BOREAS VI

Electrically Heated Wind Sensors for Cold Climates

Lawrence Jacobs

and

Barton N. Merle-Smith

NRG Systems

Why Electrically Heated?

- Propane Heated Sensor – 1991 to 1994
  - Excessive heat impacted bearing performance
  - Physical size was excessive
  - Combustion by-products created contamination issues
  - Short life cycle

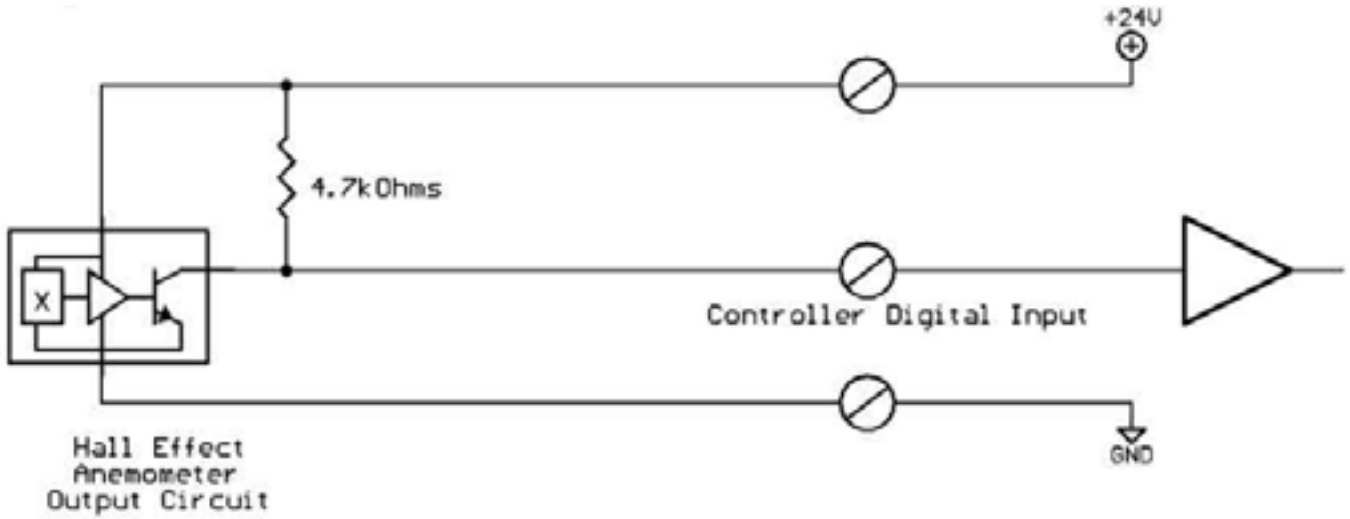
- IceFreeI Electrically Heated Sensor – 1993 to 1997
  - Self-regulating, constant temperature
  - Much smaller than the propane heated
  - Low power consumption
  - Ideal for turbine control
  - Rugged design ensures long life cycle
  - Can also be used for wind assessment
  - Requires 24 volts (AC or DC)

IceFreeII And Beyond!

- IceFreeII Electrically Heated Sensor – 1997 to Present
  - More compact design than the IceFreeI
  - Off-axis wind angle corrected
  - Same self-regulating, constant temperature
  - Hall-Effect output ideal for turbine control
  - AC sine wave output for turbine control and wind assessment
  - Continuous Improvement program in place based on customer feedback and NRG R&D

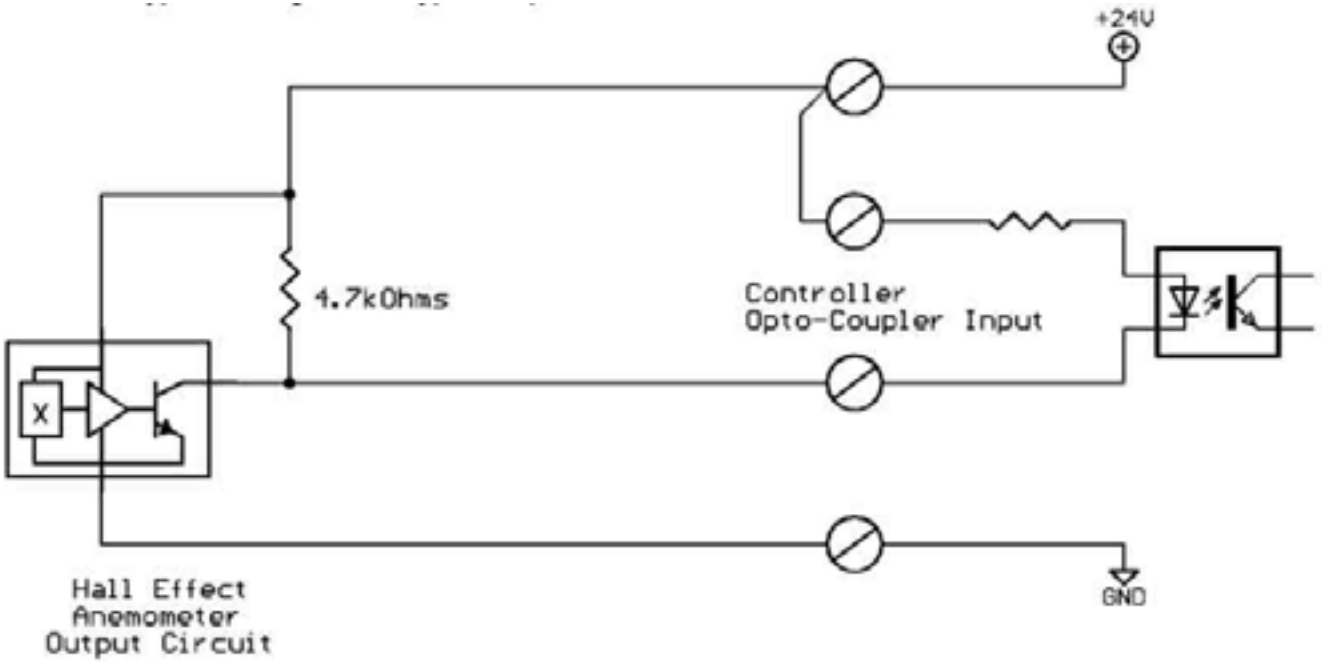
IceFreeII Sensor Applications

- Turbine Control
  - Hall-effect output for controller with digital input:
  - Typical circuit:



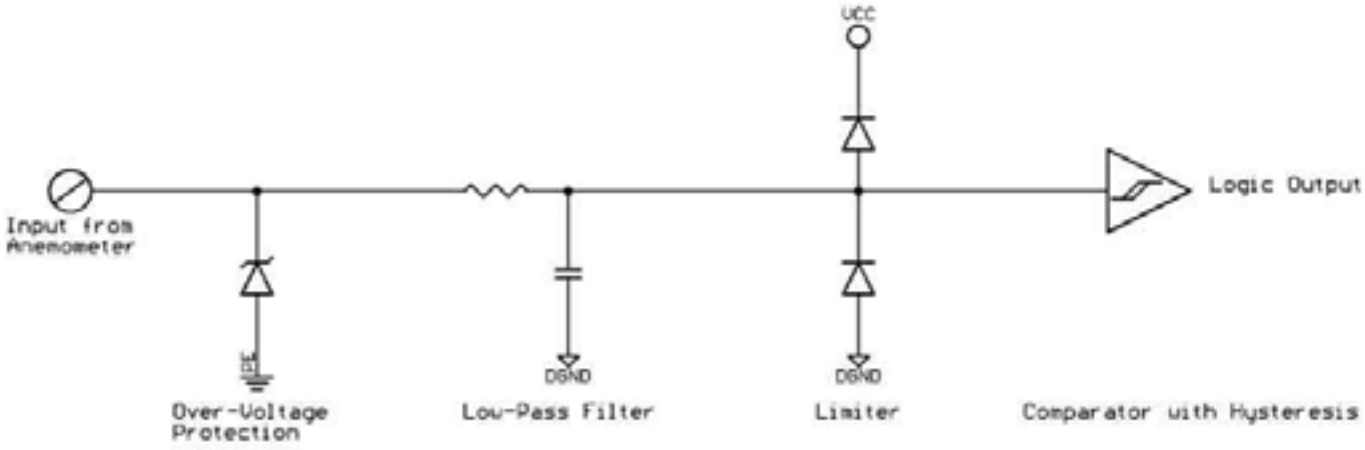
IceFreeII Sensor Applications

- Turbine Control
  - Hall-effect output for a controller with opto-isolated digital input
  - Typical circuit for this type of input:



IceFreeII Sensor Applications

- Turbine Control
  - Variable amplitude sine wave output for interfacing to controllers or data loggers
  - Typical input circuit:



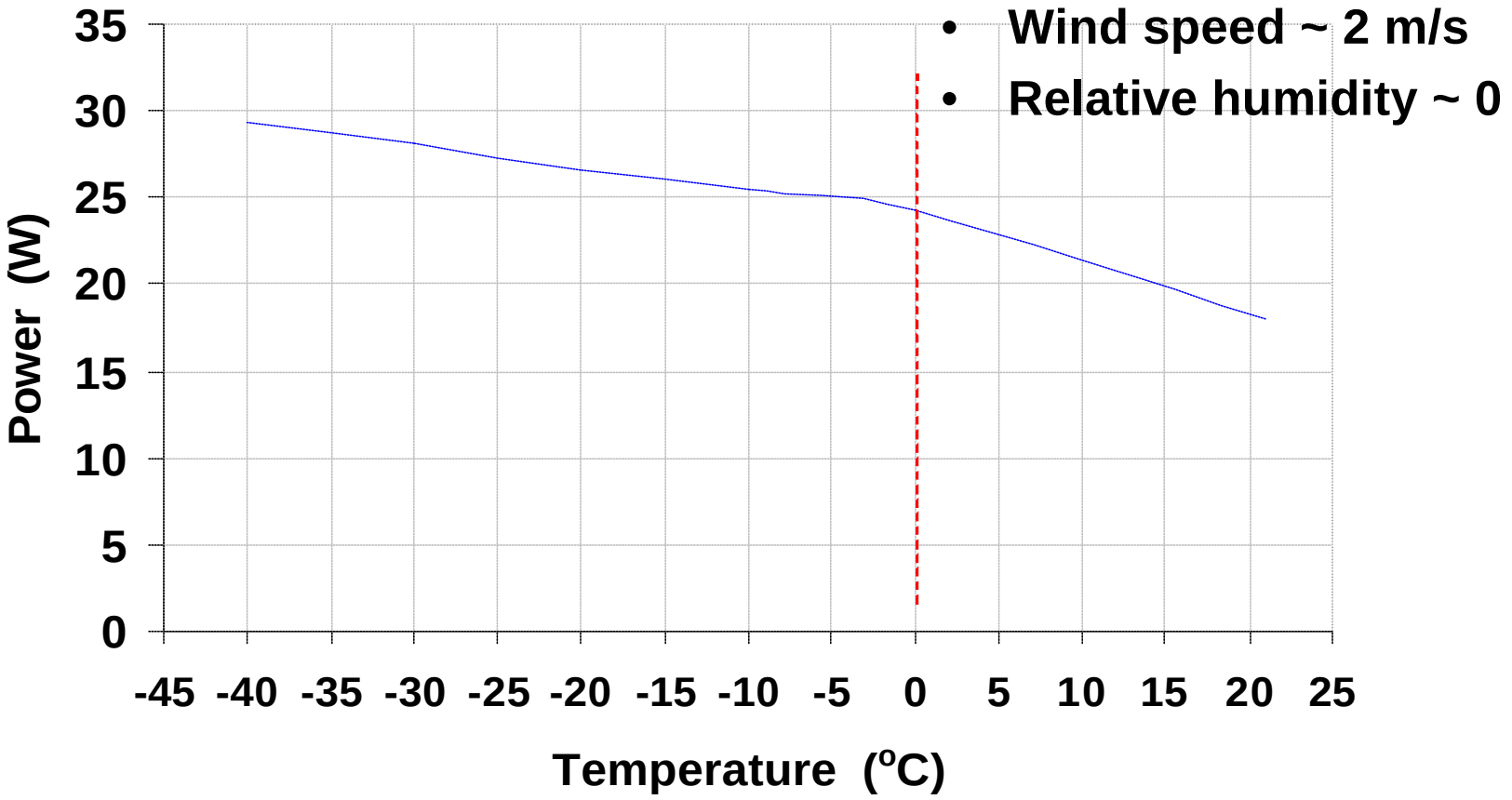
IceFreeII Anemometer

- Specifications:
  - Output signal can be either a square wave (Hall-Effect) or sine wave (generator coil)
  - Output frequency is linear with wind speed
  - Power requirements for Hall-Effect sensor: 5-24VDC (9mA max)
  - No power requirements for coil type sensor
  - Heater power requirements: 24VDC or AC
  - Temperature Range: -40 to 80 ºC
  - Humidity Range: 0 to 100%

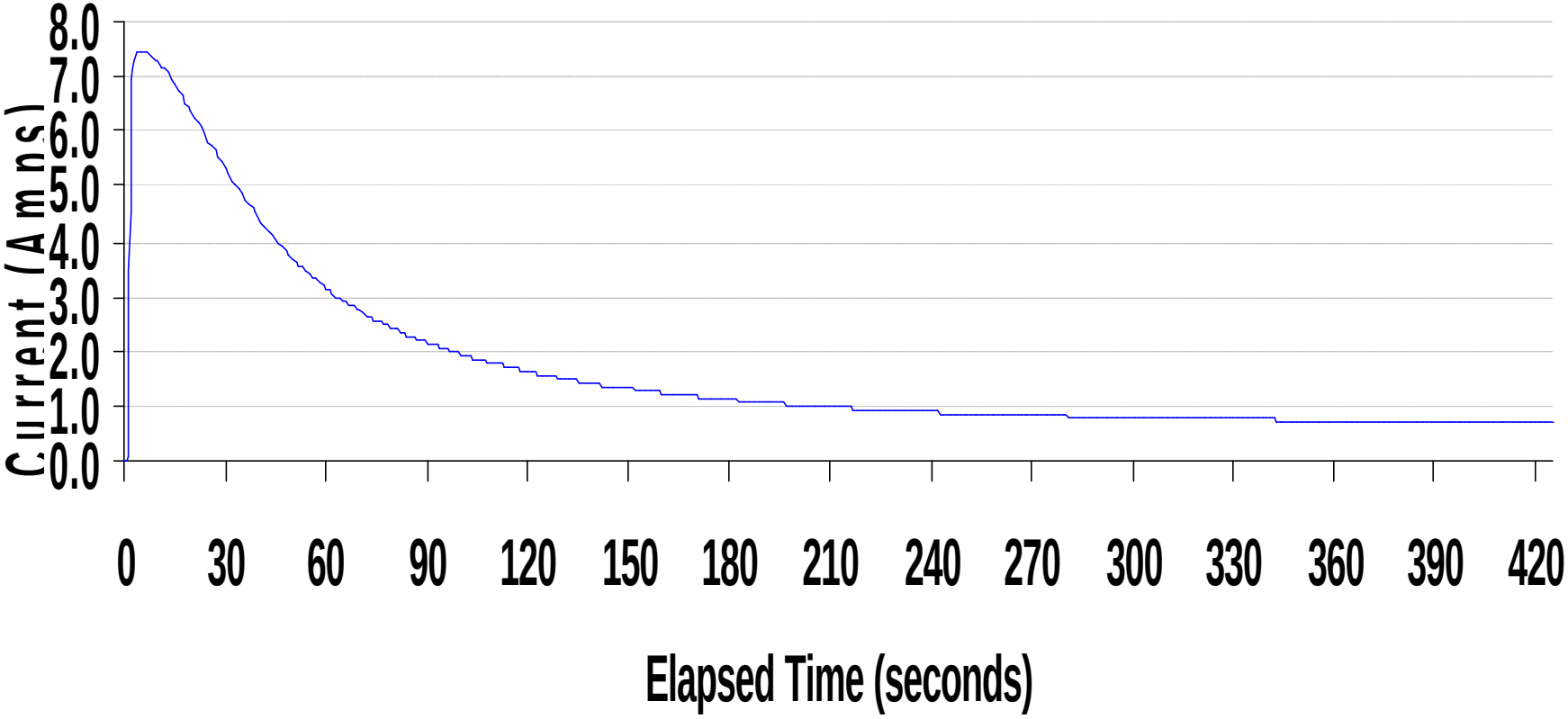
IceFreeII Vane

- Specifications:
  - Output signal can be either ratiometric DC voltage (wind vane) or four, open-collector signals (yaw vane)
  - Excitation voltage for wind vane: 1-10 VDC (typical 2.5V)
  - Sensor power for yaw vane: 8-24 VDC (30mA typical)
  - 360 degrees continuous rotation
  - Wind vane deadband approximately 8 degrees
  - Yaw vane error signal: 5 degrees, +/- 1 degree
  - Heater power requirements: 24VDC or AC
  - Temperature Range: -40 to 80 ºC
  - Humidity Range: 0 to 100%

Power versus Temperature for NRG IceFreeII Electrically Heated Sensors



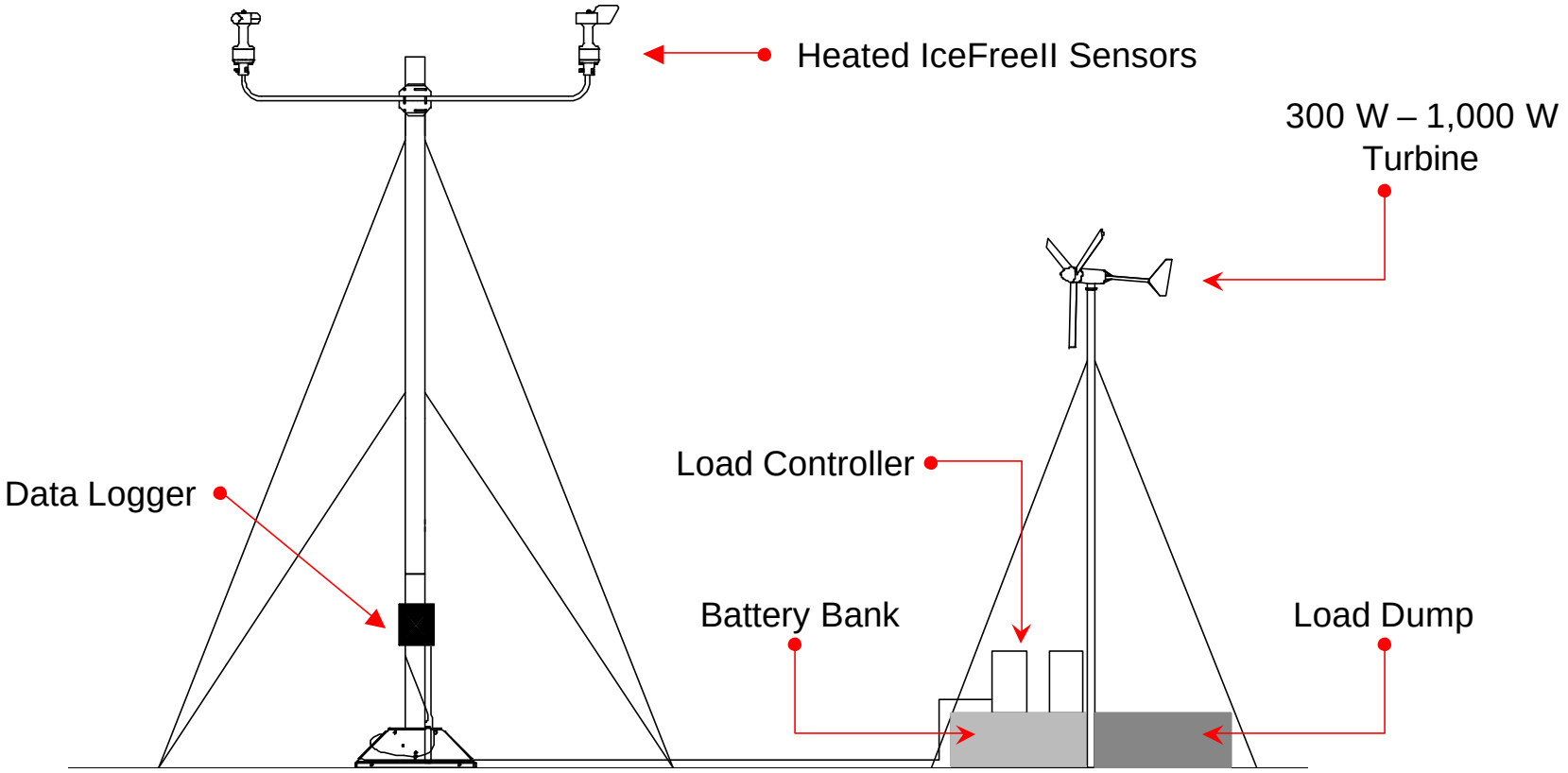
Heater Inrush Current of IceFreeII



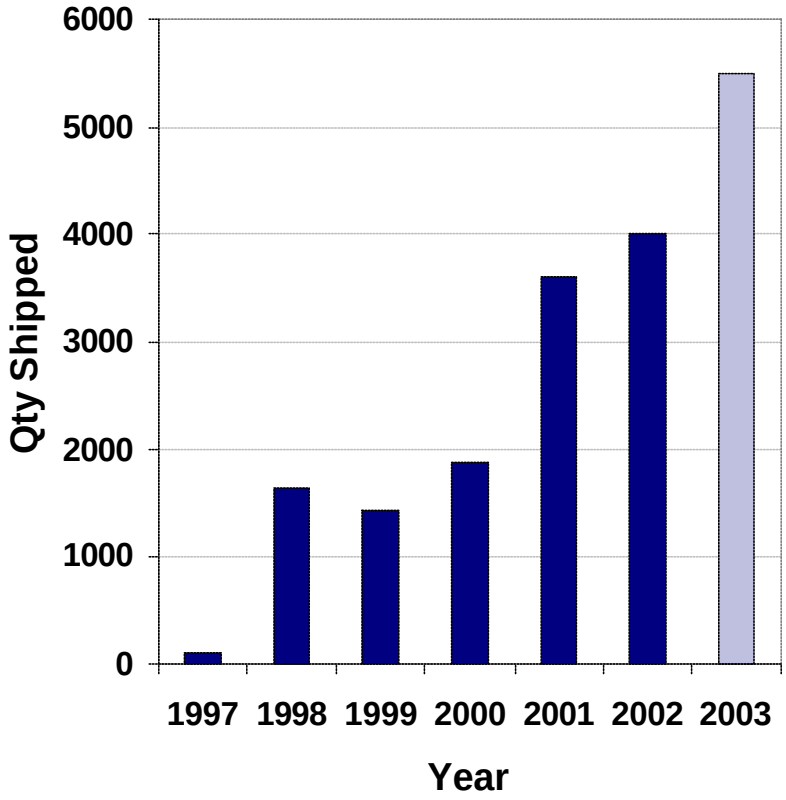
IceFreeII Sensors for Wind Assessment

- NRG IceFree II sensors can, and are, used for wind assessment
- Mount easily to met towers via mounting booms
- Easily interface to data loggers
- Heated sensors can provide assurance of data integrity in cold climates
- However, power requirements can be a detractor for remote sites
- Autonomous systems have been utilized to overcome the absence of grid power at remote sites

Typical Off-Grid Power Solution for NRG IceFreeII Sensors



Installed Base of NRG IceFreeII Sensors



- Over 13,000 sensors currently installed
- Used by majority of MW class turbine manufacturers

NRG IceFreeII Sensors

Anemometer

Wind Vane


THANK YOU
NRG
systems