Standards (CC = Common Core, NG = Next Generation Science Standards, CS = Computer Science Teachers Association Computer Science Standards):

- CS CT.L2-01: Use the basic steps in algorithmic problem-solving to design solutions
- CS CT.L3A-01: Use predefined functions and parameters, classes and methods to divide a complex problem into simpler parts
- CS CT.L3B-09: Analyze data and identify patterns through modeling and simulation
- CS CPP.L2-05: Implement problem solutions using a programming language, including looping behavior, conditional statements, logic, expressions, variables and functions.
- CS CPP.L3A-03: Use various debugging and testing methods to ensure program correctness
- CS CPP.L3B-07: Use data analysis to enhance understanding of complex natural systems
- CC F-IF.6: Calculate and interpret the average rate of change of a function over a specified interval
- CC F-IF.9: Compare properties of two functions each represented in a different way.
- CC F-BF.1.a: Determine an explicit expression, a recursive process, or steps for calculation from a context.
- NG HS-PS3-1: Create a computational model to calculate the change in the energy of one component in response to change in energy of another

Resources:

- Files PowerDensityLab1Rqmts.docx, PowerDensityLab2Rqmts.docx
- Output files generated by instructor's program for May 2014 (to be used in Excel)

Objectives:

- Create, index, and manipulate 2D arrays
- Implement loop constructs
- Write C-functions, design a program so that it modularizes functionality
- String -> numeric -> string formatting
- Learn basic file I/O (text files); tokens, parsing lines, skipping lines, NaN data
- Learn wind trends from program analysis output of raw wind data
- Choose wind turbine for wind farm at analysis sites
- Collaborate (lab nr 2) in the analysis of wind data, and choice of wind turbines
- Create multiple format visualizations of averaged data; text file and Excel 2D graph

Enrichment\Challenge:

- Design analysis programs so they read multiple monthly wind data files
- Have a parent operate Phase I lab program, using only console prompts and user guide
Pedagogy:
- TBD

Grouping:
- Students will work individually for Lab 1
- Students will work in groups of 3 for Lab 2

Instruction Sequence:
- NOTE: Completion of this activity will require several lab periods
  - Lab 1: 2 – 3 lab periods
  - Lab 2: 3+ lab periods
  - Group presentations: 1 lab period

Lab 1: setup
- Students will go to BPA website, download a common file (site, year, month)
- Students will view that file, noting
  - Header lines; these need to be skipped, although appropriate header lines need to be place in output file
  - 5 or 10 minute readings
  - Readings will be collapsed into a single hour average (average of 12 or average of 6)
  - NaN values, program must recognize these, not use them when calculating an hourly average
  - Column location of date, hour and wind speed value (not peak)
  - Barometric pressure values (a single representative value is to be used in Lab 1 and Lab 2 equations)
- Students will open Excel, import instructor's output file, create a 2D graph. A student learning activity will be to format axes, legends, titles for this graph. This will not be done as part of lesson setup.

Lab 1: Instruction topics
- Description of simple and 2D arrays
  - Index
  - Size
  - Out of bounds error
- Pointers, addresses ("*", "&")
- Reminder `instruction on for-loop and its syntax`
- C function: `char* strtok(char* str, const char* delim)`
  - Page 207 K&R
- C function: `double atof(const char* str)`
  - Page 62 K&R
- C function: `FILE* fopen(const char* filename, const char* mode)`
  - Page 131 K&R
- C function: `int fprintf(FILE* stream, const char* format)`
  - Page 132 K&R
- Review Lab1 handout
  - Assessment rubric
  - Equation 1, Equation 2; only calculating ratio of Equation 1 for Lab 1; output average is independent of turbine type

**Lab 1: Activity**
- Permit 90 minutes (or more) to write and test code

**Lab 1: Assessment**
- Instructor verifies code operation, note parent extra credit option
- Students submit code, and users guide

**Lab 2: Instruction topics**
- NOTE: may have industrial speaker for part of instruction
- Describe distinctives of wind power, comparing to coal, and other renewables
- Describe parts of a wind turbine
- Review Lab 2 handout
- Slight alterations to Phase 1 code, emphasis is on research into wind turbines, choosing one, determining output power for those turbines

**Lab 2: Activity, 1 class period each**
- Grouping, research
- Code modifications, analyzing Excel output files
- Assemble power point and accompanying verbal explanation

**Lab 2: Assessment**
- Present power point
- Submit copies of code, output files, Excel files

**Homework:**
- As necessary in support of classroom activities
- Research on wind turbine manufacturer options, wind farm design