FASTCAP SYSTEMS™

Extreme Temperature Energy Storage and Generation, for Cost and Risk Reduction in Geothermal Exploration

Project Officer: Jamie Beard
Total Project Funding: $2.6M
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FastCAP Systems Inc.

Advanced Well Completion Technologies

Relevance/Impact of Research

- Objective: Enabling key aspects of L/MWD in geothermal resulting in:
  - Reducing drilling risk in geothermal
  - Increasing rate of penetration = reducing costs in geothermal
  - Improving well-bore placement = increasing power output in geothermal

Relevance/Impact of Research

- How?
  - Build a power solution to power logging and measurement while drilling (sensor & telemetry) in geothermal exploration

The power solution includes:

A (250°C) high temperature generator

A (250°C) energy storage system

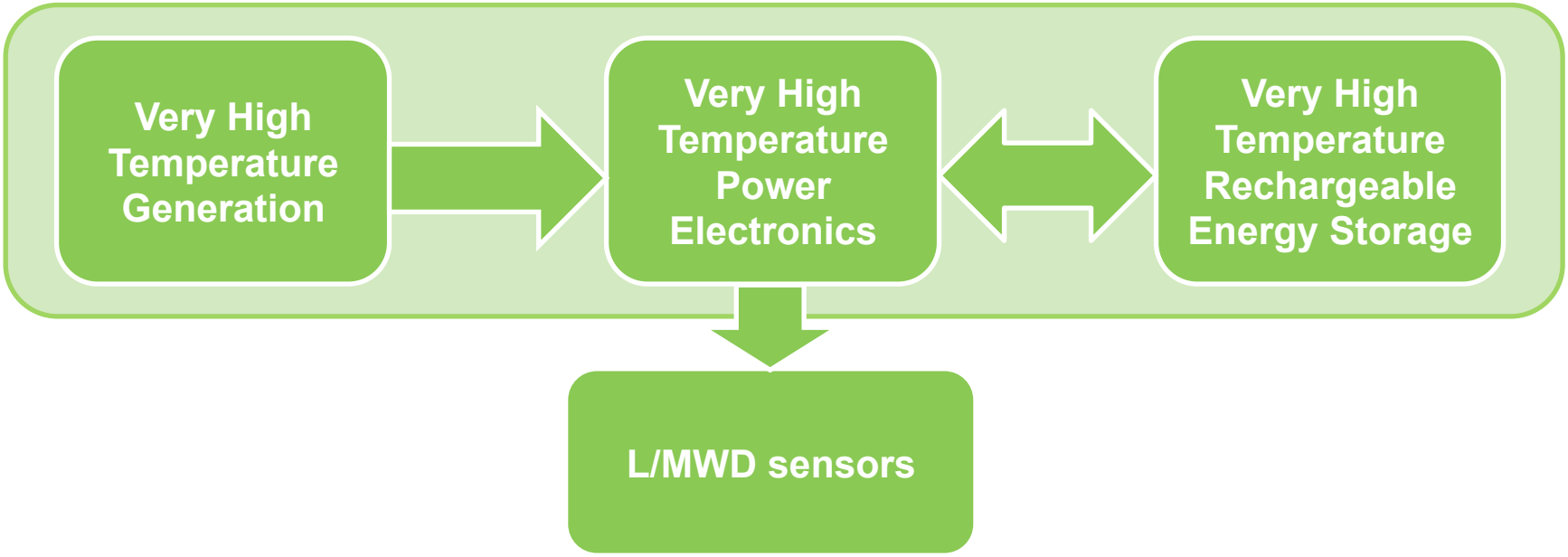
A (250°C) converter to manage and charge the ESS and power the L/MWD

Relevance/Impact of Research

- This system intends to supply sufficient power for:
  - Directional modules
  - Pressure sensing tools for managed pressure drilling
  - Wireless telemetry: EM
- Potentially
  - Formation evaluation
  - Some logging modules

Relevance/Impact of Research

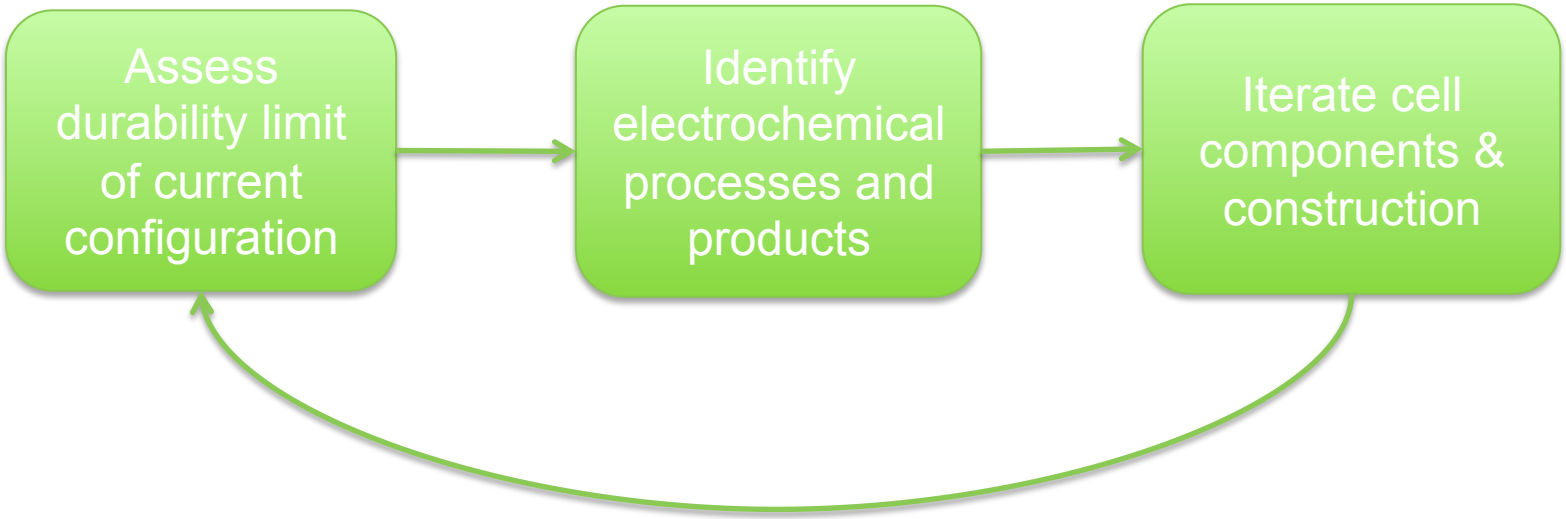
- Core Innovation 1: FastCAP's proprietary high temperature rechargeable energy storage
- Core innovation 2: FastCAP's rugged high temperature downhole generator
- Core competence 3: FastCAP's high temperature power electronics



Scientific/Technical Approach

Development Energy Storage (ultracapacitors)

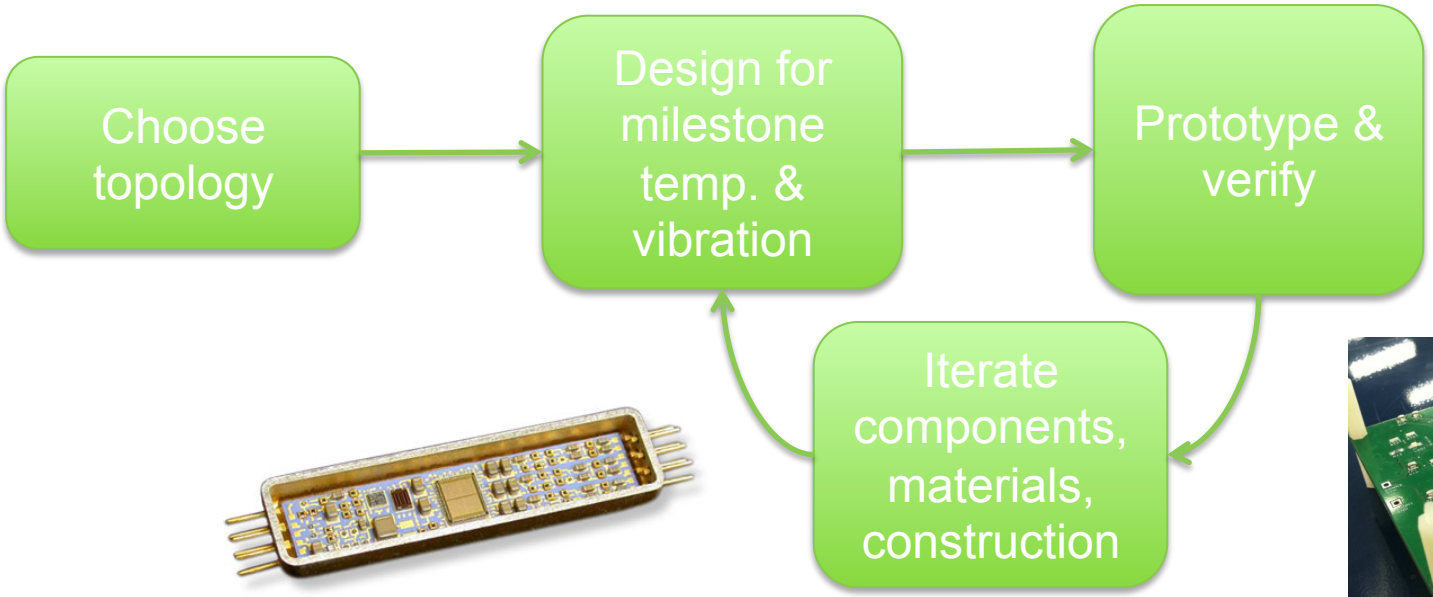
- Start from FastCAP commercial product operating at 150ºC and surviving 175ºC
- Continue FastCAP's methodology based on leadership in high temperature electrochemical systems

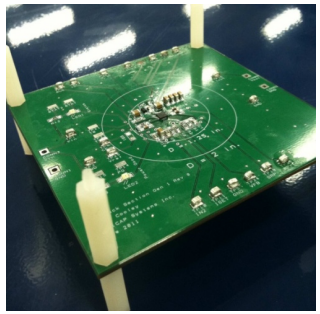


Scientific/Technical Approach

Electronics

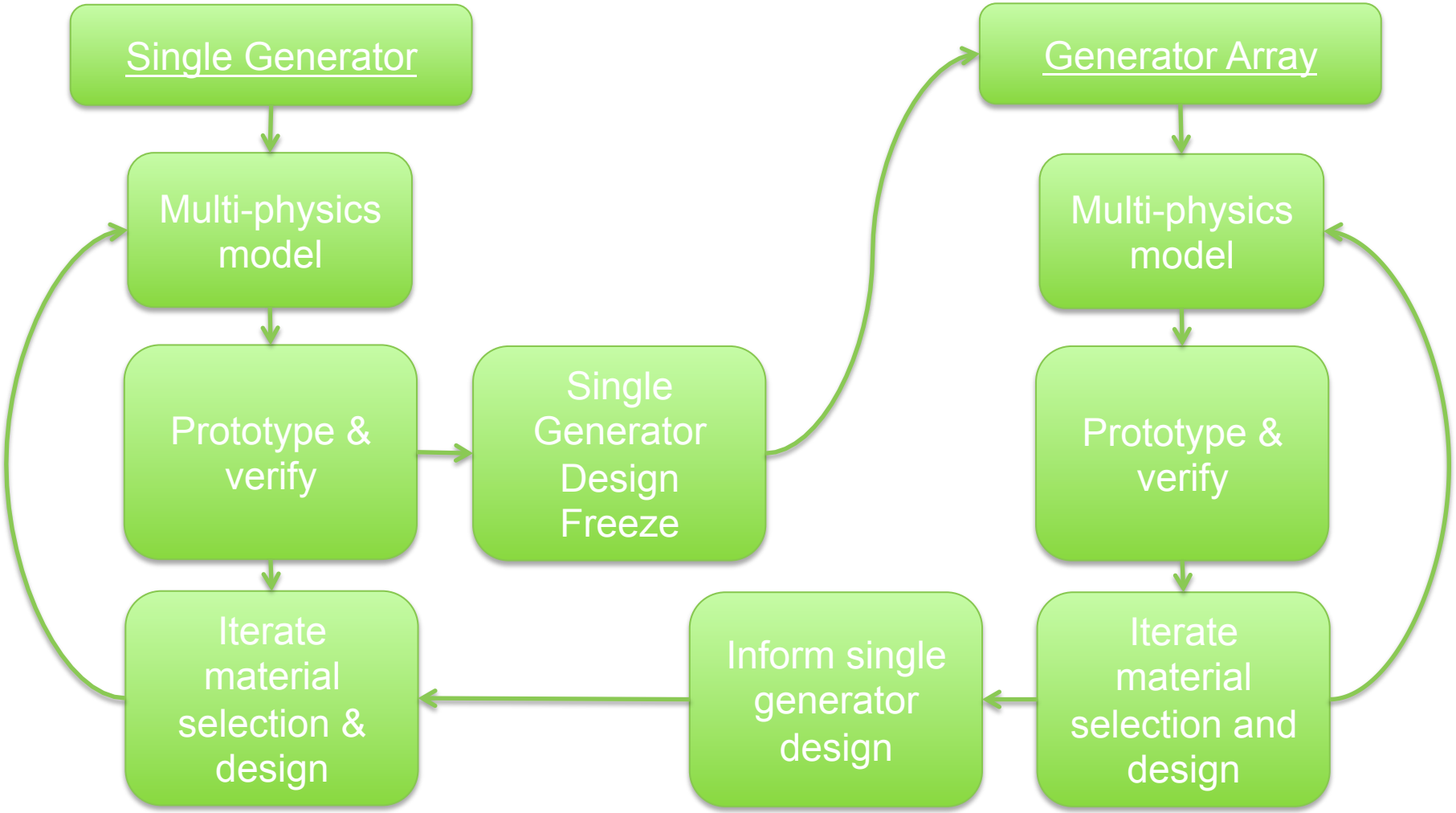
- Not New: Very high temperature (VHT) circuit techniques
- New: VHT circuit designs tailored to FastCAP's solution
- Approach: circuit topology largely decoupled from temperature & vibration milestones





Scientific/Technical Approach

Generator



Accomplishments, Results and Progress

All milestones exceeded to date:

Task 1: Generator and Electronics

- Developed energy generation element generating an average of 1 W/kg and 10 W/L

Task 2: Rechargeable Energy Storage

- Developed and commercialized energy storage capable to operate at 150°C for 2000 hours and withstand 175°C
- Developed lab prototypes of energy storage capable to operate at 200°C

Future Directions

- Key activities for the rest of FY2013:
  - Developing energy storage systems ready for field operation at 200ºC.
  - Developing control and power electronics for lab operation at 200ºC
  - Prototype generator modules for laboratory demonstration
- Activities for the rest of the project:
  - Deliver energy storage, generation and power electronics @ 250ºC & 5-10 G for 200 to 500 hours
  - Deliver an ultracapacitor pack storing 0.5 to 1 Wh of energy
  - Deliver a generator array producing 5 to 10 W of output power

Summary

- New power solution for while drilling applications in 250ºC, high vibration environments
- Combination of proprietary high temperature rechargeable energy storage with “clean-slate” approach to downhole generation
- Builds on in-house expertise around:
  - High temperature cell engineering
  - High temperature power electronics
  - Electromechanical systems

Project Management

Timeline:

Planned Start Date	Planned End Date	Actual Start Date	Current End Date
June 2012	January 2015	June 2012	April 2013

Budget:

Federal Share	Cost Share	Planned Expenses to Date	Actual Expenses to Date	Value of Work Completed to Date	Funding needed to Complete Work
$2.2M	$0.7M	$700k	$700k	$700k	$2.2M

- Aiming to branch in the agency to gain synergies with other groups laboratories and projects
- Project is on track