



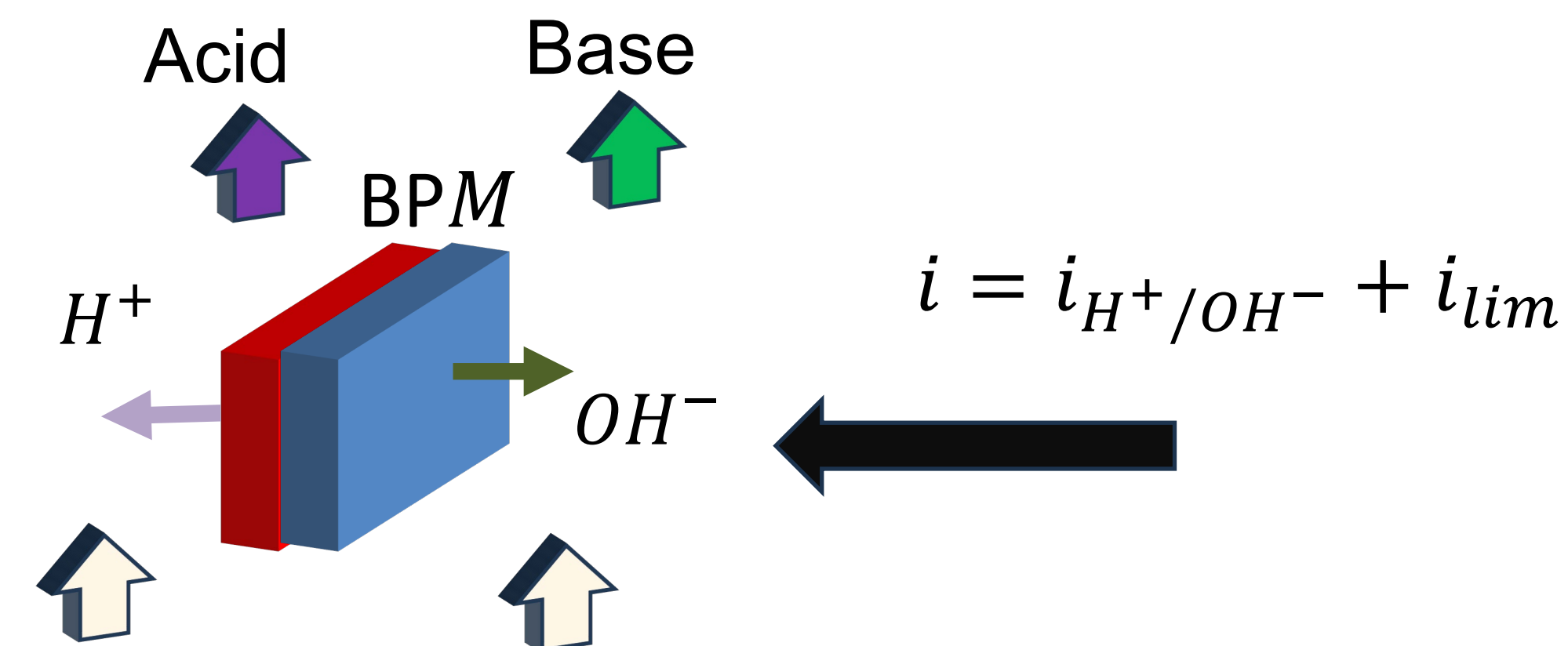
Bipolar Membrane Electrodialysis in WaterTAP

Johnson Dhanasekaran, Srikanth Allu
Oak Ridge National Laboratory

Motivation

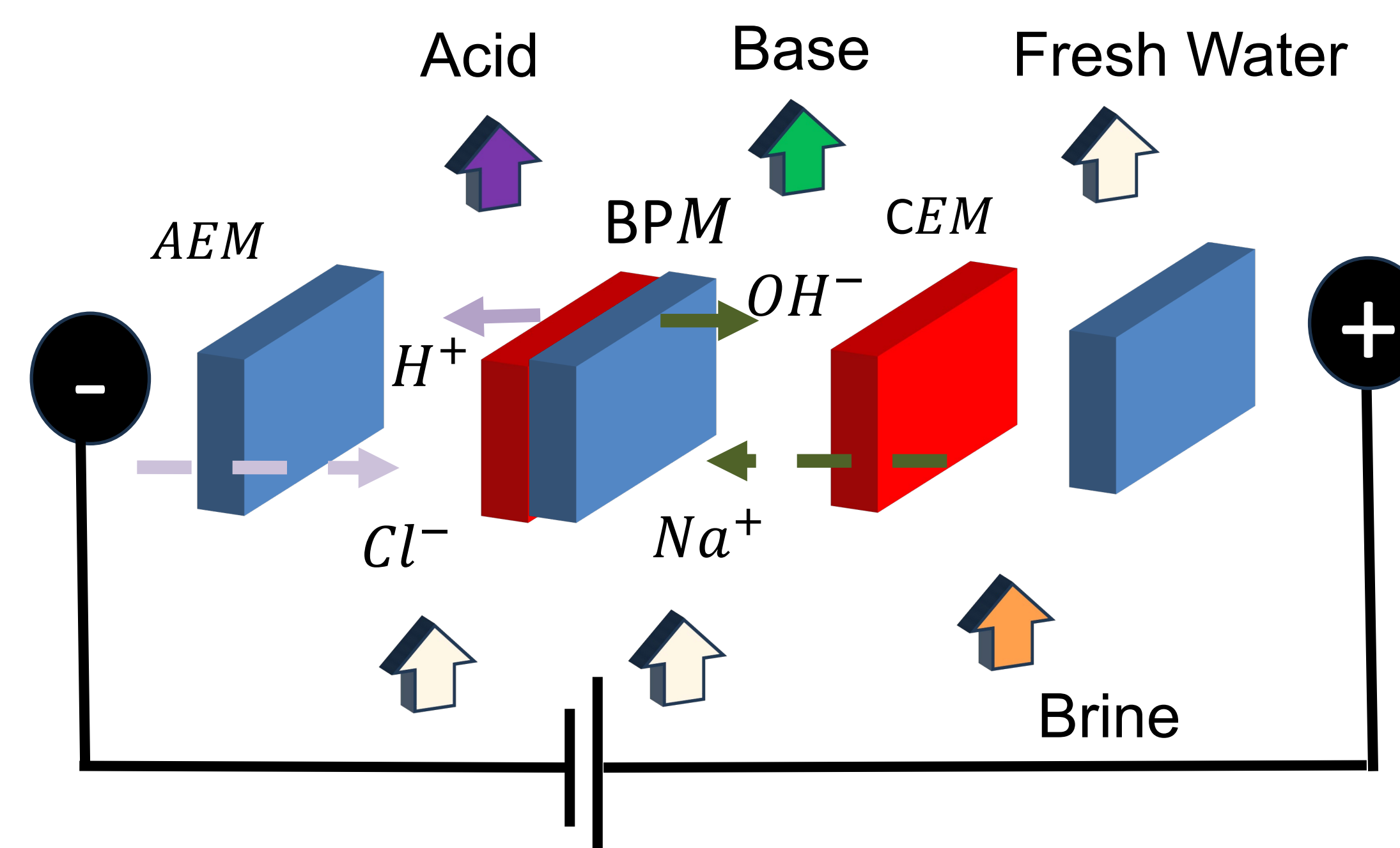
- Water purification is in critical need, but its waste products pose serious environmental challenges.
- While mitigation is important value recovery from the brine discharge can significantly impact the environmental and financial cost calculus.
- **Bipolar membrane electrodialysis (BPMED)** offers economically friendly in-situ production of high value products from waste brine.
 - These membranes induce hydrolysis and, combining with the salt ions separated out by the electro dialysis, produce **acids** and **bases**.
- **GAP:**
 - Limited options available to model the emerging BPMED technology.
 - Critical features, such as catalyst driven water-splitting, are missing.
- **VALUE:**
 - Our high-fidelity model in WaterTAP can inform design and be used to perform technoeconomic analysis on the bench, pilot, and industrial scales.
 - A crucial advantage of the WaterTAP framework is easy integration with well-tested units, such as Reverse Osmosis. This will allow building flowsheets that better resolve complexities of real-world operations and so improve accuracy.

Bipolar membrane model



i_{lim} : Depends on salt concentration in channel and membrane properties.
 i_{H^+/OH^-} : Comprehensive model that includes **Catalytic action** and the **Second Wien effect** enhanced water dissociation.

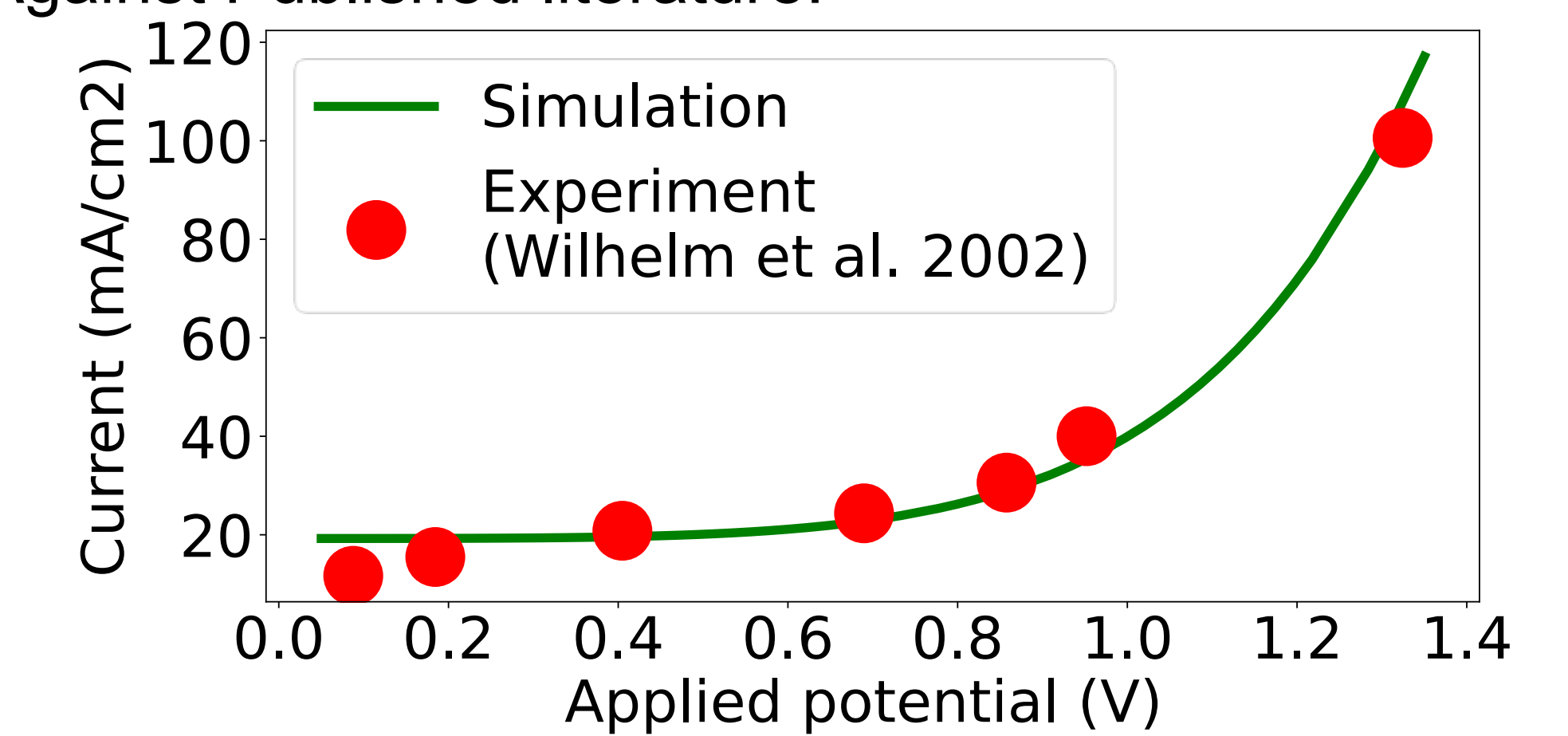
BPMED process



- Robust model couples the bipolar membrane water splitting action with the selective filtration of electro dialysis stack.
- Shows promising predictions of the bench scale tests performed by the New Mexico State team.

Validation

- Against Published literature:

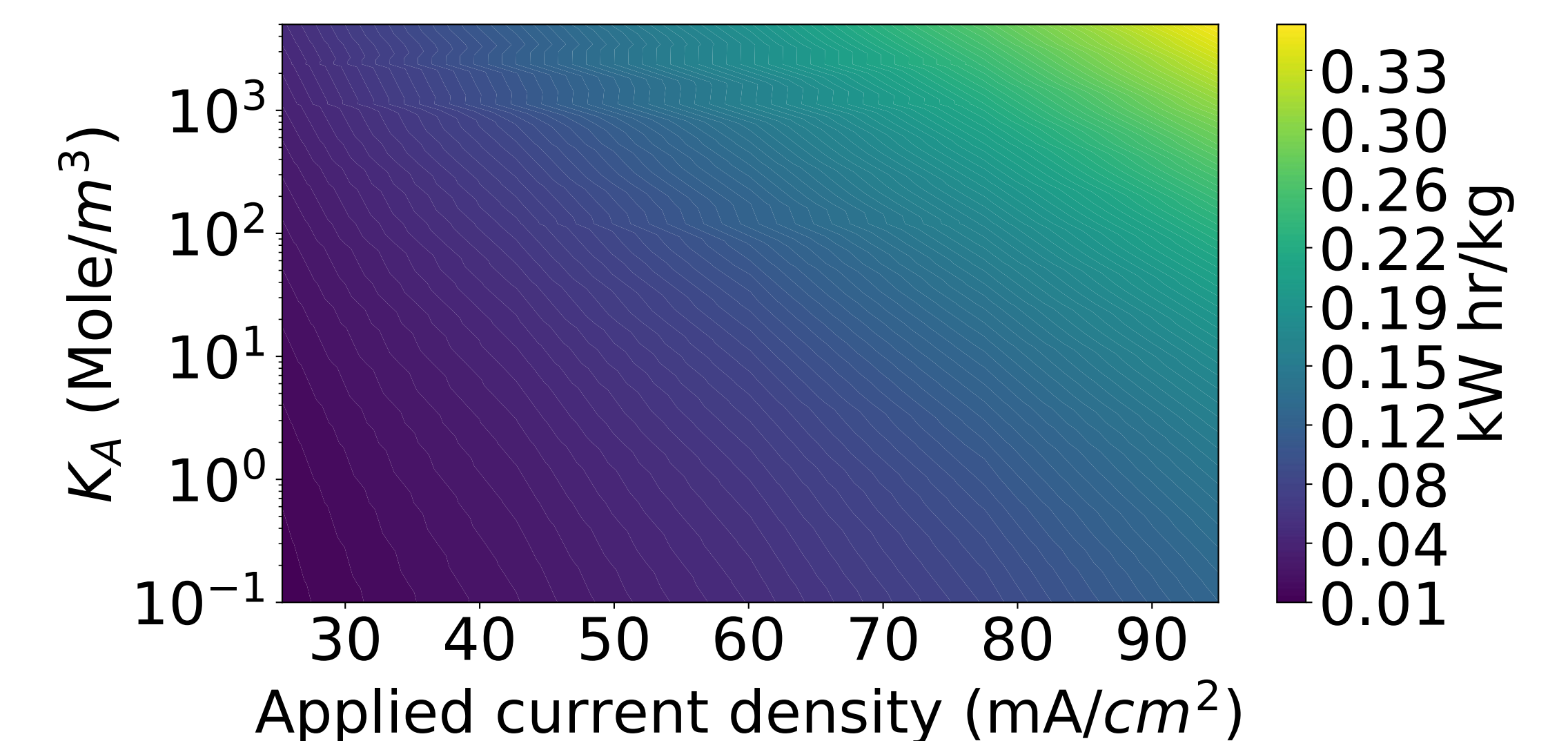


- Against Commercial datasheet:

	i_{LIM} (A/m^2)	U_{diss} (V)
Datasheet	1000	0.8
Computed	987	0.78

Fumatech, Technical Data Sheet for Fumasep FBM, 2020 with extra inputs from Ionescu, Viorel (2023)

Sample Technoeconomic Analysis



- Higher catalyst activity (lower K_A) reduces costs by half
- Costs approximately scale as $\log(K_A)$
- Larger scale analysis over multiple parameters planned

Contact: Johnson Dhanasekaran, Ph.D., dhanasekaraj@ornl.gov

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