

# Wind Speed Measurement and Turbine Performance Projection Variance between NRG Max40 and Risoe P2546A Anemometers

Jack Kline, RAM Associates

Mark Young, Global Energy Concepts

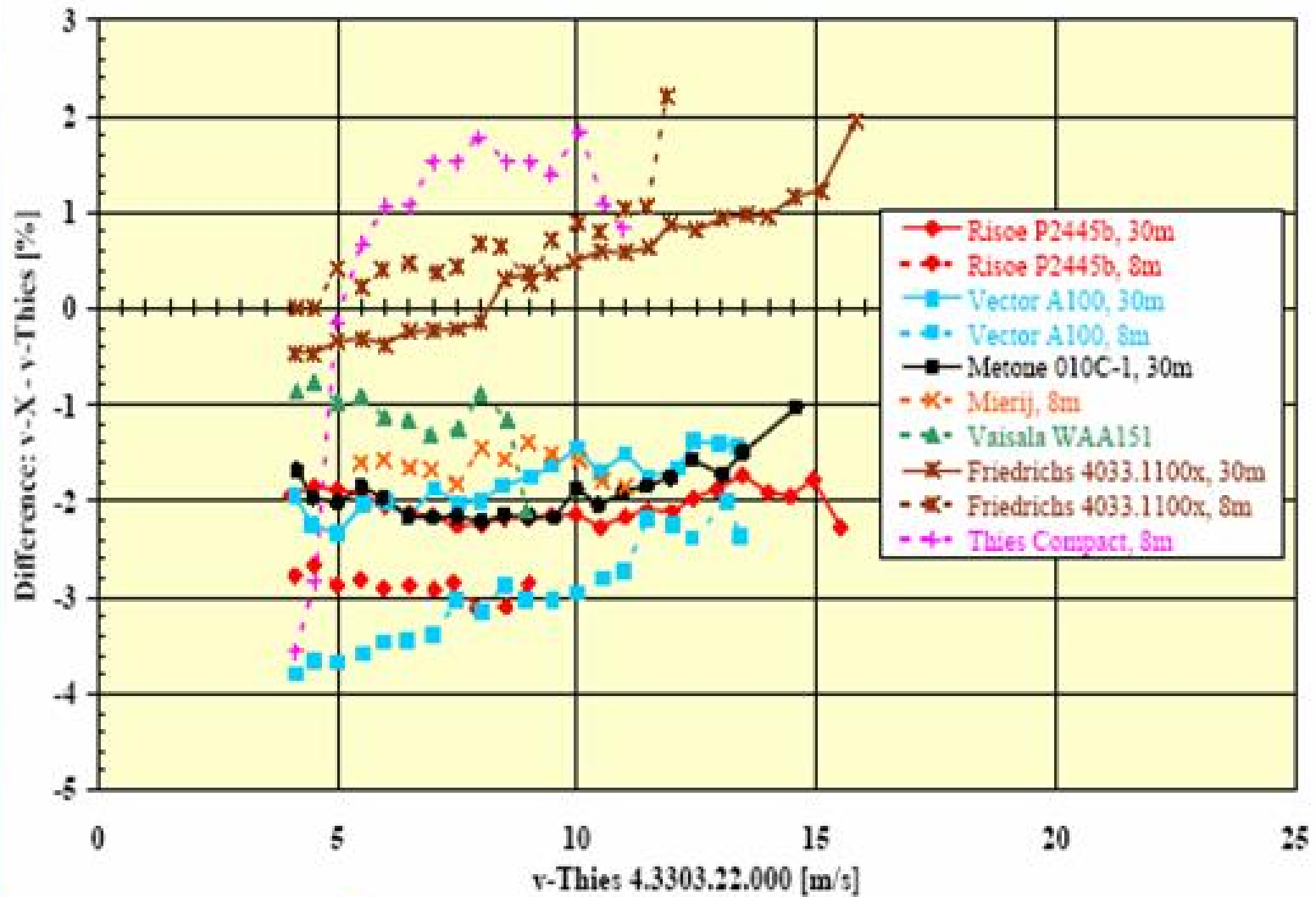
# Introduction

- Field tests show that different anemometers do not measure the wind equally.
- Variance in wind measurements for resource assessment and turbine power curves leads to errors in energy projections.
- Understanding differences of extreme importance.
- Preliminary results presented, expanded program in works.

# Topics of Discussion

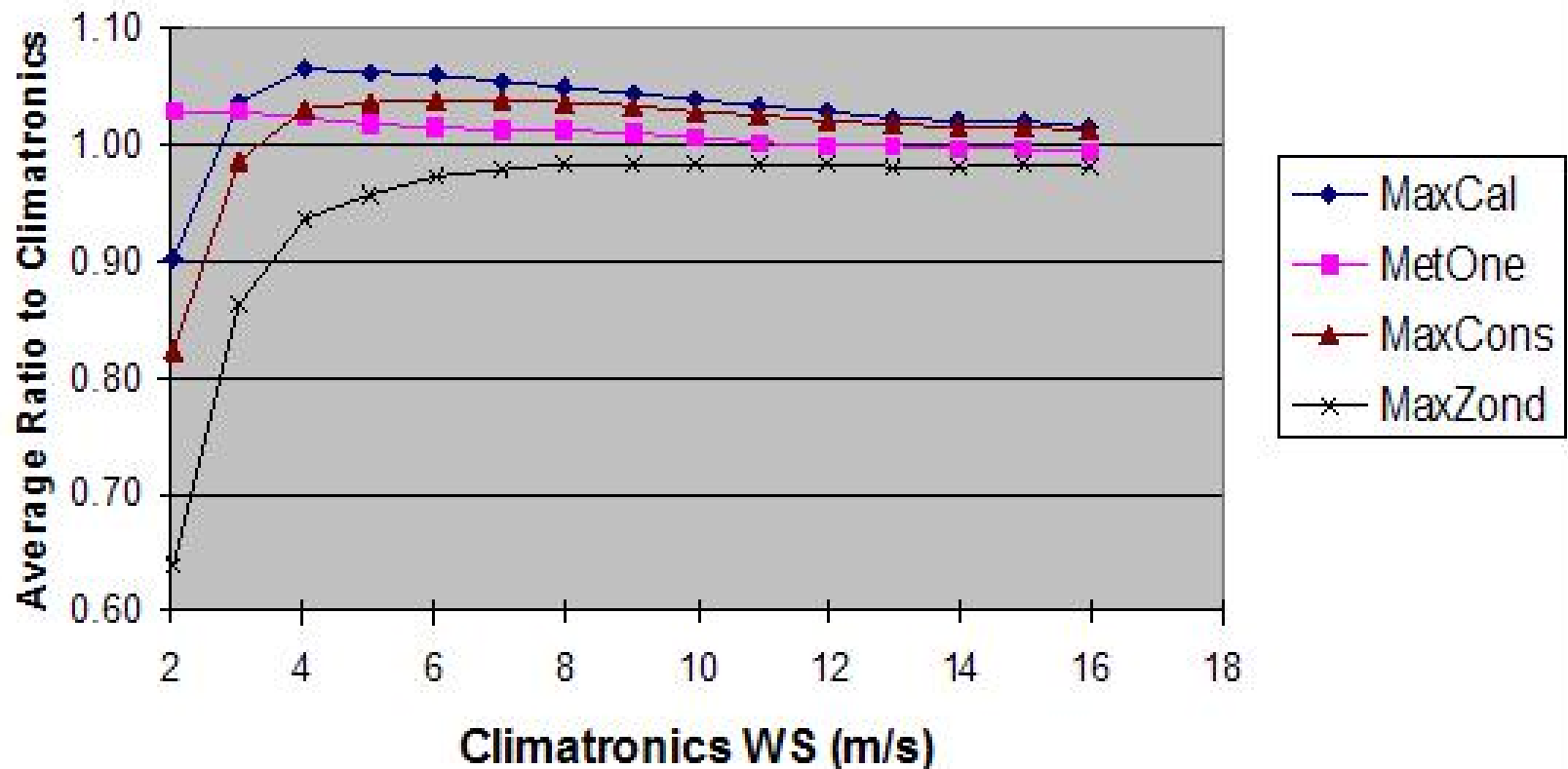
- Brief review of other results
- Measurements at 80m tower site
- Implications for WS and Energy at candidate sites
- Source of differences in WS
- Correction methods tested
- Second Max40 test results

# DEWI Test Results



# Previous Test with Max40

## Average Wind Speed Ratios to Climatronics Maximum Cup with Boot

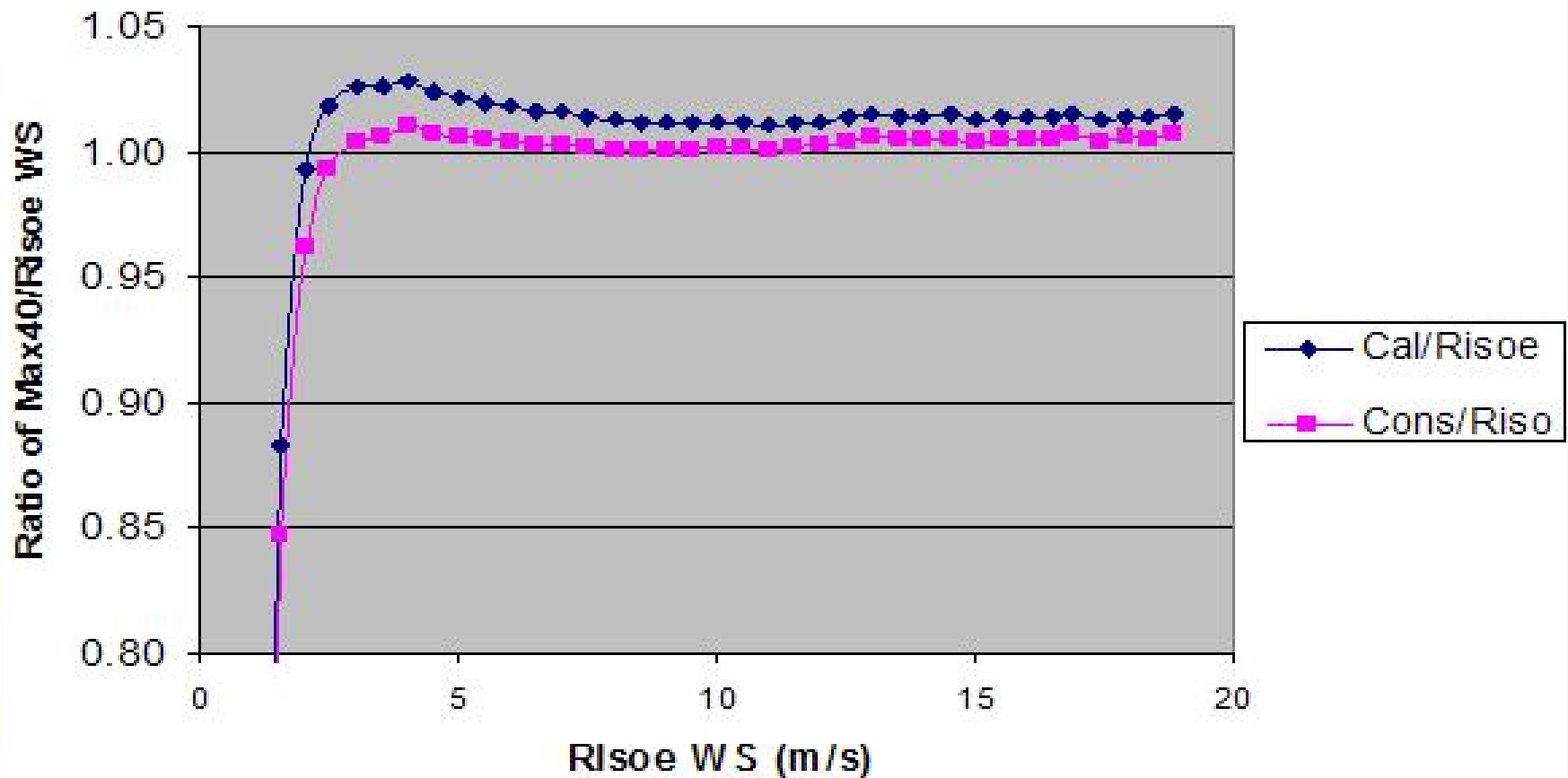


# Current Test on 80 m Tower



# Wind Speed Ratios: Max40 to Riso

## Ratio of Max40/Riso vs Riso WS



# Simulated WS & Energy at Three Prospective Sites

	<u>Low WS</u>	<u>Mid WS</u>	<u>High WS</u>
AVG WS Risoe (m/s)	6.74	7.78	8.90
<b>Calibrated Transfer Function</b>			
AVG WS Max40 (m/s)	6.83	7.89	9.02
WS diff. Max/Risoe	1.4%	1.3%	1.3%
Energy diff. Max/Risoe	3.5%	2.6%	1.7%
<b>Consensus Transfer Function</b>			
AVG WS Max40 (m/s)	6.75	7.79	8.92
WS diff. Max/Risoe	0.2%	0.2%	0.2%
Energy diff. Max/Risoe	0.5%	0.3%	0.2%

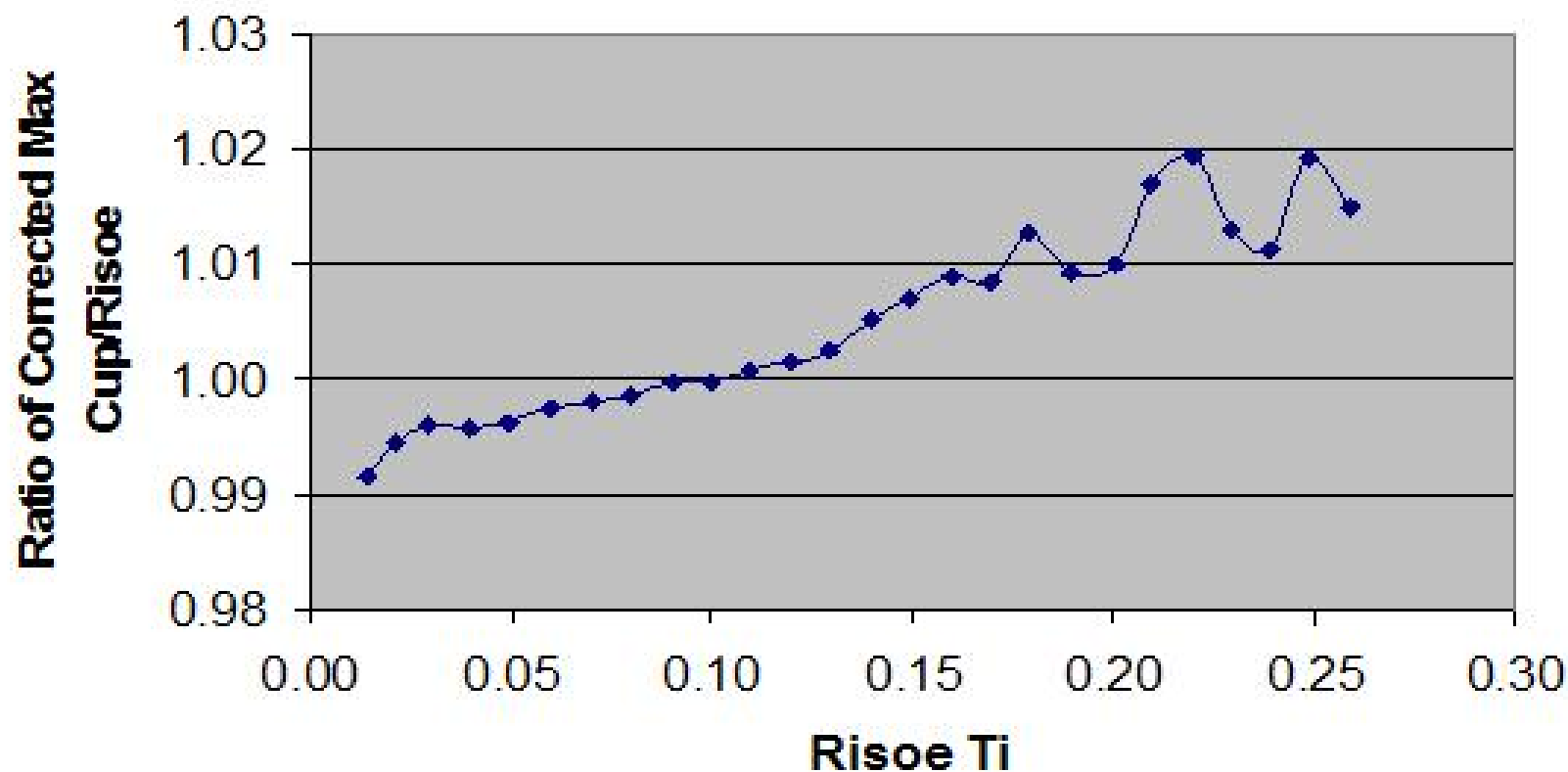


# Wind Speed Correction Process

- Risoe WS used as reference
- Binned average wind speeds:  
0.5 m/s bin width
- Calculate WS ratios (Max40/Risoe)
- Identify WS bin based on Risoe WS
- 10 min avg. Max40 WS divided by bin ratio

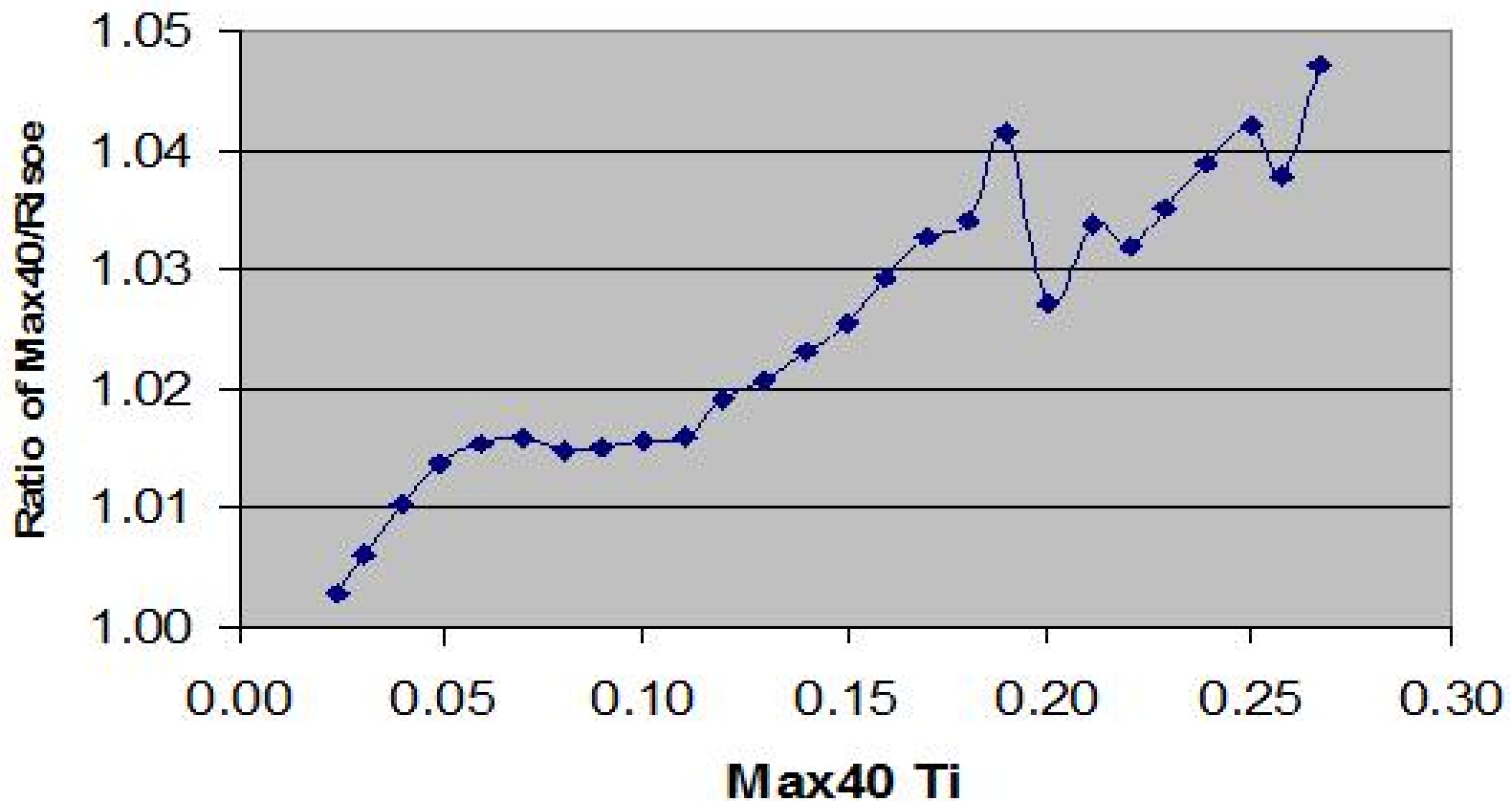
# Dependence on Horizontal Turbulence

Ratio of Corrected Max40 (Riso WS)/Riso vs  
Riso Ti



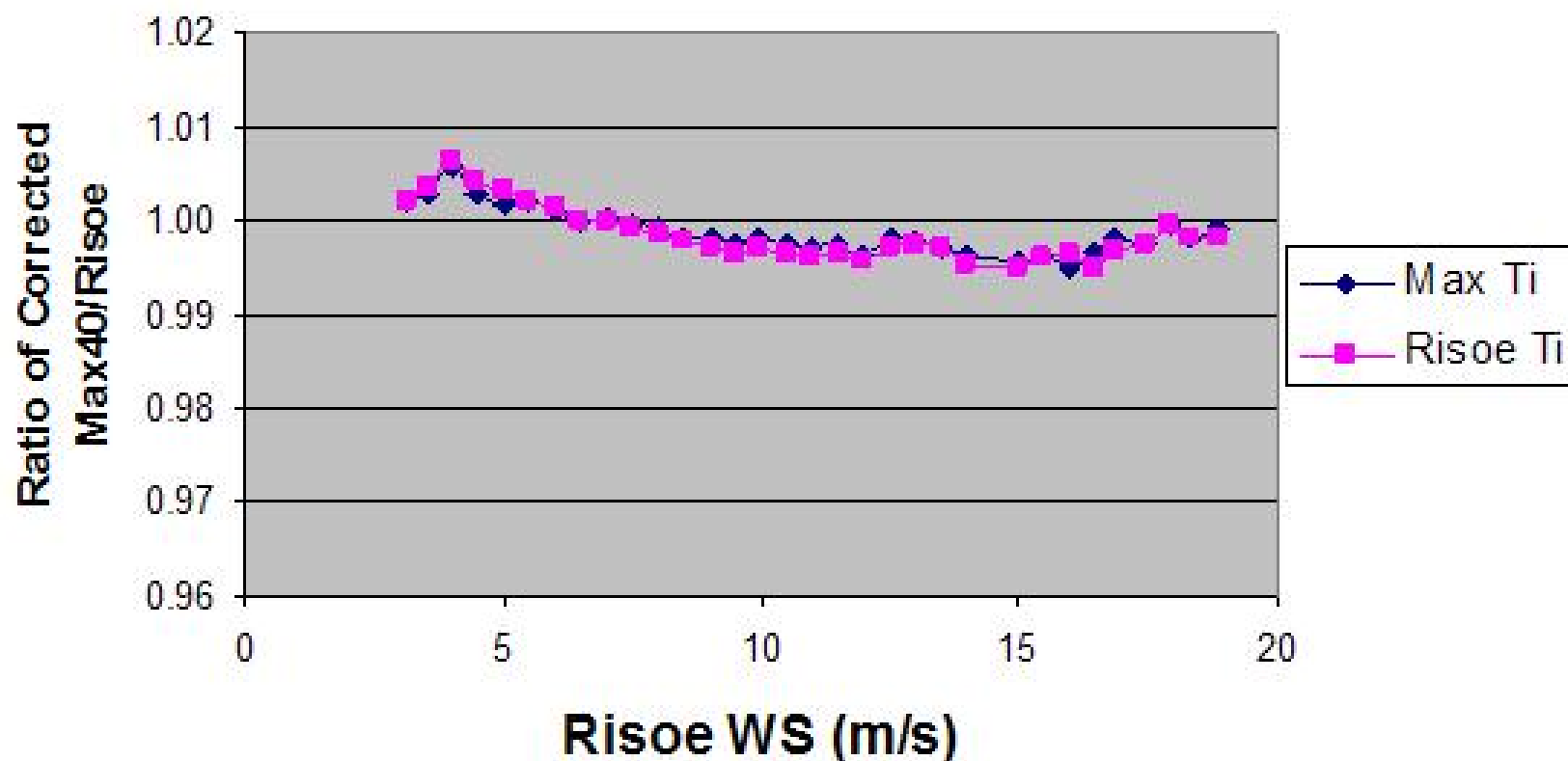
# WS Ratios as Function of Max40 Ti

Ratio of Max40/Risoe vs Max40 Ti



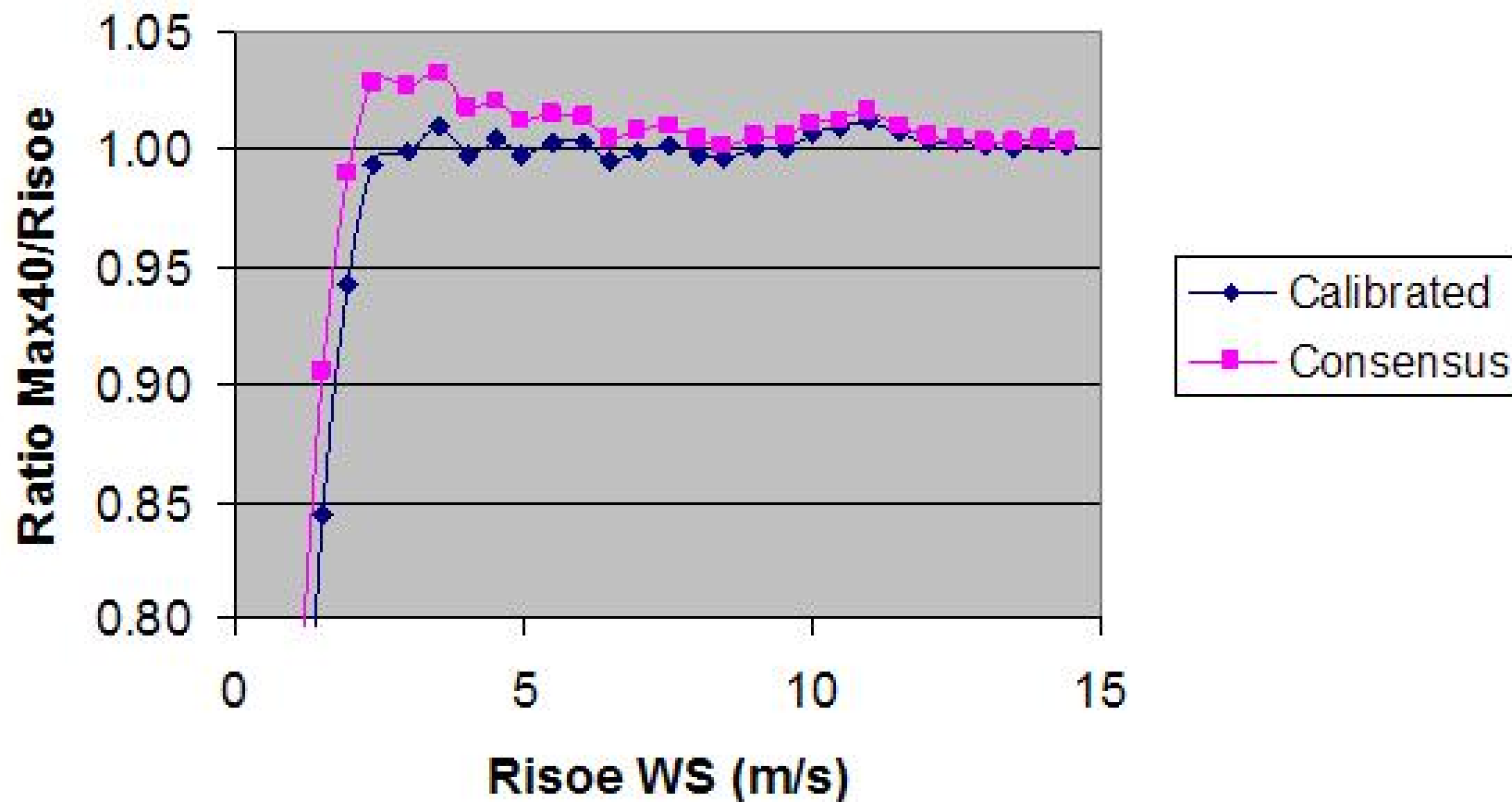
# Correcting Max40 WS based on Ti

Ratio of Corrected Max40 (Max40 Ti)/  
Riso vs Riso WS



# Comparison of Second Max40 to Riso

## Ratio of Max40/Riso WS vs Riso WS



# Simulated WS & Energy at Three Prospective Sites: 2<sup>nd</sup> Max40

	<u>Low WS</u>	<u>Mid WS</u>	<u>High WS</u>
AVG WS Risoe (m/s)	6.74	7.78	8.90
<b>Calibrated Transfer Function</b>			
AVG WS Max40#2 (m/s)	6.74	7.79	8.92
WS diff. Max#2/Risoe	0.0%	0.1%	0.2%
Energy diff. Max#2/Risoe	0.1%	0.2%	0.3%
<b>Consensus Transfer Function</b>			
AVG WS Max40#2 (m/s)	6.80	7.85	8.97
WS diff. Max#2/Risoe	0.9%	0.8%	0.7%
Energy diff. Max#2/Risoe	2.0%	1.5%	1.1%

# Conclusions

- Two Max40's Compared to Risoe
- Max40 Positive Bias – Cons or Cal
- Up to 1.4% Overestimate in WS
- Up to 3.5% Overestimate in MWh
- Correcting by  $T_i$  Rather Effective
- Probable Dependency on Vertical component
- Plans to Install Additional Similar Sites with VV