	0.782362	7.986804	2.926808	16.58773	0.073538	-0.02486	0.077626	-0.97031	-1.01903	1.407095	-0.96673	1.078036	1.448006	0.077626
-13	1	50	0	0.123	150	0.786761	7.988247	8.026897	0.782362	7.986804	2.926808	16.58773	0.427079	-0.47973	0.642288	0.176622	-0.56969	0.596439	-0.6037	1.049415	1.210672	0.596439
-13	2	50	0	0.123	150	0.786761	7.988247	8.026897	0.782362	7.986804	2.926808	16.58773	0.126081	0.022815	0.128129	-0.13134	-0.05812	0.143623	-0.73287	1.30586	1.497453	0.128129
-14	3	50	0	0.123	150	0.76008	8.312979	8.347655	0.756389	8.311664	1.957064	10.74805	0.163087	-0.03853	0.167575	-0.8056	-1.01423	1.295243	-0.80204	1.082815	1.347501	0.167575
-14	1	50	0	0.123	150	0.76008	8.312979	8.347655	0.756389	8.311664	1.957064	10.74805	0.523567	-0.43797	0.682599	0.080105	-0.61147	0.616699	-0.60367	1.049446	1.210684	0.616699
-14	2	50	0	0.123	150	0.76008	8.312979	8.347655	0.756389	8.311664	1.957064	10.74805	0.226581	0.042479	0.230529	-0.22287	-0.12341	0.254757	-0.67298	1.219794	1.393127	0.230529

Voltage sag table for 150KV bus,New strong holds scenario 2020

Voltage Sags	Voltage sag table assessment	Voltage sag table assess	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment		Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.548004	7.712151	7.731596	#INF	#INF	#INF	#INF	0.00315	-0.0151	0.015424	0.00315	-0.0151	0.015424	0.00315	-0.0151	0.015424	0.015424
-1	0	0	0	0.1	150	0.607344	8.502682	8.524346	#INF	#INF	#INF	#INF	0.27078	-0.04527	0.274538	0.27078	-0.04527	0.274538	0.27078	-0.04527	0.274538	0.274538
-2	0	0	0	0.1	150	0.548004	7.712151	7.731596	#INF	#INF	#INF	#INF	0.00315	-0.0151	0.015424	0.00315	-0.0151	0.015424	0.00315	-0.0151	0.015424	0.015424
-3	1	0	0	0.1	11	0.005017	0.067333	0.06752	0.004947	0.06732	0.000001	0.612386	1.027324	-0.30537	1.07175	-0.30927	-0.64789	0.717919	-0.71805	0.953262	1.193443	0.717919
-4	0	0	0	0.1	150	0.607344	8.502682	8.524346	#INF	#INF	#INF	#INF	0.27078	-0.04527	0.274538	0.27078	-0.04527	0.274538	0.27078	-0.04527	0.274538	0.274538
-5	0	0	0	0.1	380	0.346448	3.346294	3.36418	#INF	#INF	#INF	#INF	0.363545	0.172866	0.402551	0.363545	0.172866	0.402551	0.363545	0.172866	0.402551	0.402551
-6	0	0	0	0.1	66	0.046577	12.44789	12.44797	#INF	#INF	#INF	#INF	1.095114	0.144883	1.104656	1.095114	0.144883	1.104656	1.095114	0.144883	1.104656	1.104656
-7	0	0	0	0.1	150	0.605276	8.51957	8.541044	#INF	#INF	#INF	#INF	0.278262	-0.0457	0.28199	0.278262	-0.0457	0.28199	0.278262	-0.0457	0.28199	0.28199
-8	0	0	0	0.1	380	0.346447	3.346294	3.36418	#INF	#INF	#INF	#INF	0.363545	0.172866	0.402551	0.363545	0.172866	0.402551	0.363545	0.172866	0.402551	0.402551
-9	0	0	0	0.1	21	0.000501	0.051653	0.051655	#INF	#INF	#INF	#INF	1.161223	0.105148	1.165974	1.161223	0.105148	1.165974	1.161223	0.105148	1.165974	1.165974
-10	0	0	0	0.1	21	0.000501	0.051653	0.051655	#INF	#INF	#INF	#INF	1.161223	0.105148	1.165974	1.161223	0.105148	1.165974	1.161223	0.105148	1.165974	1.165974
-11	0	0	0	0.1	20	0.007083	0.13627	0.136454	#INF	#INF	#INF	#INF	0.892522	-0.2212	0.919524	0.892522	-0.2212	0.919524	0.892522	-0.2212	0.919524	0.919524
-12	0	50	0	0.123	150	0.601534	8.182324	8.204405	#INF	#INF	#INF	#INF	0.153286	-0.03337	0.156877	0.153286	-0.03337	0.156877	0.153286	-0.03337	0.156877	0.156877
-13	0	50	0	0.123	150	0.606315	8.511184	8.532753	#INF	#INF	#INF	#INF	0.274514	-0.04548	0.278256	0.274514	-0.04548	0.278256	0.274514	-0.04548	0.278256	0.278256
2	3	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.002441	-0.00915	0.009466	-0.9369	-1.1158	1.456983	-1.18842	0.936228	1.512897	0.009466
2	1	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.363587	-0.48165	0.603475	0.354666	-0.47154	0.590028	-0.71825	0.953186	1.193504	0.590028
2	2	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.006637	-0.01251	0.014161	-0.01133	0.007594	0.013637	-0.90464	1.234796	1.530714	0.013637
-1	3	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.165045	-0.04809	0.171908	-0.66949	-1.08505	1.274966	-0.92103	0.966937	1.335389	0.171908
-1	1	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.578492	-0.39014	0.697757	0.139697	-0.56312	0.580184	-0.71819	0.953258	1.193522	0.580184
-1	2	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.217865	0.034974	0.220654	-0.22781	-0.13137	0.262976	-0.80558	1.116287	1.37661	0.220654
-2	3	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.002441	-0.00915	0.009466	-0.9369	-1.1158	1.456983	-1.18842	0.936228	1.512897	0.009466
-2	1	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.363587	-0.48165	0.603475	0.354666	-0.47154	0.590028	-0.71825	0.953186	1.193504	0.590028
-2	2	0	0	0.1	150	0.544537	7.642867	7.662241	0.539389	7.640867	3.856543	22.18157	0.006637	-0.01251	0.014161	-0.01133	0.007594	0.013637	-0.90464	1.234796	1.530714	0.013637
-3	2	0	0	0.1	11	0.005017	0.067333	0.06752	0.004947	0.06732	0.000001	0.612386	1.165256	-0.17464	1.17827	-0.47268	-0.75312	0.889168	-0.69257	0.927757	1.157752	0.889168
-16	1	0	0	0.1	11	0.079432	0.147267	0.167323	0.079364	0.147255	0.301664	0.939158	1.123297	-0.0552	1.124653	-0.40525	-0.89823	0.985418	-0.71805	0.953434	1.193579	0.985418
-3	0	0	0	0.1	11	0.00505	0.067692	0.06788	#INF	#INF	#INF	#INF	0.983707	-0.18547	1.001038	0.983707	-0.18547	1.001038	0.983707	-0.18547	1.001038	1.001038
-4	3	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.165045	-0.04809	0.171908	-0.66949	-1.08505	1.274966	-0.92103	0.966937	1.335389	0.171908
-4	1	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.578492	-0.39014	0.697757	0.139697	-0.56312	0.580184	-0.71819	0.953258	1.193522	0.580184
-4	2	0	0	0.1	150	0.596523	8.389326	8.410507	0.592814	8.387688	1.992841	10.98217	0.217865	0.034974	0.220654	-0.22781	-0.13137	0.262976	-0.80558	1.116287	1.37661	0.220654
-5	3	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.34624	3.614577	0.656591	0.164624	0.676914	-0.20227	-1.10705	1.125378	-0.45432	0.942427	1.046218	0.676914
-5	1	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.34624	3.614577	0.555977	-0.17706	0.583491	0.161488	-0.77405	0.790712	-0.71747	0.95111	1.191372	0.583491
-5	2	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.34624	3.614577	0.502218	-0.07203	0.507358	0.095821	-0.6519	0.658907	-0.59804	0.723936	0.939007	0.507358
-6	3	0	0	0.1	66	0.046386	12.44307	12.44315	0.045804	12.44244	7.19E+08	-1.33537	1.184841	0.14507	1.193689	-0.46679	-1.09864	1.19369	-0.71806	0.953568	1.19369	1.193689
-6	1	0	0	0.1	66	0.046386	12.44307	12.44315	0.045804	12.44244	7.19E+08	-1.33537	1.118077	0.1067	1.123157	-0.40001	-1.06023	1.133177	-0.71807	0.953528	1.193667	1.123157
-6	2	0	0	0.1	66	0.046386	12.44307	12.44315	0.045804	12.44244	7.19E+08	-1.33537	1.118235	0.106433	1.123289	-0.40017	-1.05996	1.132983	-0.71807	0.953528	1.193667	1.123289
-16	2	0	0	0.1	11	0.079432	0.147267	0.167323	0.079364	0.147255	0.301664	0.939158	1.152026	-0.0246	1.152289	-0.45177	-0.91754	1.022723	-0.70026	0.942137	1.173878	1.022723
-17	1	0	0	0.1	11	0.126661	0.150317	0.196566	0.126593	0.150304	0.496089	0.951705	1.158496	-0.02961	1.158874	-0.44046	-0.92385	1.023479	-0.71803	0.953457	1.193588	1.023479
-14	1	0	0	0.1	11	0.128491	0.150269	0.197714	0.128422	0.150257	0.496089	0.951705	1.157886	-0.02805	1.158226	-0.43985	-0.92541	1.024624	-0.71803	0.953457	1.193588	1.024624
-17	2	0	0	0.1	11	0.126661	0.150317	0.196566	0.126593	0.150304	0.496089	0.951705	1.171587	-0.00173	1.171588	-0.47094	-0.94418	1.055108	-0.70065	0.945908	1.177135	1.055108

-14	2	0	0	0.1	11	0.128491	0.150269	0.197714	0.128422	0.150257	0.496089	0.951705	1.170761	-0.00045	1.170761	-0.47	-0.94532	1.055707	-0.70077	0.945767	1.177093	1.055707
-3	3	0	0	0.1	11	0.005017	0.067333	0.06752	0.004947	0.06732	0.000001	0.612386	1.076634	0.096825	1.080979	-0.41264	-1.07448	1.150987	-0.66399	0.977651	1.181815	1.080979
-16	3	0	0	0.1	11	0.079432	0.147267	0.167323	0.079364	0.147255	0.301664	0.939158	1.130102	0.109156	1.135361	-0.4394	-1.08066	1.166571	-0.6907	0.971499	1.192008	1.135361
-14	3	0	0	0.1	11	0.128491	0.150269	0.197714	0.128422	0.150257	0.496089	0.951705	1.141495	0.10697	1.146496	-0.4451	-1.07956	1.167721	-0.6964	0.972593	1.196204	1.146496
-17	3	0	0	0.1	11	0.126661	0.150317	0.196566	0.126593	0.150304	0.496089	0.951705	1.141649	0.106469	1.146603	-0.44518	-1.07931	1.167518	-0.69647	0.972844	1.196453	1.146603
-15	1	0	0	0.1	11	0.699345	0.639044	0.947344	0.699276	0.639031	2.786074	2.899675	1.178228	0.103438	1.18276	-0.46018	-1.05698	1.152809	-0.71805	0.953541	1.193665	1.152809
-18	1	0	0	0.1	11	0.770354	0.507009	0.922227	0.770284	0.506996	3.066289	2.369886	1.184641	0.102041	1.189028	-0.4666	-1.05558	1.154108	-0.71805	0.953542	1.193663	1.154108
-15	2	0	0	0.1	11	0.699345	0.639044	0.947344	0.699276	0.639031	2.786074	2.899675	1.177209	0.10541	1.181919	-0.46424	-1.05778	1.155171	-0.71297	0.952372	1.189681	1.155171
-18	2	0	0	0.1	11	0.770354	0.507009	0.922227	0.770284	0.506996	3.066289	2.369886	1.183042	0.104098	1.187613	-0.47036	-1.05721	1.157119	-0.71269	0.95311	1.1901	1.157119
-19	1	0	0	0.1	11	0.016491	0.171655	0.172445	0.021984	0.2024	4.909641	3.926728	1.197174	0.125962	1.203782	-0.47717	-1.07858	1.17942	-0.72001	0.952622	1.194109	1.17942
-15	3	0	0	0.1	11	0.699345	0.639044	0.947344	0.699276	0.639031	2.786074	2.899675	1.174467	0.133357	1.182014	-0.4616	-1.09277	1.186266	-0.71287	0.959417	1.195268	1.182014
-18	3	0	0	0.1	11	0.770354	0.507009	0.922227	0.770284	0.506996	3.066289	2.369886	1.176051	0.131603	1.183391	-0.46239	-1.0919	1.185767	-0.71366	0.960294	1.196444	1.183391
-19	2	0	0	0.1	11	0.016491	0.171655	0.172445	0.021984	0.2024	4.909641	3.926728	1.199213	0.130446	1.206287	-0.47982	-1.08319	1.184706	-0.71939	0.952745	1.193839	1.184706
-19	3	0	0	0.1	11	0.016491	0.171655	0.172445	0.021984	0.2024	4.909641	3.926728	1.18562	0.143746	1.194302	-0.46708	-1.09793	1.193149	-0.71854	0.954181	1.194473	1.193149
-7	3	0	0	0.1	150	0.594203	8.40443	8.425409	0.590542	8.402806	1.921077	10.51324	0.172518	-0.04884	0.179298	-0.65417	-1.08227	1.264608	-0.90571	0.969713	1.326894	0.179298
-7	1	0	0	0.1	150	0.594203	8.40443	8.425409	0.590542	8.402806	1.921077	10.51324	0.584318	-0.38727	0.701001	0.133868	-0.566	0.581611	-0.71819	0.95326	1.193523	0.581611
-7	2	0	0	0.1	150	0.594203	8.40443	8.425409	0.590542	8.402806	1.921077	10.51324	0.224231	0.035551	0.227032	-0.23305	-0.13662	0.270141	-0.79734	1.108014	1.365082	0.227032
-8	3	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.346239	3.614577	0.656591	0.164624	0.676914	-0.20227	-1.10705	1.125378	-0.45432	0.942427	1.046218	0.676914
-8	1	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.346239	3.614577	0.555977	-0.17706	0.583491	0.161488	-0.77405	0.790712	-0.71747	0.95111	1.191372	0.583491
-8	2	0	0	0.1	380	0.346115	3.344943	3.362802	0.340973	3.325356	0.346239	3.614577	0.502218	-0.07203	0.507358	0.095821	-0.6519	0.658907	-0.59804	0.723936	0.939007	0.507358
-9	3	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.179217	0.144448	1.188031	-0.46398	-1.09822	1.192209	-0.71524	0.953772	1.192161	1.188031
-9	1	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.164642	0.086918	1.167881	-0.44802	-1.03989	1.132292	-0.71663	0.952971	1.192353	1.132292
-9	2	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.183886	0.106595	1.188675	-0.46758	-1.05882	1.157468	-0.7163	0.952223	1.191561	1.157468
-10	3	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.179217	0.144448	1.188031	-0.46398	-1.09822	1.192209	-0.71524	0.953772	1.192161	1.188031
-10	1	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.164642	0.086918	1.167881	-0.44802	-1.03989	1.132292	-0.71663	0.952971	1.192353	1.132292
-10	2	0	0	0.1	21	0.000501	0.051651	0.051653	0.00037	0.049595	0.000025	1.670263	1.183886	0.106595	1.188675	-0.46758	-1.05882	1.157468	-0.7163	0.952223	1.191561	1.157468
-11	3	0	0	0.1	20	0.00698	0.131357	0.131542	0.006958	0.131349	0.034136	0.146783	0.772963	-0.32244	0.83752	-0.61912	-1.21451	1.36321	-0.87042	0.837517	1.207919	0.83752
-11	1	0	0	0.1	20	0.00698	0.131357	0.131542	0.006958	0.131349	0.034136	0.146783	0.997133	-0.28954	1.038319	-0.27908	-0.66383	0.720114	-0.71805	0.953371	1.193529	0.720114
-11	2	0	0	0.1	20	0.00698	0.131357	0.131542	0.006958	0.131349	0.034136	0.146783	0.756621	-0.16525	0.774457	-0.78848	-0.61566	1.000363	-0.88672	1.02034	1.351798	0.774457
-20	3	0	0	0.1	20	0.00527	0.127256	0.127365	0.005251	0.127248	0.000305	0.135006	0.829482	-0.36272	0.905321	-0.55647	-1.24822	1.366642	-0.80778	0.803805	1.139563	0.905321
-20	1	0	0	0.1	20	0.00527	0.127256	0.127365	0.005251	0.127248	0.000305	0.135006	1.013995	-0.28447	1.053143	-0.29595	-0.6689	0.73145	-0.71804	0.953375	1.193528	0.73145
-20	2	0	0	0.1	20	0.00527	0.127256	0.127365	0.005251	0.127248	0.000305	0.135006	0.754154	-0.20645	0.7819	-0.82212	-0.67697	1.064971	-0.89133	0.959254	1.30944	0.7819
-21	3	0	0	0.1	0.69	0.00001	0.000193	0.000193	0.00001	0.000193	0	0.000232	1.185227	0.144091	1.193954	-0.46661	-1.09901	1.193964	-0.71788	0.953193	1.193282	1.193282
-21	1	0	0	0.1	0.69	0.00001	0.000193	0.000193	0.00001	0.000193	0	0.000232	1.185674	0.14434	1.194427	-0.46762	-1.09791	1.193343	-0.71806	0.953567	1.193689	1.193343
-21	2	0	0	0.1	0.69	0.00001	0.000193	0.000193	0.00001	0.000193	0	0.000232	1.184813	0.144122	1.193546	-0.46765	-1.09886	1.194227	-0.71829	0.953225	1.193556	1.193546
-22	3	0	0	0.1	0.69	0	0	0	0	0	0	0	1.184841	0.14507	1.193689	-0.46679	-1.09864	1.19369	-0.71806	0.953568	1.19369	1.193689
-22	1	0	0	0.1	0.69	0	0	0	0	0	0	0	1.184841	0.14507	1.193689	-0.46679	-1.09864	1.19369	-0.71806	0.953568	1.19369	1.193689
-22	2	0	0	0.1	0.69	0	0	0	0	0	0	0	1.184841	0.14507	1.193689	-0.46679	-1.09864	1.19369	-0.71806	0.953568	1.19369	1.193689
-23	3	0	0	0.1	0.69	0.000059	0.002392	0.002393	0.000059	0.002392	0.000028	0.001212	1.18511	0.144129	1.193842	-0.4667	-1.09889	1.193882	-0.71796	0.953319	1.193436	1.193436
-23	1	0	0	0.1	0.69	0.000059	0.002392	0.002393	0.000059	0.002392	0.000028	0.001212	1.185681	0.144162	1.194413	-0.46763	-1.09773	1.193183	-0.71806	0.953567	1.193689	1.193183
-23	2	0	0	0.1	0.69	0.000059	0.002392	0.002393	0.000059	0.002392	0.000028	0.001212	1.184849	0.14417	1.193588	-0.46764	-1.09865	1.194033	-0.71822	0.953363	1.193628	1.193588
-12	3	50	0	0.123	150	0.594734	8.092324	8.114149	0.590334	8.090507	2.926808	16.58773	0.077321	-0.03129	0.083412	-0.82145	-1.10663	1.378189	-1.07297	0.945383	1.430043	0.083412
-12	1	50	0	0.123	150	0.594734	8.092324	8.114149	0.590334	8.090507	2.926808	16.58773	0.484757	-0.4314	0.648917	0.23346	-0.52183	0.571672	-0.71822	0.953227	1.193515	0.571672
-12	2	50	0	0.123	150	0.594734	8.092324	8.114149	0.590334	8.090507	2.926808	16.58773	0.123372	0.018594	0.124765	-0.13571	-0.06386	0.149988	-0.87078	1.188721	1.47354	0.124765
-13	3	50	0	0.123	150	0.595369	8.396939	8.418019	0.591684	8.395308	1.957064	10.74805	0.16875	-0.04847	0.175572	-0.66189	-1.08367	1.269822	-0.91343	0.968309	1.331158	0.175572
-13	1	50	0	0.123	150	0.595369	8.396939	8.418019	0.591684	8.395308	1.957064	10.74805	0.581398	-0.3887	0.699367	0.13679	-0.56456	0.580892	-0.71819	0.95326	1.193524	0.580892
-13	2	50	0	0.123	150	0.595369	8.396939	8.418019	0.591684	8.395308	1.957064	10.74805	0.221034	0.035275	0.223831	-0.23043	-0.13398	0.26655	-0.80153	1.11221	1.370936	0.223831
								0							0			0				

Voltage sag table for 150KV bus,New strong holds scenario 2030

Voltage Sags	Voltage sag table assessment												BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.308015	7.910944	7.9169	#INF	#INF	#INF	#INF	0.001758	-0.0157	0.0157892	0.001758	-0.015691	0.01579	0.0018	-0.015691	0.015789175	0.015789175
-1	0	0	0	0.1	150	0.42326	8.641857	8.6522	#INF	#INF	#INF	#INF	0.267792	-0.0494	0.272314	0.267792	-0.04942	0.27231	0.2678	-0.04942	0.272313958	0.272313958
-2	0	0	0	0.1	150	0.308015	7.910944	7.9169	#INF	#INF	#INF	#INF	0.001758	-0.0157	0.0157892	0.001758	-0.015691	0.01579	0.0018	-0.015691	0.015789175	0.015789175
-3	1	0	0	0.1	11	0.002183	0.069858	0.0699	0.002179	0.069846	0.000001	0.612386	1.050138	-0.4055	1.1257195	-0.360959	-0.638077	0.7331	-0.689	1.043607	1.250632594	0.733098668
-4	0	0	0	0.1	150	0.42326	8.641857	8.6522	#INF	#INF	#INF	#INF	0.267792	-0.0494	0.272314	0.267792	-0.04942	0.27231	0.2678	-0.04942	0.272313958	0.272313958
-5	0	0	0	0.1	380	0.325882	3.354456	3.3702	#INF	#INF	#INF	#INF	0.407975	0.07791	0.4153481	0.407975	0.077913	0.41535	0.408	0.077913	0.41534809	0.41534809
-6	0	0	0	0.1	66	0.029582	12.461991	12.462	#INF	#INF	#INF	#INF	1.15416	0.07507	1.1565987	1.15416	0.075069	1.1566	1.1542	0.075069	1.156598746	1.156598746
-7	0	0	0	0.1	150	0.423146	8.656848	8.6672	#INF	#INF	#INF	#INF	0.275305	-0.0499	0.2797875	0.275305	-0.049882	0.27979	0.2753	-0.049882	0.279787521	0.279787521
-8	0	0	0	0.1	380	0.325882	3.354456	3.3702	#INF	#INF	#INF	#INF	0.407975	0.07791	0.4153481	0.407975	0.077913	0.41535	0.408	0.077913	0.41534809	0.41534809
-9	0	0	0	0.1	21	0.000477	0.051662	0.0517	#INF	#INF	#INF	#INF	1.224234	0.03096	1.2246253	1.224234	0.030957	1.22463	1.2242	0.030957	1.22462534	1.22462534
-10	0	0	0	0.1	21	0.000477	0.051662	0.0517	#INF	#INF	#INF	#INF	1.224234	0.03096	1.2246253	1.224234	0.030957	1.22463	1.2242	0.030957	1.22462534	1.22462534
-11	0	0	0	0.1	20	0.00602	0.137135	0.1373	#INF	#INF	#INF	#INF	0.882579	-0.2759	0.9247073	0.882579	-0.275931	0.92471	0.8826	-0.275931	0.924707309	0.924707309
-12	0	50	0	0.123	150	0.390342	8.350082	8.3592	#INF	#INF	#INF	#INF	0.150341	-0.0365	0.1547138	0.150341	-0.036523	0.15471	0.1503	-0.036523	0.154713754	0.154713754
-13	0	50	0	0.123	150	0.423206	8.649414	8.6598	#INF	#INF	#INF	#INF	0.271541	-0.0496	0.2760423	0.271541	-0.049647	0.27604	0.2715	-0.049647	0.276042278	0.276042278
2	3	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.001814	-0.0097	0.0098338	-1.042785	-1.091096	1.50927	-1.173	1.071172	1.588378639	0.009833759
2	1	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.348658	-0.5273	0.632167	0.340531	-0.516166	0.61838	-0.689	1.043492	1.250542695	0.618375858
2	2	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.005579	-0.0135	0.0146101	-0.010812	0.008708	0.01388	-0.857	1.350395	1.599153691	0.013882673
-1	3	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.161393	-0.0372	0.1656236	-0.76241	-1.072868	1.31617	-0.892	1.089379	1.408269973	0.165623575
-1	1	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.563719	-0.4391	0.7145832	0.125475	-0.604383	0.61727	-0.689	1.043529	1.250576325	0.617270432
-1	2	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.225253	0.03868	0.2285499	-0.219467	-0.118909	0.24961	-0.753	1.222802	1.436263652	0.228549899
-2	3	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.001814	-0.0097	0.0098338	-1.042785	-1.091096	1.50927	-1.173	1.071172	1.588378639	0.009833759
-2	1	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.348658	-0.5273	0.632167	0.340531	-0.516166	0.61838	-0.689	1.043492	1.250542695	0.618375858
-2	2	0	0	0.1	150	0.309014	7.83823	7.8443	0.308347	7.836121	3.856543	22.181567	0.005579	-0.0135	0.0146101	-0.010812	0.008708	0.01388	-0.857	1.350395	1.599153691	0.013882673
-3	2	0	0	0.1	11	0.002183	0.069858	0.0699	0.002179	0.069846	0.000001	0.612386	1.21217	-0.2763	1.2432603	-0.550311	-0.739	0.92139	-0.662	1.015297	1.211975798	0.921391989
-16	1	0	0	0.1	11	0.076641	0.149743	0.1682	0.076637	0.149732	0.301664	0.939158	1.17531	-0.1416	1.1838046	-0.486095	-0.902076	1.02471	-0.689	1.043638	1.250678852	1.024709451
-3	0	0	0	0.1	11	0.002181	0.070245	0.0703	#INF	#INF	#INF	#INF	1.012275	-0.2796	1.0501786	1.012275	-0.279597	1.05018	1.0123	-0.279597	1.050178631	1.050178631
-4	3	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.161393	-0.0372	0.1656236	-0.76241	-1.072868	1.31617	-0.892	1.089379	1.408269973	0.165623575
-4	1	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.563719	-0.4391	0.7145832	0.125475	-0.604383	0.61727	-0.689	1.043529	1.250576325	0.617270432
-4	2	0	0	0.1	150	0.417313	8.524719	8.5349	0.416894	8.523151	1.992841	10.982171	0.225253	0.03868	0.2285499	-0.219467	-0.118909	0.24961	-0.753	1.222802	1.436263652	0.228549899
-5	3	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.34624	3.614577	0.7076	0.07771	0.7118547	-0.288574	-1.118652	1.15527	-0.419	1.040939	1.122112646	0.711854669
-5	1	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.34624	3.614577	0.615467	-0.2735	0.6734884	0.072886	-0.767826	0.77128	-0.688	1.041298	1.248251328	0.673488354
-5	2	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.34624	3.614577	0.556718	-0.168	0.581512	0.001503	-0.645063	0.64506	-0.558	0.813056	0.986240713	0.581512032
-6	3	0	0	0.1	66	0.029606	12.45693	12.457	0.029417	12.456302	718693285	-4.705589	1.248458	0.07508	1.2507132	-0.559213	-1.118734	1.25071	-0.689	1.043659	1.250712908	1.250712908
-6	1	0	0	0.1	66	0.029606	12.45693	12.457	0.029417	12.456302	718693285	-4.705589	1.178191	0.03493	1.1787087	-0.488953	-1.078562	1.18422	-0.689	1.043633	1.250687355	1.178708674
-6	2	0	0	0.1	66	0.029606	12.45693	12.457	0.029417	12.456302	718693285	-4.705589	1.178355	0.03465	1.1788643	-0.489117	-1.078282	1.18403	-0.689	1.043633	1.250687355	1.178864309
-16	2	0	0	0.1	11	0.076641	0.149743	0.1682	0.076637	0.149732	0.301664	0.939158	1.207972	-0.1098	1.2129537	-0.538016	-0.921277	1.06687	-0.67	1.031097	1.229634932	1.066870436

-17	1	0	0	0.1	11	0.123869	0.152764	0.1967	0.123866	0.152753	0.496089	0.951705	1.215214	-0.1154	1.2206842	-0.525997	-0.928213	1.06689	-0.689	1.043646	1.25068663	1.066889037
-14	1	0	0	0.1	11	0.12595	0.153727	0.1987	0.125947	0.153716	0.496089	0.951705	1.21353	-0.1143	1.2189048	-0.524313	-0.929304	1.06701	-0.689	1.043645	1.250685796	1.067009862
-14	2	0	0	0.1	11	0.12595	0.153727	0.1987	0.125947	0.153716	0.496089	0.951705	1.22886	-0.0849	1.2317918	-0.558532	-0.950018	1.10204	-0.67	1.034953	1.233072861	1.102040015
-17	2	0	0	0.1	11	0.123869	0.152764	0.1967	0.123866	0.152753	0.496089	0.951705	1.230636	-0.0856	1.2336125	-0.560321	-0.949575	1.10257	-0.67	1.035218	1.233287139	1.102566236
-3	3	0	0	0.1	11	0.002183	0.069858	0.0699	0.002179	0.069846	0.000001	0.612386	1.129552	0.02496	1.1298278	-0.499762	-1.093661	1.20244	-0.63	1.0687	1.240465692	1.129827762
-16	3	0	0	0.1	11	0.076641	0.149743	0.1682	0.076637	0.149732	0.301664	0.939158	1.188238	0.03673	1.1888056	-0.529105	-1.099553	1.22023	-0.659	1.062823	1.250619463	1.188805551
-14	3	0	0	0.1	11	0.12595	0.153727	0.1987	0.125947	0.153716	0.496089	0.951705	1.200196	0.0339	1.2006746	-0.535085	-1.098139	1.22157	-0.665	1.06424	1.25498184	1.200674636
-17	3	0	0	0.1	11	0.123869	0.152764	0.1967	0.123866	0.152753	0.496089	0.951705	1.200797	0.03348	1.2012637	-0.535386	-1.097931	1.22151	-0.665	1.064448	1.255317758	1.201263729
-15	1	0	0	0.1	11	0.696512	0.641573	0.947	0.696508	0.641561	2.786074	2.899675	1.240521	0.02967	1.2408758	-0.551282	-1.073328	1.20663	-0.689	1.043656	1.250707098	1.206625393
-18	1	0	0	0.1	11	0.767521	0.509536	0.9213	0.767517	0.509525	3.066289	2.369886	1.247508	0.02801	1.2478224	-0.55827	-1.071665	1.20836	-0.689	1.043657	1.250707382	1.208358914
-15	2	0	0	0.1	11	0.696512	0.641573	0.947	0.696508	0.641561	2.786074	2.899675	1.239448	0.03183	1.2398566	-0.555742	-1.07414	1.20939	-0.684	1.04231	1.246540826	1.209390719
-18	2	0	0	0.1	11	0.767521	0.509536	0.9213	0.767517	0.509525	3.066289	2.369886	1.245808	0.03027	1.2461757	-0.562421	-1.073385	1.21181	-0.683	1.043113	1.247037498	1.21180557
-19	1	0	0	0.1	11	1.226959	0.898992	1.5211	1.226955	0.898981	4.909641	3.926728	1.24624	0.04612	1.2470929	-0.556999	-1.089772	1.22387	-0.689	1.043657	1.250709035	1.22386719
-19	2	0	0	0.1	11	1.226959	0.898992	1.5211	1.226955	0.898981	4.909641	3.926728	1.24499	0.04704	1.2458784	-0.559377	-1.090262	1.22539	-0.686	1.04322	1.248347621	1.225387227
-15	3	0	0	0.1	11	0.696512	0.641573	0.947	0.696508	0.641561	2.786074	2.899675	1.236957	0.06243	1.2385312	-0.553463	-1.112407	1.24249	-0.683	1.049982	1.252847257	1.238531187
-18	3	0	0	0.1	11	0.767521	0.509536	0.9213	0.767517	0.509525	3.066289	2.369886	1.238661	0.06048	1.2401368	-0.554315	-1.111436	1.242	-0.684	1.050953	1.254125308	1.240136793
-19	3	0	0	0.1	11	1.226959	0.898992	1.5211	1.226955	0.898981	4.909641	3.926728	1.242023	0.06621	1.2437867	-0.555996	-1.114302	1.24531	-0.686	1.048088	1.2526458	1.243786729
-7	3	0	0	0.1	150	0.416955	8.53792	8.5481	0.416544	8.53637	1.921077	10.513241	0.168836	-0.0379	0.1730374	-0.74617	-1.071316	1.30556	-0.876	1.09093	1.399243633	0.173037363
-7	1	0	0	0.1	150	0.416955	8.53792	8.5481	0.416544	8.53637	1.921077	10.513241	0.569579	-0.4363	0.7174675	0.119615	-0.607252	0.61892	-0.689	1.04353	1.250577159	0.618920625
-7	2	0	0	0.1	150	0.416955	8.53792	8.5481	0.416544	8.53637	1.921077	10.513241	0.231837	0.03944	0.235167	-0.224554	-0.123968	0.2565	-0.745	1.213483	1.424030386	0.235166991
-8	3	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.346239	3.614577	0.7076	0.07771	0.7118547	-0.288574	-1.118652	1.15527	-0.419	1.040939	1.122112646	0.711854669
-8	1	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.346239	3.614577	0.615467	-0.2735	0.6734884	0.072886	-0.767826	0.77128	-0.688	1.041298	1.248251328	0.673488354
-8	2	0	0	0.1	380	0.325638	3.353016	3.3688	0.320811	3.333282	0.346239	3.614577	0.556718	-0.168	0.581512	0.001503	-0.645063	0.64506	-0.558	0.813056	0.986240713	0.581512032
-9	3	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.242382	0.07421	1.2445962	-0.556184	-1.118185	1.24887	-0.686	1.043977	1.249302074	1.244596205
-9	1	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.22853	0.01132	1.2285822	-0.540861	-1.054404	1.18503	-0.688	1.043083	1.249364158	1.185030977
-9	2	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.248737	0.03332	1.2491813	-0.561437	-1.075592	1.21331	-0.687	1.042277	1.248487589	1.213305261
-10	3	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.242382	0.07421	1.2445962	-0.556184	-1.118185	1.24887	-0.686	1.043977	1.249302074	1.244596205
-10	1	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.22853	0.01132	1.2285822	-0.540861	-1.054404	1.18503	-0.688	1.043083	1.249364158	1.185030977
-10	2	0	0	0.1	21	0.000477	0.051661	0.0517	0.000348	0.049604	0.000025	1.670263	1.248737	0.03332	1.2491813	-0.561437	-1.075592	1.21331	-0.687	1.042277	1.248487589	1.213305261
-11	3	0	0	0.1	20	0.005994	0.132163	0.1323	0.005991	0.132154	0.034136	0.146783	0.741216	-0.3547	0.8217322	-0.738741	-1.207742	1.41576	-0.869	0.954585	1.290710278	0.821732167
-11	1	0	0	0.1	20	0.005994	0.132163	0.1323	0.005991	0.132154	0.034136	0.146783	0.985109	-0.3629	1.0498105	-0.295921	-0.680746	0.74228	-0.689	1.043599	1.250631429	0.742283204
-11	2	0	0	0.1	20	0.005994	0.132163	0.1323	0.005991	0.132154	0.034136	0.146783	0.755485	-0.1917	0.7794391	-0.824443	-0.550105	0.99112	-0.85	1.145395	1.426090065	0.77943907
-20	3	0	0	0.1	20	0.004366	0.127938	0.128	0.004364	0.12793	0.000305	0.135006	0.791832	-0.4035	0.888734	-0.679557	-1.252598	1.42506	-0.81	0.909727	1.21777437	0.888733986
-20	1	0	0	0.1	20	0.004366	0.127938	0.128	0.004364	0.12793	0.000305	0.135006	1.00228	-0.3582	1.0643682	-0.313092	-0.685392	0.75352	-0.689	1.043602	1.250633933	0.753517614
-20	2	0	0	0.1	20	0.004366	0.127938	0.128	0.004364	0.12793	0.000305	0.135006	0.745633	-0.2308	0.7805394	-0.867324	-0.608341	1.0594	-0.864	1.083292	1.385422537	0.780539446
-21	3	0	0	0.1	0.69	0.00001	0.000194	0.0002	0.00001	0.000194	0	0.000232	1.248643	0.07397	1.2508323	-0.559122	-1.119154	1.25105	-0.689	1.043239	1.250312851	1.250312851
-21	1	0	0	0.1	0.69	0.00001	0.000194	0.0002	0.00001	0.000194	0	0.000232	1.249189	0.07413	1.2513868	-0.559944	-1.117793	1.2502	-0.689	1.043659	1.250712908	1.250199374
-21	2	0	0	0.1	0.69	0.00001	0.000194	0.0002	0.00001	0.000194	0	0.000232	1.248234	0.07411	1.2504318	-0.56017	-1.118764	1.25117	-0.69	1.043371	1.250648453	1.250431793
-22	3	0	0	0.1	0.69	0	0	0	0	0	0	0	1.248458	0.07508	1.2507132	-0.559213	-1.118734	1.25071	-0.689	1.043659	1.250712908	1.250712908
-22	1	0	0	0.1	0.69	0	0	0	0	0	0	0	1.248458	0.07508	1.2507132	-0.559213	-1.118734	1.25071	-0.689	1.043659	1.250712908	1.250712908
-22	2	0	0	0.1	0.69	0	0	0	0	0	0	0	1.248458	0.07508	1.2507132	-0.559213	-1.118734	1.25071	-0.689	1.043659	1.250712908	1.250712908
-23	3	0	0	0.1	0.69	0.000058	0.002393	0.0024	0.000058	0.002393	0.000028	0.001212	1.248592	0.07404	1.2507851	-0.559169	-1.119003	1.25093	-0.689	1.04339	1.250464749	1.250464749
-23	1	0	0	0.1	0.69	0.000058	0.002393	0.0024	0.000058	0.002393	0.000028	0.001212	1.249227	0.07398	1.2514157	-0.559982	-1.117639	1.25008	-0.689	1.043659	1.250712908	1.250078707
-23	2	0	0	0.1	0.69	0.000058	0.002393	0.0024	0.000058	0.002393	0.000028	0.001212	1.248336	0.07413	1.2505351	-0.560131	-1.118601	1.25101	-0.689	1.043486	1.250684856	1.250535096
-12	3	50	0	0.123	150	0.388247	8.256429	8.2656	0.38771	8.2546	2.926808	16.587726	0.074689	-0.0244	0.0785618	-0.922487	-1.085034	1.42418	-1.053	1.077227	1.506068964	0.078561783
-12	1	50	0	0.123	150	0.388247	8.256429	8.2656	0.38771	8.2546	2.926808	16.587726	0.469649	-0.4796	0.6712866	0.219543	-0.563872	0.6051	-0.689	1.043513	1.250561871	0.605103926
-12	2	50	0	0.123	150	0.388247	8.256429	8.2656	0.38771	8.2546	2.926808	16.587726	0.126728	0.01952	0.1282218	-0.130621	-0.055709	0.142	-0.82	1.302354	1.538936606	0.128221766
-13	3	50	0	0.123	150	0.417138	8.531384	8.5416	0.416722	8.529825	1.957064	10.748052	0.165082	-0.0375	0.1692974	-0.754357	-1.072099	1.3109	-0.884	1.090147	1.403777374	0.169297427
-13	1	50	0	0.123	150	0.417138	8.531384	8.5416	0.416722	8.529825	1.957064	10.748052	0.566642	-0.4377	0.7160138	0.122553	-0.605817	0.61809	-0.689	1.04353	1.250577159	0.618088566
-13	2	50	0	0.123	150	0.417138	8.531384	8.5416	0.416722	8.529825	1.957064	10.748052	0.228531	0.03907	0.2318467	-0.22201	-0.121426	0.25305	-0.749	1.218212	1.430241196	0.23184668

Voltage sag analysis table for 150 KV bus,Money rules scenario 2010

Voltage Sags	Voltage sag table assessment												BB150	BB150		BB150	BB150		BB150	BB150		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part in Ohm	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	
2	0	0	0	0.1	150	0.180893	1.672362	1.682117	#INF	#INF	#INF	#INF	0.040201	-0.04314	0.05897	0.040201	-0.04314	0.05897	0.040201	-0.04314	0.05897	0.05897
-1	0	0	0	0.1	150	0.746777	5.850527	5.897995	#INF	#INF	#INF	#INF	0.672863	0.406768	0.78626	0.672863	0.406768	0.78626	0.672863	0.406768	0.78626	0.78626
-2	0	0	0	0.1	150	0.180893	1.672362	1.682117	#INF	#INF	#INF	#INF	0.040201	-0.04314	0.05897	0.040201	-0.04314	0.05897	0.040201	-0.04314	0.05897	0.05897
-3	0	0	0	0.1	21	0.001483	0.060283	0.060301	#INF	#INF	#INF	#INF	0.834651	0.382606	0.918166	0.834651	0.382606	0.918166	0.834651	0.382606	0.918166	0.918166
-4	0	0	0	0.1	11	0.002837	0.034643	0.034759	#INF	#INF	#INF	#INF	0.838875	0.471369	0.962237	0.838875	0.471369	0.962237	0.838875	0.471369	0.962237	0.962237
-5	0	0	0	0.1	21	0.001483	0.060283	0.060301	#INF	#INF	#INF	#INF	0.834386	0.378325	0.916149	0.834386	0.378325	0.916149	0.834386	0.378325	0.916149	0.916149
-6	0	0	0	0.1	13.5	0.001156	0.071394	0.071403	#INF	#INF	#INF	#INF	0.828897	0.480909	0.958303	0.828897	0.480909	0.958303	0.828897	0.480909	0.958303	0.958303
-7	0	0	0	0.1	150	0.746777	5.850527	5.897995	#INF	#INF	#INF	#INF	0.672863	0.406768	0.78626	0.672863	0.406768	0.78626	0.672863	0.406768	0.78626	0.78626
-8	0	0	0	0.1	380	0.273593	7.834739	7.839515	#INF	#INF	#INF	#INF	0.651877	0.567889	0.864547	0.651877	0.567889	0.864547	0.651877	0.567889	0.864547	0.864547
-9	0	0	0	0.1	66	0.017858	12.08856	12.08857	#INF	#INF	#INF	#INF	0.815892	0.547551	0.982594	0.815892	0.547551	0.982594	0.815892	0.547551	0.982594	0.982594
-10	0	0	0	0.1	150	0.746935	5.898674	5.945777	#INF	#INF	#INF	#INF	0.675207	0.408611	0.78922	0.675207	0.408611	0.78922	0.675207	0.408611	0.78922	0.78922
-11	0	0	0	0.1	380	0.273592	7.834739	7.839515	#INF	#INF	#INF	#INF	0.651877	0.567889	0.864547	0.651877	0.567889	0.864547	0.651877	0.567889	0.864547	0.864547
-12	0	0	0	0.1	20	0.007355	0.120502	0.120726	#INF	#INF	#INF	#INF	0.819543	0.47128	0.945386	0.819543	0.47128	0.945386	0.819543	0.47128	0.945386	0.945386
-13	0	0	0	0.1	21	0.000525	0.067844	0.067846	#INF	#INF	#INF	#INF	0.821562	0.53436	0.980053	0.821562	0.53436	0.980053	0.821562	0.53436	0.980053	0.980053
-14	0	0	0	0.1	21	0.000525	0.067844	0.067846	#INF	#INF	#INF	#INF	0.822222	0.533926	0.98037	0.822222	0.533926	0.98037	0.822222	0.533926	0.98037	0.98037
-15	0	50	0	0.123	150	0.746898	5.874768	5.922057	#INF	#INF	#INF	#INF	0.674043	0.407697	0.78775	0.674043	0.407697	0.78775	0.674043	0.407697	0.78775	0.78775
-16	0	50	0	0.123	150	0.577049	4.12592	4.166077	#INF	#INF	#INF	#INF	0.561144	0.325282	0.648607	0.561144	0.325282	0.648607	0.561144	0.325282	0.648607	0.648607
2	3	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.027482	-0.03061	0.041137	-0.19391	-1.17567	1.191555	-1.14512	0.262501	1.174825	0.041137
2	1	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.467775	-0.22902	0.520829	0.418659	-0.21232	0.46942	-0.88644	0.441338	0.990225	0.46942
2	2	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.044345	-0.02987	0.053468	-0.05423	0.000397	0.054229	-1.09935	0.540025	1.224828	0.053468
-1	3	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.689169	0.42115	0.807664	0.055206	-0.9965	0.998023	-0.89818	0.44691	1.003225	0.807664
-1	1	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.774064	0.375043	0.860135	0.118566	-0.82108	0.829593	-0.89263	0.446034	0.997866	0.829593
-1	2	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.690753	0.402535	0.799484	0.032517	-0.79227	0.792938	-0.89401	0.449723	1.000748	0.792938
-2	3	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.027482	-0.03061	0.041137	-0.19391	-1.17567	1.191555	-1.14512	0.262501	1.174825	0.041137
-2	1	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.467775	-0.22902	0.520829	0.418659	-0.21232	0.46942	-0.88644	0.441338	0.990225	0.46942
-2	2	0	0	0.1	150	0.180665	1.66983	1.679575	0.171189	1.638181	0.422782	3.905086	0.044345	-0.02987	0.053468	-0.05423	0.000397	0.054229	-1.09935	0.540025	1.224828	0.053468
-3	3	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.818243	0.537273	0.978869	0.067857	-0.99084	0.993162	-0.8861	0.453567	0.995438	0.978869
-3	1	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.875614	0.341231	0.939754	0.011856	-0.78913	0.789215	-0.88747	0.447895	0.994089	0.789215
-3	2	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.902726	0.428612	0.999311	-0.0176	-0.87537	0.87555	-0.88513	0.446761	0.99149	0.87555
-4	1	0	0	0.1	11	0.002835	0.034631	0.034747	0.002775	0.034483	0.000001	0.612386	0.871487	0.439622	0.976093	0.021674	-0.88689	0.887154	-0.89316	0.447266	0.998891	0.887154
-4	2	0	0	0.1	11	0.002835	0.034631	0.034747	0.002775	0.034483	0.000001	0.612386	0.868629	0.495122	0.999831	0.01913	-0.93975	0.939943	-0.88776	0.444626	0.992879	0.939943
-19	1	0	0	0.1	11	0.078542	0.116074	0.14015	0.078482	0.115927	0.301664	0.939158	0.838237	0.509781	0.98108	0.055785	-0.95682	0.95844	-0.89402	0.447035	0.999557	0.95844
-5	3	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.817809	0.536948	0.978328	0.068067	-0.99067	0.993002	-0.88588	0.453719	0.995308	0.978328
-5	1	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.876323	0.335834	0.93847	0.010967	-0.78374	0.783815	-0.88729	0.447904	0.993932	0.783815
-5	2	0	0	0.1	21	0.001481	0.060264	0.060282	0.001191	0.057391	0.000025	1.670263	0.904265	0.42539	0.999326	-0.01937	-0.87213	0.872343	-0.88489	0.446738	0.991268	0.872343
-6	3	0	0	0.1	13.5	0.001155	0.071385	0.071394	0.000576	0.071281	0.000022	2.208848	0.828721	0.546608	0.992753	0.06291	-0.99587	0.997854	-0.89163	0.449262	0.99842	0.992753
-6	1	0	0	0.1	13.5	0.001155	0.071385	0.071394	0.000576	0.071281	0.000022	2.208848	0.843573	0.46665	0.964042	0.049903	-0.91331	0.914672	-0.89348	0.44666	0.998902	0.914672
-6	2	0	0	0.1	13.5	0.001155	0.071385	0.071394	0.000576	0.071281	0.000022	2.208848	0.859412	0.497096	0.992821	0.032571	-0.94332	0.943883	-0.89198	0.446225	0.997373	0.943883
-7	3	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.689169	0.42115	0.807664	0.055206	-0.9965	0.998023	-0.89818	0.44691	1.003225	0.807664
-7	1	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.774064	0.375043	0.860135	0.118566	-0.82108	0.829593	-0.89263	0.446034	0.997866	0.829593
-7	2	0	0	0.1	150	0.735578	5.796945	5.843428	0.731677	5.778791	1.350757	7.782148	0.690753	0.402535	0.799484	0.032517	-0.79227	0.792938	-0.89401	0.449723	1.000748	0.792938
-8	3	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831096	9.651443	0.723113	0.55902	0.914	0.116127	-1.00005	1.006774	-0.83924	0.441034	0.94807	0.914

-8	1	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831096	9.651443	0.690816	0.487902	0.845739	0.202467	-0.93117	0.952926	-0.89328	0.443267	0.997216	0.845739
-8	2	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831096	9.651443	0.679294	0.509673	0.849239	0.190823	-0.90737	0.927217	-0.87012	0.397696	0.956695	0.849239
-9	3	0	0	0.1	66	0.017838	12.08834	12.08836	0.016715	12.08333	7.19E+08	0.811405	0.834427	0.551118	1	0.060069	-0.99819	1	-0.8945	0.447076	1	1
-9	1	0	0	0.1	66	0.017838	12.08834	12.08836	0.016715	12.08333	7.19E+08	0.811405	0.822145	0.540667	0.983993	0.072243	-0.98756	0.9902	-0.89439	0.446895	0.999823	0.983993
-9	2	0	0	0.1	66	0.017838	12.08834	12.08836	0.016715	12.08333	7.19E+08	0.811405	0.822188	0.540616	0.984001	0.072199	-0.98751	0.990147	-0.89439	0.446895	0.999822	0.984001
-19	2	0	0	0.1	11	0.078542	0.116074	0.14015	0.078482	0.115927	0.301664	0.939158	0.840967	0.518901	0.988172	0.049553	-0.96497	0.966237	-0.89052	0.446065	0.995993	0.966237
-17	1	0	0	0.1	11	0.12229	0.113595	0.166909	0.122234	0.113458	0.496089	0.951705	0.844732	0.519419	0.991649	0.049384	-0.96655	0.967808	-0.89412	0.447128	0.999684	0.967808
-20	1	0	0	0.1	11	0.081944	0.090949	0.12242	0.081929	0.090863	0.496089	0.951705	0.842969	0.520593	0.990764	0.051165	-0.9677	0.969055	-0.89413	0.44711	0.999691	0.969055
-17	2	0	0	0.1	11	0.12229	0.113595	0.166909	0.122234	0.113458	0.496089	0.951705	0.844165	0.526079	0.994673	0.046803	-0.97305	0.974174	-0.89097	0.44697	0.996798	0.974174
-20	2	0	0	0.1	11	0.081944	0.090949	0.12242	0.081929	0.090863	0.496089	0.951705	0.843232	0.528328	0.995073	0.048571	-0.97526	0.976472	-0.8918	0.446935	0.997528	0.976472
-4	3	0	0	0.1	11	0.002835	0.034631	0.034747	0.002775	0.034483	0.000001	0.612386	0.818503	0.534591	0.977617	0.067916	-0.98977	0.992097	-0.88642	0.455179	0.996457	0.977617
-19	3	0	0	0.1	11	0.078542	0.116074	0.14015	0.078482	0.115927	0.301664	0.939158	0.826869	0.541918	0.988629	0.063782	-0.99352	0.995561	-0.89065	0.451597	0.998599	0.988629
-17	3	0	0	0.1	11	0.12229	0.113595	0.166909	0.122234	0.113458	0.496089	0.951705	0.829862	0.542097	0.991232	0.062282	-0.99363	0.995581	-0.89214	0.451534	0.999902	0.991232
-18	1	0	0	0.1	11	0.697129	0.606317	0.92391	0.69707	0.606169	2.786074	2.899675	0.836093	0.543587	0.997265	0.058314	-0.99067	0.992382	-0.89441	0.44708	0.999922	0.992382
-21	1	0	0	0.1	11	0.768149	0.474295	0.902778	0.76809	0.474148	3.066289	2.369886	0.837296	0.543817	0.998399	0.057112	-0.99091	0.992555	-0.89441	0.447094	0.999929	0.992555
-18	2	0	0	0.1	11	0.697129	0.606317	0.92391	0.69707	0.606169	2.786074	2.899675	0.835791	0.543867	0.997165	0.057694	-0.99107	0.992751	-0.89348	0.447205	0.999153	0.992751
-20	3	0	0	0.1	11	0.081944	0.090949	0.12242	0.081929	0.090863	0.496089	0.951705	0.830569	0.544219	0.992985	0.061946	-0.9947	0.996628	-0.89252	0.450482	0.999758	0.992985
-21	2	0	0	0.1	11	0.768149	0.474295	0.902778	0.76809	0.474148	3.066289	2.369886	0.836883	0.54407	0.998191	0.056602	-0.99143	0.993044	-0.89349	0.44736	0.999223	0.993044
-22	1	0	0	0.1	11	0.163032	0.522241	0.547097	0.16305	0.522229	4.909641	3.926728	0.836486	0.54605	0.998939	0.057949	-0.99314	0.994828	-0.89443	0.447089	0.99995	0.994828
-22	2	0	0	0.1	11	0.163032	0.522241	0.547097	0.16305	0.522229	4.909641	3.926728	0.836711	0.546296	0.999262	0.057558	-0.9936	0.995264	-0.89427	0.447302	0.999898	0.995264
-18	3	0	0	0.1	11	0.697129	0.606317	0.92391	0.69707	0.606169	2.786074	2.899675	0.83343	0.548479	0.997715	0.060546	-0.99686	0.998699	-0.89398	0.448383	1.000121	0.997715
-21	3	0	0	0.1	11	0.768149	0.474295	0.902778	0.76809	0.474148	3.066289	2.369886	0.833814	0.548287	0.99793	0.060352	-0.99677	0.998594	-0.89417	0.448482	1.000334	0.99793
-22	3	0	0	0.1	11	0.163032	0.522241	0.547097	0.16305	0.522229	4.909641	3.926728	0.834728	0.550208	0.99975	0.05991	-0.99774	0.999537	-0.89464	0.447532	1.000331	0.999537
-10	3	0	0	0.1	150	0.735447	5.843569	5.889667	0.731621	5.825629	1.324798	7.579722	0.691199	0.422617	0.810161	0.056988	-0.99484	0.996471	-0.8964	0.448567	1.002368	0.810161
-10	1	0	0	0.1	150	0.735447	5.843569	5.889667	0.731621	5.825629	1.324798	7.579722	0.775061	0.377414	0.862068	0.117595	-0.82346	0.831818	-0.89266	0.44605	0.997895	0.831818
-10	2	0	0	0.1	150	0.735447	5.843569	5.889667	0.731621	5.825629	1.324798	7.579722	0.692855	0.404378	0.802228	0.032723	-0.79519	0.795859	-0.89192	0.449155	0.998626	0.795859
-11	3	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831095	9.651443	0.723113	0.55902	0.914	0.116127	-1.00005	1.006774	-0.83924	0.441034	0.94807	0.914
-11	1	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831095	9.651443	0.690816	0.487902	0.845739	0.202467	-0.93117	0.952926	-0.89328	0.443267	0.997216	0.845739
-11	2	0	0	0.1	380	0.273548	7.834453	7.839227	0.252661	7.639572	0.831095	9.651443	0.679294	0.509673	0.849239	0.190823	-0.90737	0.927217	-0.87012	0.397696	0.956695	0.849239
-12	3	0	0	0.1	20	0.007205	0.116643	0.116865	0.007179	0.116541	0.024363	0.114743	0.819311	0.464462	0.941804	0.055283	-1.00783	1.009346	-0.89844	0.437156	0.999147	0.941804
-12	1	0	0	0.1	20	0.007205	0.116643	0.116865	0.007179	0.116541	0.024363	0.114743	0.839697	0.467579	0.961104	0.053844	-0.91454	0.916128	-0.89354	0.446965	0.999097	0.916128
-12	2	0	0	0.1	20	0.007205	0.116643	0.116865	0.007179	0.116541	0.024363	0.114743	0.812868	0.469883	0.938906	-0.00947	-0.95022	0.950266	-0.9041	0.445841	1.008054	0.938906
-13	3	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.834427	0.551118	1	0.060069	-0.99819	1	-0.8945	0.447076	1	1
-13	1	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.822732	0.528679	0.977952	0.069945	-0.97476	0.97727	-0.89268	0.446085	0.99793	0.97727
-13	2	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.831941	0.533962	0.988555	0.061155	-0.98081	0.982713	-0.8931	0.446847	0.998645	0.982713
-14	3	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.834427	0.551118	1	0.060069	-0.99819	1	-0.8945	0.447076	1	1
-14	1	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.823602	0.528303	0.978481	0.069044	-0.97446	0.976902	-0.89265	0.446156	0.997933	0.976902
-14	2	0	0	0.1	21	0.000525	0.067844	0.067846	0.000214	0.06068	57272.64	57174.47	0.832588	0.533915	0.989074	0.060503	-0.98082	0.982679	-0.89309	0.4469	0.998665	0.982679
-15	3	50	0	0.123	150	0.735555	5.820427	5.866721	0.731691	5.80238	1.33806	7.68261	0.83423	0.546415	0.997251	0.060896	-1.00095	1.002797	-0.71047	0.38678	0.808927	0.808927
-15	1	50	0	0.123	150	0.735555	5.820427	5.866721	0.731691	5.80238	1.33806	7.68261	0.653076	0.513397	0.830713	0.060038	-0.99607	0.997881	-0.71311	0.482675	0.861108	0.830713
-15	2	50	0	0.123	150	0.735555	5.820427	5.866721	0.731691	5.80238	1.33806	7.68261	0.671087	0.425123	0.79441	0.057259	-0.99806	0.999696	-0.69532	0.397397	0.800867	0.79441
-16	3	50	0	0.123	150	0.573316	4.106042	4.145874	0.566883	4.081577	1.449578	9.16131	0.894795	0.524	1.036935	0.121899	-1.02286	1.030096	-0.59951	0.335243	0.686876	0.686876
-16	1	50	0	0.123	150	0.573316	4.106042	4.145874	0.566883	4.081577	1.449578	9.16131	0.532575	0.50167	0.731648	0.060167	-0.99469	0.99651	-0.59274	0.493021	0.770982	0.731648
-16	2	50	0	0.123	150	0.573316	4.106042	4.145874	0.566883	4.081577	1.449578	9.16131	0.556302	0.352738	0.658708	0.066487	-1.04549	1.047603	-0.57056	0.351043	0.669904	0.658708

Voltage sag table for 150KV bus,Money rules scenario 2020

Voltage Sags	Voltage sag table assessment												BB150	BB150		BB150	BB150		BB150	BB150		
Object index	Fault Type	Fault position in %	Failure frequency in 1/a	Fault Clearing Time in s	Nominal Voltage in kV	Positive-Sequence Impedance, Real Part in Ohm	Positive-Sequence Impedance, Imaginary Part in Ohm	Positive sequence impedance (in ohms)	Negative-Sequence Impedance, Real Part in Ohm	Negative-Sequence Impedance, Imaginary Part in Ohm	Zero-Sequence Impedance, Real Part in Ohm	Zero-Sequence Impedance, Imaginary Part in Ohm	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase A voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase B voltage at 150KV bus	Voltage, Real Part in p.u.	Voltage, Imaginary Part in p.u.	Phase C voltage at 150KV bus	Minimum of phase voltages
2	0	0	0	0.1	150	0.102665	1.691668	1.69478	#INF	#INF	#INF	#INF	0.022782	-0.05473	0.05928	0.022782	-0.05473	0.05928	0.022782	-0.05473	0.05928	0.05928
-1	0	0	0	0.1	150	0.701401	5.858047	5.899888	#INF	#INF	#INF	#INF	0.770207	0.185844	0.792311	0.770207	0.185844	0.792311	0.770207	0.185844	0.792311	0.792311
-2	0	0	0	0.1	150	0.102665	1.691668	1.69478	#INF	#INF	#INF	#INF	0.022782	-0.05473	0.05928	0.022782	-0.05473	0.05928	0.022782	-0.05473	0.05928	0.05928
-3	0	0	0	0.1	21	0.000897	0.060429	0.060436	#INF	#INF	#INF	#INF	0.921836	0.107634	0.928098	0.921836	0.107634	0.928098	0.921836	0.107634	0.928098	0.928098
-4	0	0	0	0.1	11	0.00228	0.034916	0.03499	#INF	#INF	#INF	#INF	0.957674	0.194113	0.977149	0.957674	0.194113	0.977149	0.957674	0.194113	0.977149	0.977149
-5	0	0	0	0.1	21	0.000897	0.060429	0.060436	#INF	#INF	#INF	#INF	0.919964	0.102109	0.925613	0.919964	0.102109	0.925613	0.919964	0.102109	0.925613	0.925613
-6	0	0	0	0.1	13.5	0.000894	0.071463	0.071469	#INF	#INF	#INF	#INF	0.948619	0.210552	0.971705	0.948619	0.210552	0.971705	0.948619	0.210552	0.971705	0.971705
-7	0	0	0	0.1	150	0.701401	5.858047	5.899888	#INF	#INF	#INF	#INF	0.770207	0.185844	0.792311	0.770207	0.185844	0.792311	0.770207	0.185844	0.792311	0.792311
-8	0	0	0	0.1	380	0.486965	7.816132	7.831287	#INF	#INF	#INF	#INF	0.787578	0.282776	0.836804	0.787578	0.282776	0.836804	0.787578	0.282776	0.836804	0.836804
-9	0	0	0	0.1	66	0.01453	12.08983	12.08983	#INF	#INF	#INF	#INF	0.952291	0.272899	0.990622	0.952291	0.272899	0.990622	0.952291	0.272899	0.990622	0.990622
-10	0	0	0	0.1	150	0.702078	5.90604	5.947623	#INF	#INF	#INF	#INF	0.772998	0.187021	0.7953	0.772998	0.187021	0.7953	0.772998	0.187021	0.7953	0.7953
-11	0	0	0	0.1	380	0.486965	7.816132	7.831287	#INF	#INF	#INF	#INF	0.787578	0.282776	0.836804	0.787578	0.282776	0.836804	0.787578	0.282776	0.836804	0.836804
-12	0	0	0	0.1	20	0.007087	0.120556	0.120764	#INF	#INF	#INF	#INF	0.928455	0.20377	0.950553	0.928455	0.20377	0.950553	0.928455	0.20377	0.950553	0.950553
-13	0	0	0	0.1	21	0.000744	0.067824	0.067828	#INF	#INF	#INF	#INF	0.959033	0.258213	0.993186	0.959033	0.258213	0.993186	0.959033	0.258213	0.993186	0.993186
-14	0	0	0	0.1	21	0.000744	0.067824	0.067828	#INF	#INF	#INF	#INF	0.958615	0.258349	0.992818	0.958615	0.258349	0.992818	0.958615	0.258349	0.992818	0.992818
-15	0	50	0	0.123	150	0.701781	5.882212	5.923927	#INF	#INF	#INF	#INF	0.771612	0.186437	0.793816	0.771612	0.186437	0.793816	0.771612	0.186437	0.793816	0.793816
-16	0	50	0	0.123	150	0.516285	4.138787	4.170864	#INF	#INF	#INF	#INF	0.638599	0.136943	0.653117	0.638599	0.136943	0.653117	0.638599	0.136943	0.653117	0.653117
2	3	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.016207	-0.03816	0.041457	-0.55051	-1.05454	1.189591	-1.02432	0.621129	1.197928	0.041457
2	1	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.378851	-0.36481	0.525938	0.338446	-0.33194	0.474054	-0.7173	0.696741	0.999982	0.474054
2	2	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.03179	-0.04408	0.054345	-0.05054	0.018929	0.053967	-0.88402	0.863594	1.235836	0.053967
-1	3	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.790082	0.197236	0.814329	-0.25316	-0.97272	1.005121	-0.72792	0.708653	1.0159	0.814329
-1	1	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.858005	0.123274	0.866815	-0.13586	-0.82626	0.837354	-0.72215	0.702985	1.007812	0.837354
-1	2	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.787959	0.177696	0.807747	-0.20815	-0.76965	0.7973	-0.72021	0.708938	1.010591	0.7973
-2	3	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.016207	-0.03816	0.041457	-0.55051	-1.05454	1.189591	-1.02432	0.621129	1.197928	0.041457
-2	1	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.378851	-0.36481	0.525938	0.338446	-0.33194	0.474054	-0.7173	0.696741	0.999982	0.474054
-2	2	0	0	0.1	150	0.102676	1.689088	1.692206	0.09604	1.656229	0.422782	3.905086	0.03179	-0.04408	0.054345	-0.05054	0.018929	0.053967	-0.88402	0.863594	1.235836	0.053967
-3	3	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	0.951929	0.265601	0.988288	-0.23844	-0.97405	1.002811	-0.71349	0.708451	1.005473	0.988288
-3	1	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	0.949254	0.054559	0.950821	-0.23279	-0.75788	0.792823	-0.71647	0.703317	1.003981	0.792823
-3	2	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	1.002919	0.132795	1.011672	-0.28839	-0.83431	0.882747	-0.71453	0.701515	1.001337	0.882747
-4	1	0	0	0.1	11	0.002279	0.034904	0.034978	0.002234	0.034748	0.000001	0.612386	0.982077	0.154708	0.994188	-0.25976	-0.85916	0.897573	-0.72232	0.704455	1.008958	0.897573
-4	2	0	0	0.1	11	0.002279	0.034904	0.034978	0.002234	0.034748	0.000001	0.612386	0.992824	0.210715	1.014939	-0.27524	-0.91129	0.951947	-0.71759	0.700575	1.002865	0.951947
-19	1	0	0	0.1	11	0.077983	0.116608	0.140281	0.077938	0.116452	0.301664	0.939158	0.967541	0.231577	0.994869	-0.24432	-0.93599	0.967348	-0.72322	0.704407	1.009571	0.967348
-5	3	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	0.951248	0.265328	0.987558	-0.2381	-0.9739	1.002582	-0.71315	0.70857	1.00531	0.987558
-5	1	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	0.948237	0.047226	0.949412	-0.23201	-0.7505	0.78554	-0.71623	0.703269	1.003776	0.78554
-5	2	0	0	0.1	21	0.000897	0.06041	0.060417	0.000668	0.057516	0.000025	1.670263	1.003789	0.128018	1.011919	-0.28956	-0.82942	0.878514	-0.71423	0.701403	1.001041	0.878514
-6	3	0	0	0.1	13.5	0.000894	0.071454	0.07146	0.000323	0.071342	0.000022	2.208848	0.965517	0.271762	1.003034	-0.24505	-0.97758	1.007824	-0.72047	0.705817	1.008592	1.003034
-6	1	0	0	0.1	13.5	0.000894	0.071454	0.07146	0.000323	0.071342	0.000022	2.208848	0.958444	0.193508	0.977783	-0.2356	-0.89742	0.927828	-0.72284	0.703909	1.008954	0.927828
-6	2	0	0	0.1	13.5	0.000894	0.071454	0.07146	0.000323	0.071342	0.000022	2.208848	0.9812	0.21769	1.005058	-0.25962	-0.9208	0.956704	-0.72158	0.703113	1.007495	0.956704
-7	3	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.790082	0.197236	0.814329	-0.25316	-0.97272	1.005121	-0.72792	0.708653	1.0159	0.814329
-7	1	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.858005	0.123274	0.866815	-0.13586	-0.82626	0.837354	-0.72215	0.702985	1.007812	0.837354
-7	2	0	0	0.1	150	0.691027	5.804264	5.845254	0.688771	5.78556	1.350757	7.782148	0.787959	0.177696	0.807747	-0.20815	-0.76965	0.7973	-0.72021	0.708938	1.010591	0.7973
-8	3	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831096	9.651443	0.859755	0.278419	0.903712	-0.19185	-0.97885	0.997472	-0.66791	0.700429	0.967832	0.903712

-8	1	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831096	9.651443	0.830452	0.204217	0.855193	-0.10817	-0.90496	0.911401	-0.72228	0.700741	1.006343	0.855193
-8	2	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831096	9.651443	0.818312	0.225802	0.848894	-0.12058	-0.88134	0.889553	-0.69773	0.655541	0.957373	0.848894
-9	3	0	0	0.1	66	0.014528	12.08961	12.08962	0.013509	12.08452	7.19E+08	0.809675	0.971987	0.274482	1.01	-0.24829	-0.97901	1.01	-0.7237	0.704525	1.01	1.01
-9	1	0	0	0.1	66	0.014528	12.08961	12.08962	0.013509	12.08452	7.19E+08	0.809675	0.958	0.265024	0.993983	-0.2344	-0.96935	0.997286	-0.7236	0.704325	1.00979	0.993983
-9	2	0	0	0.1	66	0.014528	12.08961	12.08962	0.013509	12.08452	7.19E+08	0.809675	0.95804	0.264967	0.994006	-0.23444	-0.96929	0.99724	-0.7236	0.704325	1.00979	0.994006
-19	2	0	0	0.1	11	0.077983	0.116608	0.140281	0.077938	0.116452	0.301664	0.939158	0.972193	0.240299	1.00145	-0.25235	-0.94303	0.976205	-0.71984	0.702726	1.005982	0.976205
-17	1	0	0	0.1	11	0.125205	0.118309	0.172259	0.12516	0.118156	0.496089	0.951705	0.974699	0.239502	1.003693	-0.2514	-0.944	0.976906	-0.7233	0.704501	1.009693	0.976906
-20	1	0	0	0.1	11	0.081676	0.091222	0.122444	0.08167	0.091133	0.496089	0.951705	0.975708	0.2409	1.005007	-0.2524	-0.94542	0.978526	-0.72331	0.704515	1.009714	0.978526
-17	2	0	0	0.1	11	0.125205	0.118309	0.172259	0.12516	0.118156	0.496089	0.951705	0.975745	0.246296	1.00635	-0.25571	-0.94987	0.983688	-0.72003	0.703574	1.00671	0.983688
-20	2	0	0	0.1	11	0.081676	0.091222	0.122444	0.08167	0.091133	0.496089	0.951705	0.977335	0.248987	1.008553	-0.25644	-0.95292	0.986822	-0.72089	0.703931	1.007574	0.986822
-4	3	0	0	0.1	11	0.002279	0.034904	0.034978	0.002234	0.034748	0.000001	0.612386	0.952373	0.261801	0.987701	-0.23856	-0.97248	1.001317	-0.71381	0.710682	1.00727	0.987701
-19	3	0	0	0.1	11	0.077983	0.116608	0.140281	0.077938	0.116452	0.301664	0.939158	0.962463	0.266601	0.998705	-0.24358	-0.97498	1.004941	-0.71888	0.708374	1.009251	0.998705
-17	3	0	0	0.1	11	0.125205	0.118309	0.172259	0.12516	0.118156	0.496089	0.951705	0.965051	0.266172	1.001085	-0.24488	-0.97478	1.00507	-0.72017	0.70861	1.010334	1.001085
-18	1	0	0	0.1	11	0.696573	0.60659	0.92367	0.696528	0.606434	2.786074	2.899675	0.971898	0.266629	1.007808	-0.24829	-0.97114	1.002378	-0.72361	0.704511	1.009926	1.002378
-21	1	0	0	0.1	11	0.767594	0.474569	0.90245	0.767548	0.474413	3.066289	2.369886	0.973144	0.266578	1.008996	-0.24953	-0.9711	1.002652	-0.72361	0.704526	1.009935	1.002652
-18	2	0	0	0.1	11	0.696573	0.60659	0.92367	0.696528	0.606434	2.786074	2.899675	0.971664	0.266976	1.007674	-0.249	-0.9714	1.002803	-0.72267	0.704423	1.009189	1.002803
-20	3	0	0	0.1	11	0.081676	0.091222	0.122444	0.08167	0.091133	0.496089	0.951705	0.966756	0.267885	1.003185	-0.24572	-0.97566	1.006122	-0.72104	0.70777	1.010362	1.003185
-21	2	0	0	0.1	11	0.767594	0.474569	0.90245	0.767548	0.474413	3.066289	2.369886	0.972794	0.266924	1.00875	-0.25016	-0.9715	1.003192	-0.72263	0.704577	1.009271	1.003192
-22	1	0	0	0.1	11	0.162977	0.522176	0.547019	0.162997	0.522165	4.909641	3.926728	0.972858	0.268989	1.00936	-0.24922	-0.97352	1.004909	-0.72364	0.704526	1.009955	1.004909
-22	2	0	0	0.1	11	0.162977	0.522176	0.547019	0.162997	0.522165	4.909641	3.926728	0.973138	0.269181	1.009681	-0.24971	-0.97388	1.005385	-0.72343	0.704699	1.009923	1.005385
-18	3	0	0	0.1	11	0.696573	0.60659	0.92367	0.696528	0.606434	2.786074	2.899675	0.970391	0.272096	1.007817	-0.24751	-0.9778	1.008636	-0.72289	0.705701	1.010236	1.007817
-21	3	0	0	0.1	11	0.767594	0.474569	0.90245	0.767548	0.474413	3.066289	2.369886	0.970727	0.271817	1.008065	-0.24768	-0.97766	1.008545	-0.72305	0.705843	1.010454	1.008065
-22	3	0	0	0.1	11	0.162977	0.522176	0.547019	0.162997	0.522165	4.909641	3.926728	0.972076	0.273512	1.009822	-0.24834	-0.97852	1.009542	-0.72374	0.705009	1.010363	1.009542
-10	3	0	0	0.1	150	0.691423	5.850734	5.891448	0.689223	5.832252	1.324798	7.579722	0.792471	0.19805	0.816844	-0.25088	-0.97179	1.003649	-0.72564	0.709585	1.014923	0.816844
-10	1	0	0	0.1	150	0.691423	5.850734	5.891448	0.689223	5.832252	1.324798	7.579722	0.859618	0.125328	0.868706	-0.13745	-0.82834	0.839661	-0.72217	0.703007	1.007842	0.839661
-10	2	0	0	0.1	150	0.691423	5.850734	5.891448	0.689223	5.832252	1.324798	7.579722	0.790469	0.178904	0.810462	-0.20877	-0.7726	0.800305	-0.71842	0.707685	1.008434	0.800305
-11	3	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831095	9.651443	0.859755	0.278419	0.903712	-0.19185	-0.97885	0.997472	-0.66791	0.700429	0.967832	0.903712
-11	1	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831095	9.651443	0.830452	0.204217	0.855193	-0.10817	-0.90496	0.911401	-0.72228	0.700741	1.006343	0.855193
-11	2	0	0	0.1	380	0.486932	7.815841	7.830994	0.455912	7.622601	0.831095	9.651443	0.818312	0.225802	0.848894	-0.12058	-0.88134	0.889553	-0.69773	0.655541	0.957373	0.848894
-12	3	0	0	0.1	20	0.006955	0.116694	0.116901	0.006938	0.116588	0.024363	0.114743	0.924501	0.19859	0.94559	-0.25766	-0.98525	1.018379	-0.73234	0.697735	1.011514	0.94559
-12	1	0	0	0.1	20	0.006955	0.116694	0.116901	0.006938	0.116588	0.024363	0.114743	0.946252	0.192881	0.96571	-0.22345	-0.89698	0.924396	-0.72281	0.704103	1.009064	0.924396
-12	2	0	0	0.1	20	0.006955	0.116694	0.116901	0.006938	0.116588	0.024363	0.114743	0.921948	0.206521	0.944796	-0.2966	-0.90607	0.953381	-0.73294	0.708567	1.019443	0.944796
-13	3	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.971987	0.274482	1.01	-0.24829	-0.97901	1.01	-0.7237	0.704525	1.01	1.01
-13	1	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.9601	0.252592	0.992771	-0.23818	-0.95611	0.985332	-0.72193	0.70352	1.008026	0.985332
-13	2	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.969235	0.25764	1.002893	-0.24691	-0.96192	0.993099	-0.72233	0.704276	1.008841	0.993099
-14	3	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.971987	0.274482	1.01	-0.24829	-0.97901	1.01	-0.7237	0.704525	1.01	1.01
-14	1	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.959578	0.252665	0.992285	-0.23765	-0.95614	0.985233	-0.72193	0.703477	1.008001	0.985233
-14	2	0	0	0.1	21	0.000744	0.067823	0.067827	0.000386	0.060665	57272.64	57174.47	0.968881	0.257569	1.002533	-0.24656	-0.96182	0.992916	-0.72232	0.704247	1.008817	0.992916
-15	3	50	0	0.123	150	0.691267	5.827669	5.868524	0.689039	5.809076	1.33806	7.68261	0.968009	0.267867	1.004387	-0.25072	-0.98397	1.015412	-0.56681	0.586453	0.815601	0.815601
-15	1	50	0	0.123	150	0.691267	5.827669	5.868524	0.689039	5.809076	1.33806	7.68261	0.784796	0.295301	0.838515	-0.24773	-0.9769	1.007826	-0.53706	0.681603	0.867767	0.838515
-15	2	50	0	0.123	150	0.691267	5.827669	5.868524	0.689039	5.809076	1.33806	7.68261	0.772051	0.205038	0.798814	-0.25376	-0.97711	1.009522	-0.54903	0.594338	0.809116	0.798814
-16	3	50	0	0.123	150	0.513136	4.118762	4.150603	0.508907	4.093444	1.449578	9.16131	1.01757	0.225578	1.042274	-0.20063	-1.02584	1.045273	-0.47431	0.504415	0.692388	0.692388
-16	1	50	0	0.123	150	0.513136	4.118762	4.150603	0.508907	4.093444	1.449578	9.16131	0.663906	0.316986	0.735698	-0.24728	-0.97556	1.006413	-0.41662	0.658574	0.77929	0.735698
-16	2	50	0	0.123	150	0.513136	4.118762	4.150603	0.508907	4.093444	1.449578	9.16131	0.638674	0.166498	0.66002	-0.26104	-1.02525	1.057958	-0.44114	0.515332	0.678361	0.66002

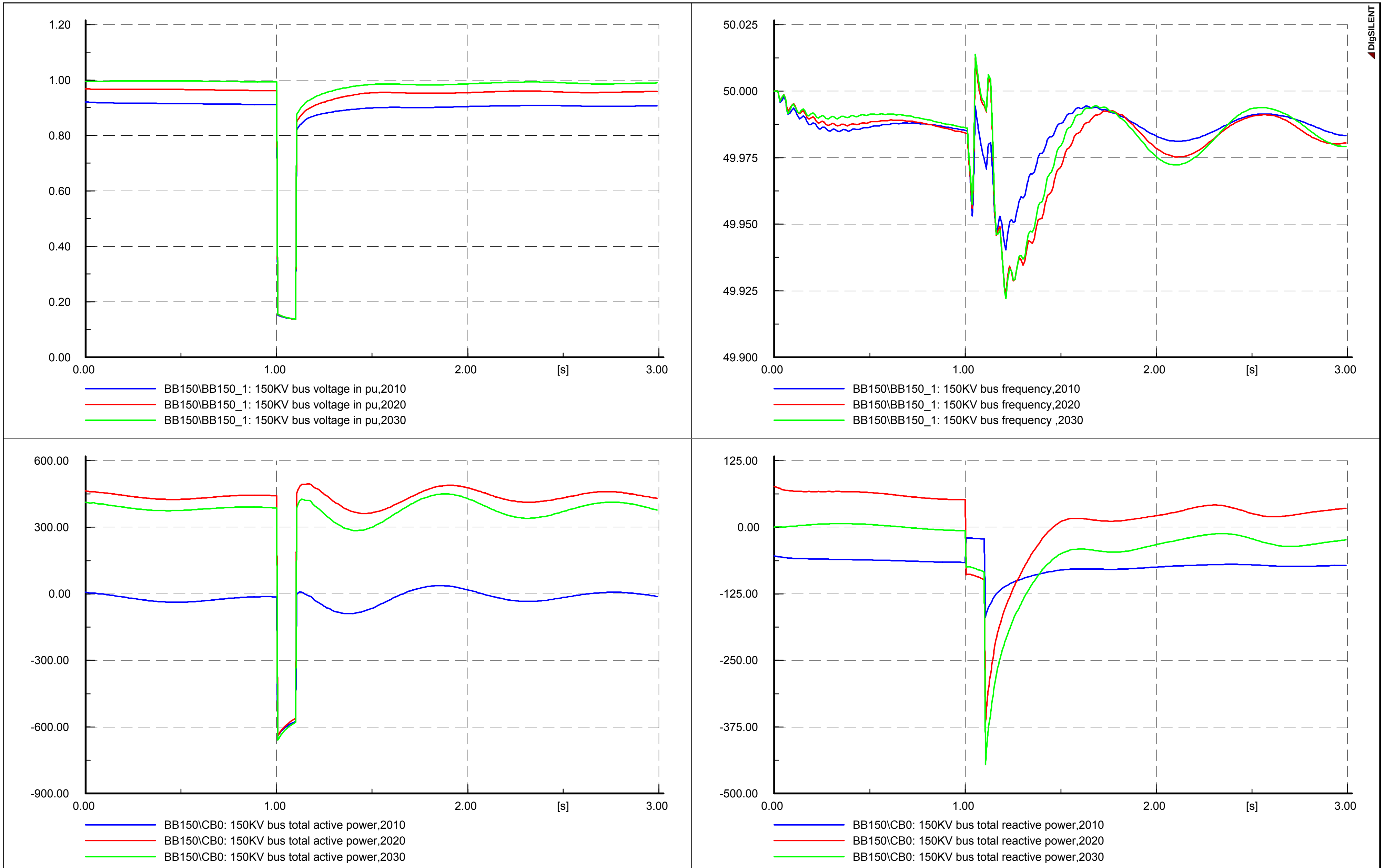
Voltage sag table for 150KV bus,Money rules scenario 2030

Voltage Sags	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment		Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	Voltage sag table assessment	BB150	BB150		BB150	BB150		BB150	BB150		
Object index	**Fault Type**	**Fault position in %**	**Failure frequency in 1/a**	**Fault Clearing Time in s**	**Nominal Voltage in kV**	**Positive-Sequence Impedance, Real Part in Ohm**	**Positive-Sequence Impedance, Imaginary Part in Ohm**	**Positive sequence impedance (in ohms)**	**Negative-Sequence Impedance, Real Part in Ohm**	**Negative-Sequence Impedance, Imaginary Part in Ohm**	**Zero-Sequence Impedance, Real Part in Ohm**	**Zero-Sequence Impedance, Imaginary Part in Ohm**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase A voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase B voltage at 150KV bus**	**Voltage, Real Part in p.u.**	**Voltage, Imaginary Part in p.u.**	**Phase C voltage at 150KV bus**	**Minimum of phase voltages**
2	0	0	0	0.1	150	0.112686	1.689821	1.693574	#INF	#INF	#INF	#INF	0.035054	-0.0471	0.058714	0.035054	-0.0471	0.058714	0.035054	-0.0471	0.058714	0.058714
-1	0	0	0	0.1	150	0.707186	5.857441	5.899977	#INF	#INF	#INF	#INF	0.702919	0.352609	0.786402	0.702919	0.352609	0.786402	0.702919	0.352609	0.786402	0.786402
-2	0	0	0	0.1	150	0.112686	1.689821	1.693574	#INF	#INF	#INF	#INF	0.035054	-0.0471	0.058714	0.035054	-0.0471	0.058714	0.035054	-0.0471	0.058714	0.058714
-3	0	0	0	0.1	21	0.000972	0.060415	0.060423	#INF	#INF	#INF	#INF	0.859977	0.316757	0.916458	0.859977	0.316757	0.916458	0.859977	0.316757	0.916458	0.916458
-4	0	0	0	0.1	11	0.002353	0.034901	0.03498	#INF	#INF	#INF	#INF	0.876828	0.41261	0.969058	0.876828	0.41261	0.969058	0.876828	0.41261	0.969058	0.969058
-5	0	0	0	0.1	21	0.000972	0.060415	0.060423	#INF	#INF	#INF	#INF	0.860212	0.319274	0.917551	0.860212	0.319274	0.917551	0.860212	0.319274	0.917551	0.917551
-6	0	0	0	0.1	13.5	0.000928	0.071456	0.071462	#INF	#INF	#INF	#INF	0.862365	0.418888	0.958718	0.862365	0.418888	0.958718	0.862365	0.418888	0.958718	0.958718
-7	0	0	0	0.1	150	0.707186	5.857441	5.899977	#INF	#INF	#INF	#INF	0.702919	0.352609	0.786402	0.702919	0.352609	0.786402	0.702919	0.352609	0.786402	0.786402
-8	0	0	0	0.1	380	0.488071	7.815789	7.831013	#INF	#INF	#INF	#INF	0.686266	0.501533	0.849998	0.686266	0.501533	0.849998	0.686266	0.501533	0.849998	0.849998
-9	0	0	0	0.1	66	0.015331	12.08967	12.08968	#INF	#INF	#INF	#INF	0.851673	0.488487	0.981818	0.851673	0.488487	0.981818	0.851673	0.488487	0.981818	0.981818
-10	0	0	0	0.1	150	0.707797	5.905449	5.947714	#INF	#INF	#INF	#INF	0.705359	0.354358	0.789367	0.705359	0.354358	0.789367	0.705359	0.354358	0.789367	0.789367
-11	0	0	0	0.1	380	0.48807	7.815789	7.831013	#INF	#INF	#INF	#INF	0.686266	0.501533	0.849998	0.686266	0.501533	0.849998	0.686266	0.501533	0.849998	0.849998
-12	0	0	0	0.1	20	0.007122	0.120552	0.120762	#INF	#INF	#INF	#INF	0.853156	0.412203	0.947516	0.853156	0.412203	0.947516	0.853156	0.412203	0.947516	0.947516
-13	0	0	0	0.1	21	0.000746	0.067823	0.067827	#INF	#INF	#INF	#INF	0.856884	0.475206	0.979832	0.856884	0.475206	0.979832	0.856884	0.475206	0.979832	0.979832
-14	0	0	0	0.1	21	0.000746	0.067823	0.067827	#INF	#INF	#INF	#INF	0.85671	0.475755	0.979946	0.85671	0.475755	0.979946	0.85671	0.475755	0.979946	0.979946
-15	0	50	0	0.123	150	0.707533	5.881612	5.924016	#INF	#INF	#INF	#INF	0.704147	0.35349	0.787895	0.704147	0.35349	0.787895	0.704147	0.35349	0.787895	0.787895
-16	0	50	0	0.123	150	0.524053	4.137621	4.170676	#INF	#INF	#INF	#INF	0.586509	0.276411	0.648379	0.586509	0.276411	0.648379	0.586509	0.276411	0.648379	0.648379
2	3	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.024639	-0.03284	0.041053	-0.28098	-1.14552	1.179482	-1.13012	0.35502	1.184574	0.041053
2	1	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.450135	-0.26182	0.520739	0.403401	-0.23995	0.469369	-0.85354	0.501763	0.990096	0.469369
2	2	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.041077	-0.03467	0.053752	-0.05318	0.006066	0.053522	-1.05378	0.622045	1.223681	0.053522
-1	3	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.718843	0.368589	0.807832	-0.01517	-0.99566	0.995773	-0.86644	0.510209	1.005496	0.807832
-1	1	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.803554	0.317167	0.863883	0.056034	-0.82391	0.82581	-0.85959	0.50674	0.997836	0.82581
-1	2	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.721877	0.349471	0.80202	-0.02837	-0.79014	0.790653	-0.85955	0.512622	1.000806	0.790653
-2	3	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.024639	-0.03284	0.041053	-0.28098	-1.14552	1.179482	-1.13012	0.35502	1.184574	0.041053
-2	1	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.450135	-0.26182	0.520739	0.403401	-0.23995	0.469369	-0.85354	0.501763	0.990096	0.469369
-2	2	0	0	0.1	150	0.112667	1.687245	1.691003	0.105653	1.654513	0.422782	3.905086	0.041077	-0.03467	0.053752	-0.05318	0.006066	0.053522	-1.05378	0.622045	1.223681	0.053522
-3	3	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.852857	0.478799	0.978066	-0.00049	-0.99281	0.992809	-0.85237	0.514011	0.995357	0.978066
-3	1	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.899301	0.271031	0.939255	-0.0452	-0.7793	0.780611	-0.8541	0.50827	0.993894	0.780611
-3	2	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.933736	0.36027	1.000828	-0.08196	-0.86722	0.871083	-0.85178	0.506949	0.99122	0.871083
-4	2	0	0	0.1	11	0.002352	0.034888	0.034967	0.002304	0.034733	0.000001	0.612386	0.905975	0.437008	1.005866	-0.05126	-0.94257	0.943958	-0.85472	0.505556	0.99304	0.943958
-19	2	0	0	0.1	11	0.078159	0.116374	0.140185	0.078111	0.116219	0.301664	0.939158	0.880428	0.459866	0.993293	-0.02311	-0.96704	0.967319	-0.85732	0.507177	0.996103	0.967319
-17	2	0	0	0.1	11	0.125229	0.118232	0.172224	0.125182	0.11808	0.496089	0.951705	0.88102	0.466443	0.996878	-0.02324	-0.97424	0.974513	-0.85778	0.507793	0.996812	0.974513
-5	3	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.853117	0.478983	0.978383	-0.00062	-0.99291	0.992908	-0.8525	0.513925	0.995427	0.978383
-5	1	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.898992	0.274225	0.939886	-0.04479	-0.78249	0.783772	-0.85421	0.508267	0.993984	0.783772
-5	2	0	0	0.1	21	0.000972	0.060396	0.060404	0.000735	0.057504	0.000025	1.670263	0.93289	0.362197	1.000735	-0.08098	-0.86916	0.872927	-0.85191	0.506966	0.991349	0.872927
-6	3	0	0	0.1	13.5	0.000927	0.071447	0.071453	0.000355	0.071336	0.000022	2.208848	0.864389	0.487643	0.992454	-0.00597	-0.99762	0.997641	-0.85842	0.50998	0.998477	0.992454
-6	1	0	0	0.1	13.5	0.000927	0.071447	0.071453	0.000355	0.071336	0.000022	2.208848	0.87711	0.403484	0.965464	-0.01669	-0.91084	0.910994	-0.86042	0.507356	0.998865	0.910994
-6	2	0	0	0.1	13.5	0.000927	0.071447	0.071453	0.000355	0.071336	0.000022	2.208848	0.894813	0.434789	0.994853	-0.03593	-0.94163	0.942318	-0.85889	0.506845	0.997285	0.942318
-7	3	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.718843	0.368589	0.807832	-0.01517	-0.99566	0.995773	-0.86644	0.510209	1.005496	0.807832
-7	1	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.803554	0.317167	0.863883	0.056034	-0.82391	0.82581	-0.85959	0.50674	0.997836	0.82581

-7	2	0	0	0.1	150	0.696706	5.803676	5.845345	0.694233	5.785026	1.350757	7.782148	0.721877	0.349471	0.80202	-0.02837	-0.79014	0.790653	-0.85955	0.512622	1.000806	0.790653
-8	3	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831096	9.651443	0.758367	0.496758	0.906581	0.047386	-1.00013	1.001252	-0.80575	0.503372	0.950064	0.906581
-8	1	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831096	9.651443	0.72866	0.422771	0.842425	0.131433	-0.92677	0.936041	-0.86009	0.503997	0.996882	0.842425
-8	2	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831096	9.651443	0.716654	0.444414	0.843266	0.119173	-0.9031	0.910927	-0.83583	0.458685	0.953414	0.843266
-9	3	0	0	0.1	66	0.015327	12.08945	12.08946	0.014274	12.08437	7.19E+08	3.056605	0.870498	0.492171	1	-0.00902	-0.99996	1	-0.86148	0.507788	1	1
-9	1	0	0	0.1	66	0.015327	12.08945	12.08946	0.014274	12.08437	7.19E+08	3.056605	0.858044	0.481515	0.983919	0.003322	-0.98912	0.989127	-0.86137	0.507606	0.999808	0.983919
-9	2	0	0	0.1	66	0.015327	12.08945	12.08946	0.014274	12.08437	7.19E+08	3.056605	0.858088	0.481464	0.983932	0.003277	-0.98907	0.989076	-0.86137	0.507607	0.999807	0.983932
-4	3	0	0	0.1	11	0.002352	0.034888	0.034967	0.002304	0.034733	0.000001	0.612386	0.85507	0.475319	0.978301	-0.00143	-0.99138	0.991381	-0.85364	0.516061	0.99751	0.978301
-20	2	0	0	0.1	11	0.081737	0.091055	0.12236	0.08173	0.090967	0.496089	0.951705	0.884005	0.469515	1.000954	-0.02541	-0.97766	0.977986	-0.8586	0.50814	0.997693	0.977986
-4	1	0	0	0.1	11	0.002352	0.034888	0.034967	0.002304	0.034733	0.000001	0.612386	0.909705	0.381418	0.986429	-0.04955	-0.88948	0.890855	-0.86015	0.508058	0.998992	0.890855
-18	2	0	0	0.1	11	0.696646	0.606575	0.923715	0.696599	0.60642	2.786074	2.899675	0.872047	0.484987	0.997837	-0.01157	-0.99293	0.993001	-0.86048	0.507947	0.999217	0.993001
-21	2	0	0	0.1	11	0.767666	0.474554	0.902504	0.767619	0.474398	3.066289	2.369886	0.87313	0.485217	0.998895	-0.01265	-0.99332	0.993398	-0.86048	0.508101	0.999299	0.993398
-19	3	0	0	0.1	11	0.078159	0.116374	0.140185	0.078111	0.116219	0.301664	0.939158	0.863713	0.482001	0.989103	-0.0057	-0.9948	0.994819	-0.85801	0.512802	0.999574	0.989103
-19	1	0	0	0.1	11	0.078159	0.116374	0.140185	0.078111	0.116219	0.301664	0.939158	0.878521	0.450273	0.98719	-0.01753	-0.95809	0.958245	-0.86099	0.507812	0.999588	0.958245
-17	1	0	0	0.1	11	0.125229	0.118232	0.172224	0.125182	0.11808	0.496089	0.951705	0.881712	0.459757	0.99438	-0.02062	-0.96762	0.967841	-0.86109	0.507864	0.999703	0.967841
-20	1	0	0	0.1	11	0.081737	0.091055	0.12236	0.08173	0.090967	0.496089	0.951705	0.885117	0.461231	0.998081	-0.02401	-0.96914	0.969434	-0.86111	0.507905	0.999735	0.969434
-18	1	0	0	0.1	11	0.696646	0.606575	0.923715	0.696599	0.60642	2.786074	2.899675	0.872355	0.484716	0.997974	-0.01096	-0.99251	0.992575	-0.86139	0.507797	0.999929	0.992575
-22	2	0	0	0.1	11	0.162982	0.522186	0.54703	0.163001	0.522174	4.909641	3.926728	0.872908	0.487418	0.999772	-0.01165	-0.99544	0.995508	-0.86126	0.508022	0.999929	0.995508
-21	1	0	0	0.1	11	0.767666	0.474554	0.902504	0.767619	0.474398	3.066289	2.369886	0.873547	0.484977	0.999143	-0.01215	-0.99279	0.992862	-0.8614	0.507811	0.999937	0.992862
-22	1	0	0	0.1	11	0.162982	0.522186	0.54703	0.163001	0.522174	4.909641	3.926728	0.87269	0.487166	0.999459	-0.01127	-0.99497	0.995035	-0.86142	0.507805	0.999956	0.995035
-18	3	0	0	0.1	11	0.696646	0.606575	0.923715	0.696599	0.60642	2.786074	2.899675	0.869577	0.489518	0.997894	-0.00858	-0.99862	0.998658	-0.861	0.509103	1.000253	0.997894
-22	3	0	0	0.1	11	0.162982	0.522186	0.54703	0.163001	0.522174	4.909641	3.926728	0.870824	0.491271	0.999841	-0.00919	-0.99951	0.999553	-0.86164	0.50824	1.000363	0.999553
-17	3	0	0	0.1	11	0.125229	0.118232	0.172224	0.125182	0.11808	0.496089	0.951705	0.86599	0.482598	0.991383	-0.00684	-0.99512	0.995145	-0.85915	0.512524	1.000411	0.991383
-21	3	0	0	0.1	11	0.767666	0.474554	0.902504	0.767619	0.474398	3.066289	2.369886	0.869964	0.489337	0.998142	-0.00877	-0.99853	0.998573	-0.86119	0.509197	1.000466	0.998142
-20	3	0	0	0.1	11	0.081737	0.091055	0.12236	0.08173	0.090967	0.496089	0.951705	0.867652	0.484134	0.993582	-0.00766	-0.99591	0.995935	-0.85999	0.511772	1.00075	0.993582
-10	3	0	0	0.1	150	0.697035	5.850161	5.89154	0.694619	5.831732	1.324798	7.579722	0.720983	0.369905	0.810337	-0.01328	-0.99414	0.994229	-0.86454	0.511729	1.004636	0.810337
-10	1	0	0	0.1	150	0.697035	5.850161	5.89154	0.694619	5.831732	1.324798	7.579722	0.804662	0.319506	0.865774	0.054951	-0.82626	0.828088	-0.85961	0.506756	0.997866	0.828088
-10	2	0	0	0.1	150	0.697035	5.850161	5.89154	0.694619	5.831732	1.324798	7.579722	0.724047	0.351193	0.804724	-0.02832	-0.79312	0.793626	-0.8575	0.511932	0.998693	0.793626
-11	3	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831095	9.651443	0.758367	0.496758	0.906581	0.047386	-1.00013	1.001252	-0.80575	0.503372	0.950064	0.906581
-11	1	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831095	9.651443	0.72866	0.422771	0.842425	0.131433	-0.92677	0.936041	-0.86009	0.503997	0.996882	0.842425
-11	2	0	0	0.1	380	0.488034	7.815499	7.830722	0.456924	7.622298	0.831095	9.651443	0.716654	0.444414	0.843266	0.119173	-0.9031	0.910927	-0.83583	0.458685	0.953414	0.843266
-12	3	0	0	0.1	20	0.006987	0.116689	0.116898	0.006969	0.116584	0.024363	0.114743	0.851371	0.406005	0.943225	-0.01549	-1.00891	1.009026	-0.8671	0.498562	1.000211	0.943225
-12	1	0	0	0.1	20	0.006987	0.116689	0.116898	0.006969	0.116584	0.024363	0.114743	0.873272	0.4079	0.963839	-0.01276	-0.91558	0.915673	-0.86051	0.507684	0.999113	0.915673
-12	2	0	0	0.1	20	0.006987	0.116689	0.116898	0.006969	0.116584	0.024363	0.114743	0.846235	0.412428	0.941388	-0.07776	-0.94817	0.951348	-0.87136	0.508313	1.008786	0.941388
-13	3	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.870498	0.492171	1	-0.00902	-0.99996	1	-0.86148	0.507788	1	1
-13	1	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.857979	0.469322	0.977953	0.001649	-0.97605	0.976052	-0.85963	0.506729	0.997865	0.976052
-13	2	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.867553	0.474566	0.988869	-0.00751	-0.98209	0.982116	-0.86004	0.507521	0.998626	0.982116
-14	3	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.870498	0.492171	1	-0.00902	-0.99996	1	-0.86148	0.507788	1	1
-14	1	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.85766	0.469933	0.977966	0.002019	-0.97664	0.976639	-0.85968	0.506704	0.997896	0.976639
-14	2	0	0	0.1	21	0.000746	0.067823	0.067827	0.000387	0.060665	57272.64	57174.47	0.867209	0.474889	0.988722	-0.00714	-0.98238	0.982409	-0.86007	0.507494	0.998635	0.982409
-15	3	50	0	0.123	150	0.696913	5.827089	5.868616	0.694468	5.808549	1.33806	7.68261	0.868725	0.485128	0.995004	-0.00977	-1.00502	1.005066	-0.67975	0.438845	0.809099	0.809099
-15	1	50	0	0.123	150	0.696913	5.827089	5.868616	0.694468	5.808549	1.33806	7.68261	0.686807	0.460602	0.826957	-0.00906	-0.99781	0.997851	-0.67775	0.537209	0.864834	0.826957
-15	2	50	0	0.123	150	0.696913	5.827089	5.868616	0.694468	5.808549	1.33806	7.68261	0.699754	0.371278	0.792151	-0.01438	-0.99966	0.999759	-0.66489	0.450944	0.803384	0.792151
-16	3	50	0	0.123	150	0.520828	4.11761	4.150419	0.516308	4.09238	1.449578	9.16131	0.926878	0.457634	1.033698	0.048832	-1.032	1.033157	-0.5721	0.37997	0.686789	0.686789
-16	1	50	0	0.123	150	0.520828	4.11761	4.150419	0.516308	4.09238	1.449578	9.16131	0.565182	0.454937	0.725533	-0.00891	-0.99641	0.996454	-0.55627	0.541477	0.776296	0.725533
-16	2	50	0	0.123	150	0.520828	4.11761	4.150419	0.516308	4.09238	1.449578	9.16131	0.579572	0.304633	0.654756	-0.00889	-1.04742	1.047461	-0.54305	0.398274	0.673442	0.654756

APPENDIX D: Compilation of all simulations (printable version)

3 phase symmetrical fault at 150KV bus, GR scenario

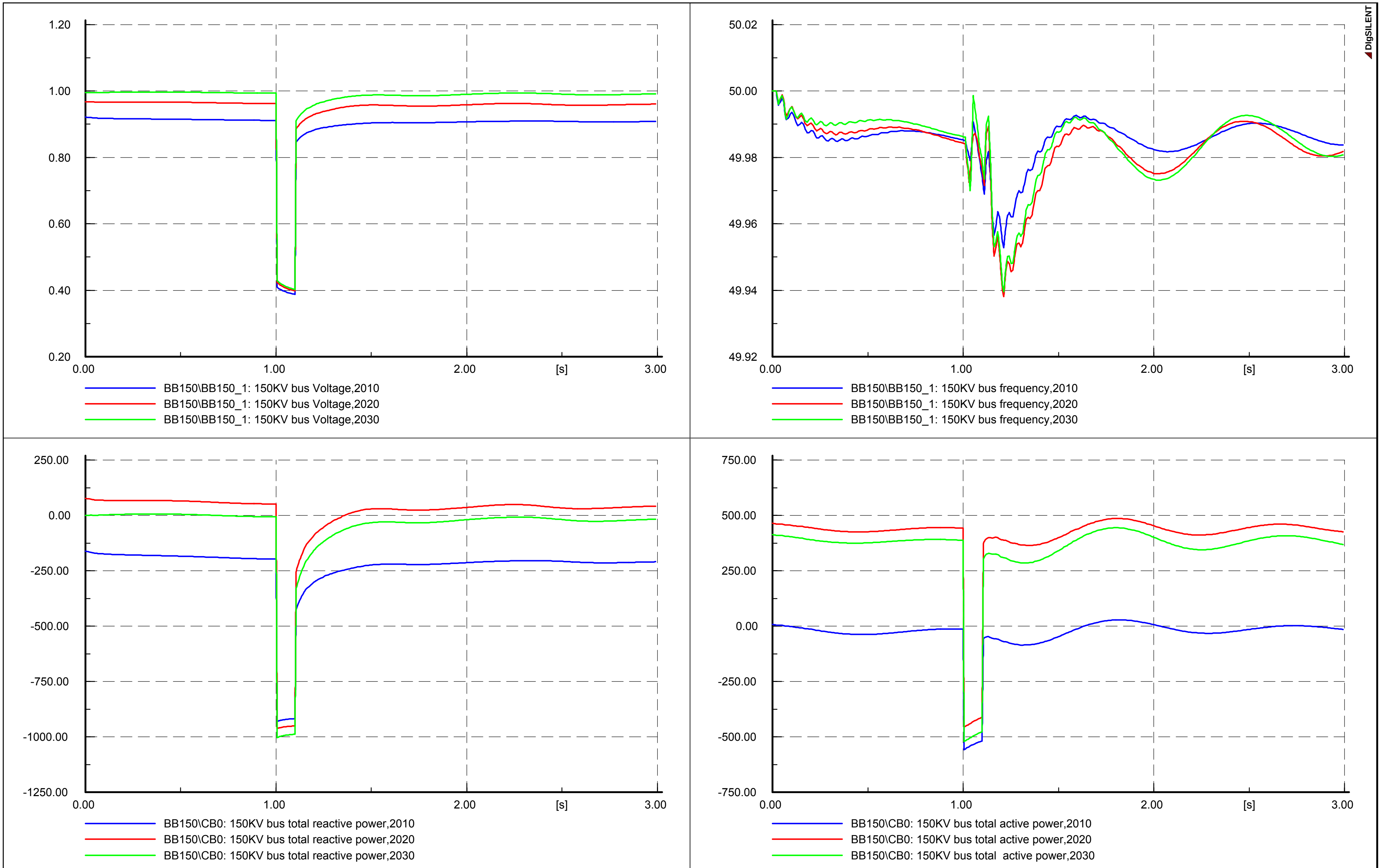


GR worst case SC

Date: 8/14/2011

Annex: /19

3 phase symmetrical fault at wind farm terminal bus,GR scenario

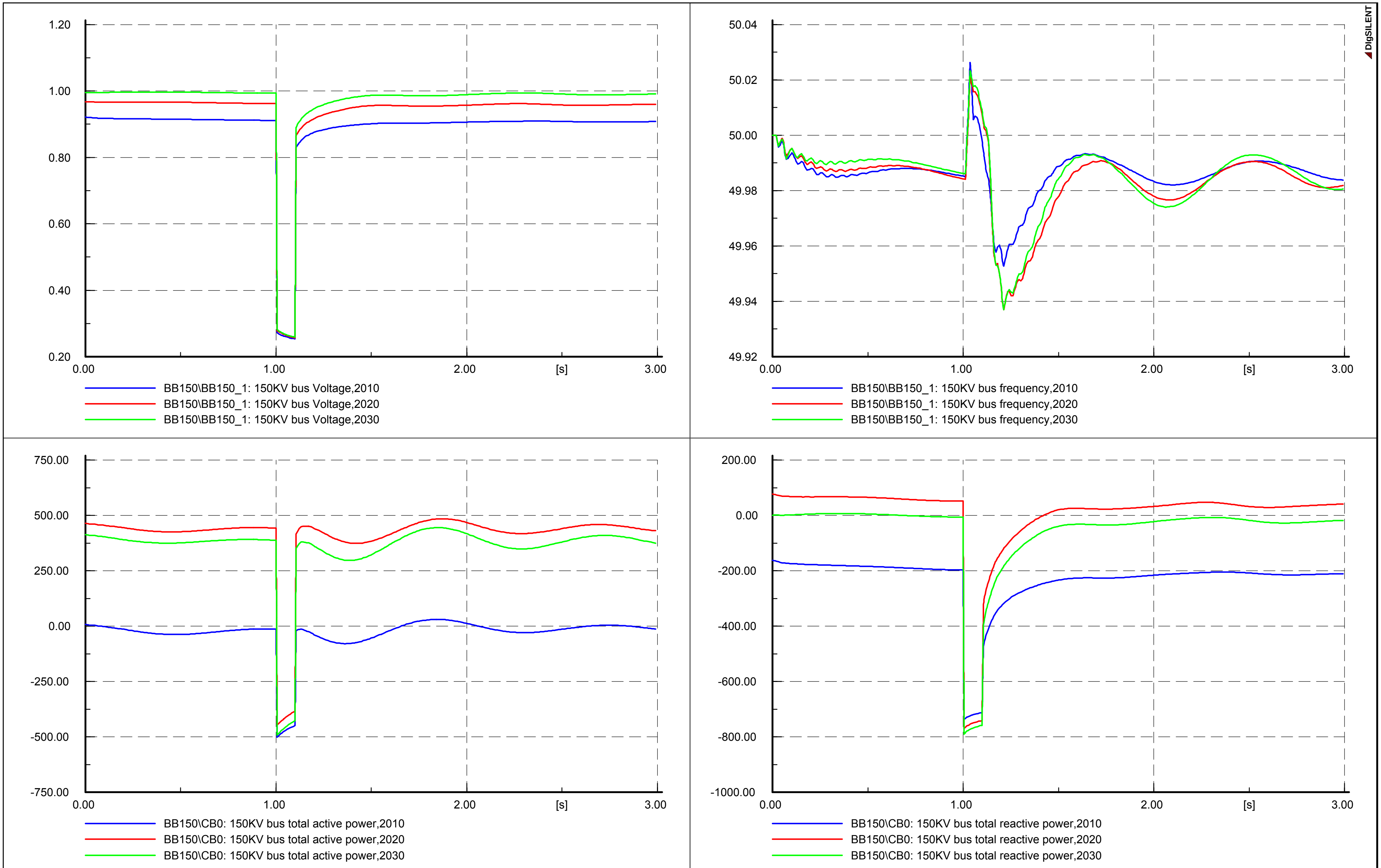


GR SC@wfbus

Date: 8/14/2011

Annex: /20

3 phase symmetrical fault at 50% of windfarm interconnecting cable,GR scenario

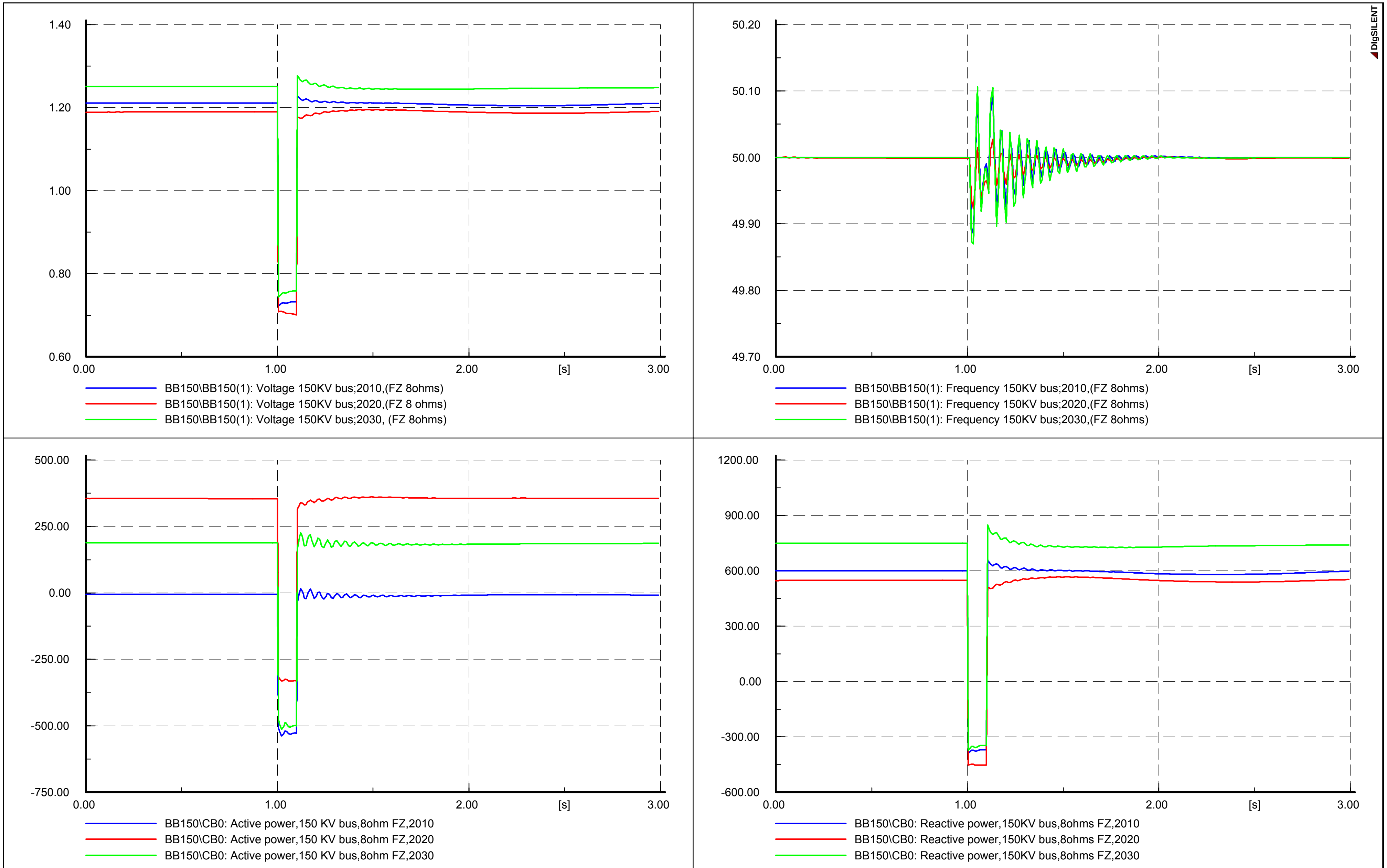


GR SC @wf cable

Date: 8/14/2011

Annex: /22

3 phase symmetrical fault at 150KV bus,NS scenario

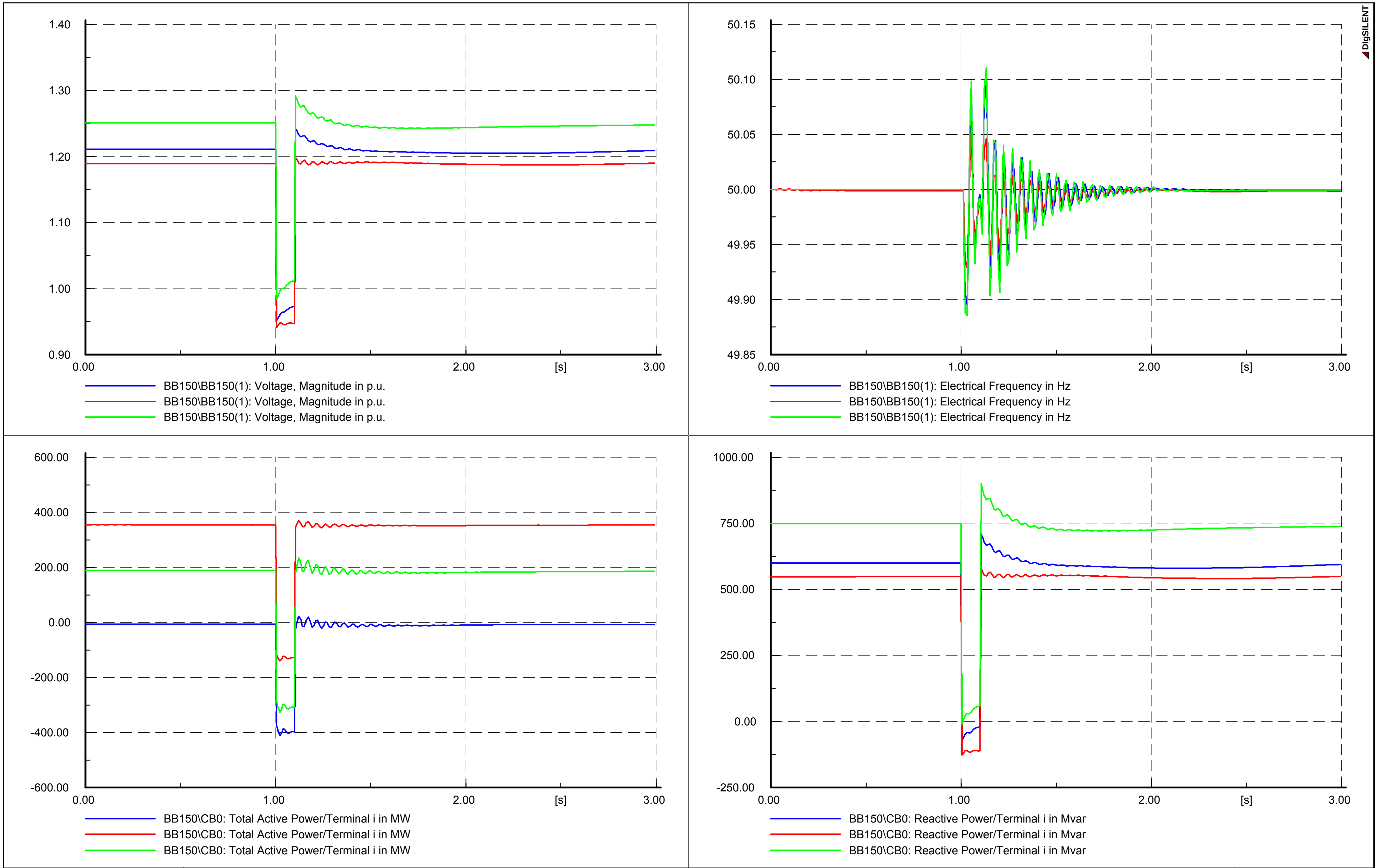


Nstr_worst case SC

Date: 8/14/2011

Annex: /14

3 phase symmetrical fault at wind farm terminal,NS scenario

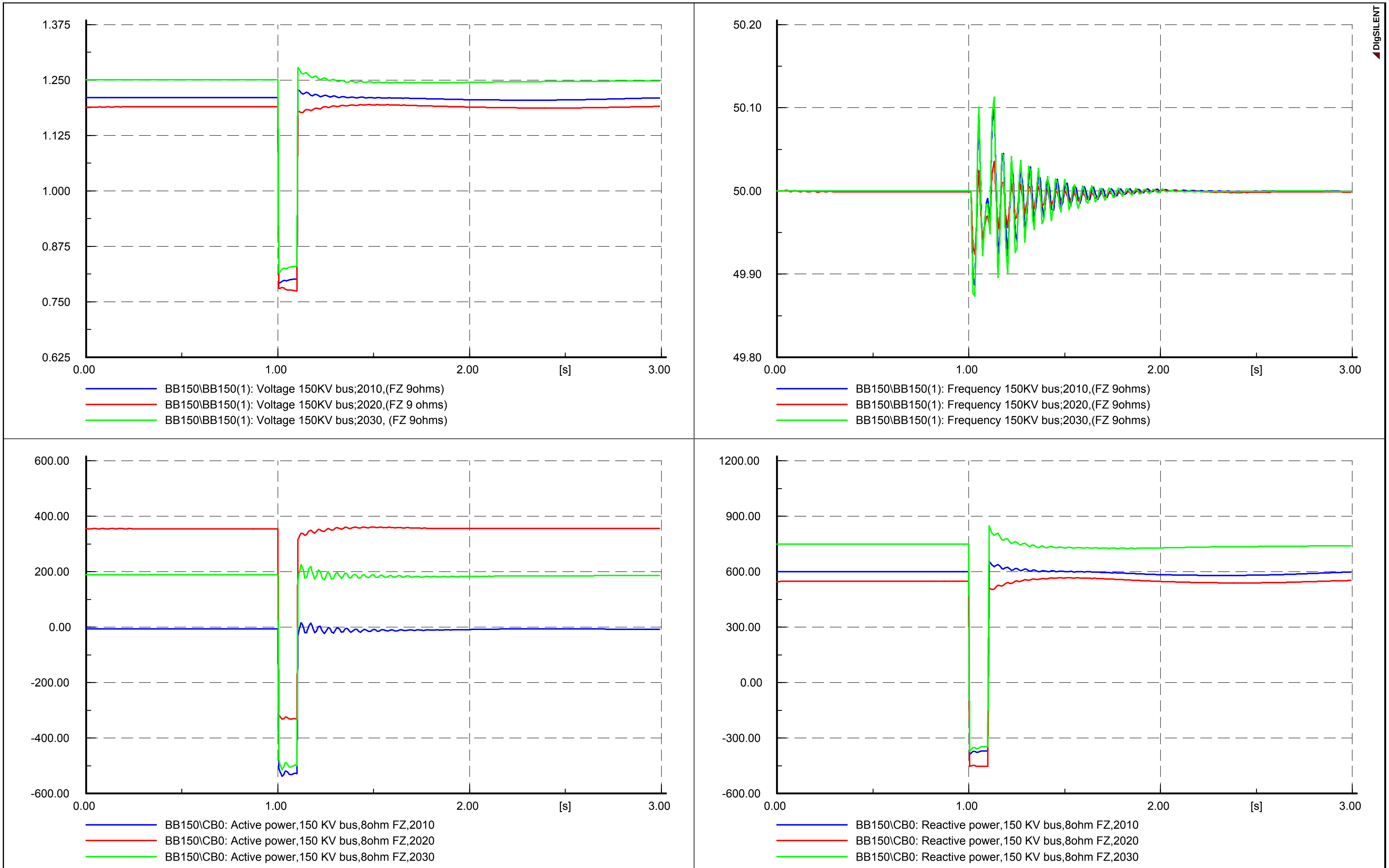


Nstr_SC@wf_ter

Date: 8/14/2011

Annex: /12

3 phase symmetrical fault at 50% of interconnection cable, NS scenario

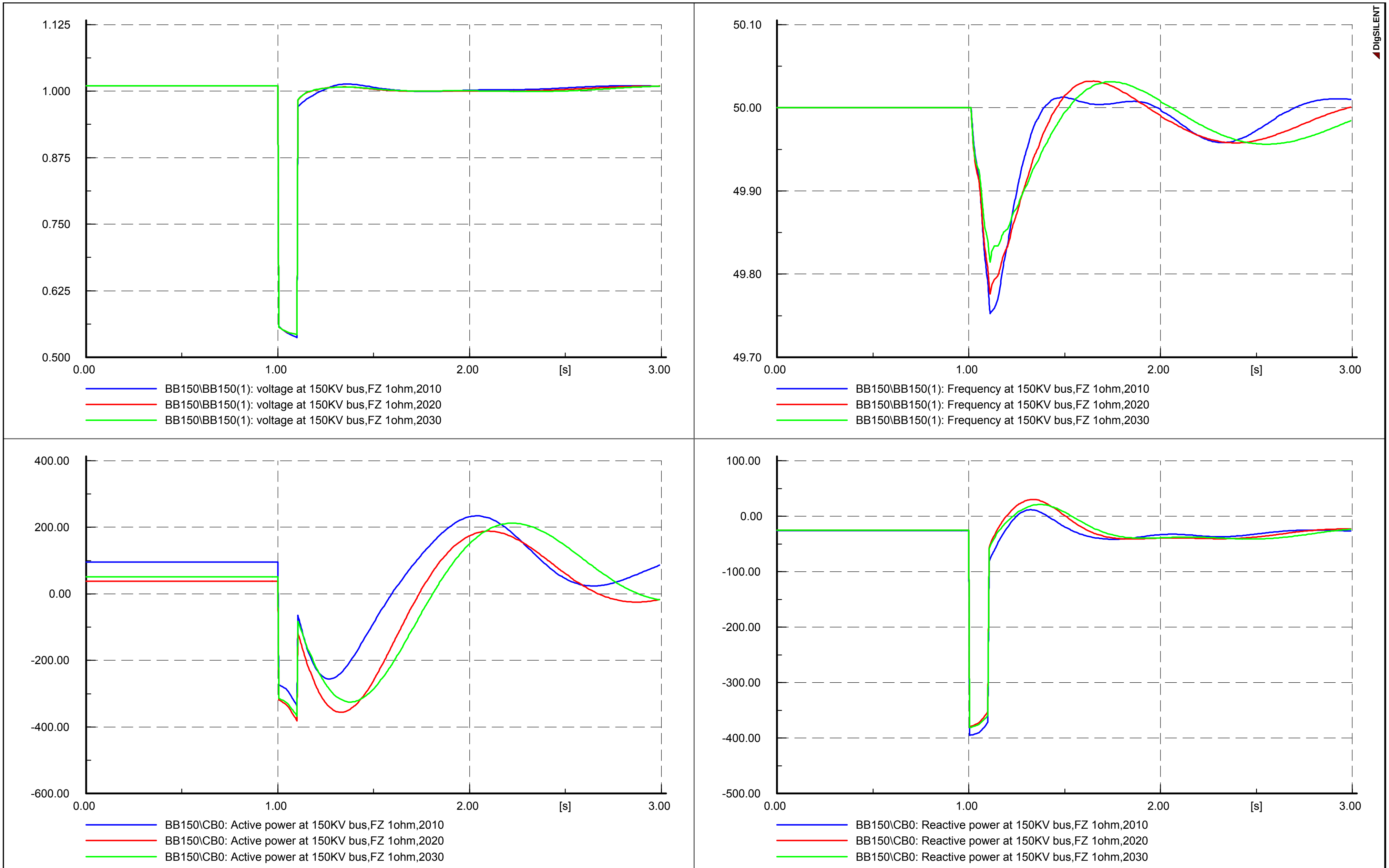


Nstr_SC@wf cable

Date: 8/14/2011

Annex: /13

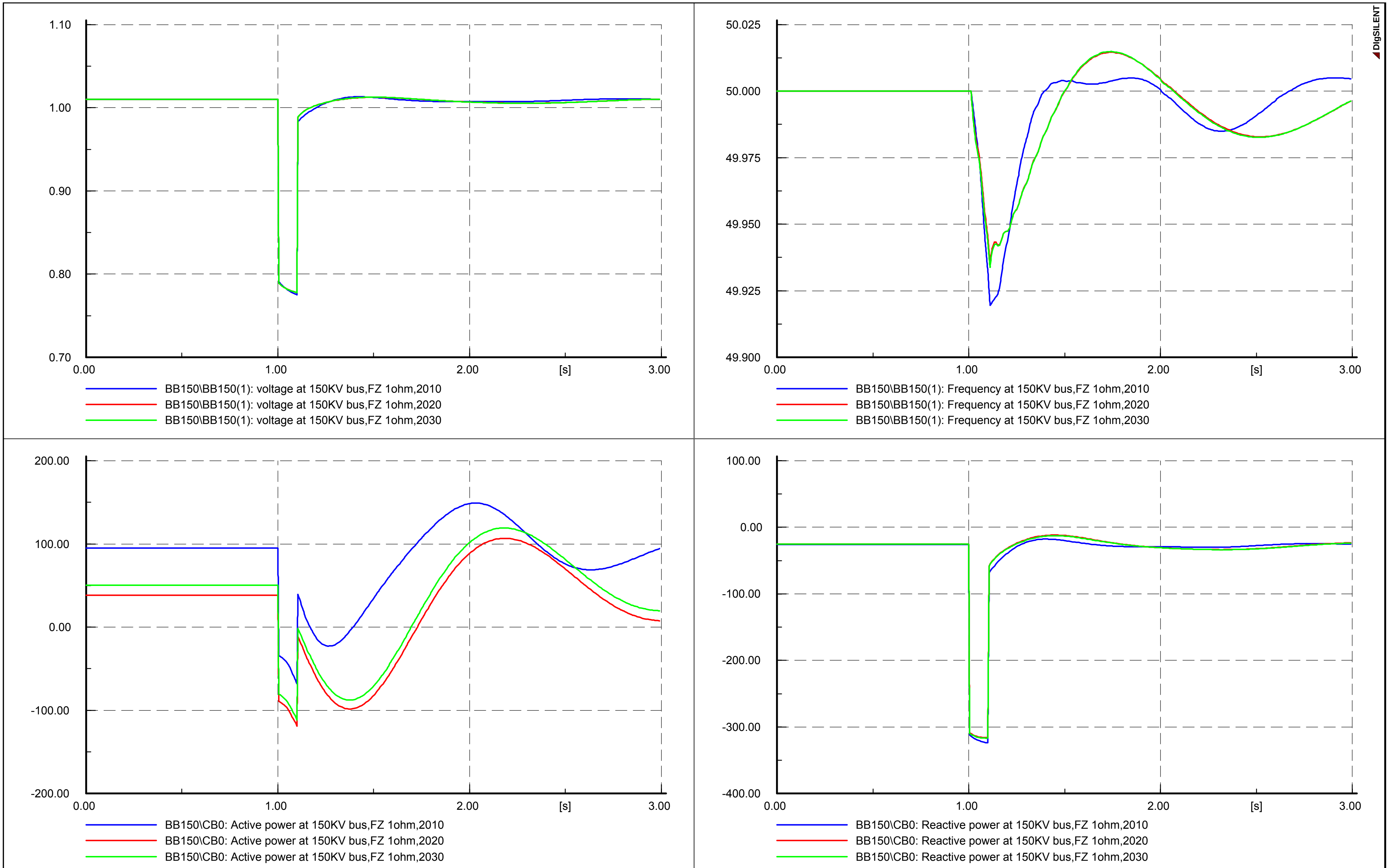
3 phase symmetrical fault at 150KV bus,SX scenario



SX_150 bus | Date: 8/14/2011

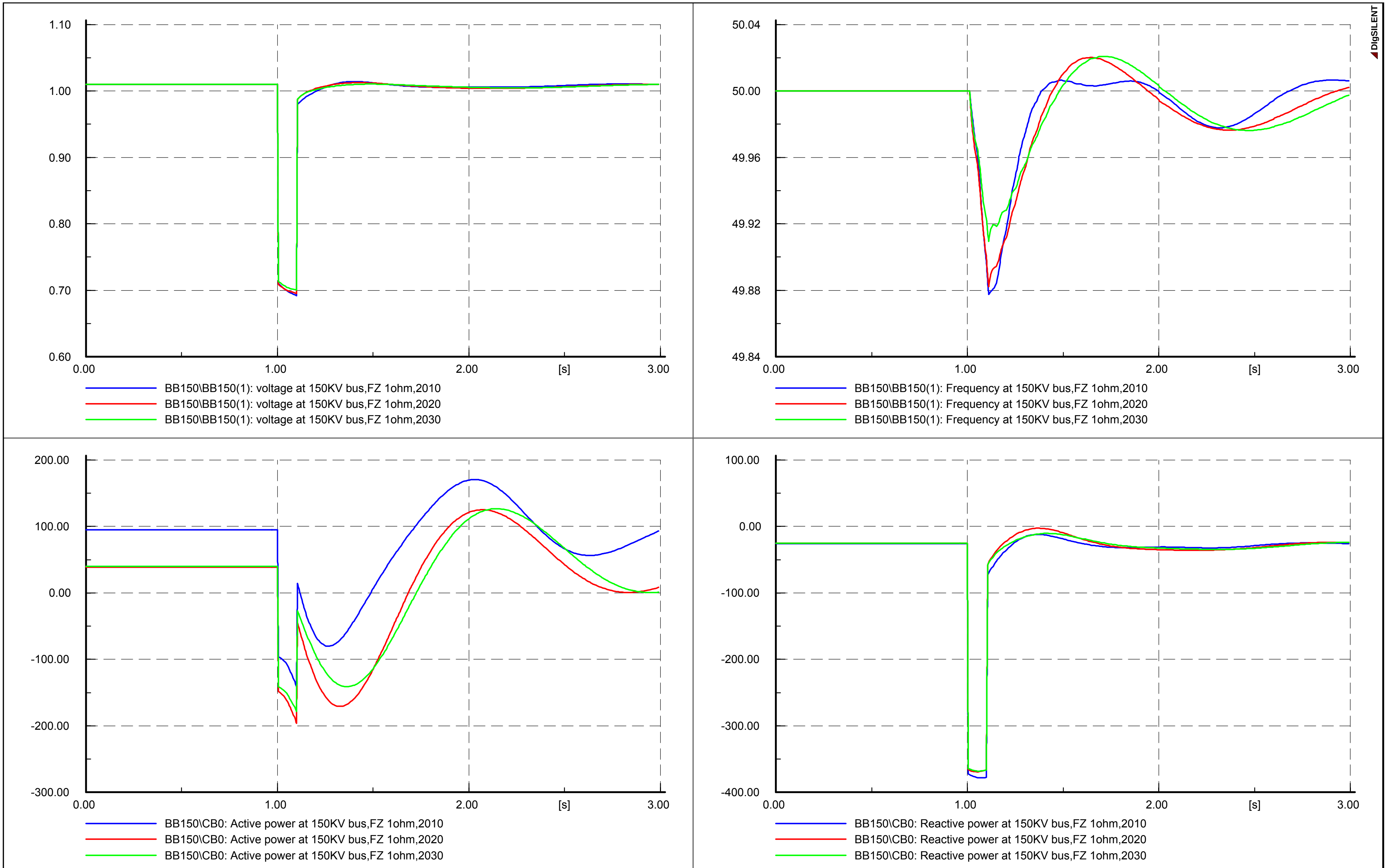
Annex: /13

3 phase symmetrical fault at wind farm terminals,SX scenario



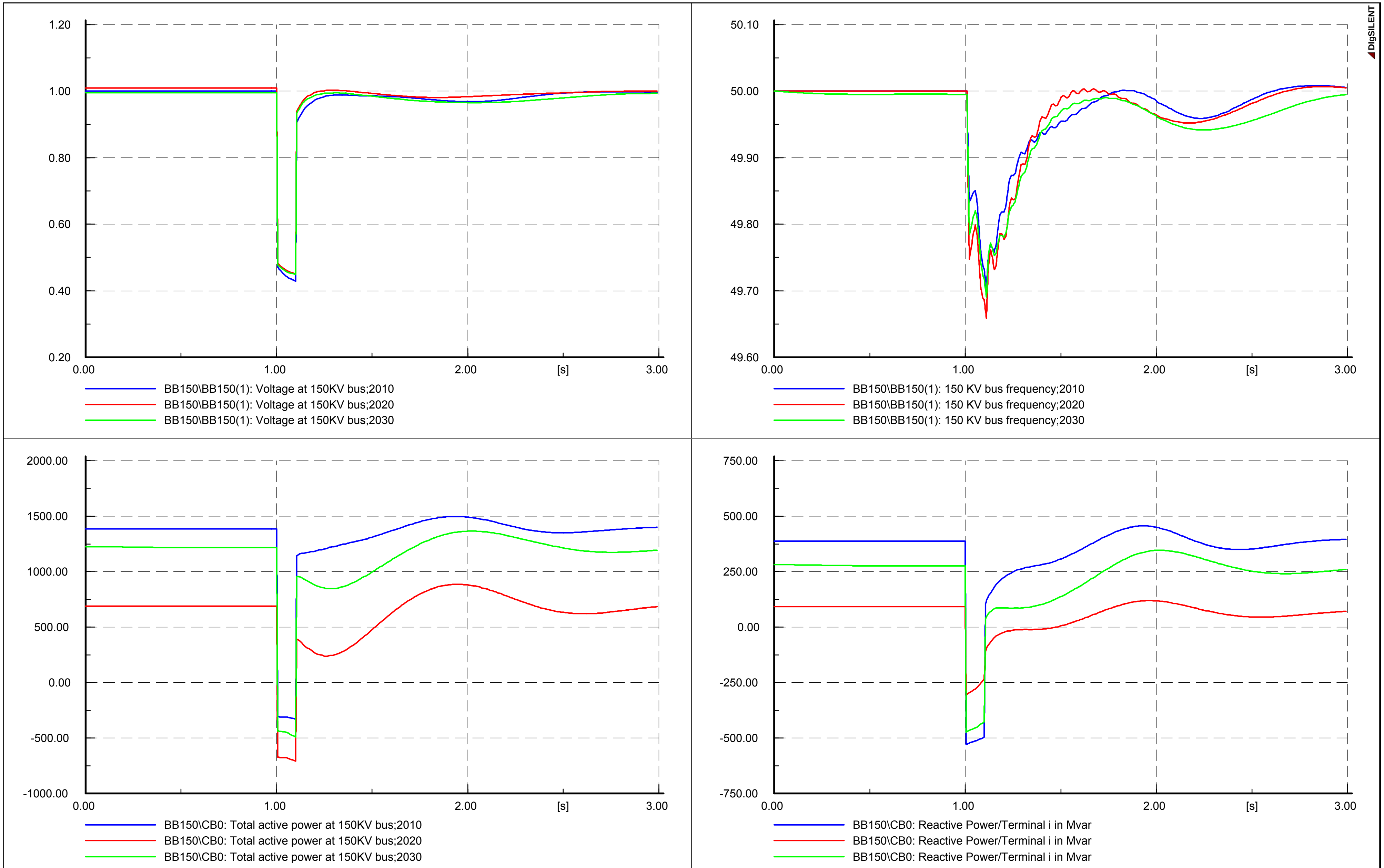
SX_wf ter | Date: 8/14/2011 | Annex: /15

3 phase symmetrical fault at wind farm interconnection cable,SX scenario



		SX_wf cable	Date: 8/14/2011 Annex: /14

3 phase symmetrical fault at 150KV bus,MR scenario

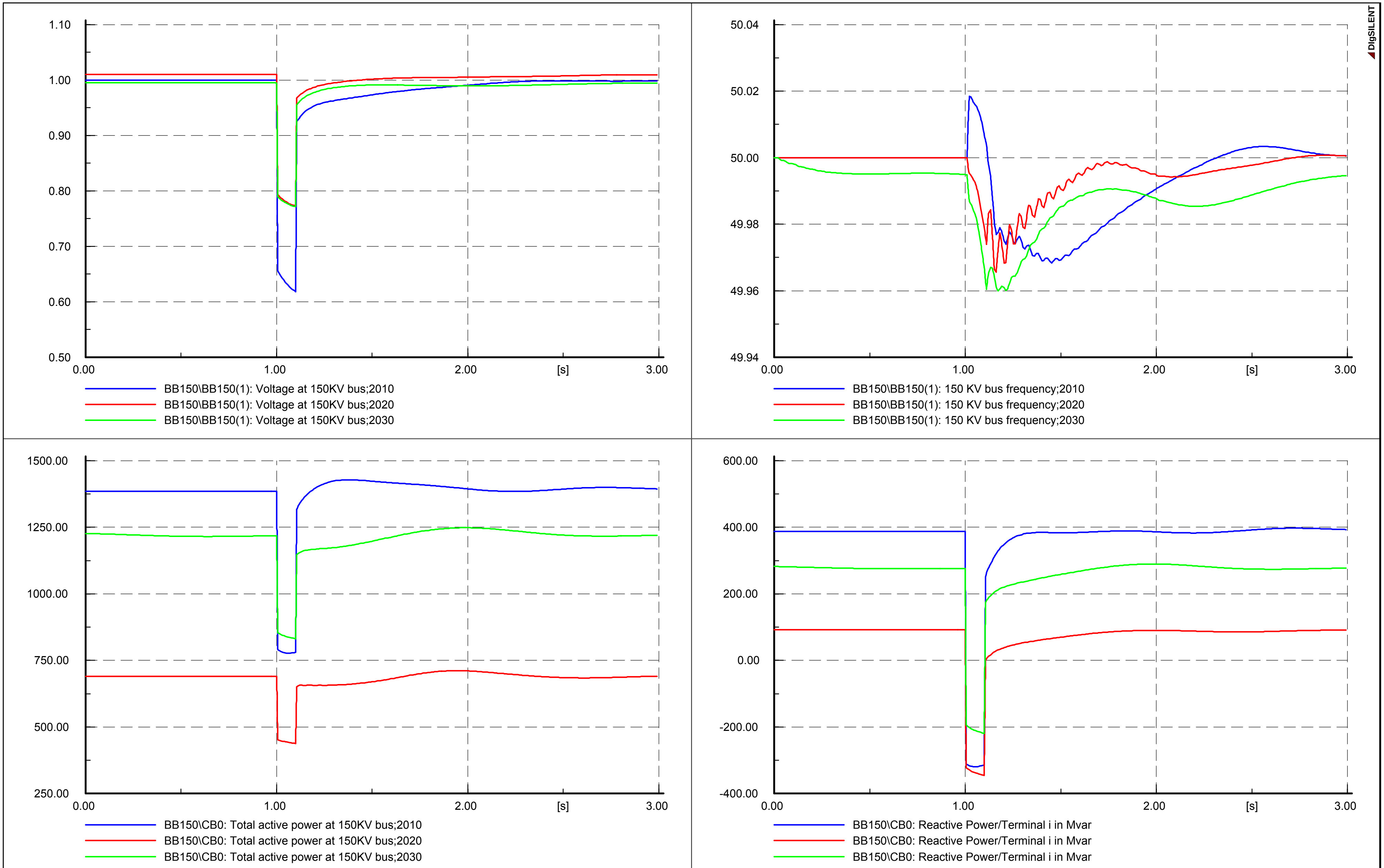


MR_SC@150 bus

Date: 8/14/2011

Annex: /11

3 phase symmetrical fault at wind farm terminal,MR scenario

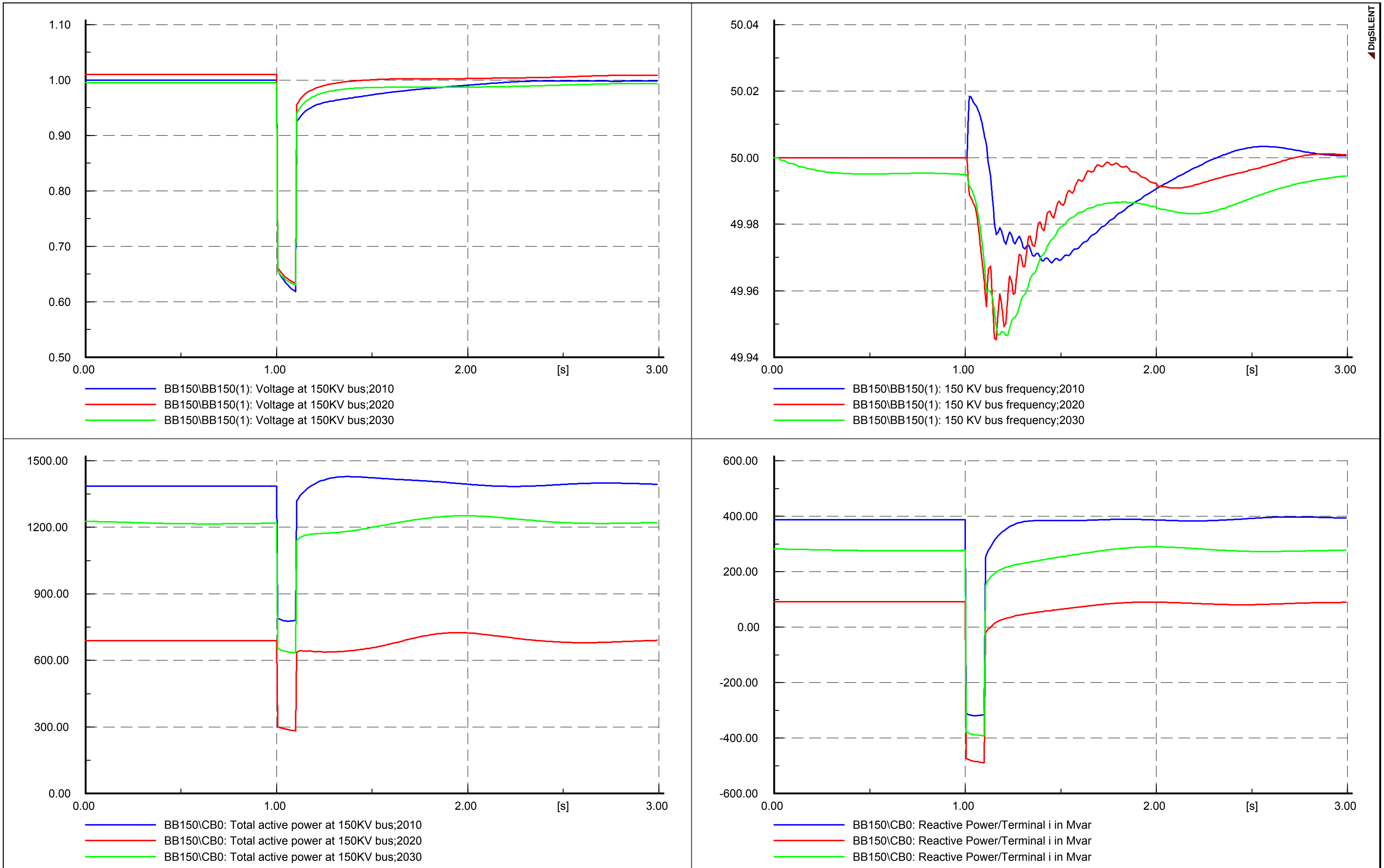


MR_SC@wf_ter

Date: 8/14/2011

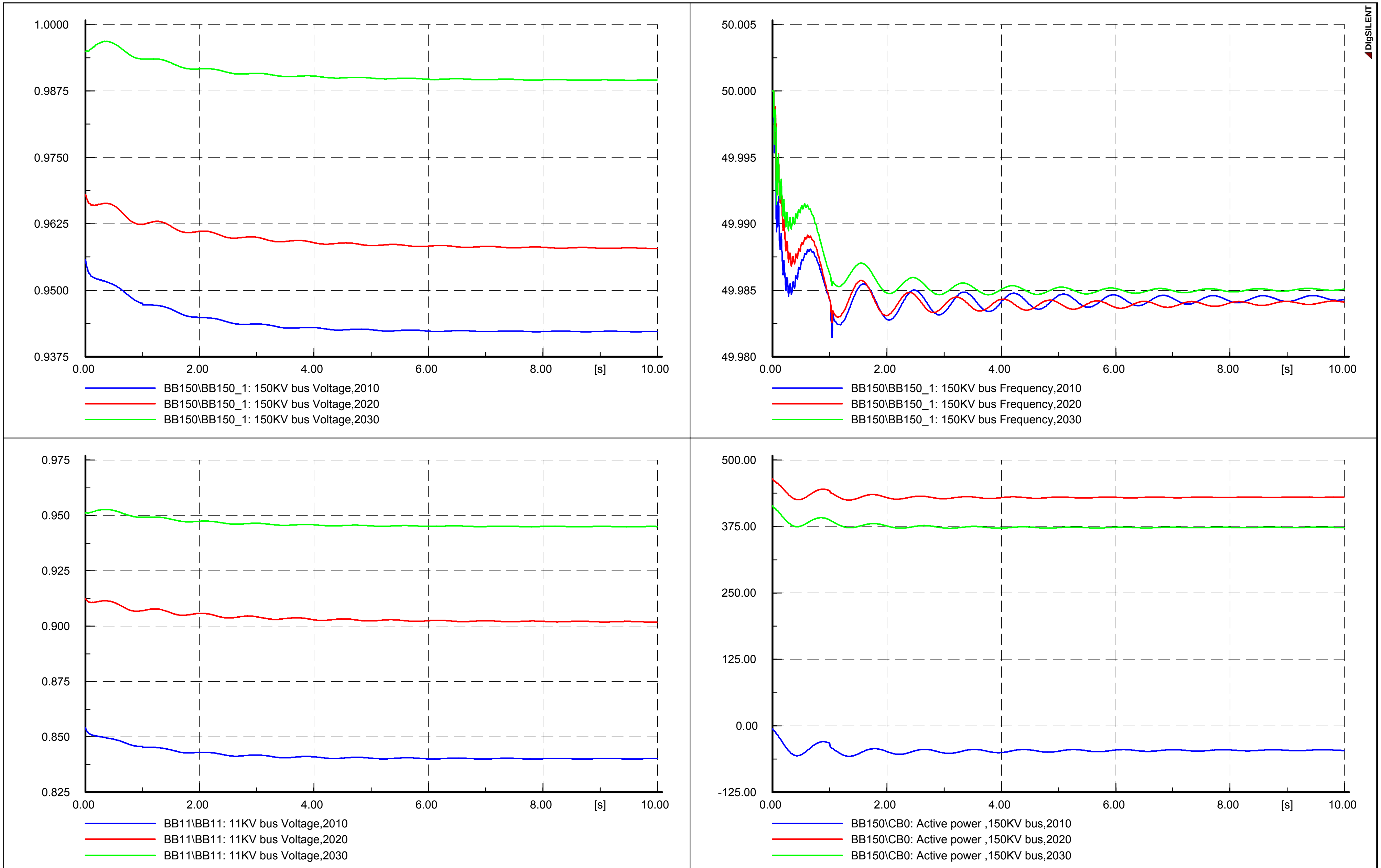
Annex: /12

3 phase symmetrical fault at wind farm interconnection cable,MR scenario



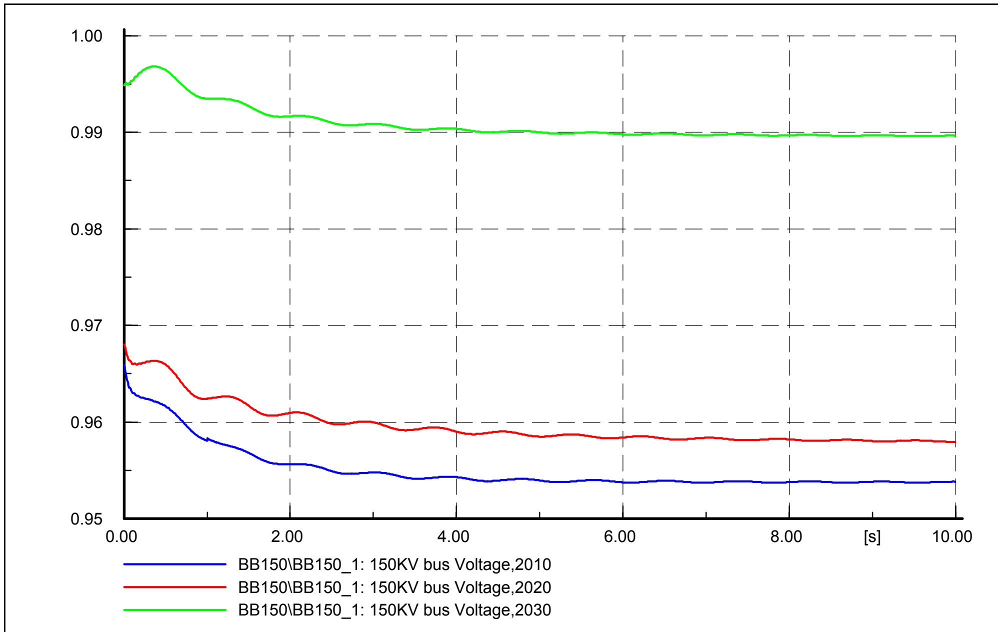
		MR_SC@wf_cable	Date: 8/14/2011 Annex: /13

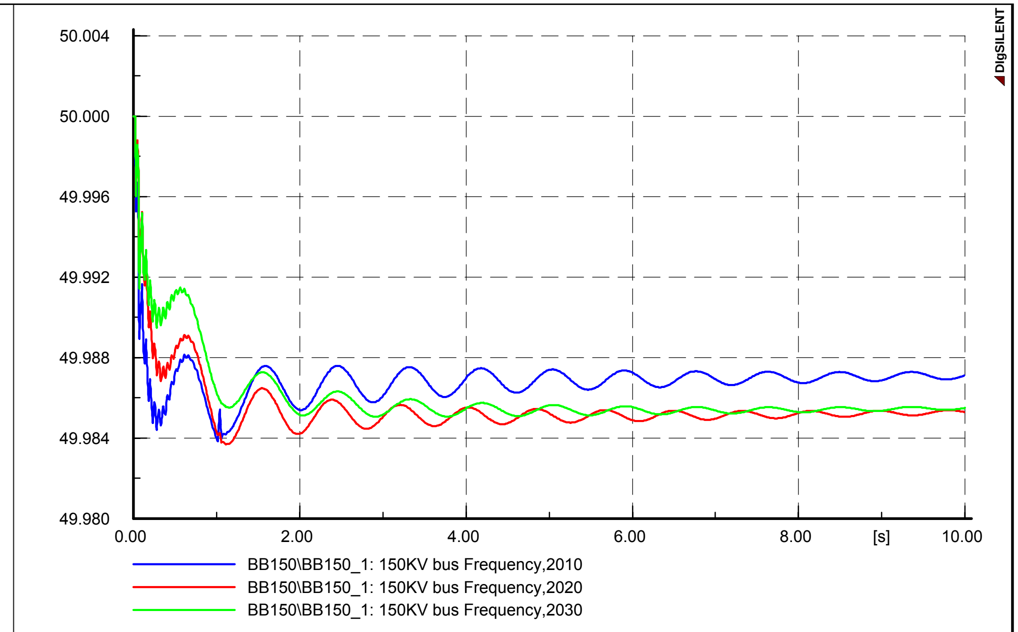
Increase in load at 150KV bus,GR scenario

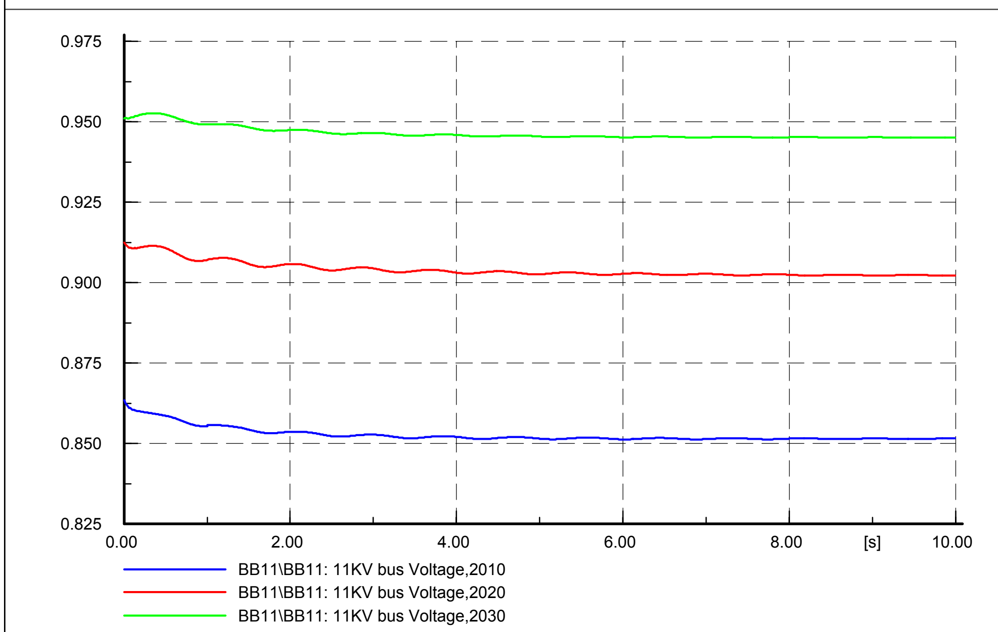


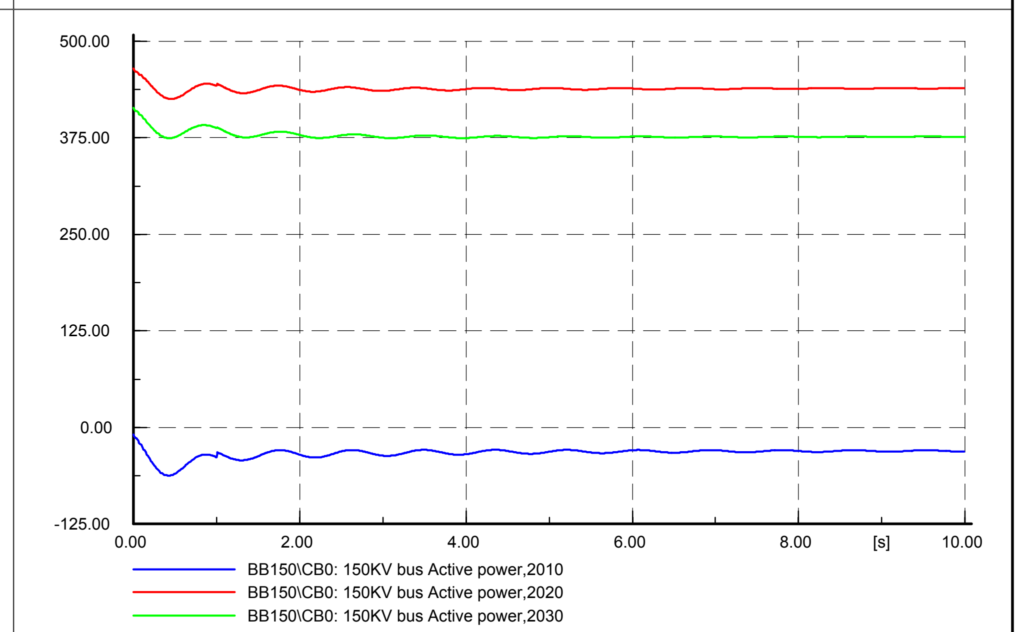
GR 150DLi	Date: 8/14/2011	Annex: /3

Decrease in load at 150KV bus, GR scenario







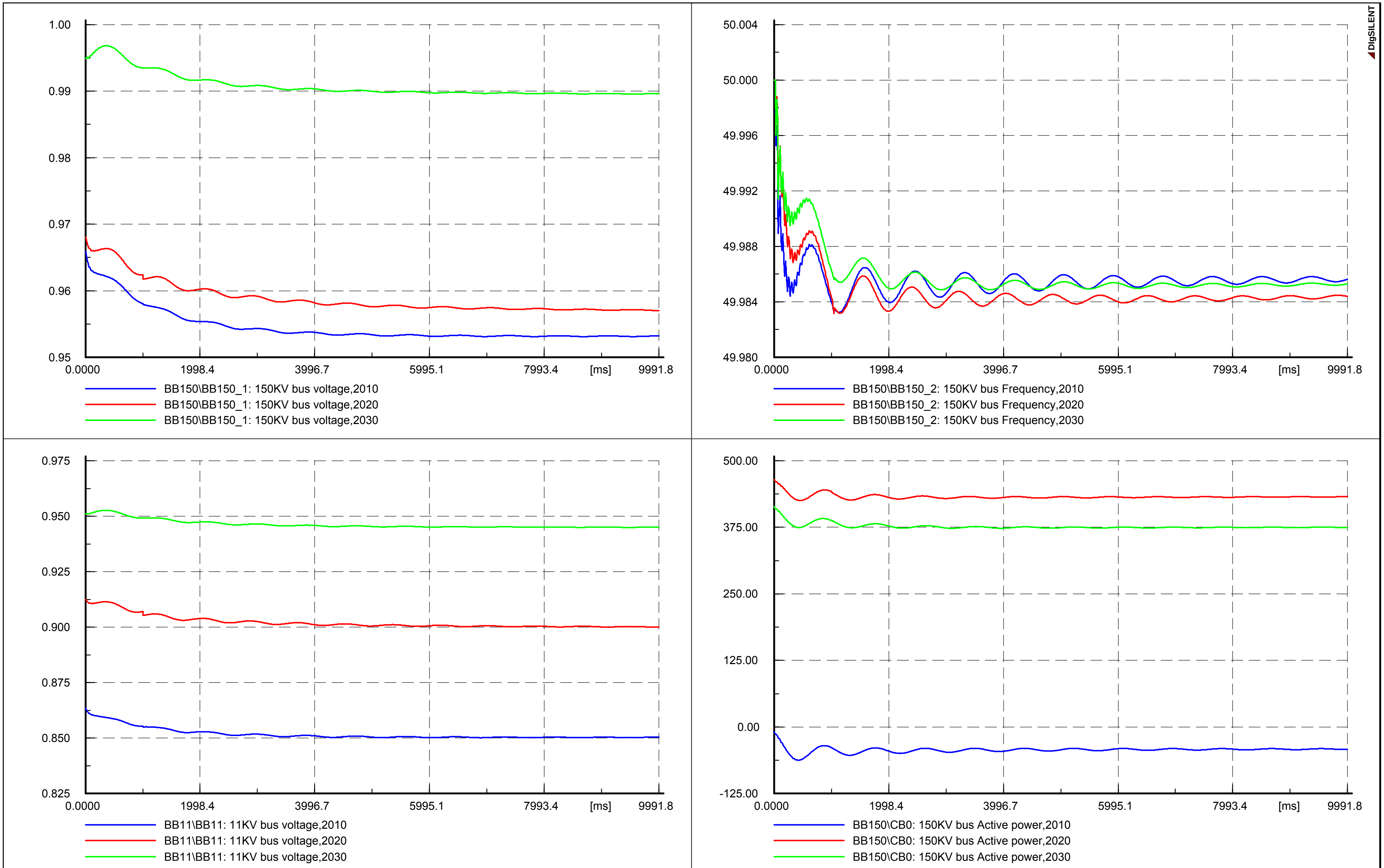


GR 150DLdec

Date: 8/14/2011

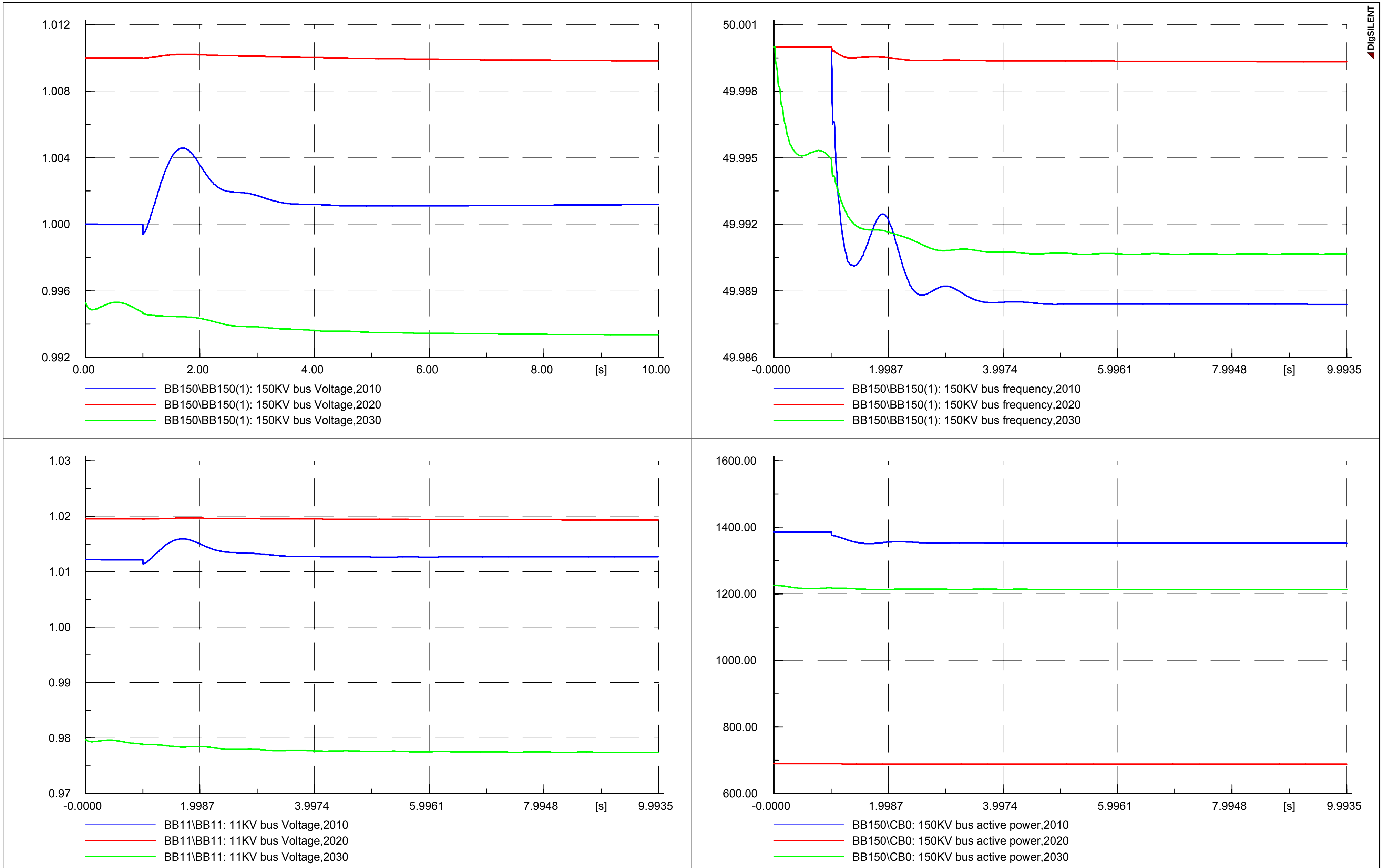
Annex: /5

Increase in load at EV bus(DC load),GR scenario



GR EVi | Date: 8/14/2011
Annex: /6

Increase in load at 150KV bus,MR scenario

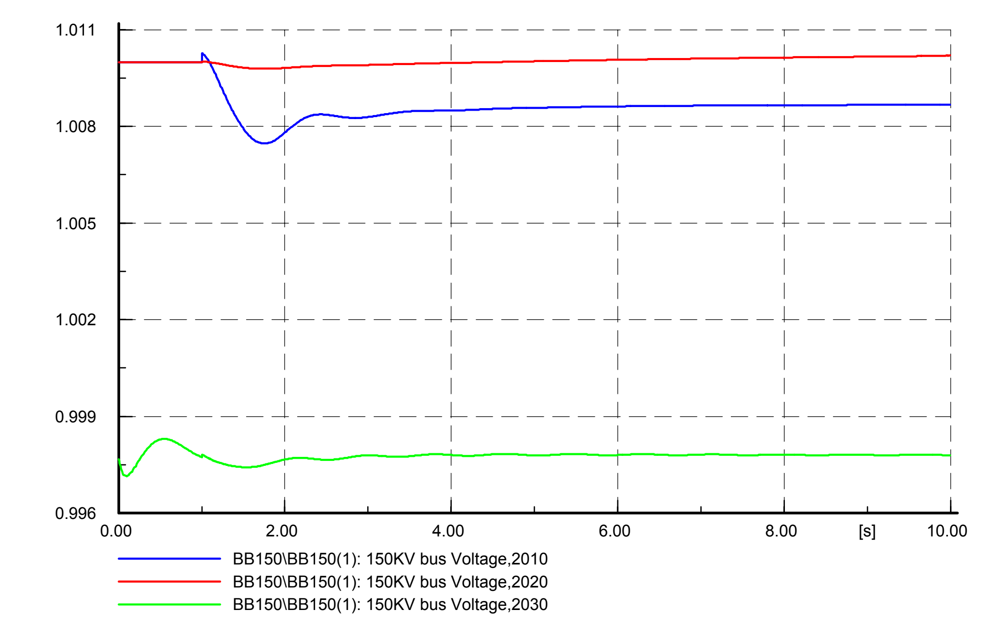


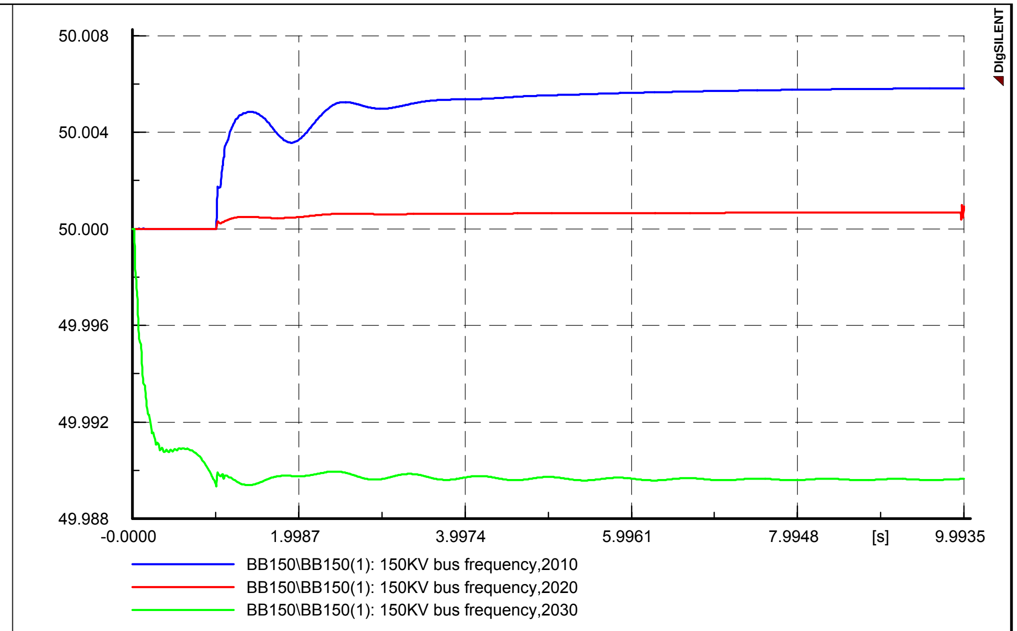
MR150DLi

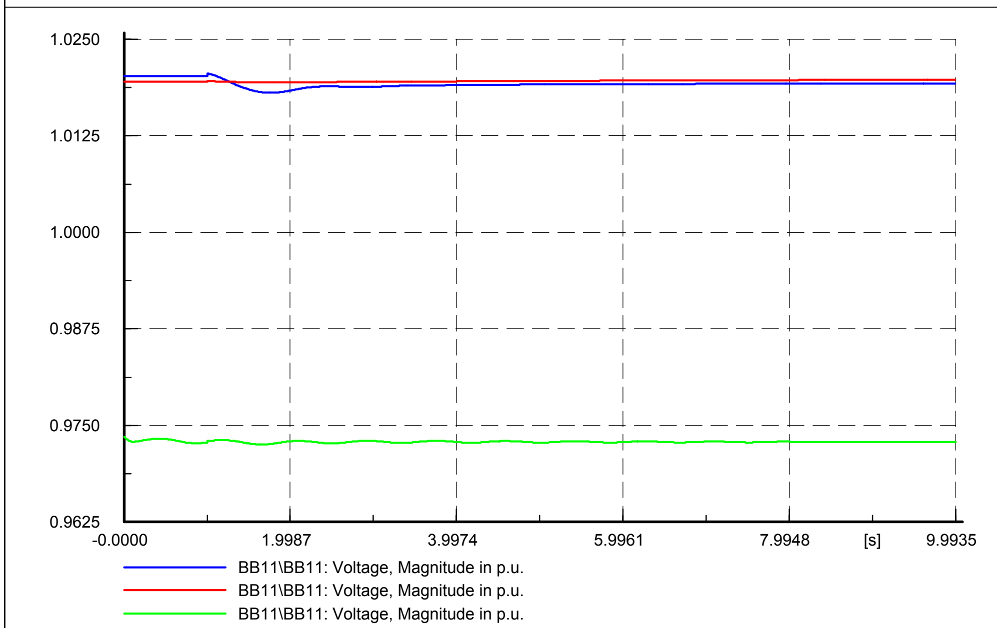
Date: 8/14/2011

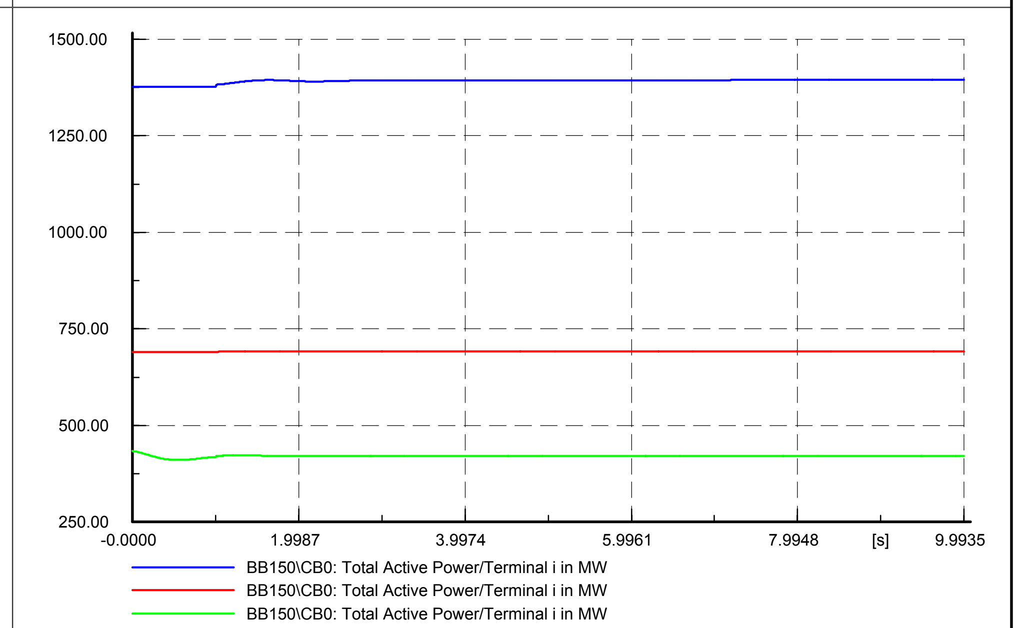
Annex: /3

Decrease in load at 150KV bus, MR scenario







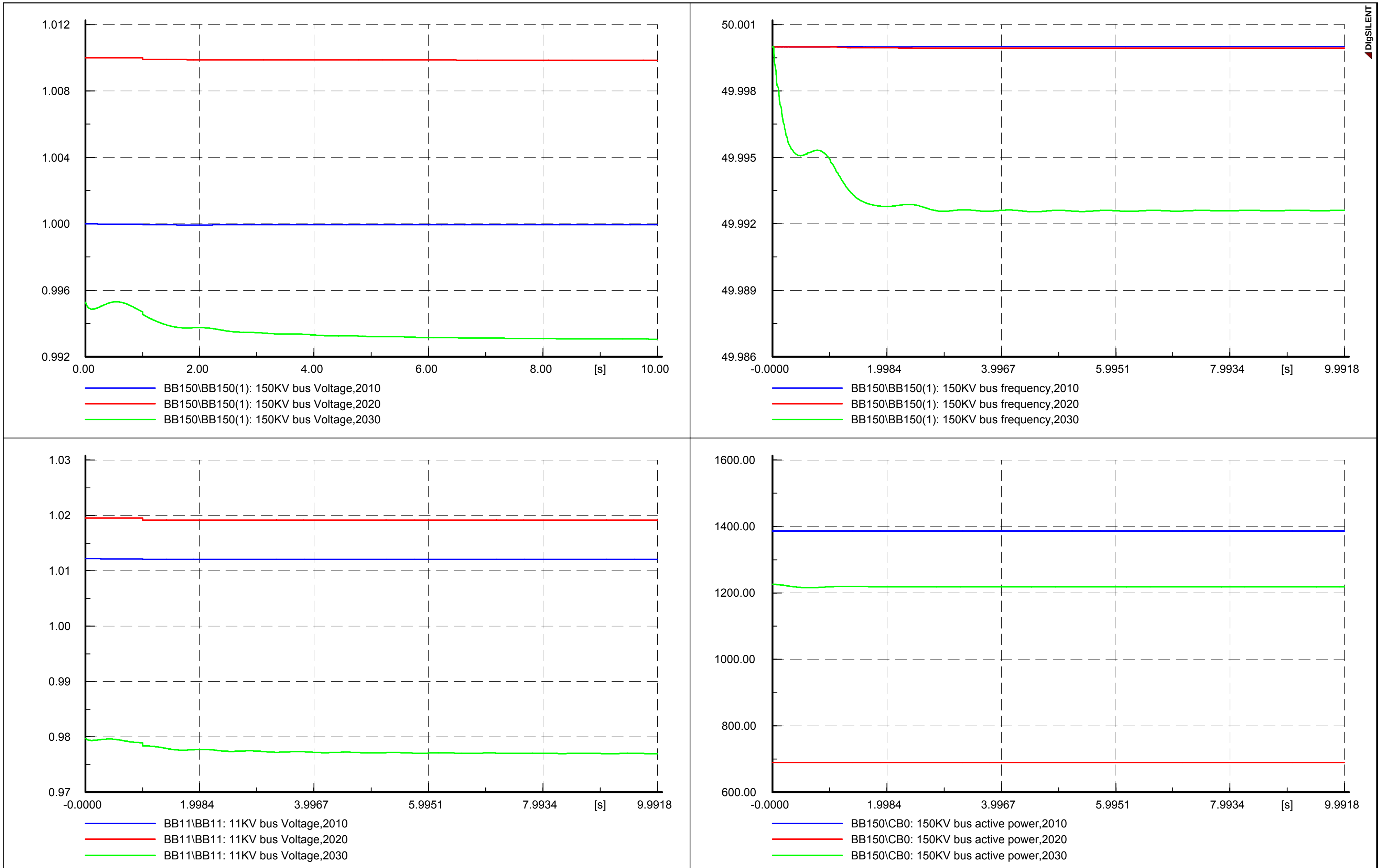


MR150DLdec

Date: 8/14/2011

Annex: /4

Increase in load at EV bus(DC load) MR scenario

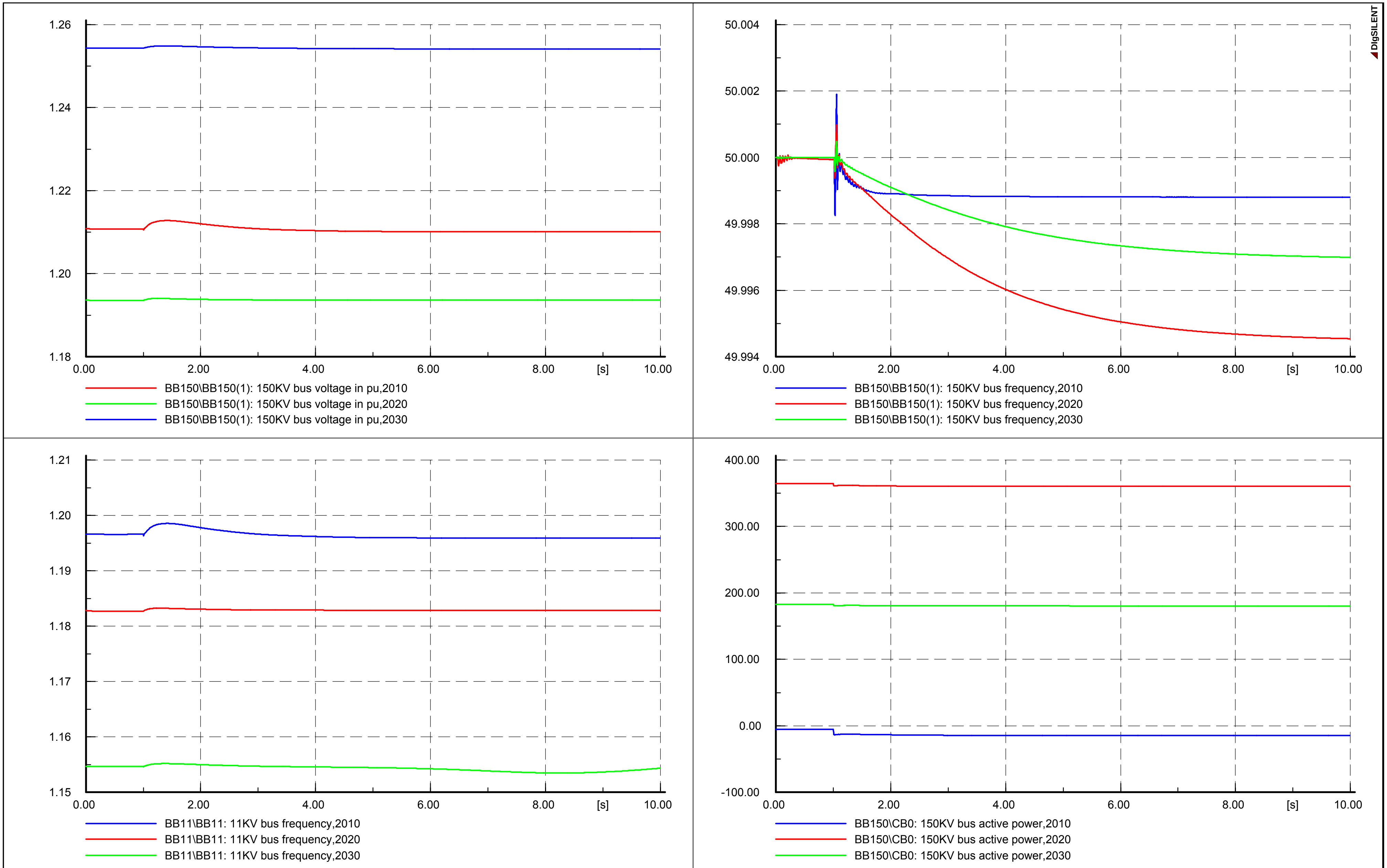


MR_EVi

Date: 8/14/2011

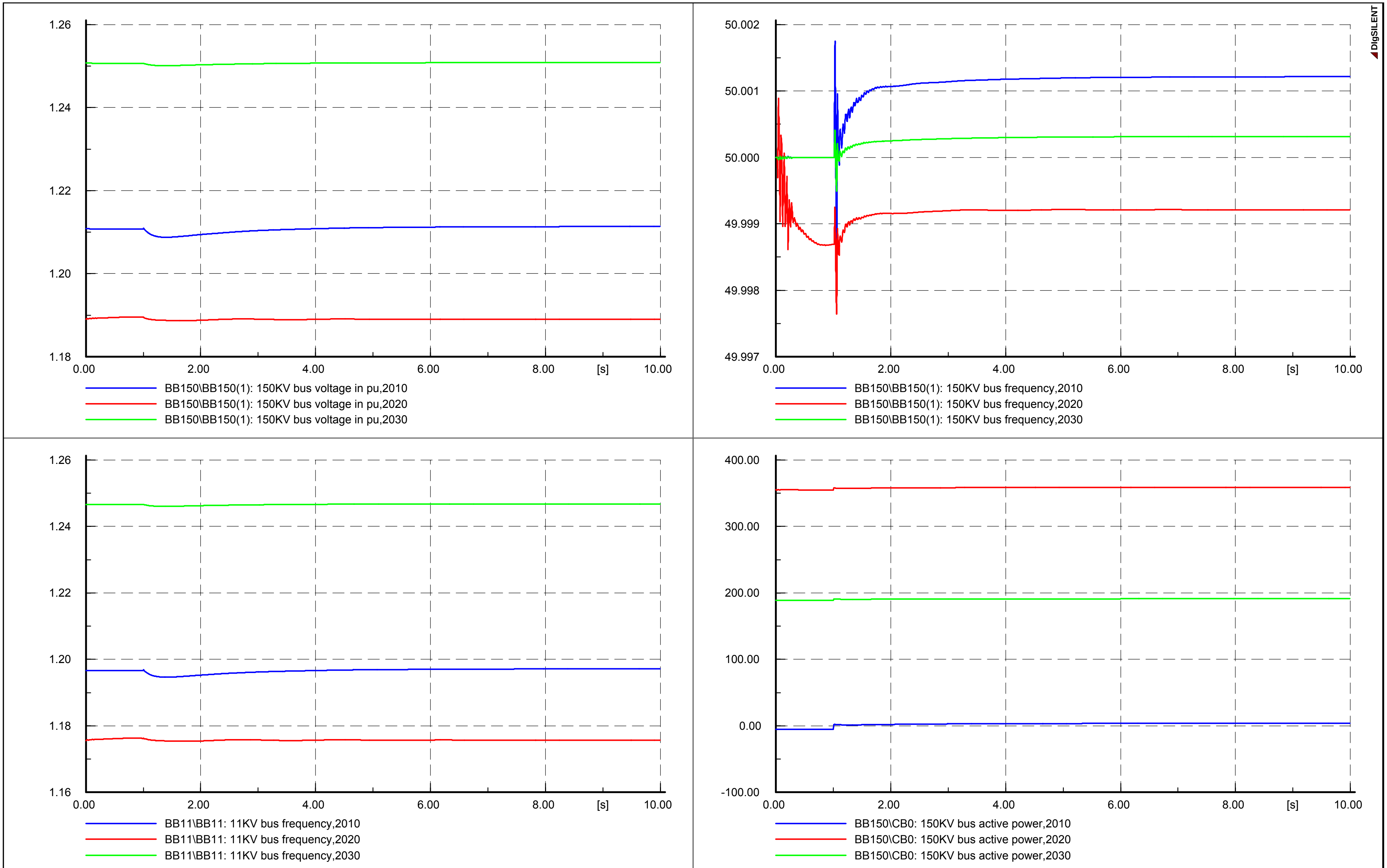
Annex: /2

Increase in load at 150KV bus,NS scenario



	Nstr_150DL	Date: 8/14/2011 Annex: /1

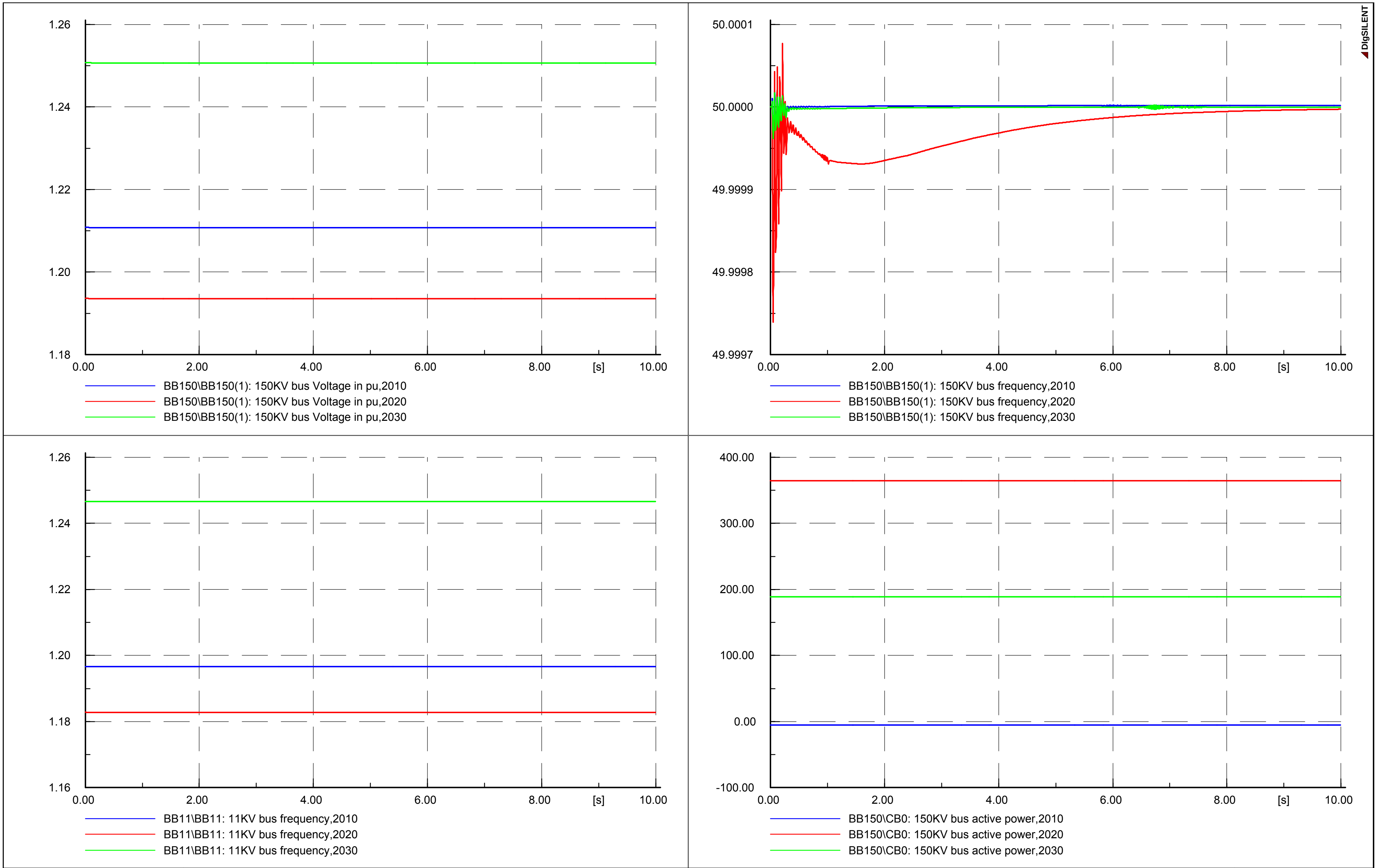
Decrease in load at 150KV bus,
NS scenario



Nstr_150DLdec Date: 8/14/2011

Annex: /2

Increase in load at EV bus(DC load),NS scenario

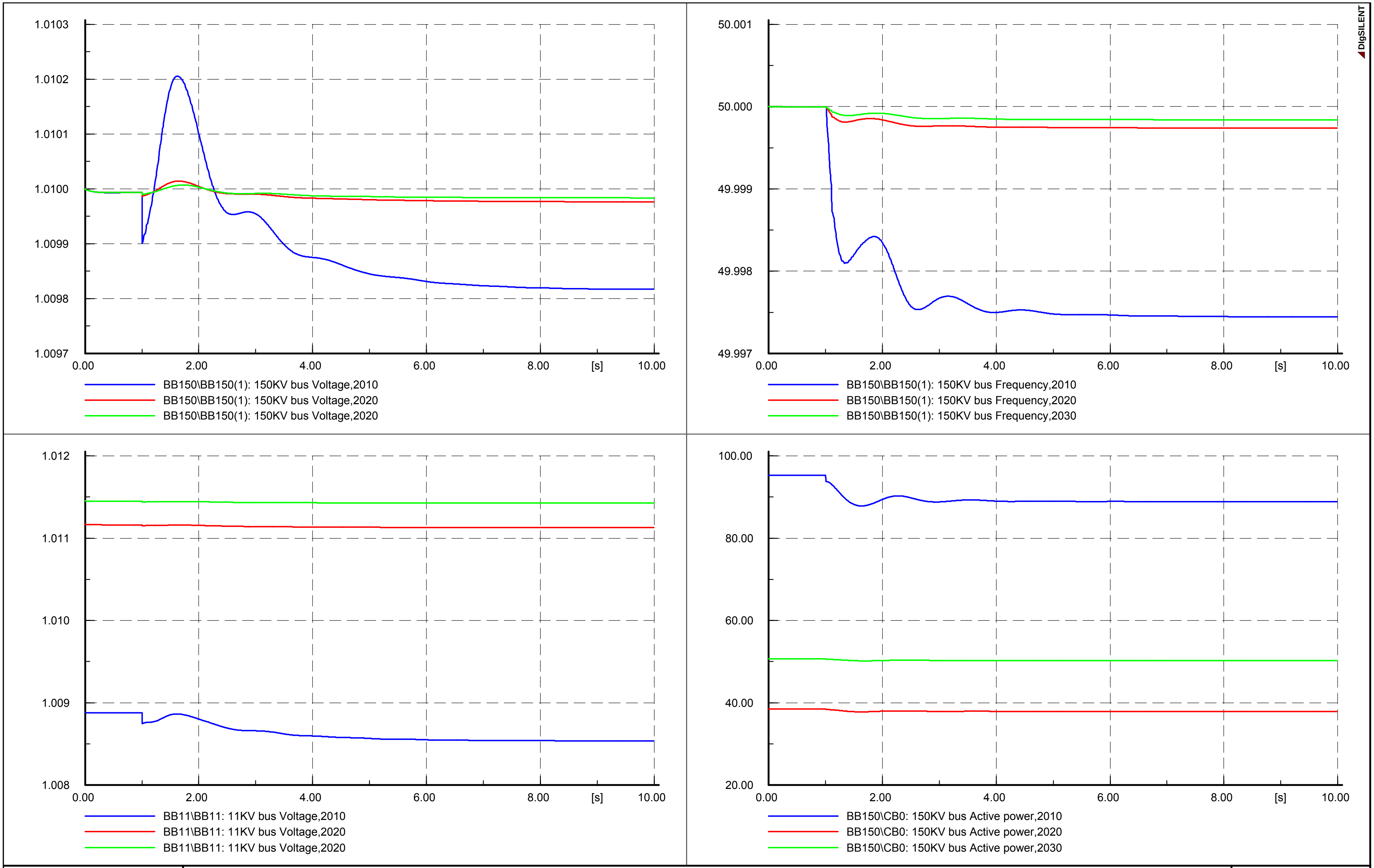


Nstr_EVloadinc

Date: 8/15/2011

Annex: /6

Increase in load at 150KV bus,SX scenario

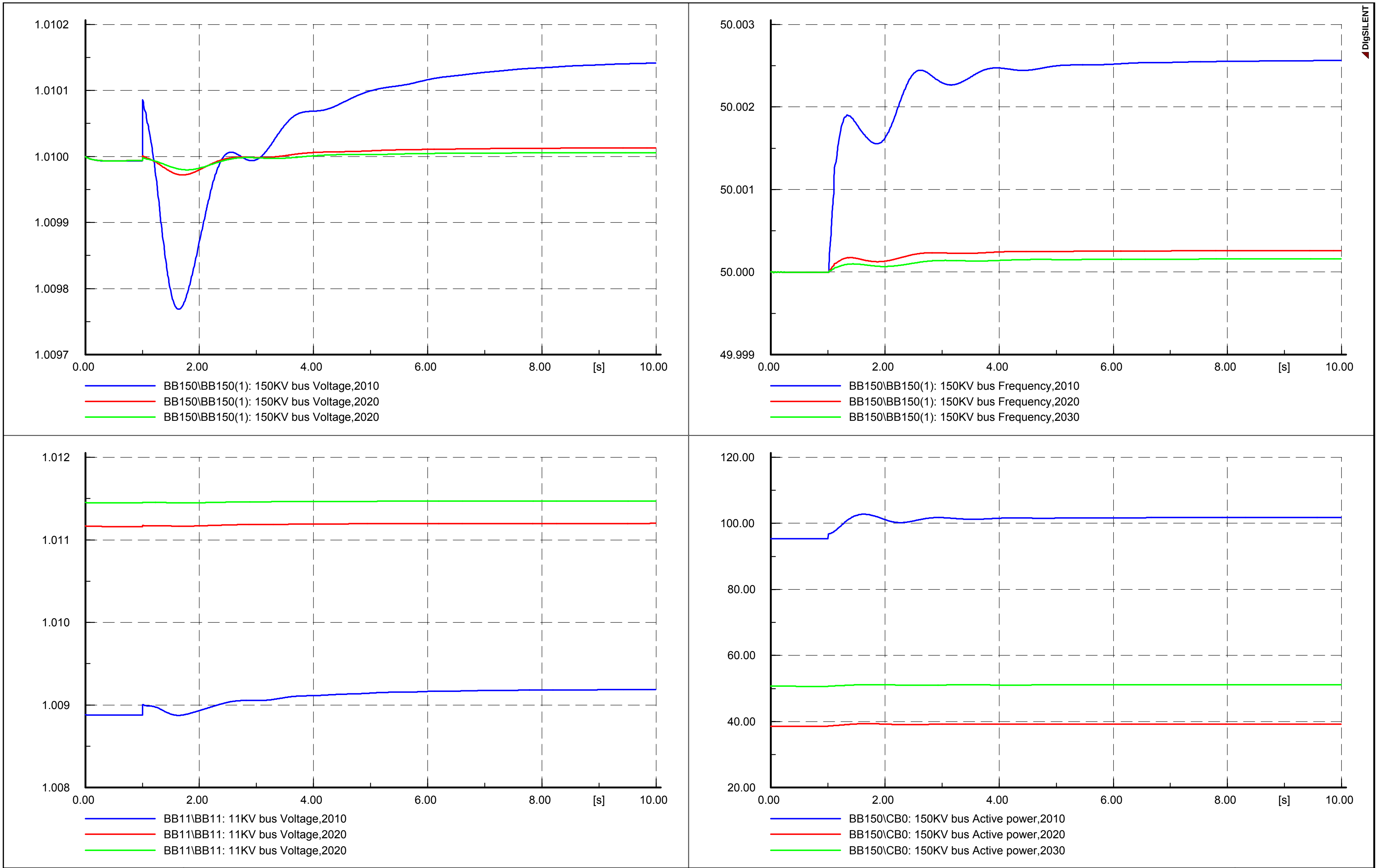


SX_150DLi

Date: 8/14/2011

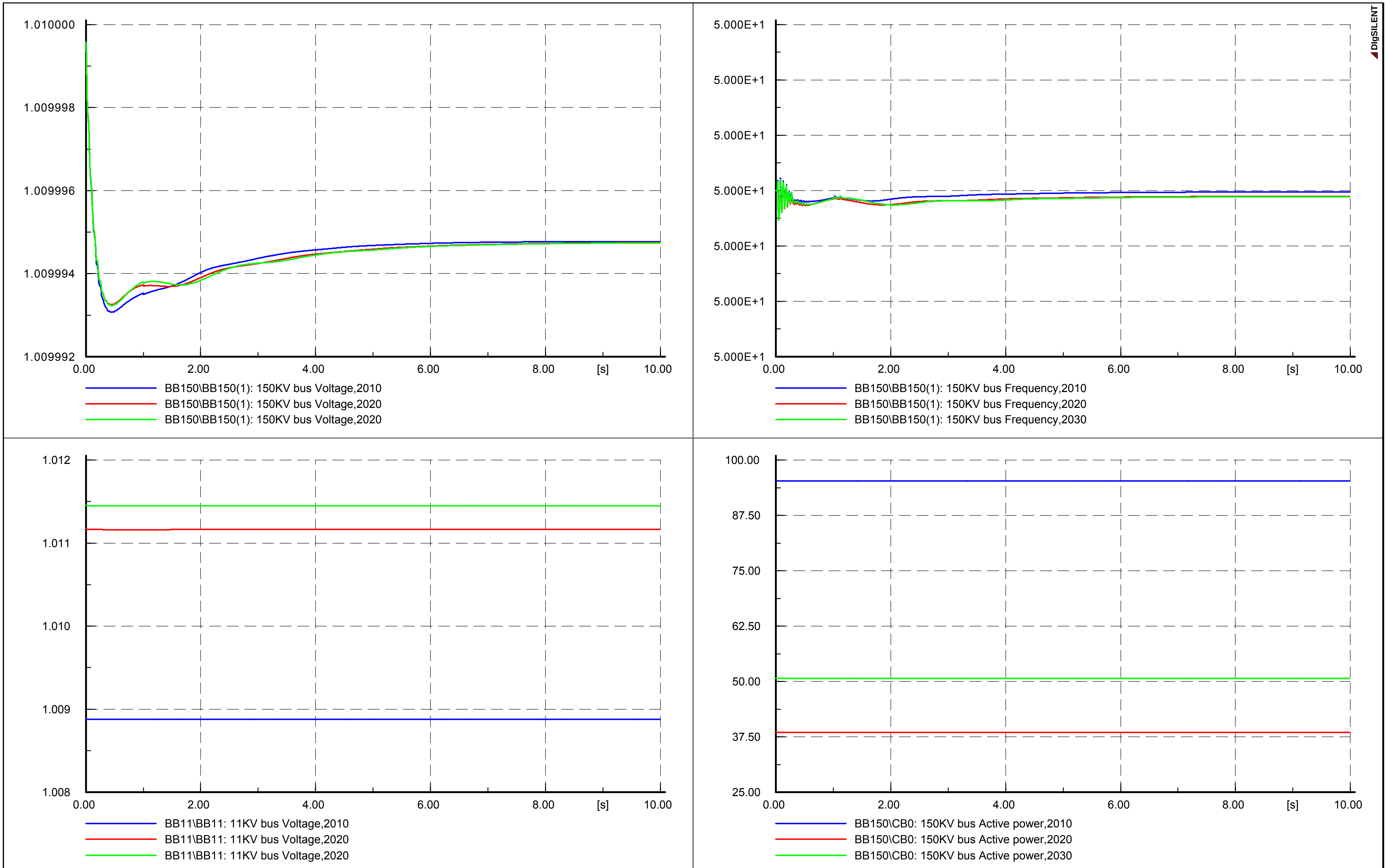
Annex: /7

Decrease in load at 150KV bus,
SX scenario



	SX_150DLdec	Date: 8/14/2011 Annex: /6

Increase in load at EV bus (DC load),SX scenario



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Thesis proposal

"A study to evaluate the required changes in the Transmission grid in order to facilitate the developments of smart grids"

Foreword

The purpose of this report is to explain the modeling strategies, studies to be carried out and expected outcomes of the project in conjunction with the thesis statement already submitted. Additionally, in this document the remarks made during the meeting with KEMA executives (R. de Groot, R.de Graff and P.Vaessen) have been taken into consideration.

1.0 Introduction

The transmission system is expected to expand in the years to come in order to cater to the increasing demand in the Netherlands in the years between 2010 and 2030 according to the Vision 2030 document and the quality and capacity plans drawn by TenneT. However the effect of several smart grid entities such as PV, EV and CHP plants at the distributed generation is not investigated in detail this report as this report simulates scenarios mostly considering the following:

1) Effect of power flows due to interconnections with the neighboring countries;
2) Effect of increased wind power production in conjunction with conventional power production along the coastal regions in the Netherlands in the years to come
3) Effect of storage facilities in the Netherlands as a means to accommodate the uncertainties of wind power production

With the above premise it becomes necessary to understand the behavior of the HV grid when faced with the possibility of distributed power production and bilateral power flows at the distribution level bus. It is noted here that the market conditions for the power production at the distributed generation level is expected to follow a single tariff responsive structure, i.e the changes in frequency due to market conditions are assumed to be fixed.

"The required changes in the transmission systems..."

Transmission systems of the future are foreseen to have the following technical requirements to be incorporated into the grid according to the vision2030 document:

1) HVDC links and FACTS links with Denmark, Norway, Germany and UK

2) Ability for power flow balancing between the different parts of the country in future years

In addition to the above the grid shall also have to face the following technical requirements:

3) Ability to maintain the system stability in face of fluctuations imposed by

a) Low inertia of wind power systems

b) Frequency regulation between large loads which occur on an around the clock basis as opposed to the almost daytime patterns of present day systems

The above effects of the future connections need to be viewed in the purview of the changes foreseen in the Ijmuiden, Emshaven, Borselle and Masvlakte substations as mentioned in the vision 2030 document for power flows in the NL for considerations of loads, generation and power import/export scenarios.

“..in order to facilitate the developments of smart grids…”

While smart grids are definitely the way forward, they are not the destination. Smart grid concepts entail actions at all levels from generation to the end consumer via distribution and transmission levels, however the focus in this project is on the smart grid entities in particular the ones pertaining to the distributed generation (DG).

Sources of distributed generation are defined as those which [3]:

a) Distributed generation is connected to the distribution network (usually at voltage levels of 110 kV and lower) and is often operated by independent power producers, often consuming a significant share of power themselves. The large-scale units are connected to high voltage grid levels and operated by incumbent utilities (sometimes a joint venture with a large industrial consumer). DG has, as it is connected to lower voltage networks, to cope with a number of specific network issues that are of less relevance to centralized generation capacity.

b) A second distinction is the location of the electricity supply. DG is usually generated close to the source and not so close to the demand site. Especially wind power is usually generated remote from the more populated regions. The consequence is that wind power plants are connected to weak (low voltage) electricity grids, i.e. grids with low consumption, having all kinds of impacts on the functionality of the distribution grid. Combined heat and power (CHP) is usually connected closer to the customer but often primarily sized to local heat demand and not to local electricity demand.

c) A third aspect is the intermittent nature of electricity supply from Renewable energy sources (RES) and CHP. In contrast with electricity supply from conventional large power plants the electricity supply from wind and photovoltaic (PV) installations is far less controllable due to influence on weather conditions. But also the controllability of power supply from CHP and small hydro-power might be poor, because of the dependency on heat demand or water flow respectively.

The major technical problems envisaged with the incorporation of distributed generation sources are summarized as follows [3]:

1) Voltage management;

2) System fault level issues in urban areas

3) Voltage rise from station to station LV grid during low load periods

4) In case of wind farms and roof top PV systems impact of decreasing inertia on the grid stability (this is assuming scenarios that consumer response to tariff regulations in the EV power sector is at a compliance of 10% and 50%)

As a consequence of above the following effects are seen on the conventional coal and gas based generation

a) Effects on the generator stability

b) Effects on dynamic behavior of generators

The possible effects of the above changes on the transmission system are summarized as follows:

a) Ability of the system to comply to fault clearance time regulations
b) Time span of voltage stabilizations and their adherence to the current norms-It is the rise of distributed generation resources a threat to the system in terms of non compliance per existing regulations?

2.0 Research questions

Q.1 what are the effects to be studied on the transmission network?

Q.2 What is the philosophy for network simplification, i.e, what is the best way to convert the pan-Netherlands model (with expected power flows in the Vision 2030 document) to a smaller, compact model which can reflect your changes?

Q.3 How to link the impacts of the system turbulence in voltage power and frequency to the network showing the required changes in the transmission grid per the vision 2030?

Q.4 How to consider systems consider the effects of systems connected to the 11 KV bus (i.e wind PV and EV's) to see their impacts on the 150 KV grid(considering the majority of them to be LV systems)?

Q.5 what are the consequences of the smart grid entities switching on and off with regard to the grid code requirements, under normal and worst case conditions? What is the impact on the grid under these conditions?

Q.6 How to consider the effects of distributed generation into account in the model?

As a further the following aspects also need to be analyzed:

a) System bus voltage profile and power flow study during short circuit events (assuming a particular power flow condition at a particular point of the day) considering fault ride through behavior of power electronic based DG systems
b) In an event when a fault occurs in the bus under consideration, is the system able to maintain stability (with and without the use of new technologies)? Does the system stability conform to the standards of current regulations?

3.0 Modelling strategy

In this stage the modelling proceeds as follows at this point:

1) Modeling of the high voltage grid

The foremost feature in the modeling of the high voltage grid is that while the network has to be detailed enough to show the transmission lines which indicate the distributed nature of the generation resources and the loads (i.e the 11 KV bus/substation) the HV grid needs to be reduced to a single bus which shows the properties of the rest of the grid under

a) The scenario under consideration
b) The power flows to be considered under each of the scenarios (in conjunction with the expected power flows from the vision 2030 document).

For example if the following network in fig.1 is being used for the purpose of simulating the green revolution scenario in the bus at Borselle the LV loads could be connected to the network at Borselle so as to study the influence of the changing of the consumer behavior pattern at this bus and the rest of the system could be represented as a single grid to represent the short circuit levels for this particular scenario. Load flow calculations performed prior to running the simulation could indicate the amount of power flow to and from the bus so that the capacity of the grid connected to the substation can be determined.

With the load flow calculations having been performed and the SC capacity of the grid representation known the network reduces to one of the rest of the network connected to the 150KV grid and the LV grid connected to the 150 KV grid at one of the outgoing bays. The system is analyzed further for the voltage settling time and power flow dynamics and investigated for the system stability.

To further the investigation it is now possible to study the effects of the system's frequency variations at the 150 KV bus during the switching actions which would occur at customer switching (which can be assumed to be an extension of a proposed market scenario).

Effects of the system's reduced inertia (owing to increased wind power and PV power production) can be observed through the calculation of equivalent inertia of the connected grid system [4] taken into consideration during the stability studies performed at the 150 KV bus. With the changes having been made the system now reduces to one shown in the fig.2. The behavior of the HV grid when connected to smart grid entities can now be studied at this bus.

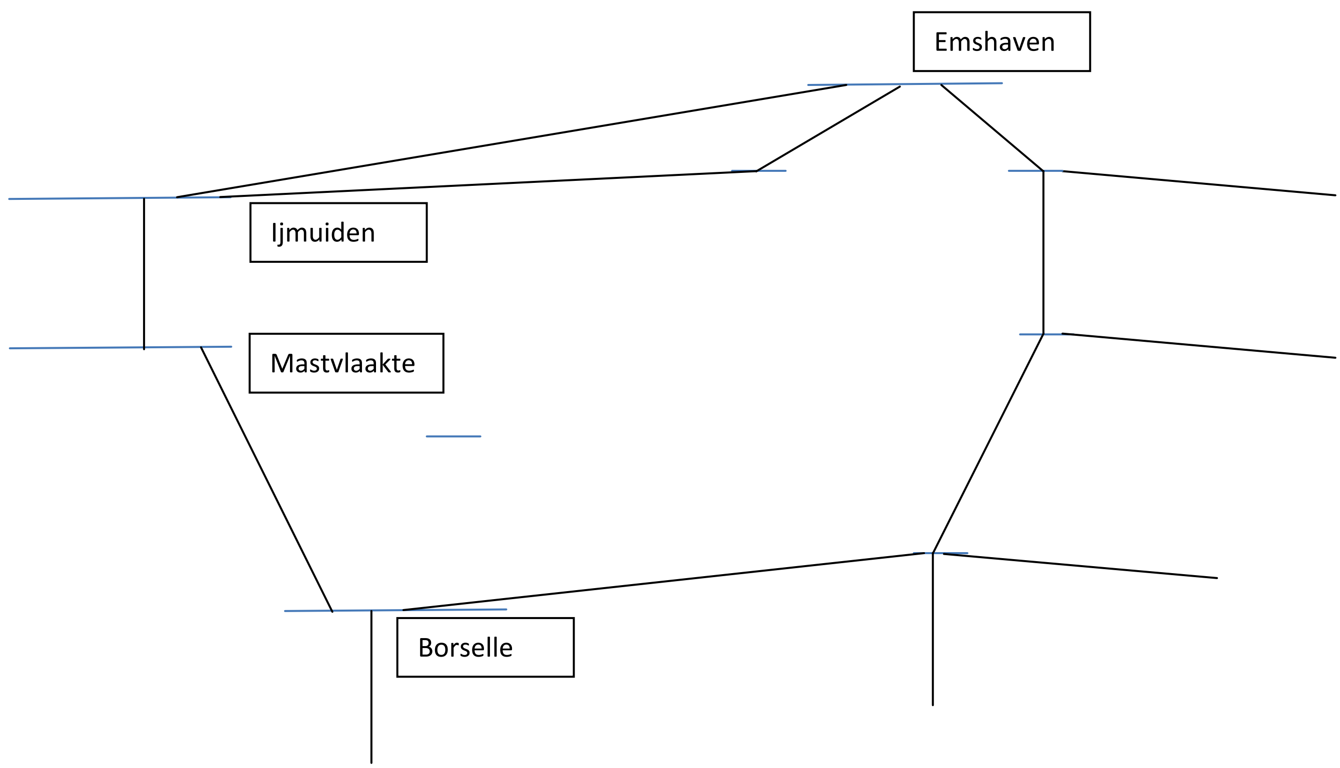

Fig.1 Approx. representation of the Dutch grid (example)

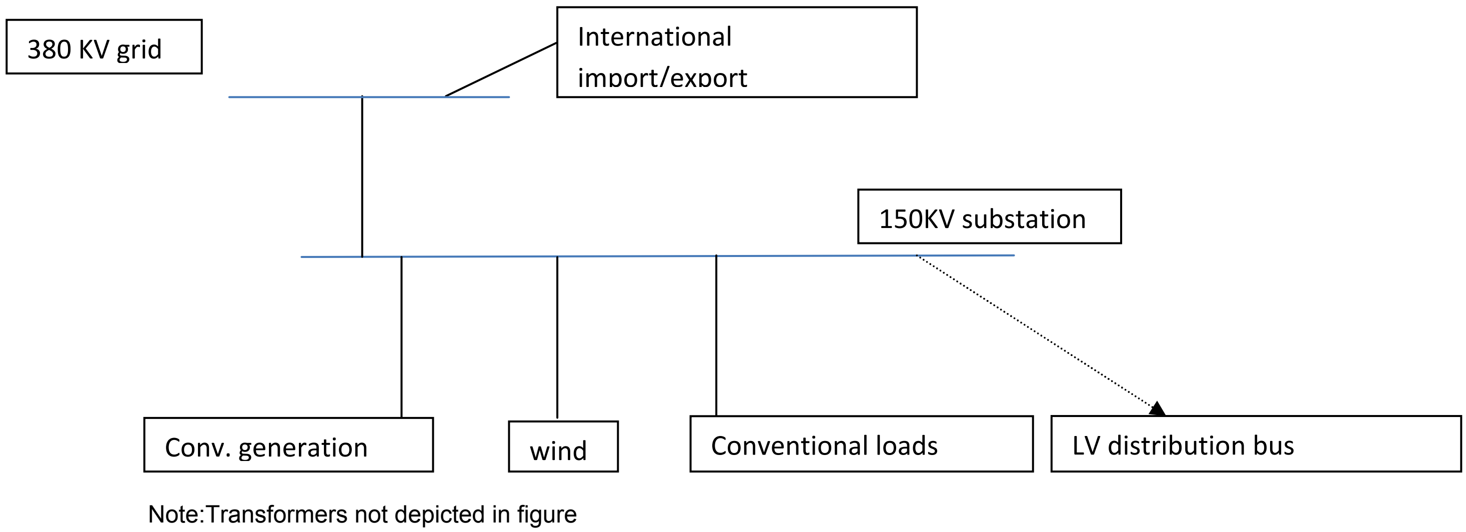

Fig.2 Grid reduced for Borselle in green revolution scenario for the year 2010 (example)

1.1 An alternate approach

An alternate approach could be to use the existing load flow models for the Netherlands and modify them to reflect a single HV grid entity which can further be connected to HV bus under consideration. Conversion of the static load flow model used for Load flow to a dynamic model was carried out in [4] by J. Bos, it is thus possible to change the existing model to reflect the changes in the grid in the future years 2020 and 2030.It is to be noted here that the model presented by J.Bos is in itself a simplified model, however the effects of the smart grids on the HV grid can be sufficiently studied by making modifications on the existing model.

2) Modeling of the smart grid entities

With the above model prepared Powerfactory software can be used to determine the variable time effects of generation of smart grid entities connected to the LV bus. As an example the following figure shows two scenarios of an EV charging load behavior. Fig 3 shows the scenario when the compliance to pricing (between 12Am to 4 AM) is followed closely by the EV consumers. The various color curves indicate the expected number of vehicles to be fully EV in the scenario [2].We see in this case the afternoon peak demand is not exceeded by the EV capacity. However since the LV grid is connected to the HV grid the scenario of wind power availability in the night feeding to this demand can be analyzed. Further the aspects of system stability, voltage profile at the 150 KV bus and fault behavior can be studied using this behavior.

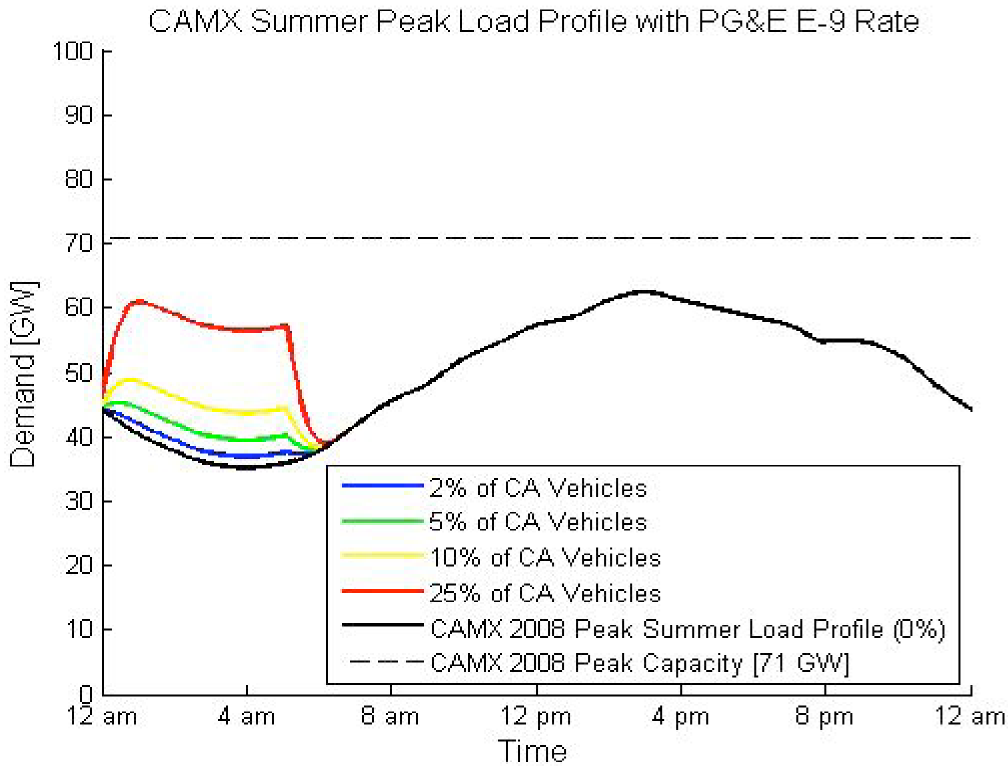

Fig.3

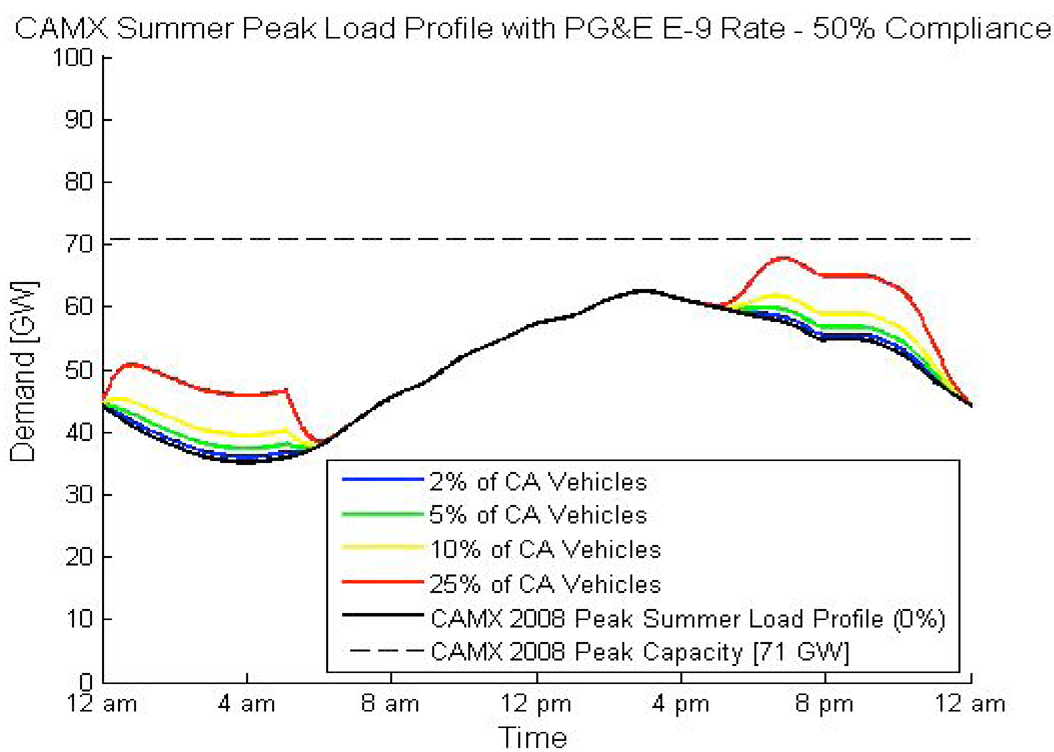

Fig.4

In fig.4 a similar plot is available as in fig.3, however in this case the compliance to charging hours is not made mandatory by the DSO. We see that the charging profiles change considerably and further that the demand at 7 PM to 10 PM (approx) exceeds the afternoon peak demand. This scenario could be used as a worst case scenario for the simulation of EV power consumption and the effects of this load profile could be studied in a case when the conventional power production is reduced and the system power flows consist mainly of interconnections with the neighboring countries (via the 380 KV grid), power production from wind farms, etc. It is possible to have time specific events in the Powerfactory software for generation and load. Using this feature the above situation can be analyzed for its impacts on the 150 KV bus.

4.0 Expected outcomes

With the models completed it would be possible to see the effects of the smart grids on the transmission network in detail. In particular aspects related to system stability, dynamic behavior and compliance to grid connection (with regard to voltage stabilization time and power swing settling times) can be studied in detail at the 150 KV bus. In addition it would be possible to study the effects of frequency deviation on the 150 KV bus.

With the above analysis it is possible to determine which technologies are the most required in a particular scenario to realize a stable system which is compliant to the present day grid connection and operation standards when connected to smart grid entities. For example it is possible that owing to the increased EV loads in the green revolution scenario it is useful to implement dynamic rating of overhead conductors in the grid, whereas the benefits due to adoption of the PMU and using the subsequent data for control of the system is not a useful feature. In the market strongholds or the money rules scenario it may be the exact opposite of the above. The outcome can also be utilized to investigate the possibility of V2G connections in the local bus and the effects of such an implementation on the 150 KV grids.

References

[1] "Vision 2030", TenneT TSO BV, Arnhem Feb. 2008

[2] "Impact of Widespread Electric Vehicle Adoption on the Electrical Utility Business – Threats and Opportunities" Center for Entrepreneurship & Technology (CET), UCB, Technical Brief aug.2009, Nicholas DeForest, Jamie Funk, Adam Lorimer, Boaz Ur,Ikhlaq Sidhu (PI), Phil Kaminsky, Burghardt Tenderich

[3] "Regulatory Improvements for Effective Integration of Distributed Generation into Electricity Distribution Networks" Martin Scheepers (ECN),et.al, Nov.2007

[4] "Connection of large-scale wind power generation to the Dutch electrical power system and its impact on dynamic behavior", Jorrit A. Bos, Master's thesis, TU Delft ,Aug 2008