

# 8<sup>th</sup> Annual Green Infrastructure Conference

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## Welcoming Remarks

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# Historic Topics

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- Storm water
- Climate Change
- Resiliency
- Energy/Smart Grid/Renewables
- Sustainability
- Public Private Partnerships

# Today

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- Panels:
  - Power purchase agreements/greening institutional resumes
  - Reducing or eliminating reliance on landfills
- Keynote: Kristiane Huber who will in part begin to answer the \$64,000,000,000,000 question.
- Closing remarks: Jim McElfish of ELI

# Annual Backdrop Slides

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- Politics
- Facts
- Damn Facts

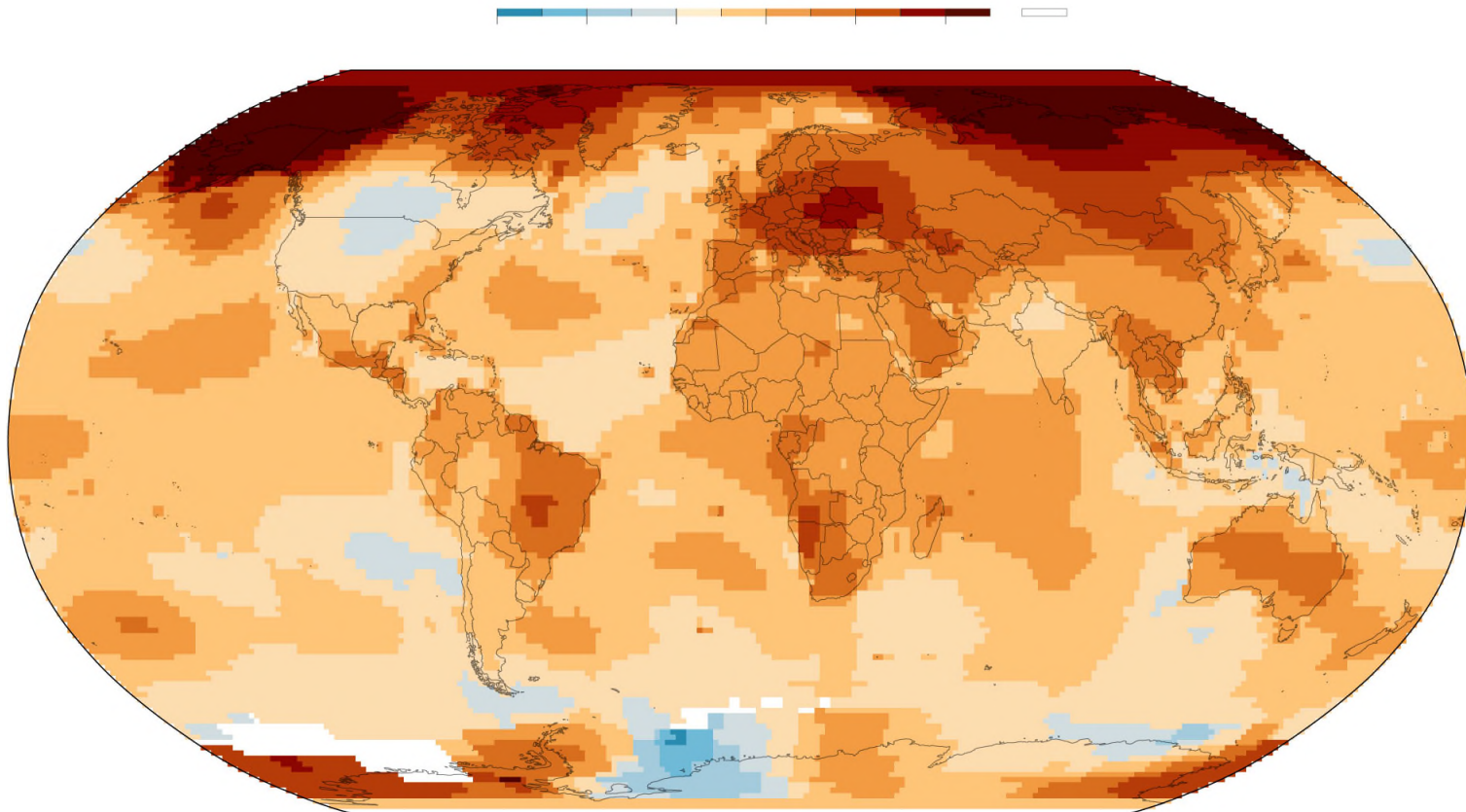
# Politics

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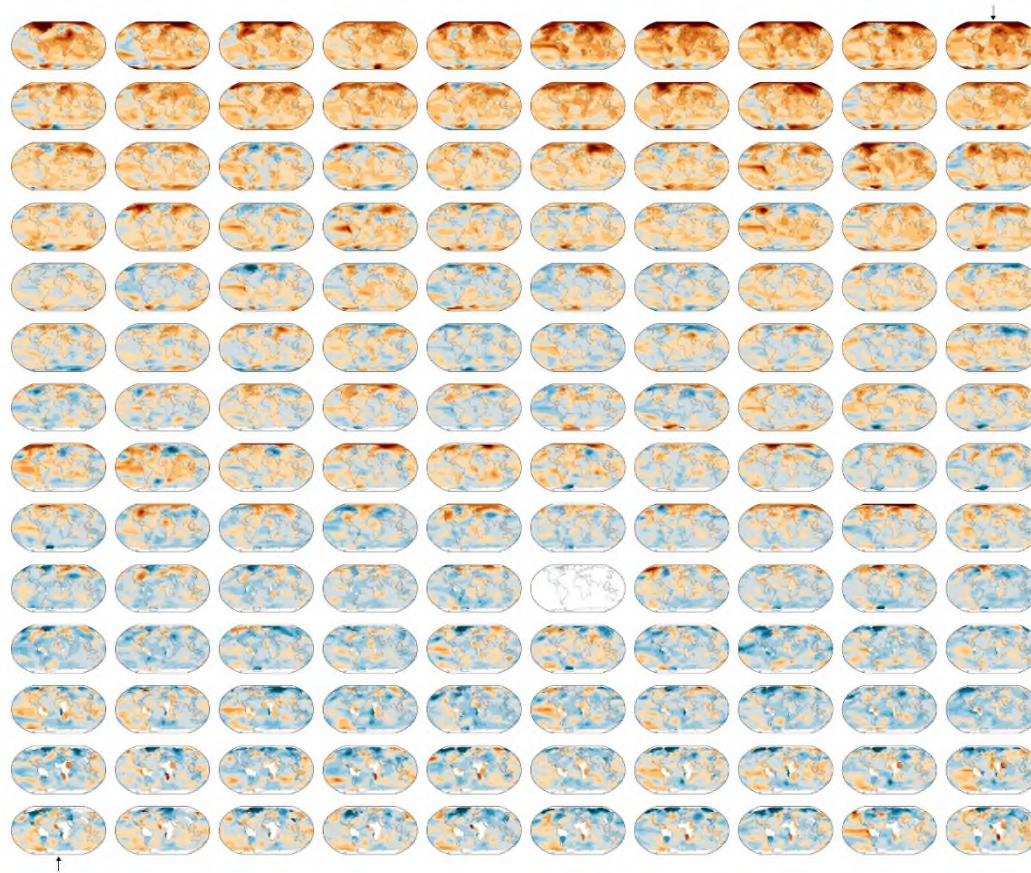
- “I like clean air and clean water”
- Role of science
- Hoaxes and witch hunts
- The U.S. Congress
- Unprecedented scale-back of fundamental programs
- The States to the rescue?



# Facts



# Facts





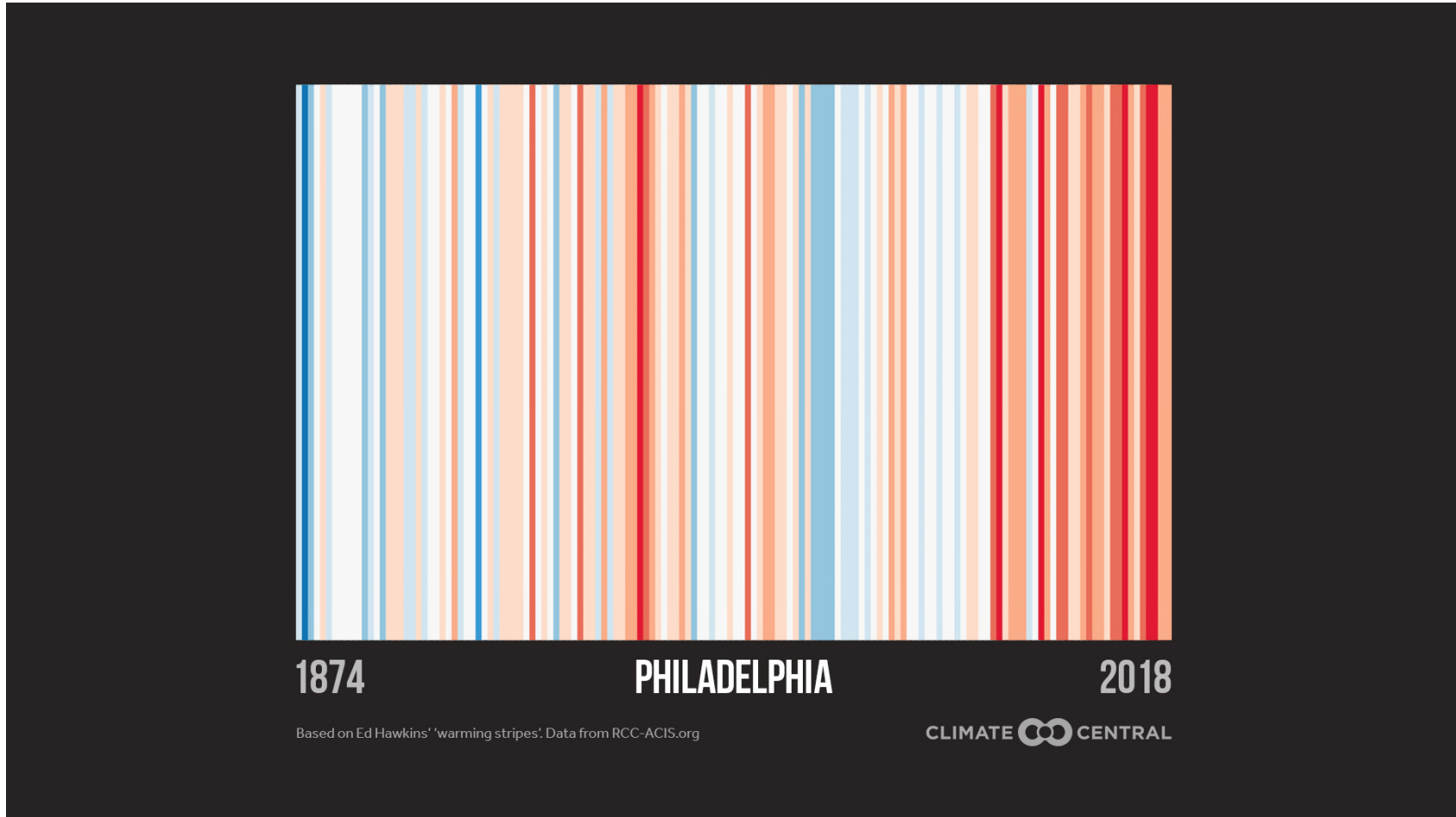
# Knitting Club



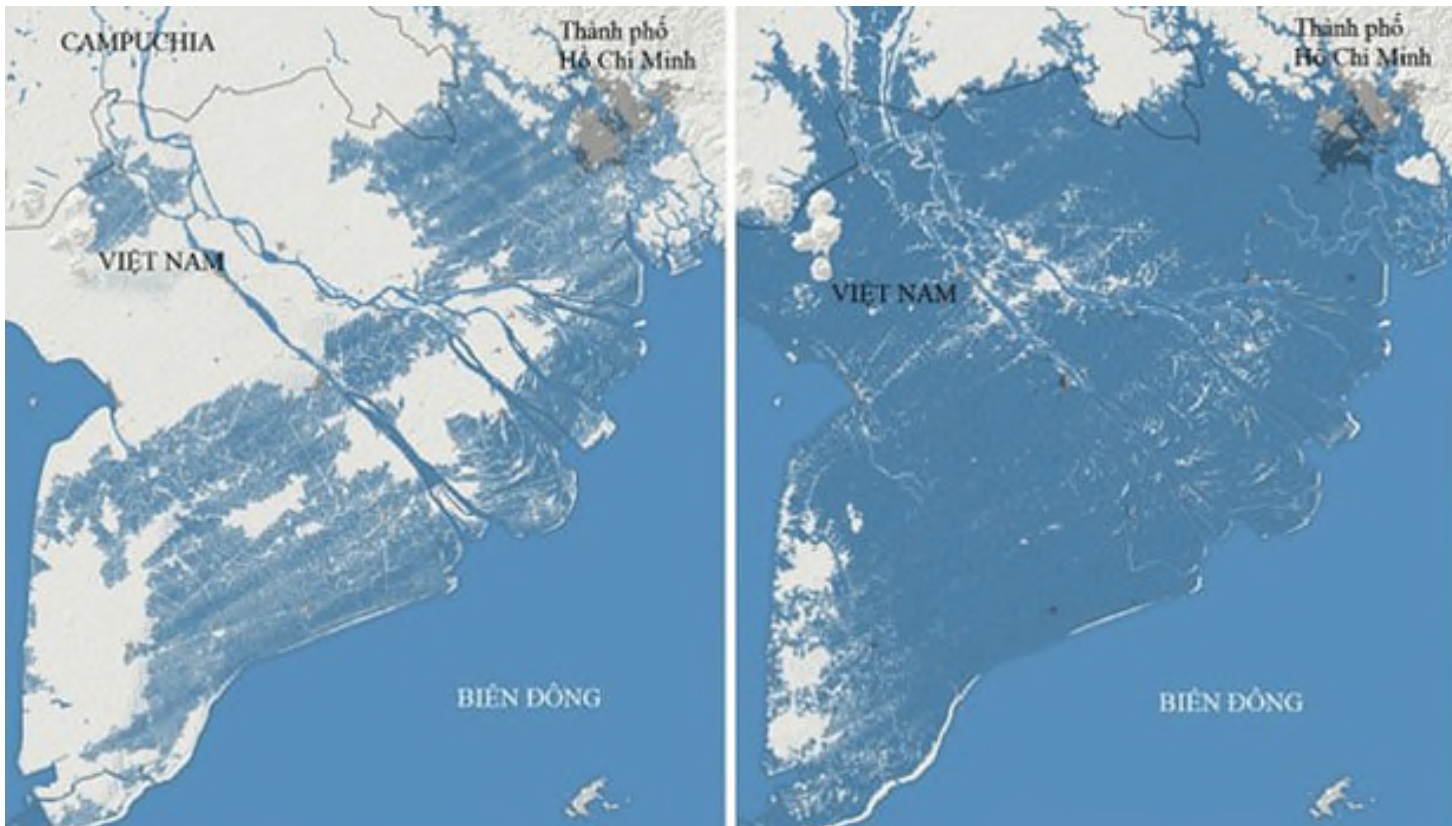
# Facts



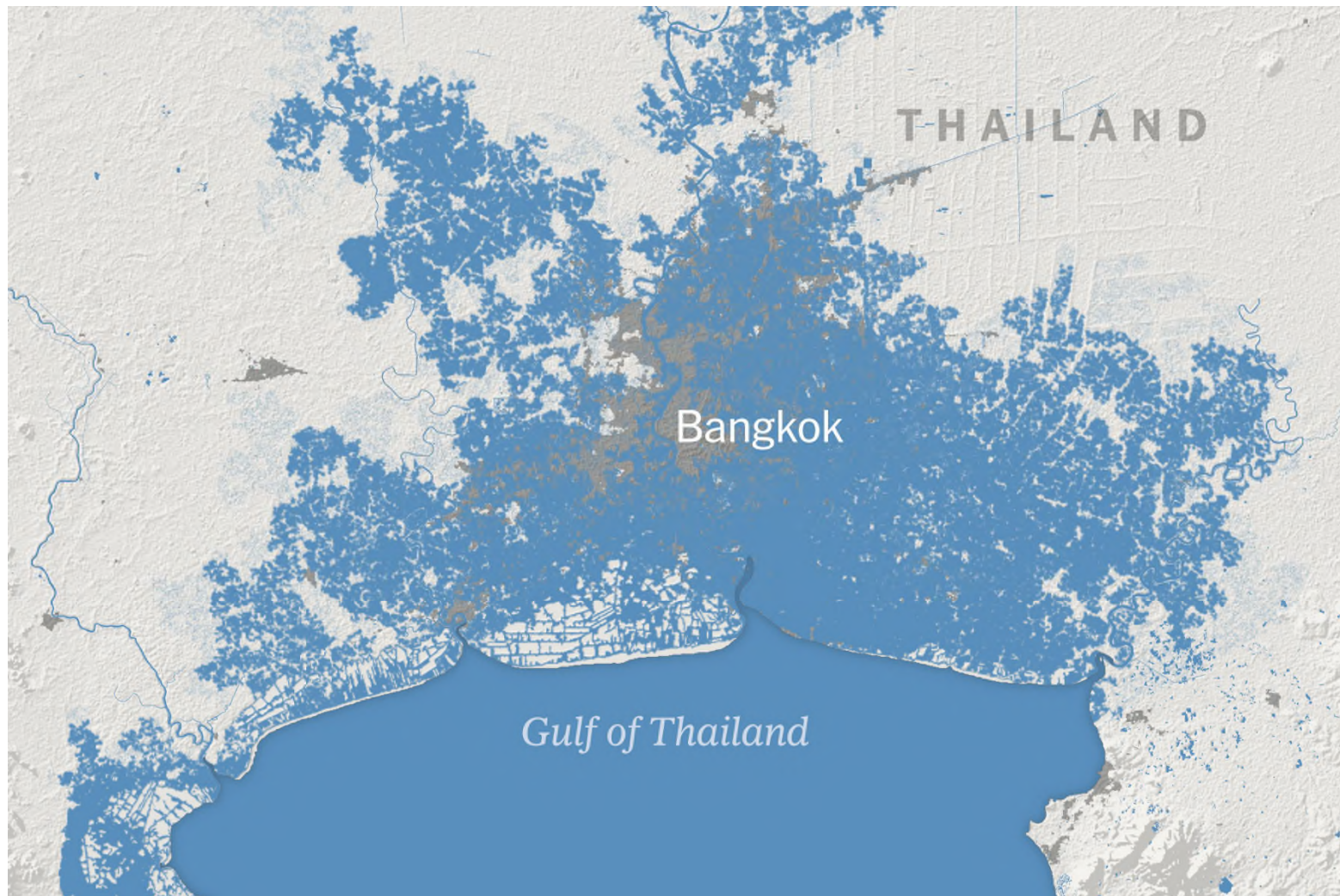
# Art, Literally and Figuratively

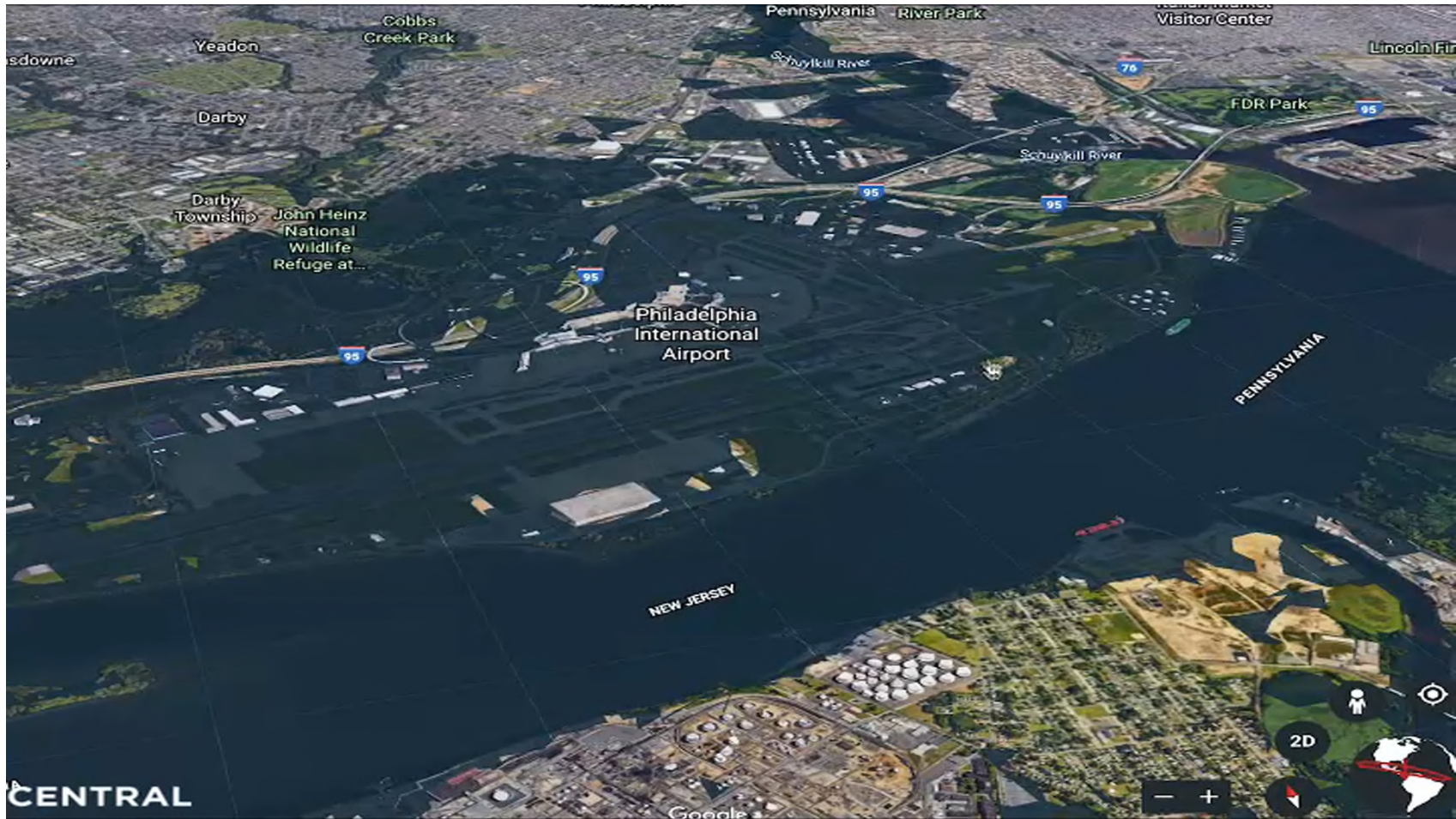


# Damn Facts



# Damn Facts





# 8<sup>th</sup> Annual Green Infrastructure Conference

## **RENEWABLE ENERGY POWER PURCHASE AGREEMENTS FOR HIGHER EDUCATION AND BUSINESSES**

*Panelists:*

Ray Faricy and David Armstrong, Ballard  
Spahr, LLP

Gerry DaRosa, Arizona State University

Kevin Rackstraw, CustomerFirst  
Renewables, LLC

## What's happening?

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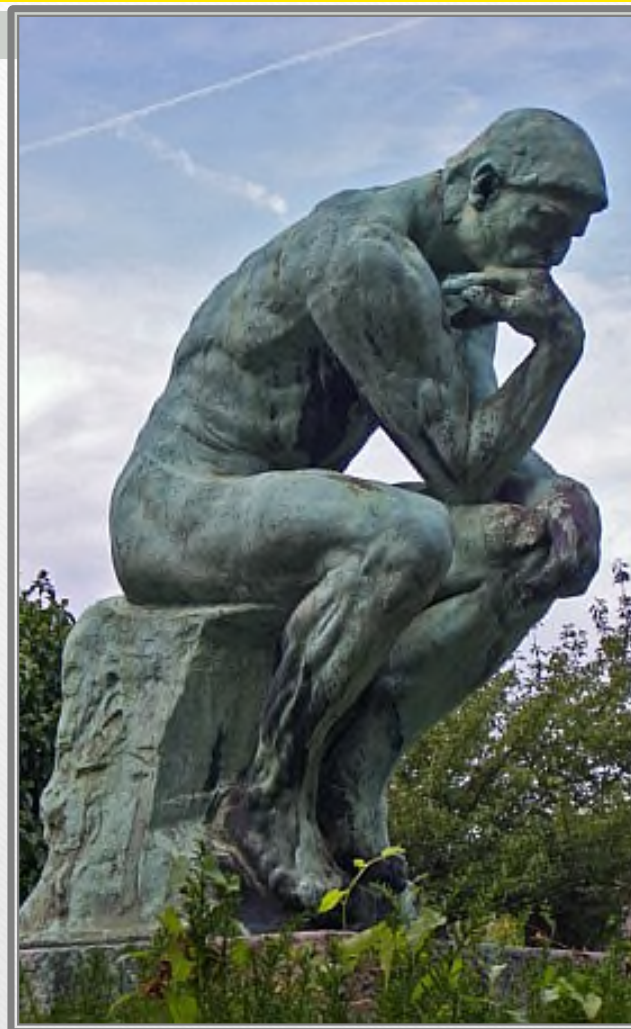
Higher education institutions are entering into renewable energy power purchase arrangements at an unprecedented rate, and they are using a variety of different structures to achieve their sustainability goals.



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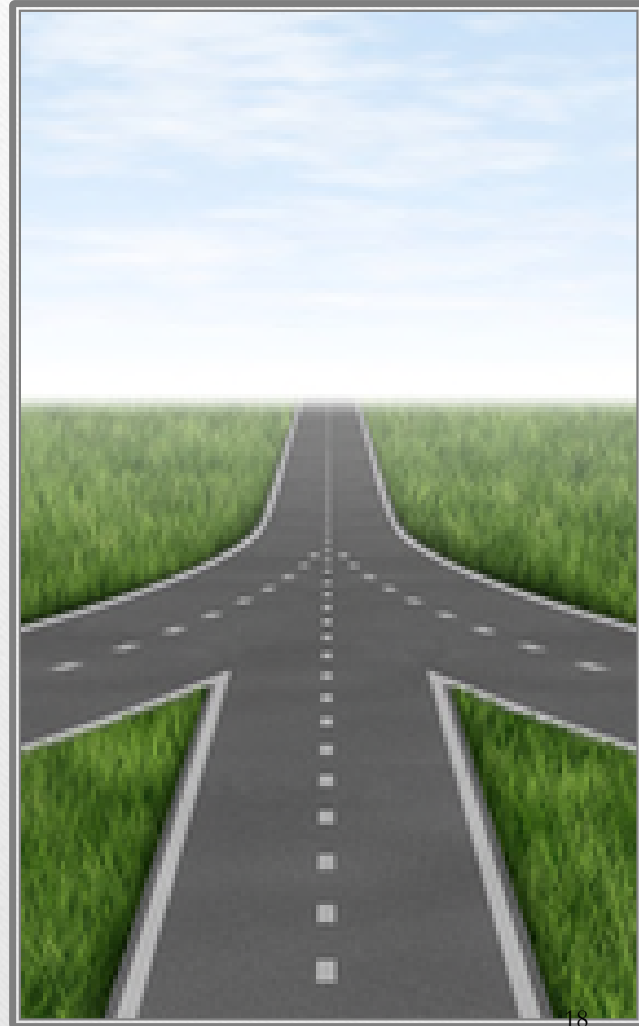


What's driving this surge in green power purchases by higher education institutions?

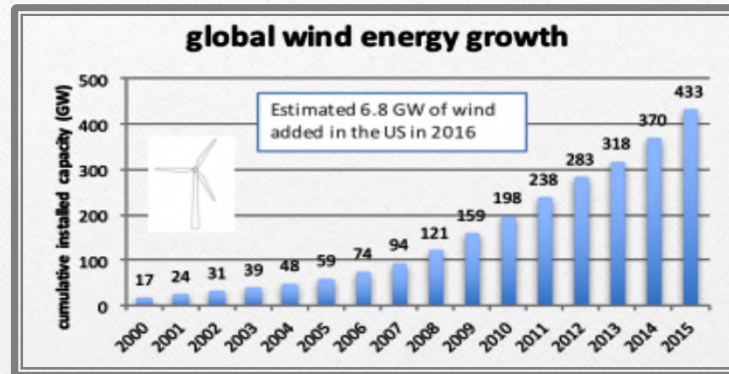


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Several key factors/trends  
have been converging



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First: The growth of renewable energy has been steadily progressing the past two decades.

The price of renewable energy has never been better.

Second: HEIs are looking for renewable energy solutions as part of their sustainability goals that require them to make meaningful progress towards becoming more energy efficient and more “green.”

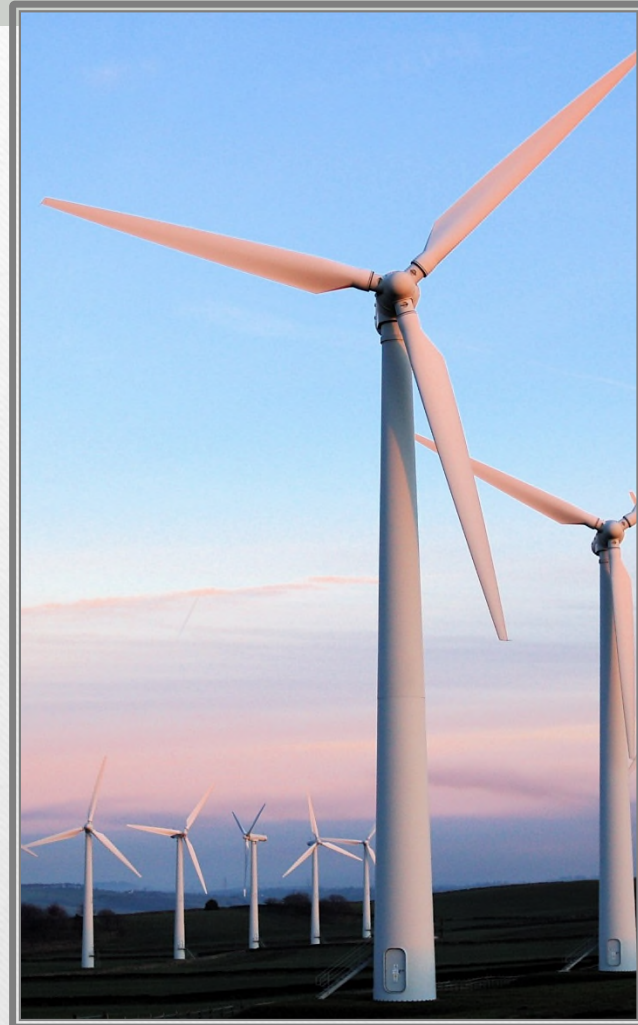
Renewable energy projects generate renewable energy credits that help further these sustainability goals.





These trends are creating a perfect storm

- Renewable energy in the US is no longer a fringe technology.
- The US now has over 100 gigawatts of installed wind capacity, up from less than 3 gigawatts in 2000.
- Another 20,000+ megawatts are currently under construction.
- Renewable energy facilities are the leading source of new generation.



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Installed solar capacity in the US now exceeds 50 gigawatts, with another 13 GWs anticipated in 2020.

In 2019, over 13,000 megawatts of renewable energy (wind/solar) was contracted in the US market from non-utility purchasers, mainly large corporate organizations.





- The 20<sup>th</sup> century was an electric century, largely powered by fossil fuels.
- Typical model for an electrical power plant was a fossil fuel generator owned by a regulated utility that had a monopoly on electric distribution in its territory.



- Rising environmental awareness brought the Clean Air Act and Clean Water Act in early 1970s.



# How did we get here?

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- Changes in the electricity markets allow for new players
- Deregulation/ Transmission/Generation
- Competition drives innovation
- The Europeans brought project expertise and technology

# PURPA

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- Adopted in 1978
- Intended to promote conservation (think: OPEC/energy shortages)
- Allows for independent power producers
- Competition begins

# Background: How did we get here?

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- Tax credits: PTCs and ITCs
- Renewable Portfolio Standards
- Equipment improvements
- Institutional buyers
- Growing concerns about environmental impacts

# Tax Credits

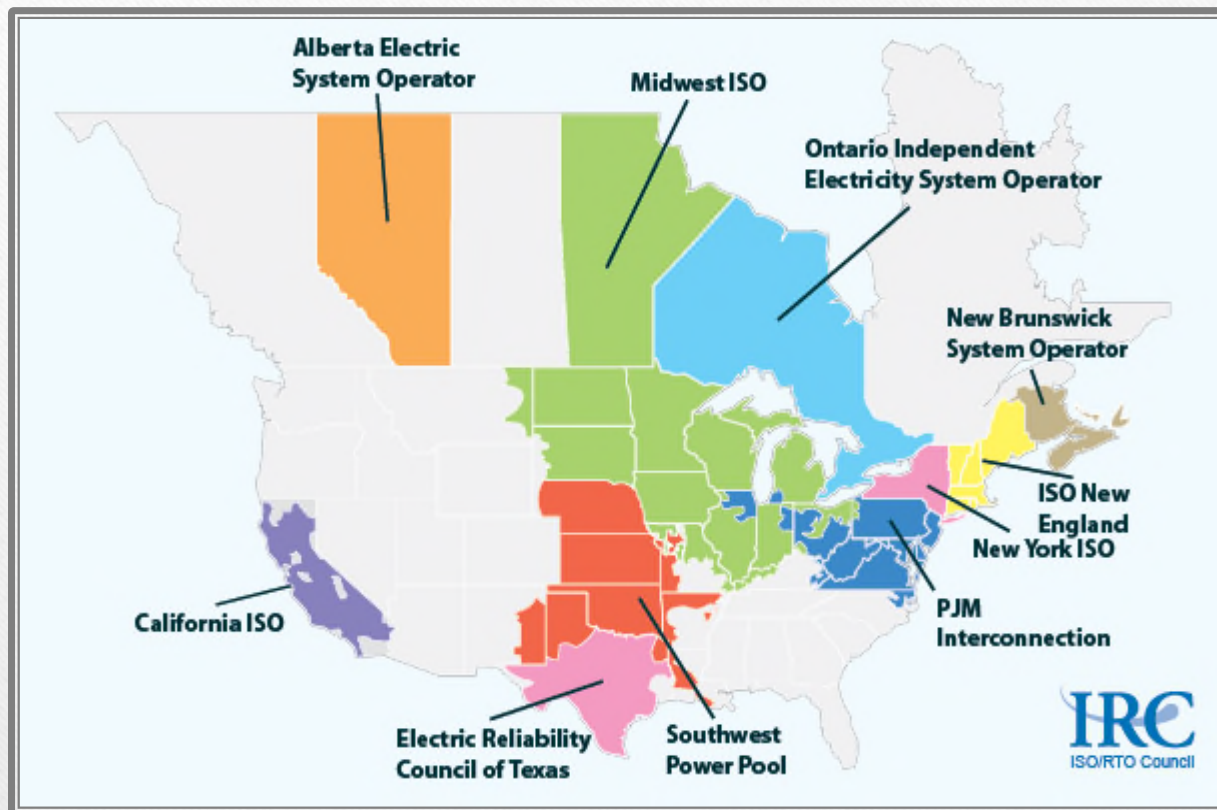
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## PTC

- Section 45 of IRC
- Production-based credit
- Ten-year duration
- “commencement of construction”

## ITC

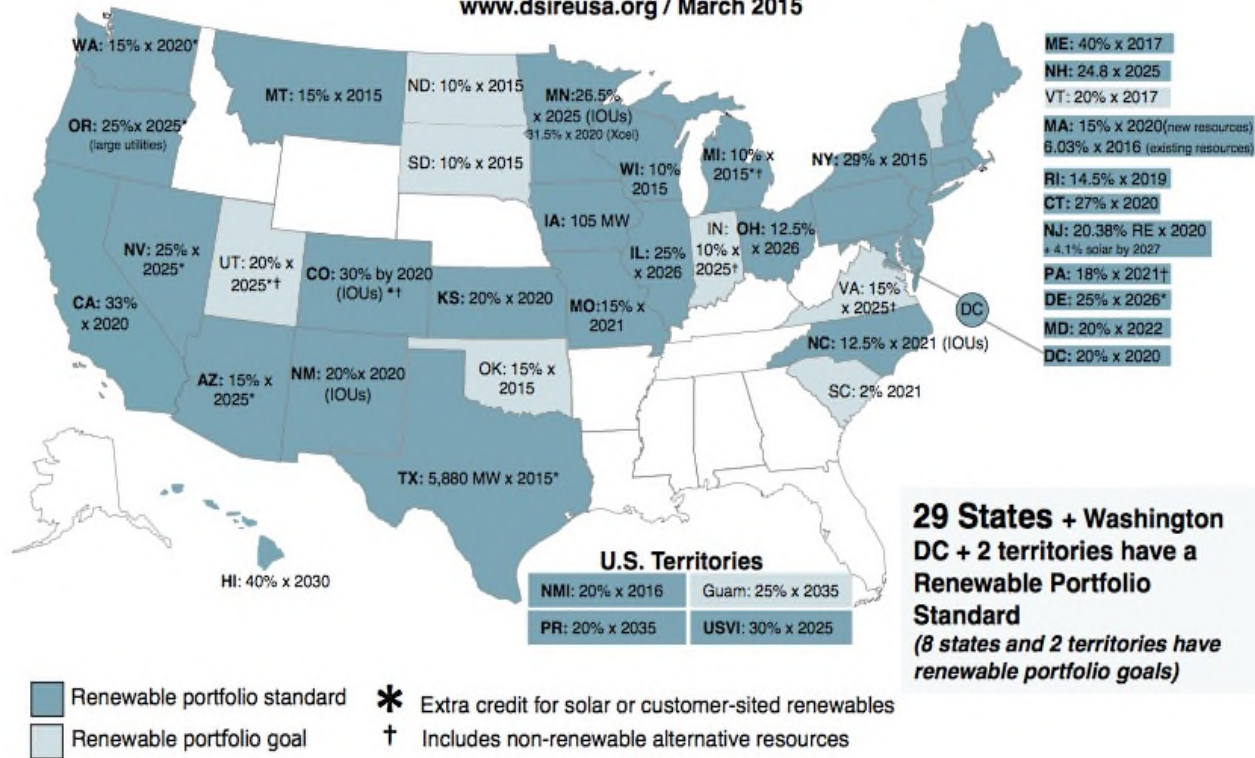
- Section 48 of IRC
- Cost-based credit
- One-time use



Creation of independent system operators

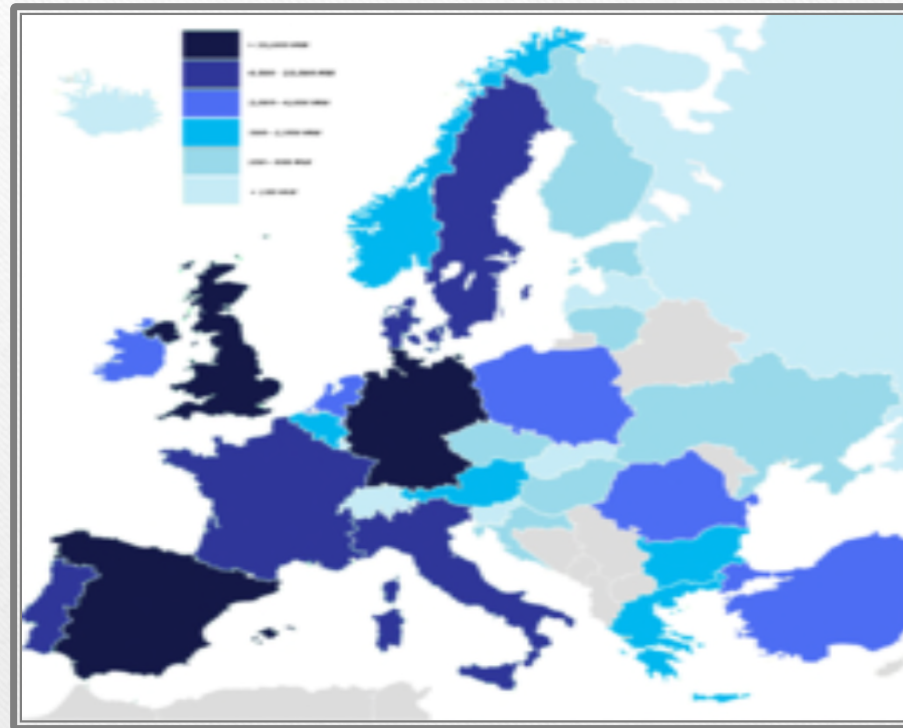
# Renewable Portfolio Standard Policies

www.dsireusa.org / March 2015

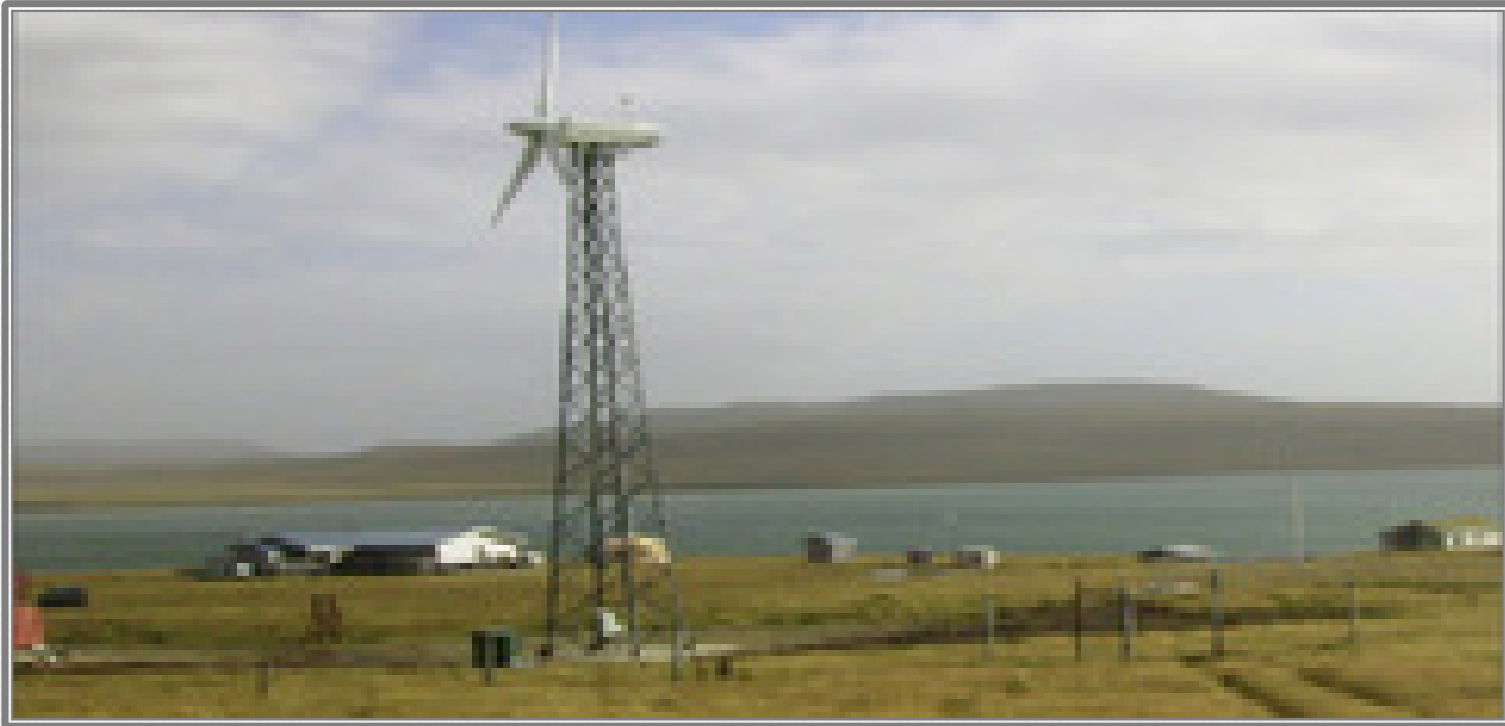


States Adopt Renewable Portfolio Standards





The Europeans brought project expertise and equipment



Equipment improvements

# Corporate/Institutional Buyers

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- Non-utility buyers
- The introduction of “corporate” PPAs.

# Higher Education Goals and Strategies

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- Sustainability Initiatives
  - What are they?
- Implementation Strategies
  - Top-down
    - Over 650 institutions of higher learning have committed to achieving carbon neutrality within a defined timeframe
    - Over 250 institutions have implemented some sort of renewable energy
  - bottom-up
    - Key stakeholders (students/teachers/parents) advocate for sustainability programs

# ASU's Perspective on Acquiring RE

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- Approach varies by institution – dependent on numerous factors
  - Sustainability goals
  - Existing infrastructure, load type, and land availability
  - Cost-benefit and financial risk
  - Regulated / unregulated market
  - Future plans / growth
  - Other factors – availability of RE resources, utility's perspective, local markets, etc.
- ASU utilizing multiple RE transaction / project types

# CFR's Perspective

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- How are higher educational institutions implementing renewable energy as part of their sustainability goals?
- On site/off-site.
- VPPAs.
- Aggregation.
  - How does aggregation work?
- Other new trends?

# How do Renewable Energy Project Economics Work?

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## Renewable energy project basics

- Project developers/owners need:
  - Resource (wind/solar)
  - Interconnection rights
  - Land rights
  - Permitting
  - Off-take
  - Finance

# How do Renewable Energy Project Economics Work?

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- Renewable energy project basics
  - Developers like institutional buyers like HEIs
    - Strong credit ratings
    - Perpetual existence
    - Significant energy load



# How do Renewable Energy Project Economics Work?

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- ❑ Project owners need a PPA they can finance
  - ❑ Projects are typically financed with three main components: Owner's equity, tax equity, debt
  - ❑ Owners have to establish how the PPA will cover the costs of building the project and provide a return on investment
  - ❑ Owner is using the credit rating of the corporate or institutional PPA buyer as part of the financing analysis
- ❑ Tax equity investors
  - ❑ Confirmation that the tax credits will be available and will generate the anticipated tax benefit
- ❑ Project lenders want certainty
  - ❑ Firm Purchase Requirement/Pricing
  - ❑ Remedies/Cure Rights
  - ❑ Collateral assignment of PPA

# PPAs

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- How do PPAs work and how are they negotiated?
  - Physical vs. financial
- How do virtual PPAs work?
  - Various structures
    - Financial contract
      - Fixed and floating prices
    - RECs
  - Practical considerations
    - Same ISO?
- Renewable Energy Certifications
- Provisions specific to higher educational institutions

# PPAs

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How do PPA negotiations start?

- Requests for Proposals (RFPs)
  - Most institutions use RFP processes
    - Generally, the buyer uses the RFP process to provide:
      - (1) An established set of rules for screening potential bidders, (2) a competitive bid process, and (3) an efficient way to learn about available projects in the marketplace
- Private Negotiations

# PPA terms

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Buyer-friendly provisions include:

- ✓ Availability guarantee
- ✓ LDs for late delivery/ capacity shortfall
- ✓ Seller security postings
- ✓ Dodd-Frank reporting by Seller

# PPA terms

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## Pricing Models

- Fixed (rate for each year is set out in the PPA)
  - a. Some PPAs have “level” pricing; meaning the rate for each year is the same
  - Some PPAs are “front-end loaded”, meaning the price is higher in the early years and then declines over the length of the PPA (to facilitate debt servicing)
- Escalators
  - Percentage increase
  - Indices
- Upside sharing
- Payment Terms

# PPA terms

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Term (often 10-to-15 years after COD)

- Extension Terms
  - Is the extension automatic? Or optional?
  - Can Project owner avoid extension?
  - Right to Purchase Facility?
- Rights of Early Termination
  - Approvals (lack of progress)
  - Equipment Purchase Requirement
  - Long-Stop Dates

# PPA terms

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- Security Requirements
  - Types of Security
    - Cash
    - Letter of Credit
    - Guaranty
  - Amount Required
    - When posted
    - Decreasing balance?
  - Credit Ratings
  - Buyer's Security Requirements
- HEI specific requirements?



Questions?



*January 30, 2020*

## **Changing Risks and the Returns of Proactive Resilience**

Kristiane Huber  
Resilience Fellow



**C2ES.ORG**

# Center for Climate and Energy Solutions - Resilience



## Cities

- Help city governments engage with their business community about climate risk.
- How to prioritize different climate actions.
- Resilience strategy briefs, looking at the costs, expected co-benefits and values of those benefits.



## Private-Sector

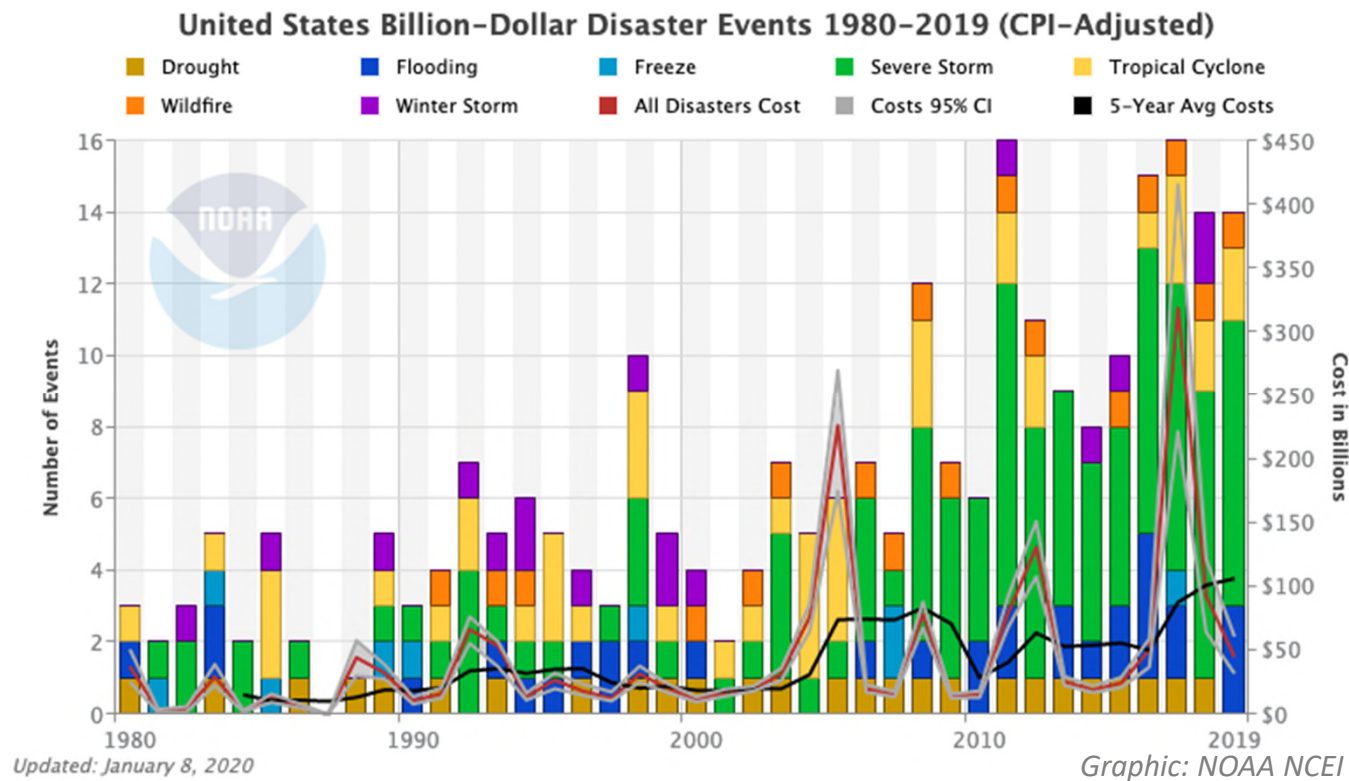
- How are companies learning about and responding to their climate risk?
- How are companies disclosing corporate climate risk



## Utilities

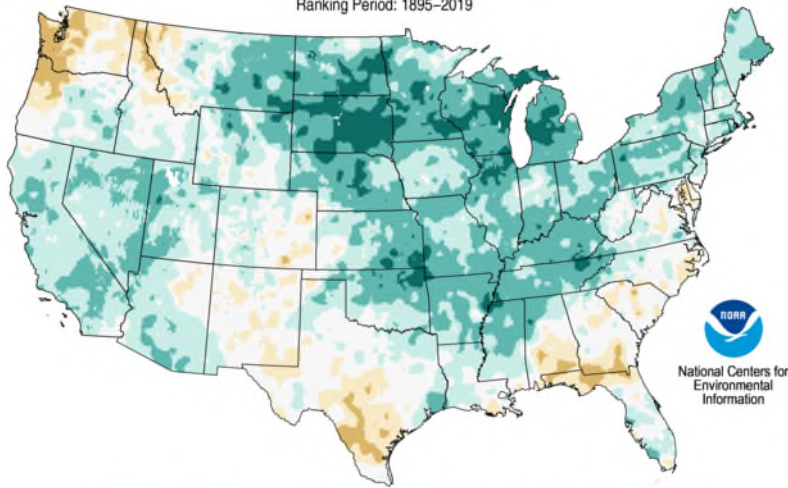
- What risks to utilities face and how can those become cascading risks?
- How can utilities learn from one another to build resilience?

# Reflecting on 2019



# 2019: Continuing Trends

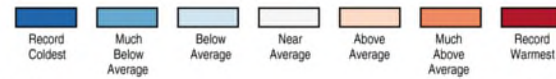
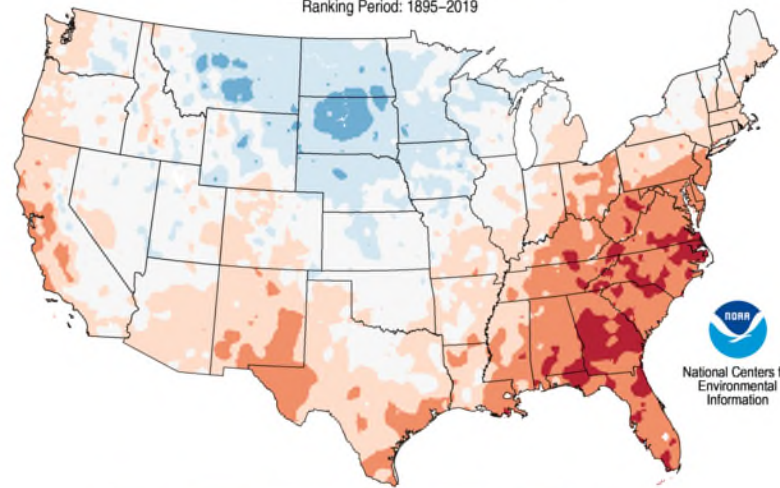
Total Precipitation Percentiles  
January–December 2019  
Ranking Period: 1895–2019



Created: Mon Jan 06 2020

Data Source: 5km Gridded Dataset (nClimGrid)

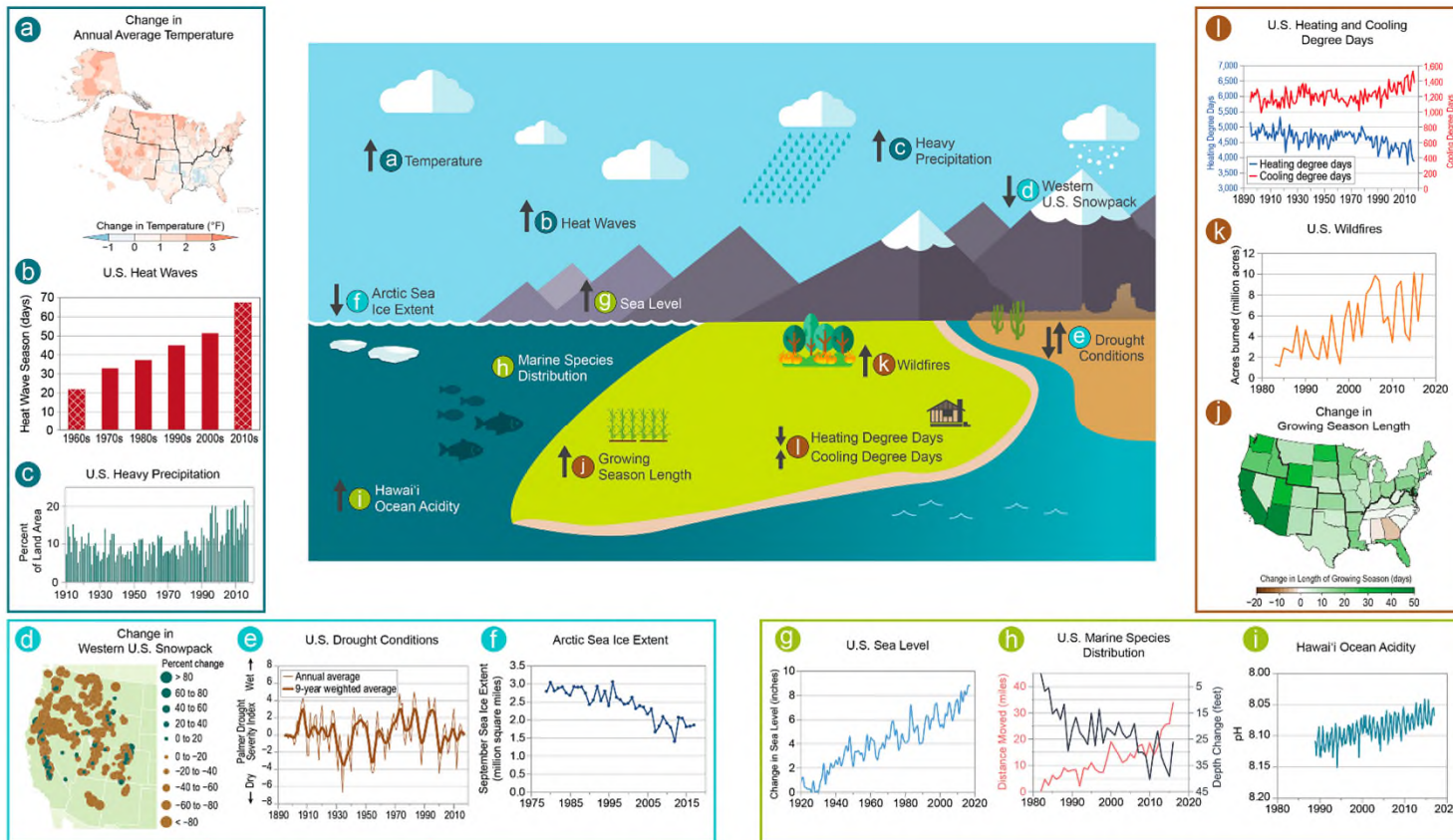
Mean Temperature Percentiles  
January–December 2019  
Ranking Period: 1895–2019



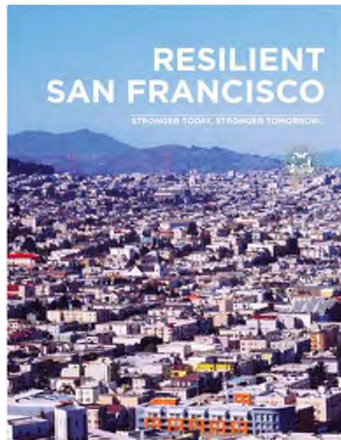
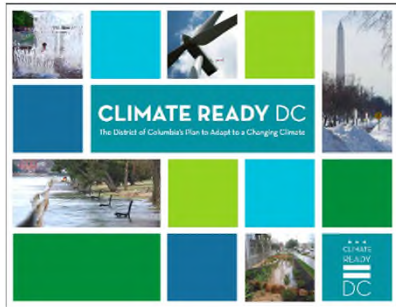
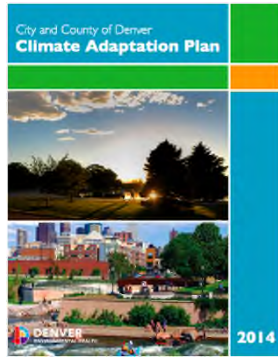
Created: Mon Jan 06 2020

Data Source: 5km Gridded Dataset (nClimGrid)


# Observed and Expected Climate Impacts



# Adaptation and Resilience Policy



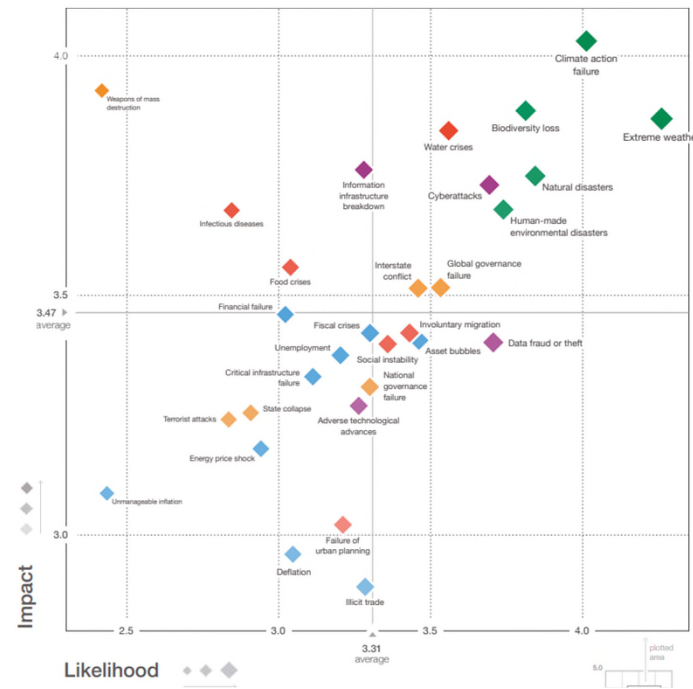
**NATIONAL POLICY**

 <b>INFRASTRUCTURE</b>	 <b>NATURAL DISASTER</b>
 <b>CLIMATE DATA AND RESEARCH</b>	 <b>NATIONAL FLOOD INSURANCE</b>

**LOCAL AND STATE POLICY**

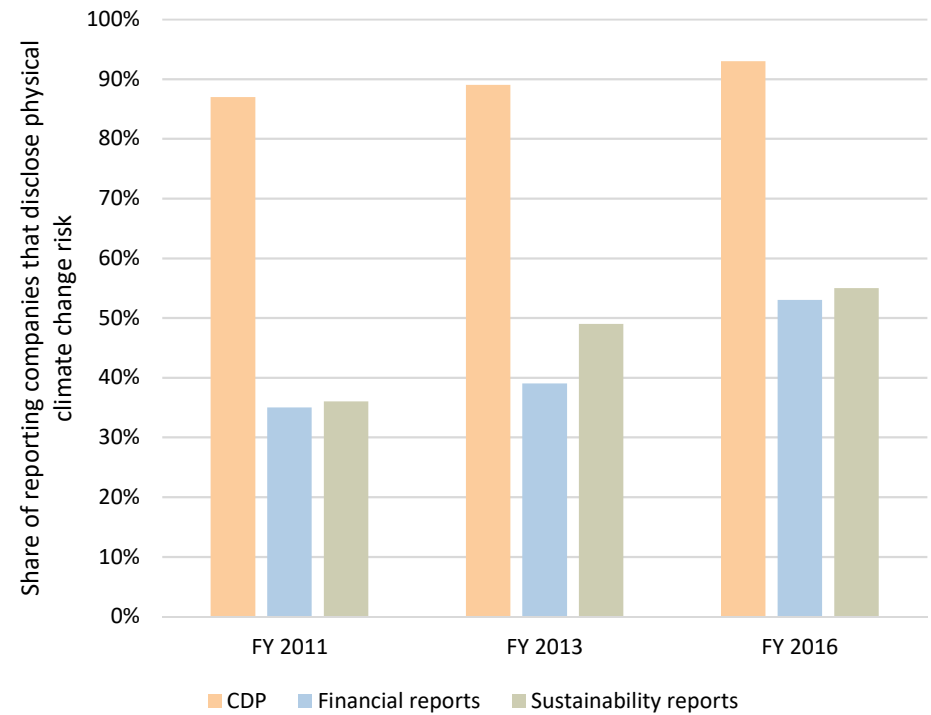
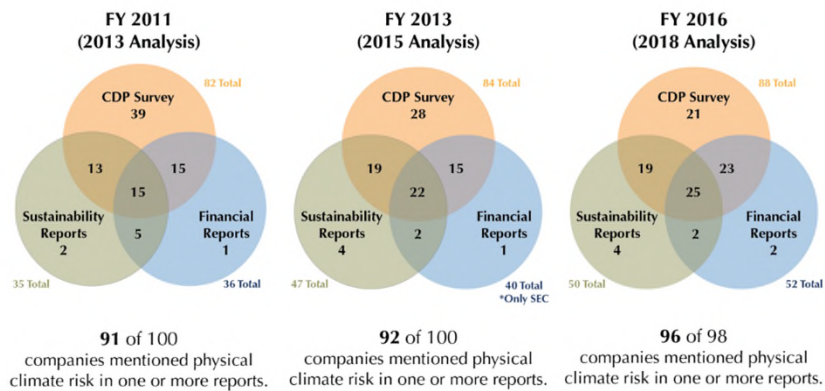
 <b>STORMWATER MANAGEMENT</b>	 <b>HAZARD MITIGATION</b>
	
<b>CAPITAL IMPROVEMENT</b>	
 <b>CITY/REGIONAL PLANNING</b>	 <b>BUILDING CODE</b>

# Corporate Resilience



Global Risks Report 2020  
 World Economic Forum

# Mention of climate risk in corporate disclosures



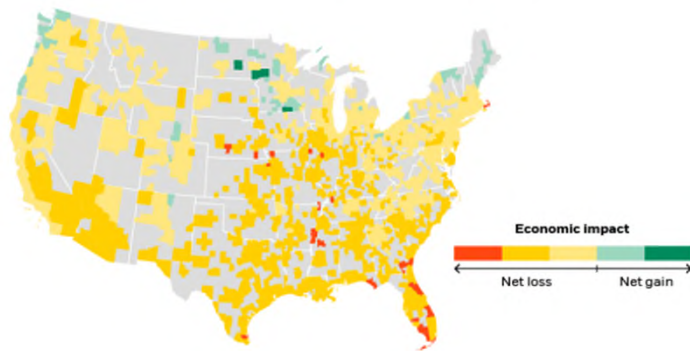
Data and Graphics: C2ES, 2018



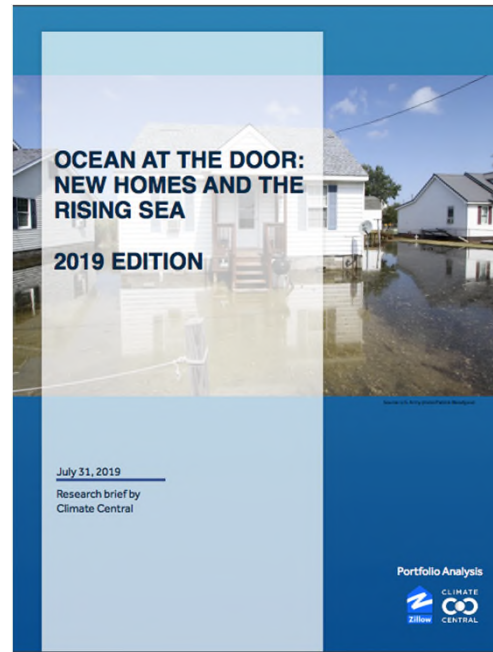
# Changing Math on Risk

## Mapping the damage

Estimated climate-related impact on U.S. regional GDP, 2060-2080



Sources: BlackRock Investment Institute, with data from Rhodium Group, March 2019. Notes: The map shows the projected GDP impact in 2060-2080 on U.S. metropolitan areas under a "no climate action" scenario. Climate changes are measured relative to a 1980 baseline. The analysis includes the effect of changes in crime and mortality rates, labor productivity, heating and cooling demand, agricultural productivity for bulk commodity crops, and expected annual losses from coastal storms. It accounts for correlations across these variables and through time — and excludes a number of difficult to measure variables such as migration and inland flooding. See Rhodium Group's March 2019 paper [Clear, Present and Underpriced: The Physical Risks of Climate Change for further details on its methodology](#). Forward-looking estimates may not come to pass.



## How might climate risk affect economic competitiveness?

Based on these conversations with corporations and news about private-sector risk, C2ES has started research on how this might ripple through different economic systems, and affect cities' ability to attract investment, residents, visitors, and businesses.



**Credit Ratings**

**Property Value and Tax Base**

**Attracting Businesses**

**Insurance**

**Quality of Life**

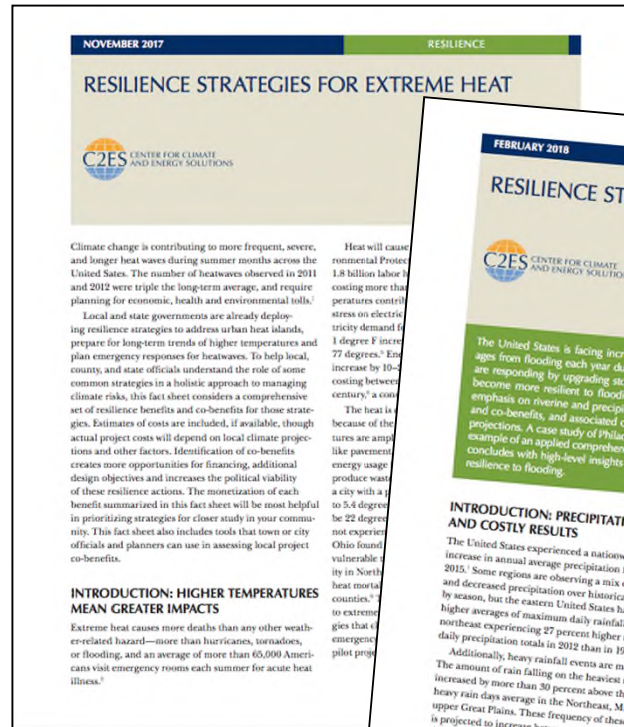
**Diversity & Equity**

# Early Insights

- Larger cities have been approached by credit ratings agencies to learn more about their climate risks and resilience. Some other cities are proactively preparing for if or when climate risk is a factor in credit ratings.
- Some cities with less risk have considered or embraced the possibility that people moving from areas with higher risk of climate impacts might resettle there.
- Almost all communities mentioned concern about housing affordability: both communities where homes are in areas that are at risk, and communities where people might choose to move because they have relatively low amounts of risk.
- In communities that perceive their economy is strong and diverse, there is less concern about climate-related economic vulnerabilities.
- In cities that have experienced extreme weather events or climate events, the economy was relatively stable after the disaster due to natural disaster aid, however smaller, repeated events are making dents in city budgets.

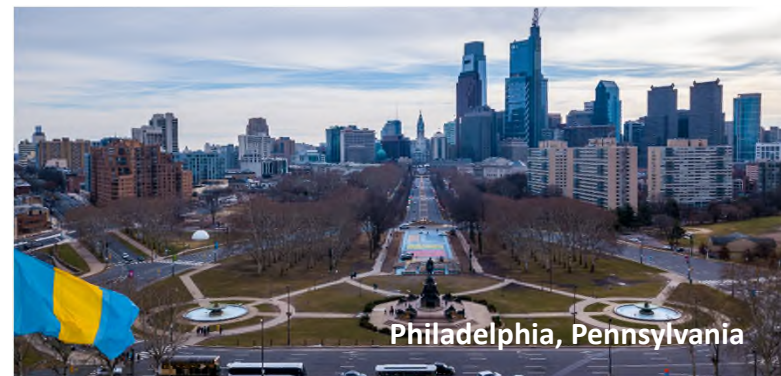
# The Role of Green Infrastructure

- Benefits of Green Infrastructure:
  - Energy savings
  - Economic development
  - Reduced sewer costs
  - Public health
  - Reduced flooding
  - Installation and maintenance (sometimes)



<https://www.c2es.org/site/assets/uploads/2018/02/resilience-strategies-for-flash-flooding.pdf>

# City Examples and Case Studies





FOR MORE INFORMATION

[C2ES.ORG](http://C2ES.ORG)

Kristiane Huber: [kristiane.huber@gmail.com](mailto:kristiane.huber@gmail.com)

# Landfills: Who Needs Them?

## Waste Diversion Regulation and Policy

Lea A. Phillips

Associate

Ballard Spahr

[phillipsla@ballardspahr.com](mailto:phillipsla@ballardspahr.com)

# Types of Landfill Diversion

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# EPA's Waste Management Hierarchy

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# What's driving this?

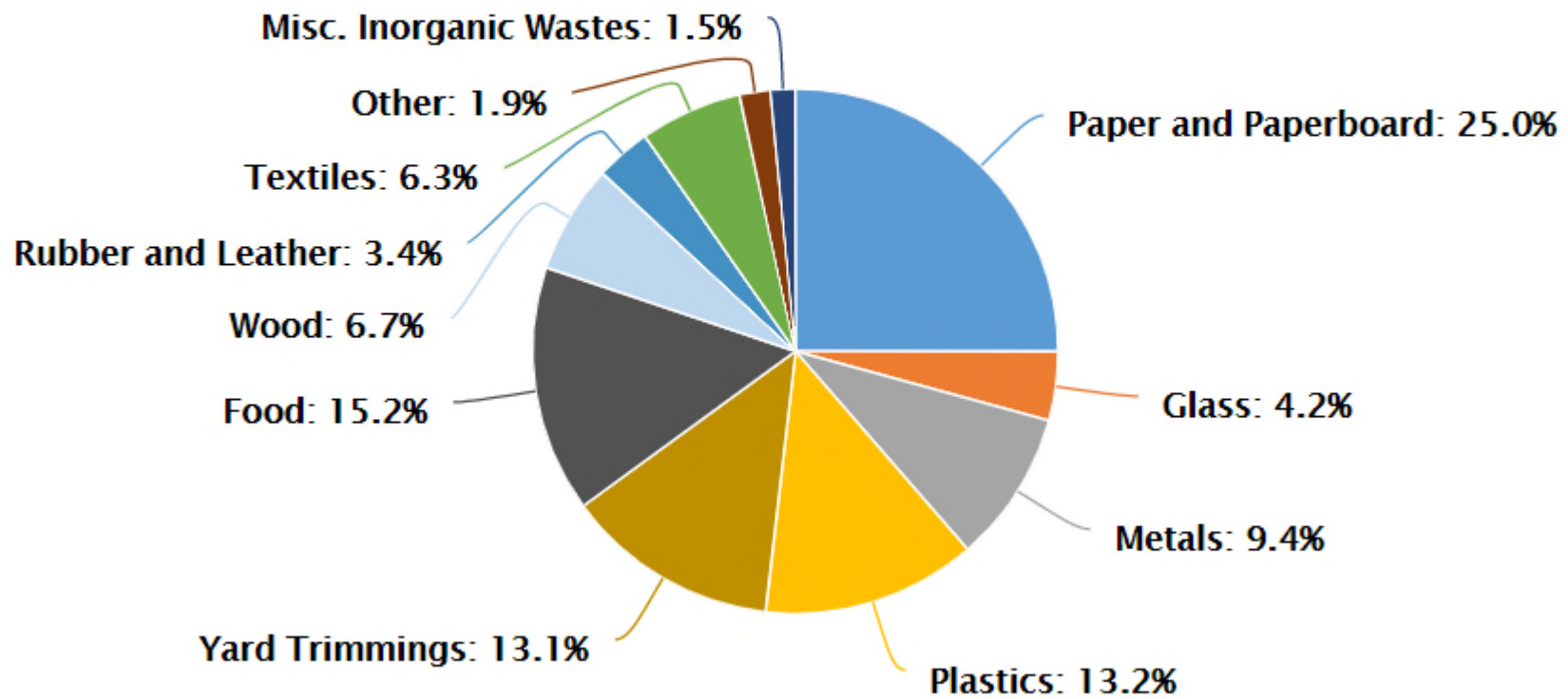
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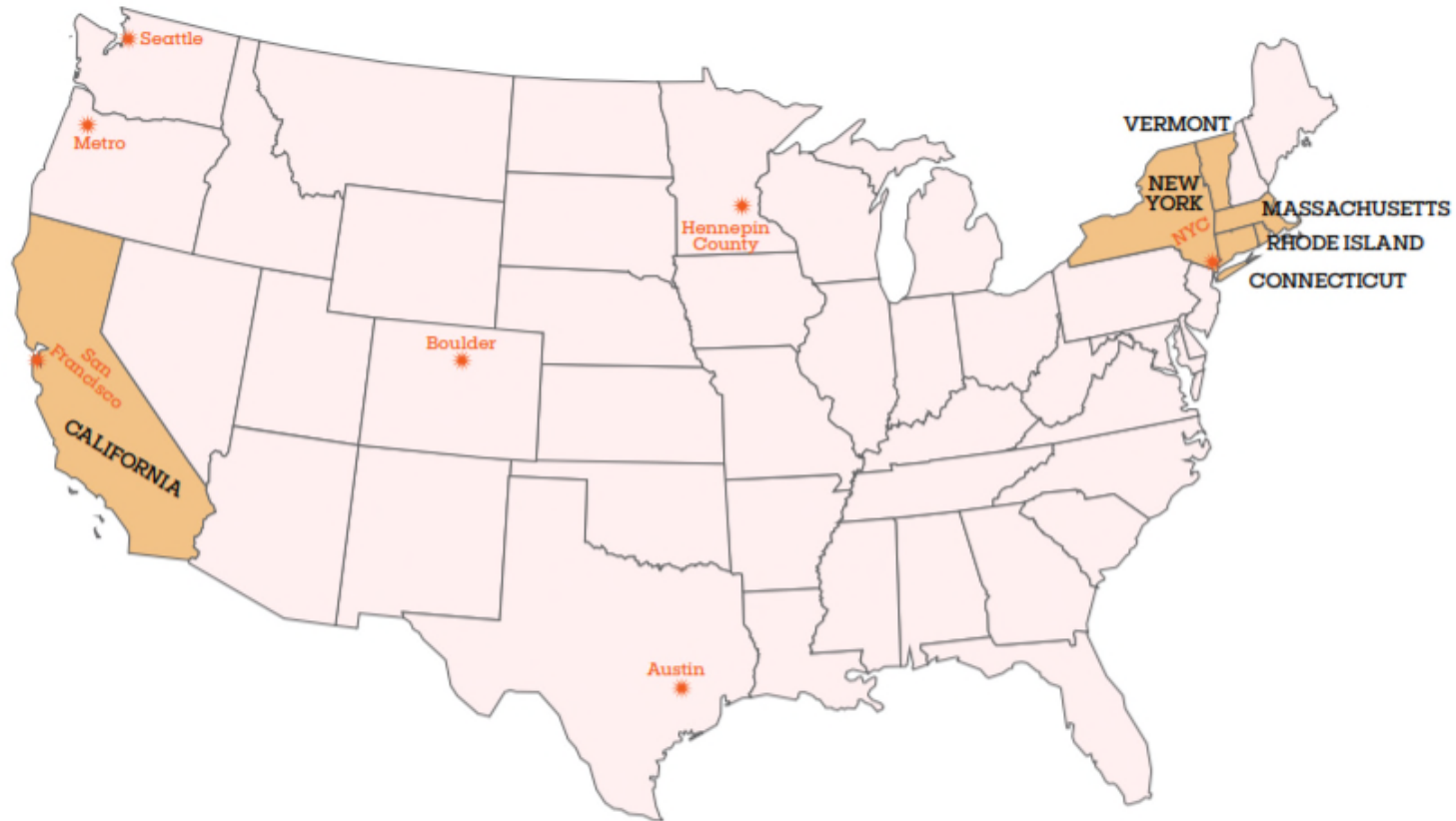
## Total MSW Generated by Material, 2017



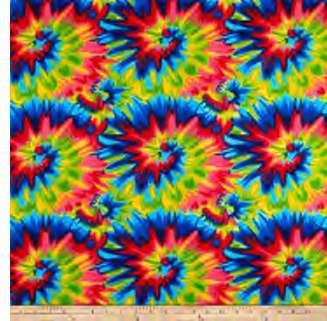
267.8 million tons



# Organic Waste Bans: State



# Organic Waste Bans: Cities



Ballard Spahr  
LLP



# Who Needs a Law/Regulation

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## *Converting MSW Into Low-Cost, Low-Carbon Jet Fuel*

**Bruno Miller**

*Managing Director – Fuels & Regulatory Affairs*

**8th Annual Green Infrastructure Conference**

Philadelphia, PA  
January 30, 2020



# Fulcrum: Solving Two Global Challenges

**Disposal of Municipal Solid Waste (MSW) at Landfills**  
**Decarbonization of Transportation**





# MSW – A Strategic Feedstock

## *Changing the way Garbage is Handled and Disposed*



- Large Volumes, Ideal Locations
- Established Infrastructure
- Carbon-Rich Feedstock Ideal for Biofuel Production
- Predictable Cost
- No Competing Uses
- Resolves Waste Disposal Problems

# Fulcrum – MSW to Low-Carbon Fuels

***MSW Available Worldwide***  
***Technology Performance Guaranteed***  
***80% Carbon Emissions Reductions***



# Sierra BioFuels Plant

## *Feedstock Processing Facility*



- In Operations; Construction Completed on Schedule and on Budget
- MSW Delivered by Waste Service Partners Waste Management and Waste Connections
- 350,000 Tons of Waste Processed Each Year
- 175,000 Tons of Feedstock Produced per Year

# Biorefinery Construction Site Overview



# Fulcrum's Strategic Partner Model





Bruno Miller  
Managing Director – Fuels & Regulatory Affairs  
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Mobile: (617) 291-6352  
[bmiller@fulcrum-bioenergy.com](mailto:bmiller@fulcrum-bioenergy.com)





# ARIES CLEAN ENERGY

DISTRIBUTED SOLUTIONS FOR A CLEANER EARTH



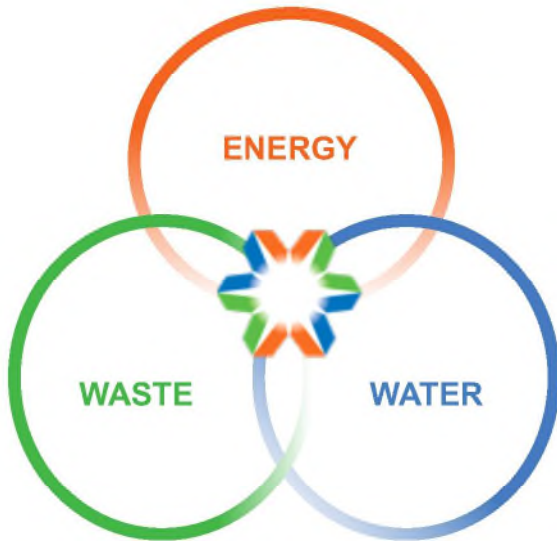
① Executive Summary	3
② Aries Solution	9
③ Case Studies	17
④ Biochar	24
⑤ Summary	26



# Executive Summary

## Aries Clean Energy

Based in Nashville, Tennessee, **Aries Clean Energy, LLC** is a patent holder, manufacturer and system integrator that develops projects using its **proven, proprietary downdraft and fluidized bed gasification systems for municipal and industrial customers**. Since 2010, Aries has been gasifying materials that would otherwise be landfilled while producing renewable and sustainable energy.



Lebanon, TN



Sanford, FL



- Closed loop energy neutral system
- 95% volumetric reduction
- Compliments de-watering systems
- Eliminates land application and incineration
- Eliminates odor problems
- Eliminates harmful run-off
- Eliminates PFAS



- Sustainable, zero landfill solutions
- Carbon neutral to negative
- Reduces hauling, which lowers costs and reduces CO2 emissions
- 90% volumetric reduction



- Technology produces clean, renewable distributed energy
- Systems can produce producer gas, thermal energy and/or electricity

- Unique business model that creates and realizes value through development, equipment sale and long term operations
- 10+ years of product development and operating history
- Full-scale commercial facility constructed and operating
- Fluidized bed 18 months of commercial operation
- Feedstock includes wood waste, sludge / biosolids, Ag wste, municipal solid waste and energy crops
- Distributed systems reduce on-road transport
- Small capital requirement that can be project financed
- Robust near-term pipeline
- Experienced team with an average of 30 years in clean technology and energy

# Company Overview

- Since inception, the Company has achieved a number of milestones with its technology:
  - Two **full-scale commercial downdraft gasifier systems** developed by Aries in Lebanon, TN (largest and highest output in the world) and in Covington, TN serve as models for municipal waste-to-energy partnerships
  - The downdraft technology has operated at small and large format sizes for more than **50,000 hours of commercial production** at several locations
  - Over **18 months of commercial-scale operations** from a developed system in Sanford, FL
  - The holder of **eight patents** in biomass and biosolids gasification
- Aries is funded by the Thompson family, owner of a multi-state Caterpillar equipment dealership (TMCC), TMCC and Spring Lane Capital.
- The Company's strategy is to:
  - Capitalize on **strong demand for Aries' commercial technology by expanding its identified pipeline of opportunities**
  - Continue to **sell its gasification systems** to municipalities and industrial customers
  - Expand in Northern New Jersey to provide a **reliable, dependable, long-term alternative land-fill solution for the NJ/NYC sludge market**
  - Continue **development efforts in California** to take advantage of BioMat program for purchase of renewable energy
  - Establish a foothold in **Australia** for both gasification systems
  - Continue to expand **feedstocks** that can be gasified in Aries patented gasification systems
  - Build on existing Aries Green retail **biochar** business
  - Complete financing of **Aries Linden** and begin construction
  - Close and finance **Aries Lost Hills**
  - Secure **growth capital** to increase deal flow

# Management Team

## Gregory L. Bafalis Chief Executive Officer

- More than 30 years of leadership in the clean technology and energy fields
- Prior to Aries, served as Senior Managing Director at El Paso Energy, CEO at Aurora Algae and was CEO and Founder of Green Earth Fuels
- Closed over \$2 billion in project financings and raised over \$250 million in venture capital and private equity funding
- Developed, constructed and managed over 5,000 MWs of power projects
- Developed and/or managed energy projects in 14 countries spread over 4 continents

## Mark N. Witt Chief Financial Officer

- More than 35 years of energy project and structured finance experience with major international companies as well as entrepreneurial start-ups
- Successfully closed numerous financings for both public and private companies including four initial public offerings
- Began his career as a CPA at KPMG
- BBA from the University of Texas at Austin, Master degree from the Darden Business School at the University of Virginia, and completed an Investment Management Program at the London Business School

## Robert W. Burke, Jr. Executive Vice President General Counsel

- More than 25 years of experience as general counsel for domestic and international energy companies including mergers and acquisitions within the United States, Latin America, and Europe
- Negotiated and managed the development of numerous thermal and renewable electric generation facilities playing an integral role in the structured financing of these facilities valued in excess of \$15 billion.
- Managed corporate governance, government affairs, and compliance on behalf of multinational companies and has served on boards of directors of private and publicly traded companies headquartered both in the US and abroad
- Served in leadership positions in a diverse spectrum of companies including Edison Mission Energy and PPL Global

## Renus C. Kelfkens Senior Vice President Engineering

- Extensive career experience in both multi-national petrochemical and new technology start-up companies in the fields of process technology scale-up and commercialization, and project development, focused on gasification
- Vast working history in the coal, natural gas, and renewables conversion to liquids industry
- Served as SVP of Engineering at Sundrop Fuels leading the front-end engineering design and project execution planning efforts for Sundrop Fuels' first commercial biogasoline facility
- BS in chemical engineering from the University of Pretoria in South Africa and a Bachelor of Business Administration from the University of South Africa

# Aries Patented Systems Can Serve Multiple Markets

## **Waste Water Treatment**

- Fluidized bed was specifically designed to gasify sewage sludge
- Downdraft can gasify sewage sludge in combination with waste wood or other bulky materials
- Destroys PFAS

## **Municipal Solid Waste**

- Fluidized bed can gasify shredded municipal solid waste, yard waste, ASR, plastics and food waste
- Downdraft system can gasify waste wood and refuse derived fuel

## **Forestry Waste**

- Fluidized bed can gasify sawdust and other small particle wood waste from lumber mills
- Downdraft can gasify wood from lumber mills, wood pellets and material from forestry maintenance

## **Agricultural Waste**

- Fluidized bed and Downdraft can convert agricultural waste such as almond shells and bagasse into producer gas that can be used for thermal applications or energy production
- Biochar byproduct can then be used as a carbon rich soil amendment on the crops

## **Small Renewable Power Generation**

- Base system design for both fluidized bed and downdraft systems can produce 3+ MWs of renewable power

## **Industrial Customers with Thermal Loads**

- Base systems can gasify multiple feedstocks that generate producer gas that can be co-fired in industrial systems or combusted to provide thermal energy

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# Aries Solution

## Gasification-centric technology portfolio with world-leading capacity and design

### Gasification-Centric Technology Portfolio

- **Gasification-centric** business that develops, manufactures, constructs and operates complete gasification systems
- Multiple product lines, including **downdraft and fluidized bed systems** that can process multiple feedstocks
- **All technologies and methodologies are patented and owned by Aries<sup>(1)</sup>**



### World-Leading Downdraft Gasifier

- Aries' downdraft designs have the **highest throughput of any downdraft system in the world**
- Consistently produce gas with a calorific value of 120 - 130 btu/ft<sup>3</sup>
- Over 50,000 hours of operating time
- The automated systems only require **minimal operating staff**
- Downdraft gasifier designed specifically for waste wood and alternative feedstock such as biosolids and refuse derived fuel
- System can be designed to maximize gas production, thermal power, electricity or biochar

### Commercially Proven Fluidized Bed Gasification System

- Specifically designed for biosolids to directly generate thermal energy
- Commercially-proven design that brings **economic benefits** including reduction of treatment expense, transportation costs, disposal costs as well as **environmental benefits** including the elimination of methane gas and other greenhouse gas release
- EPA ruling declaring fluidized bed system would not be regulated as a sewage incinerator, which means the system does not need to be permitted under 40CFR Part 60 of the Clean Air Act, thus reducing permitting time and avoiding the need for costly pollution control equipment
  - System permitted in NJ as gasification system
- System can gasify a variety of feedstocks including biosolids, MSW, wood or energy crops



Note: (1) For details on patents owned by Aries, see Appendix

# Aries Solution - Downdraft

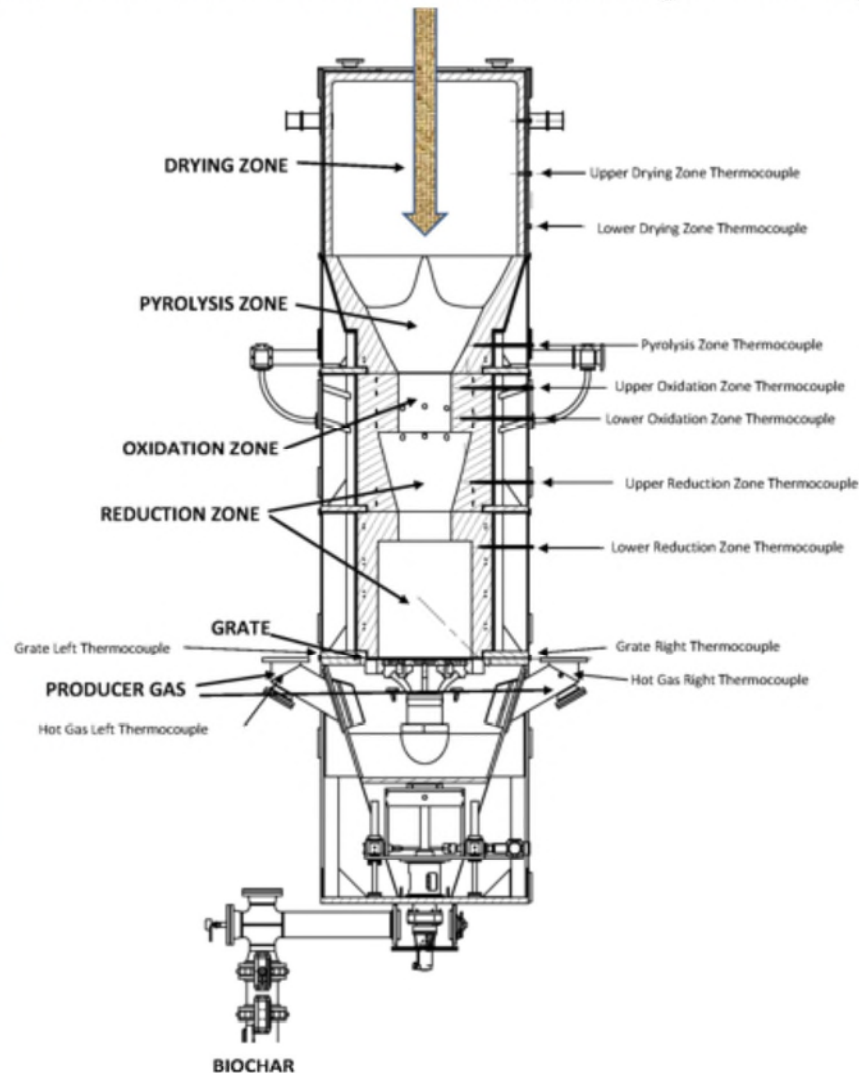
<b>Feedstock Possibilities</b>	<ul style="list-style-type: none"><li>■ The Aries downdraft gasifiers are designed to operate on approximately 1" x 1" x ¼" wood chips at 20% moisture content</li><li>■ Additional project value can be realized by blending other feedstock streams in with wood chips (e.g. testing with tires and MSW)<ul style="list-style-type: none"><li>– For example, the City of Lebanon's Gasification Plant consumes a mix of wood (80%), chipped tires (10%) and municipal sludge (10%). Ultimately, the allowable feed mix is determined by chemistry and by air permitting requirements, which vary by state (in the US)</li></ul></li></ul>
<b>Manufacturing and Construction</b>	<ul style="list-style-type: none"><li>■ Aries downdraft gasifiers are manufactured by US-based third parties under the close supervision of Aries manufacturing managers</li><li>■ The gasifiers consist of vertically-stacked pre-fabricated block sections that are welded together to form the gasifier tower</li><li>■ Design allows for equipment manufacturing at any qualified fabrication facility any where in the world</li></ul>
<b>Patents</b>	<ul style="list-style-type: none"><li>■ The Aries gasifier is protected by US patents governing both the device and the gasification methods</li><li>■ Patents were filed under the Patent Cooperation Treaty and have global reach</li><li>■ Most of the patents expire in 2033 but can be extended by adding claims under methods</li></ul>
<b>Future Developments</b>	<ul style="list-style-type: none"><li>■ Ongoing product development includes:<ul style="list-style-type: none"><li>– Improving automation capabilities and increasing reactor availability to minimize lifetime operating cost of a given installed system</li><li>– Modularizing the gasifier package including pre-packaging piping, wires and systems so that each gasifier can be deployed with minimal onsite set-up time and cost</li><li>– Evaluating a design concept that would introduce a spiral column that rotates down the center of the gasification vessel to permit gasification of much finer-sized or low density feedstock such as dried biosolids and pulverized wood at much higher throughput</li></ul></li></ul>

# Aries Solution - Downdraft

*The clean, efficient conversion of biomass into a combustible fuel gas in an oxygen-starved environment*

- A thermo-chemical process producing a clean fuel gas
- The process is **not incineration**
- Feedstock flexible

- About 90% of what goes in comes out as fuel gas
- 10% of output is a charcoal biochar with many uses in agriculture, industry and as a solid fuel



1. Evaporate moisture from the feedstock

2. Feedstock breaks down to gas and tars

3. In excess of 1,800° F oxidation layer cracks tars

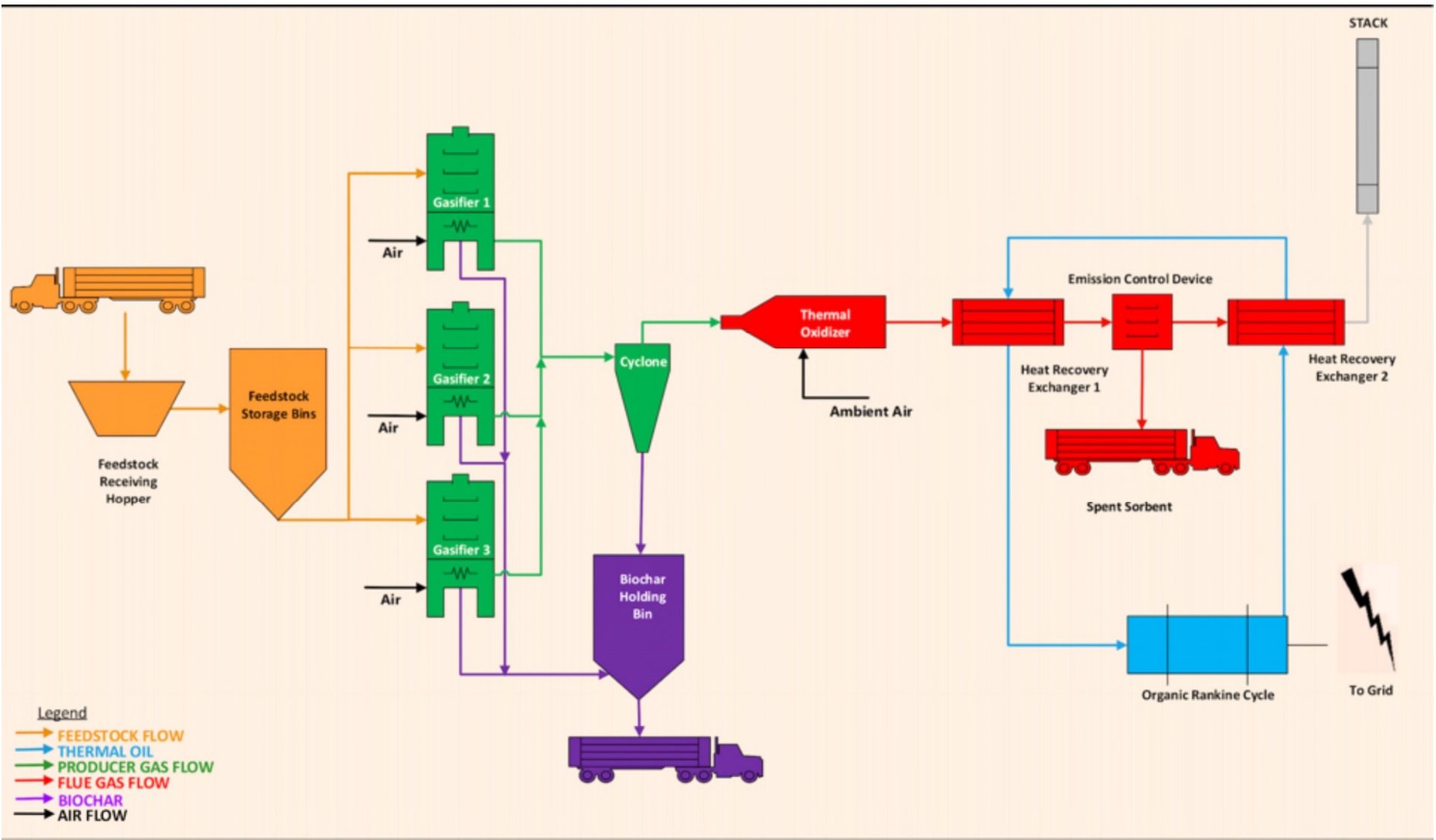
4. Carbon reforms with steam to create carbon monoxide, hydrogen and methane

5. Rotating grate shaves biochar layer

6. Biochar is discharged at the bottom



# Aries Solution - Downdraft



# Aries Solution – Fluidized Bed

## ***Fluidized bed gasification systems that deliver economic and environmental benefits***

### Technology History & Development

- Acquired the intellectual property and assets from MaxWest bankruptcy for \$180,000, which had invested ~\$52 million to develop, build and successfully validate system
- System ran for 18 months processing biosolids in Sanford, FL
- System designed initially to process sewage sludge (biosolids)
- On-site biosolids disposal system reducing wet biosolids by 95%
- EPA has ruled that the Aries fluidized bed gasification system for biosolids would not be regulated as a sewage sludge incinerator, which allows these projects to avoid more stringent permitting standards and costly advanced pollution control equipment

### Patents

- The Aries gasifier is protected by US patents governing both the device and the gasification methods
- Patents were filed under the Patent Cooperation Treaty and have global reach
- Most of the patents expire in 2033 but can be extended by adding claims under methods

### Environmental Benefits

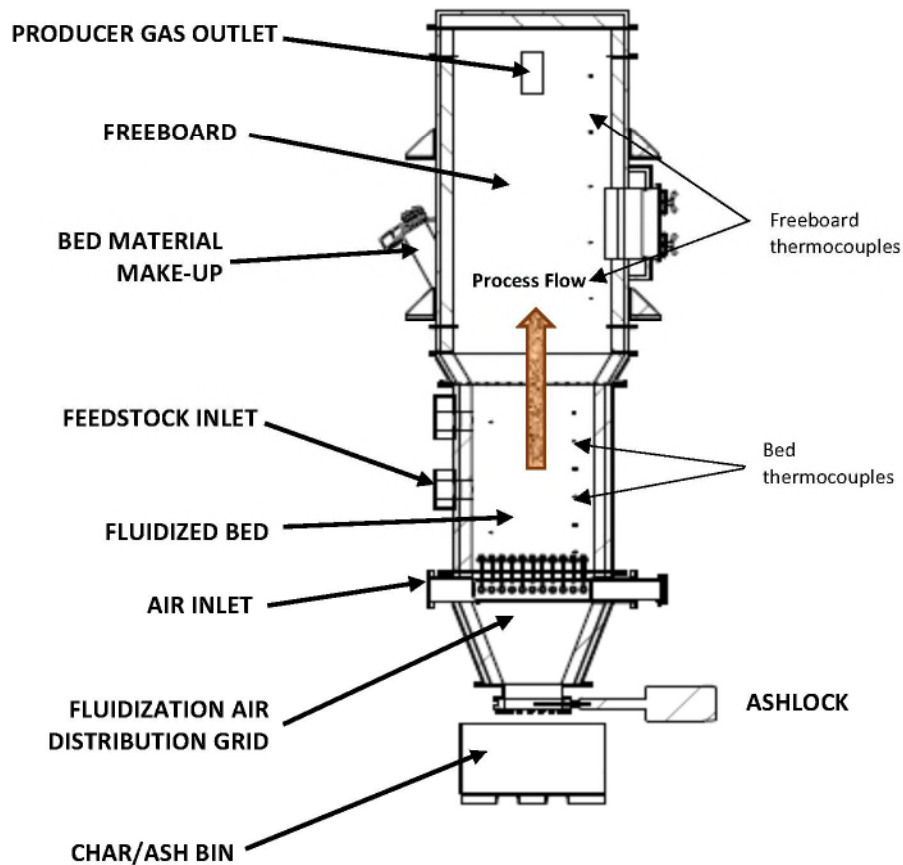
- Converts odorous and noxious material to renewable:
  - Thermal energy
  - Energy for supply to the customer's treatment facility
  - Electrical energy for sale to the grid
- Reduces issues associated with offensive gases and conditions at and around the treatment facility
- Eliminates the release of methane gas and other greenhouse gases from landfills, composting facilities or land application
- Reduces noise and air pollution from hauling operations via a reduction in truck traffic
- Eliminates the potential of groundwater pollution from disposal of biosolids in landfills or by land spreading

### Economic Benefits

- Reduces treatment costs, transportation costs, and disposal costs
- Alternative to incineration, land application and landfill
- Minimal water use
- Less expensive than anaerobic digestion
- Reduces greenhouse gas production and the carbon footprint of the treatment facility, which could potentially be monetized in the future

# Aries Solution – Fluidized Bed

***A process that converts carbon-containing waste material into a synthetic fuel gas***



1. Waste feedstock is fed into the gasifier and a controlled amount of oxygen is introduced

2. Once necessary temperatures are achieved and maintained, a thermo-chemical process converts the biomass into a combustible syngas primarily composed of carbon monoxide, hydrogen and methane

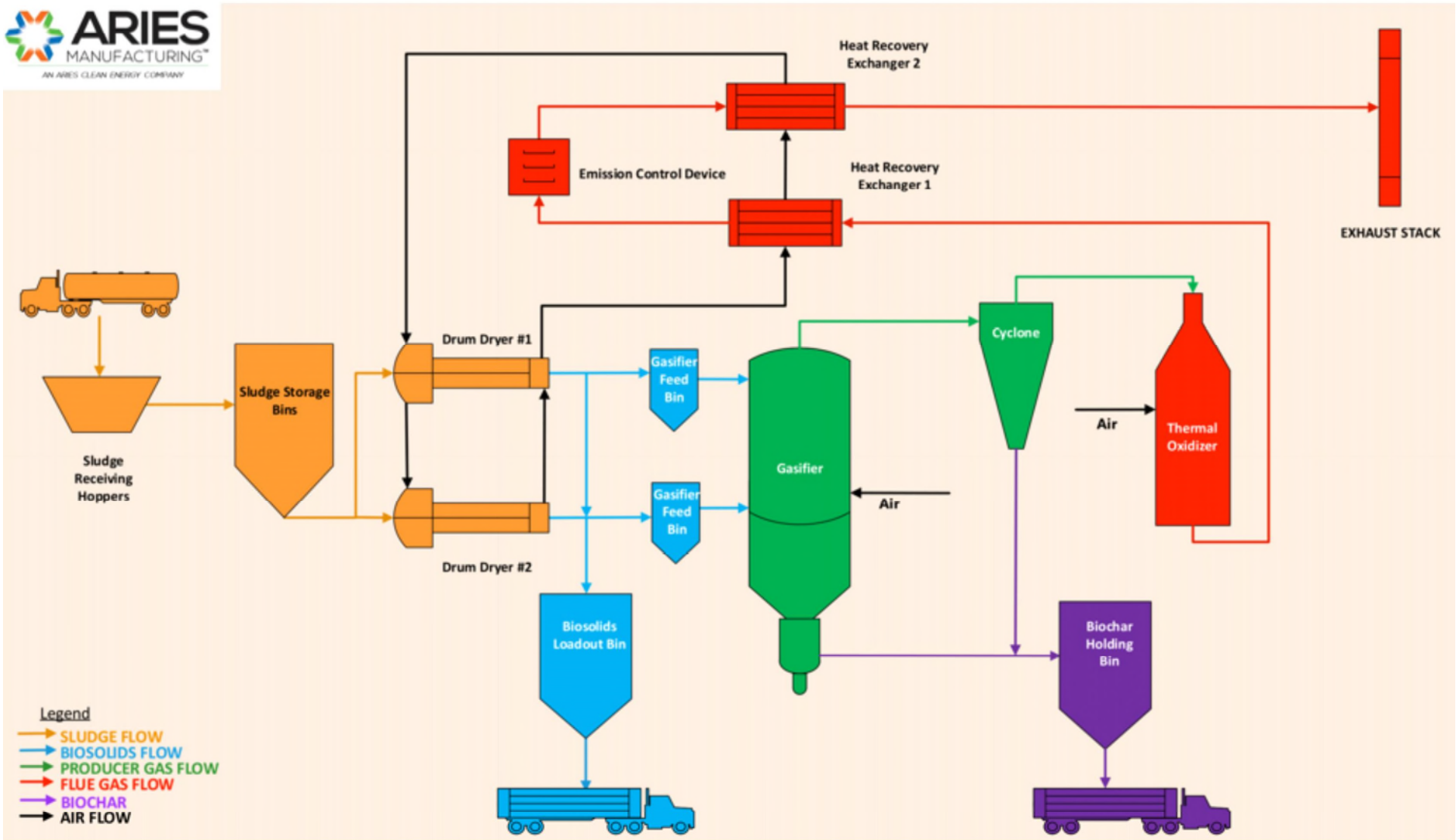
3. Ash and syngas are blown through the bed and then separated in a cyclone

4. Thermal energy produced by the gasification system can be used as energy within the waste treatment process, thereby creating a closed loop system

5. Inert ash byproducts typically represent 5% of the wet sludge mass initially entering the system and can be beneficially used

6. That sustainable fuel can be deployed in a commercial dryer to remove moisture from biosolids or used to produce electricity

# Aries Solution – Fluidized Bed



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# Case Studies – Lebanon, TN

## Commercial-scale operating facility developed by Aries for the City of Lebanon, Tennessee



### Project Overview

- Commissioned in October 2016, Aries built and sold a downdraft gasifier to the City of Lebanon, which owns and operates the plant
- The syngas produced (92% by volume input) is combusted in an industrial thermal oxidizer
- Thermal energy is transferred to heat water, which drives 400 KWs of Organic Rankine Cycle generators
  - 200 KW of net output to the waste water treatment plant
- 8% of input results in biochar
- All feedstock is locally sourced and prepped by Rockwood Recycling in Lebanon
- The footprint of the gasification plant is less than one acre

### Project Highlights

- ✓ **5,000,000 pounds (2,500 tons)** of carbon emissions kept out of the air each year
- ✓ Over **16,000,000 pounds (8,000 tons)** of material diverted from landfills each year
- ✓ Deployment will help both the city and local industries move toward zero landfill goals
- ✓ System is projected to produce **36,000 MW-hours** of power over 20 years
- ✓ Produces 1,000 TPY of biochar

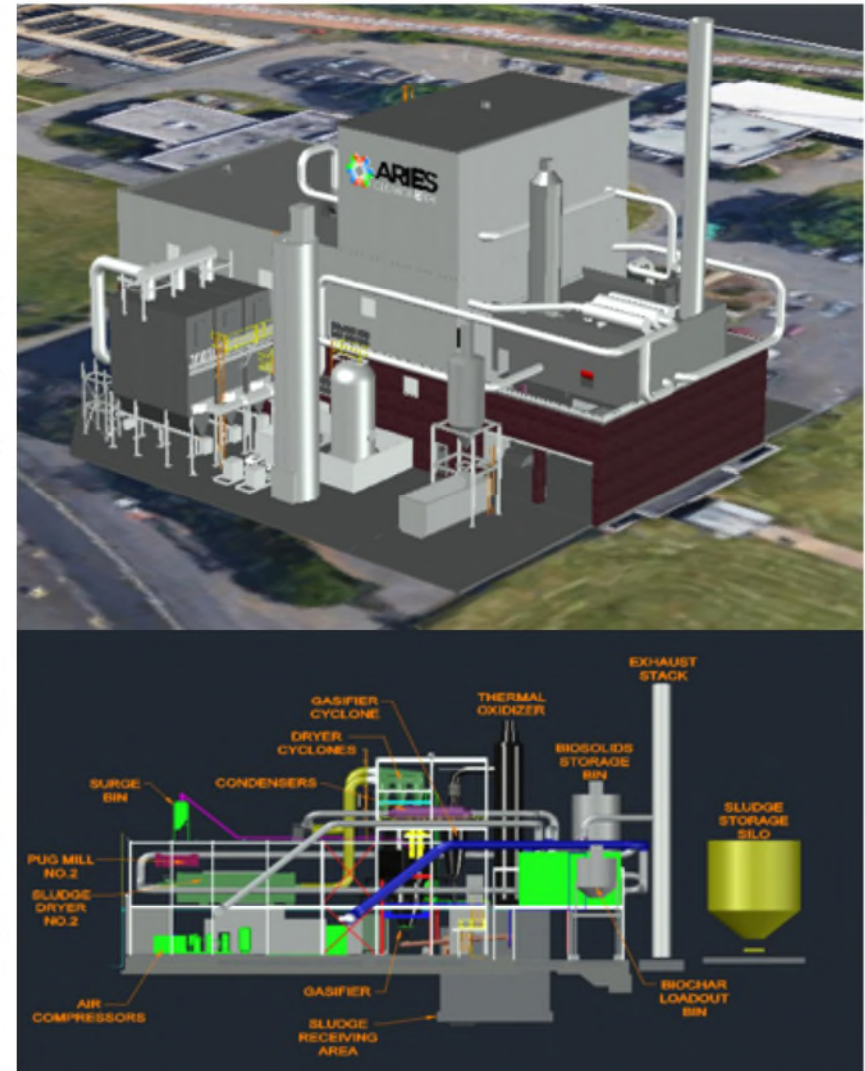
### Project Specifications

- Configuration** ■ 64-ton/day maximum capacity downdraft gasifier
- Feedstock** ■ Wood (80%) and municipal sludge(10%)
- Output** ■ 400 KW
- Commissioned** ■ October 2016



# Case Studies - Aries Linden, LLC

- System Description
  - 430 TPD throughput
  - 2 x 200 TPD Baker Rullman Drum Dryers
  - 100 TPD Aries Patented Fluidized Bed Gasifier
  - 25 TPD of Biochar produced
- Status
  - All permits received
  - All equipment supply contracts executed
  - Engineering, Construction and demolition contracts executed
  - Financing through Union County Improvement Authority
    - Using Tax Exempt Bonds - \$50 million allocation in place
    - Bonds fully Subscribed
- Counterparties
  - Feedstock (Fully Contracted)
    - 3 sources of sludge (22% solids) supply
    - totaling 430 tons/day
      - R&B debris: 350 - 400 TPD
      - LRSA to provide:
        - 125 tons/day 4-6% dry sludge
        - Aries will dewater to 22% solids
      - Up to 50 TPD on merchant basis
  - Biochar – MOU in place with local Concrete company
    - Fly ash substitute
  - Class A Biosolids – LOI in place to purchase any Class A biosolids produced
- Next Steps:
  - Financial Closing Date – October 30, 2019
  - Full Notice to Proceed – October 31, 2019
  - Commercial Operations in 1<sup>st</sup> quarter of 2021



# Biosolids Market for Linden



- Site is co-located at Linden Roselle Sewerage Authority in Linden, NJ
  - 20 Miles from Mid-town Manhattan, NYC
- Approximately 4,000 tons per day of biosolids generated in service territory
- No biosolids permitted to go into landfills in New Jersey
- Most of the biosolids currently are disposed of in Pennsylvania or Ohio
  - Majority of Sludge is trucked down NJ Turnpike and I-95, right past Linden facility
- Current spot disposal prices are \$87.50 per ton excluding transportation



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# Biochar – Aries GREEN™

Biomass feedstock processed through the downdraft gasifier exits the machine as a high-carbon biochar.

The charcoal-like biochar is consistently >80% carbon with a high BTU content. It can be used as:

- Fuel for cement kilns or other operations that utilize solid material
- Agricultural soil amendment that substantially increases the water and nutrient holding capabilities of most growing media
- Filtering agent for liquids or gases to remove contaminants or odors, since the biochar shares many chemical properties with activated charcoal
- Uses include: all-natural soil conditioner and agricultural soil amendment, fuel, a filtering agent, and a base material for the production of fabric, carpet, rubber, plastic
- Current Market pricing ranges from \$750 to \$1,200 per ton
  - Represents upside to Aries economics

## Current Retail Market

- Selling dual-certified biochar on Amazon Marketplace and HomeDepot.com via MTA Distributors in Nashville, TN
- Typical system can produce 5,000 tons per year
- Bulk sales to industrial customers in negotiation



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# Summary

## Commercially Proven Technology

- **Full-scale facility** constructed and operated
- **Institutional capital** raised December 2017
- **Project development funding secured from institutional capital**
- **Validated** downdraft and fluidized bed gasification systems
- **Feedstock flexible**
- Aries **owns the patents** for all product lines
- Validation reports by an **independent engineers**

## Identified Pipeline

- Projects in **advanced stages** of development
- **Robust pipeline of identified projects**
- Growing interest **internationally**
- **Build-Own-Operate** projects
- Projects provide **high sales margins**

## Experienced Team

- Management team with an average of **over 30 years of clean technology, waste management and energy experience**
- **Significant project development and finance experience**
- **25-person team** covering all aspects of project development, engineering, operations and management, marketing, finance, and accounting



## Strong Market Opportunity

- Suite of renewable conversion solutions (waste disposal, biomass conversion, biosolids conversion, distributed energy) that can **process numerous types of feedstock**
- Markets in the **municipal and industrial waste sector** and as a new disposal method in the **waste water market**
- **Solution to PFAS problem**
- International markets offer **future growth opportunity**

## Significant International Market

- **High energy prices** coupled with high disposal costs
- **Lack of disposal options** in many areas
- **Diversified energy solutions** reduce reliance on local power supply and transmission
- Greater acceptance of gasification as a disposal option

## High Margin Sales and Stable Infrastructure Cash Flows

- Revenue generated throughout value chain from **equipment sales, development and operating fees, long-term project revenues and project sales**
- Longer term contracted **Build-Own-Operate projects with strong returns based on multiple revenue streams**
- Revenues from **creditworthy entities**



ARIES CLEAN ENERGY

DISTRIBUTED SOLUTIONS FOR A CLEANER EARTH



**Thank You!**



## Eighth Annual Green Infrastructure Conference

Ballard Spahr  
LLP



Jan Rayman  
LANDFILLS: WHO NEEDS THEM?

**Continuus** Materials



# Importance of End Markets

NO HAPPY BUYER = NO SECOND LIFE



John Lair, President & CEO of Momentum Recycling



# Importance of Collaboration

## Public - Private - Industry Partnerships

- ✓ Develop collection infrastructure
- ✓ Accelerate new product acceptance (close the loop)
- ✓ Public education
- ✓ Promote Design for 2<sup>nd</sup> Life (Recyclability/Compostability)







## GOAL: End Markets Designed for CE

Alliance to End Plastic Waste - \$1.5 Billion to be deployed in 5 years

“TOGETHER, WE CAN HELP END THE FLOW OF PLASTIC WASTE INTO THE ENVIRONMENT”

A global vision and a comprehensive, integrated strategy focusing on:

1. **Infrastructure development** to collect and manage waste and increase recycling, especially in developing countries where the need is greatest;
2. **Innovation to advance and scale new technologies** that minimize waste, make recycling and recovering plastics easier and create value from all post-use plastics
3. **Education and engagement** of governments at all levels, businesses, and communities to mobilize action;
4. **Clean up** of concentrated areas of plastic waste already in the environment, particularly major rivers that carry vast amounts of land-based plastic waste to the ocean.

Ellen McArthur Foundation’s mission is “TO ACCELERATE THE TRANSITION TO A CIRCULAR ECONOMY”

NEW PLASTICS ECONOMY’s targets include:

1. **Eliminate** problematic or unnecessary plastic packaging and move from single-use to reuse packaging model
2. **Innovate** to ensure 100% of plastic packaging can be easily and safely reused, recycled, or composted by 2025
3. **Circulate** the plastic produced, by significantly increasing the amounts of plastics reused or recycled and made into new packaging or products



CIRCULAR MATERIAL SOLUTION



## Extracting fiber and plastic packaging from MSW and MRF residuals



## Upcycling high-performance packaging into recyclable high-performance building materials

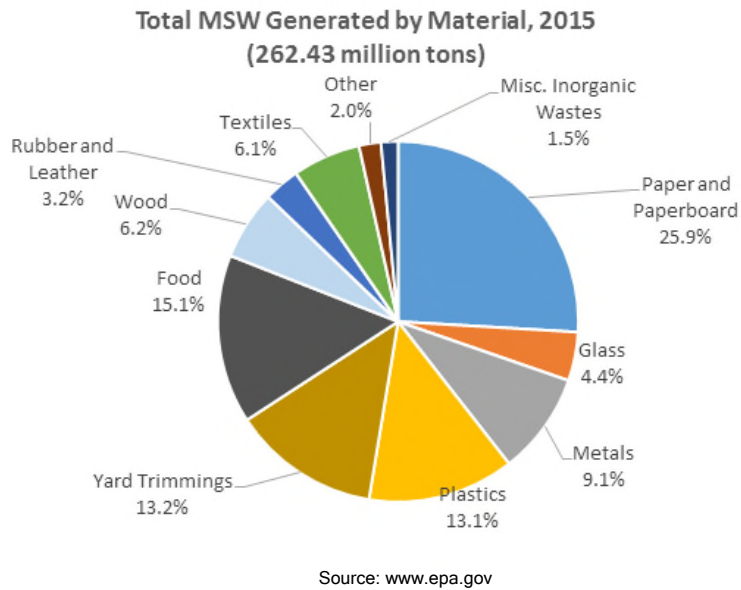


## Locally collected waste turned into locally distributed building materials - AT SCALE



Real solutions must be SCALABLE, with a massive impact and a potential to solve 100% of the problem

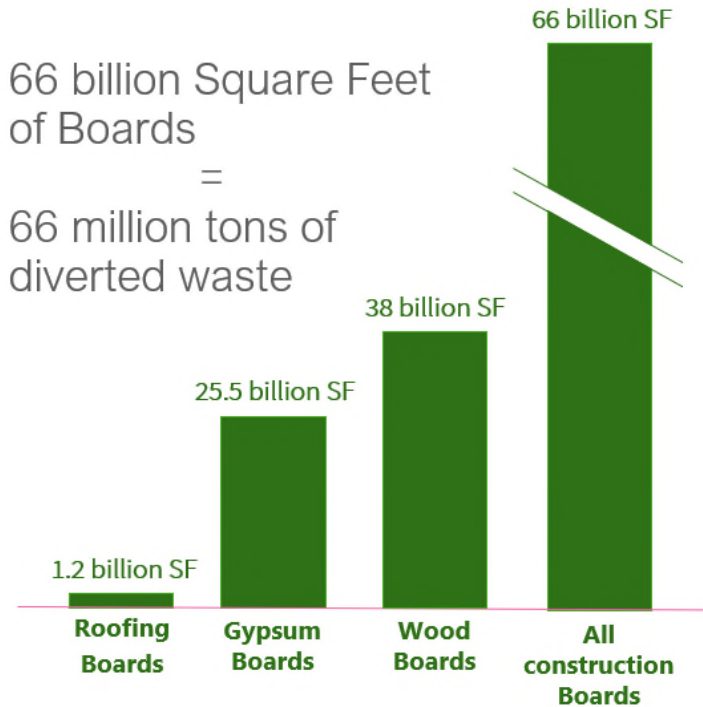
Importance of Scale



66 billion Square Feet of Boards

=

66 million tons of diverted waste





## Striving for Zero Waste



Goal to achieve zero-waste by 2025  
*Currently at 82.1%*



Re-Roofing offset: 20,000 tons per year



Help collect and recycle "the equivalent"  
of 100 percent of its packaging by 2030  
*Currently at 72.3%*



By 2025, 100% of customer packaging will  
come from renewable, recycled, or certified  
sources



Operation "Moonshot": Zero Waste by 2025  
*Currently at 62%*



# Closing the Packaging Loop



Making a Difference



# **Continuus**Materials

Disruptors in Recovery, Collection, Circularity, and Upcycling

[www.continuusmaterials.com](http://www.continuusmaterials.com)



## Who is Fundamental today?

- ✓ *Leading alternative asset manager dedicated to municipal credit and infrastructure debt in the U.S.*
- ✓ *Platform allows global institutional investors to capitalize on the inefficiencies of this opportunity set*
- ✓ *Scalable, uncorrelated and consistent absolute returns across economic cycles*
- ✓ *\$1.25 billion in funded & unfunded AUM commitments in 2 strategies*



- **Fundamental Credit Opportunities ("FCO")**
- Liquid credit strategy focused on absolute return with a broad mandate
- Launched in 2013



- **Fundamental Infrastructure Opportunities ("FIO")**
- Private credit debt strategy focused on core US infrastructure with a government attachment
- Launched in 2019

<sup>1</sup> Funded and unfunded commitments



# Fundamental Strategy Overview

## Fundamental Credit Opportunities ("FCO")

---

- **An opportunistic municipal credit strategy** which capitalizes on the frequent and recurring inefficiencies across the multi-trillion US public finance markets
  - ✓ Technical and Relative Value trading
  - ✓ Structured Credit investments
  - ✓ Idiosyncratic / Catalyst-driven situations
  - ✓ Distressed debt

## Fundamental Infrastructure Opportunities ("FIO")

---

- **Invest in U.S. public purpose infrastructure debt** with flexible, patient capital
  - ✓ Differentiated focus from other infrastructure investment strategies
  - ✓ Scalable exposure to hard to assemble local projects
  - ✓ Value added lending solutions through early stage sourcing in an inefficient market
  - ✓ Performing credit structures across the capital stack sourced from direct lending, private markets and public offerings