

NSF Funding Opportunities in Power, Energy and Climate

Aranya Chakraborty, Eyad Abed, Anthony Kuh,
Mahesh Krishnamurthy

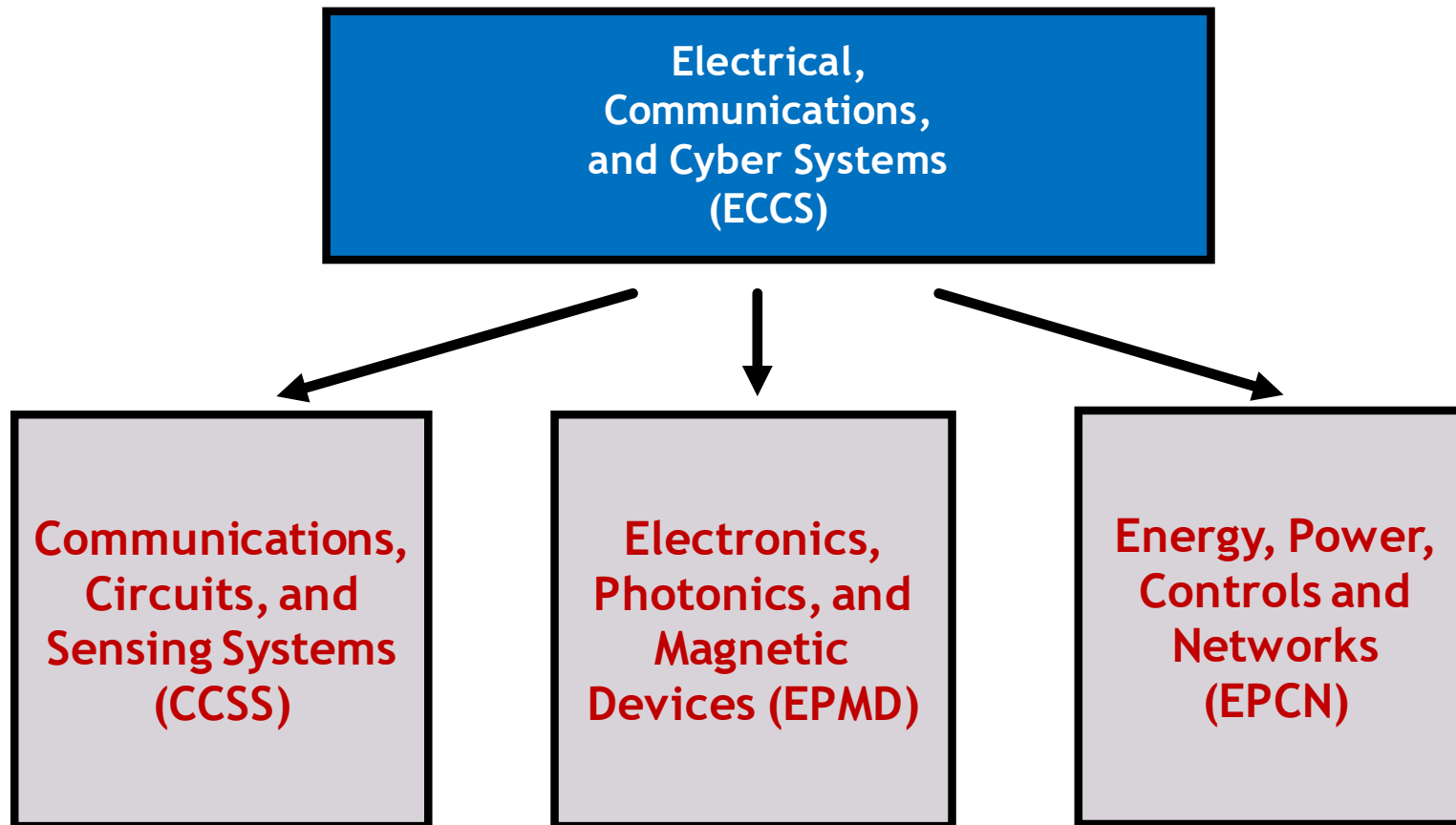
EPCN Program Directors

Energy, Power, Control and Networks (EPCN) Program
Electrical, Communications and Cyber Systems Division
Engineering Directorate, National Science Foundation

NSF FREEDM Annual Symposium
April 2, 2024

Electrical, Communications and Cyber Systems (ECCS) Division

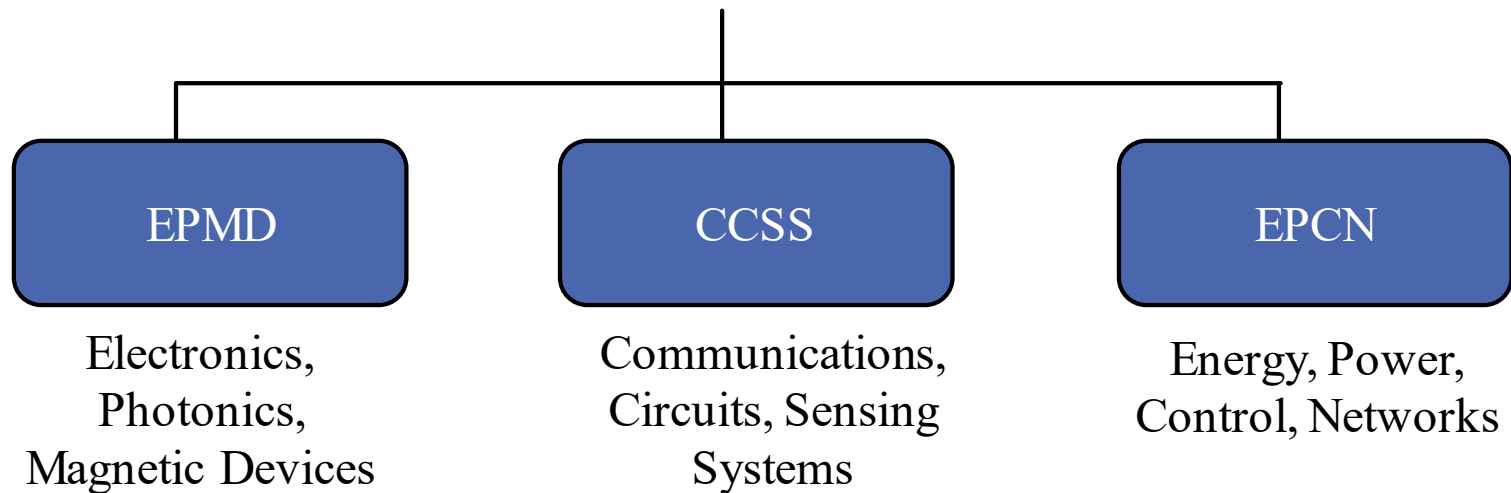
Research Clusters



My Work at NSF

2020 – 2023

Program Director, ECCS (Electrical, Communications and Cyber Systems)



1. Midscale Research Infrastructure-1
2. CAS Climate: Critical Aspects of Sustainability
3. Clean Energy Tech DCL
4. NSF-DOE Partnership on Net-Zero Energy (recent DCL for industries of the future)
3. Cyber-Physical Systems (CPS)
4. Addressing System Challenges through Engineering Teams (ASCENT)
5. Engineering Frontiers in Research and Innovation (EFRI)
6. Major Research Instrumentation (MRI)
7. Sustainable Regional Systems (SRS)
8. Smart and Connected Communities (S&CC)

TIP: C'Accel, EEC: INTERN

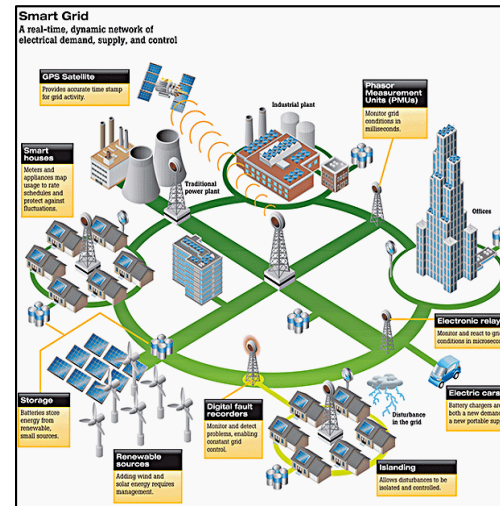
**Cumulative annual investment
portfolio of \$30M**



EPCN (Energy, Power, Control and Networks) Program Role and Priorities

Control System Thrust

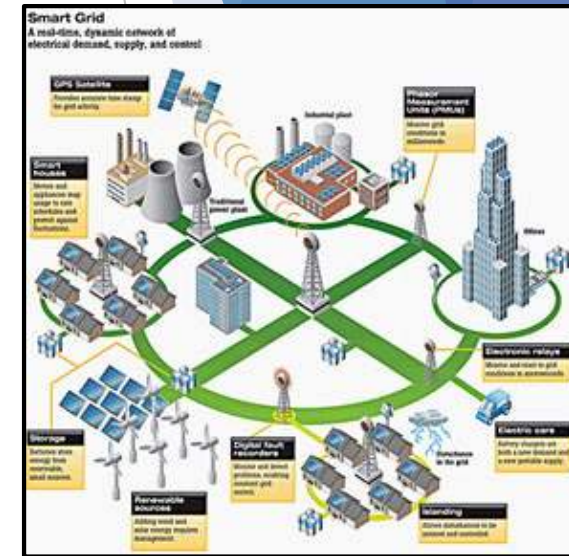
- Robust, Optimal, Nonlinear, Adaptive Control
- Data-Driven Control
- RL/DL in Control
- Massive data sets, real-time decisions
- Network control systems
- Reliability, safety, cybersecurity, and usability
- Applications in robotics, transportation, smart grids, smart buildings, multi-agent networks, machine learning



Next-Generation Power Systems

- ▶ Distributed energy resources (DERs)
- ▶ Control of inverter-dominated power grids
- ▶ Electrified transportation
- ▶ Resilience against hurricanes and wildfires
- ▶ Changing demand profiles and consumer expectations
- ▶ Extensive deployment of sensing, communications and information technologies
- ▶ Real-time decision-making based on massive data
- ▶ Cyber-security of power grid
- ▶ Integration of power electronics for power system operations

Relevant to
Climate
Change



Power Electronics and Energy Conversion

Advanced Power Electronics and Electric Machines

Electric and Hybrid Electric Vehicles

Energy Harvesting and Storage Systems

Renewable Energy Conversion Systems

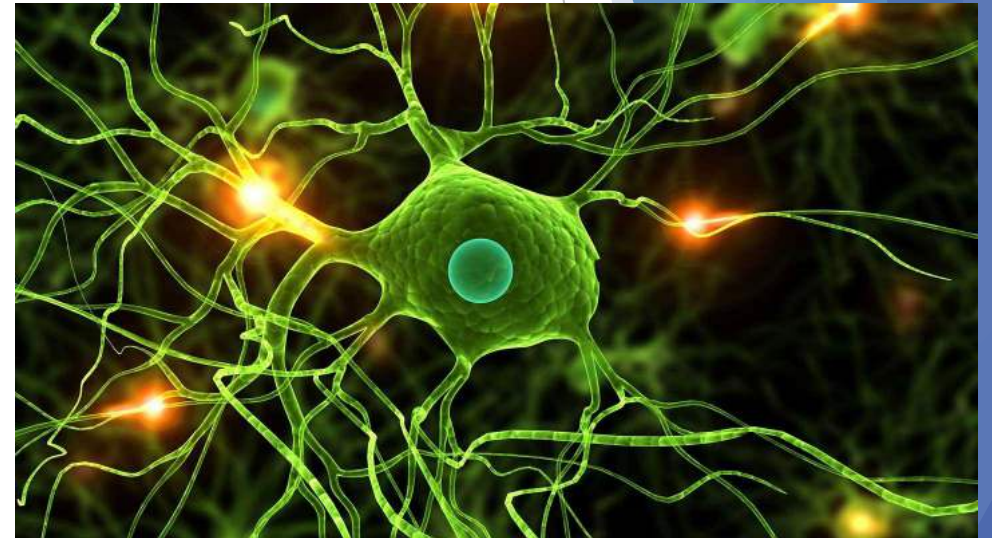
Innovative Grid-tied Power Electronic Converters

Wide Band Gap Power Electronics and Motor Drives

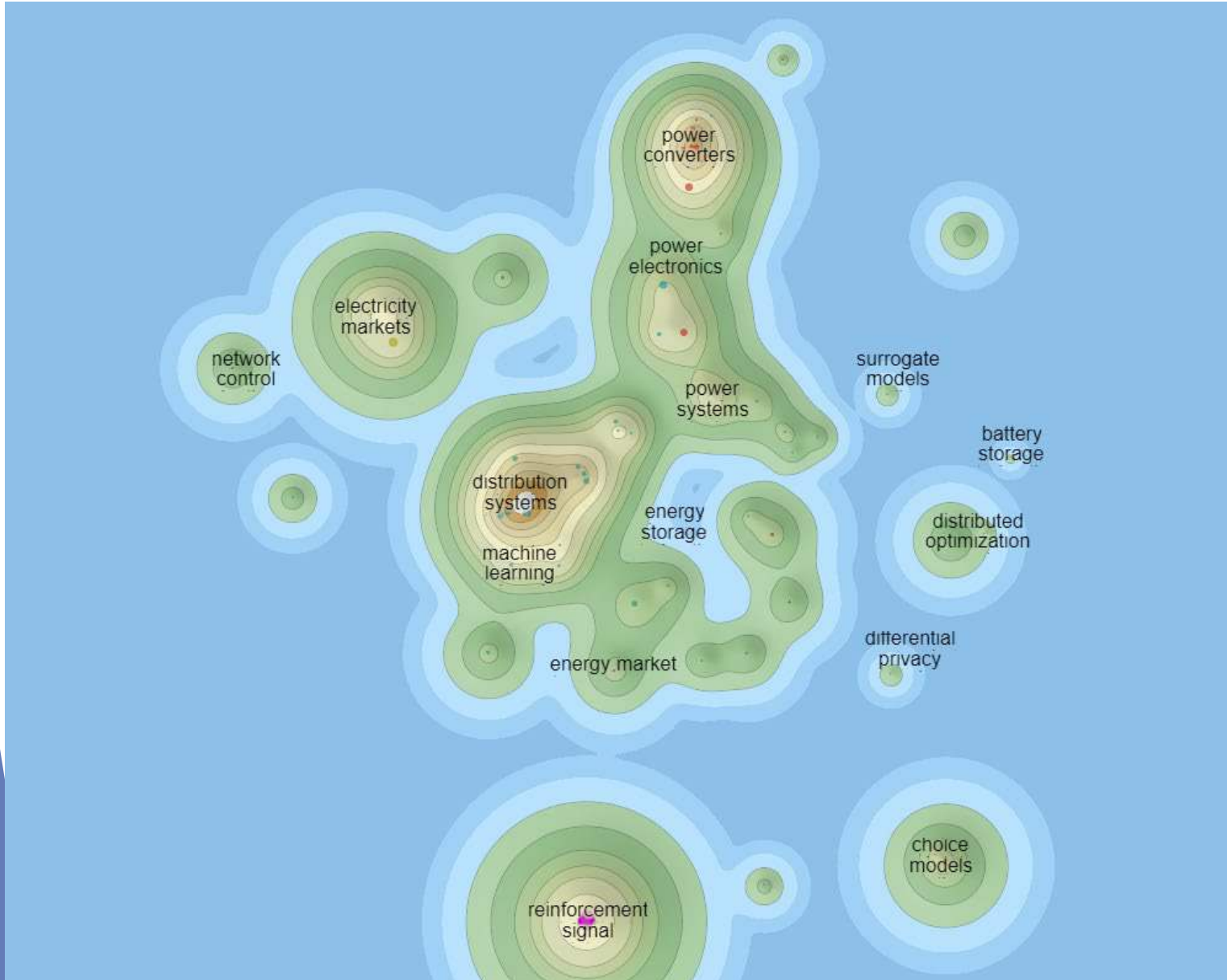


Machine Learning and Data Science Cluster

- ▶ **Learning and Adaptive Systems**
 - ▶ Neural Networks
 - ▶ Neuromorphic Engineering Systems
 - ▶ Data analytics and Intelligent Systems
 - ▶ Machine Learning hardware
 - ▶ Machine Learning Algorithms, Analysis and Applications
 - ▶ Human-machine interaction
- Usual Funding Range for EPCN core proposals: \$350K-\$400K for single-institution, \$500K-\$550K for collaborative proposals, usually over 3 years (CAREER is \$500K-\$550K over 5 years)



Recently Funded CAREER Projects in Power Systems



Some recently funded NSF CAREER projects:

CAREER: Enabling grid-aware aggregation and real-time control of distributed energy resources in electric power distribution systems
University of Vermont, 2021

CAREER: Beyond Low-Inertia Systems - Grid-Forming Control Foundations for Converter-Dominated Power Systems
University of Wisconsin Madison, 2022

CAREER: Learning-Assisted Optimal Power Flow with Confidence
University of Colorado Boulder, 2021



Recently Funded CAREER Projects in Power Electronics

Some recently funded NSF CAREER projects:

CAREER: Power Magnetics for MHz Frequencies
Univ of Texas Austin, 2022

CAREER: Universal SiC-Based Power Converters for Renewable Energy Systems, *Northeastern University, 2021*

CAREER: Toward a wireless power transfer system: high-frequency power electronics, *University of Minnesota-Twin Cities, 2021*



Cyber-Physical Systems (CPS)

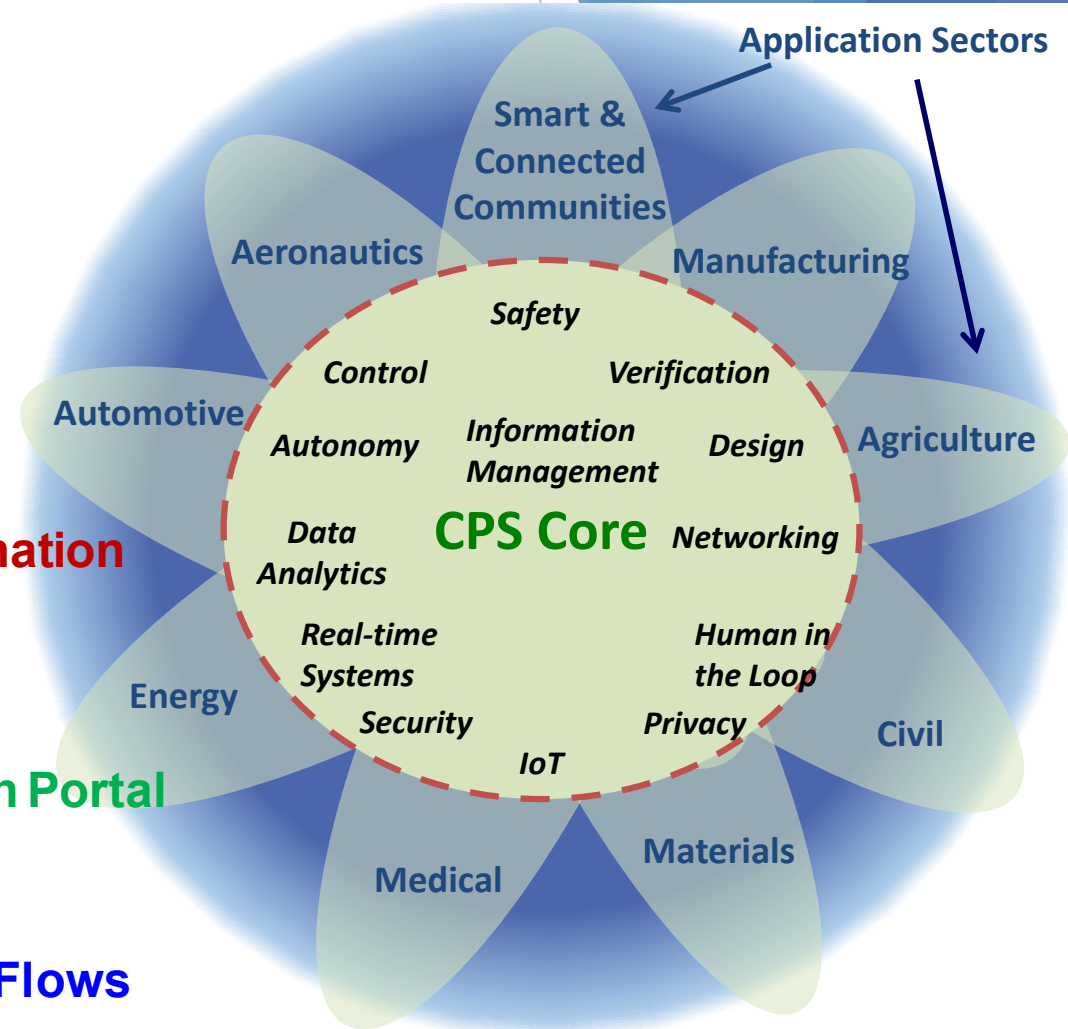
- ▶ Develop the core system science needed to engineer complex cyber-physical systems upon which people can depend with high confidence

Recently funded CPS projects in Energy Systems:

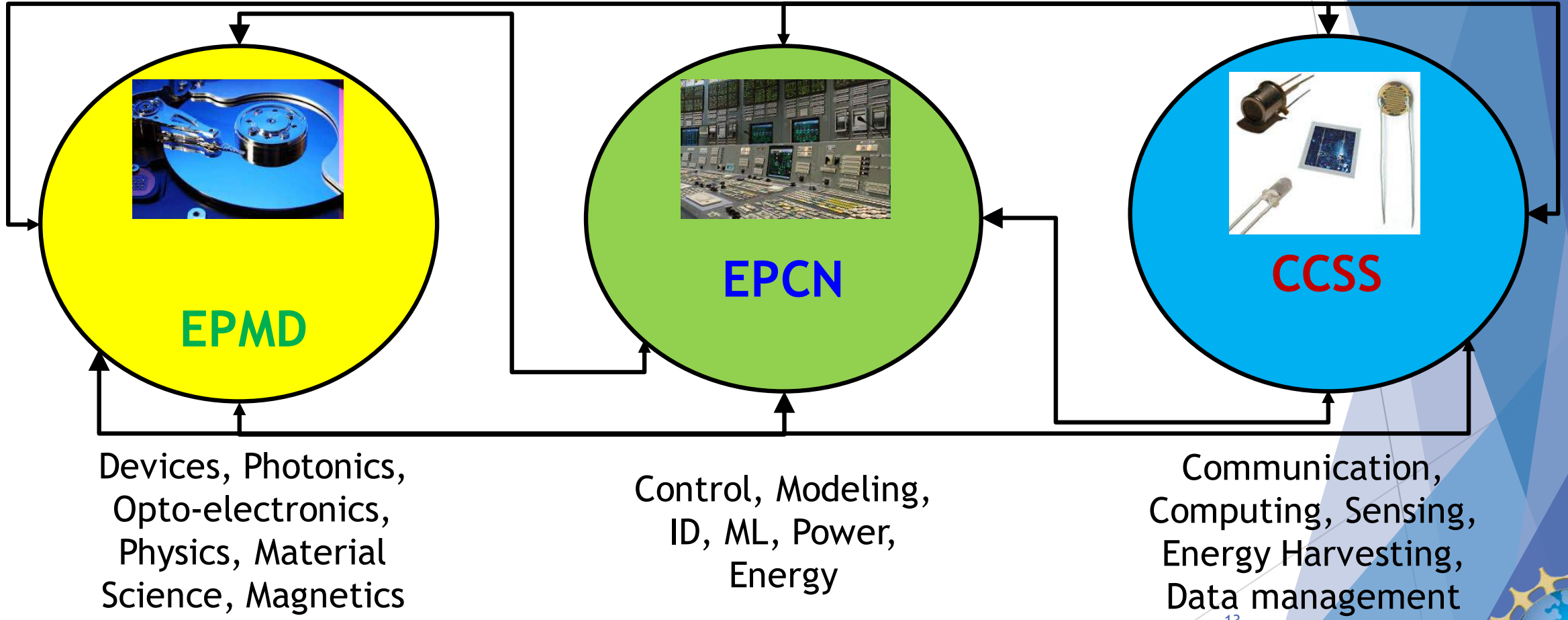
CPS: Adaptive, Human-centric Demand-side Flexibility Coordination at-scale in Electric Power Networks
Washington State Univ, 2022

CPS: TTP Option: Small: Adaptive Charging Network Research Portal
Caltech, 2019

CPS: Enabling DER Integration via Redesign of Information Flows
Johns Hopkins University, 2021



Addressing Systems Challenges through Engineering Teams (ASCENT)



FY23 Focus Area: “Climate Change Solutions”



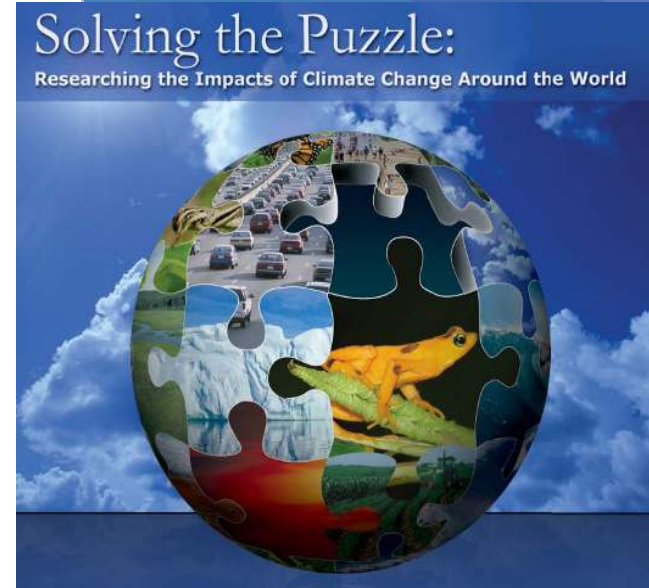
Three recent DCLs: CAS-Climate, Clean Energy Tech, Net-Zero

- Efficient and massive-scale integration of DERs
- Collaboration between climate science, physics, chemistry, material science, ML and power systems
- Resilience against hurricanes and wildfires
- EAGER (\$300K), RAISE (\$1M), Workshop grants (\$50K)

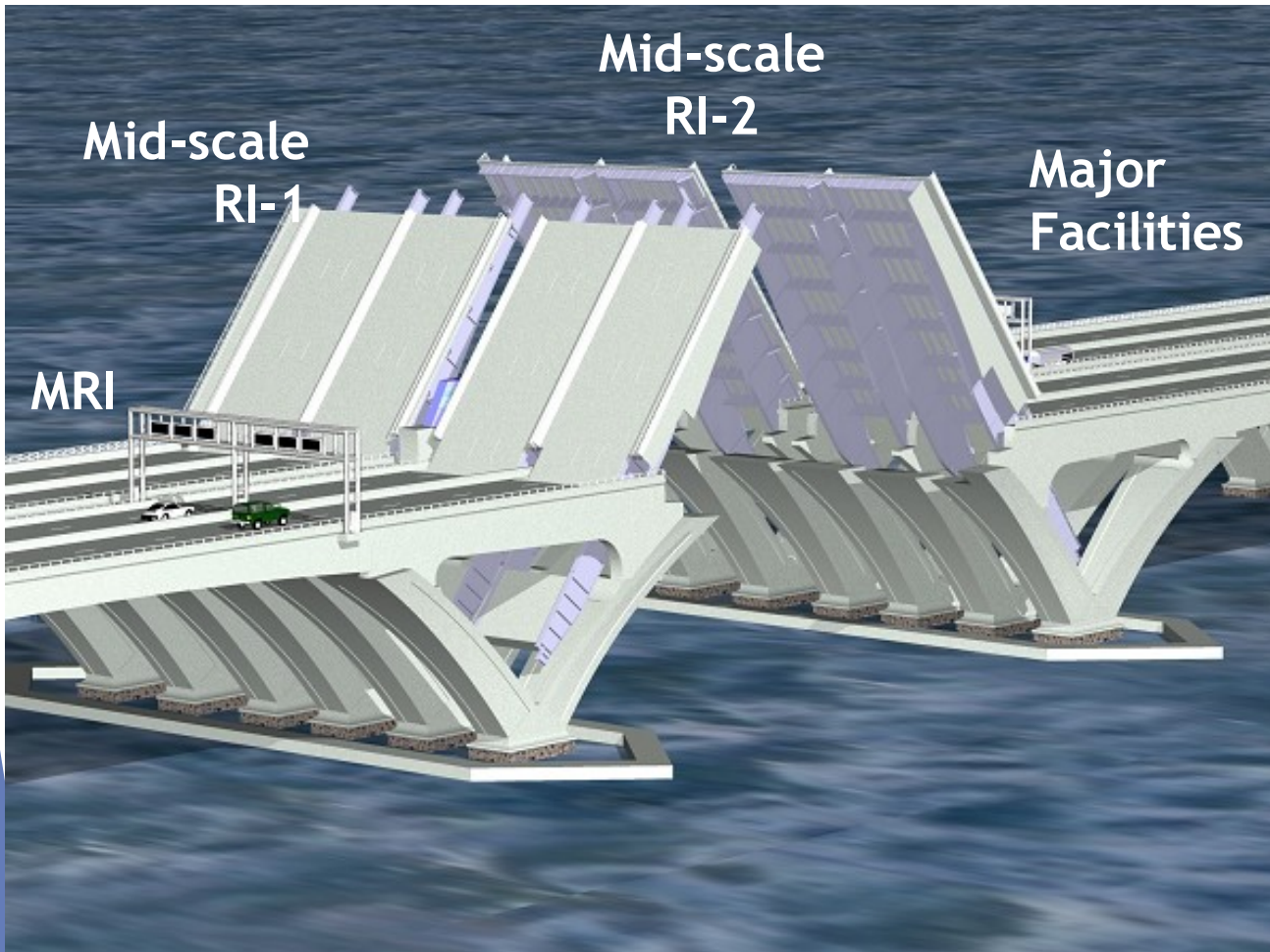


Sustainable Regional Systems (SRS)

- **Prediction:** Unable to accurately frame and model urban sociotechnical futures and how to improve them
- **Coordination:** Limited understanding on how different actors can effectively coordinate to build and maintain SUS.



Midscale Research Infrastructure 1 & 2



- **Midscale-2 award to UC San Diego on Microgrid Infrastructure Development (DER-Connect)**
- **Midscale-1 award to U Arkansas for SiC testing**

- Facilities that fall between Major Research Instrumentation (MRI) program and the Major Multi-user Facilities range.
- NSF needed a new agile process for funding experimental research capabilities in the mid-scale range.
 - Mid-scale RI-1: \$4 - <\$20 M
 - Mid-scale RI-2: \$20 - \$100 M

UC San Diego News Center

thisweek@ucsandiego

By Ioana Patringenaru

Oct 29, 2020

Subscribe

\$39 Million Grant to Better Integrate Renewables into Power Grid

The National Science Foundation has awarded \$39 million to a team of engineers and computer scientists at the University of California San Diego to build a first-of-its-kind testbed to better understand how to integrate distributed energy sources such as solar panels, wind turbines, smart buildings and electric vehicle batteries into the power grid. The goal is to make the testbed available to outside research teams and industry by 2025.

Question & Answer

Email: achakrab@nsf.gov

