

TBD

# Passive fuel-Cell Surface power System (PaCeSS)

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## EXECUTIVE SUMMARY

This effort produces a fully-passive surface power generation capability for fuel cell technology. The concept replaces the actively pumped thermal management of a state of the art (SOA) fuel cell/electrolyzer stack with a passive 2-phase thermosyphon for heat transport and a passive shape memory actuating radiator for temperature management.

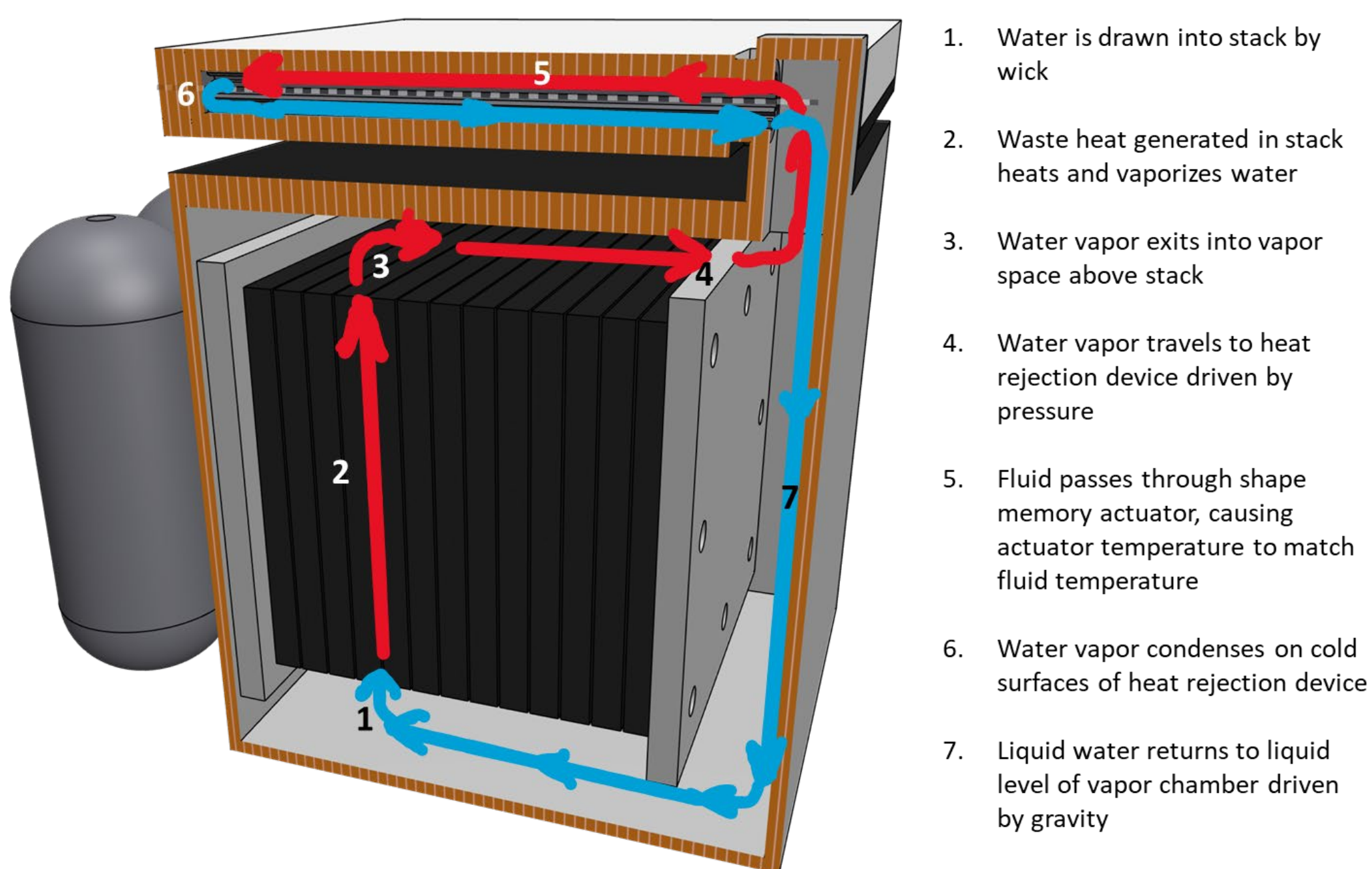
## INNOVATION

The overall passive fuel cell concept eliminates wearing parts and control complexity associated with fuel cell system thermal management. It is a system-level solution that spans heat acquisition, transport, and rejection.

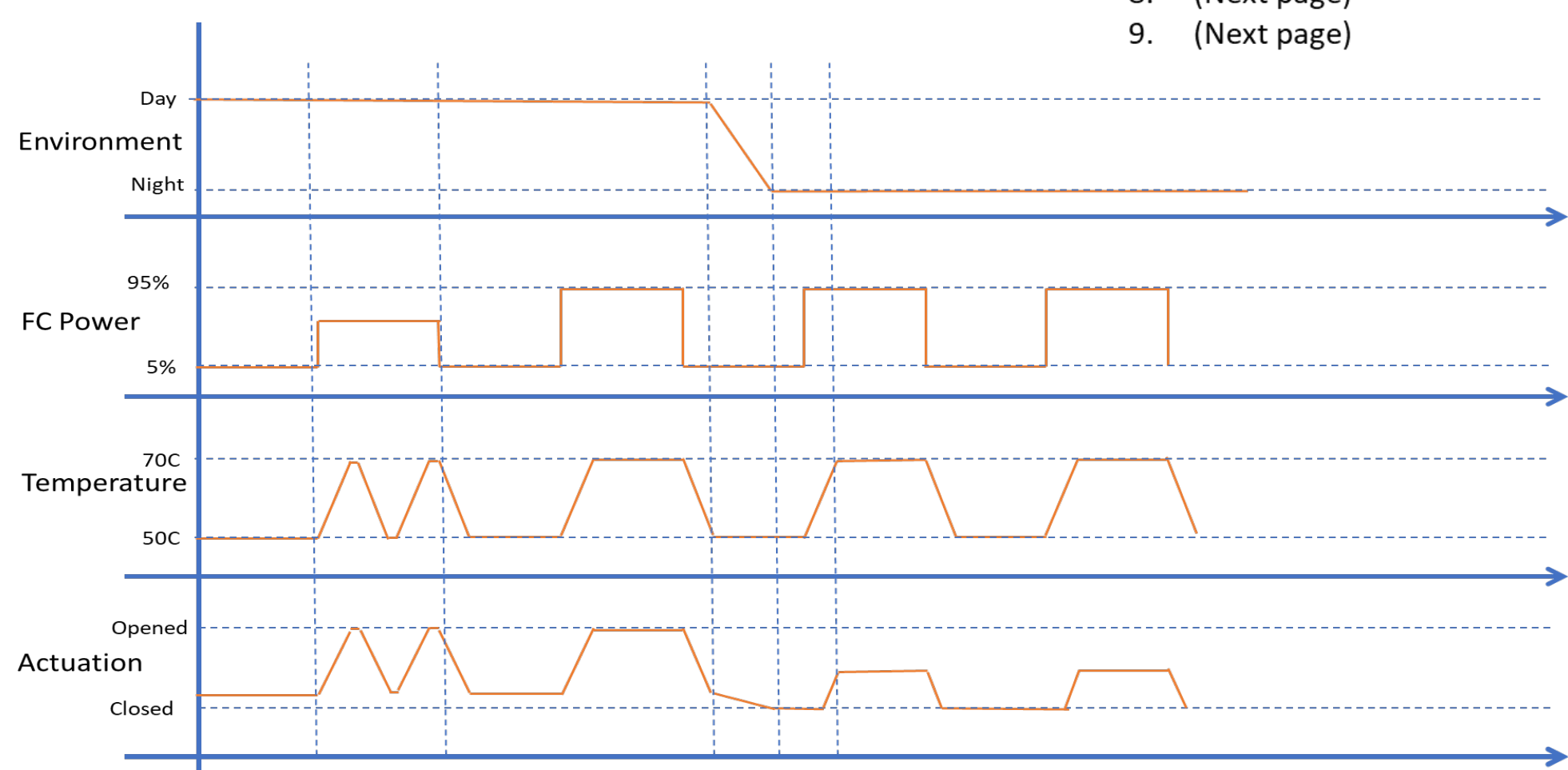
This integration broadly:

- *Improves reliability and operating life by removing pumps and control valves/devices and electronics from thermal management subsystem.*
- *Reduces control complexity through inherently temperature dependent material behaviors (Shape memory alloy actuates between 50C and 70C)*
- *Improves mission flexibility (survive night, direct solar, permanent shadow) via high thermal turndown. Applies to Moon and Mars.*

It also overcomes scalability issues identified in previous fuel cell passive thermal [-strapping] approaches by developing a system-level solution that spans heat acquisition, transport, and rejection.

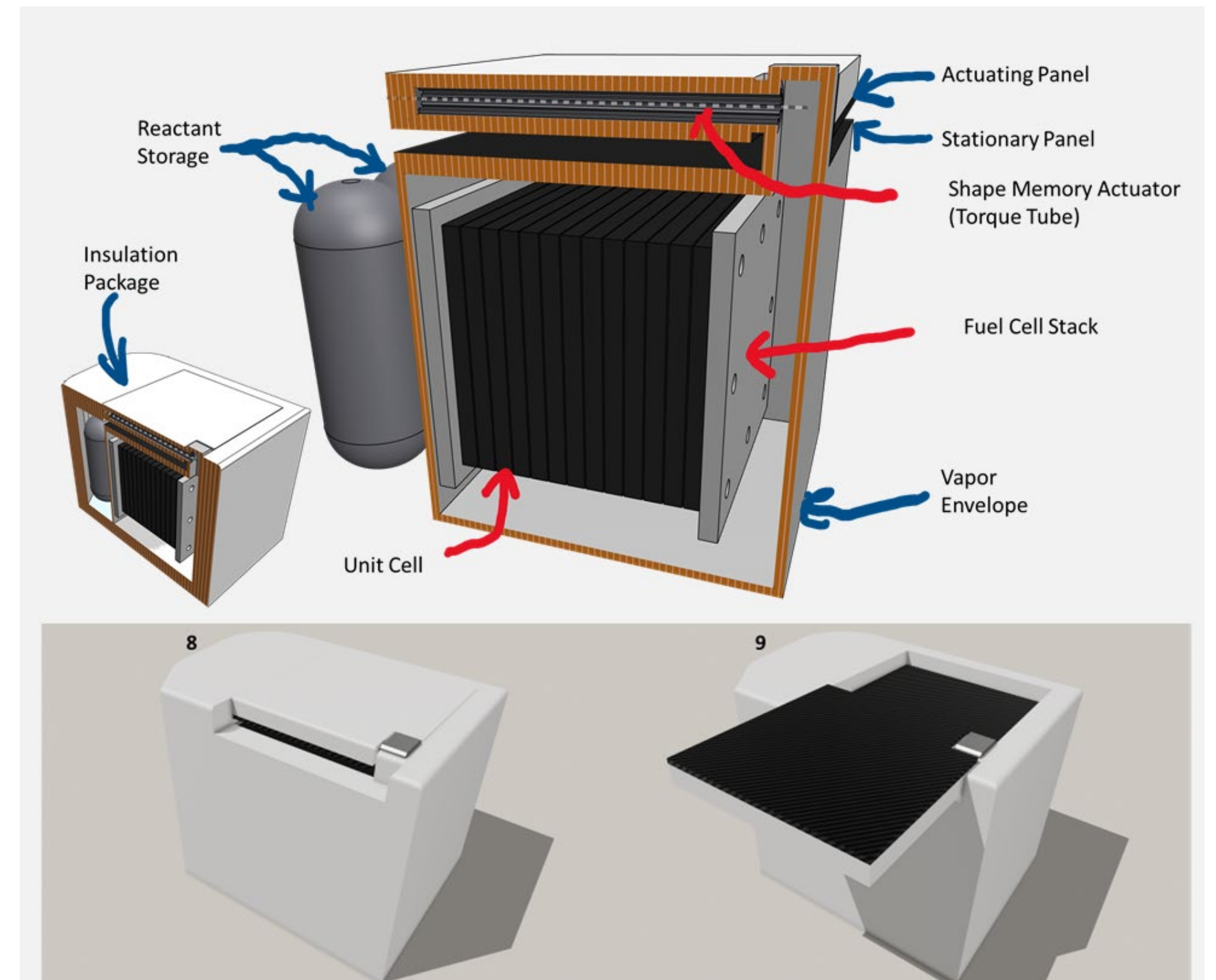


1. Water is drawn into stack by wick
2. Waste heat generated in stack heats and vaporizes water
3. Water vapor exits into vapor space above stack
4. Water vapor travels to heat rejection device driven by pressure
5. Fluid passes through shape memory actuator, causing actuator temperature to match fluid temperature
6. Water vapor condenses on cold surfaces of heat rejection device
7. Liquid water returns to liquid level of vapor chamber driven by gravity
8. (Next page)
9. (Next page)



## COLLABORATION

Texas A&M University collaborates on this effort toward the development of a shape memory alloy actuator and panel.



A PaCeSS sketch showing (top) components and (bottom and left) behavior of the concept.

## OUTCOMES & INFUSION

### Planned Deliverables (year 1)

- Midterm progress, Final reporting and presentation
- Test data demonstrating benchtop performance of prototype concept in simulated environment and operation

### Planned Outcomes (year 1)

- Concurrent scopes will be developed: EP leads the fuel cell thermal management scope, EC/TAMU the heat rejection scope.
- Produces a benchtop prototype demonstrating the proposed thermal management concept. (Fuel cell operating behavior and thermal environments will be simulated, e.g. waste heat via resistive heating, cell voltages via power supply, heat rejection via chiller, etc. (No H<sub>2</sub>/O<sub>2</sub> or TVAC))
- Benchtop testing will be performed in B7/B15, & TAMU.
- The first year will conclude with an integrated benchtop test of the concept prototype, raising TRL to 4

Milestone Name	O	N	D	J	F	M	A	M	J	J	A	S
STMD Authority to Proceed, wrap up ICA findings (Aug/Sept)												
Project Planning Phase												
Project Kickoff Presentation (EP, EC, TAMU, and stakeholders)			13 <sup>th</sup>									
System Design Phase – System modeling and requirements development (EP/EC)												
System Design Presentation (EP, EC, TAMU, and stakeholders)				15 <sup>th</sup>								
Prototype Design Phase – Design and analysis (EP, EC and TAMU)												
Prototype Design Presentation (EP, EC, TAMU, and stakeholders)					23 <sup>rd</sup>							
Procurement and Build Phase - Execute design (EP, EC, and TAMU)												
Mid-term Review, Test Readiness Review (JTWG, EP, EC, and TAMU)									3 <sup>rd</sup>			
Testing Phase – (EP, EC, and TAMU)												
Reporting Phase – (EP, EC, and TAMU)												
Final Performance Review (JTWG, EP, EC, and TAMU) and closeout												

## FUTURE WORK

A second phase will mature this technology and perform testing to demonstrate it to a TRL 5 level.

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