Small Signal Evaluation of Power System using Wind and Power storage Device

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Abstract— A brief study of small signal analysis of energy unit including wind power technology and energy storage capacitor system structures (ECSs) is explained on this paper. Designing of wind device technology with squirrel-cage induction generator linked to energy system device via a full-scale AC/AC converter and ECS unit are defined in detail. The Energy storage capacitor system unit includes electric double-layer capacitors (EDLC) and DC/AC converter. Small signal conduct of 3 test structures are analyzed and compared with one making a different use of simulations system technique. The three program models are: 1) WSCC Nine-bus procedure system units with three conventional synchronous generator (SGs), 2 the WSCC system devices with one of the traditional Synchronous generator modified by using wind strength device system units, and 3) The unit identical as second machine unit but with including of an ECS unit. The study at includes evaluating of dominant Eigen values, the participant state variables, and the related participation variables for the 3 program systems units. In addition further more cause of loading on the unstable modes of the machine system with conventional synchronous generator, wind energy machine procedure and ECS unit (Device 3) are considered utilizing the trajectory of different modes increased load in the device.

Key words: Dynamic Model, Dynamic Studies, Energy Capacitor System, Wind Units

I. INTRODUCTION

WIND electrical energy is a cleanest and cheapest resource of electrical energy. Wind power plant potential has improved from 59.3 gw in 2005 to 198gw in 2010 almost $50 billion spend on wind electricity plant systems structures in lat twenty years [1]. Accelerated dispersion of wind electricity in electrical circuit is observed with reduce power system dynamics (due to irregular character of wind power pace), which have to be taken into subject. To compensate for these reduce original techniques and system need to be in work. The power storage systems units can correctly enhance energy program dynamics [2]-[10]. In current years, Power storage device capability has been multiplied by 10 Mwh to 100 Mwh. In this power system to absorb/deliver large quantity of power makes them a appropriate for enhancing the dynamics and efficiency of basic energy gadget units. Many numerous research contain and exist referred in literature survey regarding production energy even of wind electricity units related to infinity bus with electricity storage capacitor device compensate for wind energy fluctuation[12]-[15]. However, many results of electricity fluctuation in wind electricity devices on multi machine energy devices have not been studied very well.

This system gives a study of small signal evaluation of energy structures together wind power and power storage capacitor system structures (ECSs), which include electric powered double layer capacitors (EDLC). It wants easy charging mechanism and it's no longer required a few different defensive circuits. Sometime overcharging or over-discharging of in ECS unit does not have any negative effects on its lifespan, because it depends on chemical batteries. In MATLAB simulation three test systems are used. : 1) WSCC nine-bus system devices with 3 conventional synchronous generator (SGs), 2) the WSCC method with one of the conventional Synchronous generator changed via wind electricity devices, and 3) The unit equal as second system unit however with addition of an ECS unit 2. All experiment process Eigen values, participant elements, and participation variables are discovered and comparison. In addition, for the scan methods contain wind and ECS models (scan model 3), via small signal balance is carried out. Subsequent segment, wind model and ECS units are explained. The united states-area equations of the machine are common and characteristics of wind energy unit and energy storage capacitor units are calculated and comparing three test systems. Subsequent segment, wind model and ECS units are explained. The united states-area equations of the machine are common and characteristics of wind energy unit and energy storage capacitor units are calculated and comparing three test systems.

II. SYSTEM MODELING

For performing small signal evaluation different components of power system should be modeled first. This model assumes one-mass steam turbine including four dynamic equations together with two algebraic equations. Two other components, wind and ECS units, are shown below Fig.1

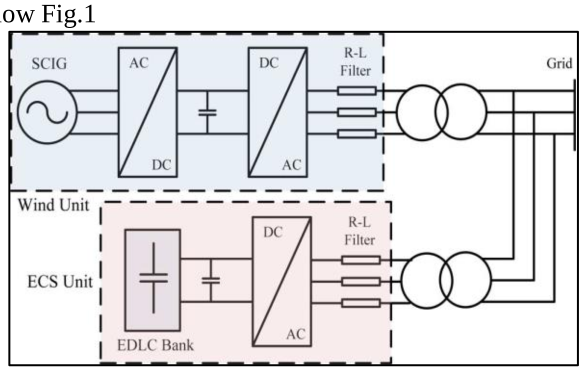

Fig. 1: Block diagrma of wind and ECS unit

A. Designing of Wind Energy Unit

For wind electricity generation system and a squirrel cage generation turbine are linked to the network strength tool via complete-scale AC/AC converter (a mixture of synchronous turbine aspect AC/DC and network electricity device aspect DC/AC converters) is utilized. Wind pace is layout step with Dynamic equations of squirrel-cage induction generator and the related converters.

$$s\omega r = \left(\frac{P}{2J}\right)(Tm + Te) \quad (1)$$

$$sIqs = \left(\frac{1}{L\sigma}\right)\left(\frac{1}{2}mqs\, Vdc - RIqs - \omega eL\sigma Ids - \frac{\omega rLm}{Lr}\lambda r\right) \quad (2)$$

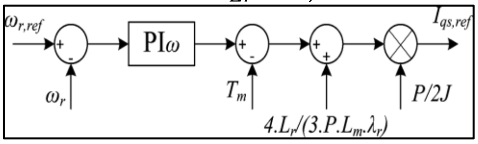

Fig. 2: Block diagram rotor speed control loop

B. Designing of ECS Unit

Fig.3 shows the schematic diagram of an energy capacitor system. The control objectives for this unit are to regulate the output active and reactive powers of the unit through controlling the q-axis and d-axis components of the ECS output (I_{qe} and I_{de}) according to current control loops are shown below Fig.4

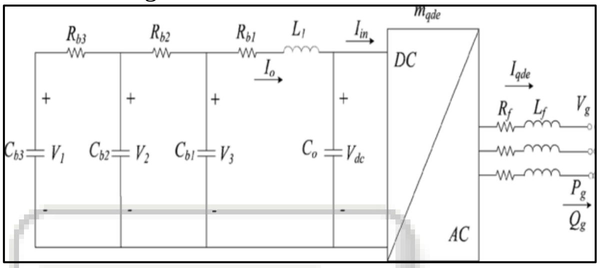

Fig. 3: Circuit Diagram of ECS Unit

$$Pref = \left(\frac{3}{2}\right)|Vg|Iq,ref \quad (3)$$

$$Qref = -\left(\frac{3}{2}\right)|Vg|Id,ref \quad (4)$$

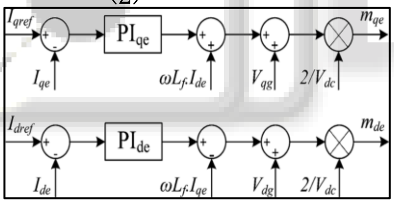

Fig. 4: Current Control Loops of the ECS

III. Small Signal Evaluation of Wind and ECS Unit

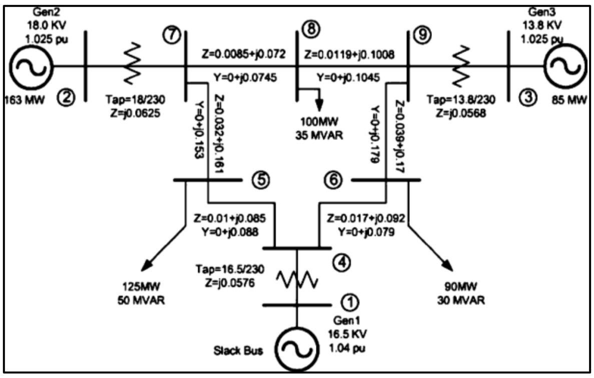

Fig. 5: Single line diagram of WSCC 9-bus system.

The causes of wind and ECS unit on small signal behavior of overall power system including a wind unit together with an ECS unit connected to an infinite bus. The control parameters of wind unit and turbine and generator data are given in table 1. The EDLC data and its controller is given in table 2, 3. First we find the Eigen values and state space matrices of the wind system after participant variables and participation factors can be calculated participation factors are dimension less measure. Participation factors of state variable and Eigen values in between zero and one.

$R_t = 54\,m$	$\rho = 1.225\,kg/m^3$	$N_g = 37$
$J = 2\,kg.m^2$	$R_s = 1.102\,m\Omega$	$R_r = 1.497\,m\Omega$
$L_{ls} = 0.06492\,mH$	$L_{lr} = 0.06492\,mH$	$L_m = 2.13461\,mH$
$\lambda_r = 1.74\,Wb$	$R_g = 0.002\,\Omega$	$L_g = 0.15\,mH$

Table 1: Wind Turbine Data and Generator Data

$K_{p\omega} = 0.3889$	$K_{i\omega} = 0.075626$	$K_{pP} = 15.556$
$K_{iP} = 121$	$T = 0.2$	$K_{pr} = 194.45$
$K_{ir} = 18900$	$K_{pqs} = 0.0852$	$K_{iqs} = 30.09$
$K_{pds} = 0.0852$	$K_{ids} = 30.09$	$K_{pdc} = 1.4849$
$K_{idc} = 16.75$	$K_{pqL} = 0.2025$	$K_{iqL} = 304.5925$
$K_{pdL} = 0.2025$	$K_{idL} = 304.5925$	

Table 2: Controller Data for all Controller Loops used for modeling the Wind Unit

$R_{b1} = 0.03125\,\Omega$	$R_{b2} = 0.78125\,\Omega$	$R_{b3} = 0.75\,\Omega$	$L_1 = 0.001\,H$
$C_{b1} = 1.68\,F$	$C_{b2} = 42\,F$	$C_{b3} = 40.32\,F$	$C_o = 60\,mF$

Table 3: ECS Parameters Used In All the Simulations

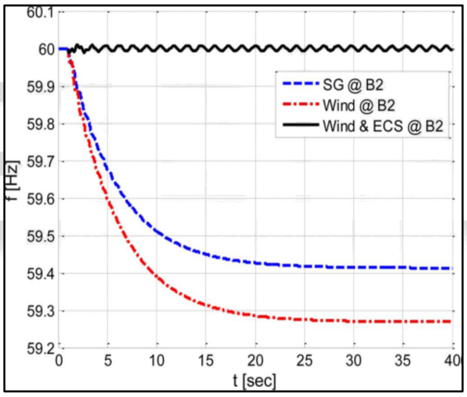

Fig. 6: Comparing the frequency of synchronous generator at Bus 1 to the load change

Fig shows comparing the study state values of 3 test systems it can be seen that the system with wind power unit (test system 2) frequency decrease than the system with all synchronous generator (test system 1). This is to be expected as wind power unit unlike synchronous generators, do not posses governor. The fig also shows that when the ECS unit is added (test system 3), the steady-state error almost zero.

IV. Simulink Results and Outputs

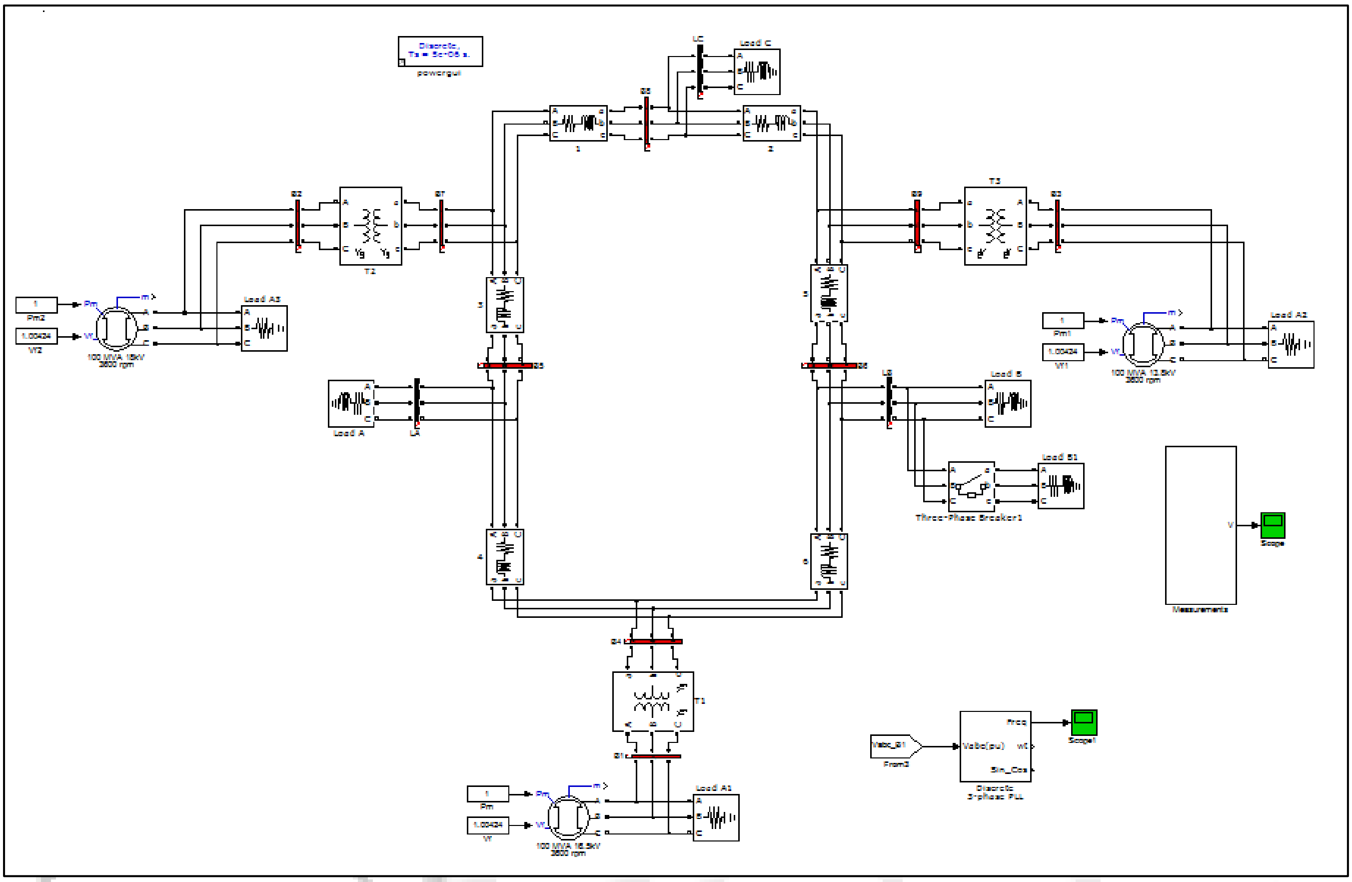

Fig. 7: Bus 3- synchronous generator machine system

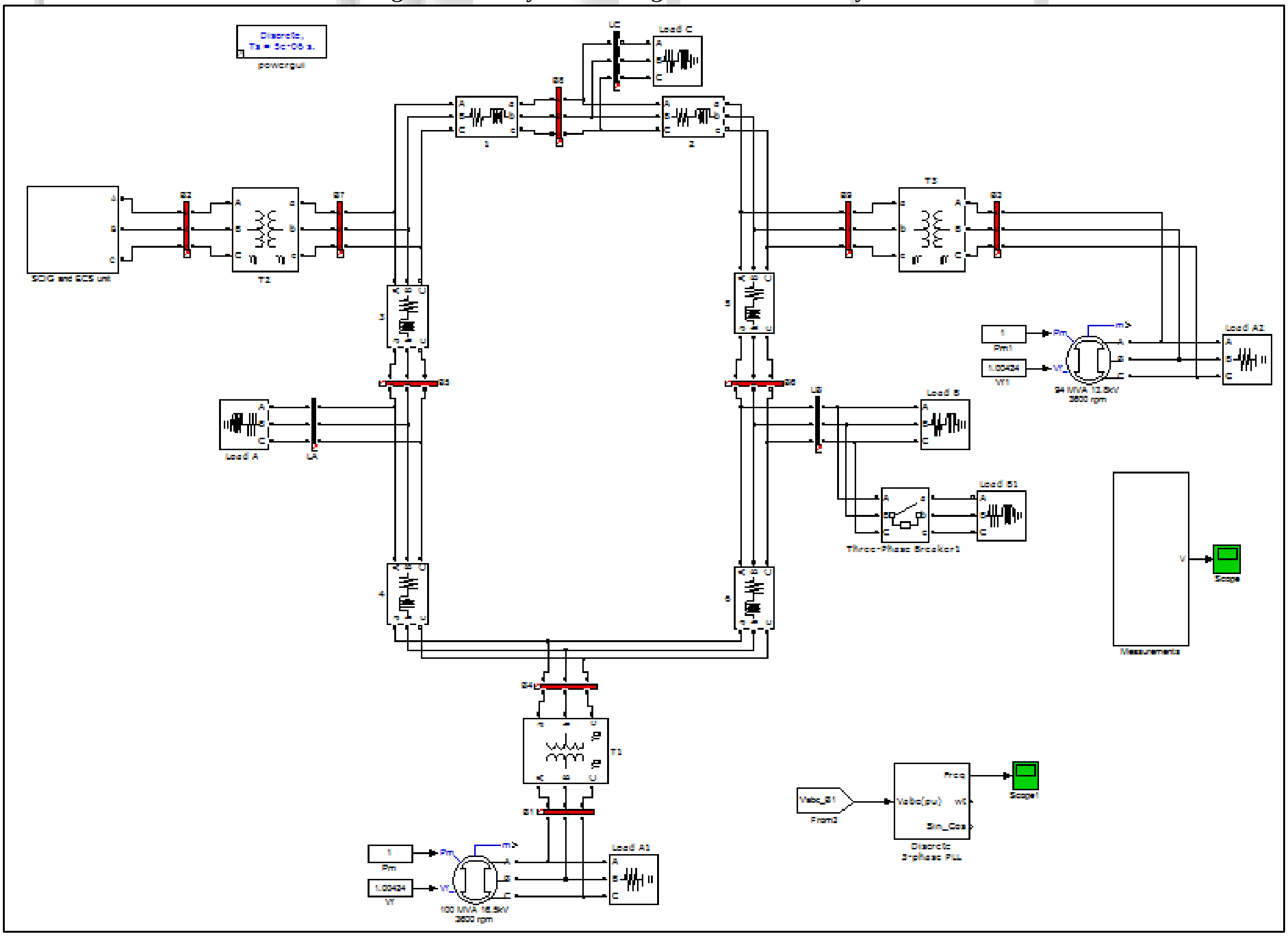

Fig. 8: Synchronous generator at bus 2 is changed with a wind electricity unit

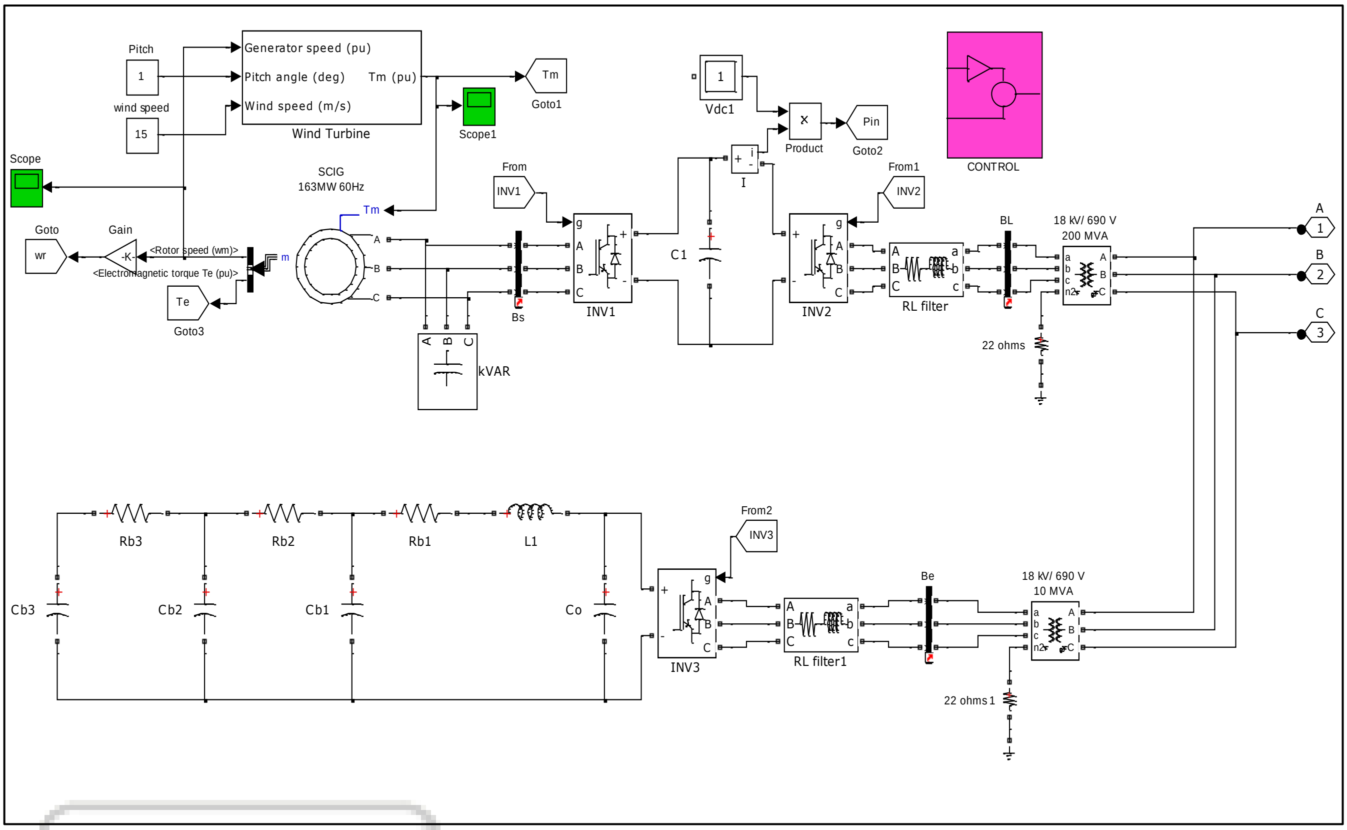

Fig. 9: Synchronous generator at bus two is replaced with a wind electricity unit with addition of ECS unit

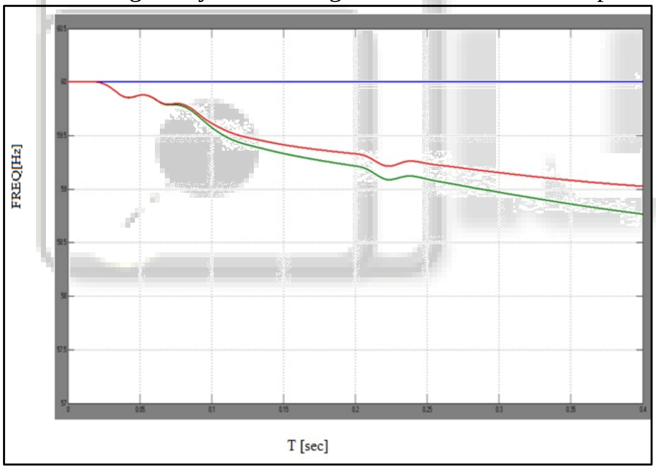

Fig. 10: Comparing the frequency of synchronous generator

V. CONCLUSION

On this proposed concept small signal evaluation of energy strength process along with wind electricity unit and ECS unit analyzed and in comparison with other two systems. Outcome result of loading on unstable modes of this machine changed into investigated. While changing the synchronous generator unit with wind power unit output results bad effect on load capacity electricity system. Using energy storage system unit can expand load capacity Load strength of the energy system unit is extended even more than the usual process having synchronous generator simplest. Outcomes result of the synchronous turbine can be observed that wind units tool without energy storage capacitor unit however does not take unstable modes of the energy method. After adding energy storage capacitor unit to the machine each energy storage capacitor unit and wind energy devices cause unstable Eigen values.

In these power models the main cause of using energy storage capacitor unit is gives the stable output of wind energy units. Primarily support on the output outcome of this proposed system unit, it may be completed that including energy storage capacitor (ECS) unit can also enhance the steadiness and/or load potential of the general device unit. The usage of energy storage capacitor unit with wind energy technology unit the outcomes result is stable and load capacity of overall energy storage unit and system gives high efficiency.

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