IMPROVED SYNCHRONIZATION OF DIESEL GENERATORS IN VARIABLE FREQUENCY CONDITIONS USING PREDICTIVE METHOD

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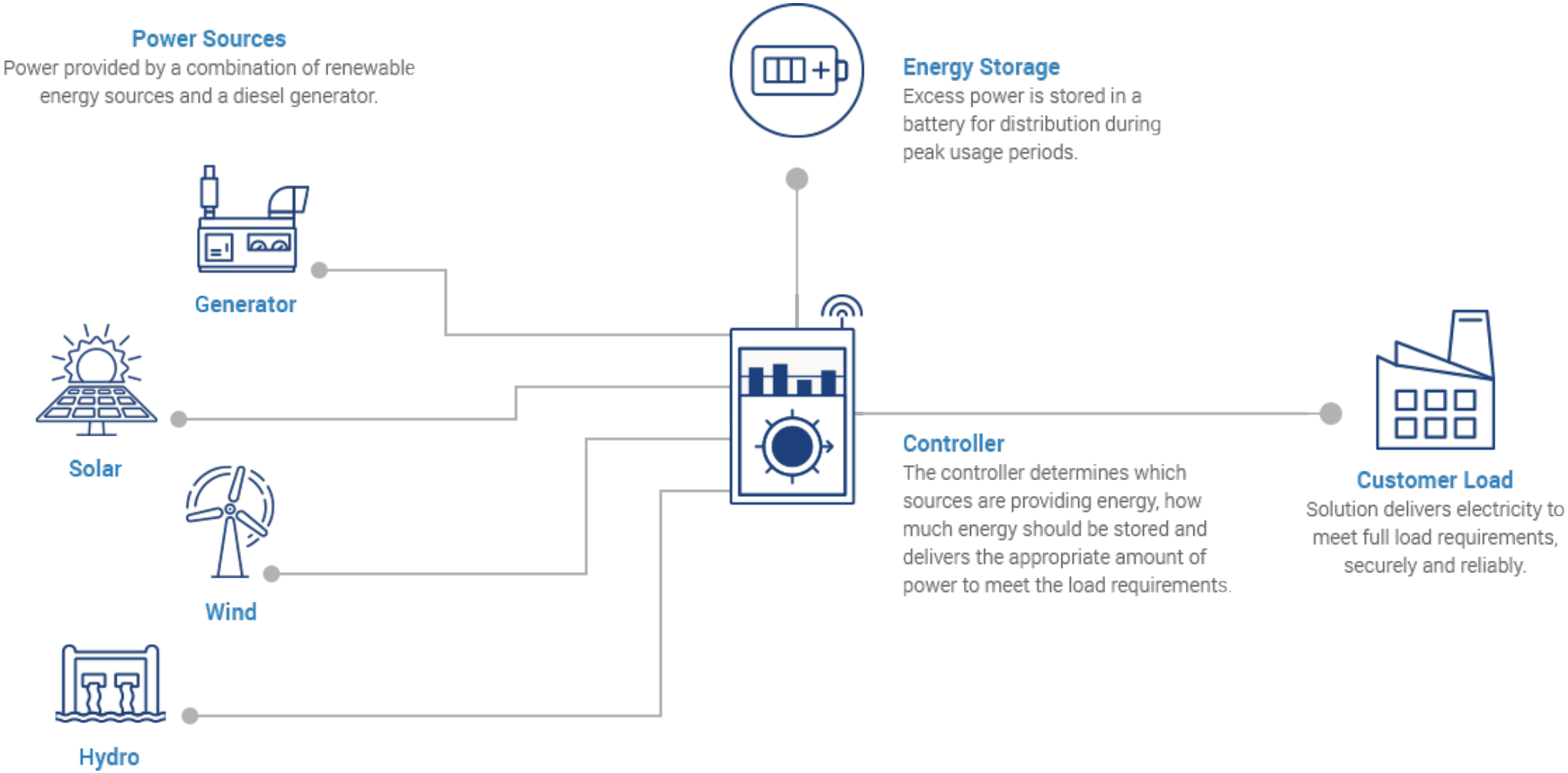
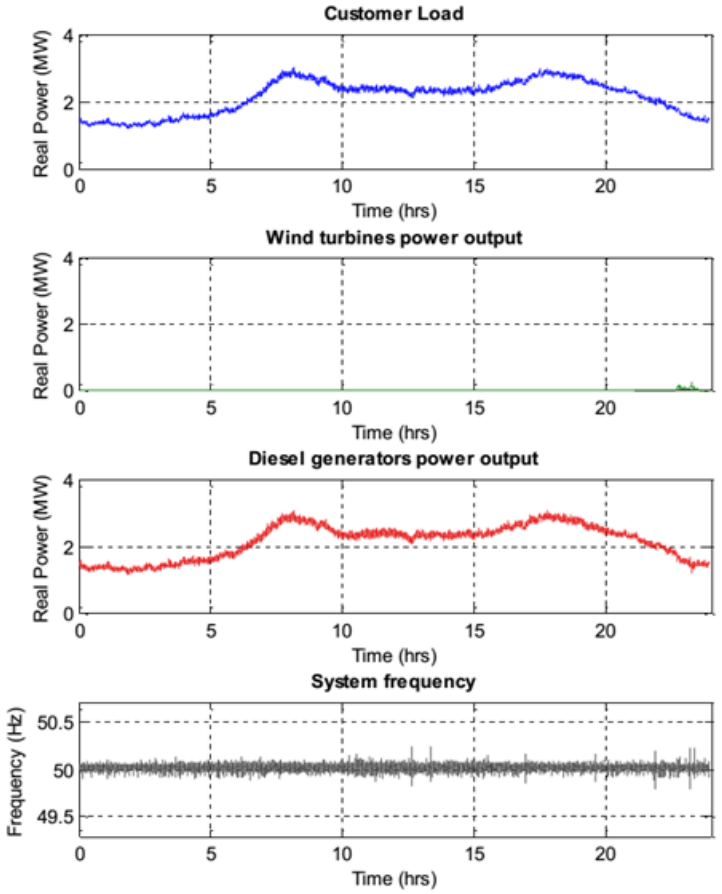
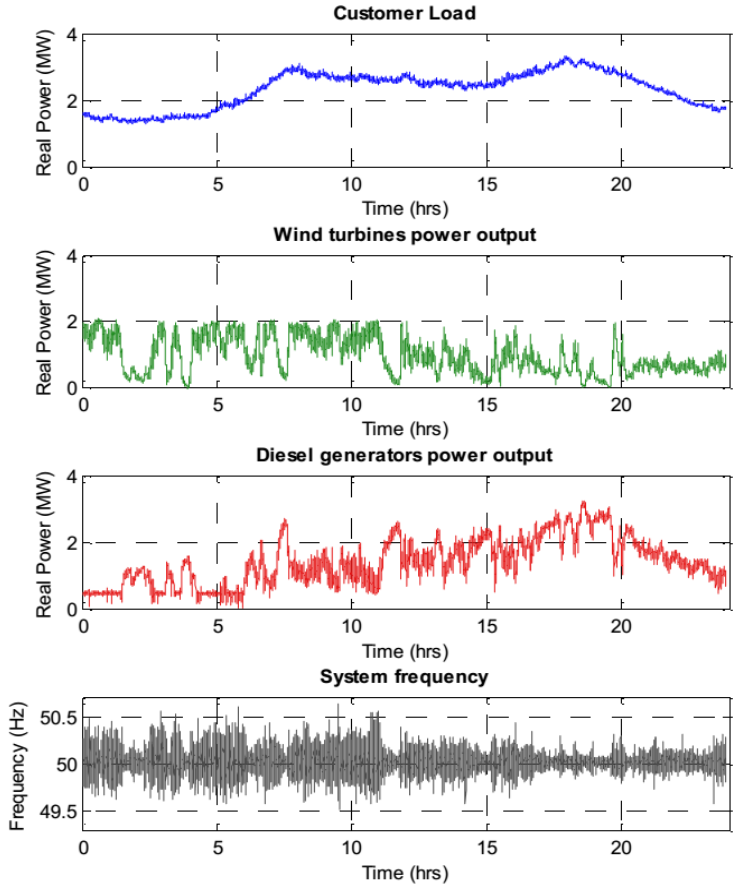
1. Introduction



2. Standard generator synchronization



a) without wind turbines



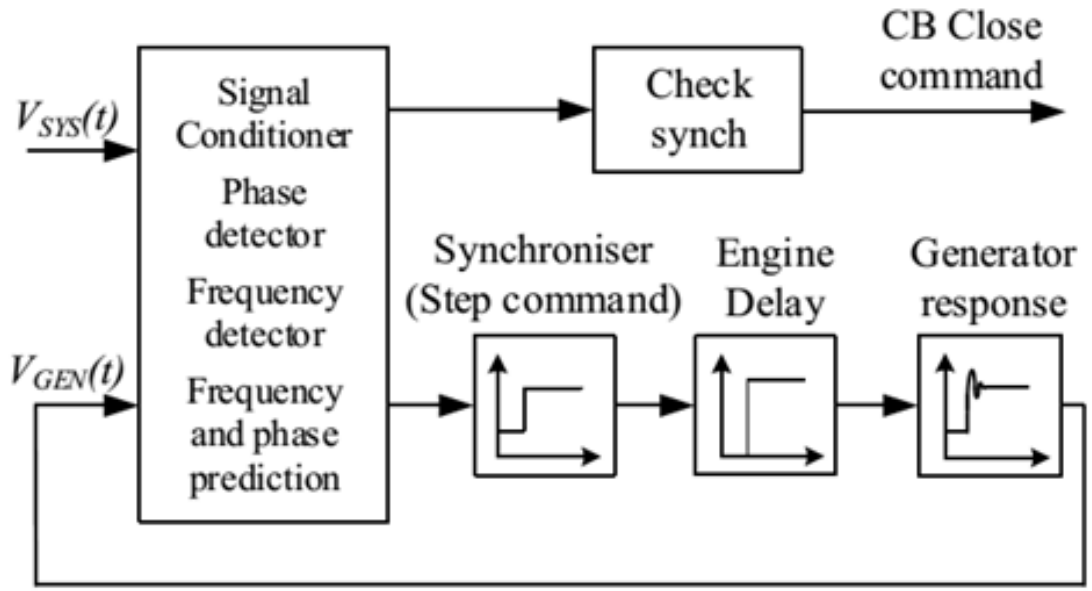
b) with wind turbines

Network frequency in IPS, as a consequence of load during the day and generation of electricity from wind turbines and diesel generators

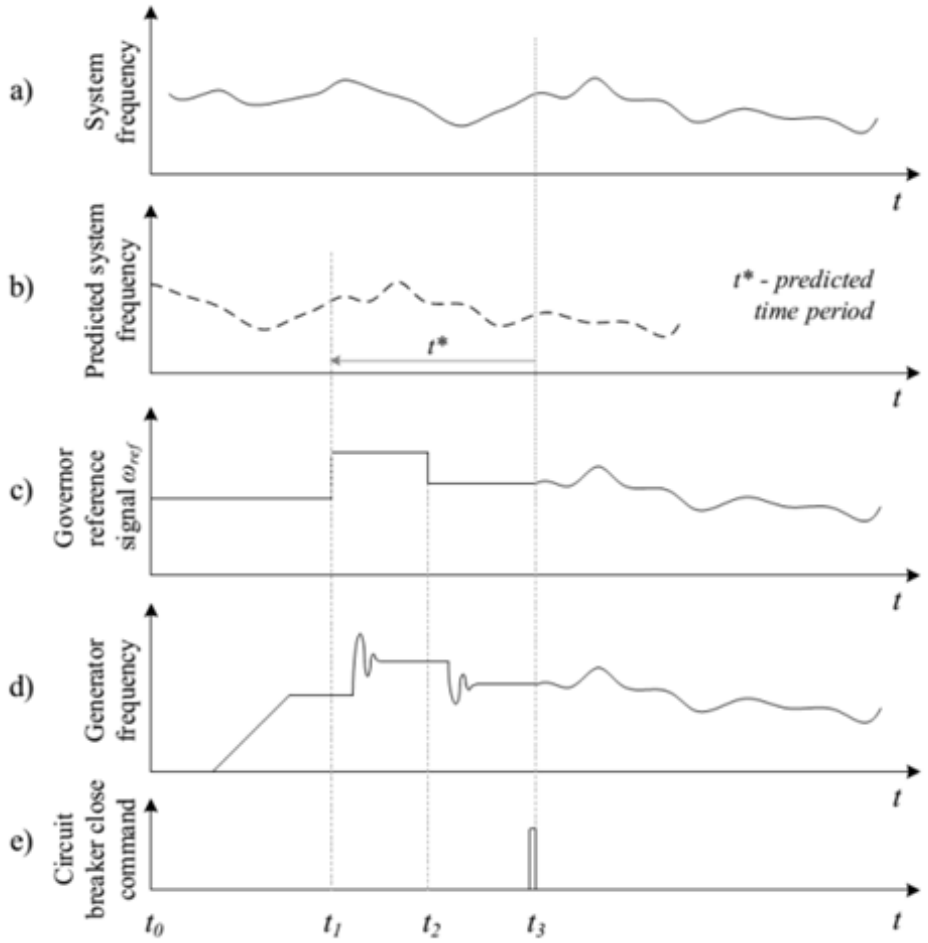
3. Predictive synchronization method

OPERATION OF THE PREDICTIVE SYNCHRONIZER HAS A FIVE-STEP PROCESS

1. **The differences between the system and generator frequencies ($\Delta f = f_{SYS} - f_{GEN}$) and the system and generator phases ($\Delta\varphi = \varphi_{SYS} - \varphi_{GEN}$) are calculated.**
2. **Based on the recorded time-series of the system frequency and the system phase, a predictive module calculates the future values for the system frequency, $f_{SYS}(t+n)$ and its phase $\varphi_{SYS}(t+n)$**
3. **Using (Δf, $\Delta\varphi$, $f_{SYS}(t+n)$, and $\varphi_{SYS}(t+n)$), the speed reference signals for the synchronizing generator governor are calculated and issued to the governor. The two steps are communicated as a step-up signal issued at t_1, and a stepdown signal at t_2.**
4. **After a short delay, the generator responds to given speed correction commands from the synchronizer.**
5. **Synchronization has been achieved, so the Check Synch module issues CB close signal to bring the generator online.**

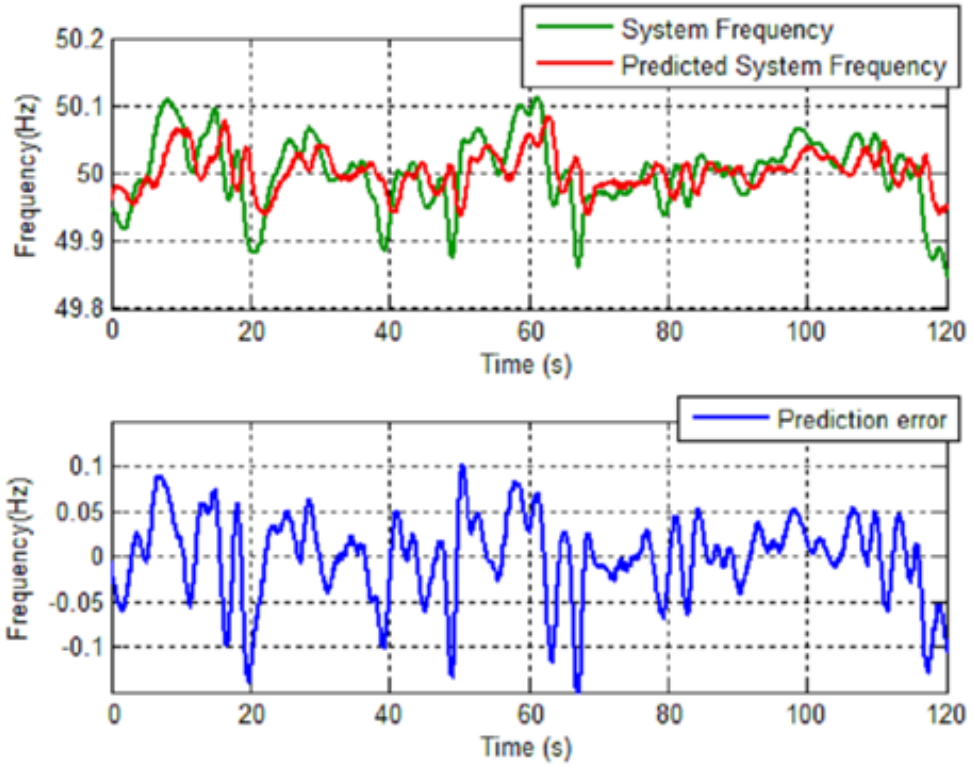


Functional diagram of the predictive synchronizer control loop.

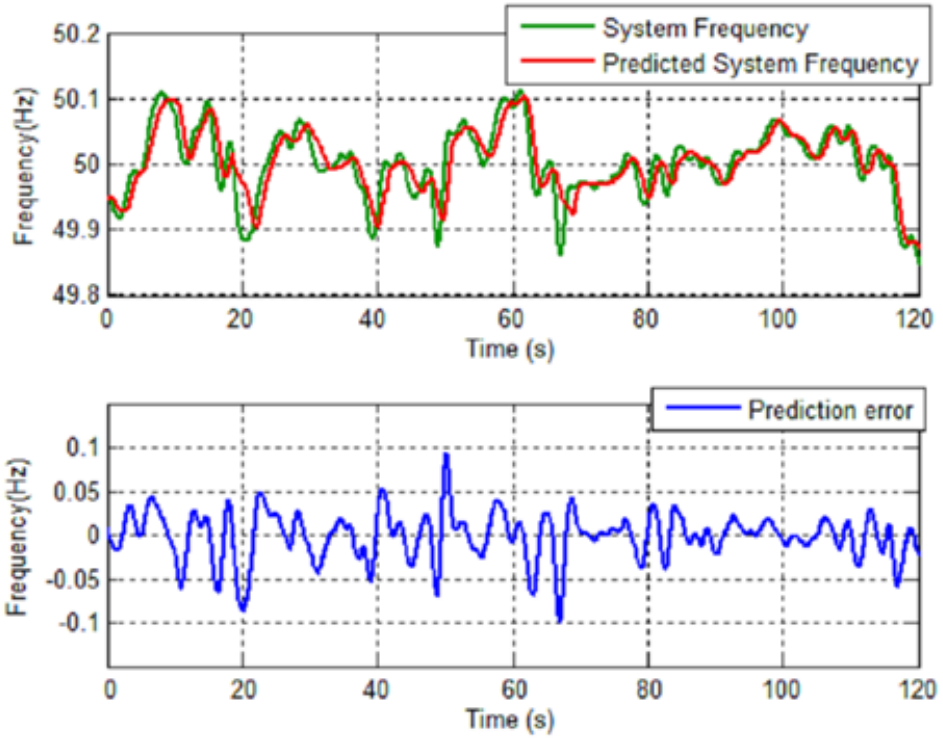


Operation of the predictive synchronizer.

5. Results of application of the predictive synchronization method



Moving average prediction results. Mean frequency prediction error was ~0.043Hz



ANFIS prediction results and prediction error example. Mean frequency prediction error was ~0.019Hz

6. Conclusion

a) ANFIS prediction technique is more suitable for use in predictive synchronization of processes due to higher prediction accuracy.

b) ANFIS technique is accurate enough to be used in the IPS diesel generator synchronization process, because it reduces the synchronization time and thus increases the stability of the system

THANKS FOR YOUR ATTENTION