University of Maryland sustainability council

Meeting Summary
May 6, 2021

Council Members Present (via Zoom):

Carlo Colella, Vice President for Administration (Chair)
Mary Hummel, Assistant Vice President, Student Affairs (in for Patty Perillo, Vice President, Student Affairs)
David Cronrath, Associate Provost
Maureen Kotlas, Executive Director, Department of Environmental Safety, Sustainability & Risk
Scott Lupin, Assoc Dir., Environmental Safety, Sustainability & Risk, & Dir., Office of Sustainability
Susan Corry, Manager, Engineering & Energy, Facilities Management
Bryan Quinn, Director of Technical Operation, Department of Electrical & Computer Engineering
Eric Wachsman, Prof., Materials Science and Engineering and Director, MD Energy Innovation Institute
Jana VanderGoot, Associate Professor, Architecture
Jennifer Hadden, Associate Professor, Government and Politics
Nina Jeffries, Undergraduate Student Representative
Nicole Barbour, Graduate Student Representative

Guests Present:

Nathan Hultman, Director, Center for Global Sustainability

Meeting start time: 10:00am

Meeting Highlights

"Maryland, Creating a Hotbed of Innovation to Cool the Planet" – *as presented by Dr. Eric Wachsman*
Dr. Eric Wachsman provided an update on the Maryland Energy Innovation Institute (MEI^2). The presentation highlights the institute's purpose, the associated Energy Storage Centers, funding support from DOE, ARPA-e awards to MEI^2 researchers, specific innovative projects, and the future of the institute in Maryland legislation. (Appendix A)

"U.S. and Global Climate Action in 2021" – *as presented by Dr. Nathan Hultman*
Dr. Nathan Hultman provided an update on the current political climate of climate action policy in the U.S. and internationally. The presentation highlights rising focus on climate change in politics, businesses, and grassroots organization. The presentation includes progress on national and sub-national climate commitments and projections for successfully meeting and surpassing these goals. (Appendix B)

Update on Student Sustainability Fee Proposals
Nina Jefferies and Mark Stewart provided a progress update on the proposal to increase the student sustainability fee. This fee funds the Sustainability Fund and the Undergraduate Commuting Offset program.

"Complete Scope 3 Progress Including Upstream Emissions from Energy" – *as presented by Sally DeLeon*
Sally DeLeon presented on the protocols for including upstream emissions from natural gas and other energy commodities in the University's annual greenhouse gas emissions inventory. Currently, the University reports on the following Scope 3 emissions: sponsored air travel; commuting; and waste. The University offsets all air travel emissions and undergraduate students offset their commuting emissions. (Appendix C)

The Council thanked Jana VanderGoot, Nina Jeffries and Nicole Barbour for their time and interest as their terms expire.

Adjourn 11:30 pm

Appendices:

Appendix A: Maryland, Creating a Hotbed of Innovation to Cool the Planet

Appendix B: U.S. and Global Climate Action in 2021

Appendix C: Complete Scope 3 Progress Including Upstream Emissions from Energy

Maryland, Creating a Hotbed of Innovation to Cool the Planet

Eric D. Wachsman
Maryland Energy Innovation Institute

www.energy.umd.edu

Bridging the Gap in 2021

MARYLAND ENERGY INNOVATION ACCELERATOR

Company Creation

Research & Innovation → Deployment & Finance

MARYLAND ENERGY INNOVATION INSTITUTE

Linked in 2017 by HB410 / SB313

MARYLAND CLEAN ENERGY CENTER

Maryland Energy Innovation Institute

(10-829) MEI² Purpose:

- Collaborate with Academic Institutions in the State to participate in Clean Energy Programs
- Develop and Attract Private Investment in Clean Energy Innovation and Commercialization in the State

MARYLAND ENERGY INNOVATION INSTITUTE

Gov. Hogan Signs into Law $7.5M Maryland Energy Innovation Institute at UMD

MAY 4, 2017 SHARE EMAIL PRINT Recommend 0 Tweet

Contacts: Pamela R.M. Phetphongsy, 301.405.6266

ANNAPOLIS, Md. — Maryland Governor Larry Hogan held a signing ceremony today that included a bill authorizing $7.5 million in funding to create the Maryland Energy Innovation Institute (MEI2) at the University of Maryland (UMD), an initiative that will catalyze clean energy research programs at academic institutions in the state and attract and develop private investment in clean energy innovation and commercialization. The institute will bolster economic jobs in the clean energy industry sector in Maryland, and also promote the deployment of clean energy technology throughout the state.

"We are proud to sign legislation to create the Maryland Energy Innovation Institute, which will develop and attract private investment and commercialize clean energy innovation in our state," said Governor Hogan. "We thank the legislature for working with our administration on these bipartisan efforts to grow clean energy investment and jobs, and ensure that Maryland continues to lead the charge when it comes to protecting our environment."

MEI2 is a collaboration between the Maryland Clean Energy Center (MCEC) and the University of Maryland Energy Research Center (UMERC) within UMD's A. James Clark School of Engineering. UMD is an established leader in energy research, with more than 100 faculty and students developing innovations that harness the power of clean energy such as solar photovoltaic technology, solar heating, geothermal, wind, biofuels, ethanol, and other sources.

"The University of Maryland continues to lead the way in clean energy research, moving discoveries and technology into the commercial space," said University of Maryland Provost Mary Ann Rankin. "This is the perfect means to bring together expertise in science, government and industry to bring value to the State of Maryland."

"The University of Maryland has made numerous breakthroughs in battery, fuel cell, solar, wind, and energy efficiency technologies," said Eric Wachsman, University of Maryland professor and director of MEI2. "The Maryland Energy Innovation Institute will provide the critical infrastructure to enable these breakthroughs to become commercially viable companies benefiting both the economy and the environment of the State of Maryland."

UMERC, which has been led by Wachsman for eight years, is a multidisciplinary university initiative dedicated to advancing the frontiers of energy science and technology, with a focus on energy storage, efficiency, and clean energy generation. The center has attracted approximately $70 million in funding and has spun off six companies, to-date.

"This policy and funding commitment allows MCEC to move forward in our efforts to advance the Maryland Clean Energy economy," said Josh Green, Vice President of Government and Industry Affairs, A. O. Smith Corporation and Chairman of the MCEC Board of Directors. "The board looks forward to continuing our partnership with the University of Maryland."

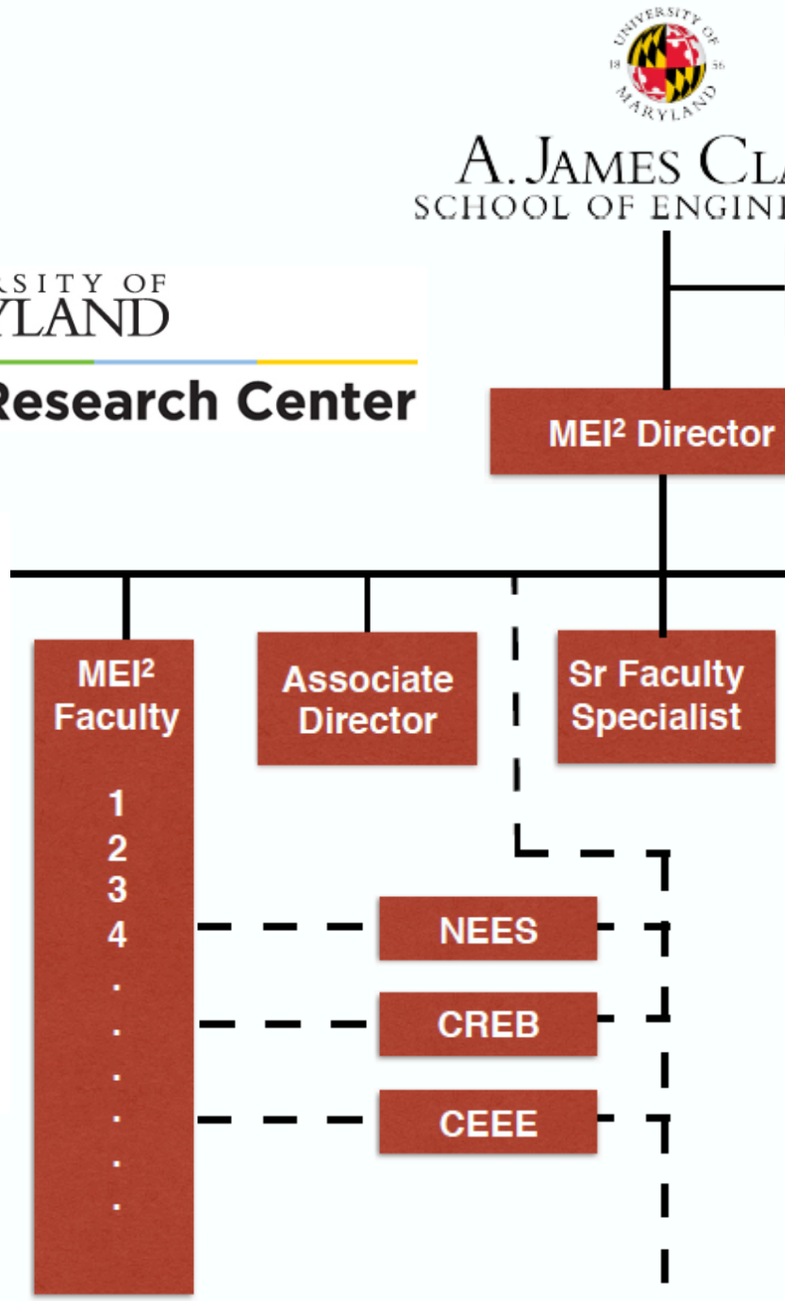
MCEC was created by the General Assembly of Maryland to support innovation and technology deployment to achieve renewable energy generation, energy conservation, and greenhouse gas emission reduction goals. MCEC uses statute enabled financing authority to leverage private capital investments and provide financing to assist residential, commercial, municipal, and not-for-profit consumers.

MEI2 is one of several programs in Governor Hogan's 2017 Environmental Package, which includes market-based solutions to protect and preserve Maryland's environment and natural resources.

Maryland Energy Innovation Institute

UNIVERSITY OF MARYLAND
Energy Research Center

A. JAMES CLARK SCHOOL OF ENGINEERING



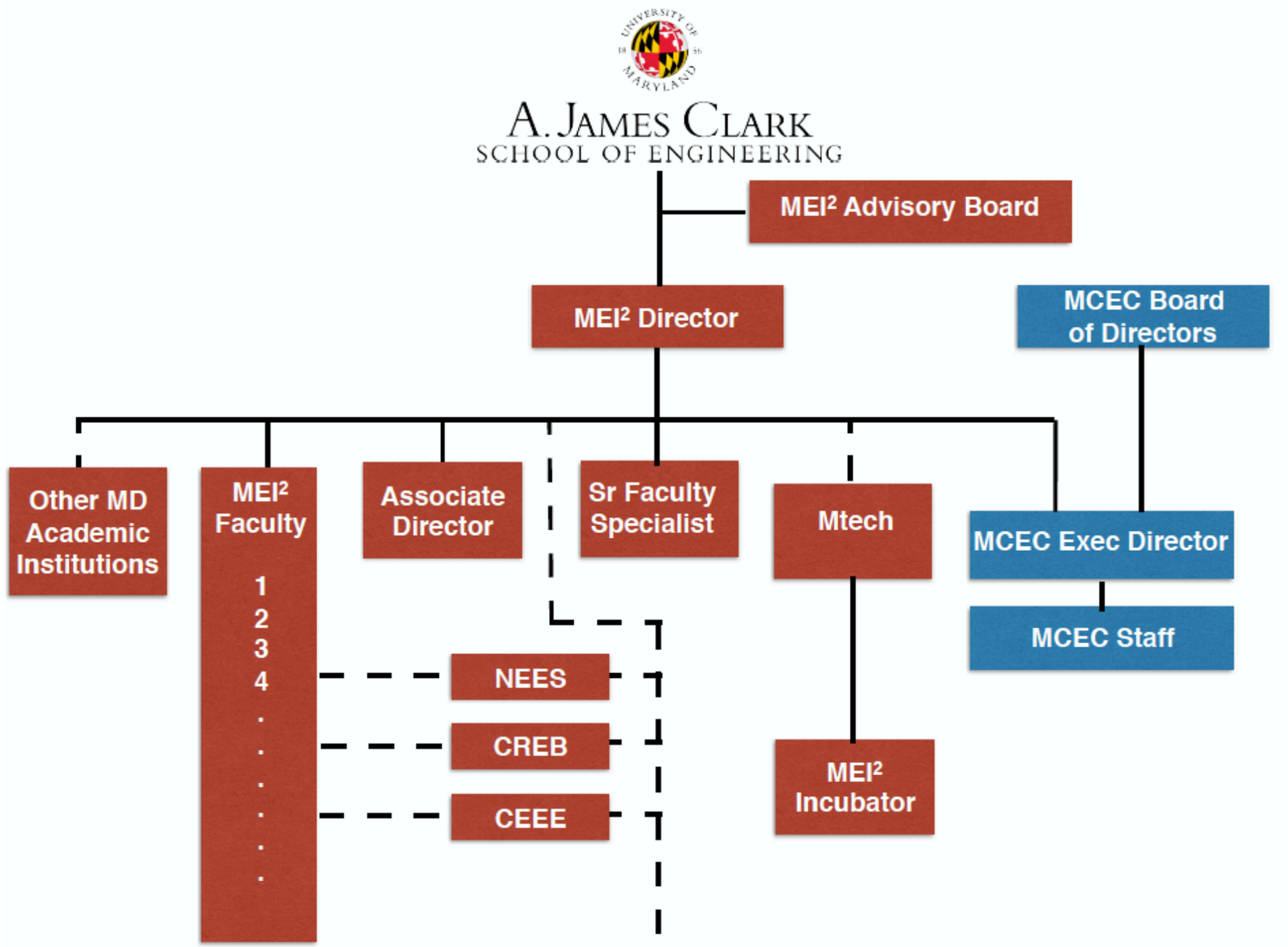
MARYLAND CLEAN ENERGY CENTER

MARYLAND CLEAN ENERGY CAPITAL
providing financial solutions

MARYLAND COMMERCIAL PACE

MARYLAND HOME ENERGY LOAN PROGRAM
advancing energy efficiency

Maryland Energy Innovation Institute



MEI² integrates energy research & innovation with incubation and financing under a single organization at UMD to advance the State of Maryland energy economy

MEI² Energy Storage Centers

Nanostructures for Electrical Energy Storage

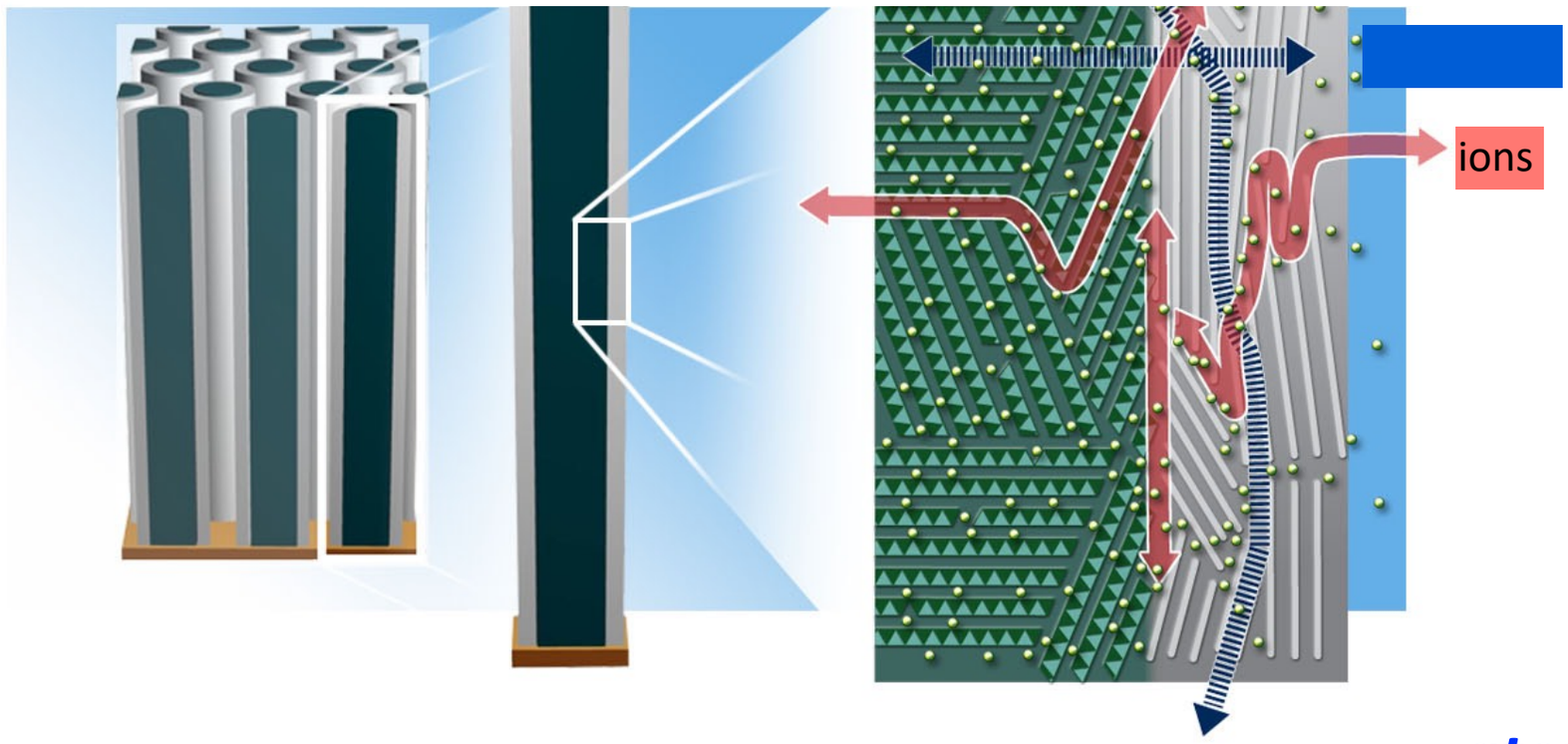
DOE/BES

Energy Frontier Research Cen

Lead: University of Maryland

Partners: UCI, UF, Yale, SNL, LANL

$29M over 9 years



Charge storage material

- **High energy density**
- **Low electrical, ionic conductivity**
- **Low mechanical stability**

Cathode: $LiMnO_2$, $LiFePO_4$, $LiCoO_2$

Anode: Si

Transport & support material

- **High electrical conductivity**
- **High mechanical stability**
- **High ionic conductivity**

Low-D carbon, conducting polymer

MEI² Energy Storage Centers

CENTER FOR RESEARCH ON EXTREME BATTERIES

https://creb.umd.edu

U.S. ARMY RDECOM

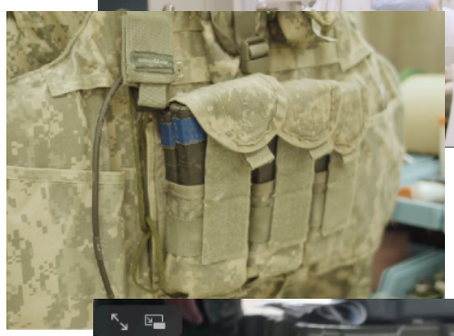
MARYLAND ENERGY INNOVATION INSTITUTE

MONTANA STATE UNIVERSITY

NIST National Institute of Standards and Technology

Argonne NATIONAL LABORATORY

NY BES+ NEW YORK BATTERY AND ENERGY STORAGE TECHNOLOGY CONSORTIUM



DEPARTMENT OF DEFENSE APPROPRIATIONS ACT, 2020

R-1		Budget Request	Final Bill
13	GROUND TECHNOLOGY	35,199	146,399
	Program increase - environmental quality enhanced coatings		5,000
	Program increase - environmental friendly coatings technology		3,000
	Program increase - additive manufacturing for artificial intelligence and machine learning		5,000
	Program increase - earthen structures soil enhancement		4,000
	Program increase - M1 Abrams tank track system		2,200
	Program increase - high performance polymers		5,000
	Program increase - materials manufacturing processes		6,000
	Program increase - highly durable advanced polymers for lightweight armor		8,000
	Program increase - cellulose nanocomposites research		5,000
	Program increase - countermine program		5,000
	Program increase - materials research		17,500
	Program increase - additive manufacturing and materials processing		15,000
	Program increase - cold weather military research		3,000
	Program increase - sensing technologies for rapid hazard detection		2,500
	Program increase - cold spray technologies		15,000
	Program increase - center for research in extreme batteries		10,000

Another $10M in FY21 Act

MEI² Energy Storage Centers

UISEC: US Israel Solid Energy Center

The Energy Storage Consortium of the BIRD Energy Center

Project title: Lithium and Sodium Metal Solid State Batteries for Advanced Energy Storage Applications

- UMD (US lead) and Bar Ilan Univ (Israel lead) lead the Energy Storage Consortium.
- $9.2M from BIRD ($4.4M US, $4.8M IL), $18.4M total (50% cost share), 5 years.

Bar-Ilan University אוניברסיטת בר-אילן · A. James Clark School of Engineering · Tel Aviv University אוניברסיטת תל אביב · 3DB · Forge Nano · Saft · MaterialsZone · ion Storage Systems

MARYLAND ENERGY INNOVATION INSTITUTE

2020 Research Highlights - DOE VTO

Vehicle Technology Office

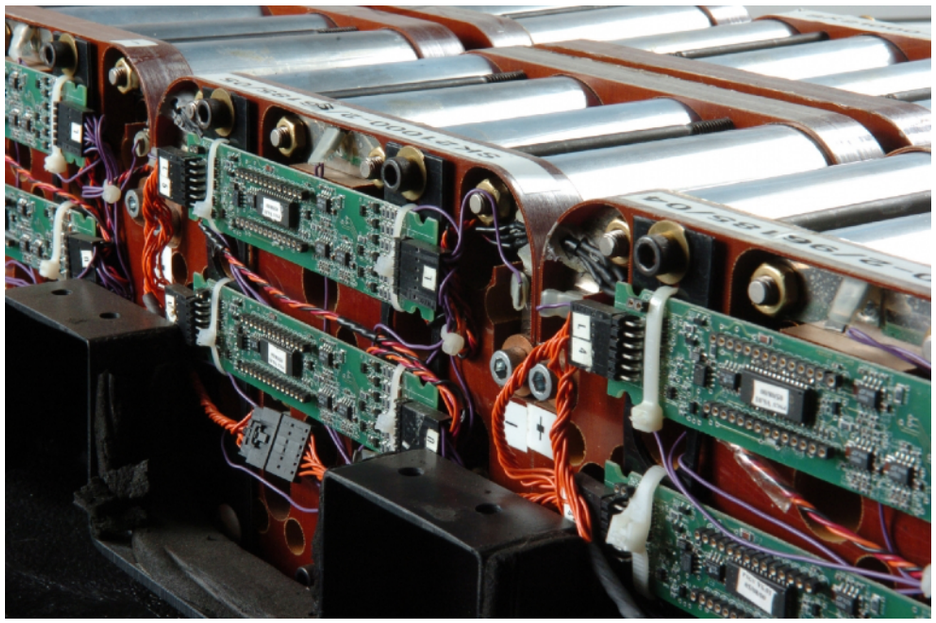
UMD Awarded 2 projects

U.S. DEPARTMENT OF ENERGY

Energy Efficiency & Renewable Energy

- Dr. Eric Wachsman, MEI² Director and William L. Crentz Centennial Chair in Energy Research, was awarded $1M for his work on "**Low Impedance Cathode/Electrolyte Interfaces for High Energy Density Solid-State Batteries**". The project will research, develop, and test lithium metal-based batteries that implement solid lithium-ion conductors equipped with nickel manganese cobalt cathodes integrated into the lithium-metal tri-layer architecture. Performance targets for the batteries include a 15-year calendar life, cycle life of 1,000 with less than 20% performance degradation, and a specific energy greater than 350 Wh/kg.

- Dr. Chunsheng Wang, Department of Chemical & Biomolecular Engineering and Robert Franklin and Frances Riggs Wright Distinguished Chair, also received $1M in funding for his research in "**Lithium Dendrite-Free Solid Electrolytes for High Energy Lithium Batteries**". His work will focus on optimizing the next generation, high-energy lithium ion batteries.



- *UMD received more funding than any other university and is the only one to receive multiple awards in this category. It is also one of only two universities to receive two awards overall in all categories*

MARYLAND ENERGY INNOVATION INSTITUTE

2020 Research Highlights - DOE BTO

Buildings Technology Office

UMD Awarded 2 projects

U.S. DEPARTMENT OF ENERGY

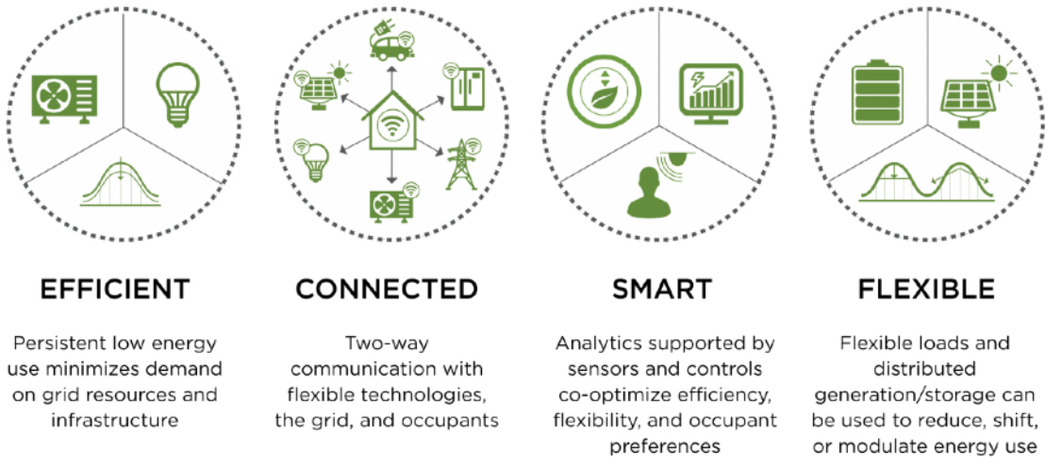
Energy Efficiency & Renewable Energy

Flexible Building Technologies

- **A Novel Framework for Performance Evaluation and Design Optimization of PCM Embedded Heat Exchangers for the Built Environment -** *PI: Vikrant Aute, Co-Director CEEE* The project will create a solid-state energy storage composite phase change material and heat exchangerHeating, Ventilation and Air Conditioning. The team at CEEE, in collaboration with Heat Transfer Technologies LLC (HTT), will develop and validate a novel framework for performance evaluation and design optimization of phase change material (PCM) embedded heat exchangers (HX). These heat exchangers, when integrated with building HVAC&R equipment and envelope, provide thermal storage capabilities leading to reduction in peak energy demand.

Heating, Ventilation and Air Conditioning Technologies

- **Ni-Ti Metal Bolster Cooling Technology** — *PI: Ichiro Takeuchi, UMD Professor MSE and Reinhard Radermacher, Director CEEE;* The project will develop thermoelastic active regenerators to advance the state of the art of thermoelastic cooling technology, a potentially more sustainable and efficient alternative to vapor compression cooling technology. The goal is to demonstrate for the first time thermoelastic active regenerators with hitherto unattainable system ΔT using cascade active regeneration schemes implemented to increase temperature gradient across thermoelastic refrigerants.



- *UMD is the only university to receive multiple awards.*

MARYLAND ENERGY INNOVATION INSTITUTE

MEI² - ARPA-e Awards

Power Generation

REBELS - Reliable Electricity Based on Electrochemical Systems

Eric Wachsman, "Low Temperature Solid Oxide Fuel Cells for Transformational Energy Conversion"
$5.3M

REDOX

REBELS – Reliable Electricity Based on Electrochemical Systems

Eric Wachsman, "Bi-functional Ceramic Fuel Cell Energy System"
$3.2M

REBELS – Reliable Electricity Based on Electrochemical Systems

Ichiro Takeuchi, "Metal Supported Proton Conducting Solid Oxide Fuel Cell Stack"
$3.5M

MEI² - ARPA-e Awards

Energy Storage

RANGE - Robust Affordable Next Generation Energy Storage Systems

Eric Wachsman, "Safe, Low-Cost, High-Energy-Density, Solid-State Li-Ion Batteries"
$4.7M

RANGE - Robust Affordable Next Generation Energy Storage Systems

Chunsheng Wang, "Multiple-Electron Aqueous Battery"
$4.1M

IONICS - Integration and Optimization of Novel Ion-Conducting Solids

Chunsheng Wang, "Self Forming Solid State Batteries"
$1M

OPEN IDEAS – Open Innovative Development in Energy-Related Applied Science

Liangbing Hu, "Highly Conductive, Robust, Corrosion-Resistant Nanocarbon Current Collectors for Aqueous Batteries"
$0.5M

MARYLAND ENERGY INNOVATION INSTITUTE

MEI² - ARPA-e Awards

Energy Efficiency

BEETIT - Building Energy Efficiency Through Innovative Thermodevices MEST

Ichiro Takeuchi, "Thermoelastic Cooling"
$3.3M

OPEN IDEAS – Open Innovative Development in Energy-Related Applied Science

Michael Ohadi, "Dry Cooling for Thermoelectric Power Plants"
$0.5M

ARID – Advanced Research in Dry Cooling

Michael Ohadi, "Novel Polymer Composite Heat Exchanger for Dry Cooling of Power Plants"
$2.0M

ARID - Advanced Research in Dry Cooling

Bao Yang "Novel Microemulsion Absorption Systems for Supplemental Power Plant Cooling"
$3.0M

MEI² - ARPA-e Awards

Energy Efficiency

DELTA - Delivering Efficient Local Thermal Amenities

YuHuang Wang, "Meta-Cooling Textile with Synergetic Infrared Radiation and Air Convection for Bidirectional Thermoregulation"
$3.0M

DELTA - Delivering Efficient Local Thermal Amenities

Reinhard Radermacher, "Robotic Personal Conditioning Device"
$2.6M

Mobile Comfort Inc.

Efficient Transportation Networks

TRANSNET - Traveler Response Architecture using Novel Signaling for Network Efficiency in Transportation

Lei Zhang, "Integrated, Personalized, Real-Time Traveler Information and Incentive Technology for Optimizing Energy Efficiency in Multimodal Transportation Systems"
$3.8M

incenTrip

MARYLAND ENERGY INNOVATION INSTITUTE

arpa·e

MEI² - ARPA-e Awards

Advanced Materials

REACT - Rare Earth Alternatives in Critical Technologies

Ichiro Takeuchi, "MnBi Based Permanent Magnets"
$5.4M

OPEN IDEAS – Open Innovative Development in Energy-Related Applied Science

YuHuang Wang, "Melt Epitaxy of Carbon: A Silicon-inspired approach to next-generation electrical wires"
$0.5M

OPEN 2018 – Transformational Energy Research

Liangbing Hu, "Superstrong, Low-cost Wood for Lightweight Vehicles"
$3.6M

MEI² Faculty have lead or participated in 28 ARPA-E awards for $64M since 2009

More than any other university in the US except MIT

MARYLAND ENERGY INNOVATION INSTITUTE

MEI² Energy Research

Maryland an academic powerhouse in energy research:

DOE BES Energy Frontier Research Center, $29M

Bi-National Center on Solid State Batteries, $18.4M

Transformational Army Batteries, $7.2M + $10M

- UMD leads the nation in DOE ARPA-E Awards (*2nd only to MIT*), leading or participating in 28 awards for $64M in research funding since 2009

  ARPA-E is the only DOE agency focused on energy innovation and economic development

- Since its creation in 2017 MEI² has helped obtain $55M in federal funding for the State of Maryland economy

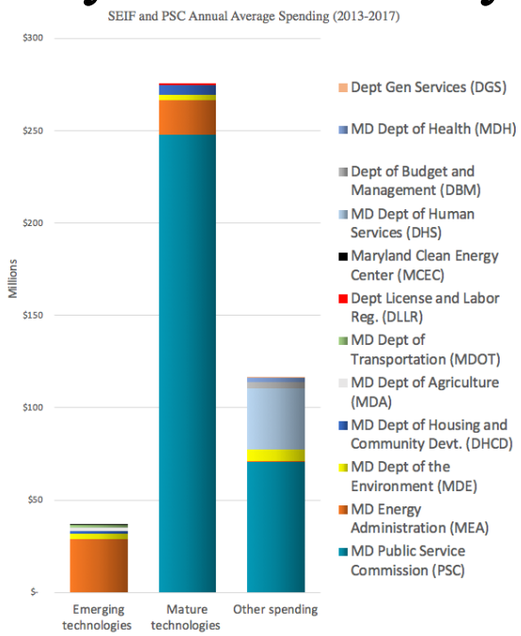
- **MEI² has provided a 23X rate of return on Maryland's investment**
  based on its share of the SEIF ($2.4M to date)

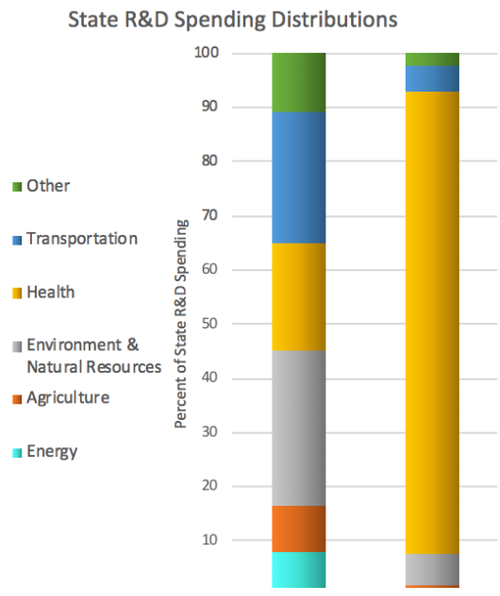
Transforming MEI² Research to Innovation

MEI² legislation (HB410/SB313) mandated report to Governor and General Assembly on development, deployment, and commercialization of clean energy technology from SEIF and other forms of financing and any need for additional funding for these purposes.

Report Findings include:

- With Maryland's energy research leadership and appropriate innovation infrastructure this could be major growth area for the Maryland economy.
- Maryland spends over $400M/yr on energy-related programs. However, none is authorized to support in-state development of clean energy firms.
- Maryland is last (#50) among all states in diversity of technology support for economic development
- Health-related R&D accounts for on average 85% of Maryland's total investment
- <u>There was no Maryland focused early stage energy investment in Maryland until MEI²</u>





Report Recommendations include:

- Designate clean energy an economic development opportunity
- Expand seed funding and developmental support for clean energy innovation

Transforming MEI² Research to Innovation

MEI² Innovation Seed Grants

- Bridge the gap between transformative academic research and VC-Ready Proof-of-Concept
- Advance energy technology and economic growth of Maryland university spin-off company. Must have appropriate IP protection and commercialization plan.
- In first three years 14 seed grants were awarded to University of Maryland College Park (UMCP), University of Maryland Baltimore County (UMBC), University of Maryland Eastern Shore (UMES), Johns Hopkins University (JHU), and Morgan State University (MSU).
- Demand for these seed grants has grown rapidly far exceeding current budget to support.
- Several have resulted in follow on private investment.

MEI² Investment Committee

Ellen Williams, *UMD Distinguished University Professor, Former Director ARPA-E*
Julie Lenzer, Assoc.Vice-President for Economic Development, UM Ventures
Eric Chapman, *Asst.Vice-President of Research, UMD*
Rob Briber, *Interim Dean, A. James Clark School of Engineering*
Arti Santhanam, *Exec. Director Innovation Initiative, TEDCO*

Transforming MEI² Research to Innovation

The Washington Post

Energy and Environment

This robot follows you around and blasts you with air conditioning

By Darryl Fears June 30, 2016

Reinhard Radermacher has a vision: A person walks into a room hot and sweaty after exercising, and somewhere in the dark, tucked in a corner, a small robot notices and lights up. It moves forward and speaks.

"I see you're coming home from the gym," it says in a pleasant voice. "I will give you maximum cooling now."

This isn't a line ripped from the 2014 animated Disney movie "Big Hero 6," in which a "personal health-care companion" called Baymax sprang to life whenever it sensed human pain. This is something happening now at the University of Maryland, as Radermacher and a team of engineers, researchers and designers race to develop RoCo — a robotic personal air conditioner capable of sensing when a person is too hot or too cold and taking action to make them more comfortable.

The big-picture aim is to one day cut the energy used to cool or heat a room, office or industrial space, regardless of whether anyone is there. RoCo, short for Roving Comforter, would follow its owners like a self-propelled vacuum cleaner and provide enough comfort to allow homes and businesses to adjust the thermostat up to four degrees.

Federal energy officials estimate that 14 percent of U.S. energy output goes for air conditioning, heating and ventilation in buildings — much of which is wasted. That usage contributes to almost the same percentage of the nation's greenhouse-gas emissions. Saving only two degrees of energy would be "an enormous amount," equal to converting a quarter of all vehicles on the road to electric hybrids, said Jennifer Gerbi, program director for the Department of Energy's Advanced Research Projects Agency-Energy.

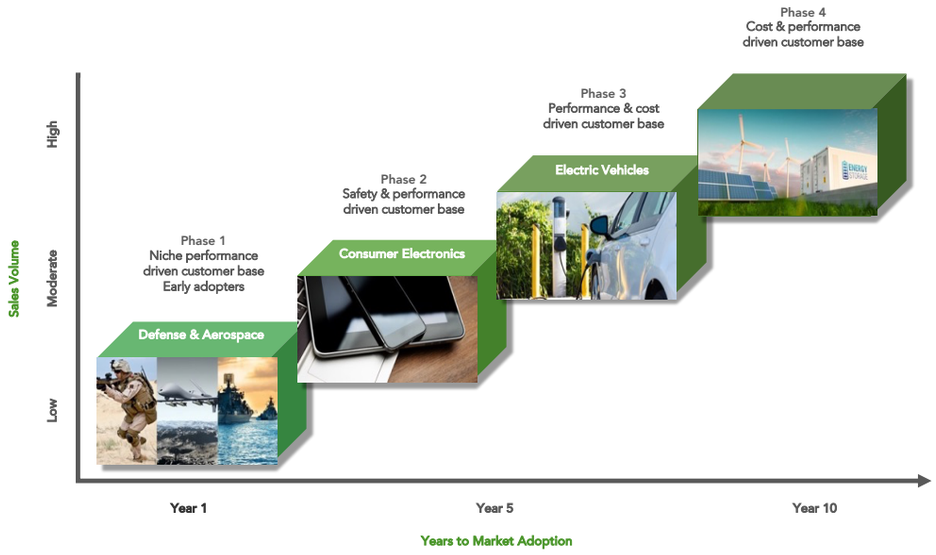
MARYLAND ENERGY INNOVATION INSTITUTE

Transforming MEI² Research to Innovation

ion Storage Systems

- Commercializing next generation batteries developed at UMD
- Over $20M in R&D funding
- $8M investment lead by Alsop Louie Partners
- 20 Employees and growing
- CEO, *former Exec Director Battery Operations - Apple*

- Moving into 20,000 ft² facility
- Scaling to 10 MWh/yr production
- Commercial prototypes available Q2 2021
- First product in defense market due to higher margin at lower volume
- Moving to higher volume markets as scale production



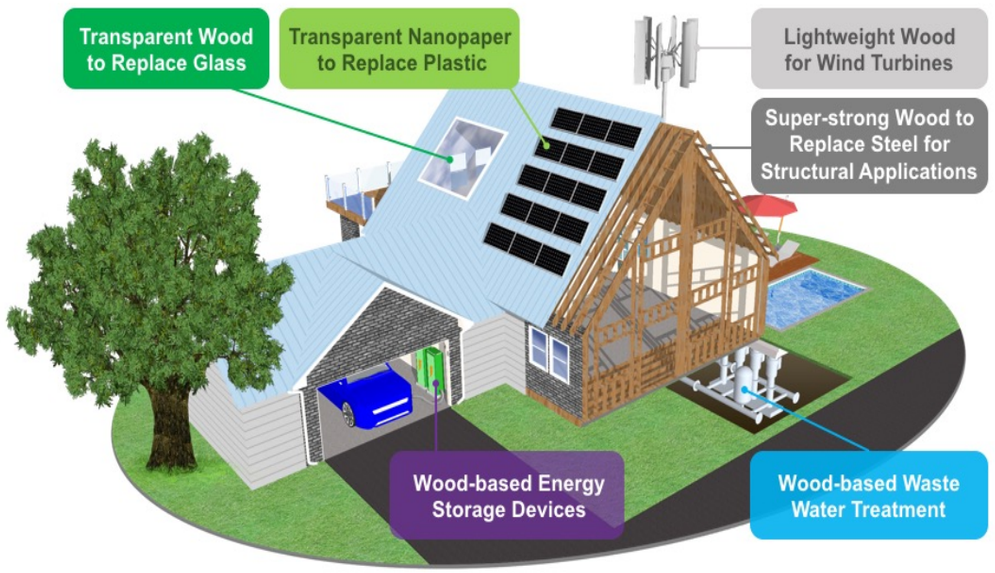
- Selected as "*Maryland Future 20*" company

MARYLAND ENERGY INNOVATION INSTITUTE

Disclaimer: *Ion Storage Systems founded by Wachsman and this is meant as only an example of potential spinoffs and not an endorsement of this company or request for any support on its behalf*

Transforming MEI² Research to Innovation

InventWood™
From Nature | For the Future



Revolutionizing Sustainable Building Materials

MettleWood™

An extremely strong and tough material that is stronger, lighter, and cheaper than titanium and carbon fiber. It also offers numerous safety benefits over alternatives, and it is responsibly created and biodegradable.

Potential uses:

Vehicles · Buildings & Houses · Aerospace · Furniture · Electronics

Insulating Wood

A bright-white material that is stronger than natural wood and insulates against both heat loss and impacts better than commercially available alternatives. It is also biodegradable and eco-friendly.

Potential uses:

Residential Insulation · Packaging · Furniture · Electronics · Musical Instruments

Transparent Wood

A clear wood material that is lighter and tougher than glass, with up to 3x better thermal insulation. It also offers benefits in terms of both light channeling (to reduce glare) and far more environmental sustainable.

Potential uses:

Windows & Doors · Electronics · Glassware · Solar Panels · Vehicles

Revolutionary Technology, Millions of Years Old

InventWood is transforming the world by developing cellulose-based materials that are high-quality, cost-effective, and environmentally-sustainable. Our proprietary technologies offer superior alternatives to the most commonly-used materials today while providing solutions to some of the world's most intractable environmental challenges.

- Selected as "*Maryland Future 20*" company

MARYLAND ENERGY INNOVATION INSTITUTE

2020 MEI² Legislation

HB 419

Department of Legislative Services
Maryland General Assembly
2021 Session

FISCAL AND POLICY NOTE
Enrolled

House Bill 419 (Delegate Qi)
Economic Matters Finance

Economic Development - Advanced Clean Energy and Clean Energy Innovation Investments and Initiatives

This bill requires the Maryland Energy Innovation Institute (MEII) and the Maryland Clean Energy Center (MCEC) to implement an accelerator program for Maryland-based technology companies engaged in clean energy innovation. MEII and MCEC must also coordinate and consult with certain State entities, as specified. MCEC is designated as a green bank for the State and must work in conjunction with other local and private green banks. MCEC's financing authority is also clarified as it relates to State entities. The Strategic Energy Investment Fund (SEIF) must transfer at least $2.1 million annually to the Maryland Energy Innovation Fund (MEIF), which must be apportioned to MEII (at least $0.9 million) and MCEC (at least $1.2 million). In fiscal 2022 only, the transfer is offset by the amount transferred under a separate provision of law. MCEC's board membership is altered, related terms are defined, and an annual MCEC report is modified to include information related to the bill. **The bill takes effect July 1, 2021.**

Fiscal Summary

State Effect: Special fund revenues for MEIF increase by at least $0.6 million in FY 2022 and by at least $2.1 million annually thereafter, as discussed below. Special fund expenditures for MEIF increase correspondingly as funds are used for required and authorized purposes. Overall special fund expenditures for SEIF are not affected, but diverting funds to MEIF decreases revenues available for other SEIF-funded programs. **This bill establishes a mandated distribution beginning in FY 2022.**

Local Effect: The bill does not materially affect local government finances or operations.

Small Business Effect: Meaningful.

SB 460

Department of Legislative Services
Maryland General Assembly
2021 Session

FISCAL AND POLICY NOTE
Third Reader - Revised

Senate Bill 460 (Senator Feldman)
Finance Economic Matters

Economic Development - Advanced Clean Energy and Clean Energy Innovation Investments and Initiatives

This bill requires the Maryland Energy Innovation Institute (MEII) and the Maryland Clean Energy Center (MCEC) to implement an accelerator program for Maryland-based technology companies engaged in clean energy innovation. MEII and MCEC must also coordinate and consult with certain State entities, as specified. MCEC is designated as a green bank for the State and must work in conjunction with other local and private green banks. MCEC's financing authority is also clarified as it relates to State entities. The Strategic Energy Investment Fund (SEIF) must transfer at least $2.1 million annually to the Maryland Energy Innovation Fund (MEIF), which must be apportioned to MEII (at least $0.9 million) and MCEC (at least $1.2 million). In fiscal 2022 only, the transfer is offset by the amount transferred under a separate provision of law. MCEC's board membership is altered, related terms are defined, and an annual MCEC report is modified to include information related to the bill. **The bill takes effect July 1, 2021.**

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Local Effect: The bill does not materially affect local government finances or operations.

Small Business Effect: Meaningful.

- Identifies Energy as an economic opportunity
- Broadens definition of included energy technologies
- Designates MCEC as Maryland Green Bank
- Removes sunset of MEI² funding
- Increases MEI² funding to $2.1M/yr with focus on innovation
- Passed both House and Senate awaiting Governor's signature

U.S. and International Climate Action in 2021

Nate Hultman
Director, Center for Global Sustainability
University of Maryland
May 6, 2021

SCHOOL OF
PUBLIC POLICY
CENTER FOR GLOBAL
SUSTAINABILITY

Entering 2021
Four Linked Crises

Climate
Change

Global
Pandemic

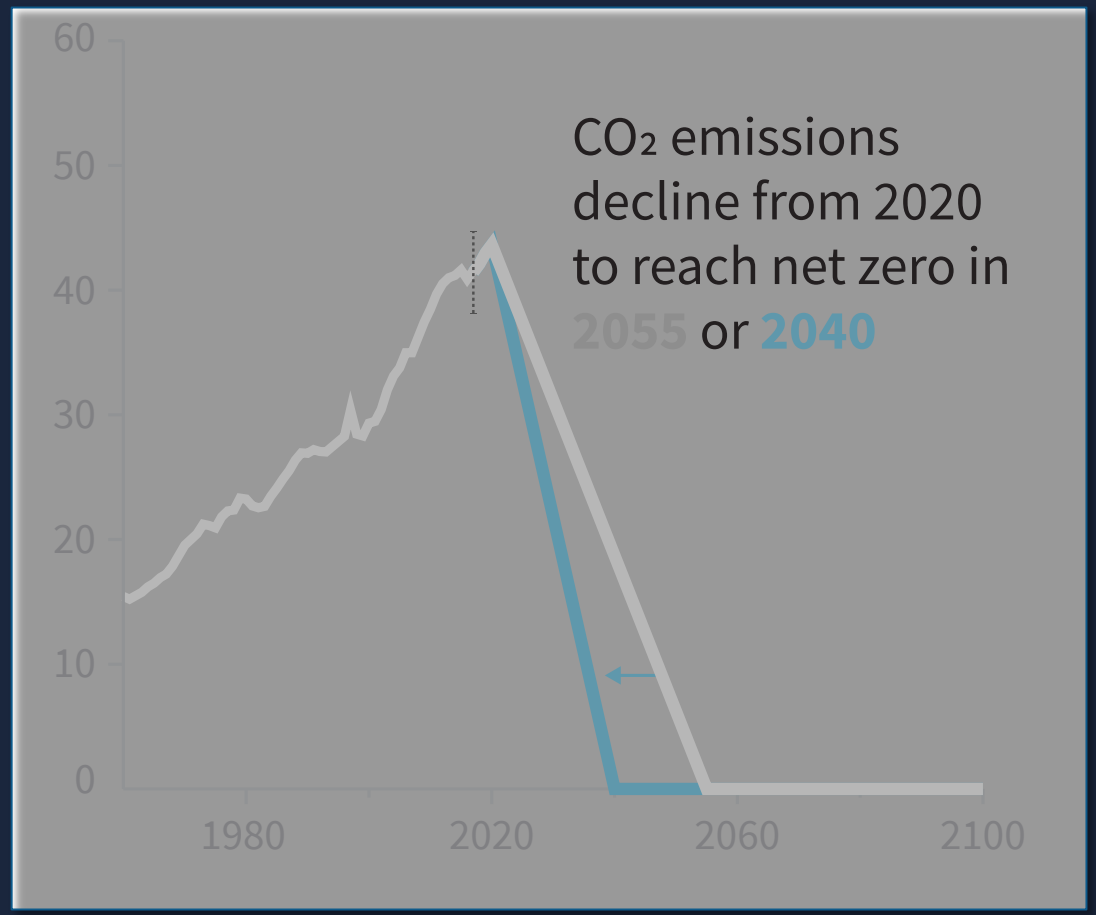
Economic
Recession

Global
Justice and Democracy

2021: Opportunity to Raise Climate Action

Climate Marches in Sydney – Seoul – Hyderabad – Johannesburg - Washington

A rapid global transformation 2020-2050

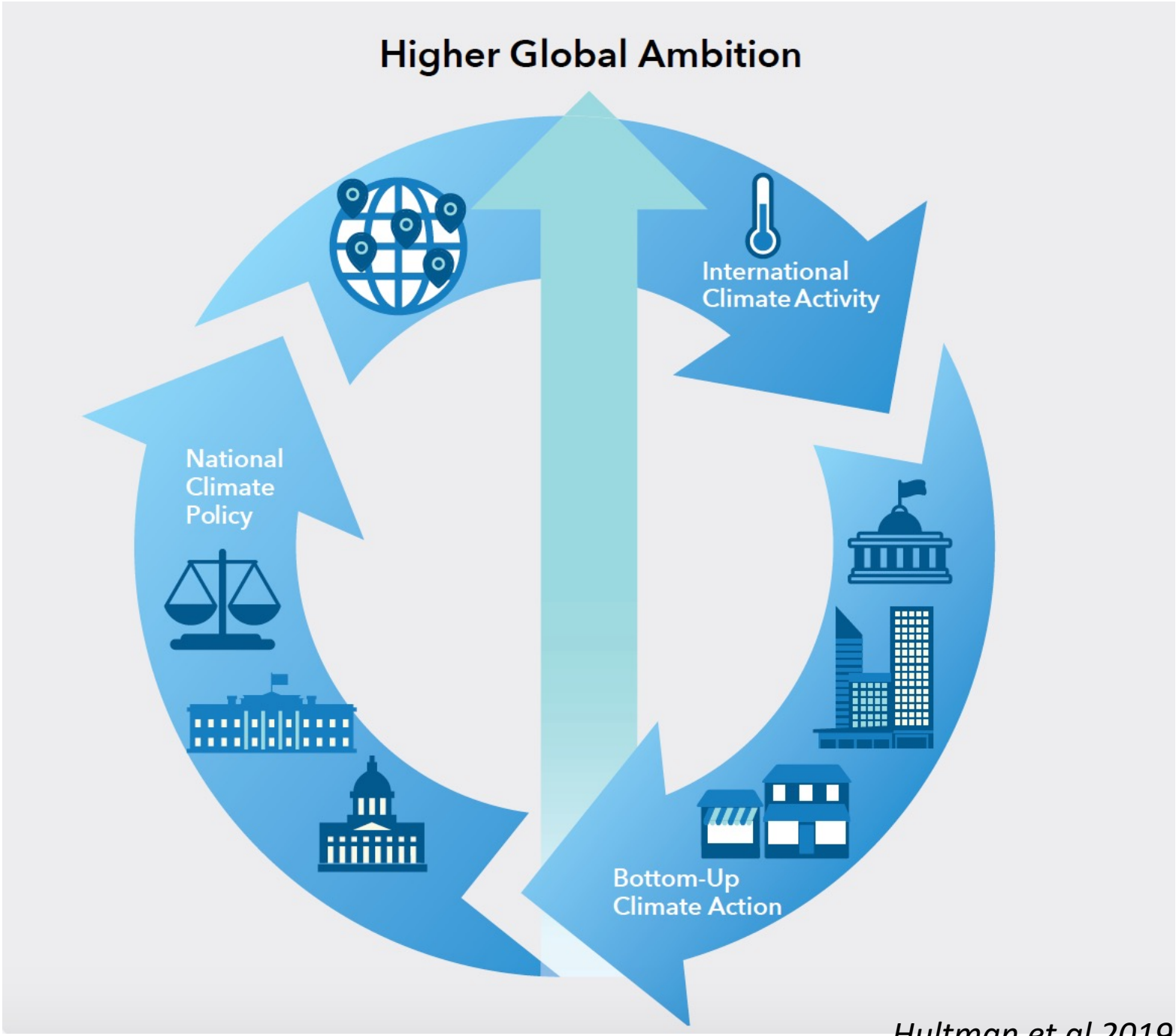


Global Indicator (rel to 2010)	2030	2050
CO2 emissions	-50%	-98%
All GHG emissions	-47%	-86%
Energy from Coal	-69%	-85%
Electricity from Renewables	56%	78%

Source: IPCC SR1.5. Table shows average of interquartile Fig SPM.3b; ranges not shown

Raising global climate action

- International coordination through Paris
- Ambitious national actions called by NDCs
- Broad climate politics required for robust and rapid transition built from bottom up



Hultman et al 2019

A Global Re-Focusing on Climate in 2021

International Actions

- Countries delivering new national targets in advance of COP26
- Integrative focus on adaptation, subnational action, nature, finance and more
- Global movement toward net-zero

UN CLIMATE CHANGE CONFERENCE UK 2021

IN PARTNERSHIP WITH ITALY

Milestone Events

- President Biden's Global Leaders Summit, Earth Day, April
- COP26 Glasgow, November

RACE TO ZERO

Recent Major National Actions 2020-21

United States
- 50-52% by 2030 (below 2005)
- 2050 Net Zero

China
- Goal of net-zero by 2060
- Peak by 2030
- Other goals such as lowering emissions/GDP by 65%
- Coal phasedown

UK
- 68% below 1990 levels by 2030
- 78% by 2035

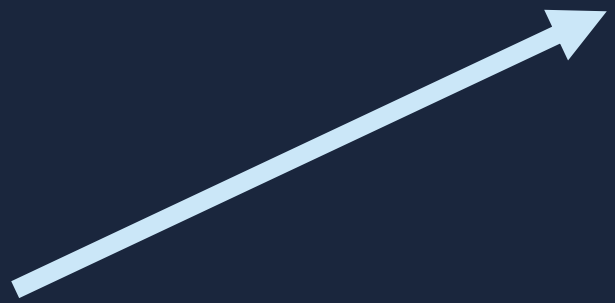
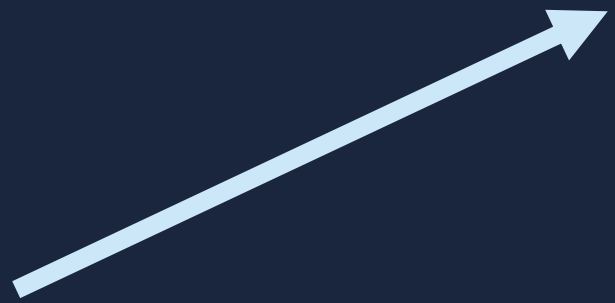
EU
- 55% below 1990 levels by 2030
- Net-zero 2050

Korea
- Net-zero 2050

Japan
- 46-50% by 2030
- Net-zero 2050

Canada
- 40-45% by 2030

Climate Action in the U.S.: Standard View

	→2016	2016-2020	2021
Federal			
Climate Action			

U.S. Climate Action 2017-21

25
Governors

500+
Cities and counties

80+
Cultural institutions

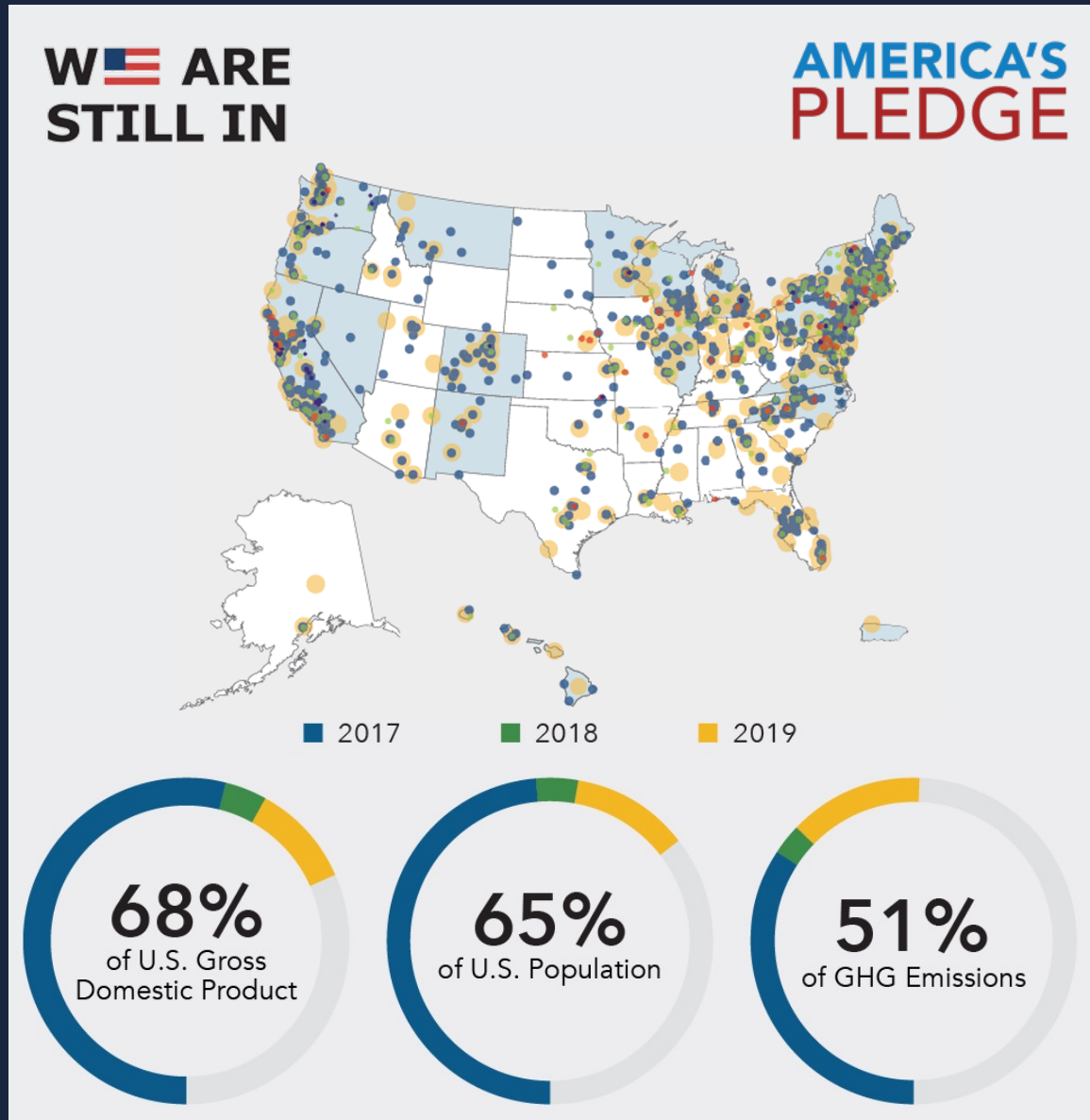
350+
Colleges and universities

2,275
Businesses and investors

850+
Faith groups

30+
Health care organizations, representing 900+ hospitals

Tribal associations
Representing hundreds of tribes



The Story of U.S. Climate Action 2017-21

2X increase in **EVs**

16 STATES committed to **HFC** phase down

100% Clean Energy Commitments

1 → 13 STATES +Puerto Rico

33 → 165 CITIES

7 STATES & **27** GAS COMPANIES committed to **methane leak reduction**

6 MILLION people live in cities with **all-electric** new construction

79% of Americans think the country should **prioritize its energy supply toward developing** renewable energy

AMERICA'S PLEDGE WE ARE STILL IN

Climate Action in the U.S.: Reality

→2016 | 2016-2020 | 2021

Federal

Subnational & Rest of Society

AMERICA'S PLEDGE

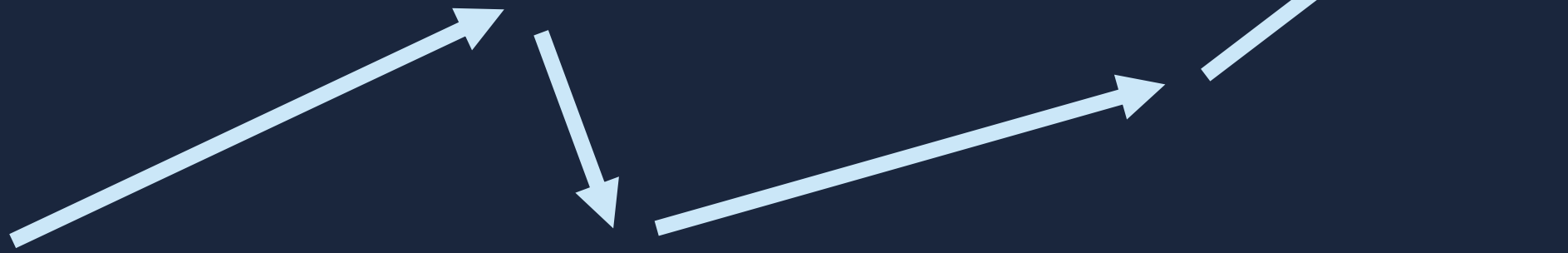
CLIMATE MAYORS

USCA
States United for Climate Action

WE ARE STILL IN

WE MEAN BUSINESS

Climate Action




LEADERS SUMMIT
ON CLIMATE
LEADERS SUMMIT
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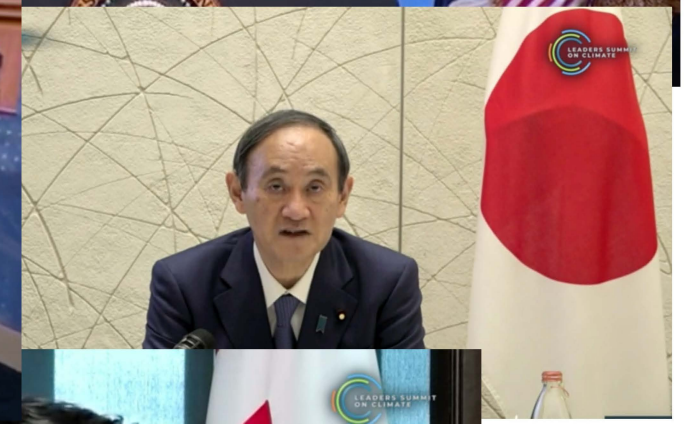
LIVE
CHINA




LIVE
INDIA - HOD (Narendra Modi)

US “All In” National Climate Strategy

John Kerry: UK climate summit is world's 'last best chance'

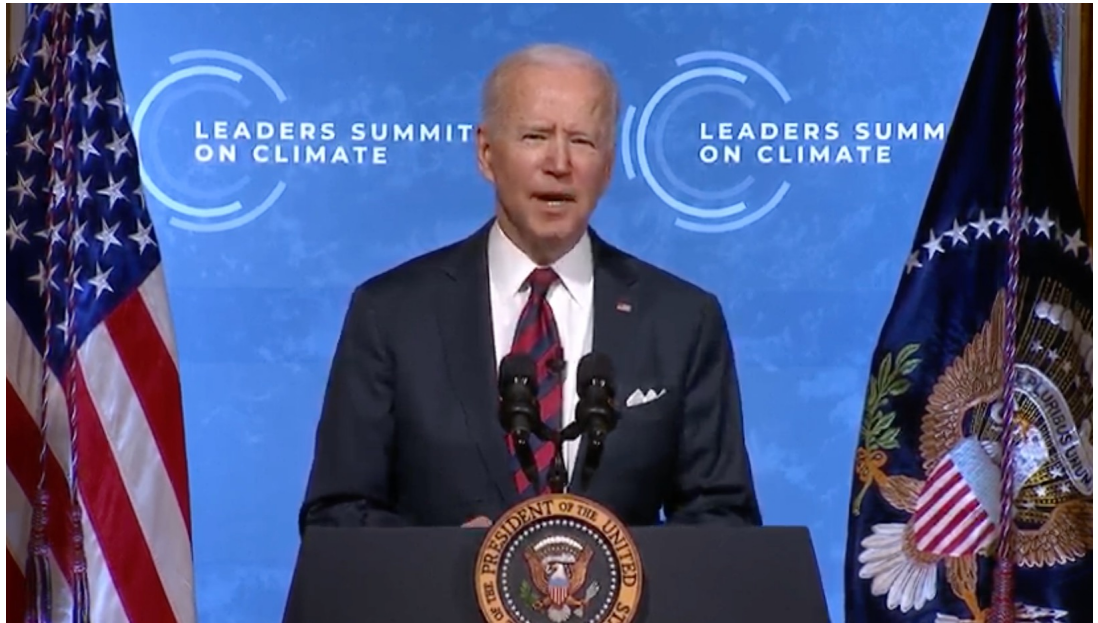
17 hours ago

US climate envoy John Kerry has told the BBC a UN climate summit in the UK this November is "the last best chance" to avert the worst environmental consequences for the world.

AMERICA IS
ALL IN

Building on Past U.S. Leadership, including Efforts by States, Cities, Tribes, and Territories, the New Target Aims at 50-52 Percent Reduction in U.S. Greenhouse Gas Pollution from 2005 Levels in 2030

Today, President Biden will announce a new target for the United States to achieve a 50-52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030 – building on progress to-date and by positioning American workers and industry to tackle the climate crisis.



UMD estimates demonstrate 50% reduction potential by 2030

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CGS has conducted two separate assessments that show alternate pathways, based on detailed policy platforms, to over 50% emissions reductions by 2030, relative to 2005 levels

Our assessments include impacts across all sectors and all gases, include lands, and are rooted in a longstanding, scientifically well-vetted, open-source global integrated assessment model (GCAM)

- **Federal Focus 51%** (UMD Analysis) includes significant and immediate federal policy strategies such as tax credits, investments, and regulatory actions across the power, transportation, industrial, buildings, land sectors
- **Subnational + Federal Focus 50%** (UMD-WRI-RMI Analysis, with *America Is All In*) includes expanded federal and state action consistent with expanded power sector approaches, along with transport and other major sectors

Interpretation is that our assessments show multiple potential pathways to an ambitious, achievable, and robust 50%—with broad engagement across society and new actions from Congress

- Multiple pathways in these and other analyses provide evidence of some flexibilities to achieving 50%
- Achieving significantly more than 50% is quite challenging
- "All-In" strategy including subnationals improves ability to achieve 50% by bolstering action, backstopping, and proving robustness across regions and over time

US Analysis 1
Federal Platform: 51% by 2030

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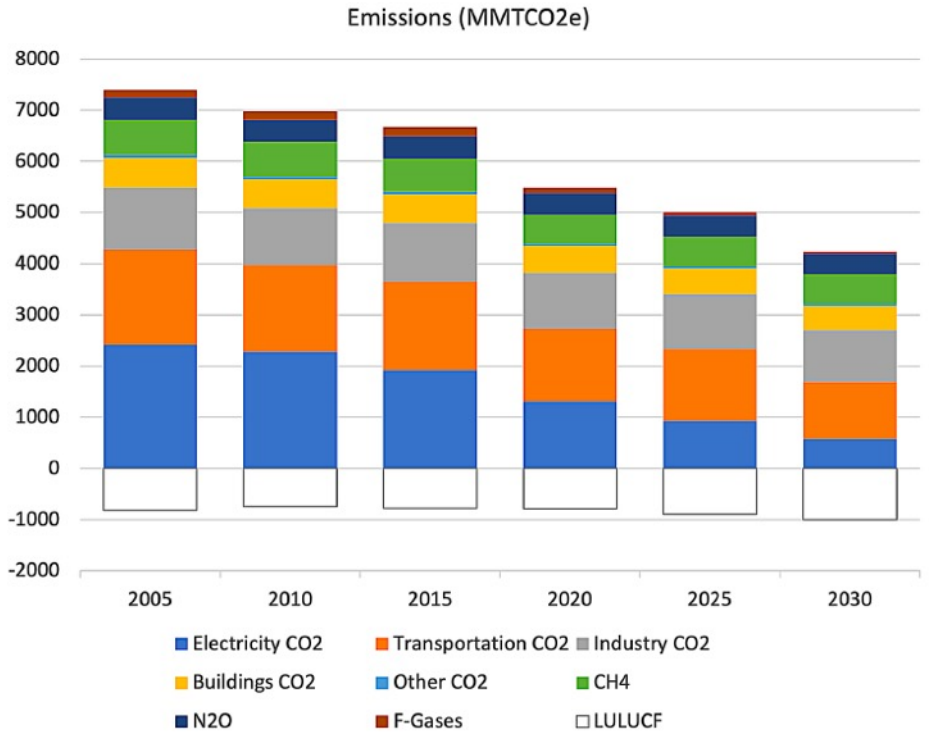
- A comprehensive federal effort across all sectors and gases could deliver U.S. GHG emissions reductions of **51% below 2005 levels by 2030.**
- The electricity and transportation sectors are the biggest contributors to overall reductions by 2030—representing 3/4 of all reductions—but actions must be taken across all sectors to meet this target and to set the stage for subsequent reductions.
- Achieving these emissions reductions would require a broad federal approach that includes Congressional and Executive branch actions across all sectors and gases. While there are multiple policy pathways to achieve significant reductions, **this scenario focuses specifically on substantial new investment through economic recovery packages: tax credits in renewables, CCS, and transportation: and strong federal performance standards.**
- This new analysis was carried out using a version of the GCAM-USA modeling platform and conducted by the Center for Global Sustainability at the University of Maryland.
- Analysis featured front pg New York Times; Wall Street Journal, Nature, Politico, others



Hultman, N., L. Clarke, H. McJeon, R. Cui, P. Hansel, E. McGlynn, K. O'Keefe, J. O'Neill, C.Wanner, A. Zhao (2021). **Charting an Ambitious US NDC of 51% Reductions by 2030**. Center for Global Sustainability Working Paper. College Park, MD: University of Maryland Center for Global Sustainability. 5 pp. Available at: go.umd.edu/ChartingNDC2030

N. Hultman (2020). **Building an ambitious and robust U.S. climate target: A comprehensive process to catalyze national and subnational climate action for the next NDC**. Brookings & Center for Global Sustainability. Brookings Global Economy & Development Working Paper 146, 30 pp. Available at: https://www.brookings.edu/research/building-an-ambitious-and-robust-us-climate-target/

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US Analysis 1 Policy Platform

Electricity:
- Renewable tax credits (PTC, ITC)
- Carbon capture and storage (45Q)

Transportation
- Fuel economy standard enhancement (CAFE)
- Electrification of passenger vehicles
- Electrification of freight vehicles
- EV tax credits and cash-for-clunkers

Buildings
- Energy efficiency measures
- Electrification of heating and water heating

Industry
- Energy efficiency measures
- Industrial Carbon capture

Non-CO_2
- Methane reduction
- Nitrous Oxide reduction
- HFC, PFC, SF6 reduction

LULUCF
- Reduced degradation potential

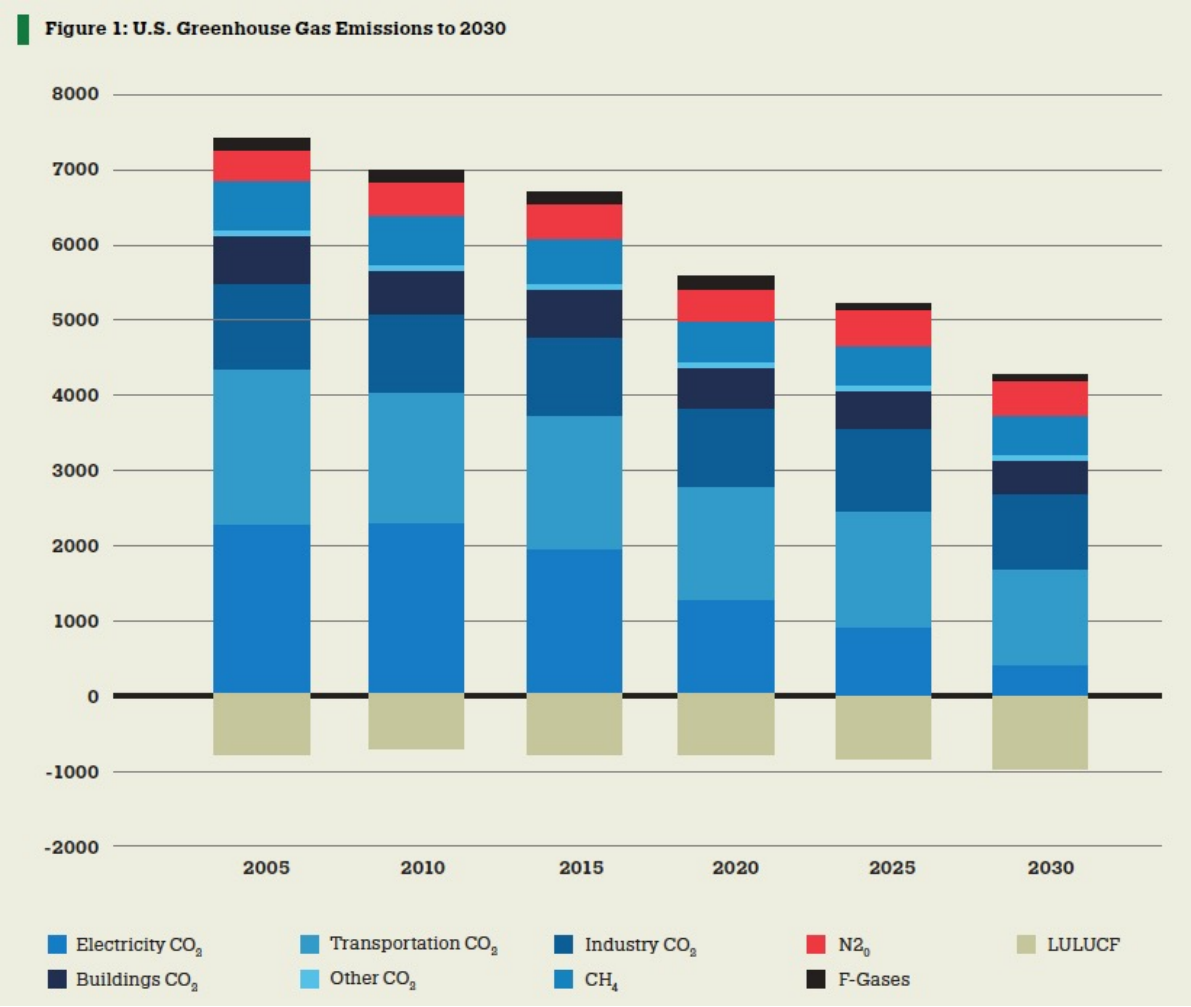
Sector	Modeled Policy	Approach
Power	Renewable Energy Incentives	Investment tax credit extends through 2030 at 30% of development costs. Production tax credit extends through 2030 at 2.5 cents/KWh.
	Standards on existing coal	Federal regulations impose an equivalent of a carbon price starting at $5/ton in 2023, rising to $25/ton by 2035.
	Standards on existing gas	Federal regulations impose an equivalent of a carbon price starting at $10/ton in 2030, rising to $25/ton by 2035.
	Standards on new gas	All new gas plants are built with 90% CCS starting in 2025.
	Incentives for Carbon Capture and Sequestration	45Q tax credit for CCS projects is increased to $100/ton through 2030, achieving 154 $MTCO_2$ sequestration.
	Nuclear Retention Incentives	Incentives retain existing nuclear generation at 680 TWh in 2030.
Transport	Combustion Engine Performance	ICE GHG performance reaches 118gCO_2/mi for new passenger cars and 160g/mi for new light trucks and SUVs by 2030.
	LDV ZEV incentives	For MY2021 through MY2025, EV credit is fixed at $7,000/new sales. Post-2025, EV sales increase such that by 2030 new EV sales reach 40%, and by 2035 new sales reach 90%. Additional cash for clunkers incentive is set at $5000/vehicle older than 15 years of age.
	M/HDV ZEV incentives	2030 ZEV sales reach 15% for Class 2b-3 trucks, 20% for Class 4-8 straight trucks, and 15% for Class 7-8 tractors.
Buildings	Electrification	Combination of appliance incentives and standards leads to 58% of appliances stock being electrified. New sales of electrified appliances are consistent with the National Renewable Energy Laboratory's Electrification Futures Study "High Electrification" scenario.
	Energy efficiency	High efficiency appliance standards and investments achieve reduced energy demand consistent with the Appliance Standards Awareness Project's A Powerful Priority report.
Industry	Energy efficiency	Efficiency increase to reduce overall energy demand by 1.7 EJ by 2030.
	Carbon Capture and Sequestration	45Q tax credit for CCS projects is increased to $100/ton through 2030, achieving 79 $MTCO_2$ sequestration.
Non-CO_2 emissions	Methane (CH_4)	Standards on oil and gas methane to address fugitive methane emissions. Incentives and standards for agricultural CH_4 emissions abatement consistent with economic potential from the EPA MAC report.
	Nitrous Oxide (N_2O)	Incentives for N_2O emissions abatement achieve 9.7% below 2015 levels by 2030, achieving economic abatement potential from the EPA MAC report.
	Hydroflourocarbons (HFCs)	Incentives and standards on HFC emissions leads to reduction of 77% below 2015 levels, achieving economic abatement potential from the EPA MAC report.
LULUCF	LULUCF	Substantial new investment to pay for reforestation and improved land management practices grow the land sector sink to achieve -1000 TCO_2e/year in LULUCF emissions (applying up to $35-40/ton price as proxy).

Hultman, N., L. Clarke, H. McJeon, R. Cui, P. Hansel, E. McGlynn, K. O'Keefe, J. O'Neill, C.Wanner, A. Zhao (2021). **Charting an Ambitious US NDC of 51% Reductions by 2030**. Center for Global Sustainability Working Paper. College Park, MD: University of Maryland Center for Global Sustainability. 5 pp. Available at: go.umd.edu/ChartingNDC2030

US Analysis 2

Federal + Nonfederal: 50% by 2030

- A comprehensive "all of society" federal + nonfederal effort across all sectors and gases could deliver U.S. GHG emissions reductions of **50% below 2005 levels by 2030.**
- Actions by cities, states, and businesses provide additional, complementary pathways to support overall ambition and could serve as a backstop should some federal actions not fully materialize.
- Working with **America Is All In** (formerly America's Pledge / We Are Still In). Details and technical available in new working paper by the *America Is All In* analytical team (UMD, RMI, WRI).



Nate Hultman, Kevin Kennedy, Leon Clarke, Haewon McJeon, Tom Cyrs, John O'Neill, Alicia Zhao, Jenna Behrendt, Wendy Jaglom, Todd McGarvey, John Feldmann, Ryna Cui, Kowan O'Keefe (2021) **"An All-In climate strategy can cut U.S. emissions by 50% by 2030."** America Is All In Working Paper. Published by America Is All In with University of Maryland, World Resources Institute, and Rocky Mountain Institute. Available at:https://www.americaisallin.com/wp-content/uploads/2021/04/all-in-climate-strategy-for-50april-2021-1.pdf

Hultman, N., K. Kennedy, T. Cyrs, W. Jaglom, C. Frisch, L. Clarke, A. Light (2021). An All-In National Climate Strategy to Deliver Ambitious, Robust, and Credible U.S. Action. America Is All In working paper, 4 pp.https://www.americaisallin.com/wp-content/uploads/2021/02/all-in-national-climate-strategy.pdf

Hultman, N., L. Clarke, C. Frisch, K. Kennedy, H. McJeon, T. Cyrs, P. Hansel, P. Bodnar, M. Manion, M.R. Edwards, R. Cui, C. Bowman, J. Lund, M. Westphal, A. Clapper, J. Jaeger, A. Sen, J. Lou, D. Saha, W. Jaglom, K. Calhoun, K. Igusky, J. deWeese, K. Hammoud, J.C. Altimirano, M. Dennis, C. Henderson, G. Zwicker, J. O'Neill (2020). Fusing national and sub-national climate action is central to rapid near-term decarbonization: The case of the United States. Nature Communications 11, 5255. https://doi.org/10.1038/s41467-020-18903-w

America's Pledge (2019) by Hultman, N., C. Frisch, L. Clarke, K. Kennedy, P. Bodnar, P. Hansel, T. Cyrs, M. Manion, M. Edwards, J. Lund, C. Bowman, J. Jaeger, R. Cui, A. Clapper, A. Sen, D. Saha, M. Westphal, W. Jaglom, J.C. Altamirano, H. Hashimoto, M. Dennis, K. Hammoud, C. Henderson, G. Zwicker, M, Ryan, J. O'Neill, E. Goldfield (2019). Accelerating America's Pledge: Going All-In to Build a Prosperous, Low-Carbon Economy for the United States. New York: The America's Pledge Initiative on Climate Change and Bloomberg Philanthropies, with the University of Maryland Center for Global Sustainability, Rocky Mountain Institute, and World Resources Institute. 156 pp. consisting of 94 pp. Report, 62 pp. Technical Appendix. Available at: www.AmericaIsAllIn.com

Our Global Recovery and Renewal: Climate Action Across All Levels

- Build a robust basis for ambition and implementation through **subnational action**
- Press our global and national leaders for **higher national ambition** and cooperation
- **Re-establish global collaborations** for supporting increasing action from individual countries and the global economy
- Work with shared goals to recover from COVID and build a new, innovative growth pathway with **broadly shared prosperity**

New Collaborative Research Needed for All of These

Further details

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- Hultman et al, All In working paper (Apr 2021) "**An All-In climate strategy can cut U.S. emissions by 50% by 2030**." America Is All In Working Paper. Published by America Is All In with University of Maryland, World Resources Institute, and Rocky Mountain Institute. Available at: https://www.americaisallin.com/wp-content/uploads/2021/04/all-in-climate-strategy-for-50april-2021-1.pd
- Hultman et al, CGS-UMD working paper (Feb 2021) **"Charting an ambitious U.S. NDC of 51% reductions by 2030."** This paper lays out and assesses a federal policy platform built largely on a suite of incentives, tax credits, and new investments with some regulatory actions. Link: https://cgs.umd.edu/sites/default/files/2021-03/Working%20Paper_ChartNDC_Feb2021.pdf
- Hultman et al, Nature Communications paper (Oct 2020). **"Fusing subnational with national climate action is central to decarbonization: the case of the United States."** Peer-reviewed research paper presenting some of our larger America's Pledge work (49%) and framing it in the context of thinking about all-of-society climate strategies. https://www.nature.com/articles/s41467-020-18903-w
- Hultman et al, America's Pledge/America Is All In commentary (Jan 2021) **"An All-In National Climate Strategy to Deliver Ambitious, Robust, and Credible U.S. Action"** This commentary lays out the logic for and potential benefits from integrating subnational action into an "all in" national climate strategy. Link: https://www.americaisallin.com/wp-content/uploads/2021/02/all-in-national-climate-strategy.pdf
- Hultman, Brookings / CGS-UMD working paper (Nov 2020). **"Building an ambitious and robust US climate target: A comprehensive process to catalyze national and subnational climate action for the next NDC."** This is a longer-form report on strategies for creating good NDCs and improving their durability. Link: https://www.brookings.edu/wp-content/uploads/2020/11/Building-ambitious-robust-US-climate-target.pdf
- Hultman et al, America's Pledge (Dec 2019) Report. **"Accelerating America's Pledge: Going All-In to Build a Prosperous, Low-Carbon Economy for the United States"** This report was the first major new assessment of 2030 NDC options for the U.S. It develops our core methodology for understanding the contribution of subnational actors to the U.S. emissions trajectory and then estimates a potential 49% reduction by 2030 based on a comprehensive federal + non-federal platform. Link: https://www.americaisallin.com/wp-content/uploads/2021/02/accelerating-americas-pledge-1.pdf
- Hultman, Op-Ed in The Hill (April 14, 2021). "Slash emissions by 2030? How big goals will help tackle climate change." OpEd discussing 50% target. https://thehill.com/opinion/energy-environment/548174-slash-emissions-by-2030-how-big-goals-will-help-tackle-climate

Acknowledgments

CGS Climate and Energy team

Leon Clarke, Ryna Cui, Haewon McJeon,* Sha Yu,* John O'Neill, Alicia Zhao, Jenna Behrendt, Andy Miller, Kavita Surana, Jiehong Lou, Mengye Zhu, Jiawei Song, Tom Hilde, Lucy Qiu, Arthur Ku, Brinda Yarlagadda, Pat O'Rourke, Diyang Cui, Kowan O'Keefe, Mel George, Xingchi Shen, Todd McGarvey, Christina Bowman, Shannon Kennedy, Jae Edmonds*, Meredydd Evans*, Gokul Iyer*

**Our Joint Appointees with PNNL-JGCRI*

Plus others in CGS Finance cluster, CGS China Program; and collaborators across campus and other research organizations

SCHOOL OF PUBLIC POLICY
CENTER FOR GLOBAL SUSTAINABILITY

Thank you

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Complete Scope 3 Progress, Including Upstream Emissions from Energy

Allison Leach, Jennifer Andrews, Ben Robinson,
Tigran Aslanyan, & Emily Mello

University of New Hampshire

Outline

What is complete scope 3?

- *What aspects of scope 3 are already in SIMAP?*
- *Benefits to accounting for complete scope 3*

Progress on fuel and energy-related activities

- *Solar, fuel oil, and natural gas*

Managing changing system boundaries

SIMAP
SUSTAINABILITY INDICATOR MANAGEMENT & ANALYSIS PLATFORM

Our Team

Alley Leach

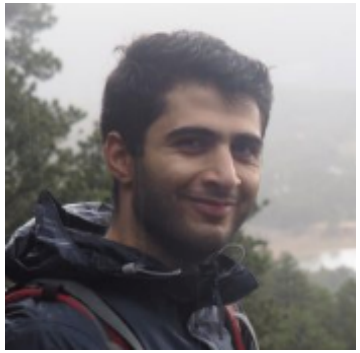
Postdoctoral Researcher

Jenn Andrews

Program Director

Ben Robinson

Technical Program Assistant



Tigran Aslanyan

UNHSI Summer Fellow

Emily Mello

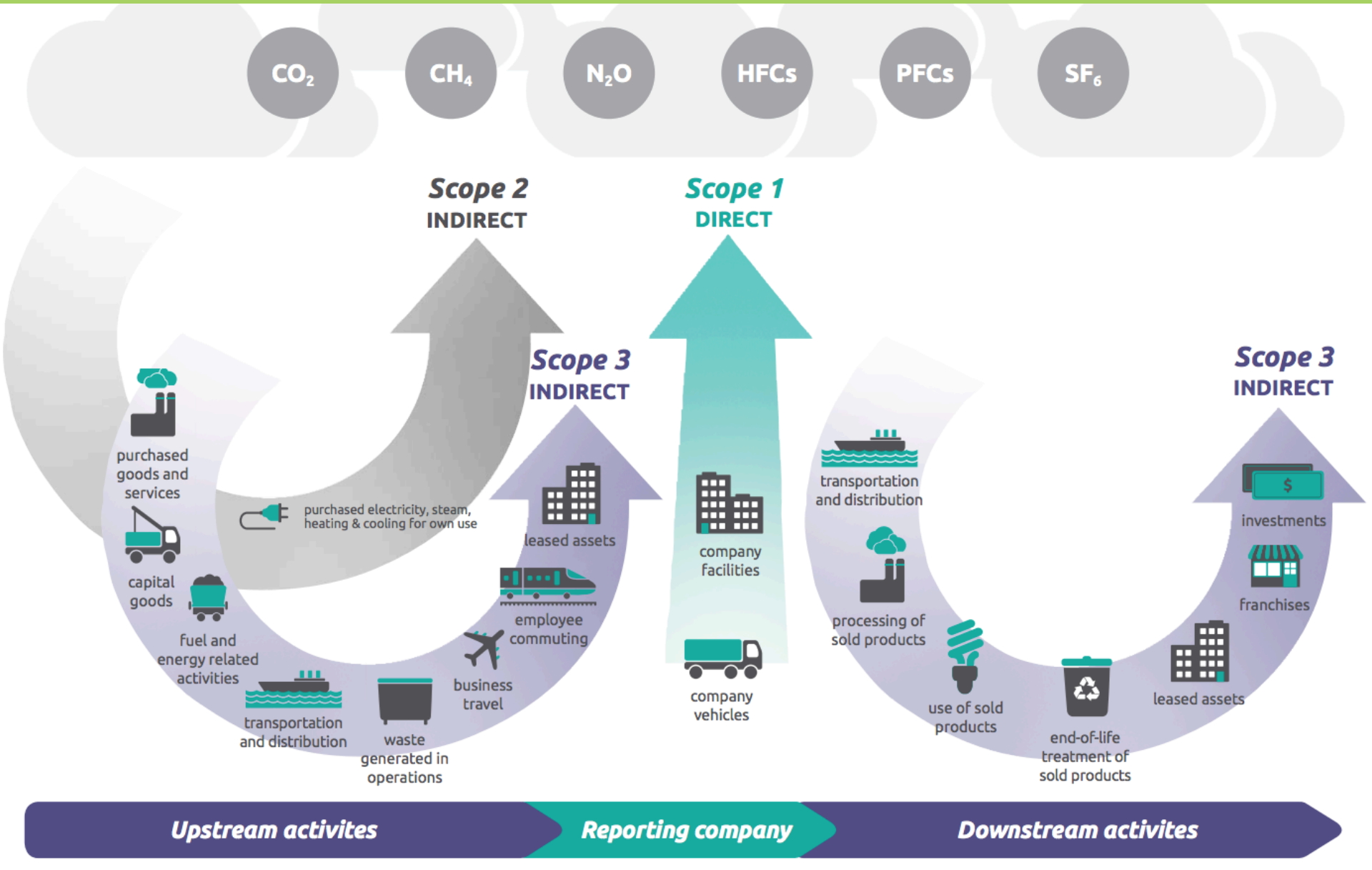
UNHSI Summer Fellow

SIMAP
SUSTAINABILITY INDICATOR MANAGEMENT & ANALYSIS PLATFORM

GHG Protocol for Scope 3

- Standards developed by the World Resources Institute for reporting scope 3 at the corporate level
- For SIMAP, we are adapting these guidelines for higher ed

What are Scope 3 Emissions?



Which scope 3 categories are in SIMAP now?

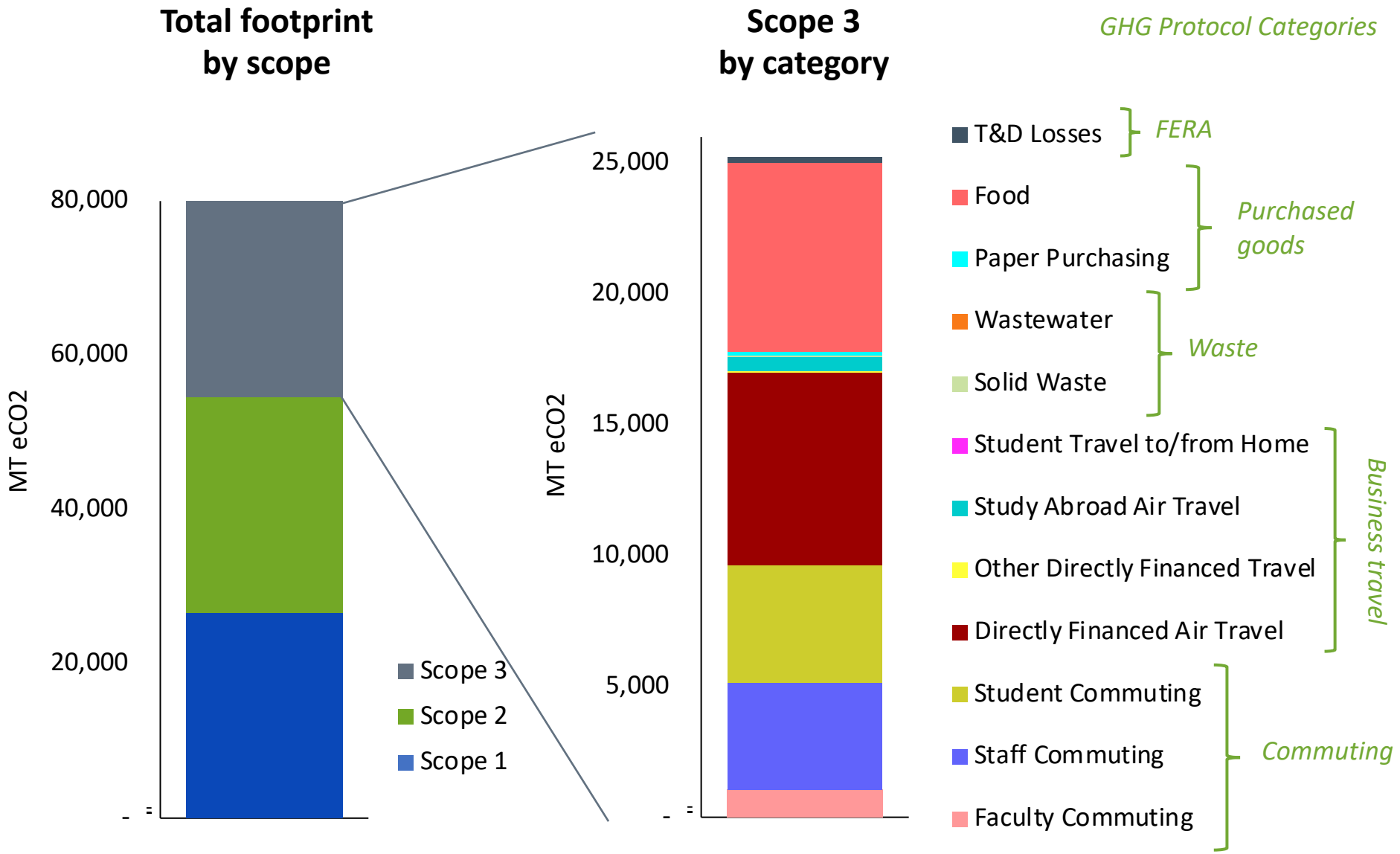
Upstream scope 3 emissions

Downstream scope 3 emissions

Scope 3 category	
1.	Purchased goods and services **Partial: Food, Paper**
2.	Capital goods
3.	Fuel- and energy-related activities (not included in scope 1 or scope 2) **Partial: Electricity T&D losses** Second Nature
4.	Upstream transportation and distribution **Partial: Food**
5.	Waste generated in operations ✓
6.	Business travel ✓ Second Nature
7.	Employee commuting ✓ Second Nature
8.	Upstream leased assets
9.	Downstream transportation and distribution
10.	Processing of sold products
11.	Use of sold products
12.	End-of-life treatment of sold products
13.	Downstream leased assets
14.	Franchises
15.	Investments

Reference: Figure [5.3] Time boundary of scope 3 categories, Corporate Value Chain (Scope 3) Accounting and Reporting Standard

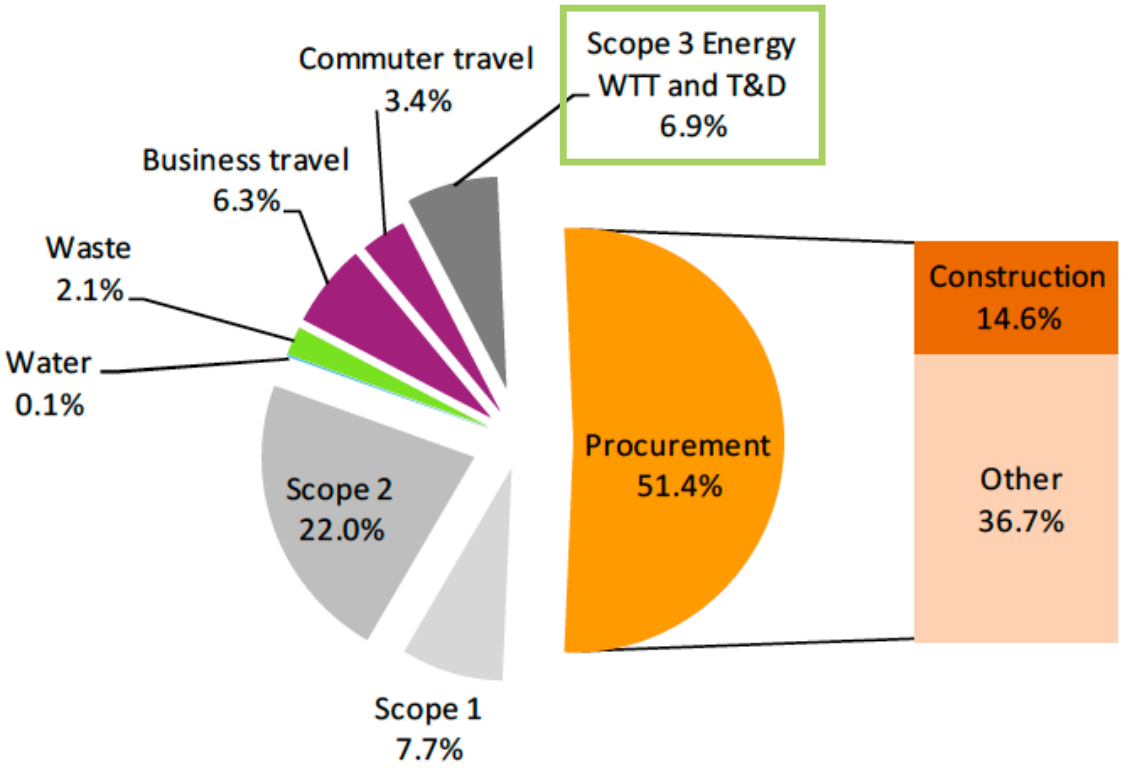
Scope 3 categories already in SIMAP



Complete scope 3: Potential magnitude

University of Cambridge

GHG Inventory 2011-2012 AY



Scope 1 + 2 = 30%

Scope 3 = 70%

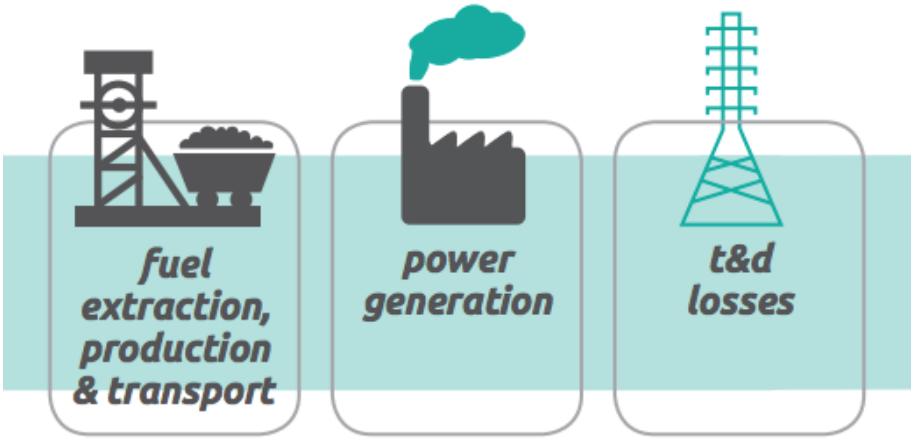
Scope 3 could be a significant proportion of total campus footprints

AECOM. 2014. University of Cambridge Footprinting and Analysis of Scope 3 Emissions.
https://www.environment.admin.cam.ac.uk/files/university_of_cambridge_scope_3_element_1_final.pdf

Value proposition in scope 3 accounting

1. Informs decision-making
   - "Can't manage what you don't measure"
2. Quantitative data supports other initiatives
3. Campus as a 'living lab'
   - Student research, high-impact learning
4. Leadership opportunity
   - For campus and vendor partners

Progress on
Fuel- and Energy-Related Activities



SIMAP
SUSTAINABILITY INDICATOR MANAGEMENT & ANALYSIS PLATFORM

What is included in category 3 of scope 3 emissions?

Emissions related to the production of fuels and energy purchased and consumed by the reporting company that are not included in scope 1 or scope 2

This category includes emissions from four activities

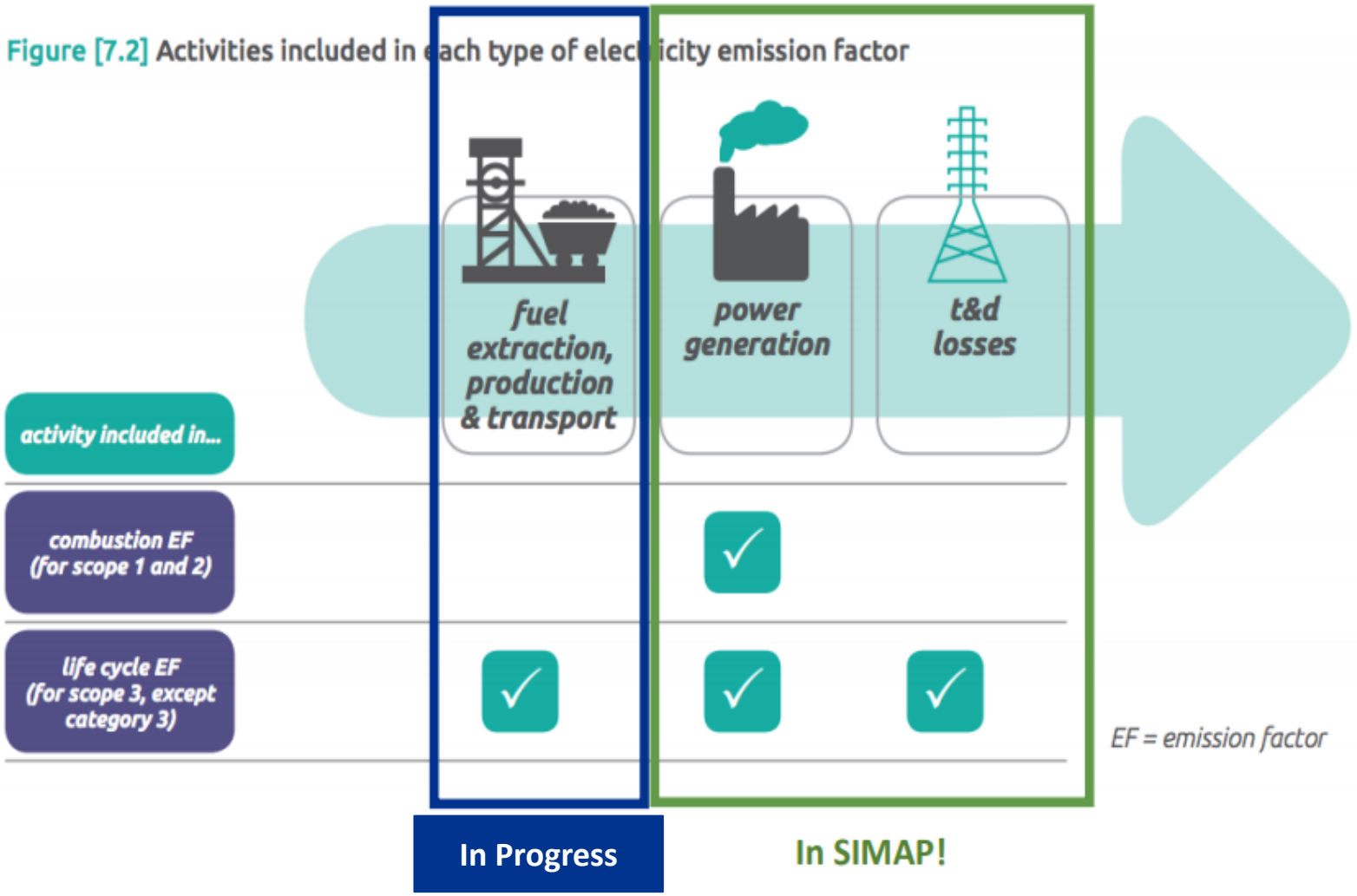
A) Upstream emissions of purchased fuels

B) Upstream emissions of purchased electricity

C) Transmission and distribution (T&D) losses

D) Generation of purchased electricity that is sold to end users

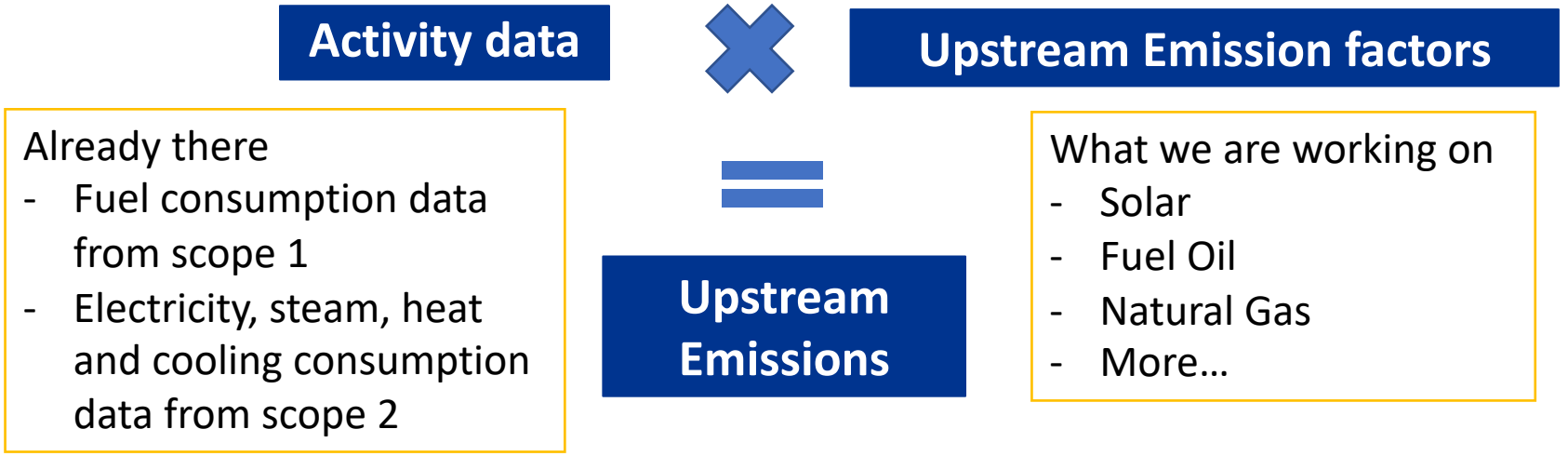
Activities included in each type of emission factors



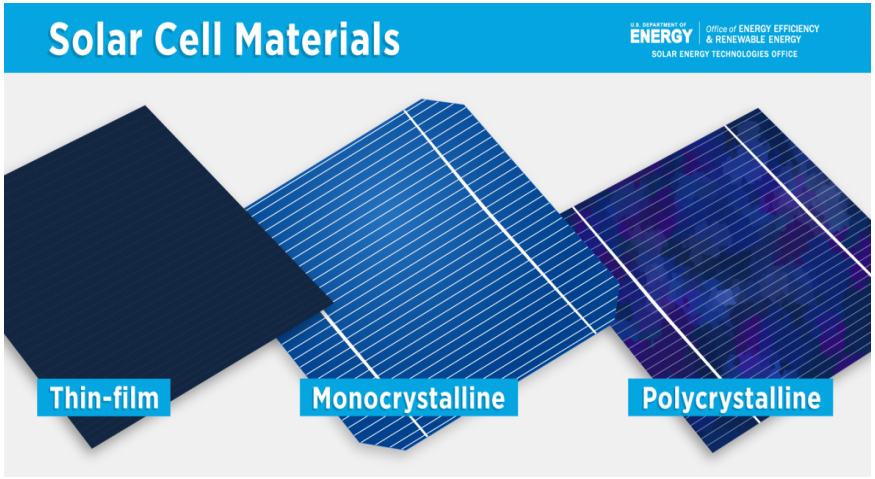
Calculation of category 3 (FERA) emissions in scope 3

Methods

- Average-data method / Default EF
- Supplier-specific method / Custom EF



Solar Energy Technologies



- Photovoltaic (PV) Solar Energy:
  - Crystalline silicon
  - Thin film
- Thermal Solar Energy:
  - Solar thermal collectors
  - Concentrating solar power (CSP)

Life Cycle Stages of Solar Technologies

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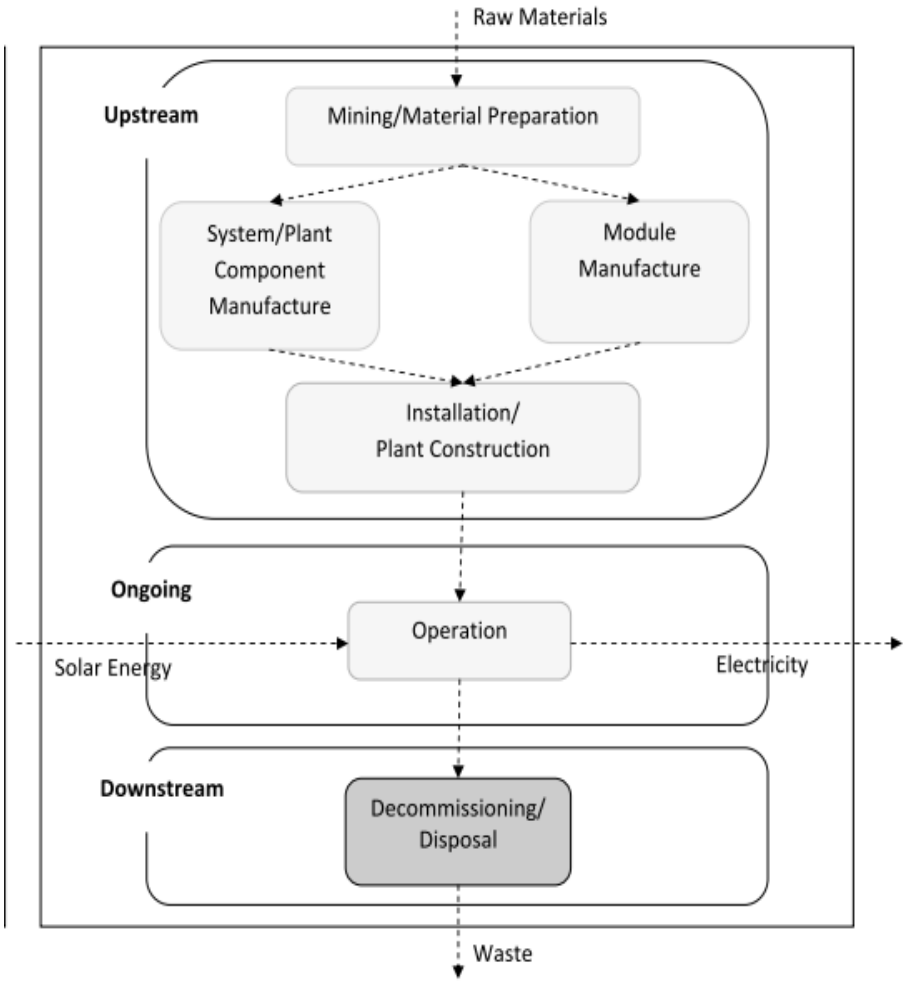
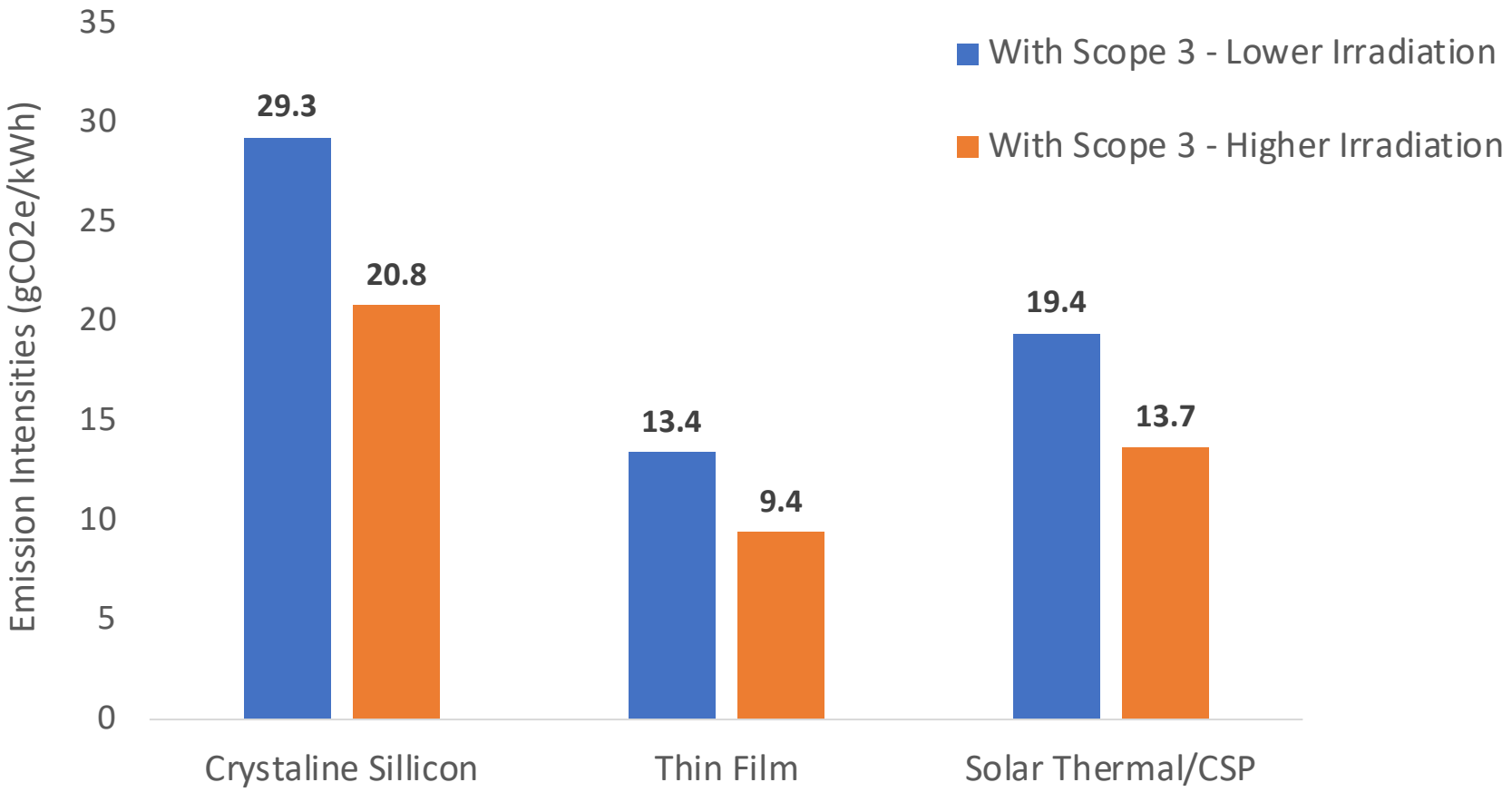


Factors affecting life cycle emissions of solar energy

- **Solar irradiation (DNI) –** amount of sunshine they absorb – *changes by location*
- **Operating lifetime** – *30 years*
- **Module efficiency** - *varies by technology*
- **Performance ratio** – *varies by type of installation*

Upstream Emissions of Solar Energy Technologies



Without scope 3, no emissions from solar technologies

Future Steps for Solar Scope 3 Emissions

Add emission factors for each life cycle stage instead of using average proportions

Add emission factors for each GHG type separately in order to account for future GWP changes in SIMAP

Questions we have for the user community about solar

Do your institutions own solar PV panels, thermal collectors or RECs?

Are you aware of types of technologies used for your solar panels/RECs?

Who is responsible for operational processes /maintenance of your solar systems?

Scope 3 Emissions of Fuel Oil

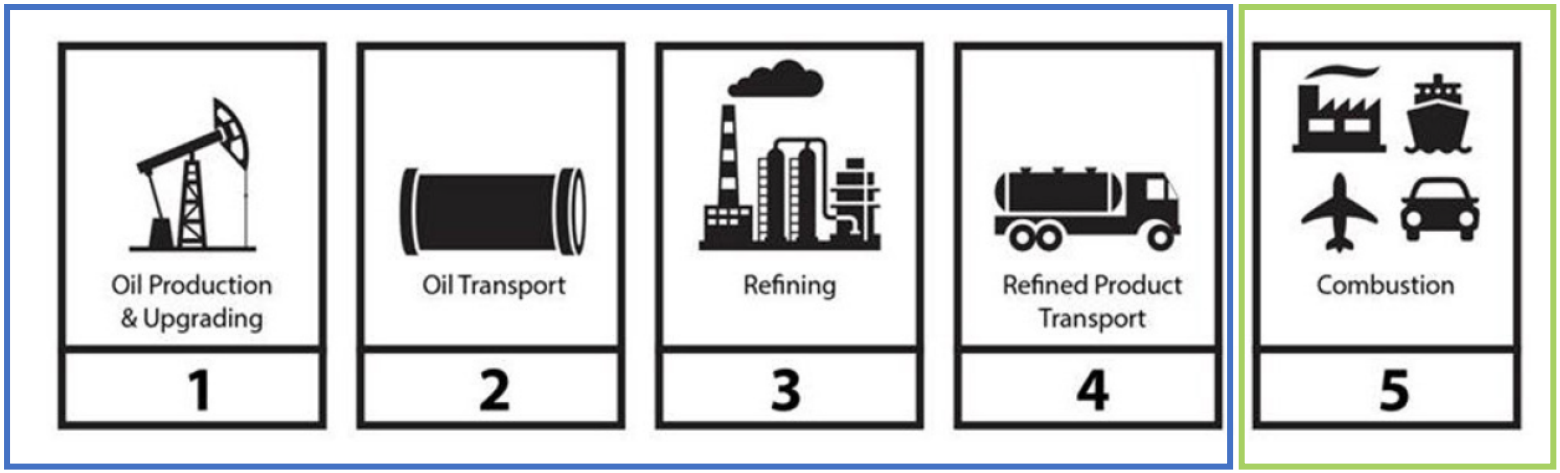
- Fuel Oil is a petroleum product
  - Derived from crude oil
  - Used mainly in furnaces and boilers

- Types of Fuel Oil considered in SIMAP:
  - Distillate Oil (#1-4)
  - Residual Oil (#5-6) (not common anymore)

- The type is determined by how it is REFINED

Scope 3 Emissions of Fuel Oil

System Boundaries



Source: ARC Financial Corp.

Scope 3

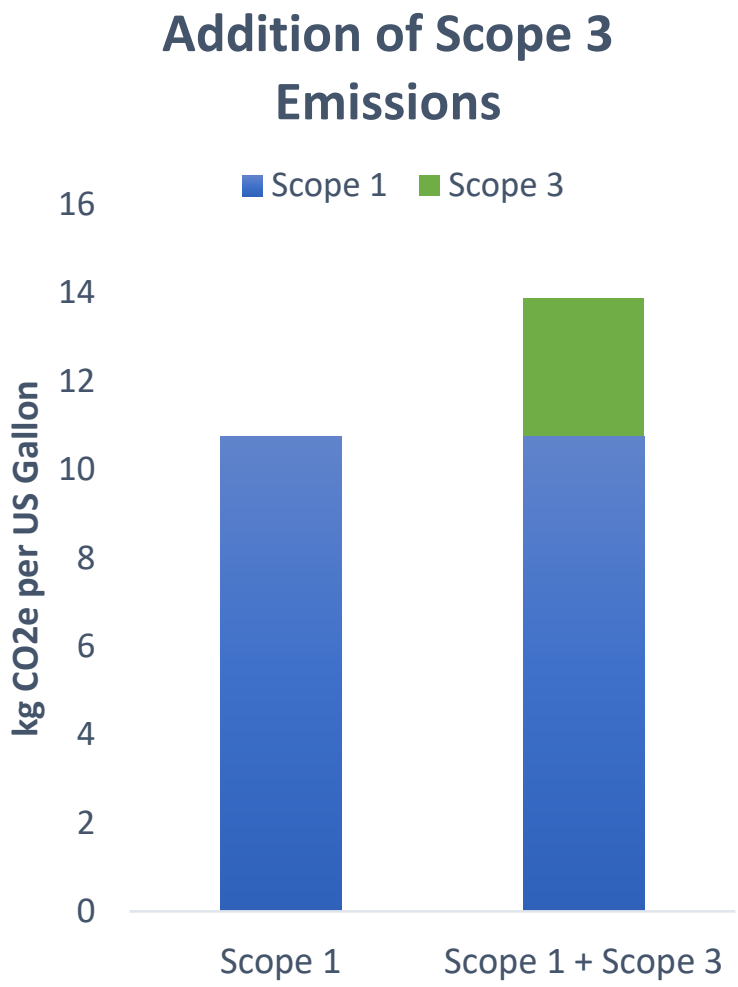
To be added into SIMAP

Scope 1

Currently Included in SIMAP

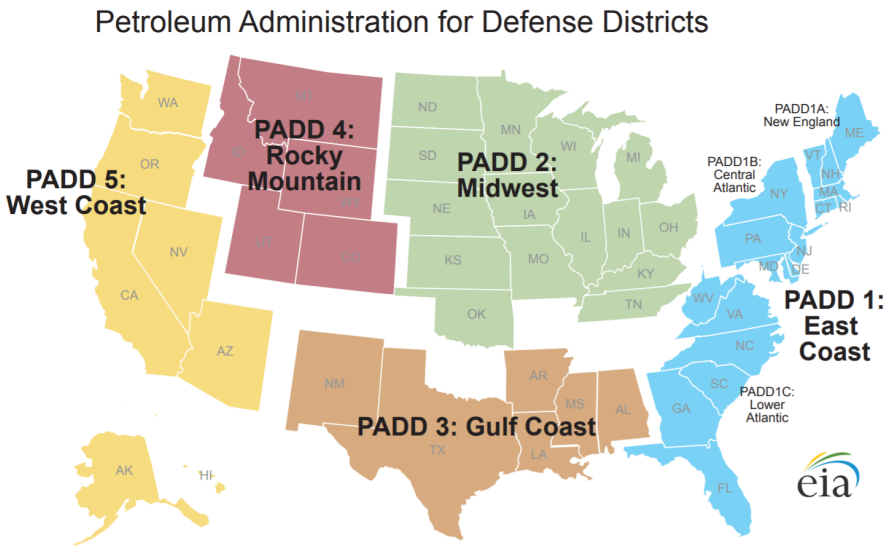
Fuel Oil Scope 3 Emissions

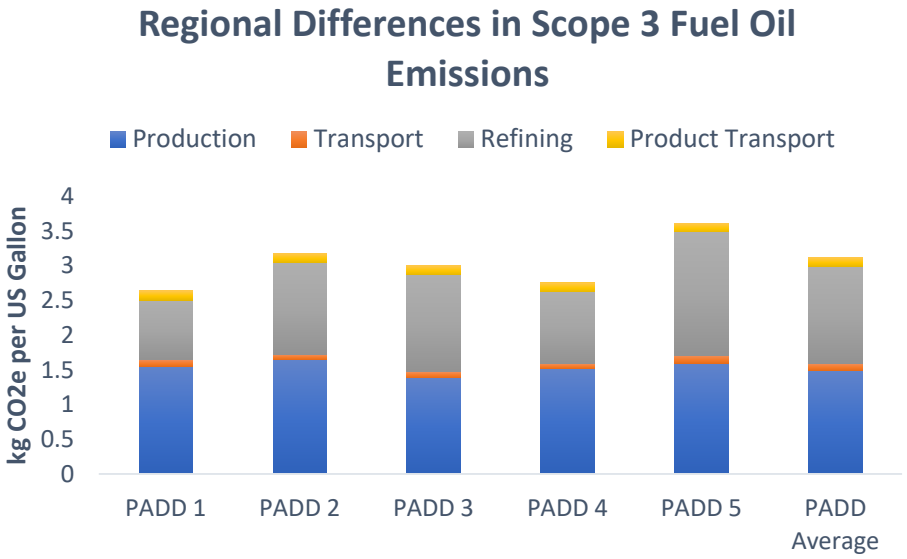
- The addition of Scope 3 Emissions will add 25-34% to the life cycle emissions from fuel oil based on location
- The average Scope 3 Emission Factor for Fuel Oil is 3.12 kg CO2e per US Gallon



Fuel Oil Regional Districts (PADDs)

SIMAP will be using the emission factors for the user's specific region





Regional differences in emissions are due to the regional differences in the type of crude oil being processed and refined

Scope 3 Emissions for Natural Gas

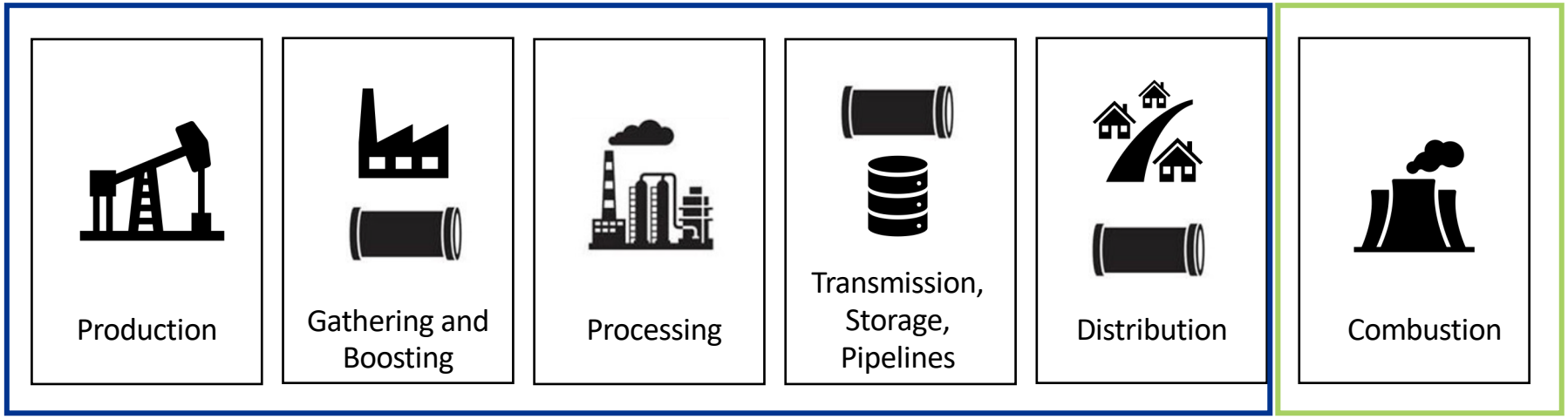
- Natural Gas is composed of mainly methane (CH4)
- It is commonly used for heating, cooking, and electricity generation

- There are several types of Natural Gas
  - Shale (75% of US Natural Gas Production)
  - Conventional
  - Tight
  - Associated

- The type is determined by how it is EXTRACTED

Scope 3 Emissions for Natural Gas

Supply Chain Boundaries



Scope 3

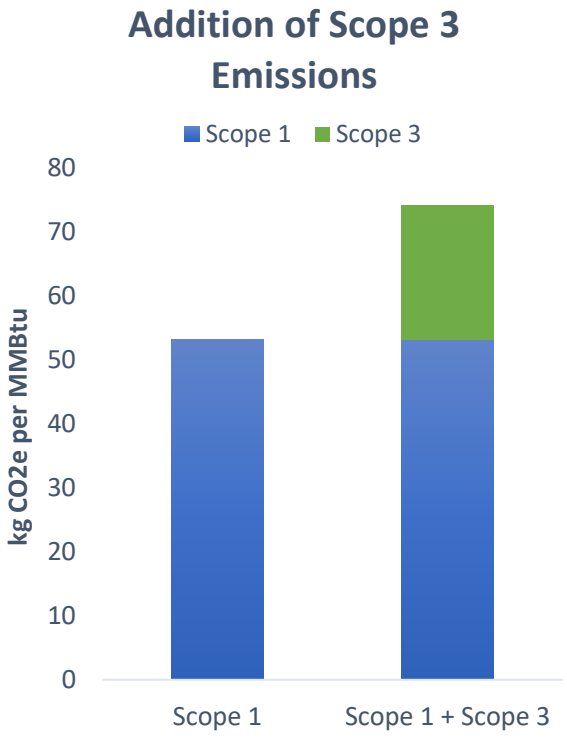
To be added into SIMAP

Scope 1

Currently Included in SIMAP

Natural Gas Scope 3 Emissions

- The addition of Scope 3 Emissions will add 39% to the life cycle emissions from natural gas
- The scope 3 emission factor for natural gas is 21.01 kg CO2e per MMBtu
- This is a weighted average for the US

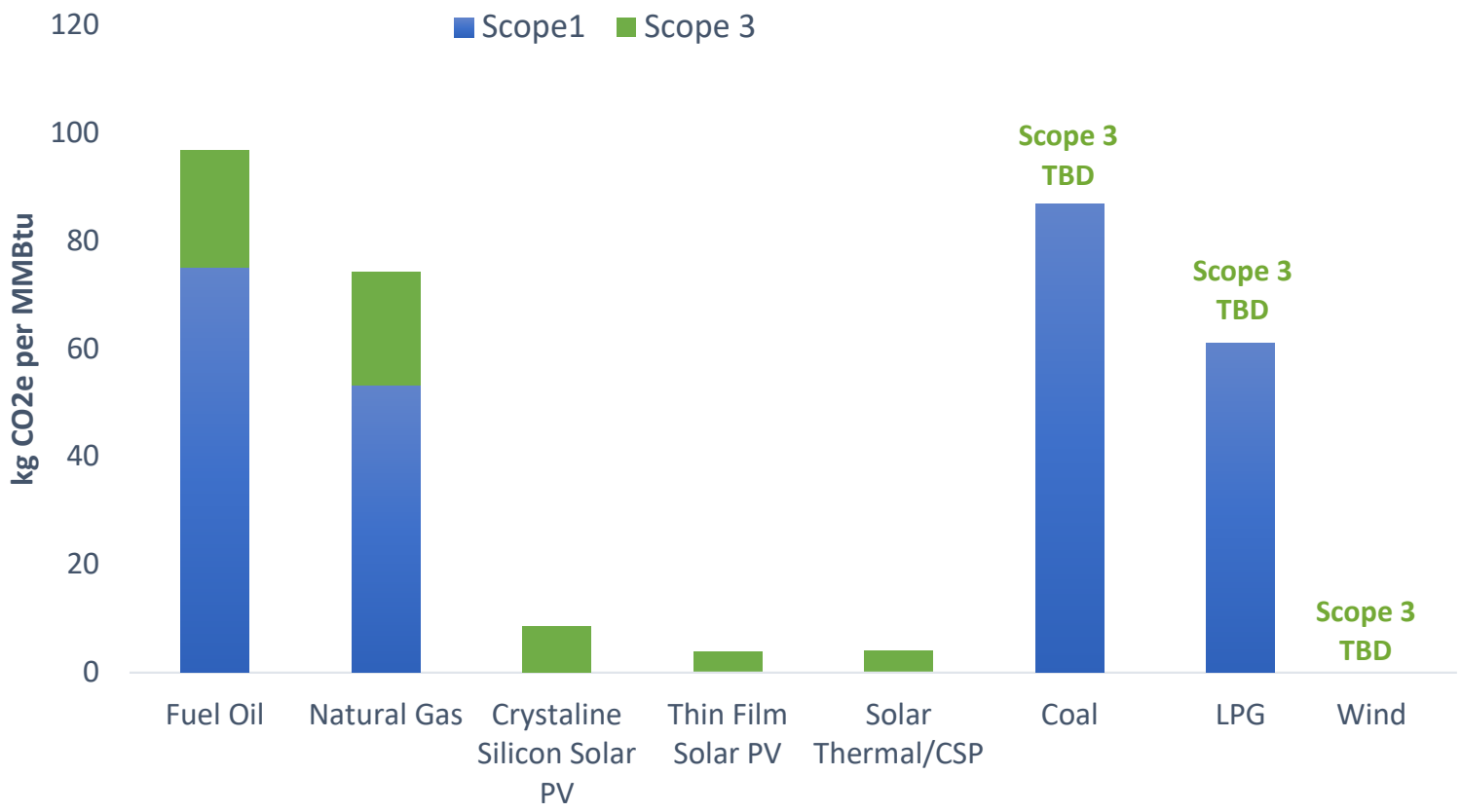


Natural Gas Scope 3 Methane Leaks

Further research is needed!

- Methane leakage rates range from 1% to 7% (per unit of natural gas delivered) depending on method and boundaries
- Shale Natural Gas extraction produces significantly higher amounts of CH_4 than Conventional Natural Gas
- Howarth et al. 2014 suggests that when using the 20-year GWP, Natural Gas has higher life cycle emissions than coal

Scope 1 and Scope 3 Emissions for Stationary Fuel and Energy Related Activities



Note: This graph does not include biofuels

Managing changing system boundaries

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Challenges w/Expanding Boundaries

1) Social capital: maintaining ”credibility” and buy-in

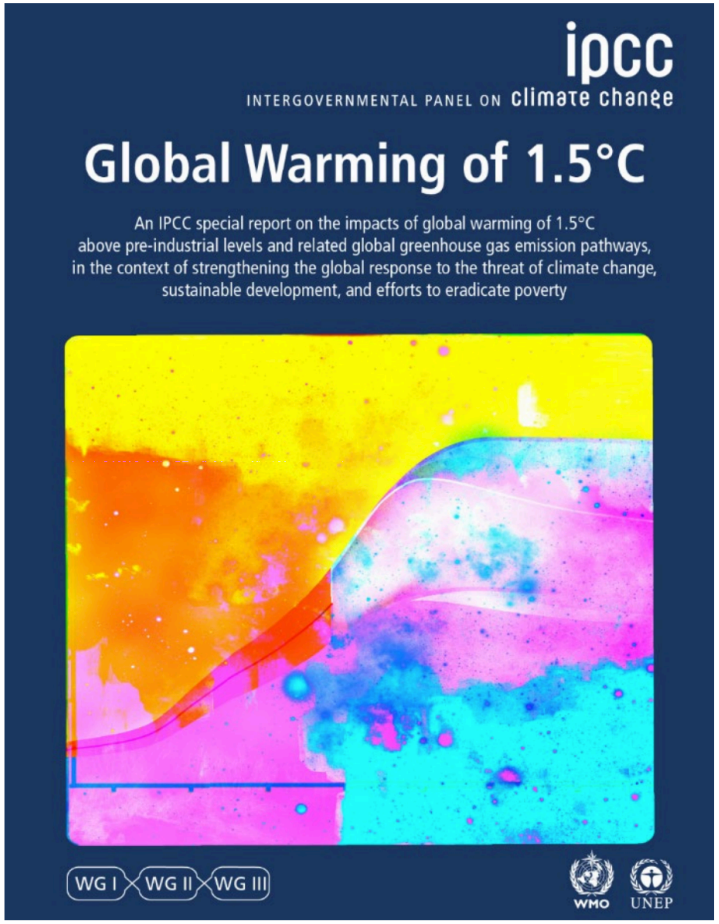
2) Capacity: balancing hours, energy and focus w/potential for impact

3) Communications: balancing clarity and context to motivate ACTION and CHANGE

So **Why** "Move the Goalposts"?

Because reality demands it

From the IPCC slide deck.
Accessed at https://www.ipcc.ch/sr15/mulitimedia/presentation/ on 8/13/20



Wrestling with Changing Boundaries at UNH

Original WildCAP goals and reporting

1. **Reporting and setting goals using Climate Commitment "combined" boundaries**
   - 80% across-the-board reductions by 2050; 50% by 2020
2. **2001 baseline**
   - "back-casted " for business air travel, still don't have complete business travel or study abroad

WildCAP 2020 – Plans for updated goals and reporting

1. **Reporting and setting goals separately**
   - Scope 1+2: Net zero by 2030
   - Scope 3: category-specific, with categories added over time as available (purchasing, investments)
2. **Varied baseline year**
   - For S1+S2, adjusted to 2010 to be able to communicate how we are aligned with IPCC 1.5c report
   - For Scope 3 categories, first year for which there is complete data/analysis (e.g. food, 2014)

Summary

Scope 3 Accounting

- Challenging to do, but can be of strategic value, especially if coupled with related initiatives (e.g. student research, STARS)
- Need to move toward “dual reporting”
- SIMAP will help!

FERA next steps

- Finalize emission factors for additional categories (e.g., biofuels, wind, coal)
- Finalize methods for upstream direct energy and purchased electricity
- Incorporate into SIMAP!

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Questions?

Website: unhsimap.org

Contact us: simap@unh.edu