



# *Holistic, Global Decarbonization through Hydrogen*

**Jay Kapat**

Pegasus Professor and Trustee Chair  
Mechanical & Aerospace Engineering

Director, Center for Advanced Turbomachinery & Energy Research

[jayanta.kapat@ucf.edu](mailto:jayanta.kapat@ucf.edu)

(407) 617-1201

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# Proposed Activities

*(This slide will be revisited after motivation behind this proposal is presented)*

## **(1) Creating a Local Hydrogen Hub**

- Hydrogen as a means for long-duration storage for renewable energy
- Hydrogen as a fuel for combined cycle power plants
- Towards Zero-Carbon Aviation with GOAA/MCO as a Test Bed
- Decarbonized Tourism Industry

## **(2) Decarbonizing Hard-to-Carbonize Industries**

- Cement Industry
- Steel Industry
- Aluminum Industry

## **(3) Education and Outreach on “Holistic, Global Decarbonization”**

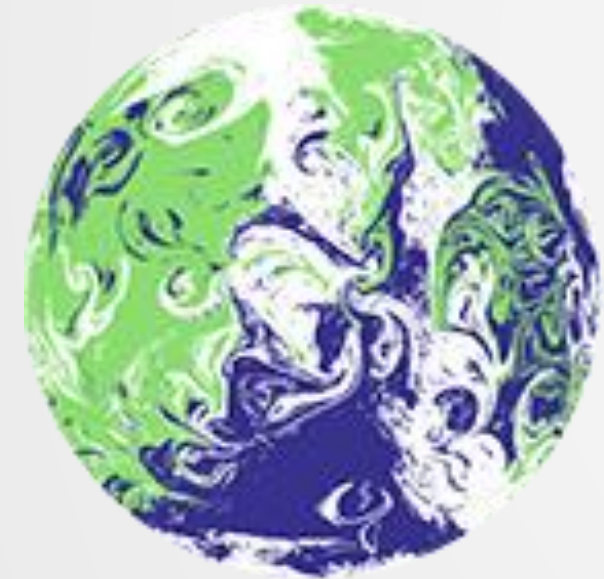
- To include Political Science, Economics, Hospitality Management
- New Certificates and Masters
- Creating MOU’s with International Universities to “Share”
- Outreach to Community/State Colleges and K-12

# Decarbonization, COP26, and Energy Earth Shots

## What is Decarbonization:

*Decarbonization can be defined as collection of steps or actions that avoid release of carbon dioxide\* into the atmosphere.*

(\* and other greenhouse gases)



**UN CLIMATE  
CHANGE  
CONFERENCE  
UK 2021**



*Fashioned after President Kennedy's  
MoonShot program from 60's*

*First Summit was held on Aug 31 & Sep 01*



*Fashioned after President Kennedy's MoonShot program from 60's*

*First Summit was held on Aug 31 & Sep 01*

## **A Quick Look at the Infrastructure Bill:**

**Just *Hydrogen and Carbon Capture+Removal* topics total ~\$20B.**

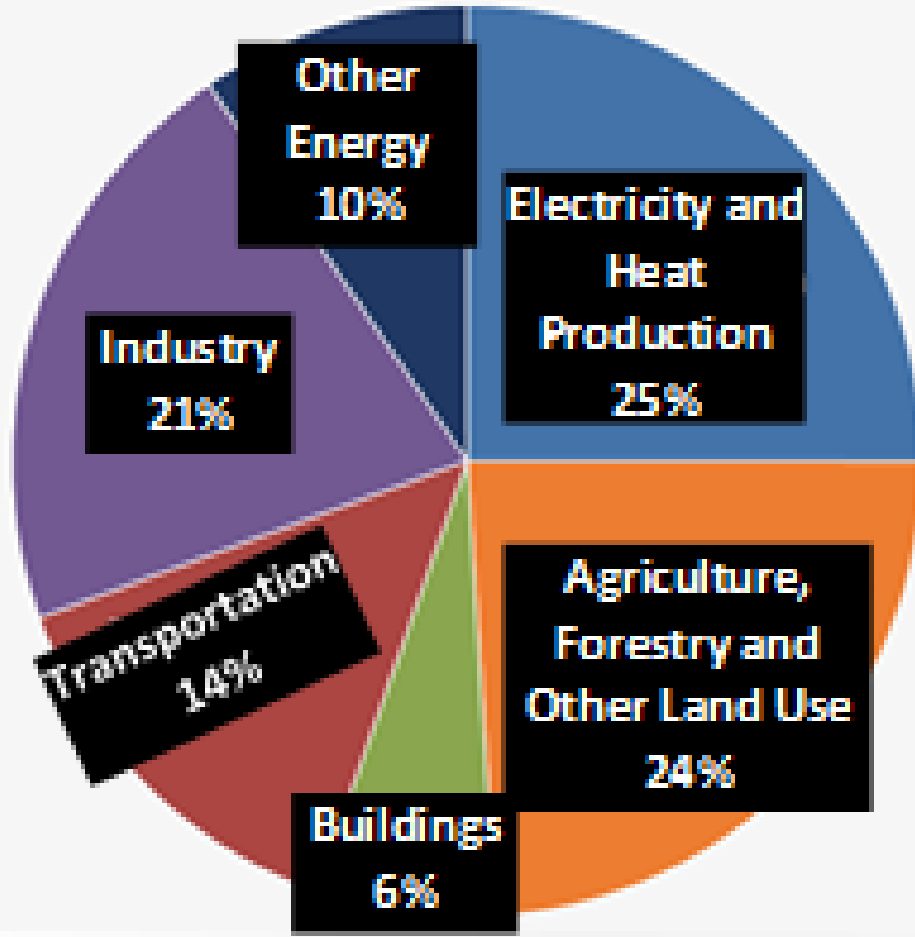
*This amount, for example, includes 4 regional hydrogen hubs for a total of \$8B.*

***We are working with GTA and CURC (congressional advocacy groups) to identify opportunities and helping them to develop 15-year roadmaps.***

### **Google Scholar Citations**

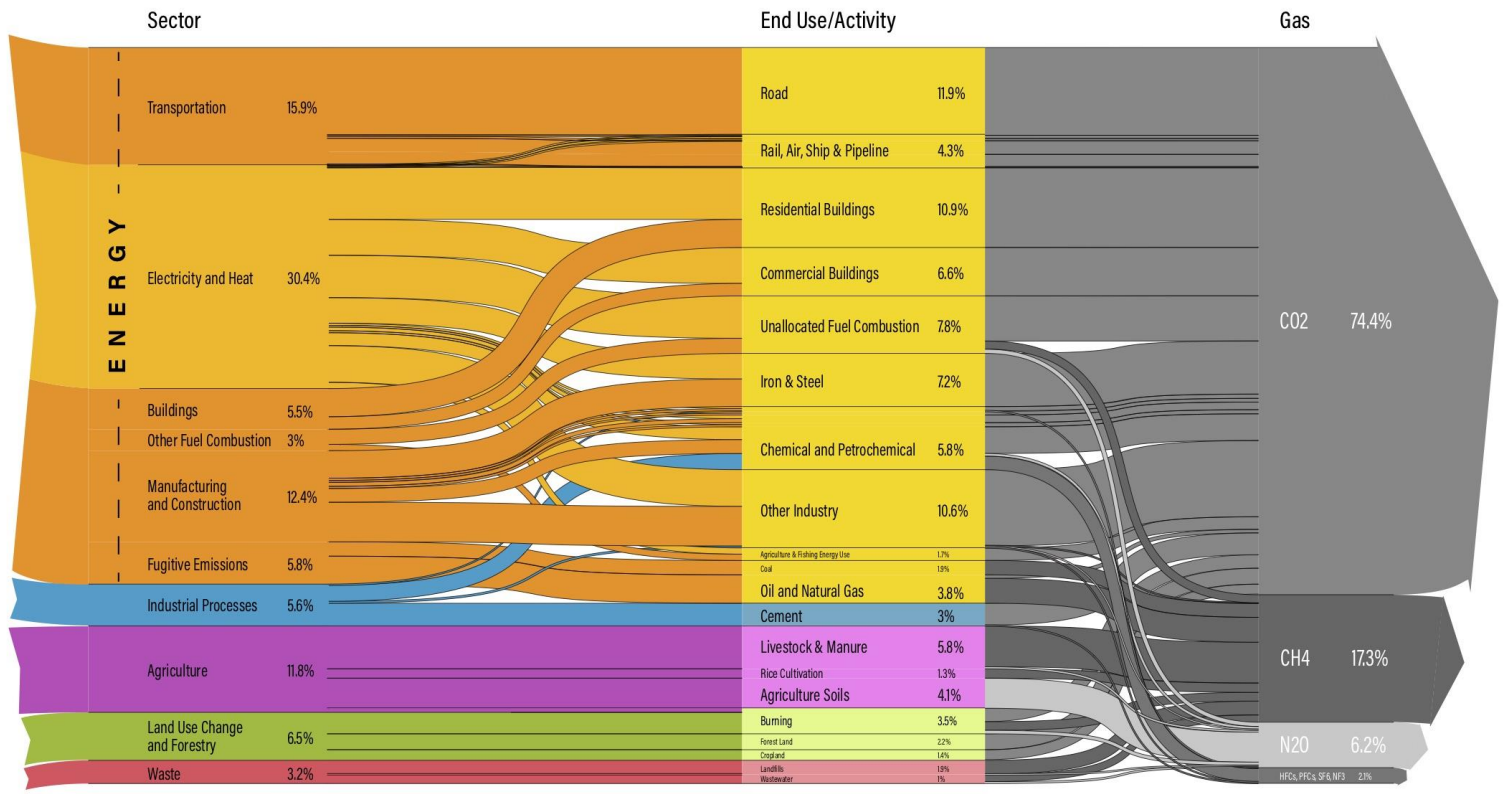
<b>Decarbonization</b>	<b>4.41M</b>
<b>Hypersonics</b>	<b>0.21M</b>
<b>Smart Grid</b>	<b>1.65M</b>

# Decarbonization must encompass all aspects of life



Global Greenhouse Gas Emissions by Economic Sector

World Greenhouse Gas Emissions in 2016  
Total: 49.4 GtCO<sub>2</sub>e

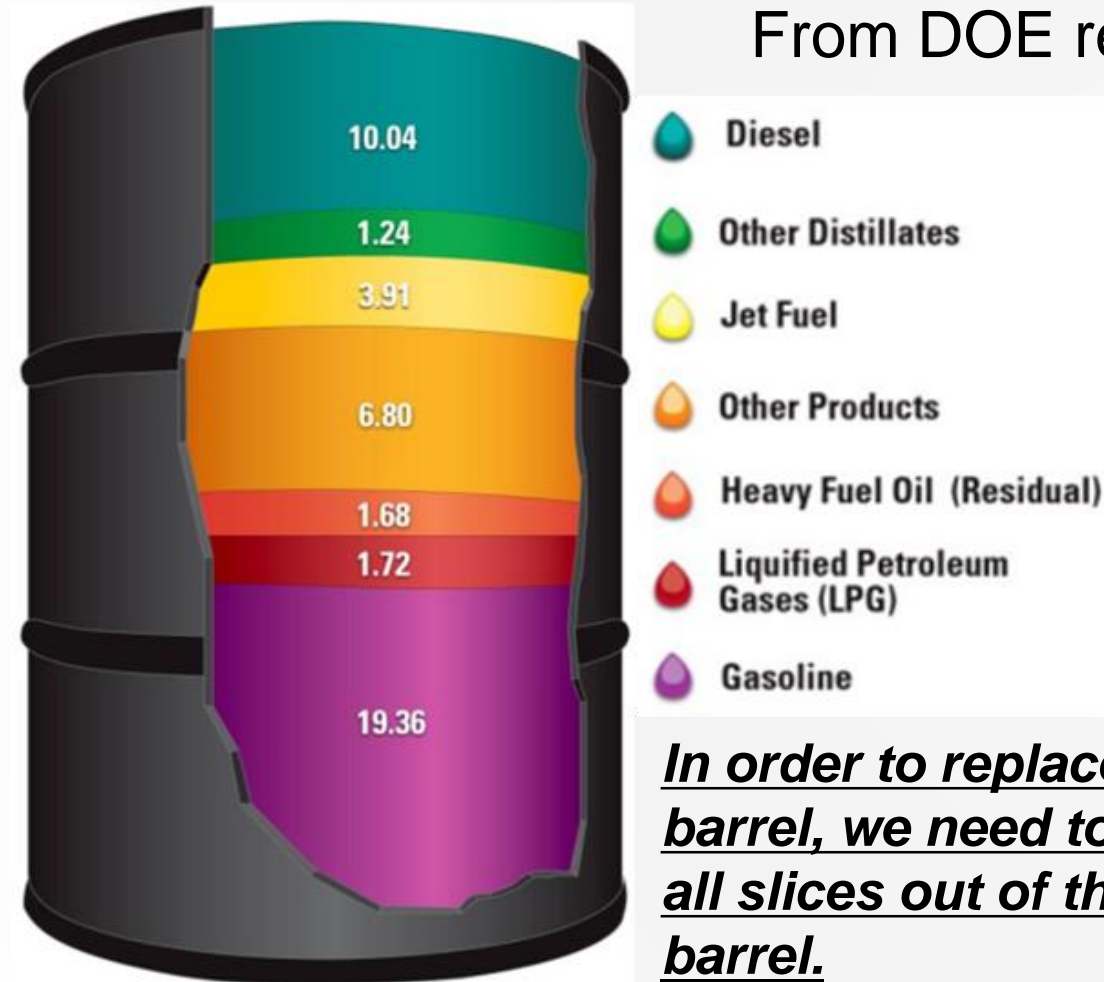


Source: Greenhouse gas emissions on Climate Watch. Available at: <https://www.climatewatchdata.org>

# Decarbonization must encompass all aspects of life (cont)

Out of about 45 gallons of products that are derived from one barrel of crude:

From DOE report



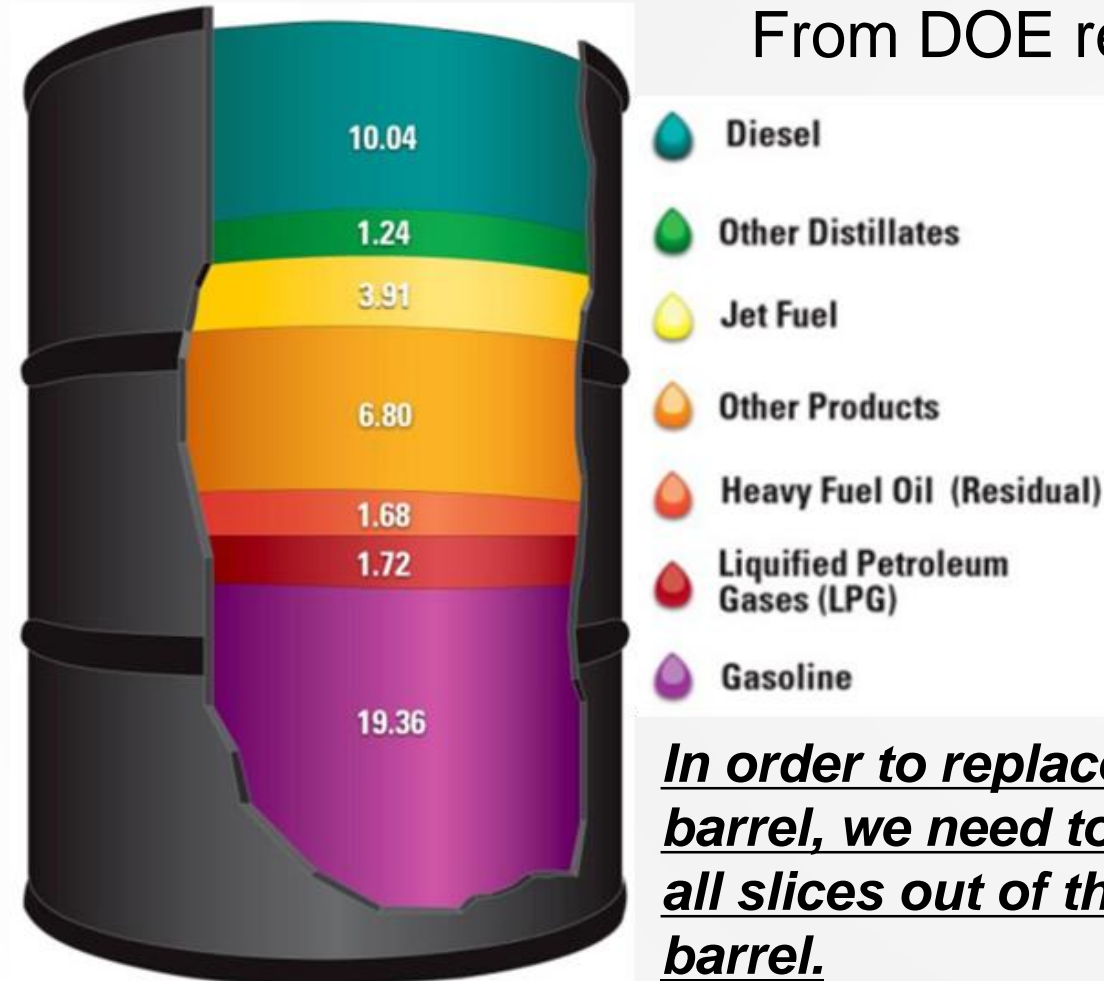
*In order to replace one barrel, we need to replace all slices out of that barrel.*

***Incomplete information can only provide incorrect conclusion.***

# Decarbonization must encompass all aspects of life (cont)

Out of about 45 gallons of products that are derived from one barrel of crude:

From DOE report

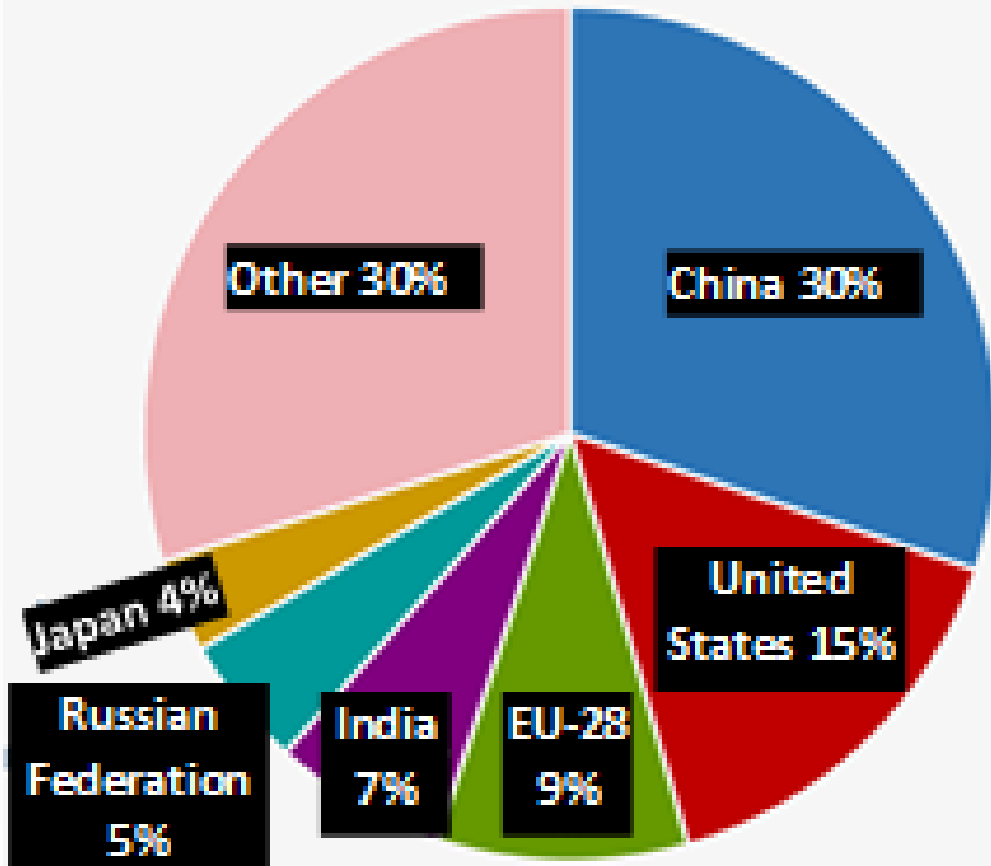


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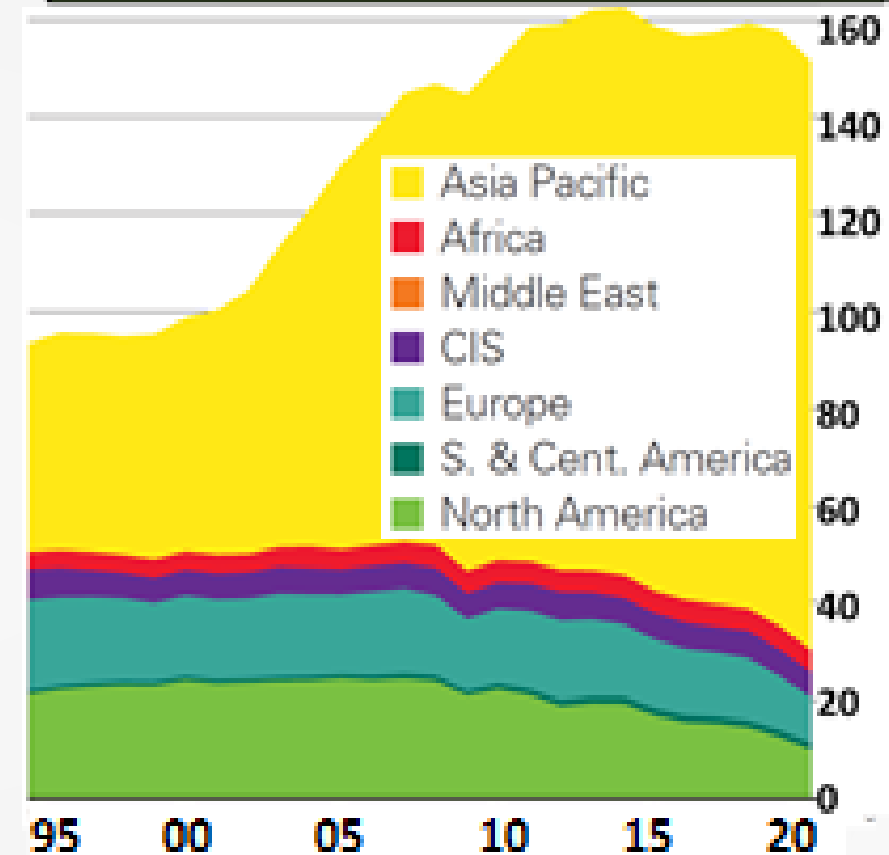
***Engineers (1) must start with definition of problem, ROM estimation of cost, and cost-solution optimization to arrive at affordable solutions, (2) must educate the public and policy makers.***

# Decarbonization must encompass all parts of the world

2014 Global CO<sub>2</sub> Emissions from Fossil Fuel Combustion and Some Industrial Processes



Coal consumption over 25 years (in exajoules)



*So far, Quality of life in modern civilization has been proportional to release of CO<sub>2</sub> (and GHG).*

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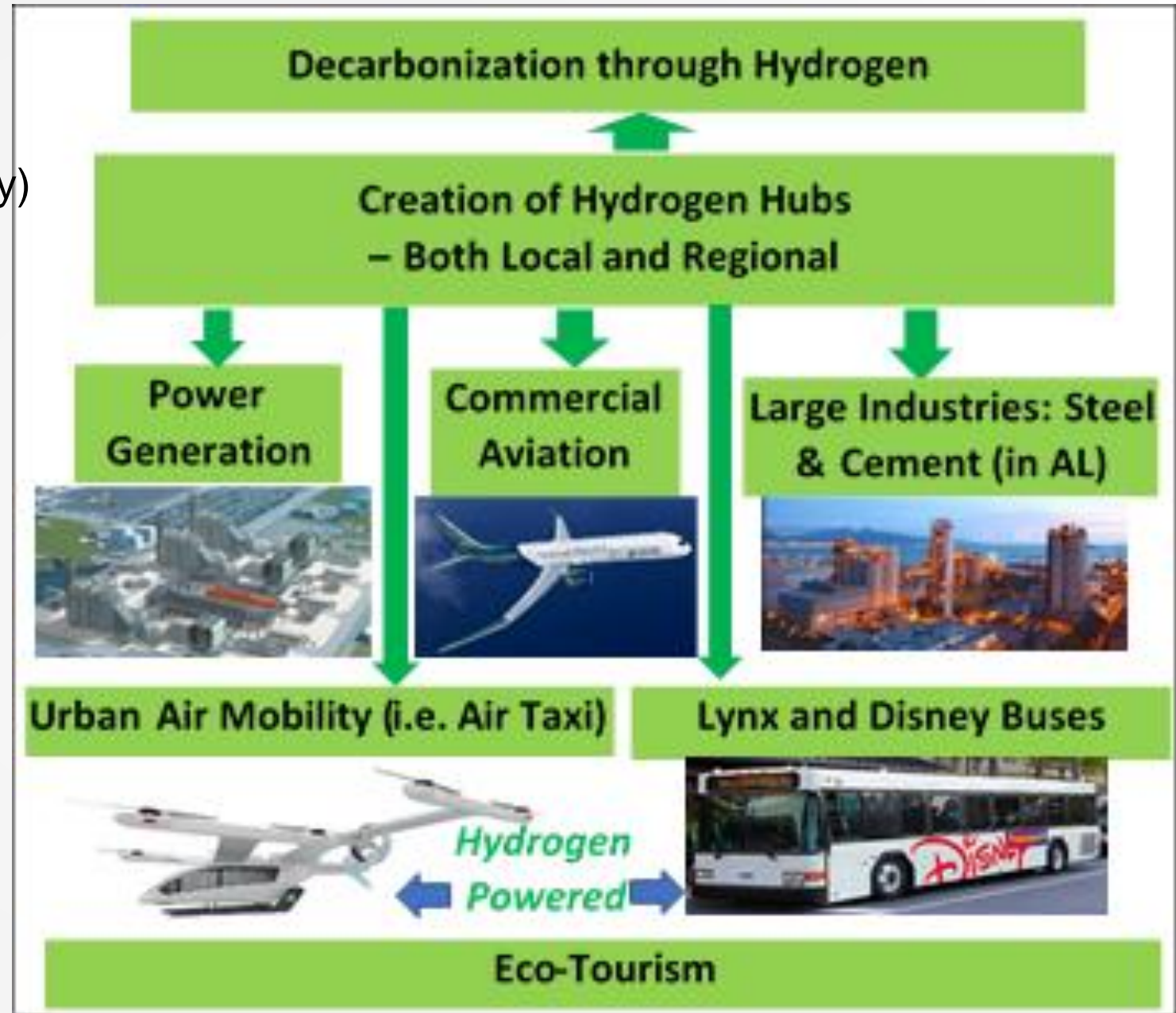
# Example:

## Potential Hydrogen Hub

(originally proposed by Southern Company)

### *Just An Example*

*But can be a reality with a number of world's best known companies in our city, in and around our state, and potentially partnering with GA (GTech), AL (UA), SC (Clemson), NC (UNCC).*



# Zero-Carbon Engine Core with Supercritical Carbon Dioxide Power Cycle for Onboard Power

NASA ULI Strategic Thrust 7 – Zero Emission Aviation

**J. Kapat (Overall PI), S. Vasu, R Blair, S. Hick, H-J. Kiesow, E. Fernandez, L. Vesely, M. Otto** – *University of Central Florida (MSI)*

**G. Paniagua (Institutional PI), T. Meyer** – *Purdue University*

**D. Mavris (Institutional PI), J. Gladin** – *Georgia Institute of Technology*

**G. Natsui (Institutional PI), K. McManus,** – *GE*

**M. Stoia (Institutional PI), K. Jui, N. Applegate** – *Boeing*

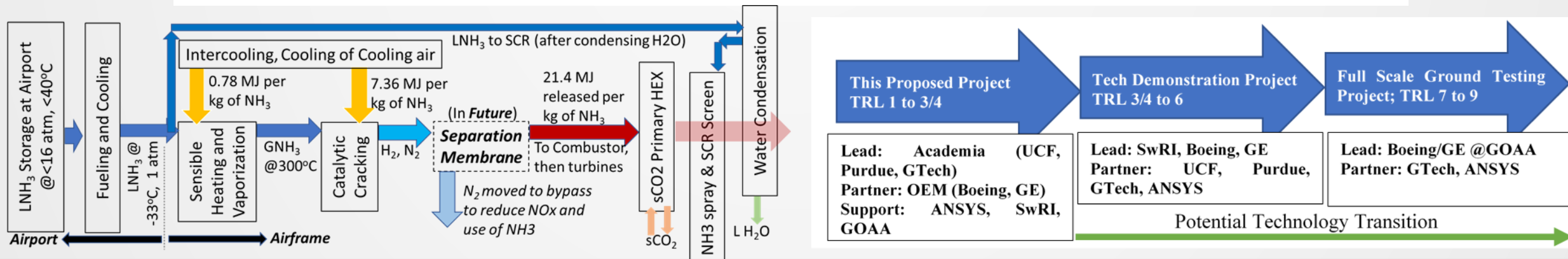
**S. Saxena** – *ANSYS*

**J. Schmitt, T. Allison, G. Musgrove** – *Southwest Research Institute,*

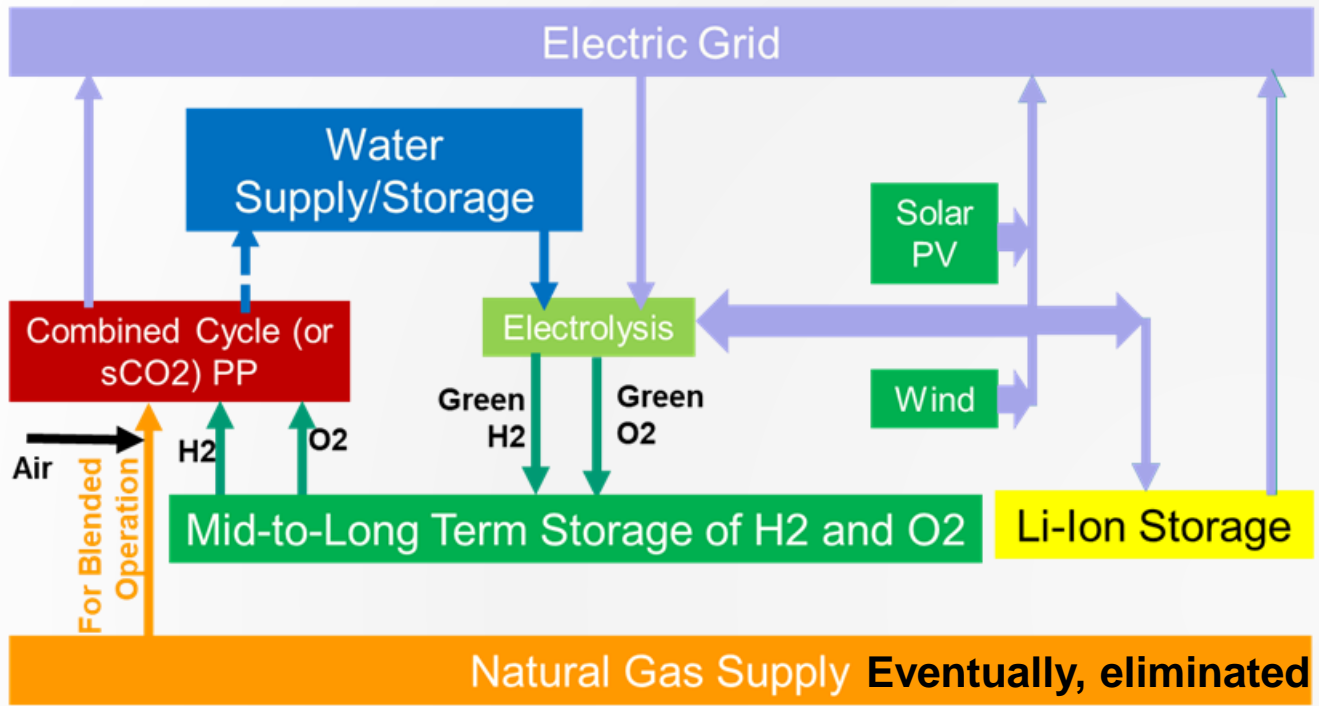
**K. Thompson** – *Greater Orlando Aviation Authority*

**Total Budget Requested: \$9,978,816 (August 1, 2022 – July 31, 2027)**

**Total Cost Share: \$486,761 (not including some Faculty release time, and industry internships)**



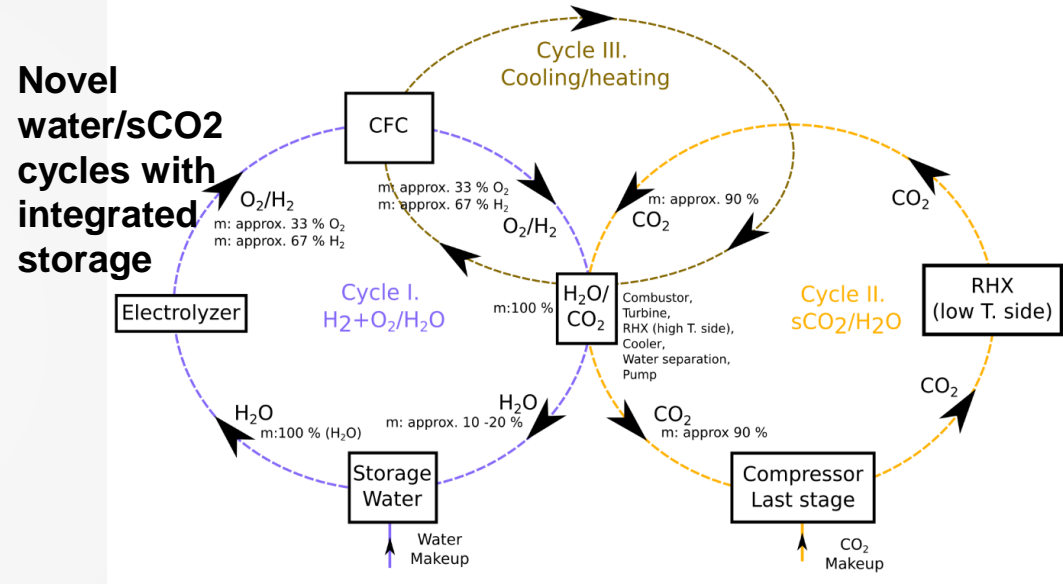
# Example: Hydrogen as a storage for Renewables for Power Generation



Mitsubishi Power, Florida university develop online generation sector NOx tracking tool

**POWER Engineering**

By Rod Walton - 8.20.2021



UCF TODAY

## UCF Leads Hydrogen Gas Turbine Research Aimed at Decarbonizing Power Sector

The work is funded by an \$800,000 award from the U.S Department of Energy.

BY ROBERT WELLS | SEPTEMBER 13, 2021

DOE (NETL, ARPA-E, SETO, NE\*):

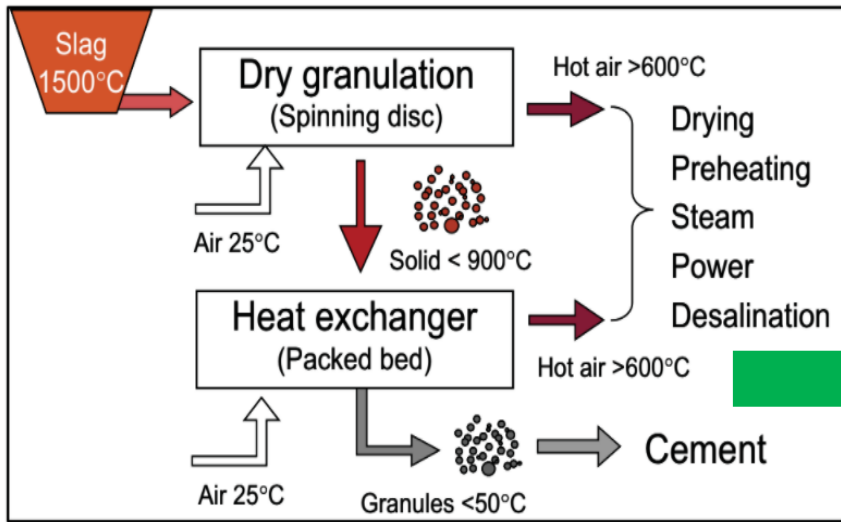
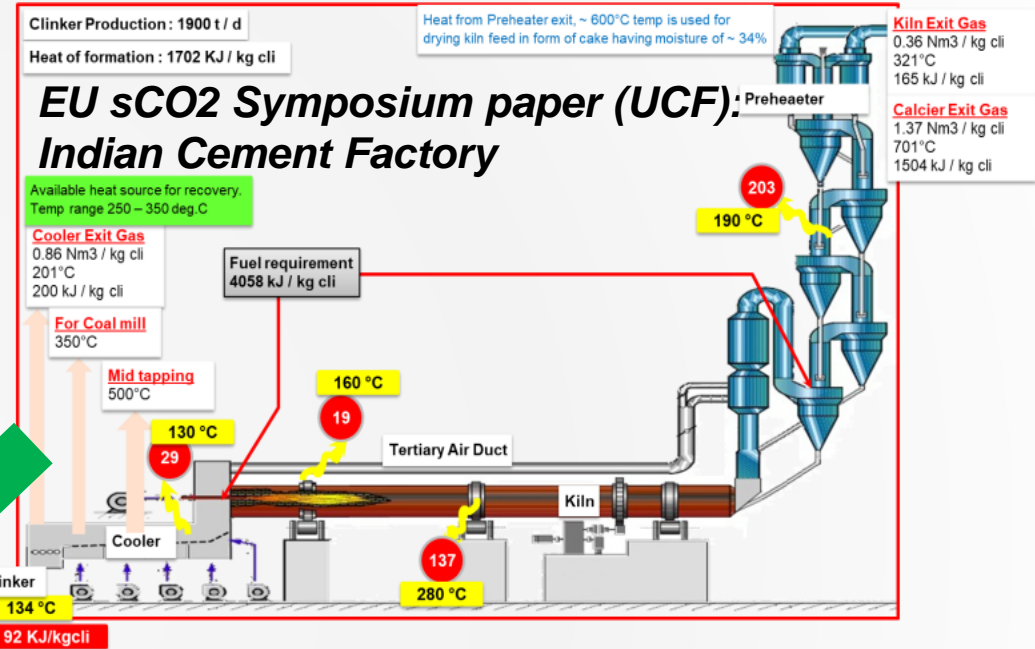
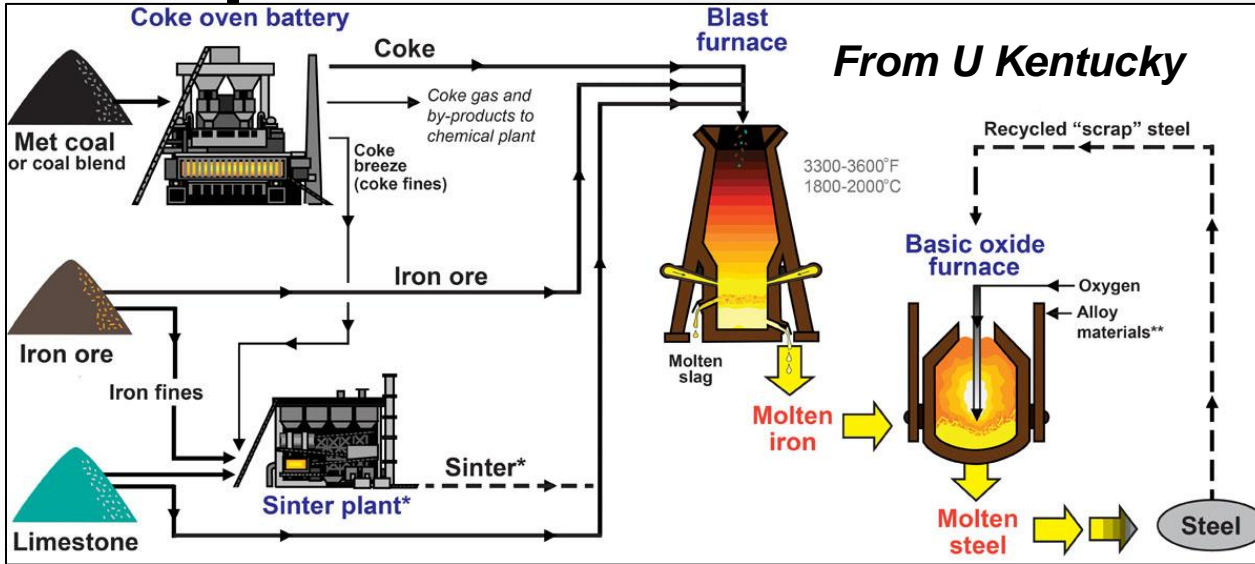
*Vasu (H<sub>2</sub> comb)*

*Kapat (H<sub>2</sub> storage)*

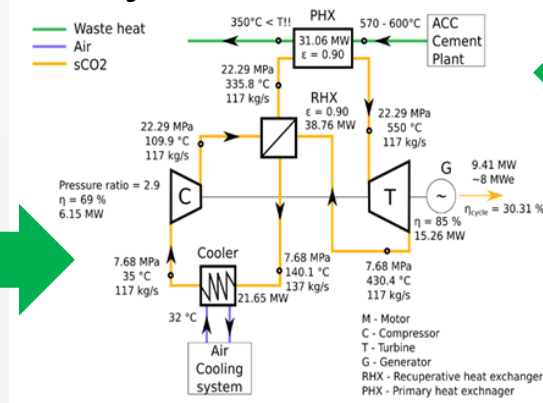
*\*Extracting thermal energy from a fusion reactor*

Ahmed (Coal Detonation), Kapat (3 on sCO<sub>2</sub>), Kapat (\*high temp energy extraction)

# Example: Decarbonization of Steel and Cement Industry



## sCO2 Cycle for WHR



Sandia Lab funded Project Kapat (Steel/Cement Waste Heat Recovery)



We have technological challenges to address that could take a few lifetimes. But we only have a couple of decades.  
But engineers have done it before .....  
The MoonShot program, and  
The Apollo Moment for our Generation

(entities)

FL has its "Turbine Turnpike".

INDUSTRY WATCH

Industry, UCF team to fuel Florida's "Turbine Turnpike"

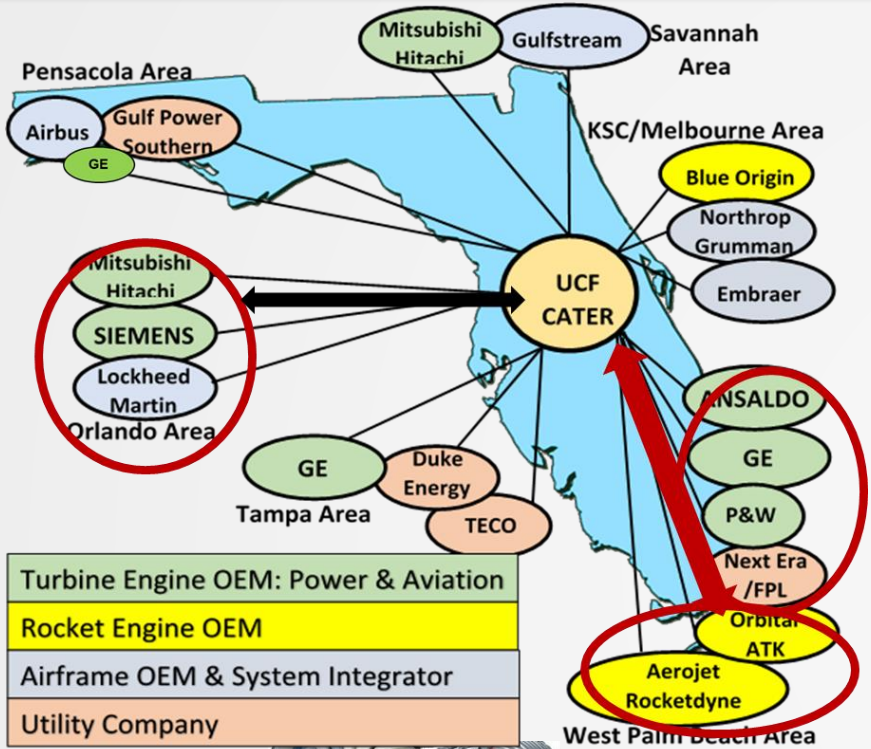


BY JAY KAPAT, SC.D., PROFESSOR OF MECHANICAL AND AEROSPACE ENGINEERING, UNIVERSITY OF CENTRAL FLORIDA



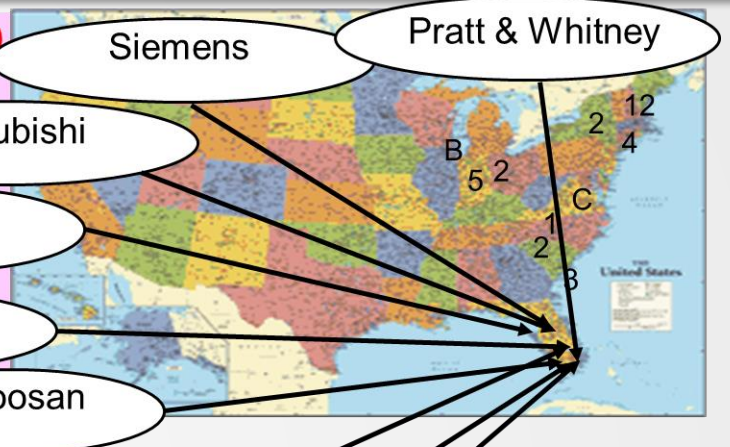


# Center for Advanced Turbomachinery and Energy Research University of Central Florida, Orlando, FL



*(entities in red have significant FL presence)*  
**OEM's for Turbines for Power and Aviation:**  
 Large **Frames** for Power/Aviation

1. Siemens
2. General Electric (+ Alstom)
3. Mitsubishi
4. Pratt & Whitney
5. Rolls Royce
6. Ansaldo / Shanghai (+Alstom)
7. Doosan



**US OEM's for Rocket Engines are in FL as well:**

1. Aerojet Rocketdyne
2. Orbital ATK
3. Blue Origin



Top Utility Companies of the Nation are in FL too:

- #1. Duke/Progress
- #5. FPL
- #29. TECO Electric



**CA has its Silicon Valley.**  
**FL has its "Turbine Turnpike".**

INDUSTRY WATCH

## Industry, UCF team to fuel Florida's "Turbine Turnpike"

BY JAY KAPAT, SC.D., PROFESSOR OF MECHANICAL AND AEROSPACE ENGINEERING, UNIVERSITY OF CENTRAL FLORIDA





# Center for Advanced Turbomachinery and Energy Research University of Central Florida, Orlando, FL

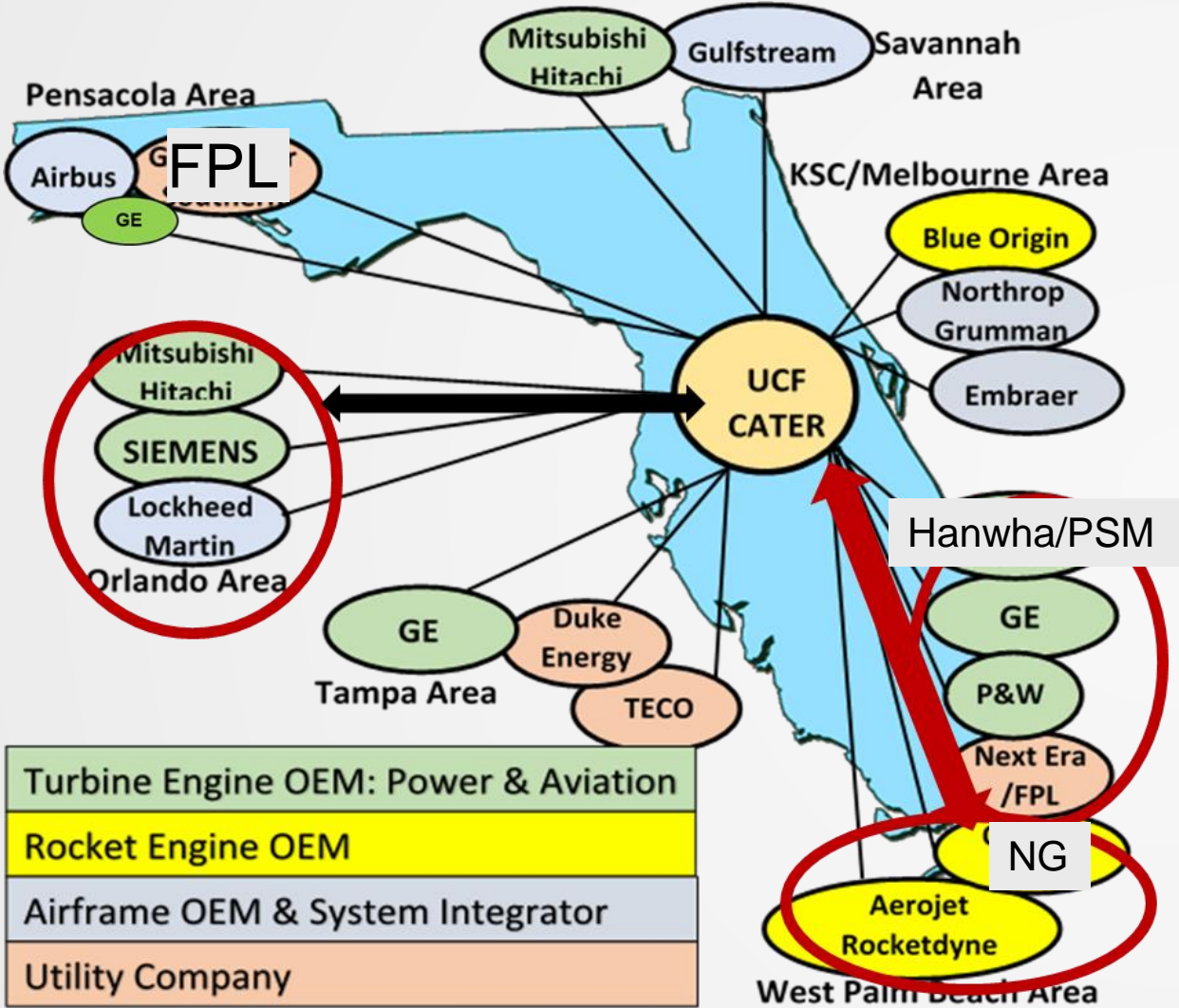
An Example: SEC (Siemens Energy Center, opened in Oct 08, 2008)



## CATER's Industry Engagement Model

- (1) OPERATED AS A COMPANY R&D Facility.
- (2) 24/7 Access for industry in a dedicated laboratory.
- (3) Security & Audit (IT & Physical) by industry.
- (4) Strict control of access, TCP (technology control plan) and SOP (standard operating procedure), including adherence to ECC & ITAR rules.
- (5) Publications happen, only when appropriate and only after approval and negotiation with the company sponsor.
- (6) Each person working subject to company
- (7) Flexible, and negotiable IP agreement.

# WE need to AUGMENT our Industry Engagement Model:



- (1) **Approach & Engagement:** Know your customer, do NOT start with the solution before knowing the problem, create a Key Account Management plan with a designated subject matter expert as the TPOC and at the table.
- (2) **Access and Communication:** Limit access to research, give access to industry partner, create a hot line to administration.
- (3) **Post-Project Feedback and Analysis:** List the lessons learned, identify the shortcomings, create a plan for future improvement.

**Thank You  
for Your Time and Attention**