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Stack Arrangement for Maximum Productivity

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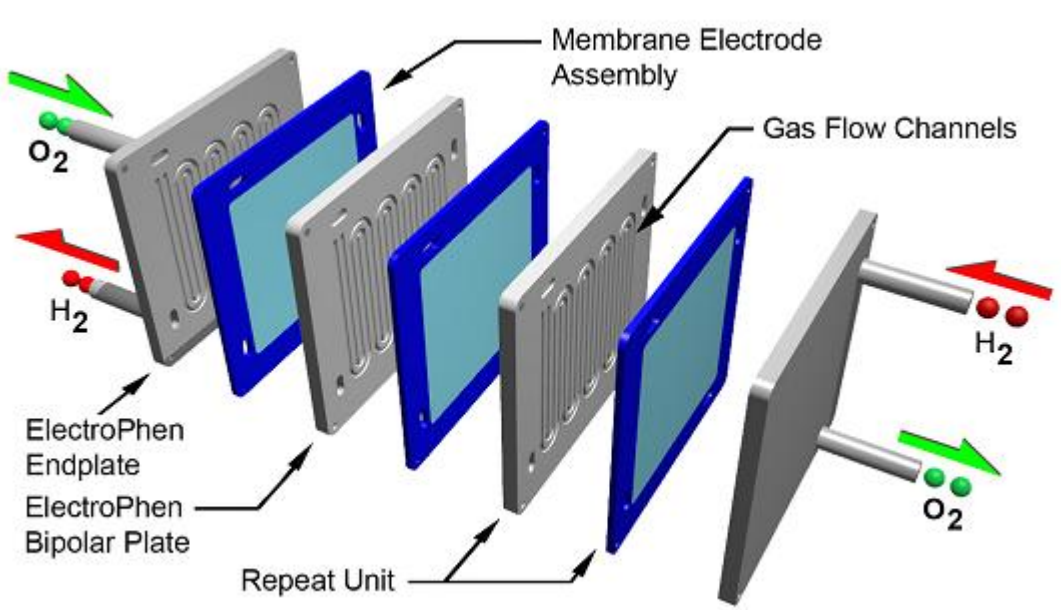
Background on Bloom Energy

- Bloom Energy's mission is to make energy affordable and clean
  - Distributed Power Generation >200 kws to MWs
  - Solid Oxide Fuel Cell (SOFC) Technology
  - Based on Sunnyvale, CA
  - Now breaking ground in a manufacturing facility in DE
  - Start-up with funding from venture capitalists
- Customers include
  - Walmart, Adobe, Google, FEDEX and many other Fortune 100 companies

Basics of SOFC's and nomenclature



Interconnects, (IC)
Cells with anode and cathode (E)
Stack = a fixed number of repeat units (10<N<50)

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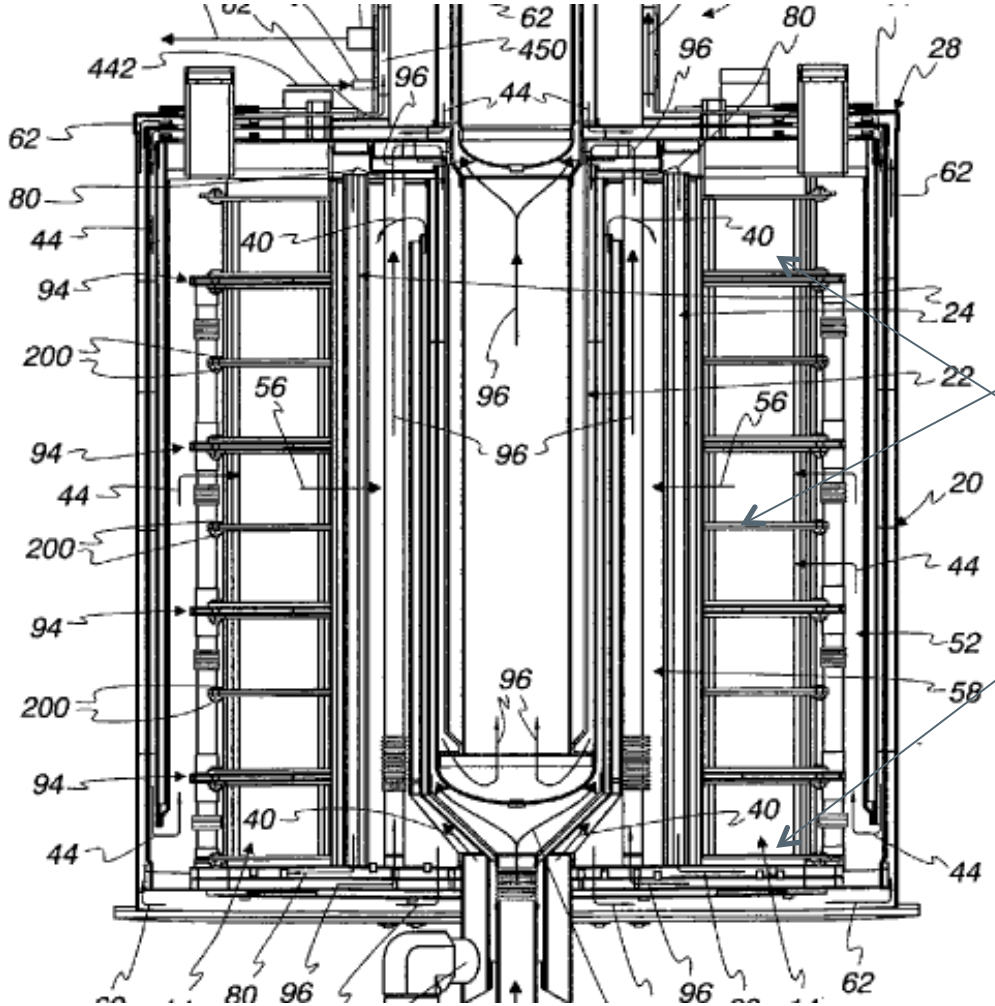
Basics continued.. (Power Module)



Stacks
Positioned
Bottom to top
Shown here
1 to 8 positions

Groups of Stacks in a column, A fixed number of columns in a PWM

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Basics continued

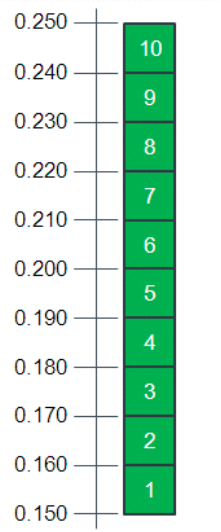
- Number of stacks in a column = 8 or 10 (input variable)
- Number of columns in a PWM = 8

Typical Assembly Process

1. IC's received from multiple vendors [V1, V2, V3, V4], go through QC, Parameters recorded [A1, A2] (numerical values)
2. Stacks assembled with IC's and Cells
3. Stacks tested and graded [G1B, G1T(numerical), G2, G3(state variables)]
4. Stacks selected to go into a power module (includes some spares (say 10%), N1*1.1)
5. Power module tested, if ok, spares returned to inventory for use again

Rules for making power modules

1. Prefer to not mix vendors in a PWM. No more than 10% (input parameter) of the PWM's can have mixed vendors
2. A1 is a critical parameter for stack positioning in the HB. It is discretely divided into 10 bins. There are 3 ways they can be stacked
    1. All belong to the same bin
    2. Bottom 5 or lower can be of 1 lower bin than the ones on top of them
    3. Least preferred to have 3 bins with at least 3 on top with higher bin, followed by next 3 or 4 with one lower bin, followed by remaining with two lower bin)



Continued

- A2 is less critical and not position dependent, how ever, the stacks in a PWM should be with in a range of 0.06 (input parameter) [values are in the same as A1]
- All columns in a PWM should have similar A1 bin arrangement
- Two stacks next to each other should have the sum of their {G1T(bottom)+G1B(top)} be no more than 400 (input parameter)
- If G2=TRUE, it can go only in the top position
- If G3=TRUE, it can go only in the bottom 5 positions
- ELSE it can go any where

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Problem Statements

- Predictive model for maximizing number of PWM's
- Is it better to allow A1 to be a continuous variable or a discrete variable (which is better for getting more PWM's)
- Which constraints have a bigger impact ? (so that we can work on relaxing these first)

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