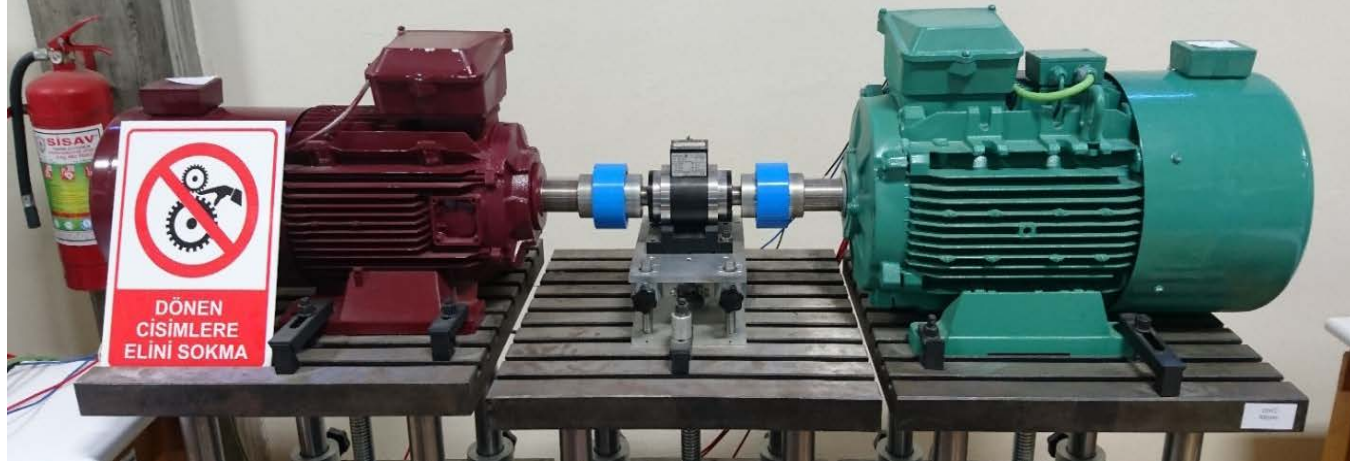




Rüzgar Enerjisi Dönüşümü Elülatorü



5. İzmir Rüzgar Sempozyumu ve Sergisi

Siamak Pourkeivannour



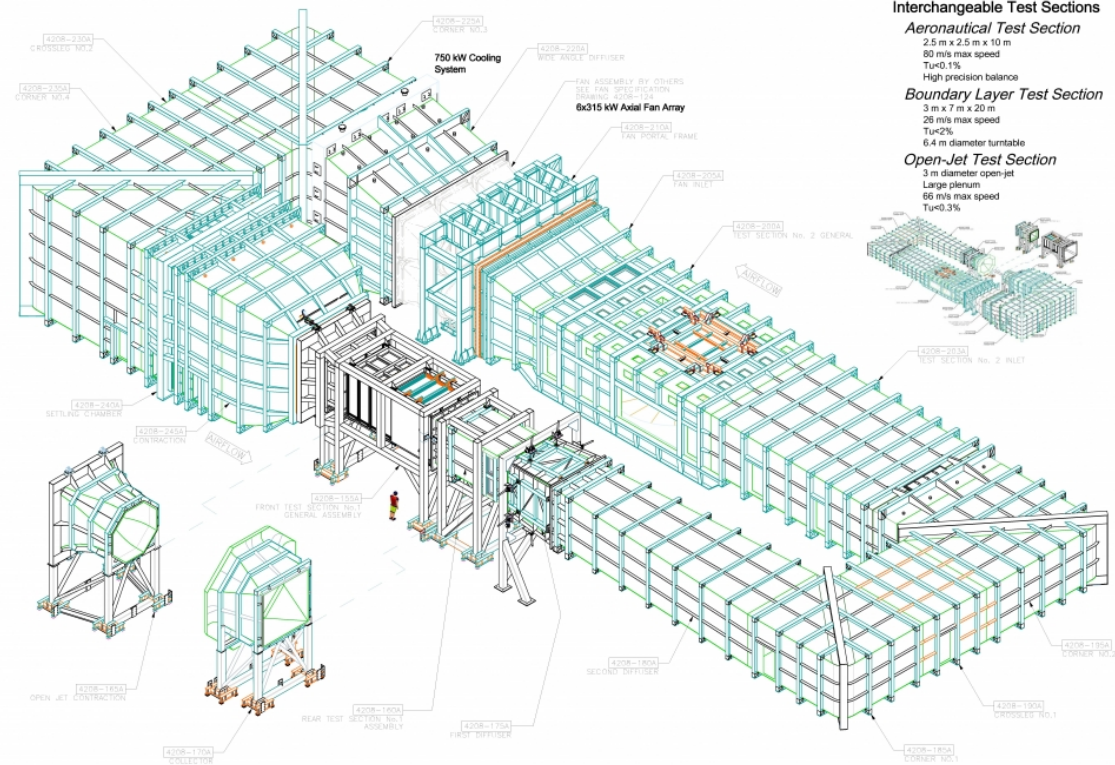
ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY





ODTÜ Rüzgem

- Hesaplamalı Aerodinamik
- Deneysel Aerodinamik
- Yapı ve Malzeme
- Elektromekanik
- Büyük Rüzgar Tüneli



METUWIND Large Scale Multi-Purpose Wind Tunnel
Detail Design - April 2014





Başlıklar

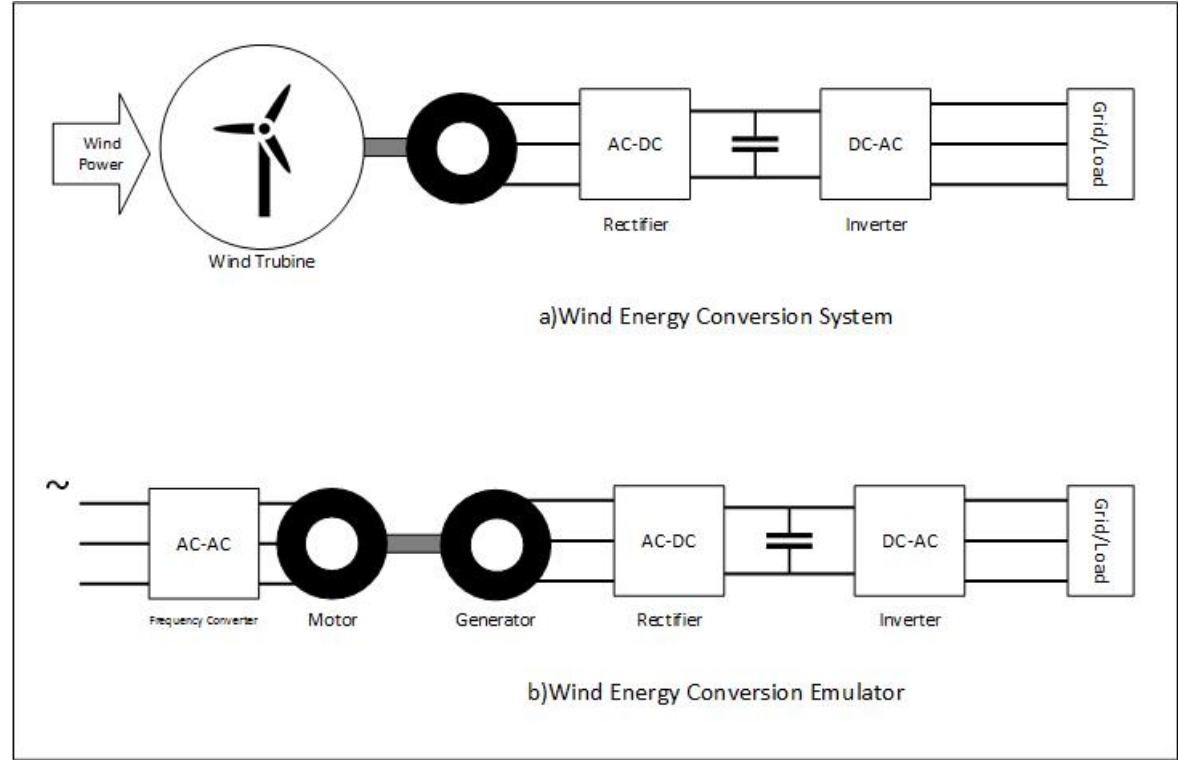
- Rüzgar Türbünü Emülatörü
- MPPT Yöntemleri Uygulaması
- Emülatör Üzerinde Büyük Rüzgar Türbinlerini Ölçekleme Yöntemi ile Emülasyon
- Ada Modunda Çalışan Mikro Şebeke





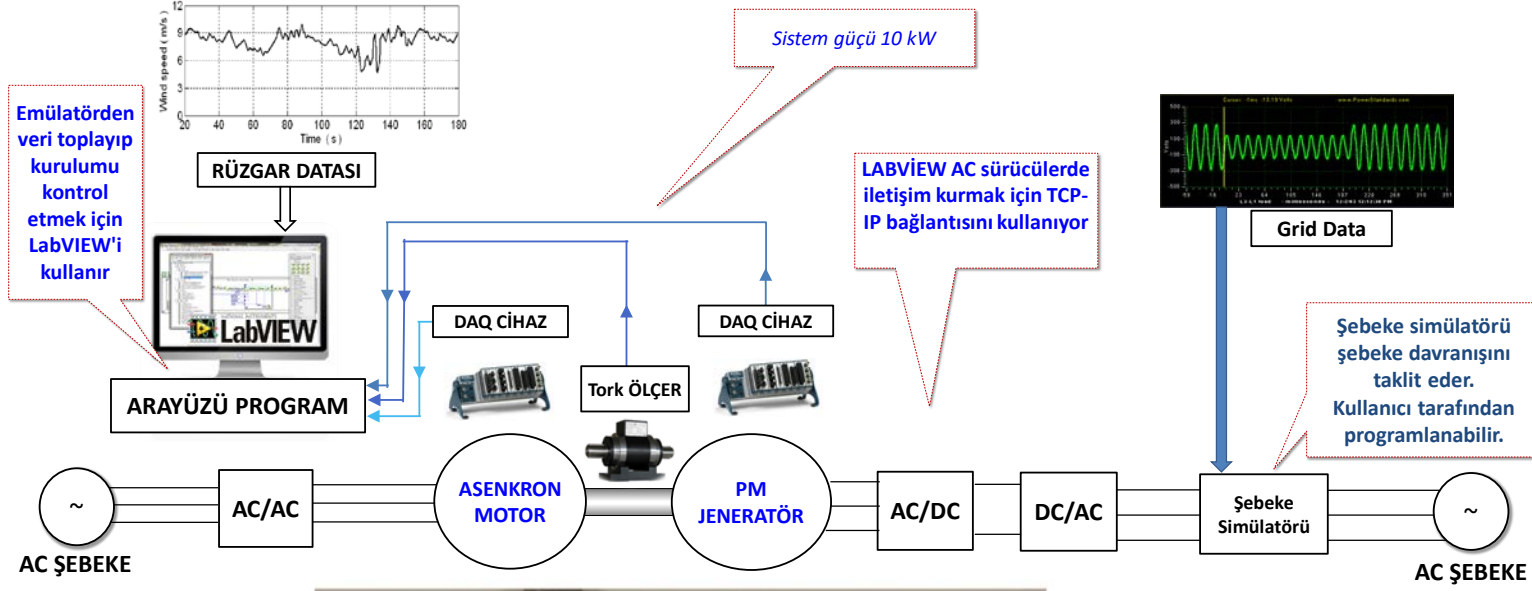
Rüzgar Türbini Emülatörü

- Rüzgar Profillerini Sisteme Uygulama
- MPPT Algoritmalarını Sisteme Geliştirme
- Güvenli Test Ortamı
- Şebeke Hatalarını Oluşturma ve Çözüm Üretme





Rüzgar Türbini Emülatörü

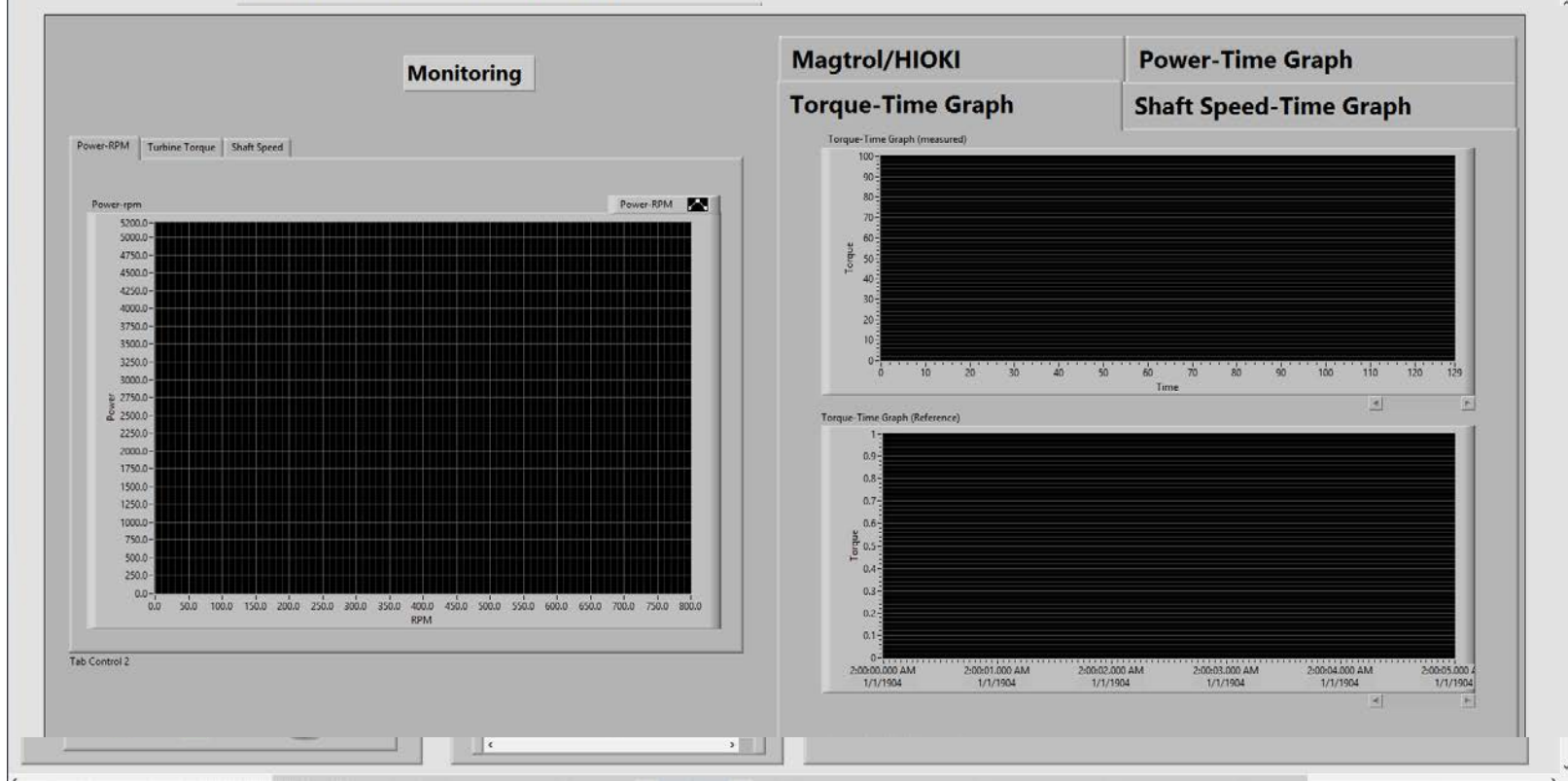


- Arayüzü Bilgisayar
- AC-DC-AC Dönüştürücüler
- Sabit Mıktatıslı Jeneratör
- Sincap Kafesli Motor
- Tork Ölçer
- Veri Toplama ve Kontrol





Rüzgar Türbini Emülatörü Arayüz Programı



- Türbin Özellikleri
- Rüzgar Hızı Girişi
- Jeneratör Hız Referance/MPPT
- Şaft Tork ve Hız
- Voltaj Akım ve Güç Verileri





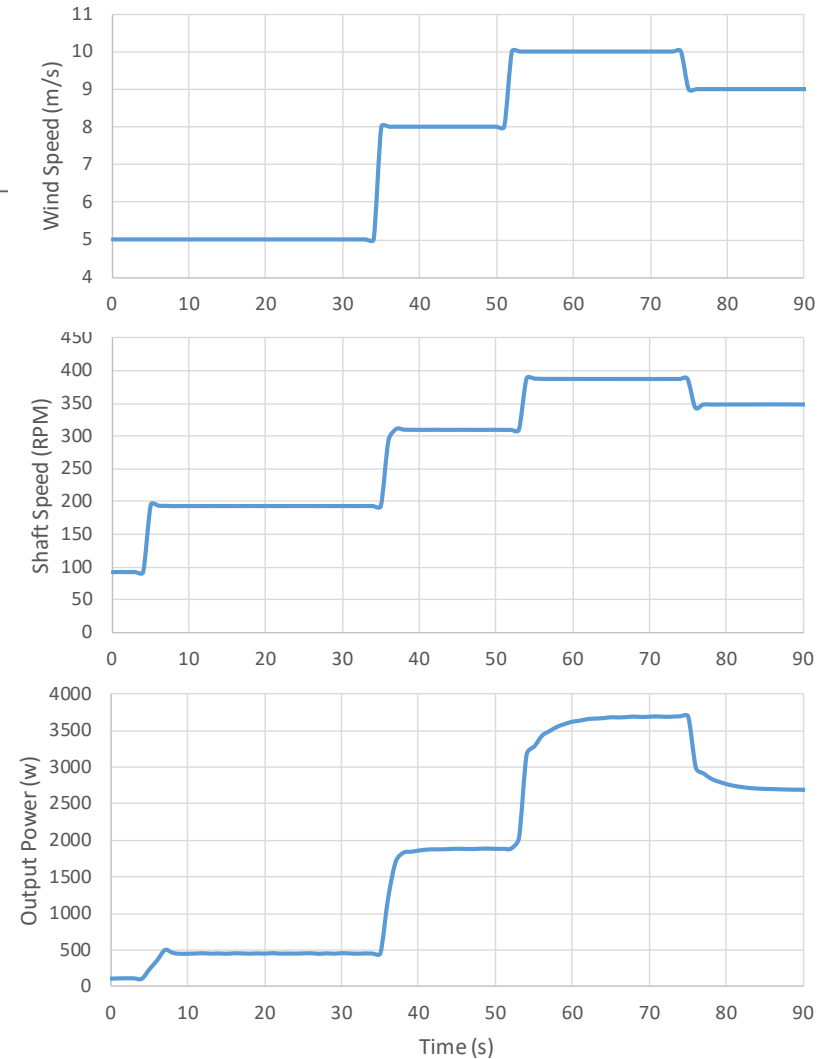
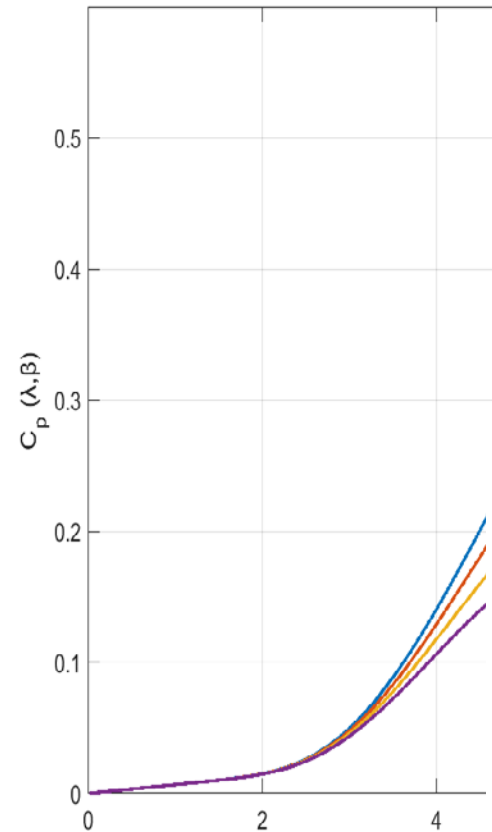
MPPT (Maksimum Güç Noktası Takibi)

- Optimum Tip Speed Ratio

$$P_t = 0.5 \rho C_p(\lambda, \beta) A v^3$$

$$C_p(\lambda, \beta) = C_1 \left(\frac{C_2}{\lambda_i} - C_3 \beta - C_4 \right) e^{\frac{-C_5}{\lambda_i}} + C_6 \lambda$$

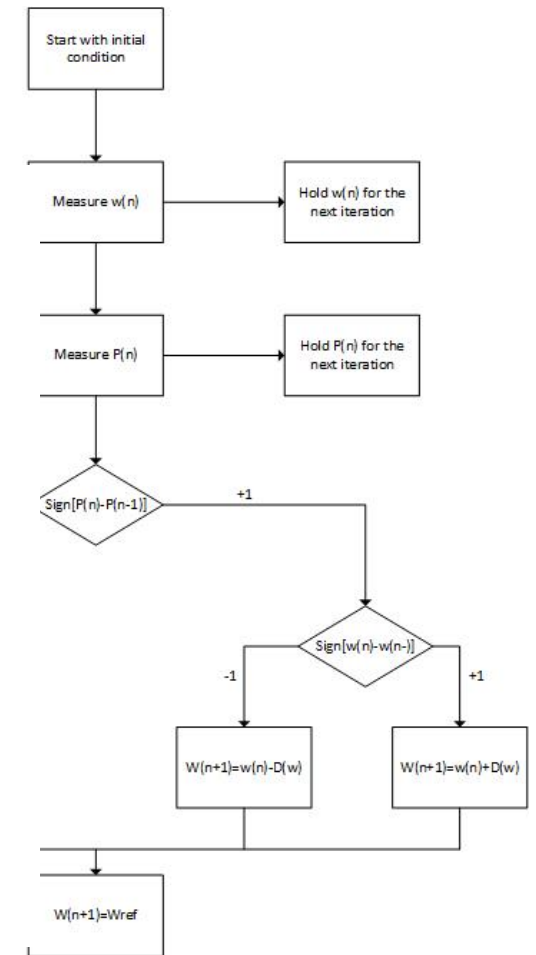
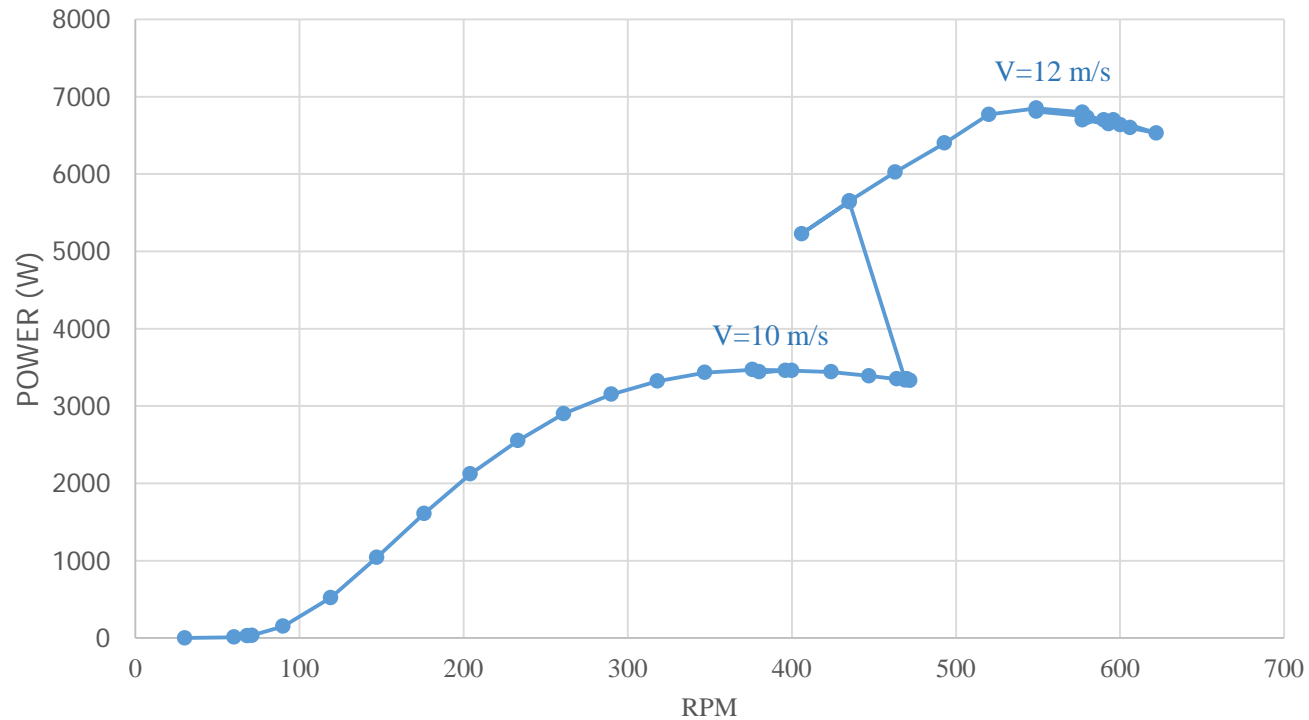
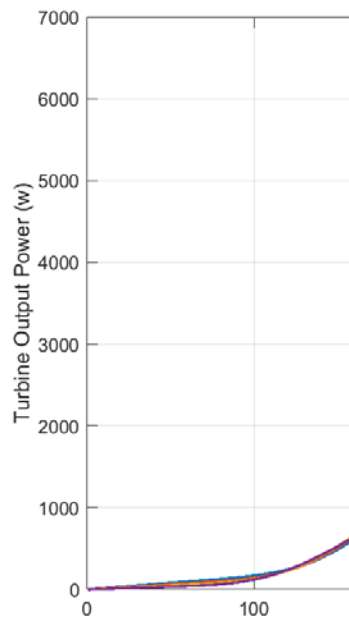
$$\omega_{opt} = \frac{\lambda_{opt} v}{R}$$





MPPT (Maksimum Güç Noktası Takibi)

- Hill Climb Method



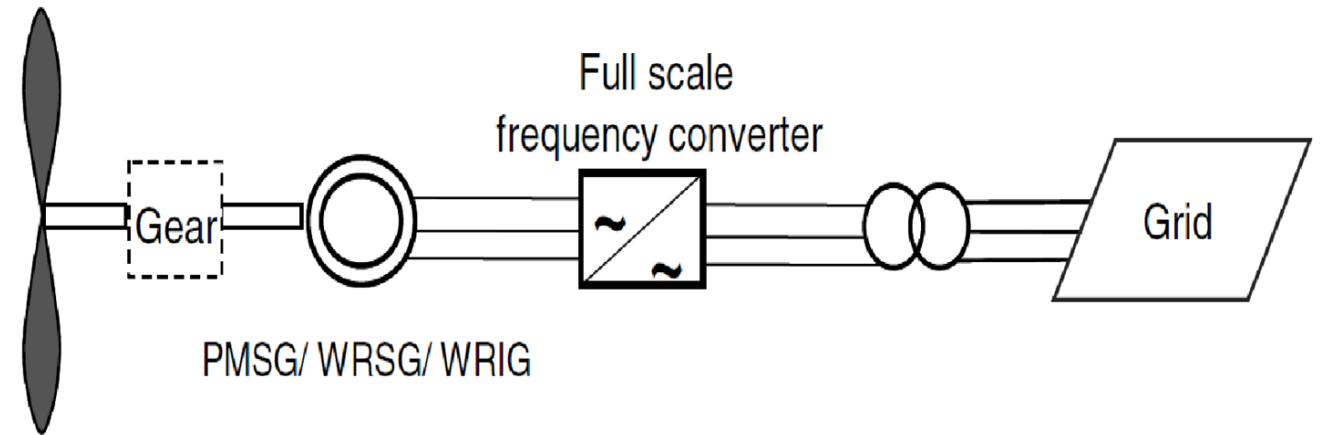


Dinamik Davranışının Ölçekli Emülasyonu

$$P_t = 0.5 \rho C_p(\lambda, \beta) A v^3$$

$$T_t = \frac{0.5 \rho C_p(\lambda, \beta) A v^3}{\omega_t}$$

$$\left(J_{tg} + \frac{J_t}{G_b^2} \right) \frac{d\omega_{tg}}{dt} = \frac{T_t}{G_b} - T_{tg}$$



$$(J'_t) \frac{d\omega_{tg}}{dt} = T'_t - T_{tg}, \quad J'_t = J_g + \frac{J_t}{G_b^2}, \quad T'_t = \frac{T_t}{G_b}$$



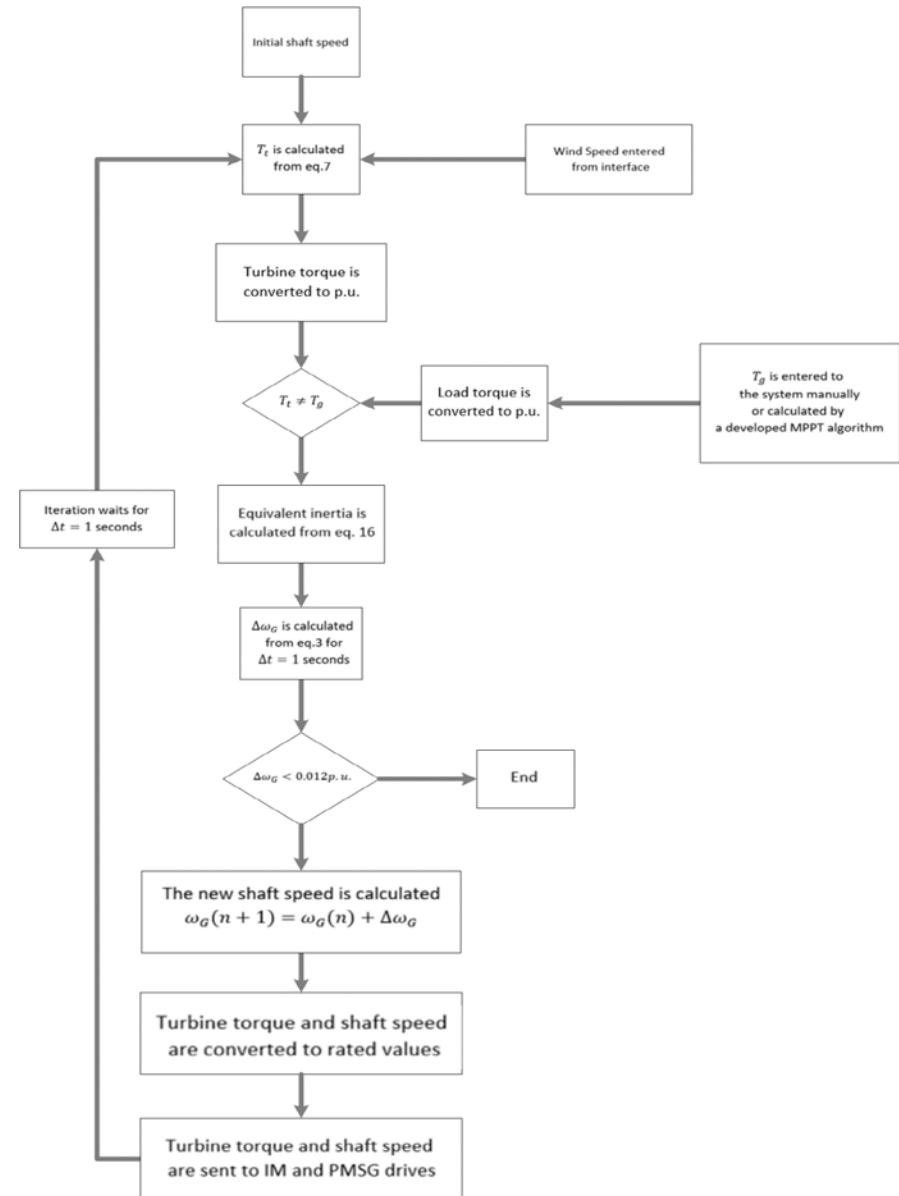


Dinamik Davranışının Ölçekli Emülasyonu

$$\frac{d\omega_{eg}}{dt} = \frac{1}{K_\omega} \frac{T'_t - T_{tg}}{J_{eq}}$$

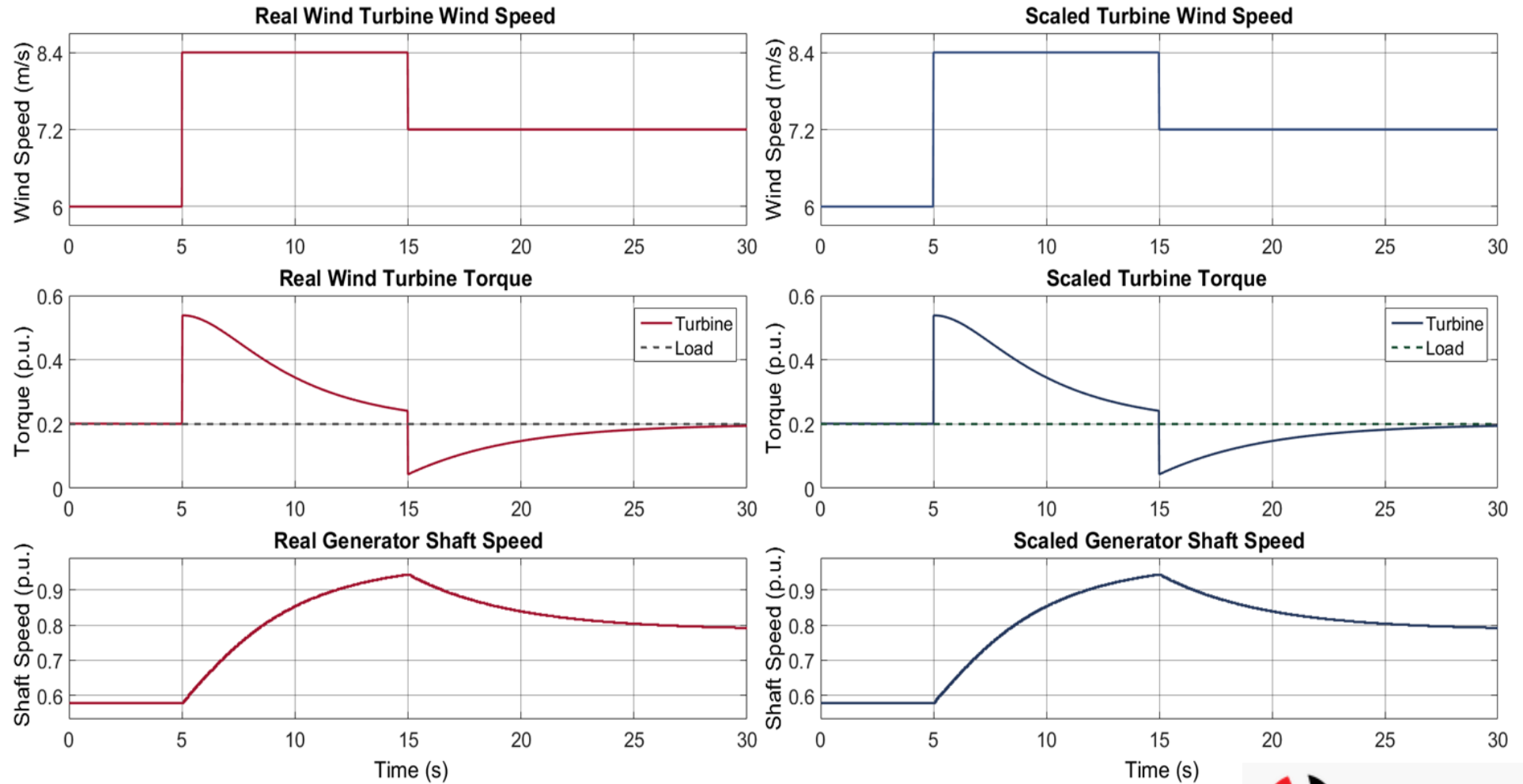
$$\frac{\Delta\omega_{eg}[n+1]}{\Delta t} = \frac{1}{K_\omega} \frac{T'_t[n] - T_{tg}[n]}{J_{eq}}$$

$$\omega_{eg}[n+1] = \omega_{eg}[n] + \Delta\omega_{eg}[n]$$



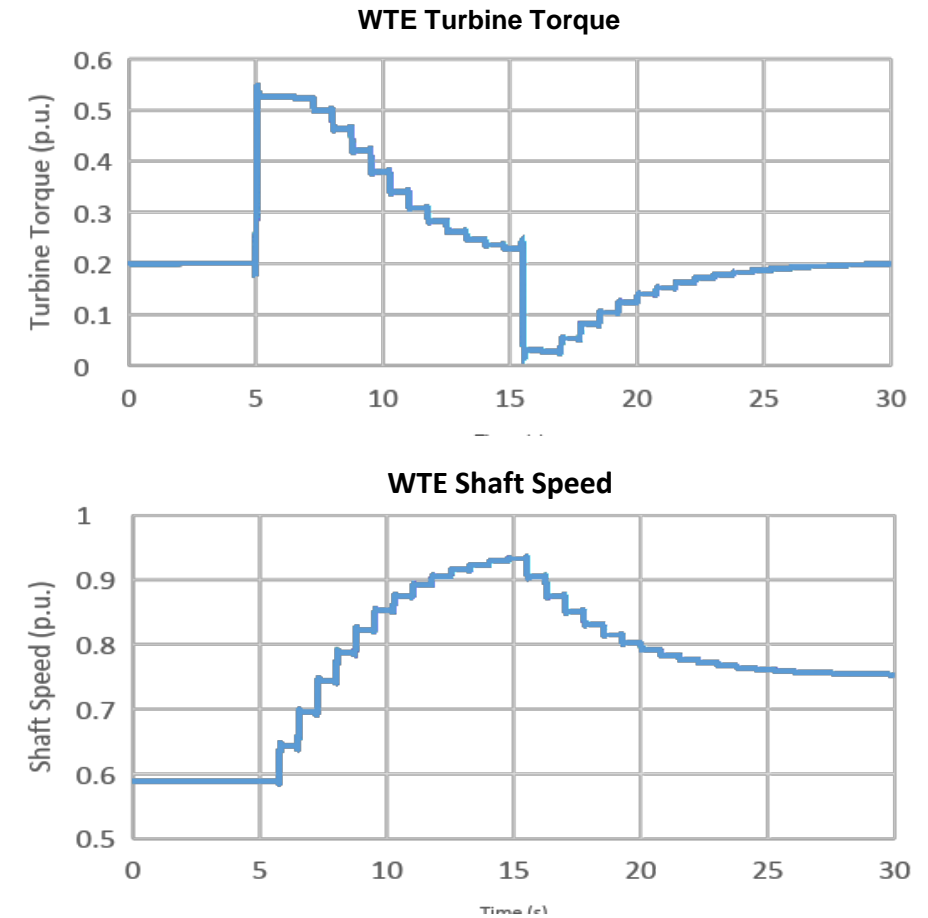
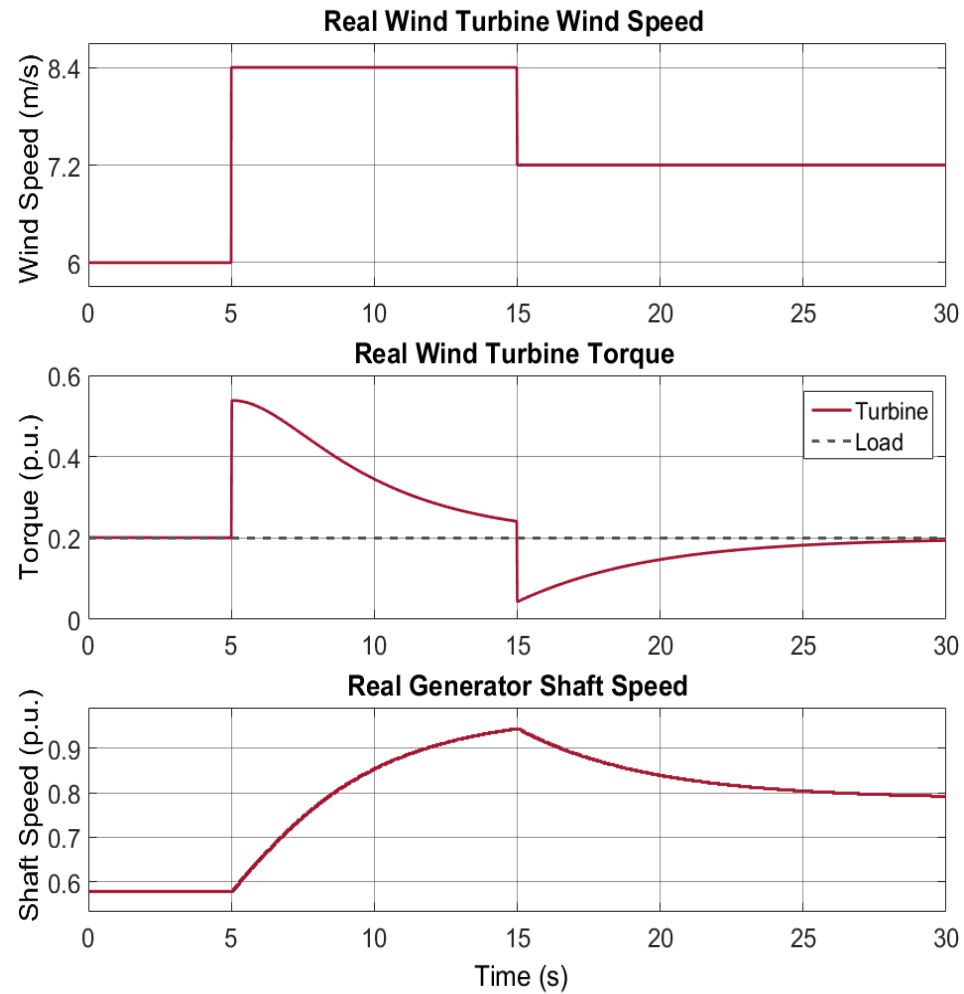


Simülasyon Sonuçları





Deneysel Sonuçlar





Simulasyon ve Deneysel Sonuçları Karşılaştırması

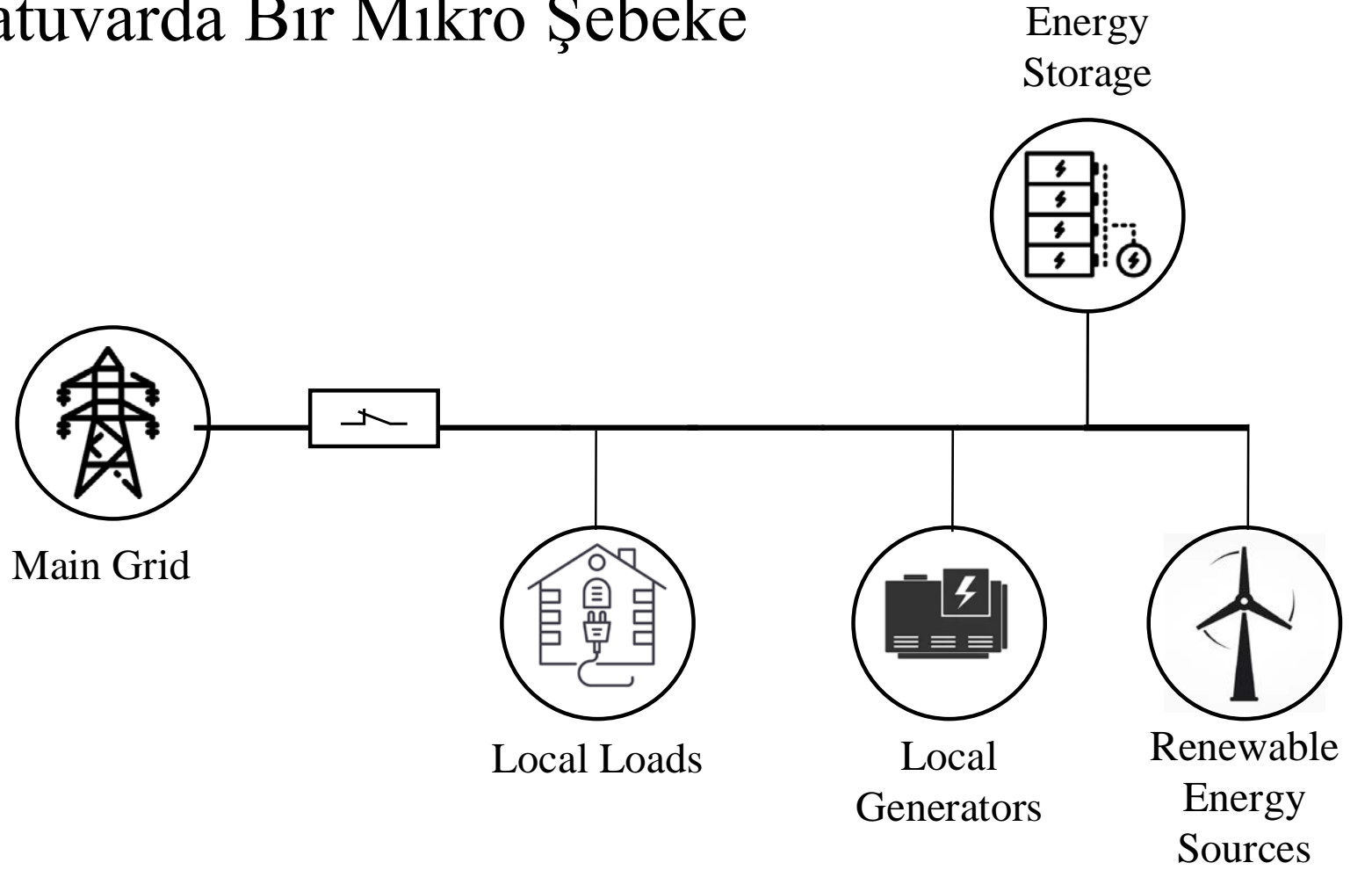
	Initial Shaft Speed (p.u.)	Final Shaft Speed (p.u.)	Time Constant for 63% of Exponential Growth (s)	Shaft speed value after 1 time constant (p.u.)	Shaft speed value after 5 time constant (p.u.)
1.5 MW Sim	0.509	0.615	3.43	0.5761	0.615
Scaled Down to 10.8 kW Sim	0.509	0.615	3.43	0.5761	0.615
Scaled Down to 10.8 kW WTE	0.51	0.61	4	0.58	0.61





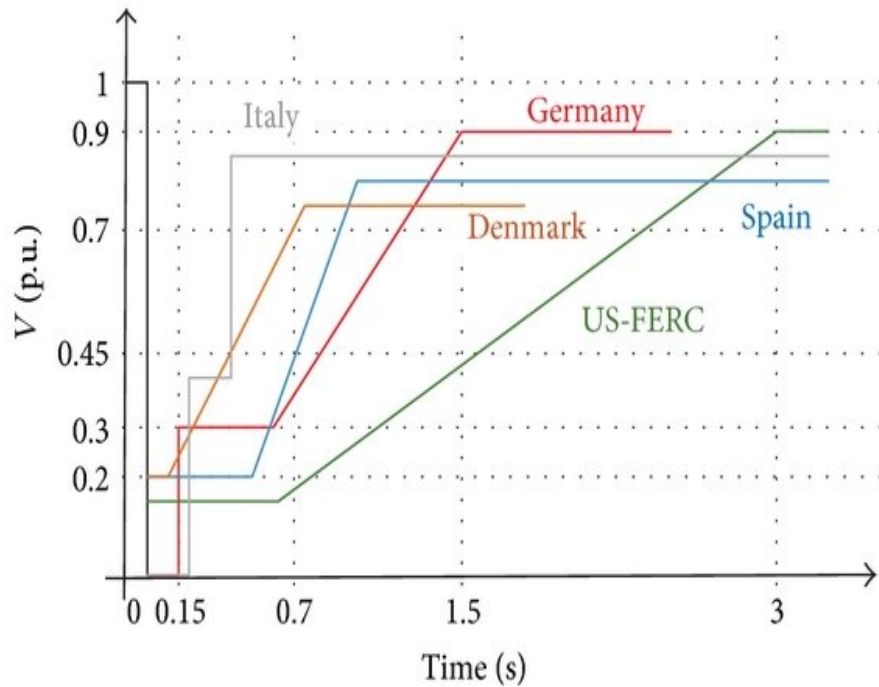
Labratuvarda Bir Mikro Şebeke

- Ana Şebeke
- Yükler
- Güç Üreticileri
- Enerji Depolama Ünitesi

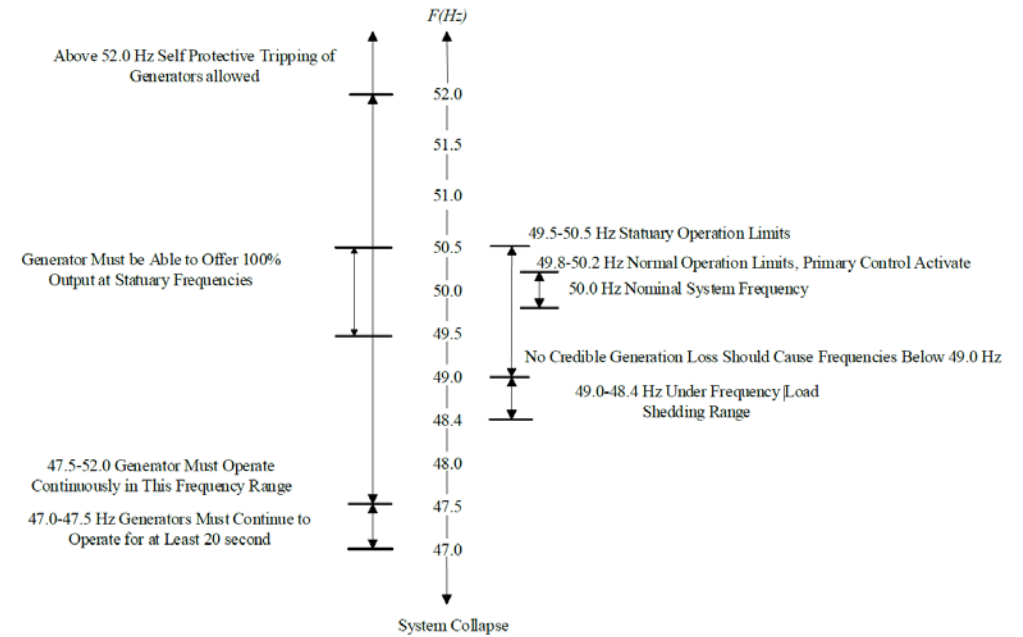




Şebeke Standartları



Voltage Ride Through Regulations



ENTS-O DG's Frequency Regulations

(European Network of Transmission System Operators for Electricity)





Beni dinlediğiniz için teşekkür ederim.

