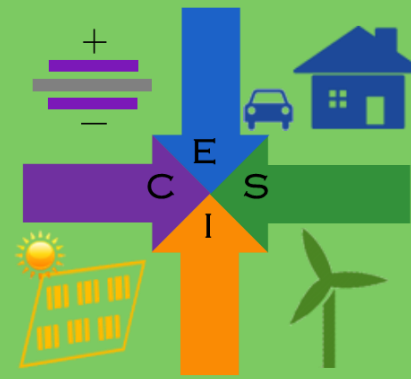
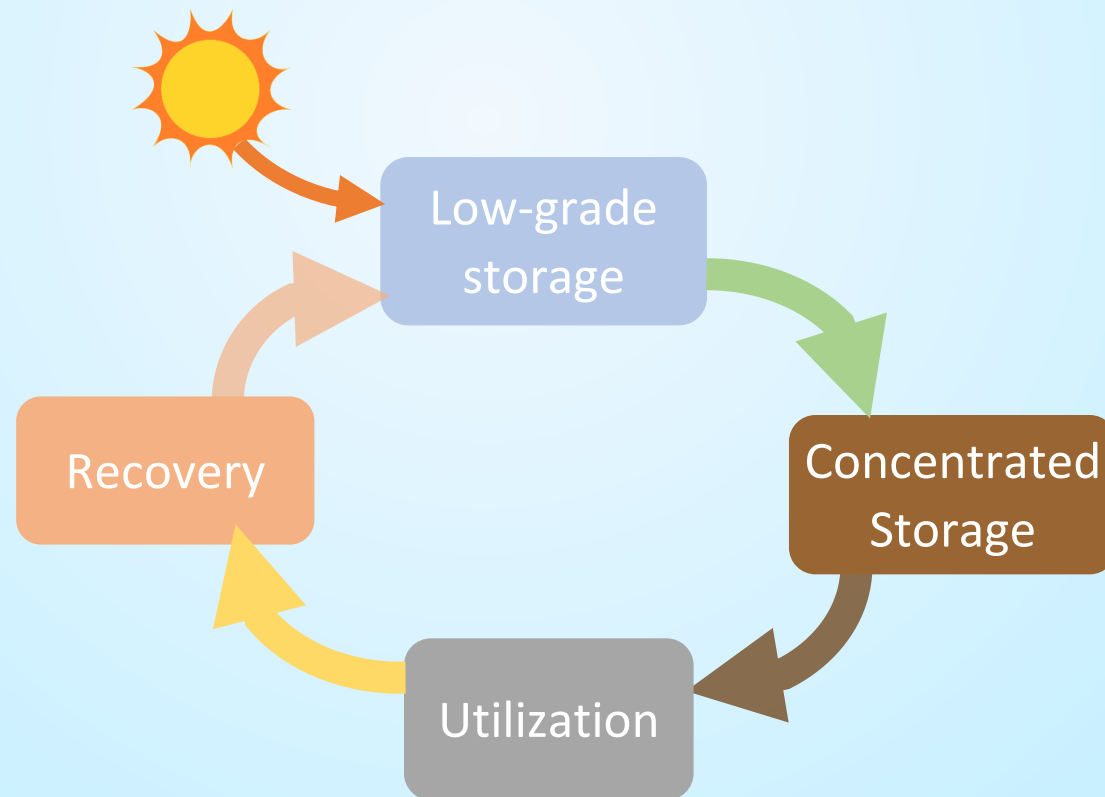


# CLEAN ENERGY SYSTEMS INTEGRATION LAB

WASHINGTON STATE UNIVERSITY



# Food-Energy-Water



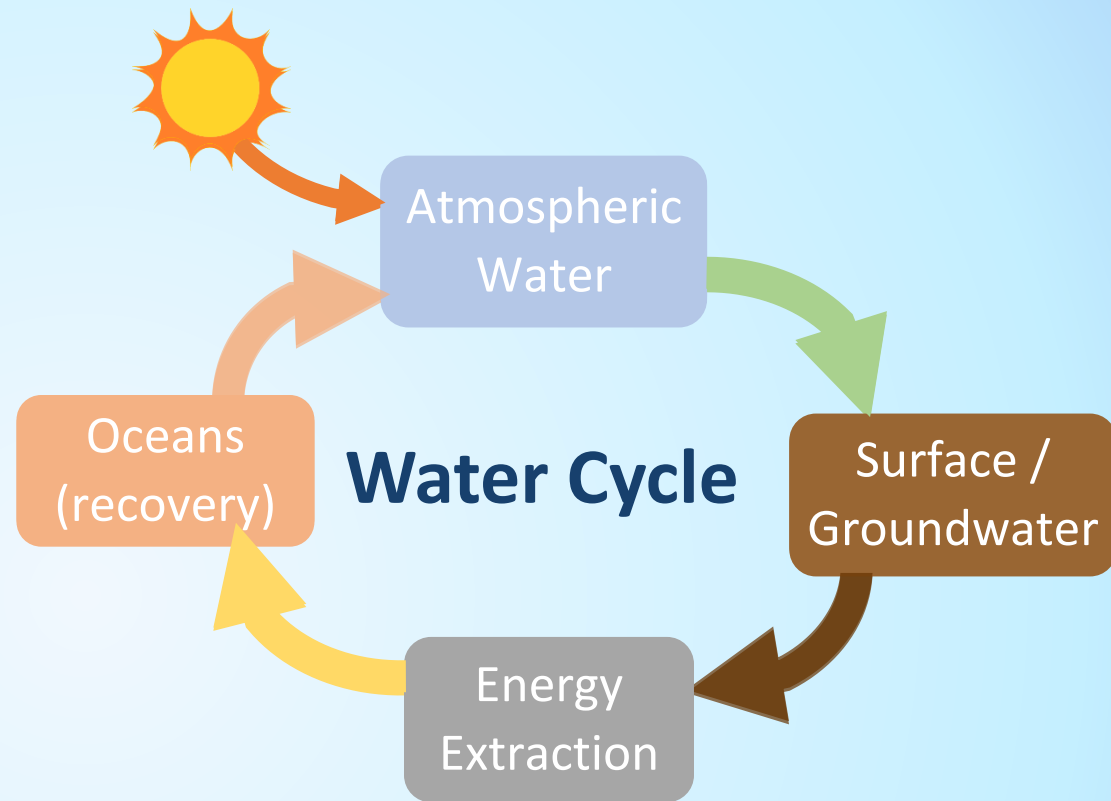
# Meeting Outline

- » FEW umbrella context
- » NSF solicitation
- » Example of integrating diverse topics under FEW umbrella
- » FEW concept exercise
- » Brain storm cross-discipline project concepts
- » Form teams around project concepts
  - > Identify additional faculty to recruit to teams



# FEW Umbrella

Build storage into renewable energy generation using the natural food, water, and energy cycles



- » **Storing Energy:** finding synergies that allow food/energy/water extraction from the cycles at the time of demand
- » **Concentrating** the resource through artificial pathways for more efficient extraction
- » **Accelerating** the slowest part of the natural system to increase the resource capacity
  - > Enhance positive feedback
  - > Increase transport pathways
  - > Extract negative feedback components



# NSF Solicitation

## » Innovations at the Nexus of Food, Energy and Water Systems (INFEWS)

- > \$50M in funding split between Cat1 (\$1M→\$3M) and Cat2 (<\$1M)
- > Track 1: FEW System Modeling
  - + Must define/quantify spatially heterogeneous FEW systems responses to various internal and external driving factors that occur on both short and long timescales.
  - + Must be generalizable to multiple sites or time scales
- > Track 2: Visualization and Decision Support for Cyber-Human-Physical Systems at the FEW Nexus
  - + New analytic algorithms that will (a) support real-time management, near-real time decision making, and longer term planning; and (b) provide a science basis to aid in policy generation for decision making on week to decadal timescales and across multiple closely integrated systems



# NSF Solicitation

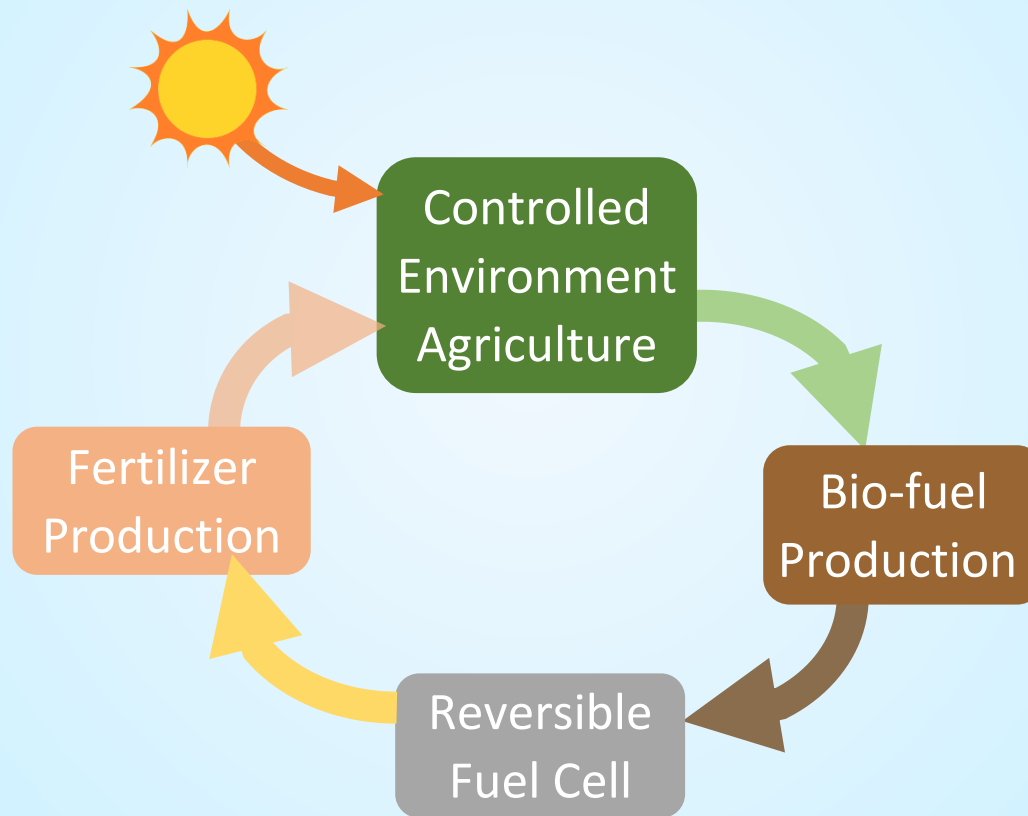
## » Innovations at the Nexus of Food, Energy and Water Systems (INFEWS)

- > Track 3: Research to Enable Innovative System Solutions
  - + Efficient Use of Resources: address production, consumption and waste
    - Devices, sensors, catalysts, nanomaterials, smart filters, and processes for detecting, removing, destroying or converting compounds of concern from waste streams
    - Or conversion into valuable primary or secondary products
    - Reveal uses for ‘waste’ that do not require complete reversion back to pristine conditions.
  - + Research on innovative strategies for appropriate management of natural and physical systems
- > Track 4: Education and Workforce Development
  - + Develop a cadre of citizens, scientists and engineers capable of thinking across Food-Energy-Water disciplines and systems
  - + “could be aligned with an INFEWS Track (1, 2, or 3)”
    - I believe a Track 4 project should be coupled with Track 1, 2, or 3 for an extra \$500K-\$1M addressing the outreach/education portion of any NSF project



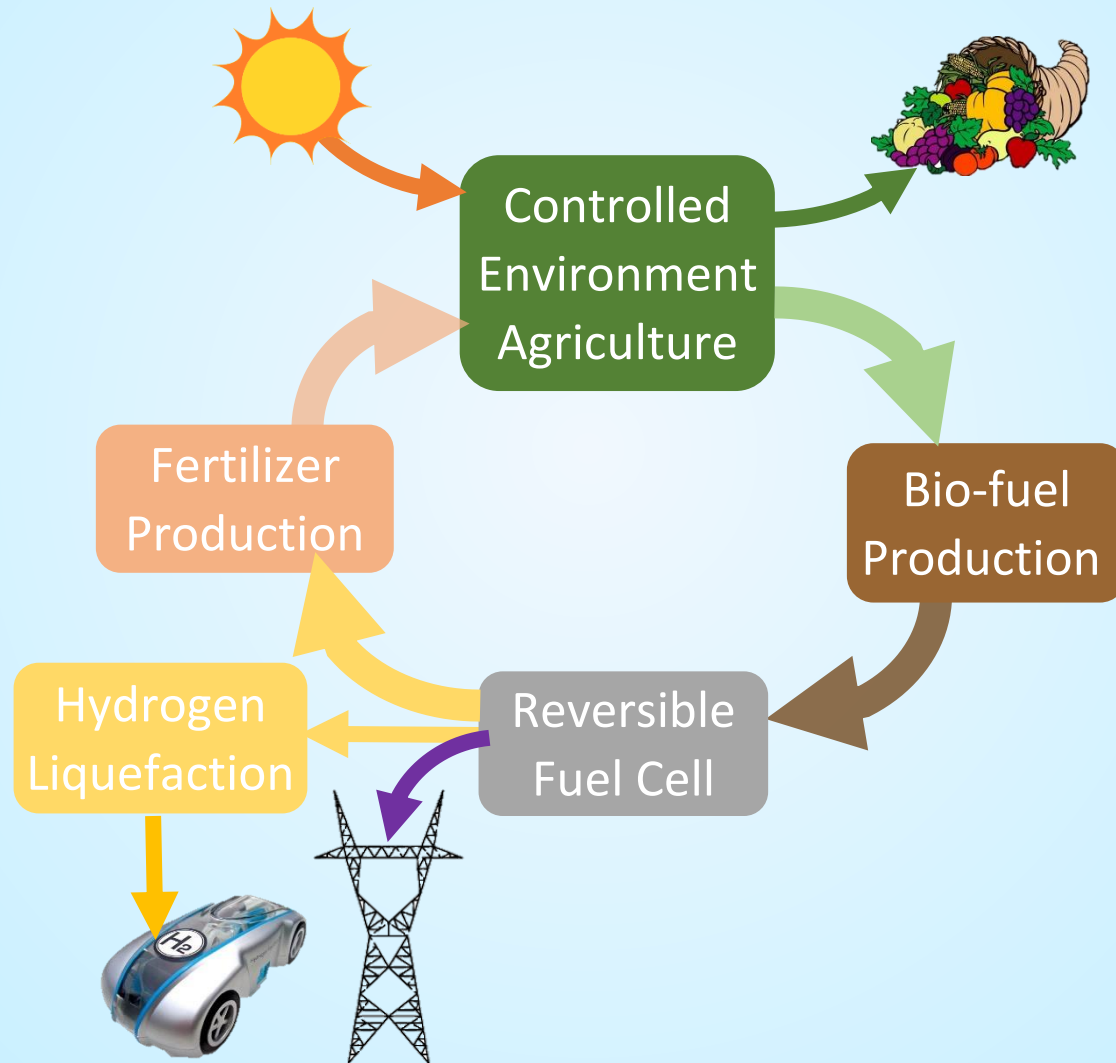
# Cross-disciplinary Example

1. Replace natural processes with engineered (accelerated) pathway



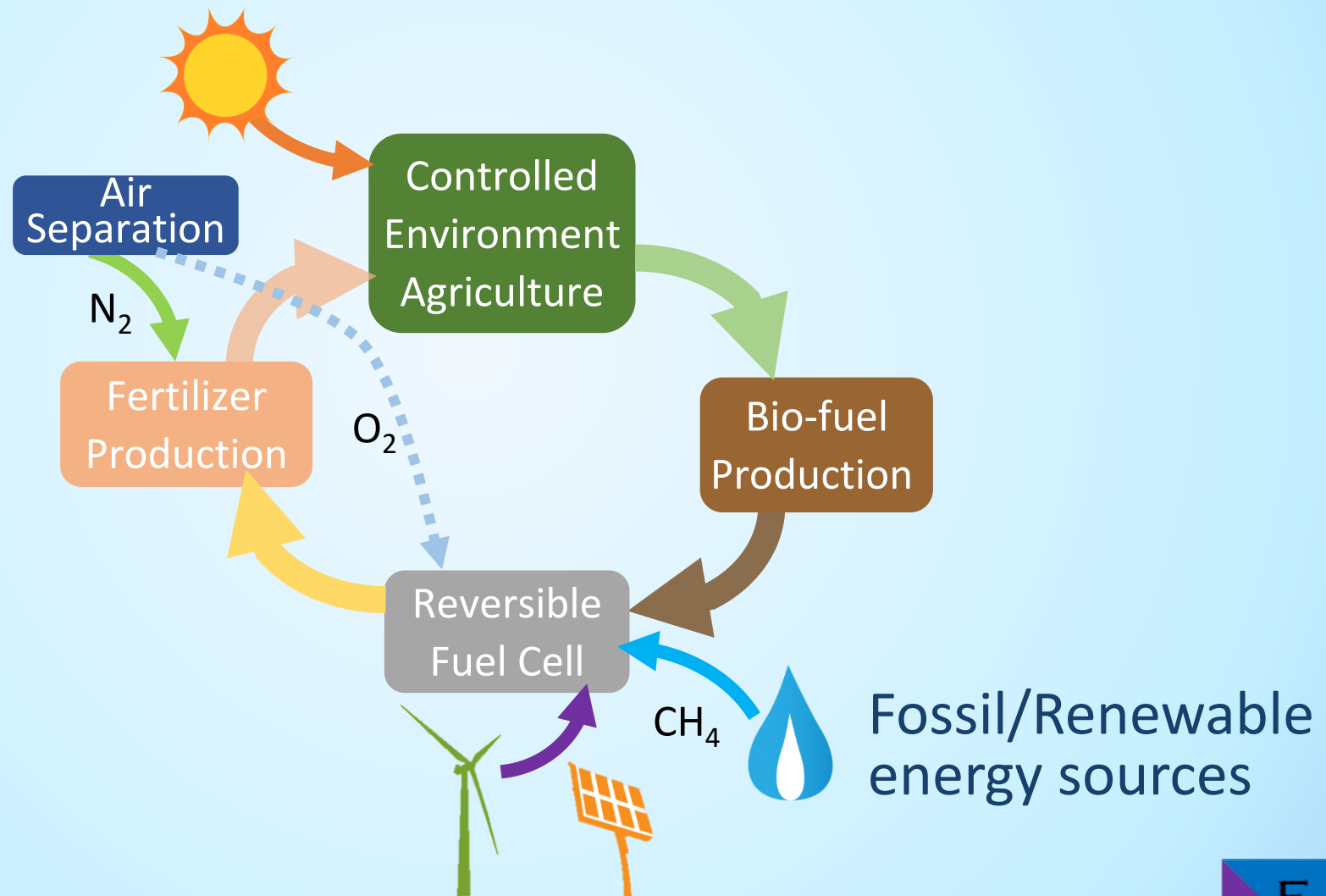
# Cross-disciplinary Example

## 2a. Identify energy extraction goals



# Cross-disciplinary Example

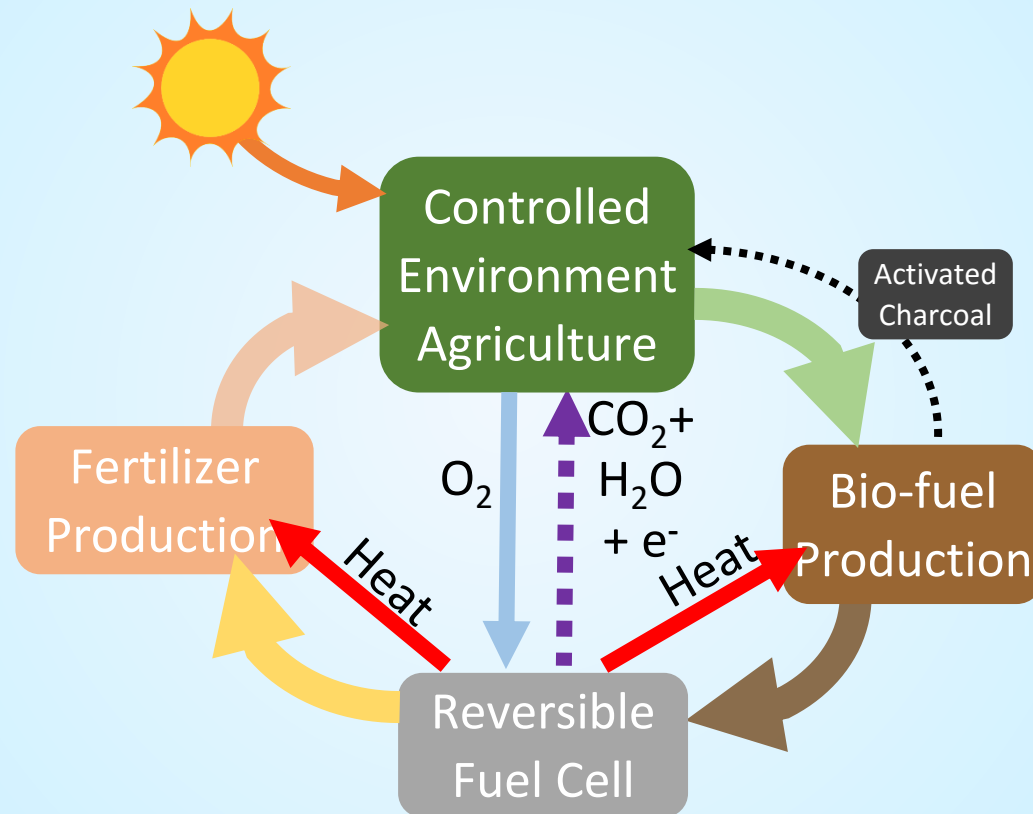
## 2b. Identify additional inputs





# Cross-disciplinary Example

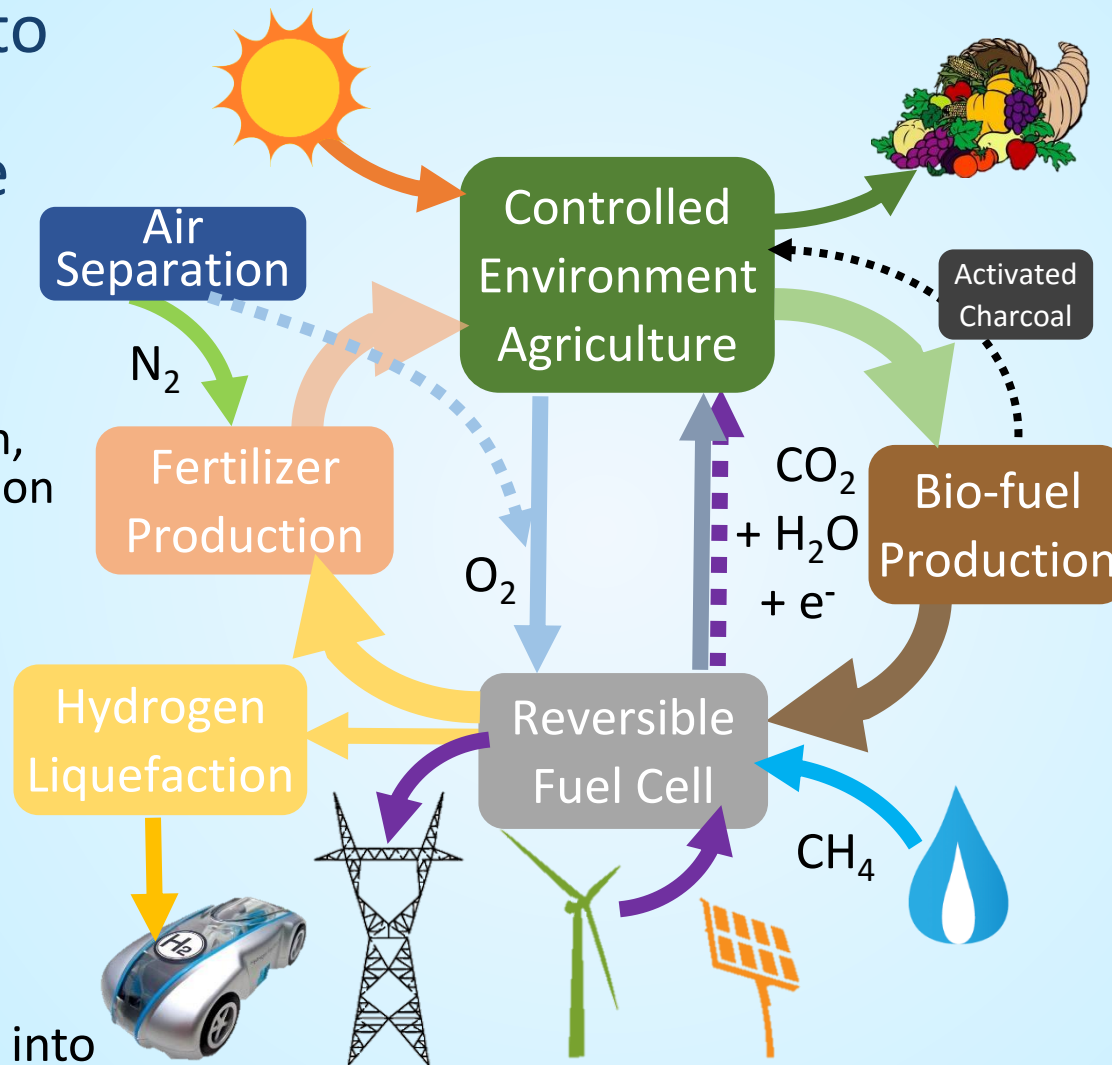
## 3. Identify feedback pathways & synergies



# Cross-disciplinary Example

## » Track 3: Research to Enable Innovative System Solutions

> Address  
production,  
consumption  
and waste



+ Conversion into  
valuable primary or  
secondary products

+ Use of 'waste' without  
reversion back to  
pristine conditions.

+ Devices, sensors,  
catalysts,  
nanomaterials, smart  
filters, and processes  
for detecting,  
removing, destroying  
or converting  
compounds of  
concern from waste  
streams

