

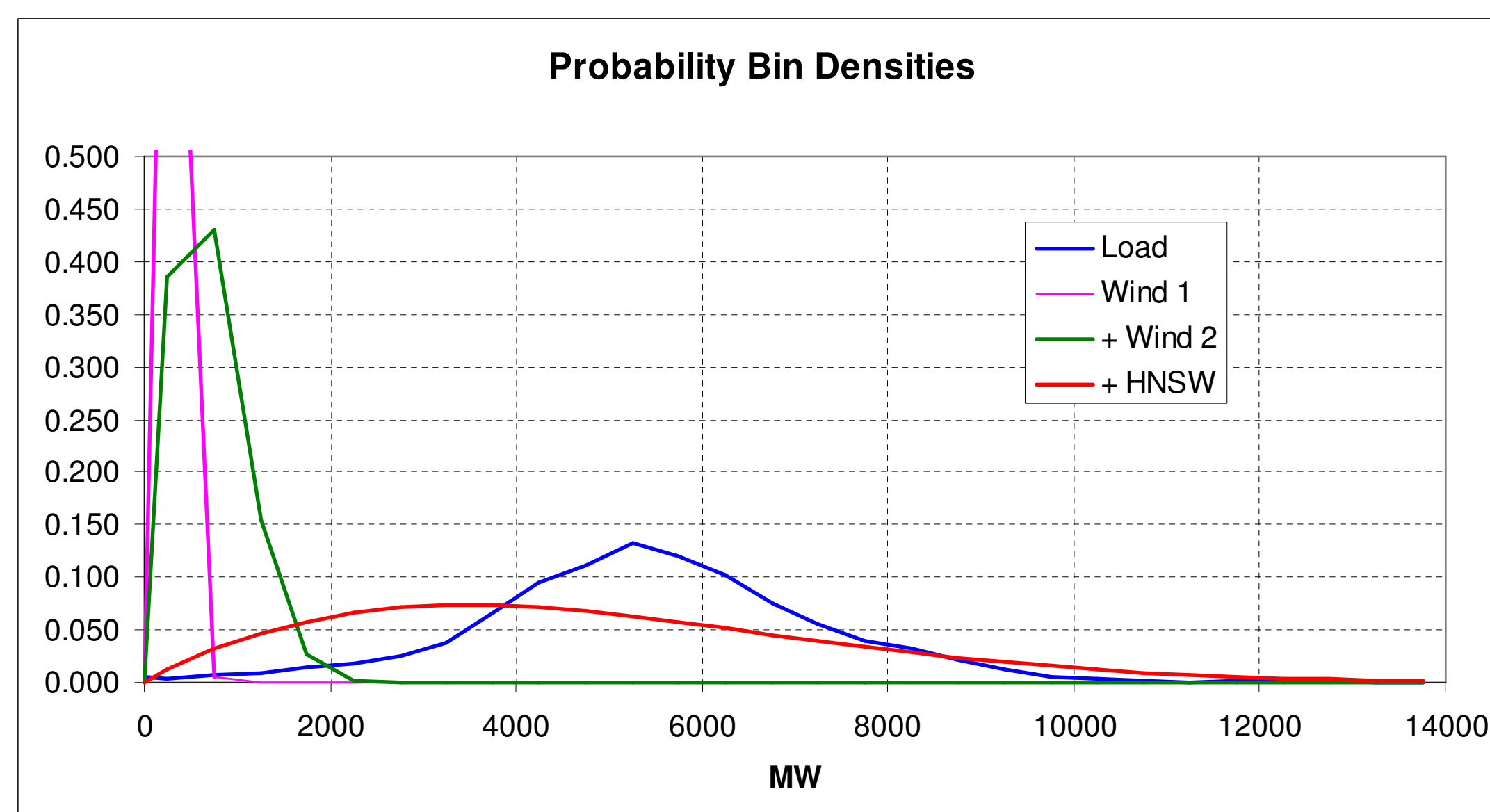
Distributed Wind Evaluation Methodology

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Systematic Approach in 10 Steps:

1. Capacity Factor Estimate
2. Financing and Power Purchase Agreement Options
3. Maximum Voltage Change – Full-On vs. Full-Off
4. Islanding Assessment – Probability Generation > Load
5. Flicker Screening
6. Changes in Fault Detection – Ground Fault Resistance
7. Check Overcurrent Device Coordination
8. Check Voltage Control – Capacitor Switching and Tap Changes
9. Interconnection Design – Transformer Connections, DG Protection Settings
10. Post-Installation Monitoring – Production and Flicker

Islanding Assessment for Hull

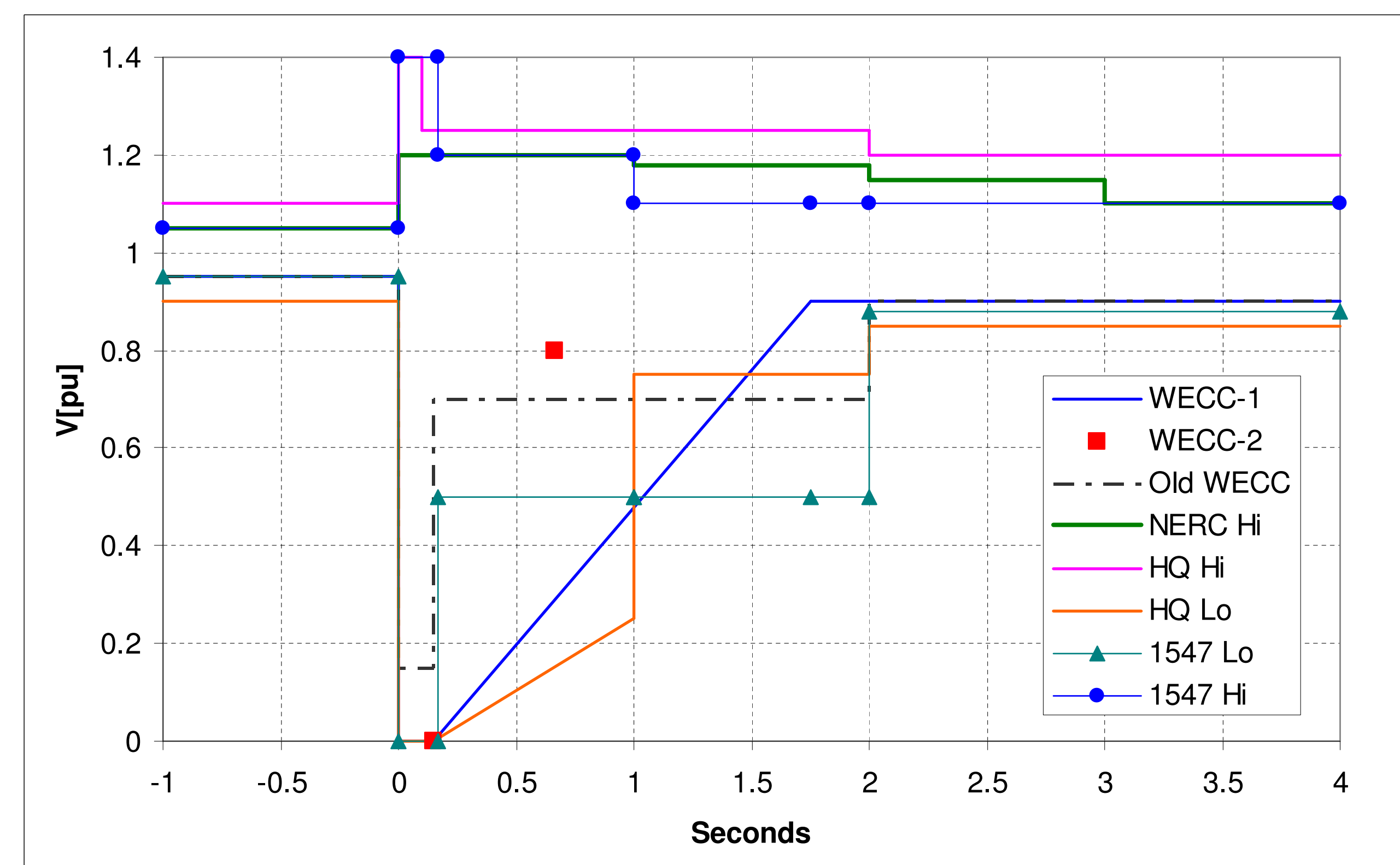


- Wind 1 Only → 0.19% Probability Generation ≥ Load
- Wind 1 and Wind 2 → 0.69%
- Wind 1, Wind 2, and HNSW → 39.72%
- Therefore, use Transfer Trip with HNSW

Checklist Approach to IEEE Std. 1547 (note: applies up to 10 MVA project size)

1. Do not actively regulate voltage.
2. Do not cause any voltages outside ANSI C84 Range A. Basically, this is 114 to 126 volts at the service level, or +/- 5%.
3. Create no damaging overvoltages in the Area Electric Power System.
4. Create no disruption of overcurrent protective device coordination.
5. De-energize for faults on the connected circuit.
6. De-energize prior to circuit reclosure.
7. Trip in response to any phase-phase voltage at the point of interconnection:
 - a. In 0.16 s for any voltage; $V < 50\%$.
 - b. In 2.00 s for any voltage; $50\% \leq V < 88\%$.
 - c. In 0.16 s for any voltage; $110\% < V < 120\%$.
 - d. In 1.00 s for any voltage; $120\% \leq V$.
 - e. These are default tripping times; the standard allows adjustment.
8. Detect and de-energize unintentional islands within 2 seconds, for example:
 - a. DG aggregate is less than 1/3 minimum electric power system load.
 - b. Reverse power flow detection at the point of common coupling, for small generators.
 - c. Transfer trip.
 - d. Forced frequency or voltage shifting.
 - e. Constant power or power factor controls.
 - f. Certified to pass a non-islanding test.
9. Trip for frequency deviations:
 - a. 0.16 s if $f > 60.5$ or $f < 57.0$
 - b. Adjustable 0.16 – 300 s if $57.0 \leq f \leq 59.8$
10. Cause no voltage fluctuation > 5%
11. Cause no objectionable voltage flicker per IEEE Std. 1453.
12. Meet the harmonic limits in IEEE Std. 519.
13. Do not energize the electric power system.
14. There must be an accessible, visible, and lockable isolation device.
15. Monitor at least the on/off status, voltage, real power, and reactive power.

IEEE1547 Voltage Trip vs. LVRT Requirements



UWIG Screening Tool

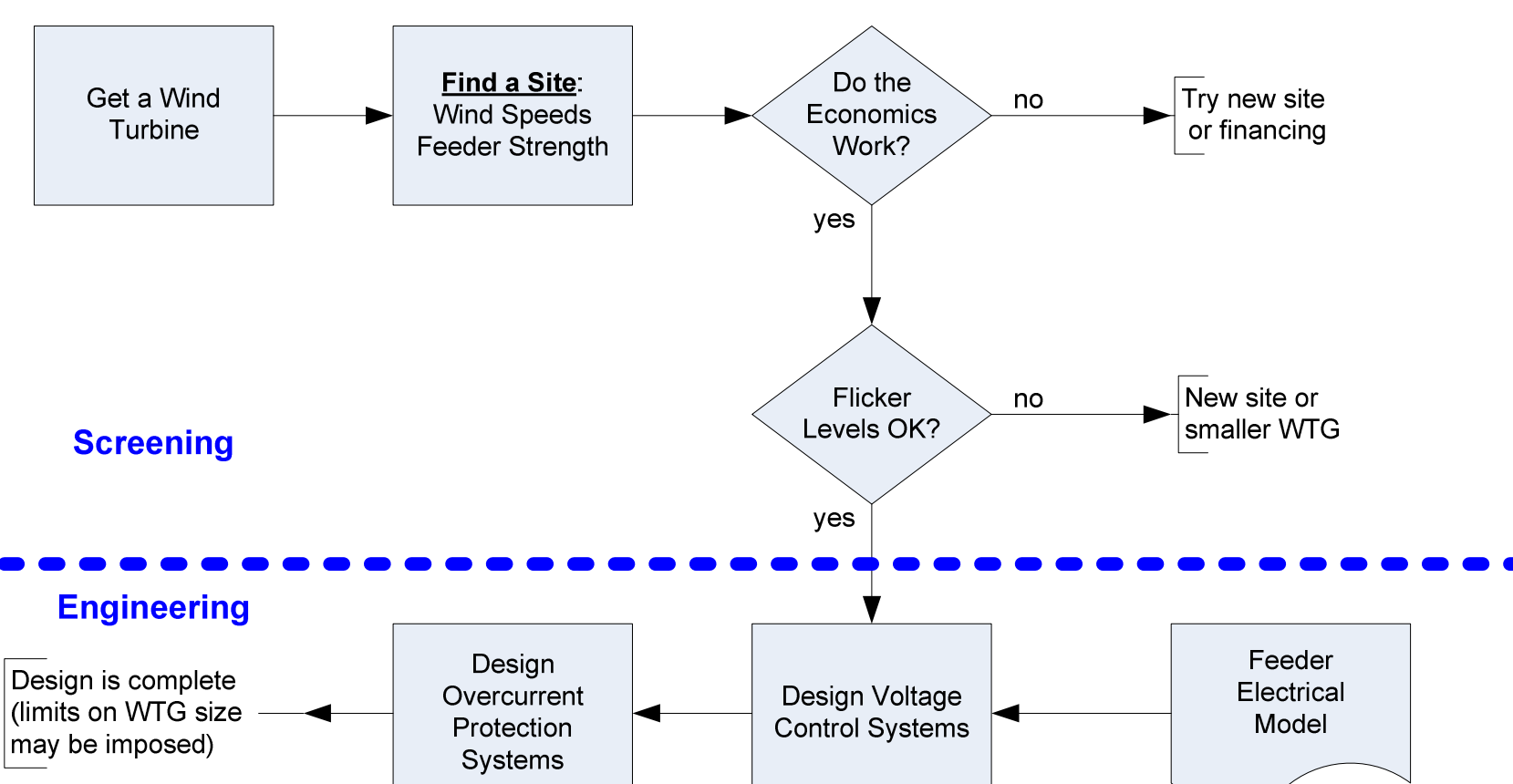
The screenshot shows the 'UWIG Distributed Wind Impacts Project' interface. It includes a navigation bar with 'Home', 'Index', 'Log Out', 'tmcdermott', and 'Help'. The main area is divided into sections for 'Turbine (WTG) Inputs', 'Feeder Inputs', 'FERC Outputs', and 'Flicker Outputs'. The 'Turbine (WTG) Inputs' section shows 'Pike County' as the project name, 'Vestas NM82 / 1850' as the turbine type, and '1652.00' kW as the size. The 'Feeder Inputs' section shows a '5.00' MVA substation transformer and '12.47' kV feeder primary voltage. The 'FERC Outputs' section shows '68.83' % WTG portion of peak load and '0.35' kA WTG fault contribution. The 'Flicker Outputs' section shows '26.08' MVA system apparent power and '73.60' degrees system impedance angle.

FERC Fast-Track Acceptance (not applied in all jurisdictions)

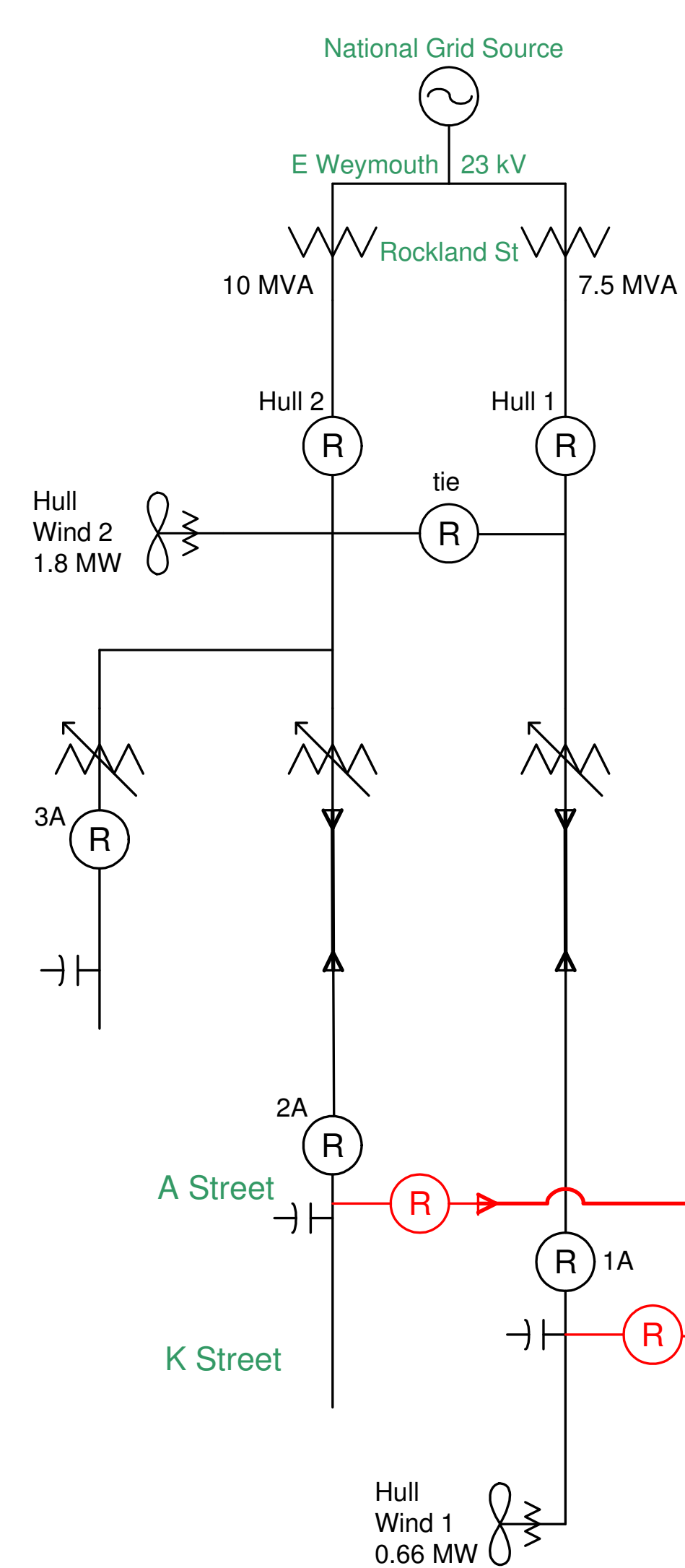
1. Design is certified
2. Project size ≤ 2 MW
3. Size ≤ 15% of Segment Load
4. Contribute ≤ 10% Utility Fault Current
5. All Utility Devices ≤ 87.5% Fault Rating

Flicker Planning Levels (IEEE Std. 1453)

1. Continuous, $P_{ST} \leq 0.9$
2. Switching, $P_{ST} \leq 0.9$ and $P_{LT} \leq 0.7$



Hull, MA Near-Shore Wind (Proposed)



Estimated Capacity Factors

Wind Speed [m/s]	V47 (Hull 1)	V80 (Hull 2)	V90	GE 2.5	GE 3.6
5.5	0.1928	0.2830	0.2372	0.2875	0.2304
6.0	0.2388	0.3364	0.2820	0.3396	0.2759
6.5	0.2851	0.3876	0.3267	0.3899	0.3212
7.0	n/a	n/a	0.3703	0.4373	0.3655
7.5	n/a	n/a	0.4120	0.4813	0.4079
8.0	n/a	n/a	0.4511	0.5217	0.4478

Steady-State Voltage Changes

Case	Pn	Qn	dV[%]	I3 [kA]
K L2P14	6.00	0.00	9.44	1.26
K L2P14	6.00	1.87	14.72	1.26
K L2P14	6.00	-1.87	4.27	1.26
Wind1	0.66	0.00	1.37	0.92
Wind2	1.80	0.00	1.13	2.41
Wind2 on Hull 1	1.80	0.00	1.24	2.20
HNSW on Hull 2	12.00	-3.75	3.45	2.41

$$V_{drop} = \frac{100}{U_n^2} (R_1 + jX_1)(P_n - jQ_n)$$

$$\frac{dV}{U_n} = \sqrt{(100 + \text{Re}V_{drop})^2 + (\text{Im}V_{drop})^2} - 100$$

Maximum Turbine Flicker Coefficients (Cf and Kf)

Name	Distance	Angle	S1 [MVA]	I3ph [kA]	Pst-c	Pst-k	Pit-k
Hull2	6.50	69.5	50.96	2.13	0.400	0.453	0.355
L2P14	26.27	65.2	31.91	1.34	0.639	0.724	0.567
		Sn	3 => 4@Hull2		0.801	0.699	0.548
		C	6.8 => 2@L2P14		0.904	0.899	0.705
		N10	10				
		N120	55				
		K	0.25				

