Ultra-low-cost Logging Anemometer for Wind Power Generation Feasibility Surveys

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Te Whare Wānanga o Waikato

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- Private Wind Generation
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- Interesting problems

Engineering details left to the printed paper

Popular Wind Power

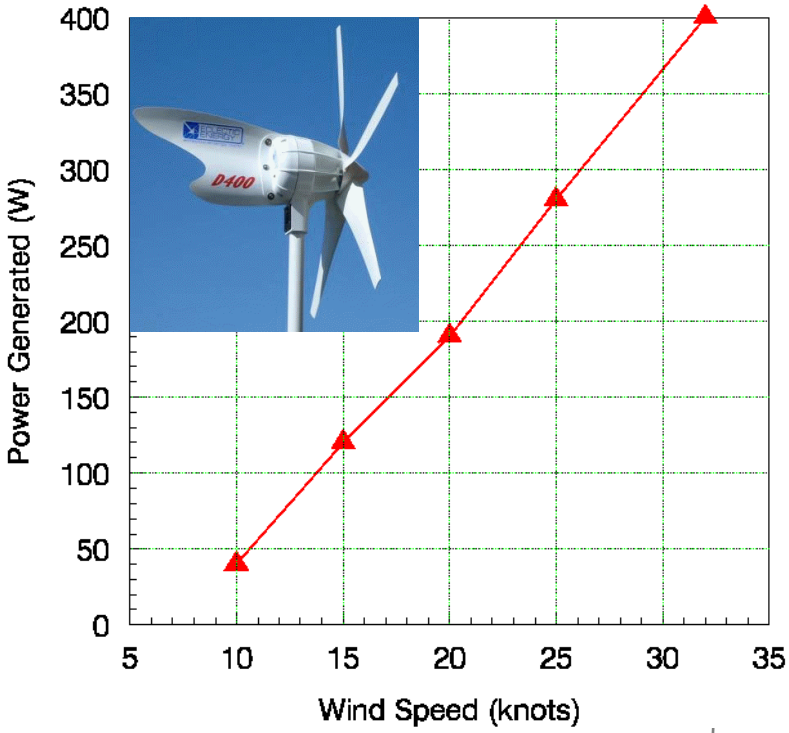
- Aotearoa could have been called Te Hauwhenua "the land winds" or more practically "the land of howling bloody gales"
- Wind is free, but wind power is not
- Wind costs
  - Capital depreciation
  - Installation
  - Maintenance
  - Becalm risk

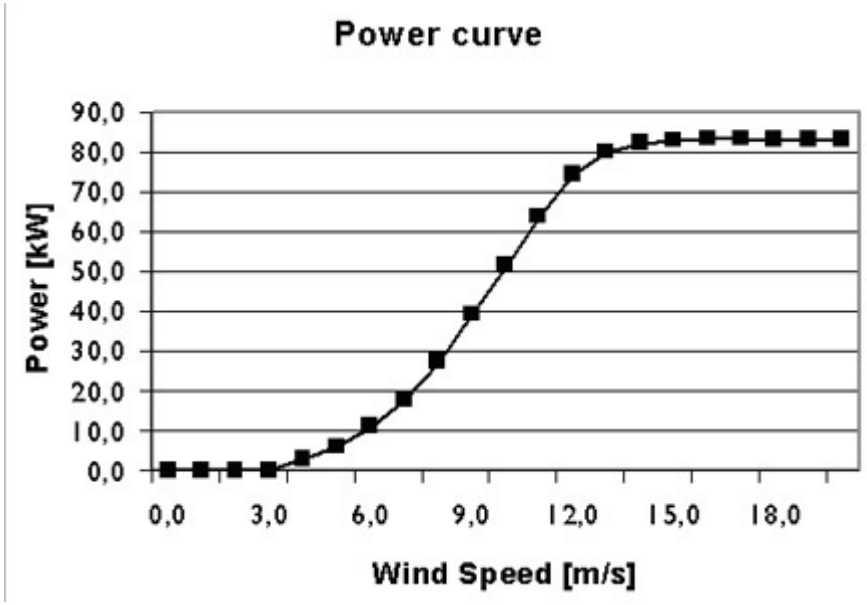
Popular Wind Power

- "Single-user" wind turbines:
  - Serious 5-80 kW (grid-connected buildings)
  - Commercial 300-3000 Watt (remote equipment, boats)
  - Domestic < 500 Watt (tinkering, standby power)
- Cost 2 to 4 $/W
- Grid type:
  - >150kW
  - ~US$1/W

Popular Wind Power

- Claimed payback: 5 to 10 years
- Wind required…



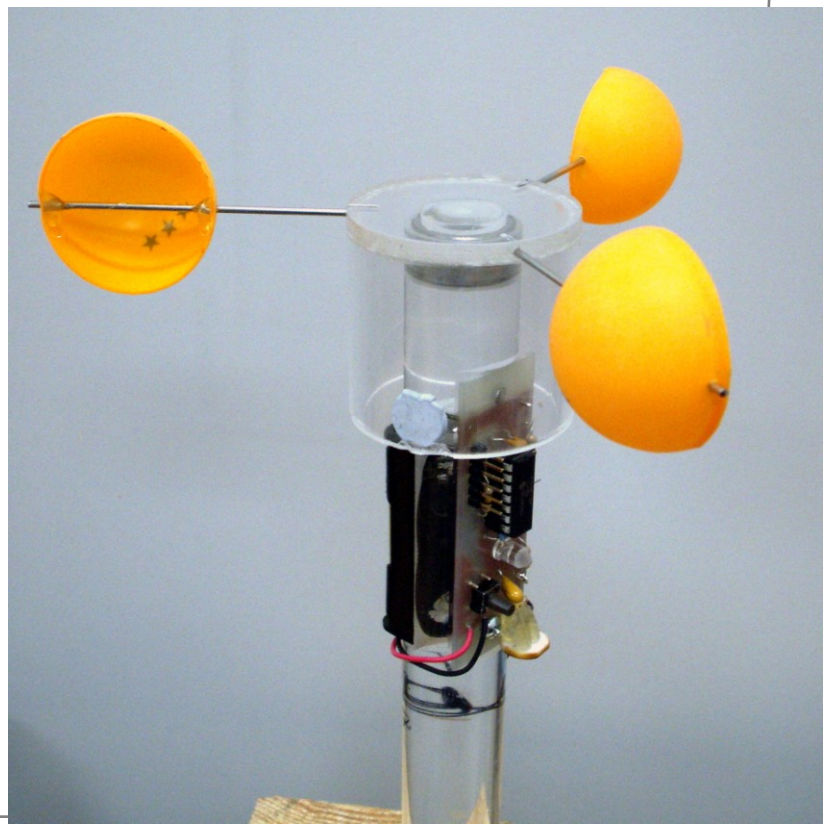


Wind Requirements

- Suspicion: Most units do not pay
  - Site not windy enough
  - Not situated high enough
  - Inappropriate power/wind curve
  - Energy delivery too “peaky”
- Wind power only makes sense in “no brainer” situations
  - Boat? Not if you start the diesel weekly or turbine ungalvanised

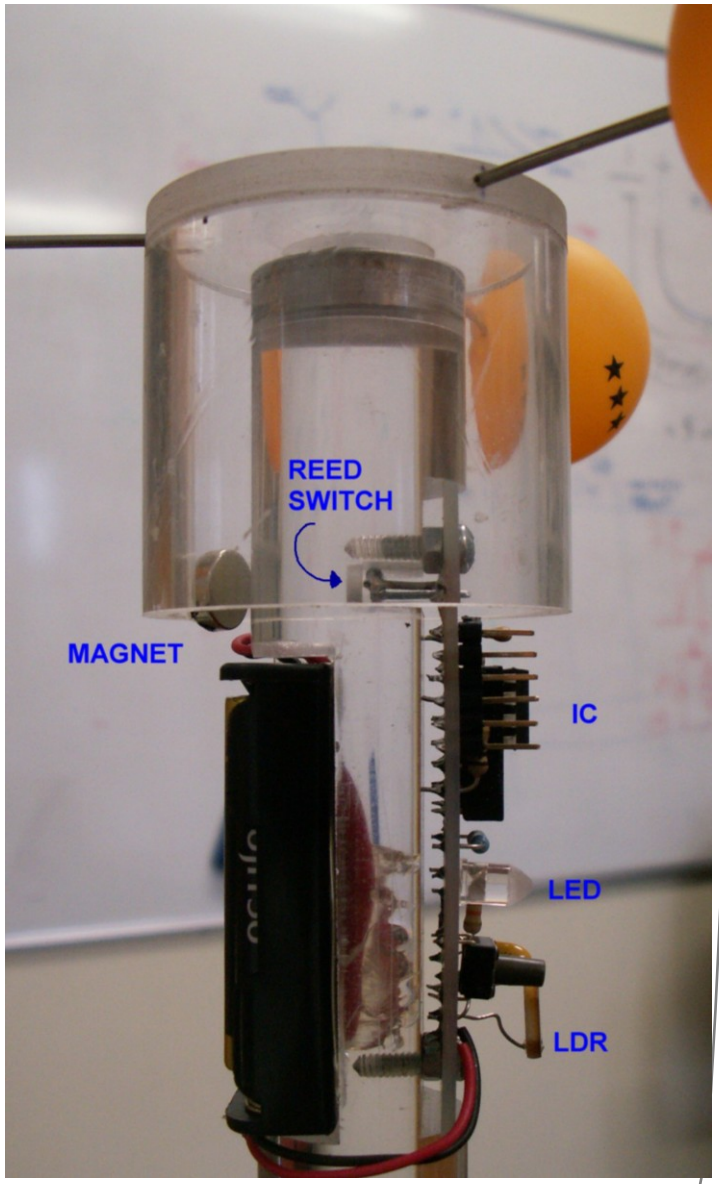
Solution

- Log wind and predict output!
- Weather stations cost as much as small generators
- Might want to try several spots
- $\Rightarrow$cheap logging Anemometer



Solution

- $2 micro, $10 electronics
- Run 1 year on 2xAA cells
- Use reed switch *or* HDD motor
- Support PIC 12F683 & 16F684
- Diurnally synchronised
- Store mean, peak, secs>critical
  - Daily for a week
  - Weekly for a year
- Store mean speed^3

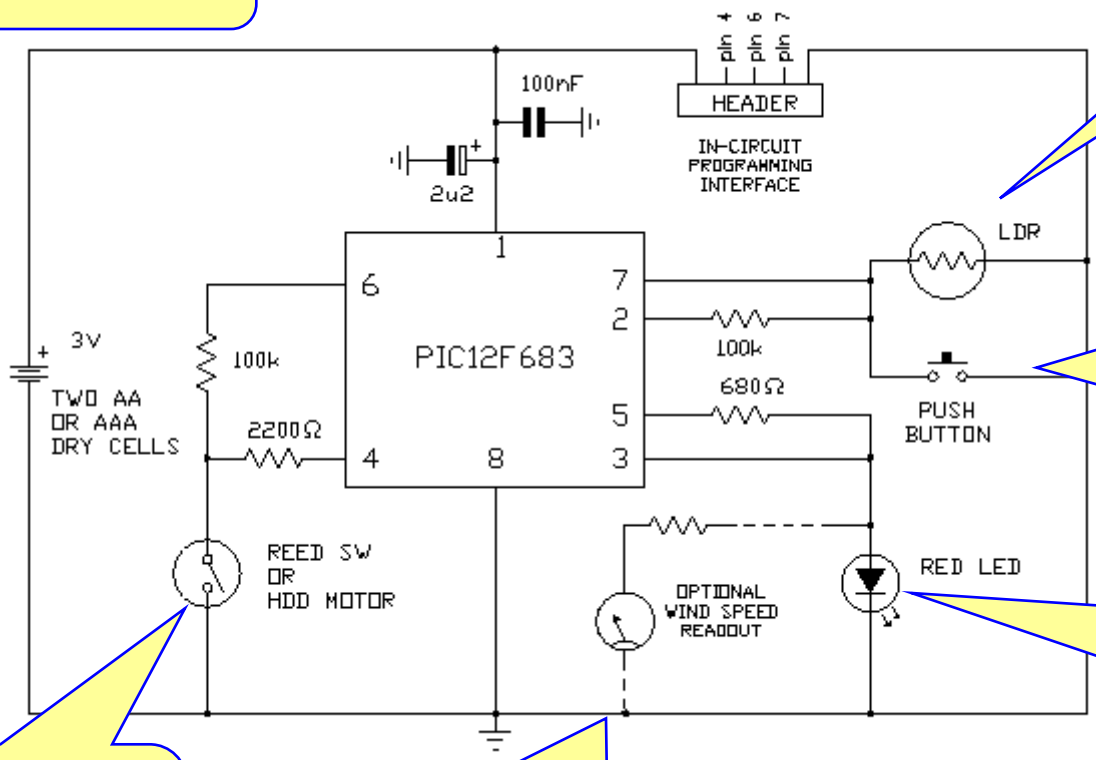


Circuit

Firmware upgrade & data readout

Draws 300—700uA
(adjustable clock speed)

LDR for diurnal synch



Button for meter control & cup speed calibration

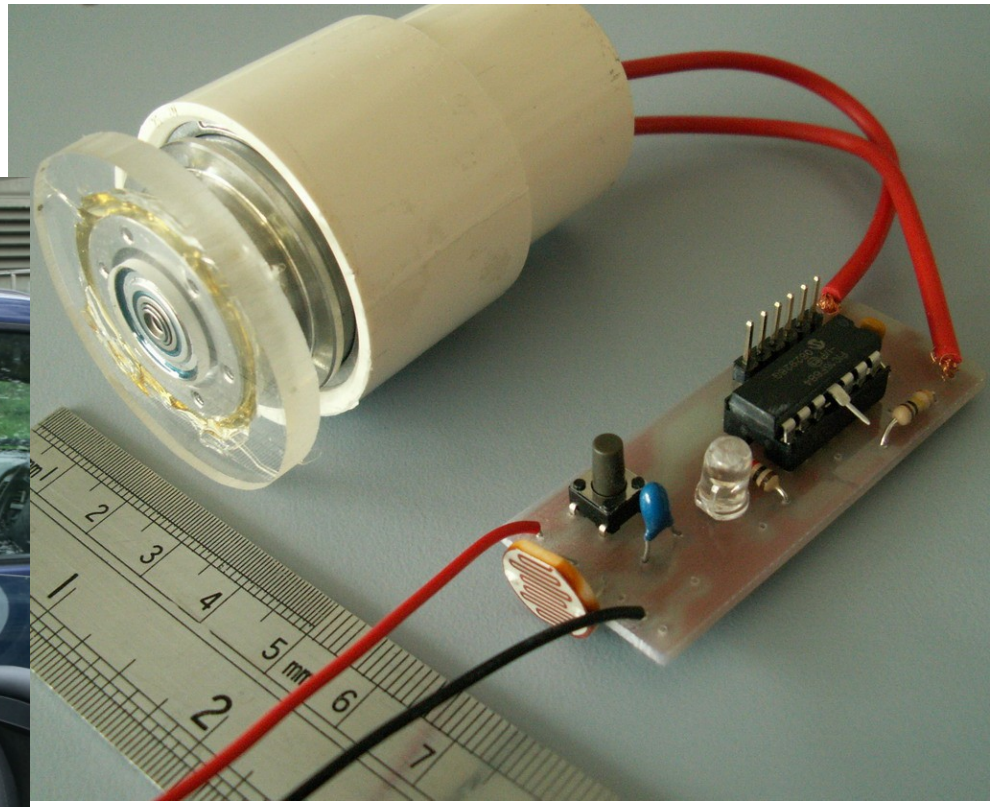
Rotation sensing via reed switch or HDD PM motor

Off-card meter for readout & calibration

LED for heartbeat, Vref & signalling

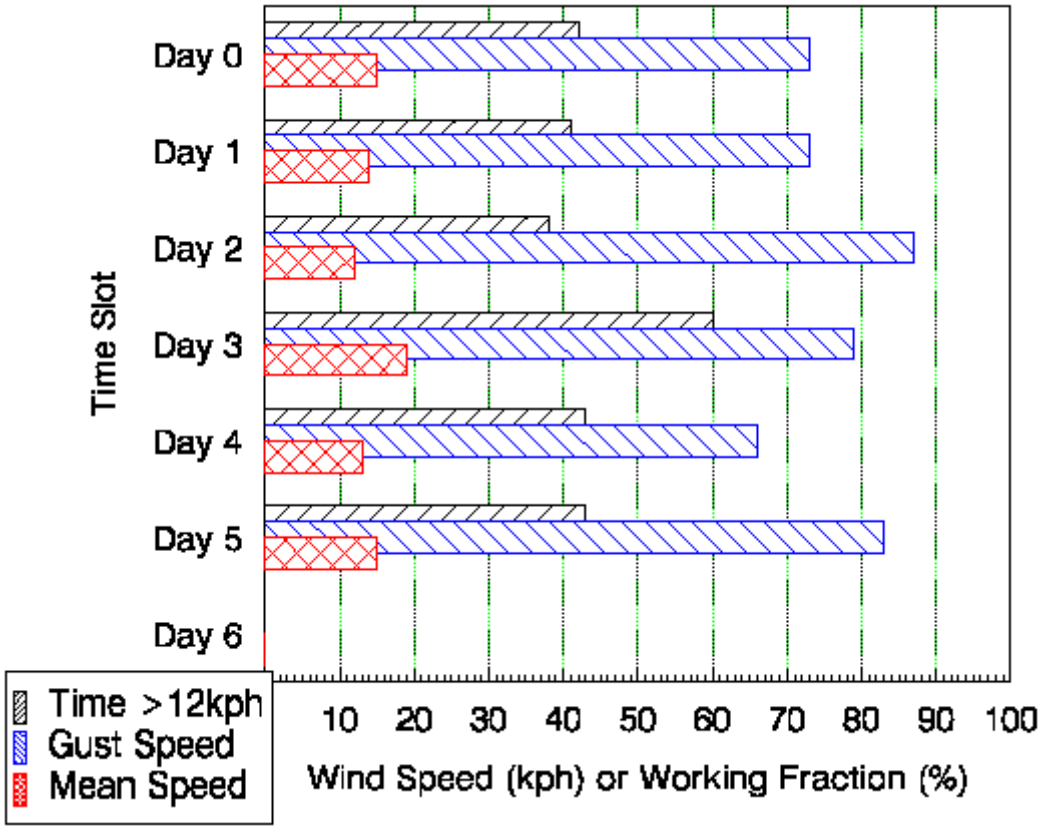
Prototype

- PCB supports 683 (& 684 via lifted pin)
- Plumbing fixture hardware
- Vehicular cal



Data Output

- Output via simple script using exported HEX file

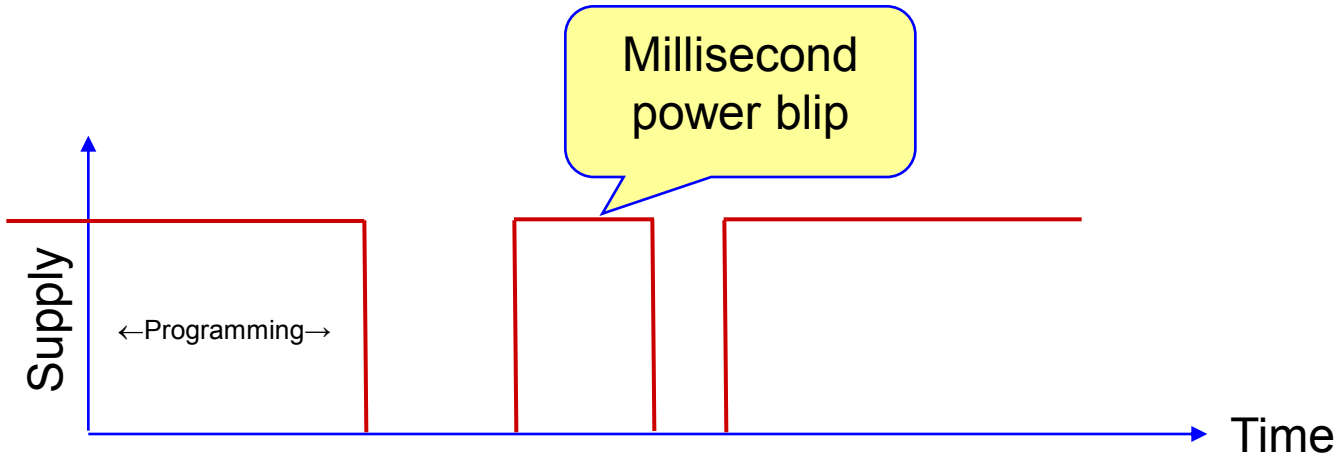


Ulterior Motives

- Monitor to leave with wind generators
- Model “benchmark project” for EE students
- Use uP intended for U/G labs
  - Found several fatal “features” (bugs?) you need to know…

Interesting “bug” #1

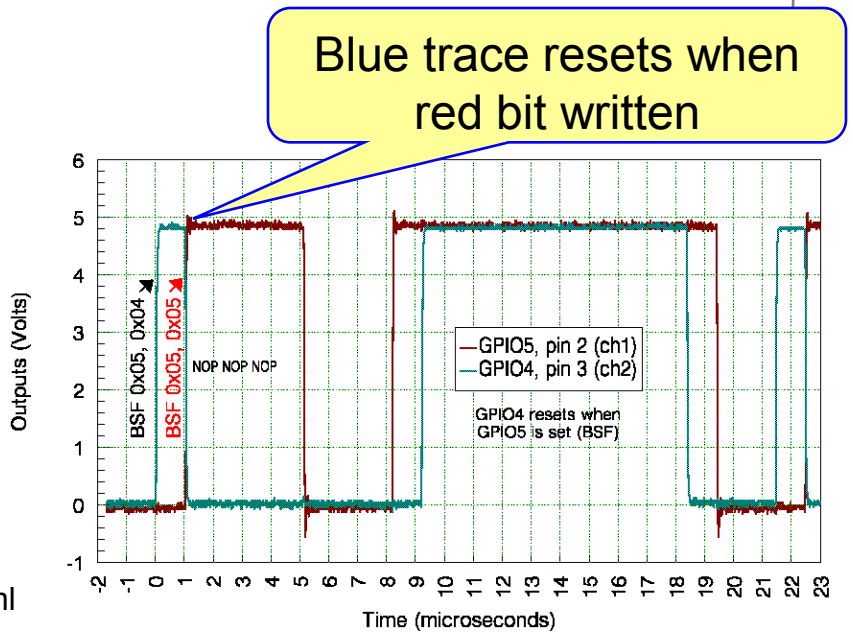
- PICkit1 has power blip after programming
- Microchip: Should refresh EERAM
- EERAM erases if write is interrupted
- Programmmer-induced glitch erased single byte
- Result:
  - Need a boot delay before doing any EE-writes



Interesting “bug” #2

- PIC offer useful bit-manipulation instructions
- Microcode uses read-modify-write within instruction cycle
- Read-phase reads port pin ***not latch***!
- Read-phase *reads whole* port, not only bit to be modified!
- Result:
  - Can flash data back into program
  - Sequential bit-writes to adjacent pins glitch data if pin C-loaded
- Known (not by PIC!) bug
- Aggravated by PICkit2

http://eng.waikato.ac.nz/research/scott/BugReport-PIC12F675.html



Interesting “bug” #3

- HiTech/PIC offer free compiler for ‘684 (limited memory)
- There are differences in the compilers
- There are differences in “passive” configuration files
- Result:
  - Must always use the same version everywhere on one project
  - Do not swap compilers willy-nilly on a machine
  - “Commercial” code can give bad binary on “Lite” compiler
    - Beware bank switching!

Conclusion

- Wind power needs careful thought (more to come?)
- ‘Embedded’ programmers well-paid for good reasons
- Fully-commented code available for the asking