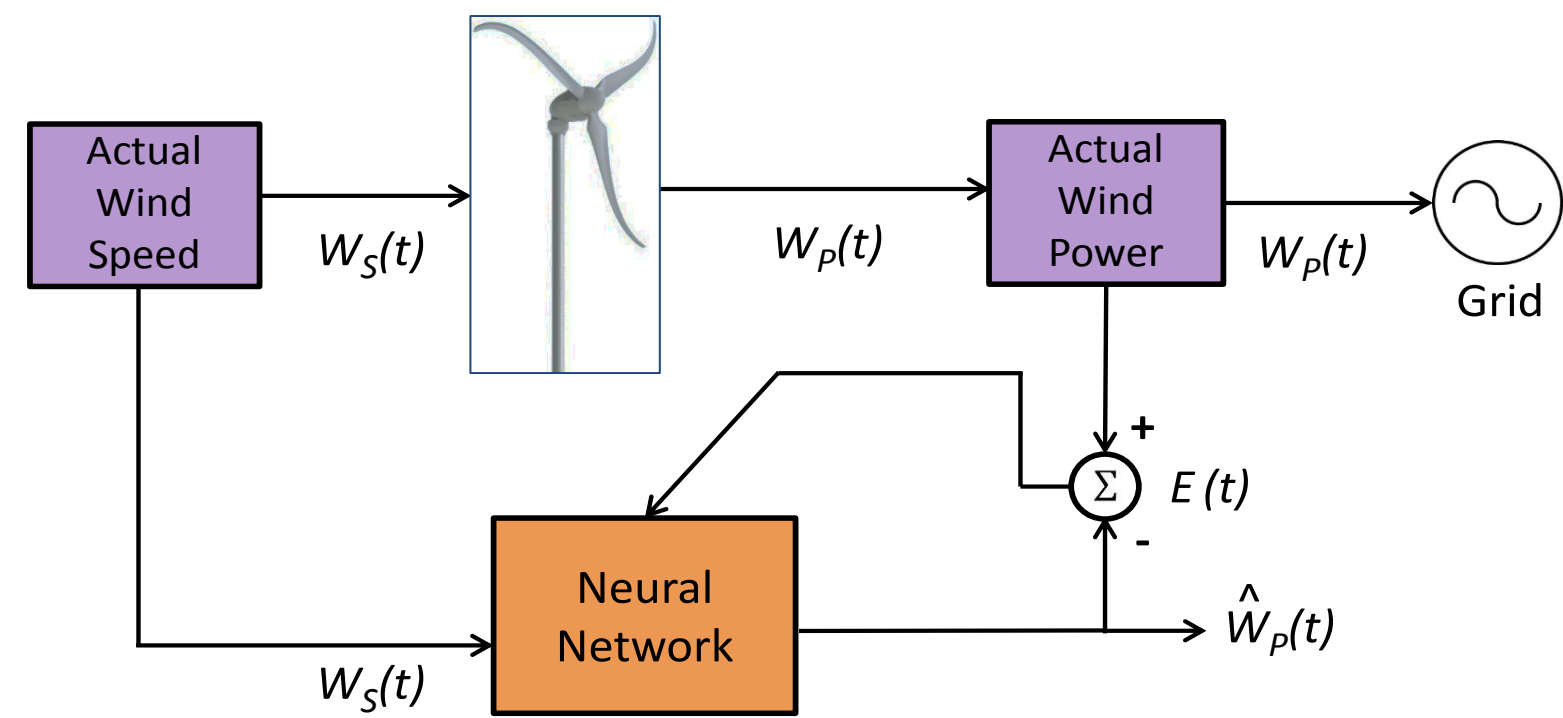# Dynamic Performance Model for Wind Turbine Generators

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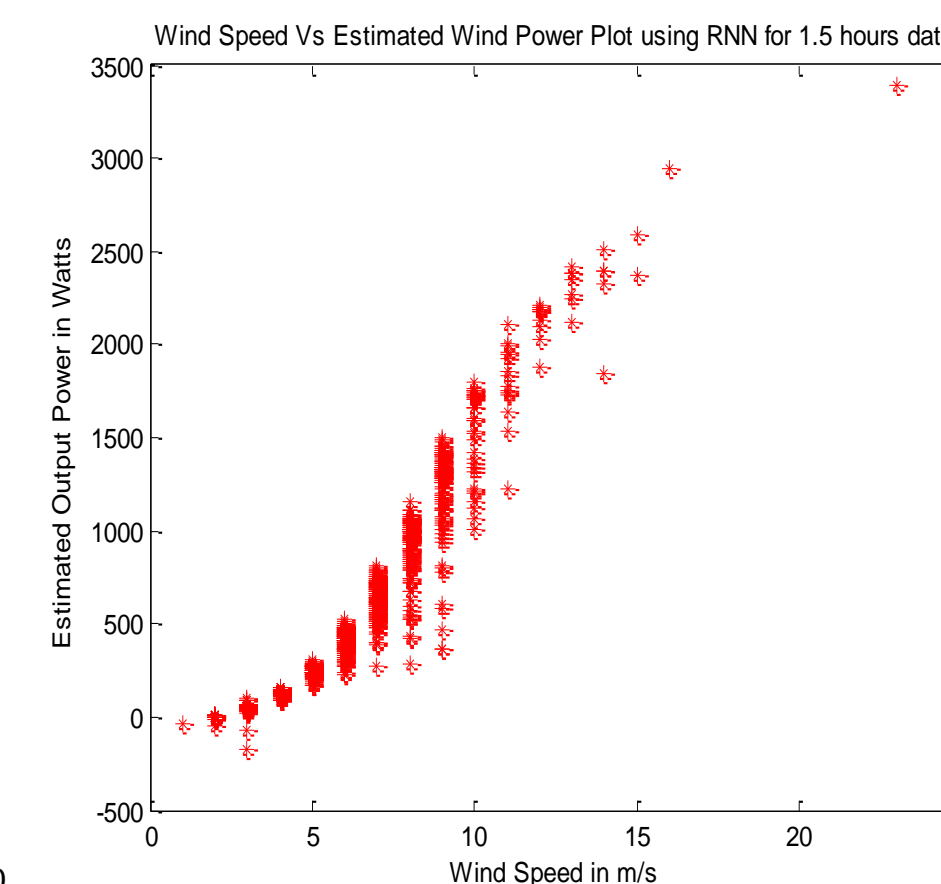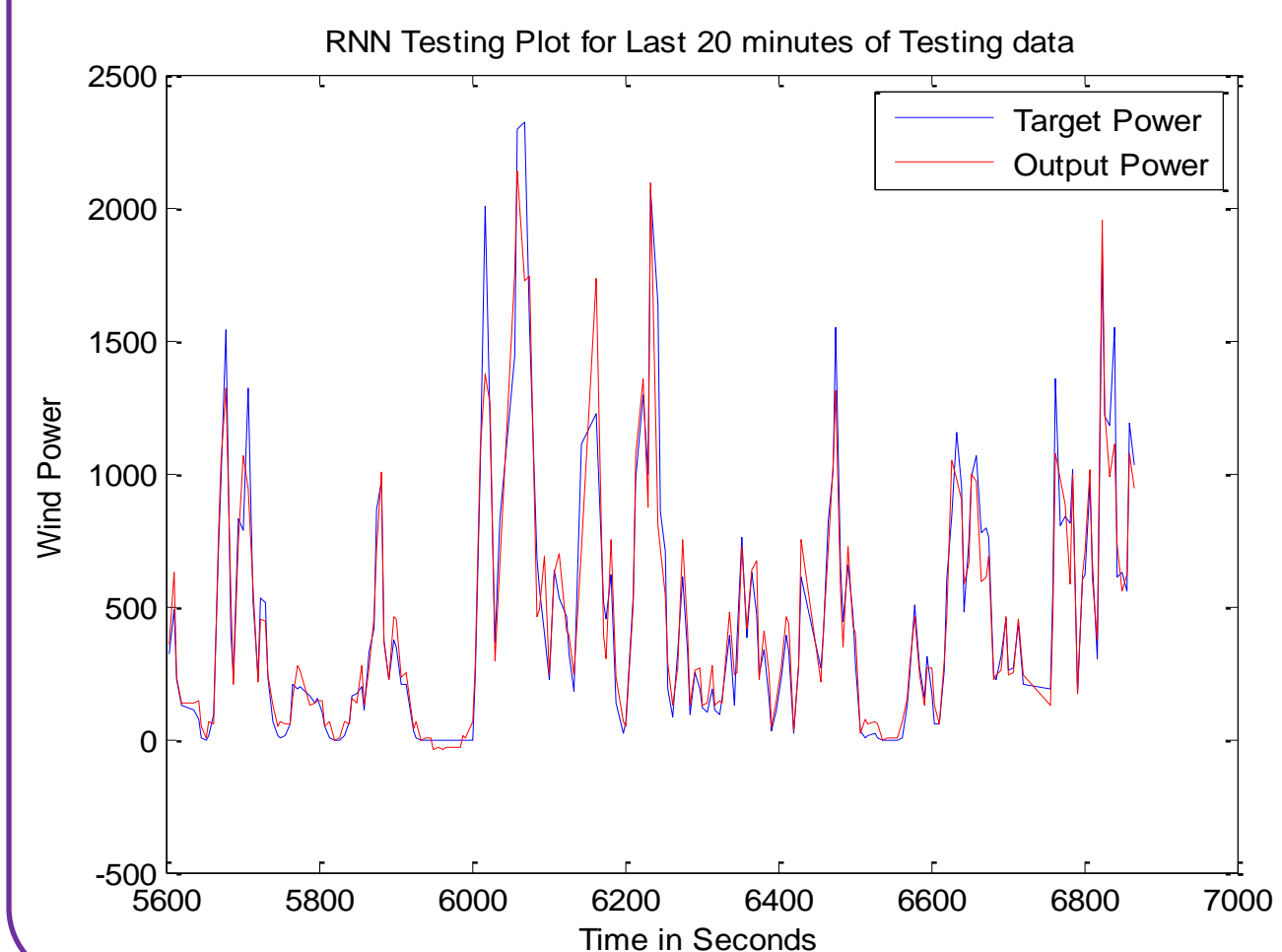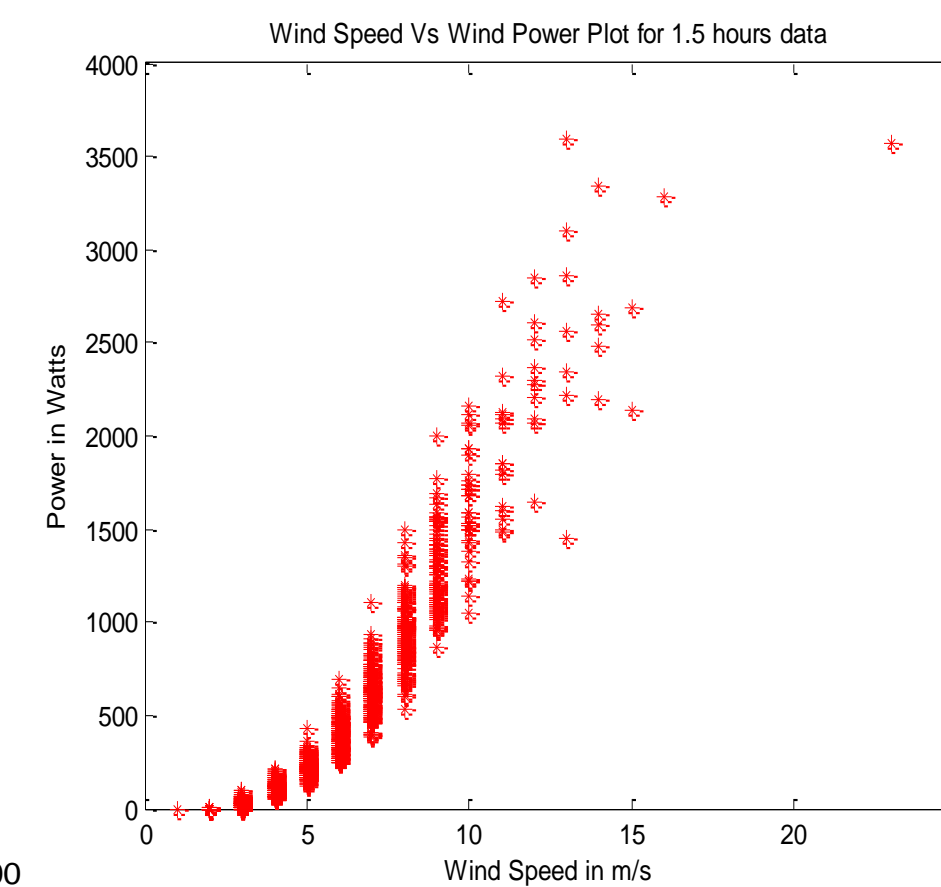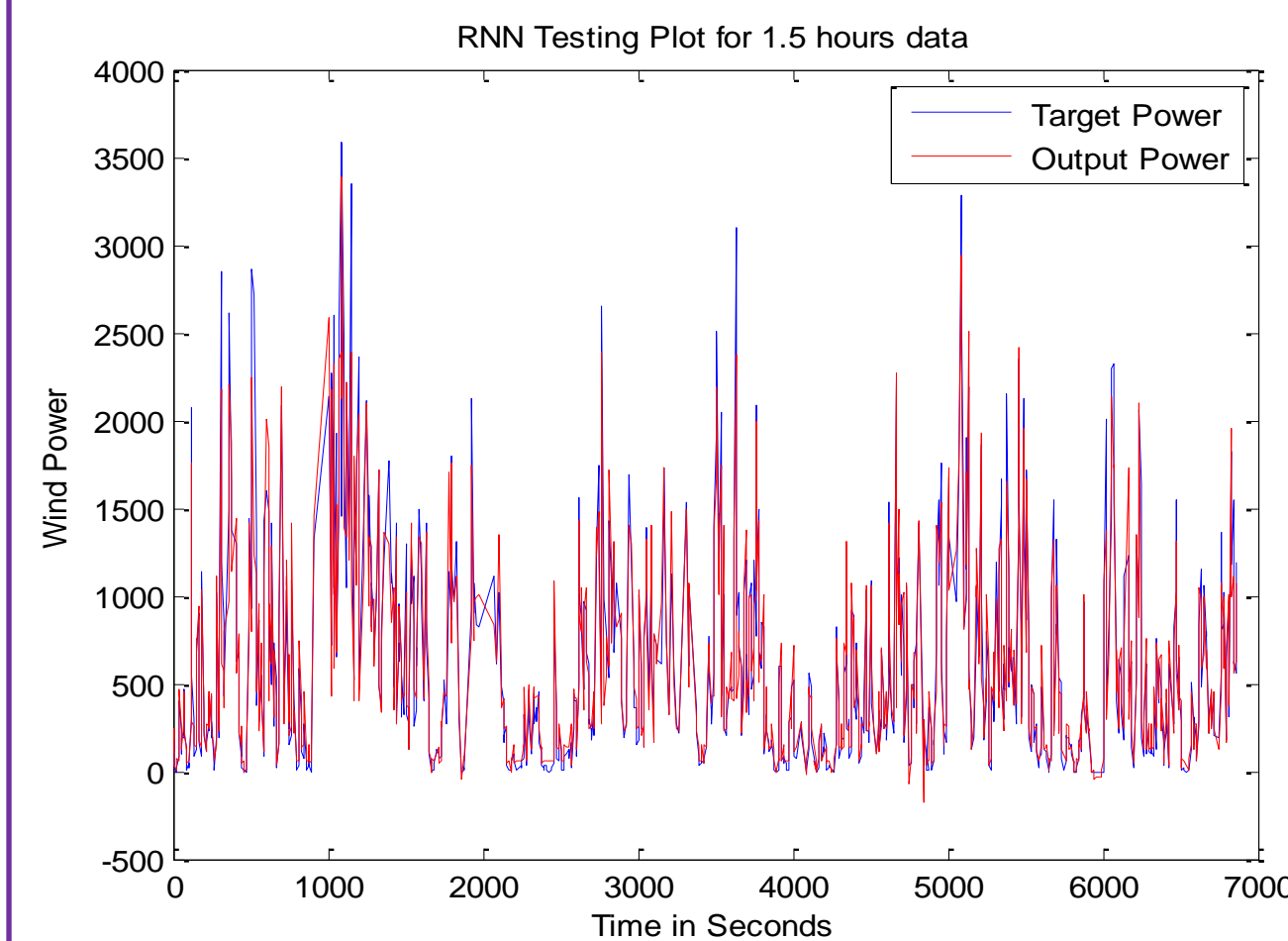
Introduction

- Wind turbine power curves are based on the industry standard IEC 61400-12-1.
- Power curves are used for planning purposes and estimating total wind power production.
- Wind velocity are collected and averaged over 10-minute periods.
- Traditional methods do not explain varying characteristics in wind dynamics where multiple power productions are observed for same wind speed.
- When the input parameters such as wind speed and wind directions are known and the output parameter wind power are known for an installed wind turbine generation plant, an dynamic computational network such as neural network is used to developed operation model and estimate the wind power generation.
- Architecture: Dynamic Neural Network

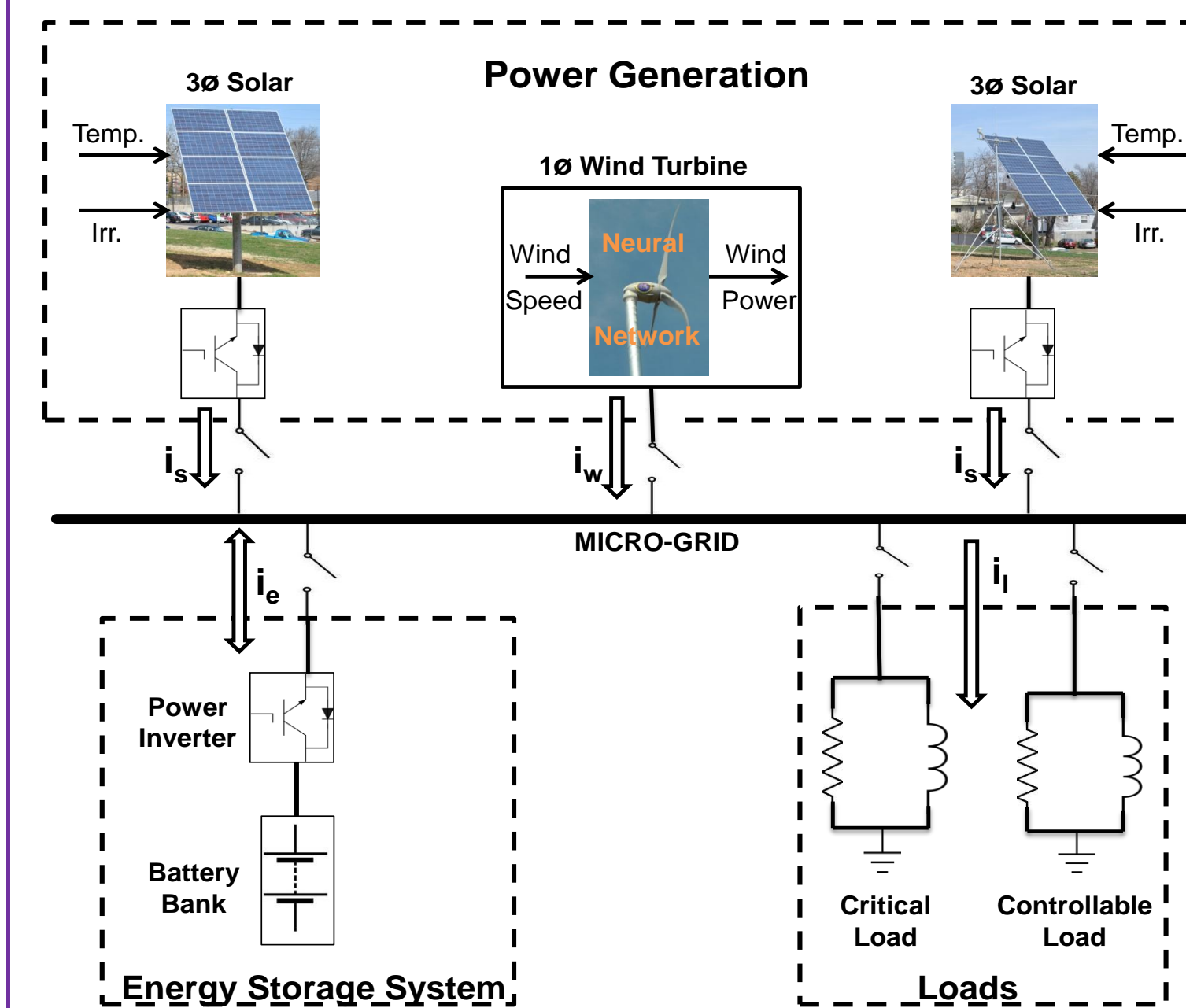## Dynamic Model of Wind Turbine

Performance Model of Simulated DFIG Type WT

Simulation DFIG model in Real Time Digital Simulator.
- 400 MW wind farm represented by a single DFIG unit
- Cut in wind speed - 6 m/s
- Rated wind speed - 12 m/s.

Training Data

Testing Data

Wind Power Estimation for Skystream 3.7 WT

Single-phase permanent magnet synchronous machine type 2.4 kW wind turbine
- Rated wind speed - 13 m/s
- Cut in speed - 3.5 m/s

RNN Testing Plot for 1.5 hours data

Wind Speed Vs Wind Power Plot for 1.5 hours data

RNN Testing Plot for Last 20 minutes of Testing data

Wind Speed Vs Estimated Wind Power Plot using RNN for 1.5 hours data

Real-Time Simulation of MicroGrid using Dynamic Performance Model WT

Power Generation

Energy Storage System

Loads

MICRO-GRID

Power Flow with ESS and Solar are active

Power Flow with ESS, Solar and varying Wind every seconds

Micro-Grid
- Photovoltaic – 4.8 kW
- Wind Turbine – 2.4 kW
- Energy Storage – 72 Ah 350 VDC
- Load – 6 kW 0.8 pf

Results

Case I:
- ✓ Photovoltaic supplies active power
- ✓ Energy storage supplies unmet active and reactive power

Case II:
- ✓ Photovoltaic and wind supplies active power
- ✓ Energy storage supplies unmet active and reactive power
- ✓ Wind generation changes every second; the energy storage device is capable to absorb excess energy or supply unmet energy

Weather Monitoring System

Data logger & Analog Interface

RTDS

Download

Remote RSCAD Work-Station (Draft and Runtime File for Micro-Grid Simulation)

RTDS – DSP Interface

Dynamic Performance Model of Skystream 3.7 WT (M67 DSP Card – Host PC)

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