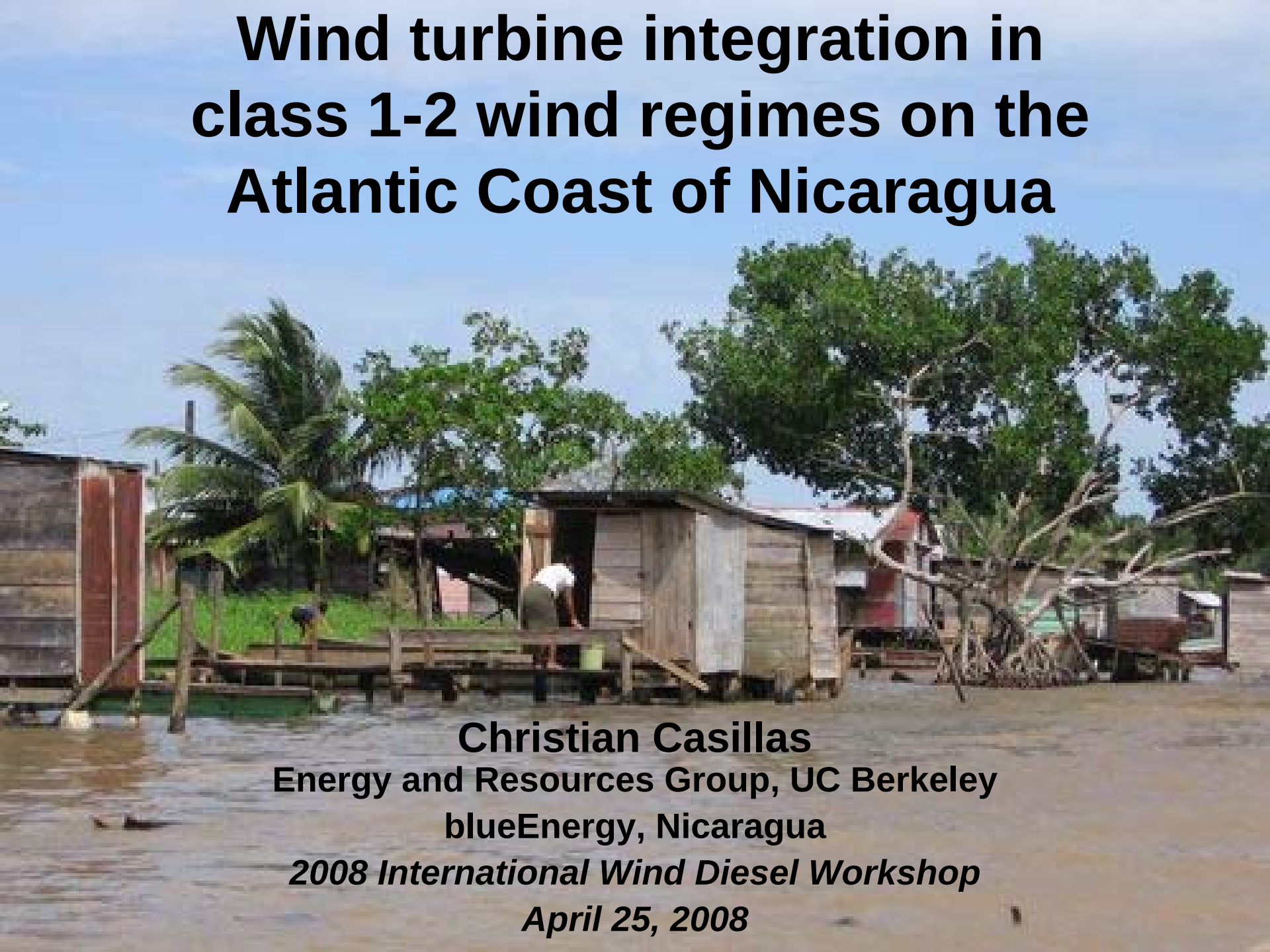
Wind turbine integration in class 1-2 wind regimes on the Atlantic Coast of Nicaragua



Christian Casillas
Energy and Resources Group, UC Berkeley
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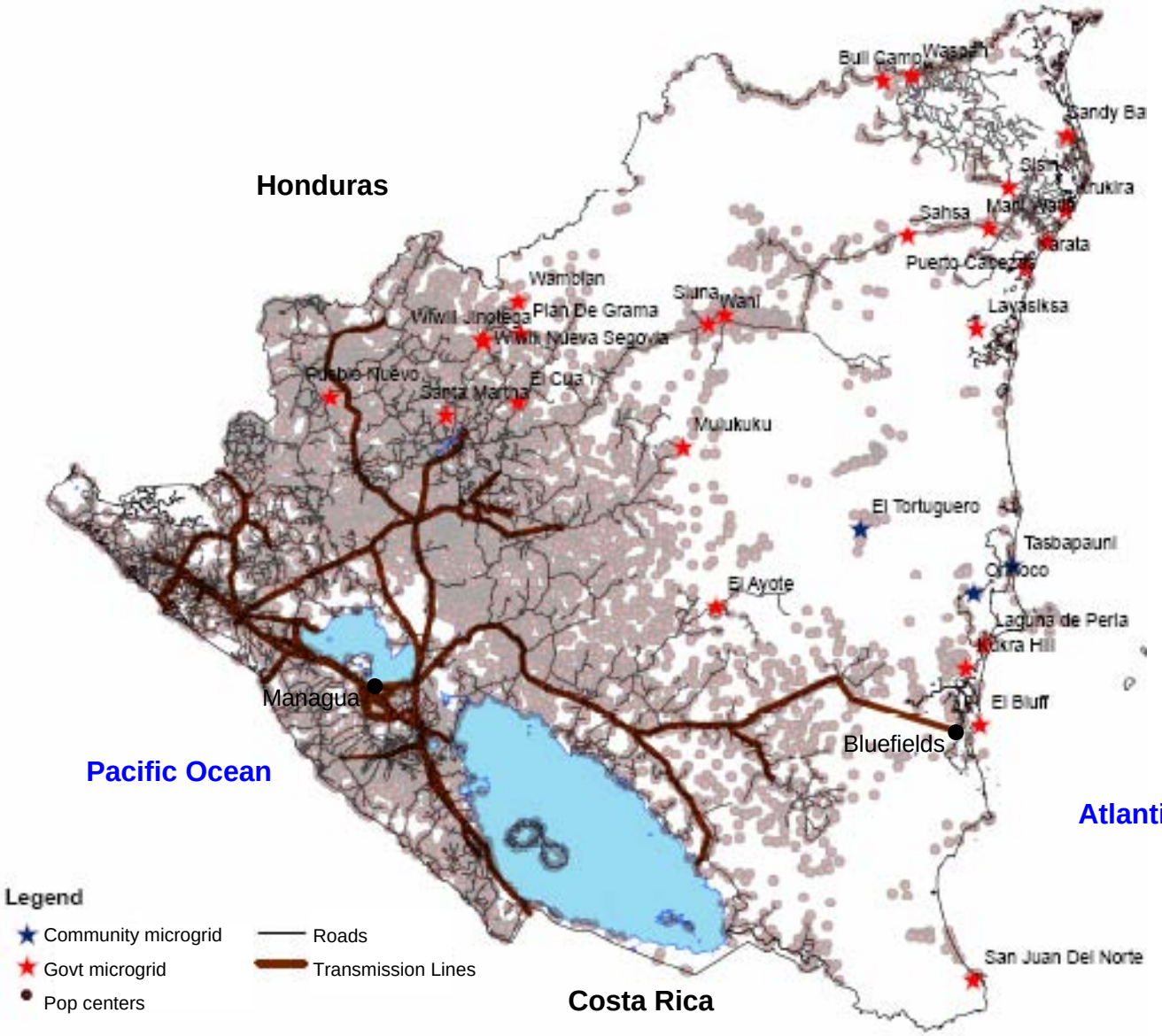
2008 International Wind Diesel Workshop

April 25, 2008

Electricity Access on the Atlantic Coast



Atlantic Coast

15% of pop

70% rural

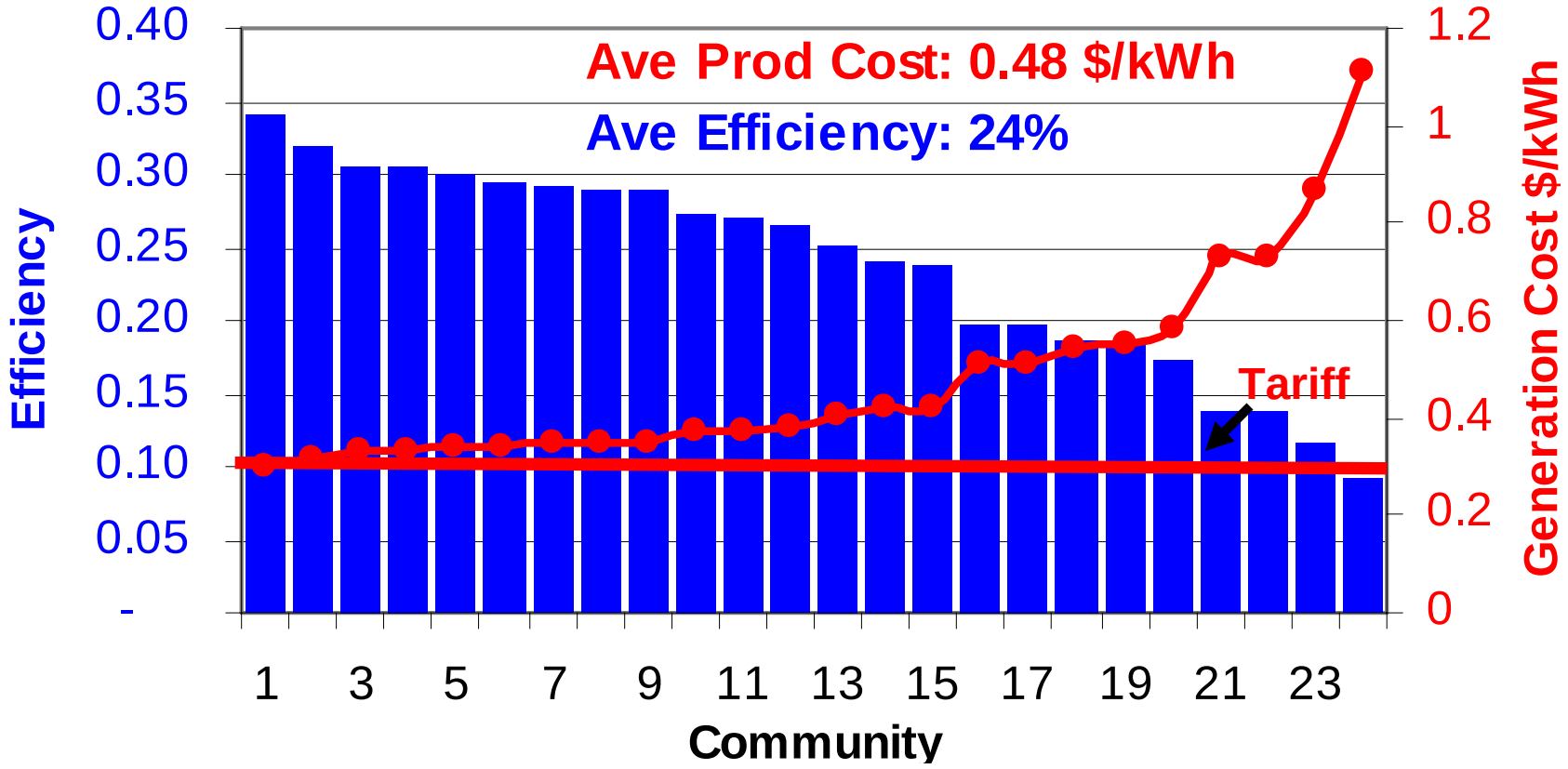
89% below poverty line

20% access to electricity

Some diesel microgrids

The Cost of Diesel

Diesel Microgrid Operating Efficiency/Gen Cost



Residential tariffs on the national grid 0.05-0.14 $/kWh (2007)

Efficiency/Generation calculations based on ENEL statistics 2007

Renewable Energy Resources

Wind Regimes:
Class 1 – Class 2

Ave Annual Solar Radiation:
4.7 kWh/m^2/day

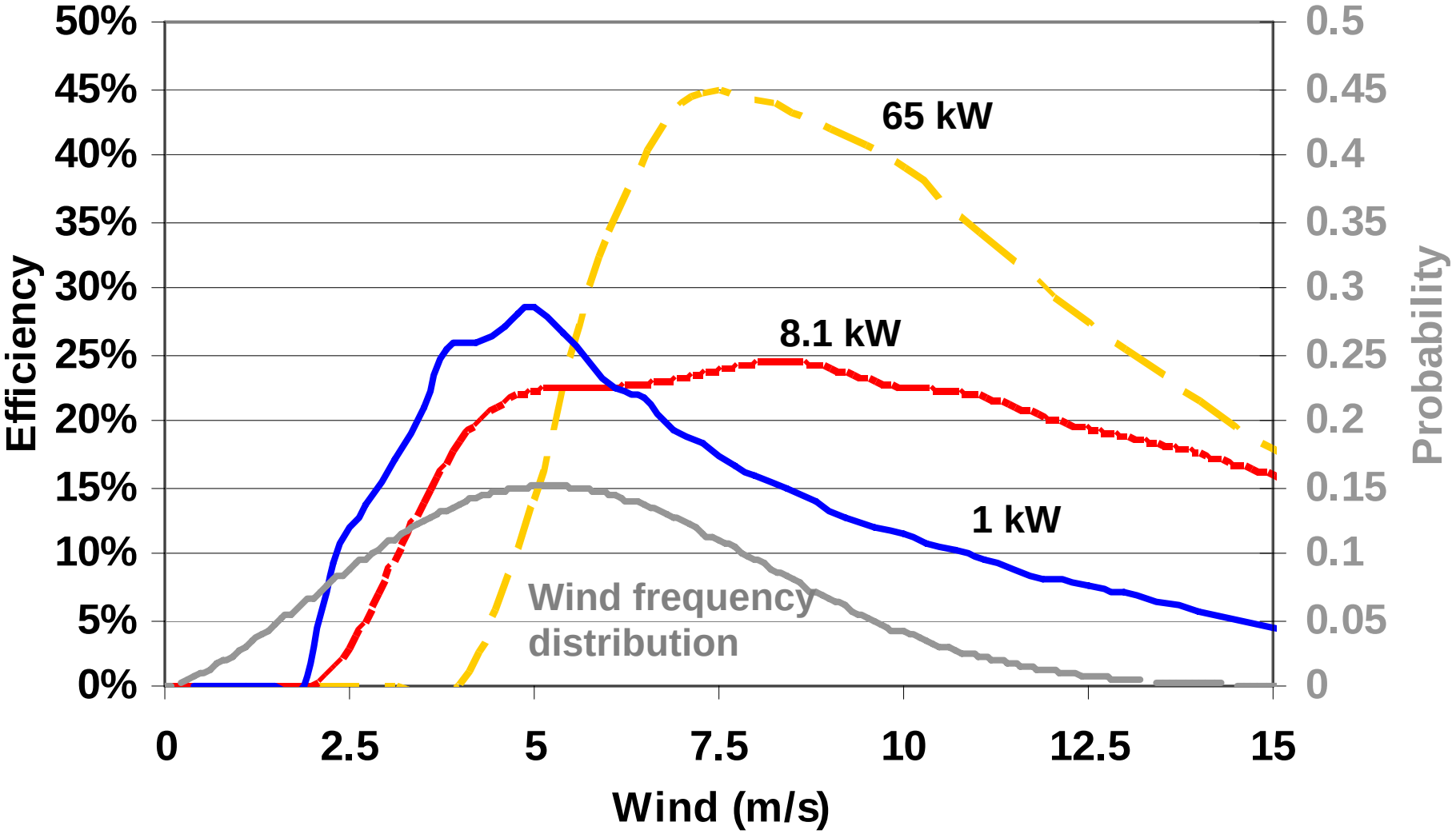
Potential wind turbines

Entegrity Wind
Diam: 15 m
Pk pwr: 65 kW

Bergey Excel-R
Diam: 6.7 m
Pk pwr: 8.1 kW

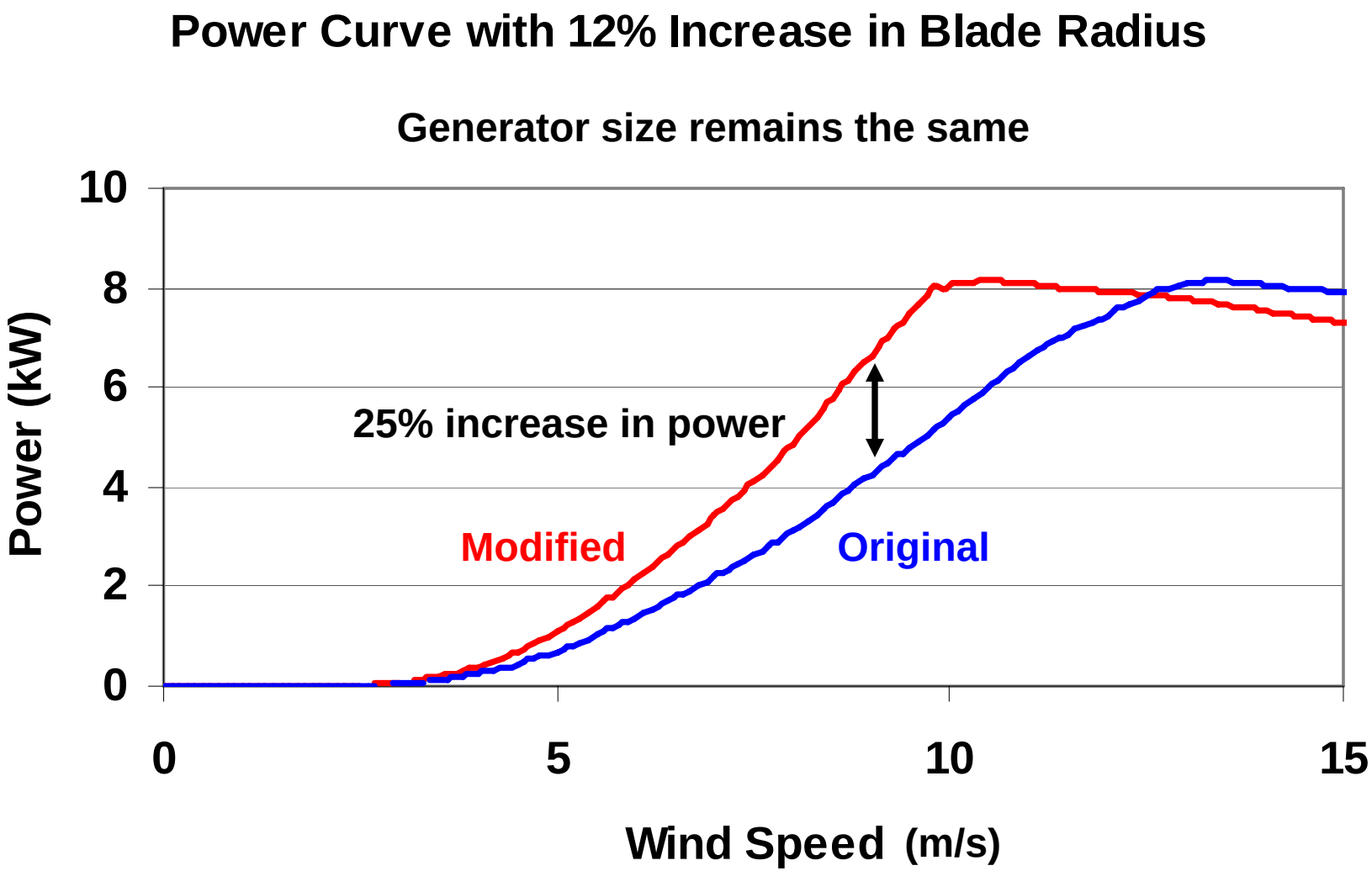
blueEnergy
Diam: 3.7 m
Pk pwr: 1 kW

Turbine Efficiencies

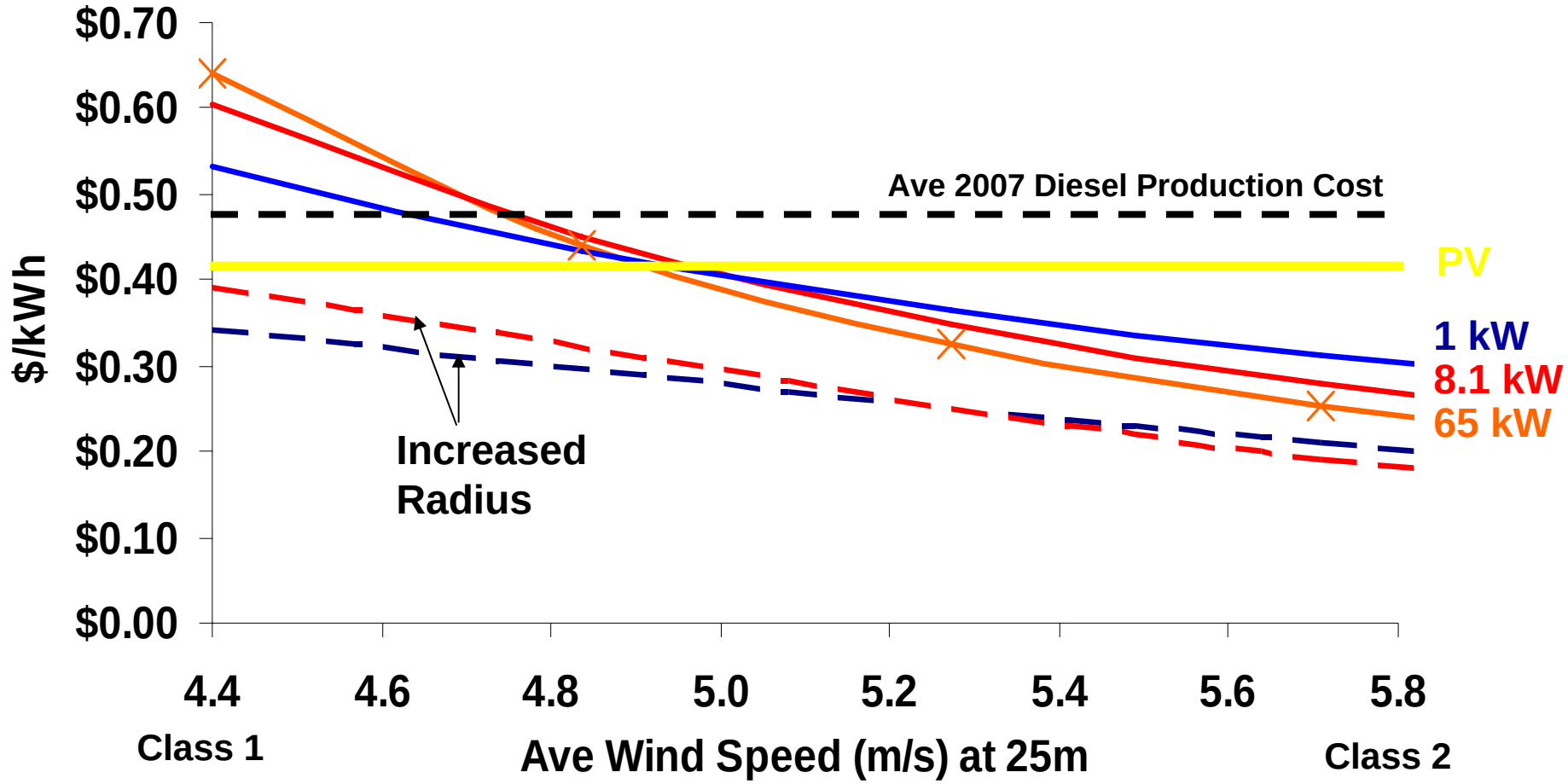


Measured wind distribution: Weibull k=2.4, c=4.3

Improving power at low wind speeds



Wind/solar lifetime cost of electricity



25 yr lifetime 6% discount rate

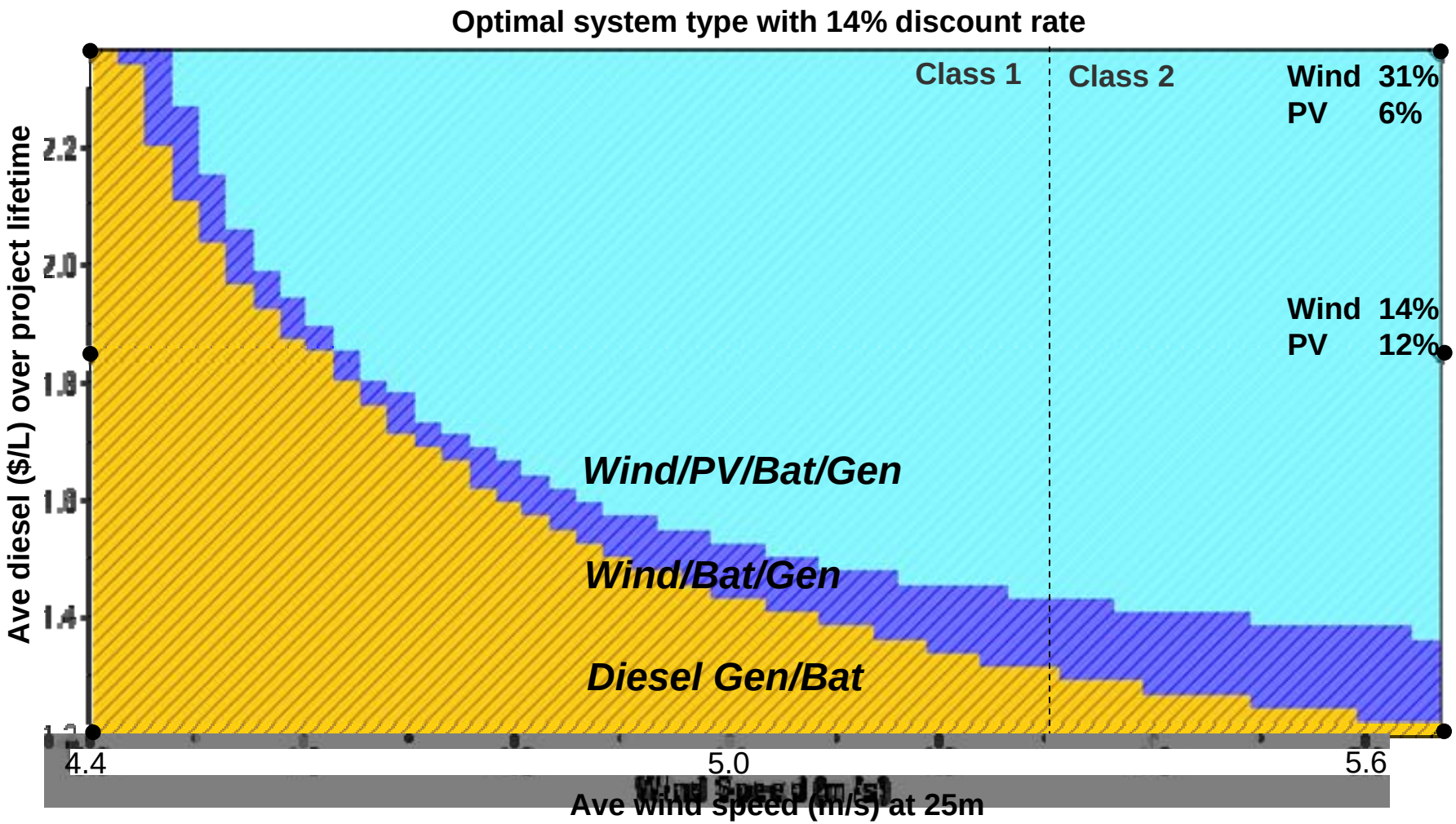
Potential Hybrid Generation in Pearl Lagoon

HOMER model parameters for Low-Med penetration

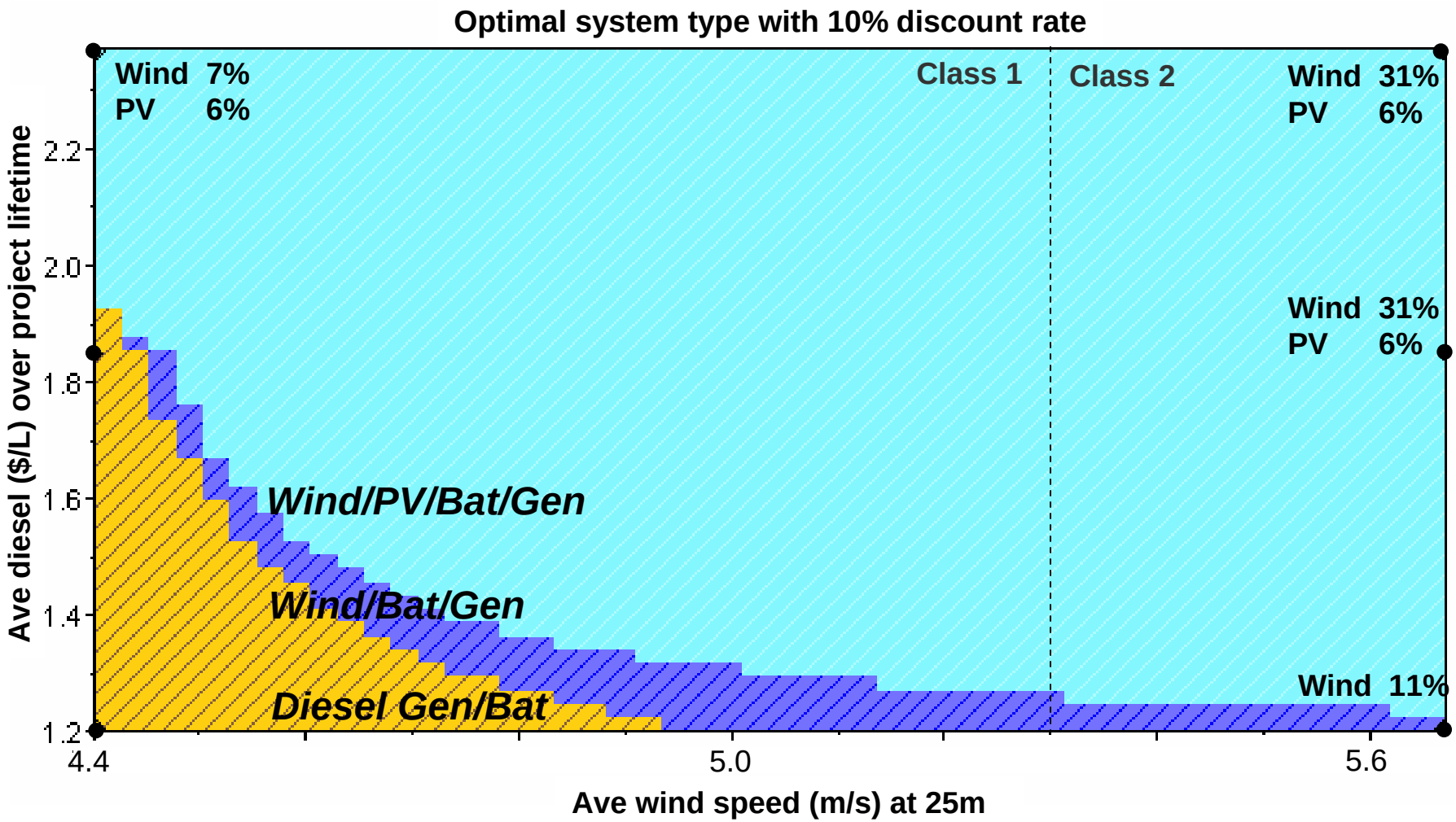
- Wind speeds: Class 1 – Class 2
- Discount rate: 6-14%
- Project lifetime: 15 yrs
- Diesel fuel cost: 1.2 – 2.74 $/L
- Battery Capacity: 328 kWh (2.5 hrs aut.)
- Max # of turbines*: 8x 8.1kW, 3x 65kW
- Max PV: 100kW
- 2 Generators**: 100 – 300 kW

***Used modified power curve for 8.1 kW** ****Gens are force on**

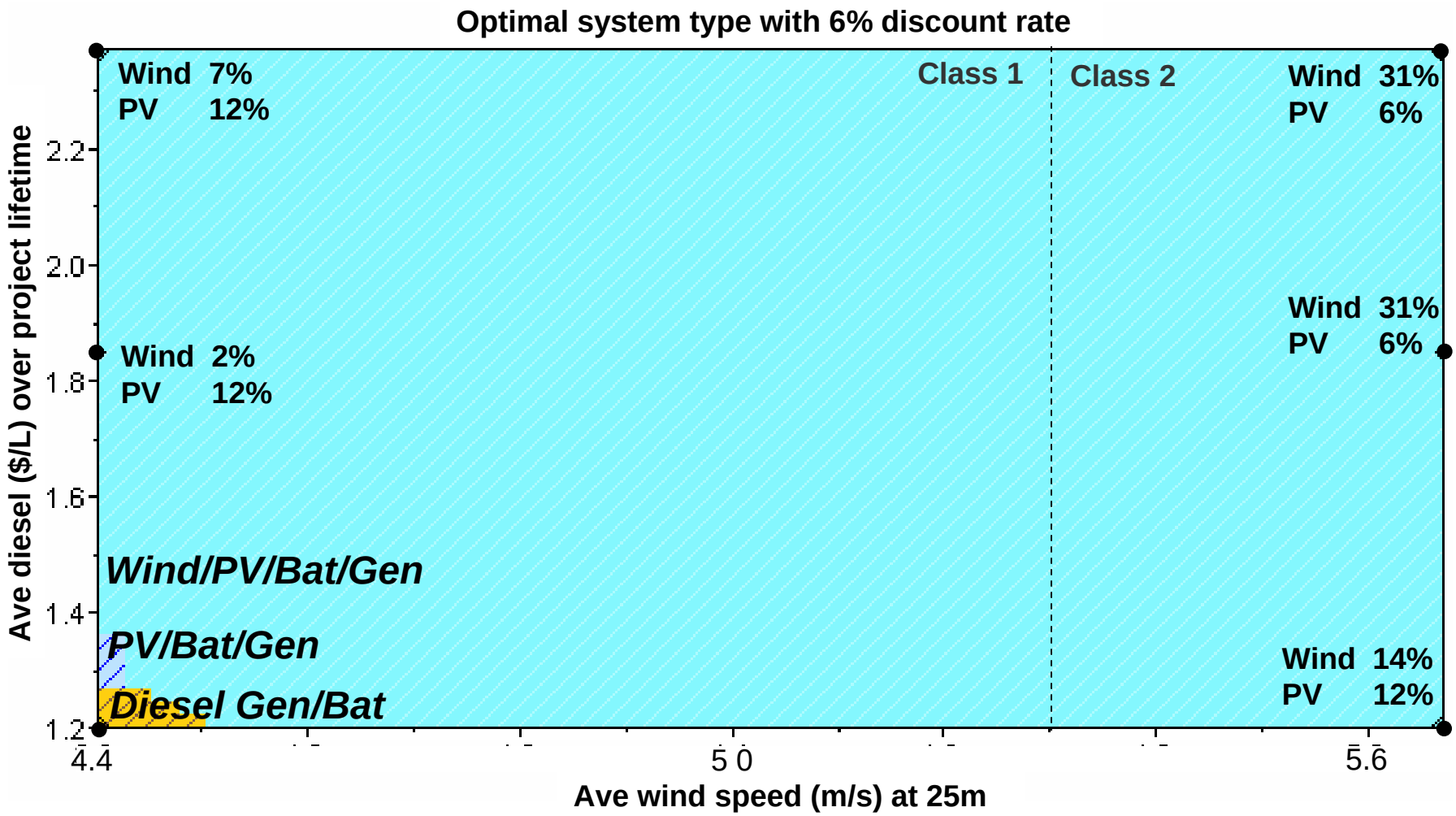
Discount Rate 14%



Discount Rate 10%



Discount Rate 6%



Conclusions

- Class 1 wind regimes – viable with **rising fuel costs**, **good financing**, and **marginal technology adaptation** for low/med penetration systems
- Class 2 regimes can be **economically competitive today**

Future Work/Research

- Optimization of 1kW wind turbine
- Develop a training diesel/wind/solar microgrid in Bluefields, Nicaragua
- Community biodiesel production
- Optimal financing and management
- Impact of development of markets on indigenous autonomy

Thanks!

www.blueEnergygroup.org

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Energy and Resources Group
Staff and Students

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