

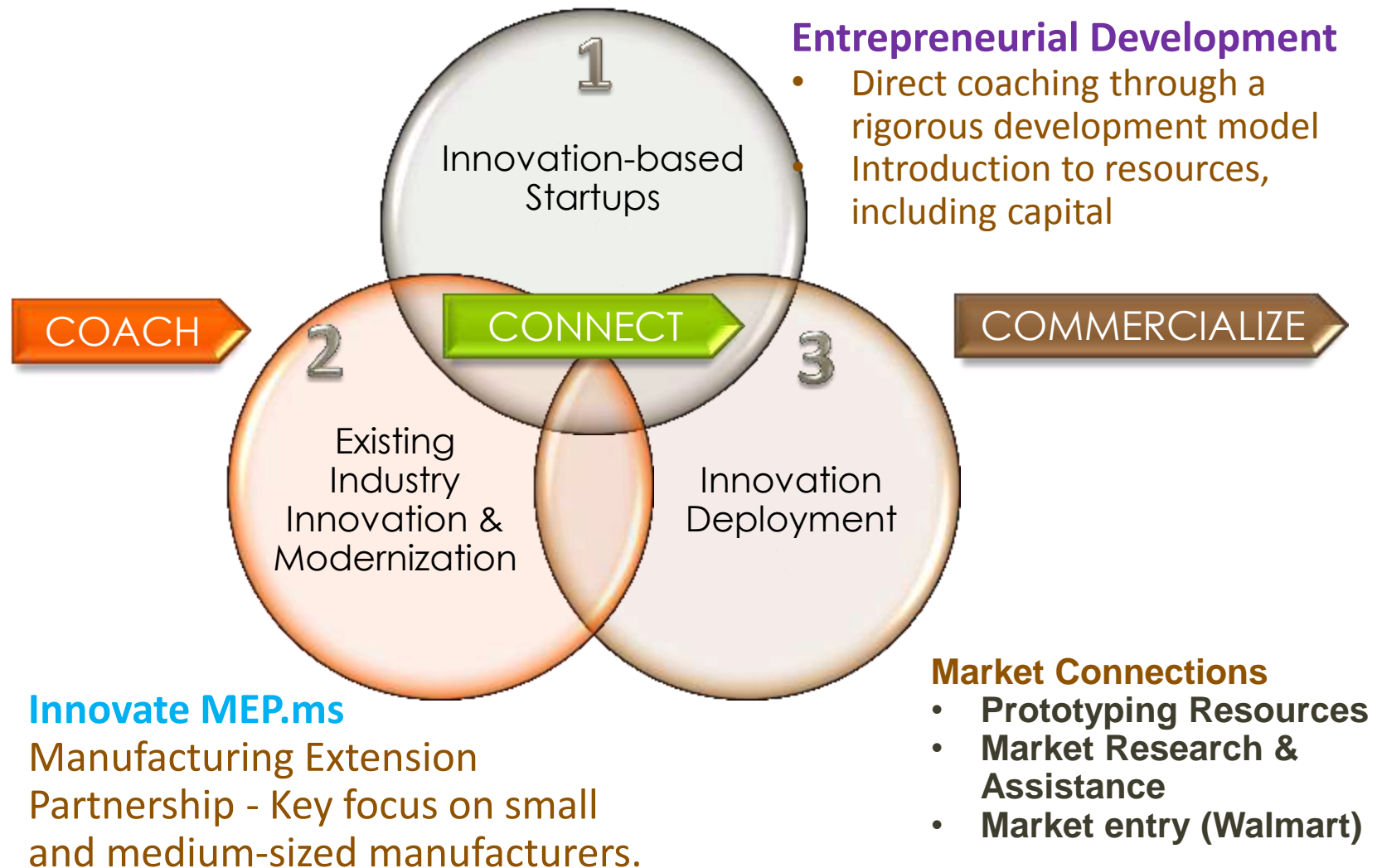


# Renewable Energy in Mississippi: *Technologies & Markets*

Mississippi Public Service Commission  
Special Working Session  
August 17, 2016  
Jackson, Mississippi  
**Sumesh Arora, Ph.D.**

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# Innovate Mississippi



# How Innovate Mississippi helps companies?

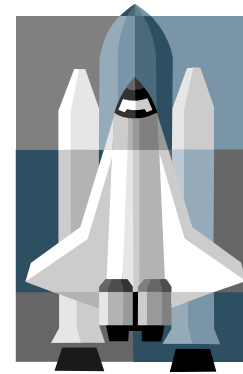
- Ideation
- Business Plan Review
- Project Evaluation/Feasibility Studies
- Access to Capital (Seed, Angel, Grants)
- Process/Product Improvement
- Venture Development Academies  
**(REVSup: Renewable Energy Venture Startup – launched in 2010)**

***NG1 Techflo won Cleantech Open 2014 grand national title***

# REVS<sup>up</sup> Risk Areas



1. **Technology**
2. **Market**
3. **Management**
4. **Finance**
5. **Execution**

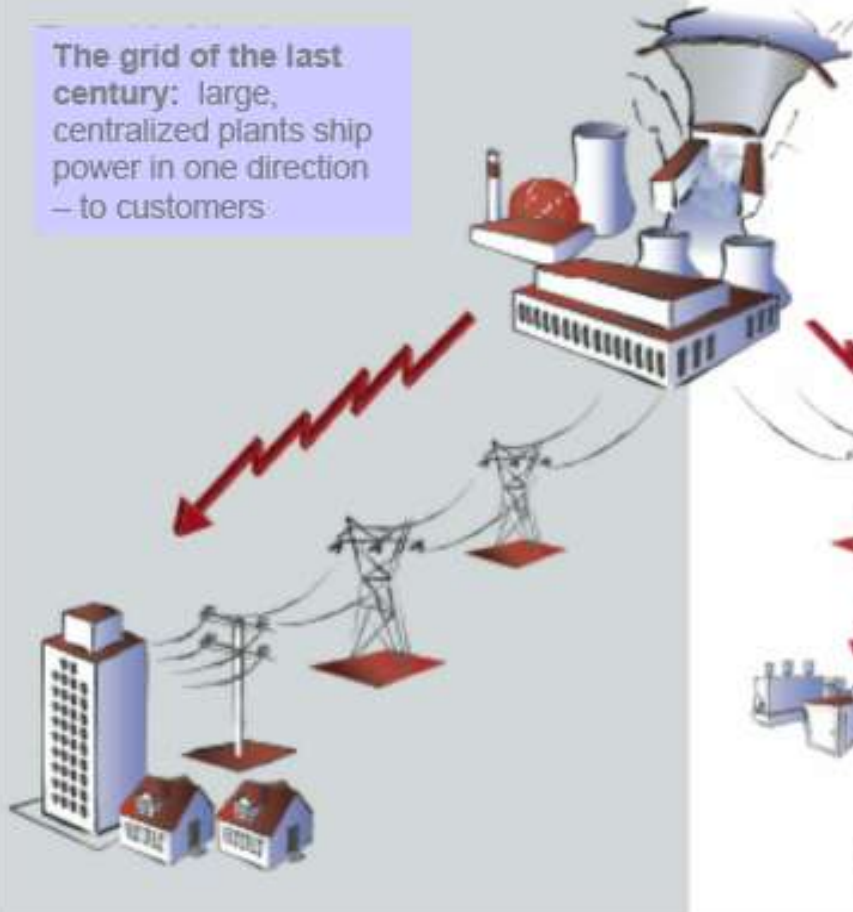


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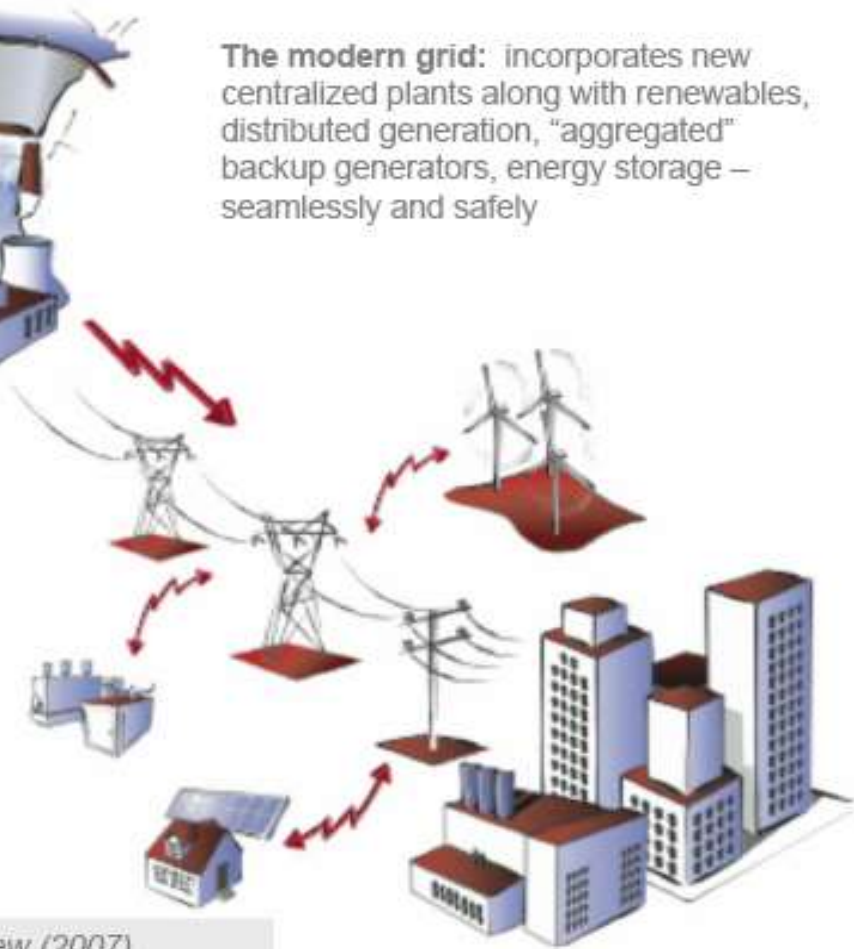


# The New Grid Paradigm

**The grid of the last century:** large, centralized plants ship power in one direction – to customers



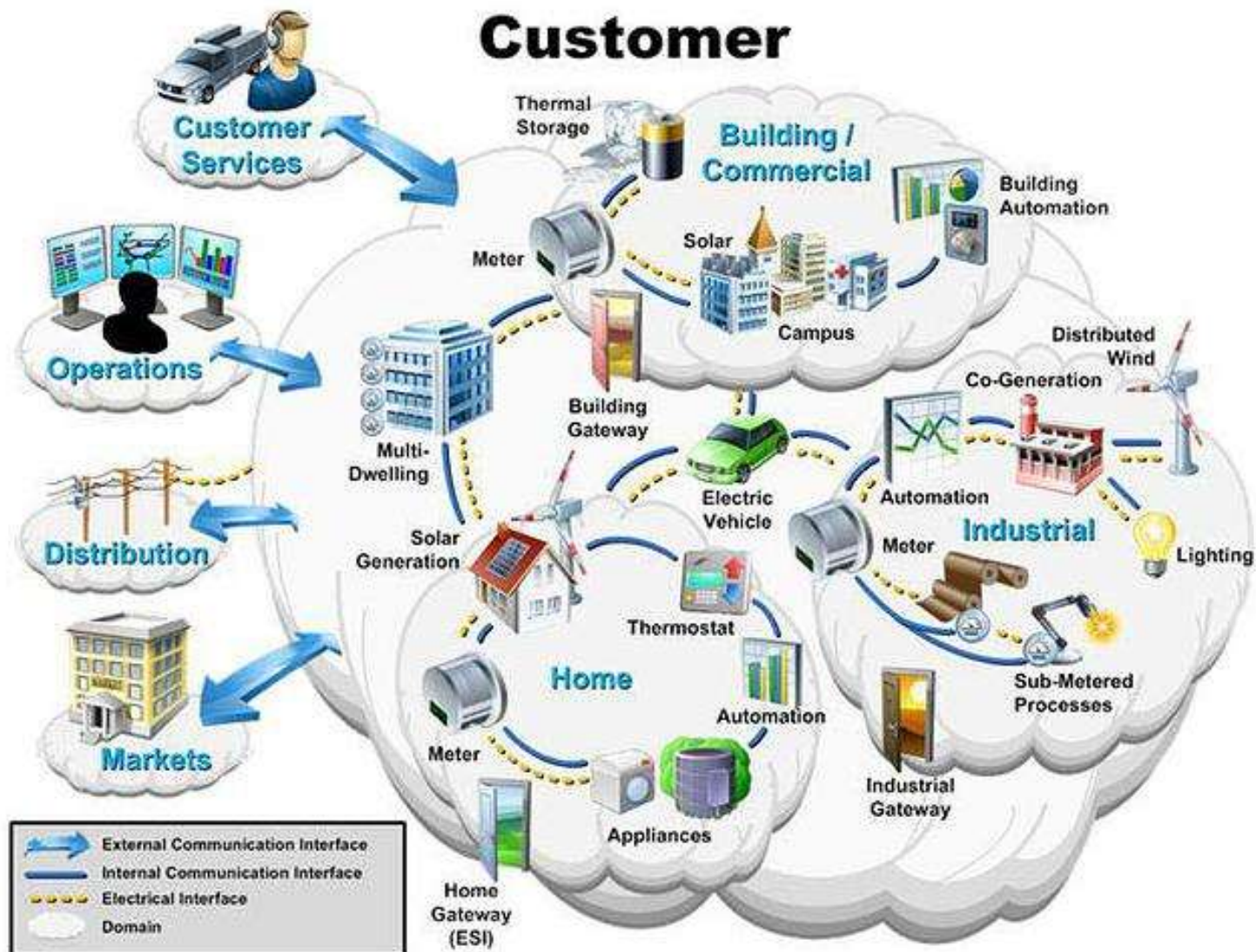
**The modern grid:** incorporates new centralized plants along with renewables, distributed generation, “aggregated” backup generators, energy storage – seamlessly and safely



*Reference: NETL/DOE Modern Grid Systems View (2007)*



# The Newer Grid...



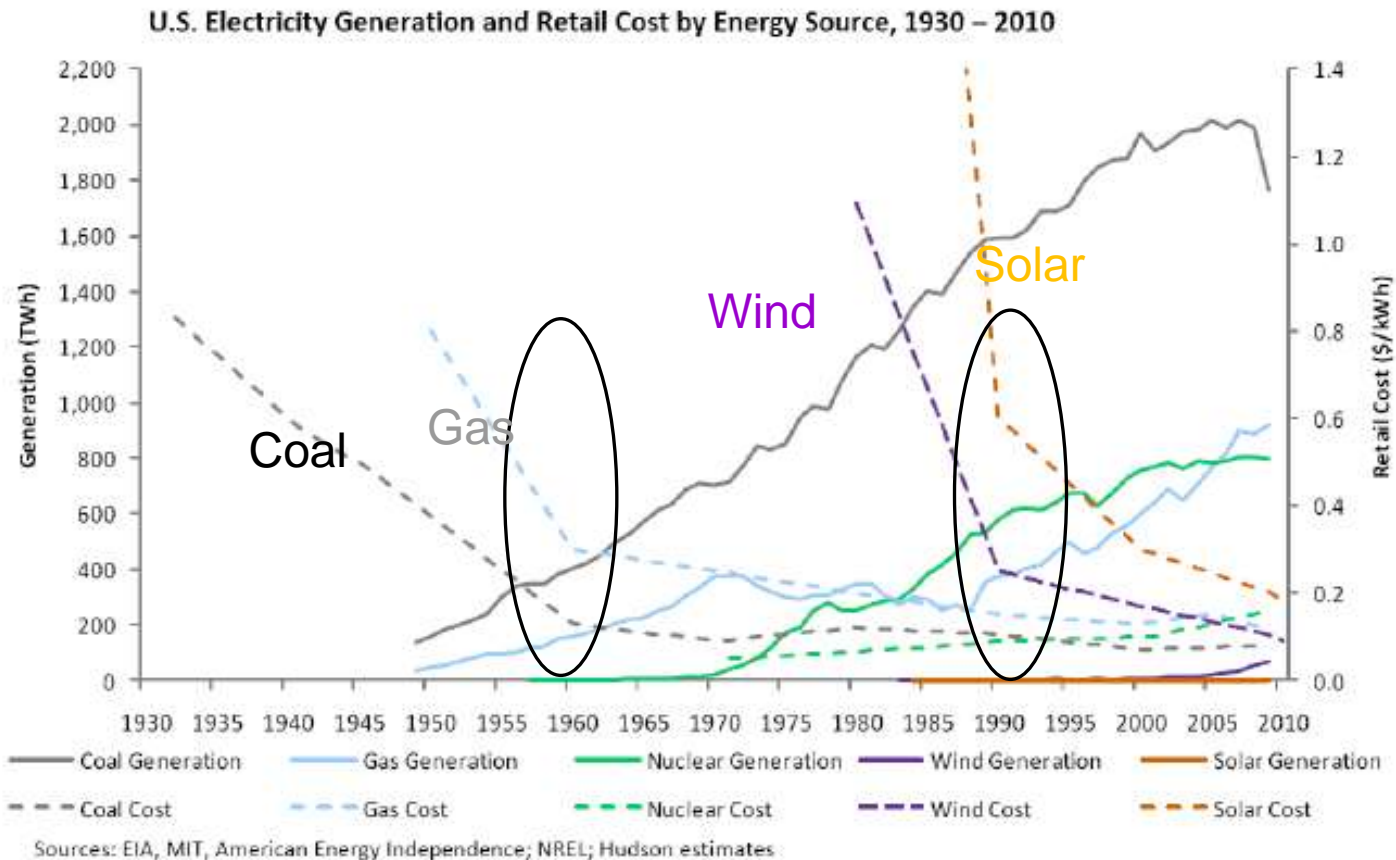
# Benefits of Renewable Energy

- ◉ Diversity of energy supplies
- ◉ Low (or no) fuel costs
- ◉ Lower emissions/improved health
- ◉ Grid resiliency
- ◉ Rural economic development

## Challenges with Renewable Energy

- Intermittent fuel supply (in some cases)
- Scalability/grid integration
- Energy storage/transmission
- System costs
- Changing mind-sets & existing business models

# Electricity Generation Evolution



Source: ACORE Leadership Council Report



# Global weighted average solar and wind power investment costs, capacity factors and LCOEs, 2015 and 2025

	Global weighted average data								
	Investment costs (2015 USD/kW)		Percent change	Capacity factor		Percent change <sup>2</sup>	LCOE (2015 USD/kWh)		Percent change
	2015	2025		2015	2025		2015	2025	
Solar PV	1 810	790	-57%	18%	19%	8%	0.13	0.06	-59%
CSP (PTC: parabolic trough collector)	5 550	3 700	-33%	41%	45%	8.4%	0.15 -0.19	0.09 -0.12	-37%
CSP (ST: solar tower)	5 700	3 600	-37%	46%	49%	7.6%	0.15 -0.19	0.08 -0.11	-43%
Onshore wind	1 560	1 370	-12%	27%	30%	11%	0.07	0.05	-26%
Offshore wind	4 650	3 950	-15%	43%	45%	4%	0.18	0.12	-35%

Source: IRENA report, The Power to Change

# Solar Power in Mississippi



Image Source: Mississippi Business Journal

# Solar in Starkville

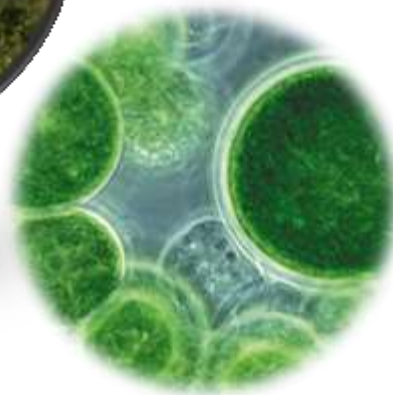


Synergetics owners, Jim Raines, left, and David Palmer stand on the roof of their corporate headquarters in Starkville.

(Photo by: Micah Green/Dispatch Staff)

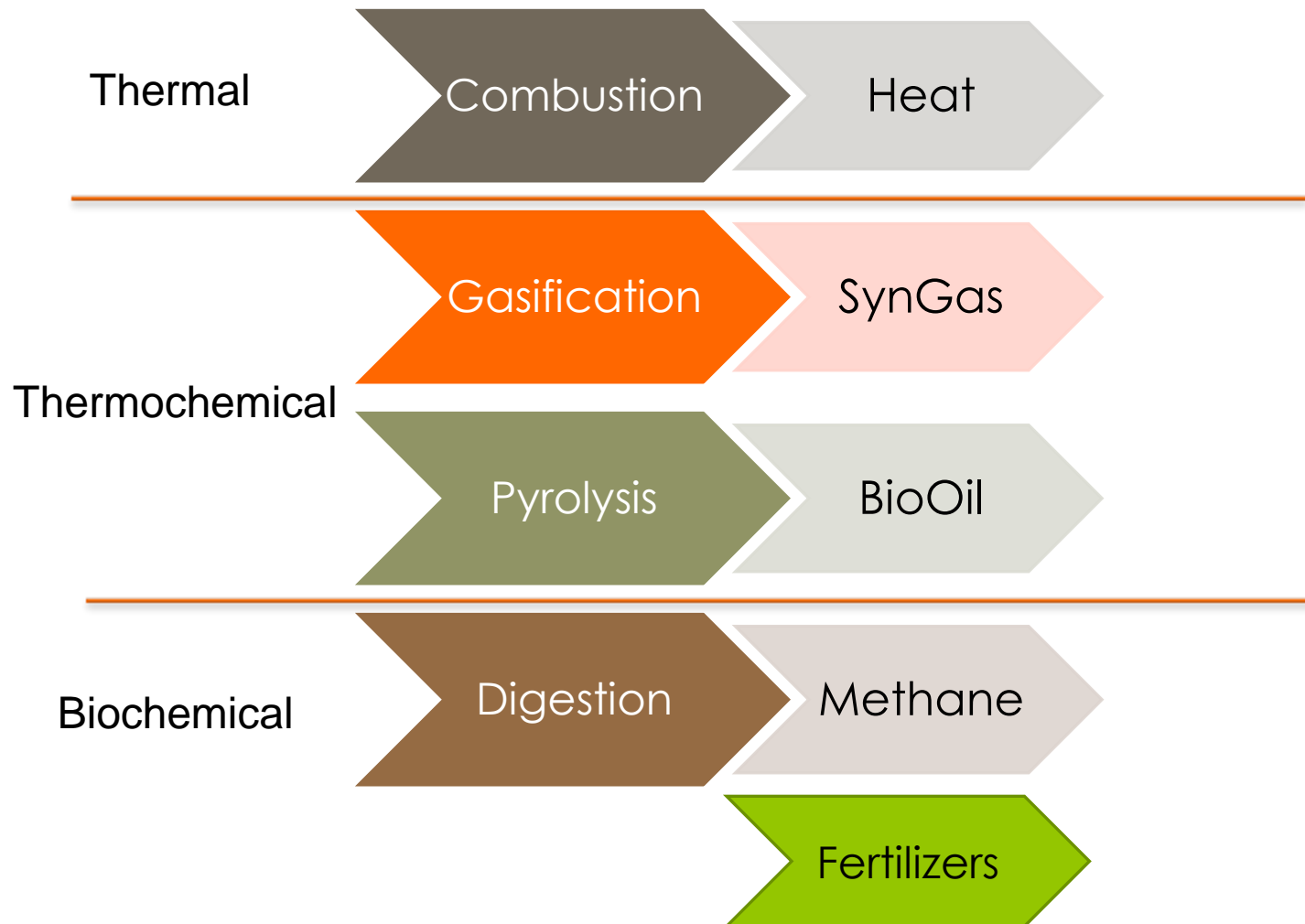


# Biomass Feedstocks: **Top 5 State in the country\***



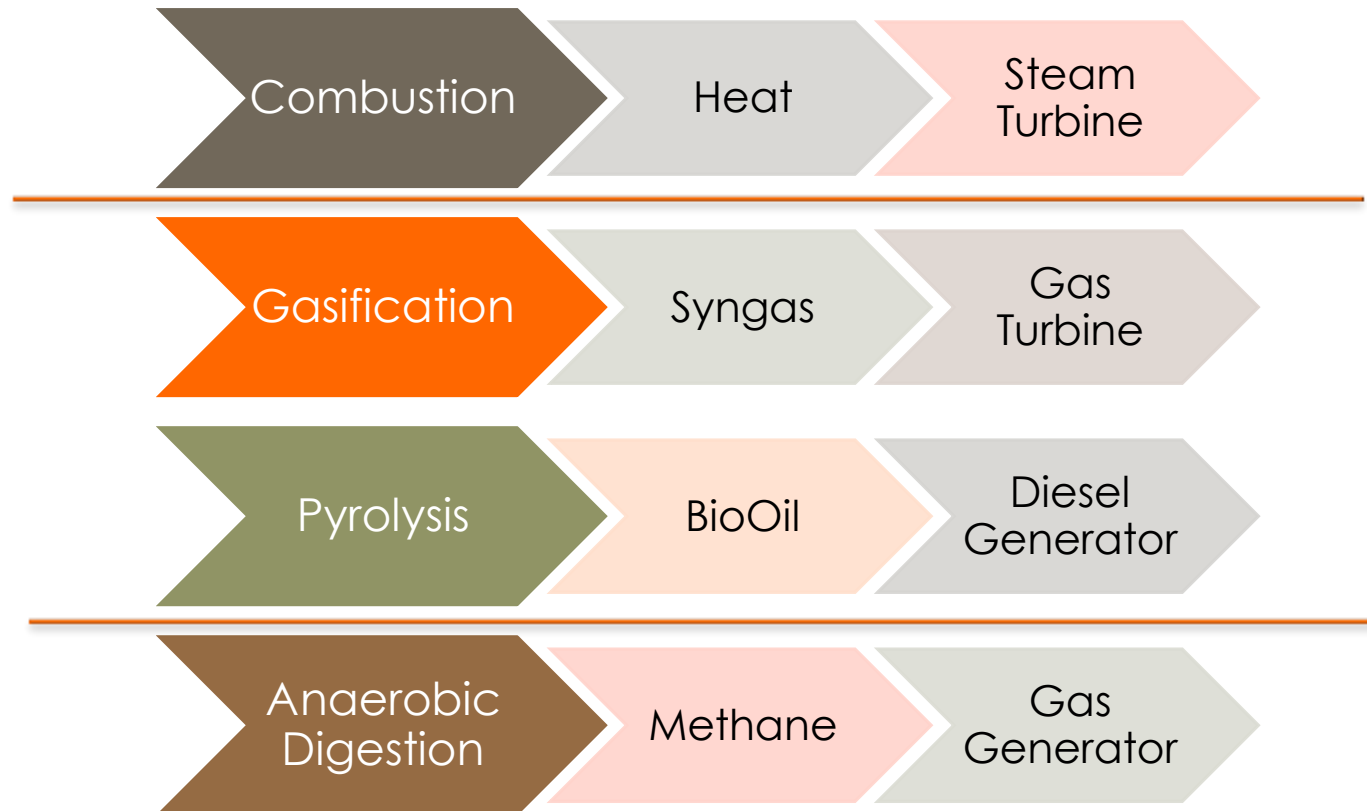
\*Forbes Magazine (2008)

# Biomass Processes & Outputs





# Biomass Power Generation



# Raceway Station (Highway 6, Batesville exit, I-55 N)



60 cents/gallon difference!



# Renewable Activities in MS

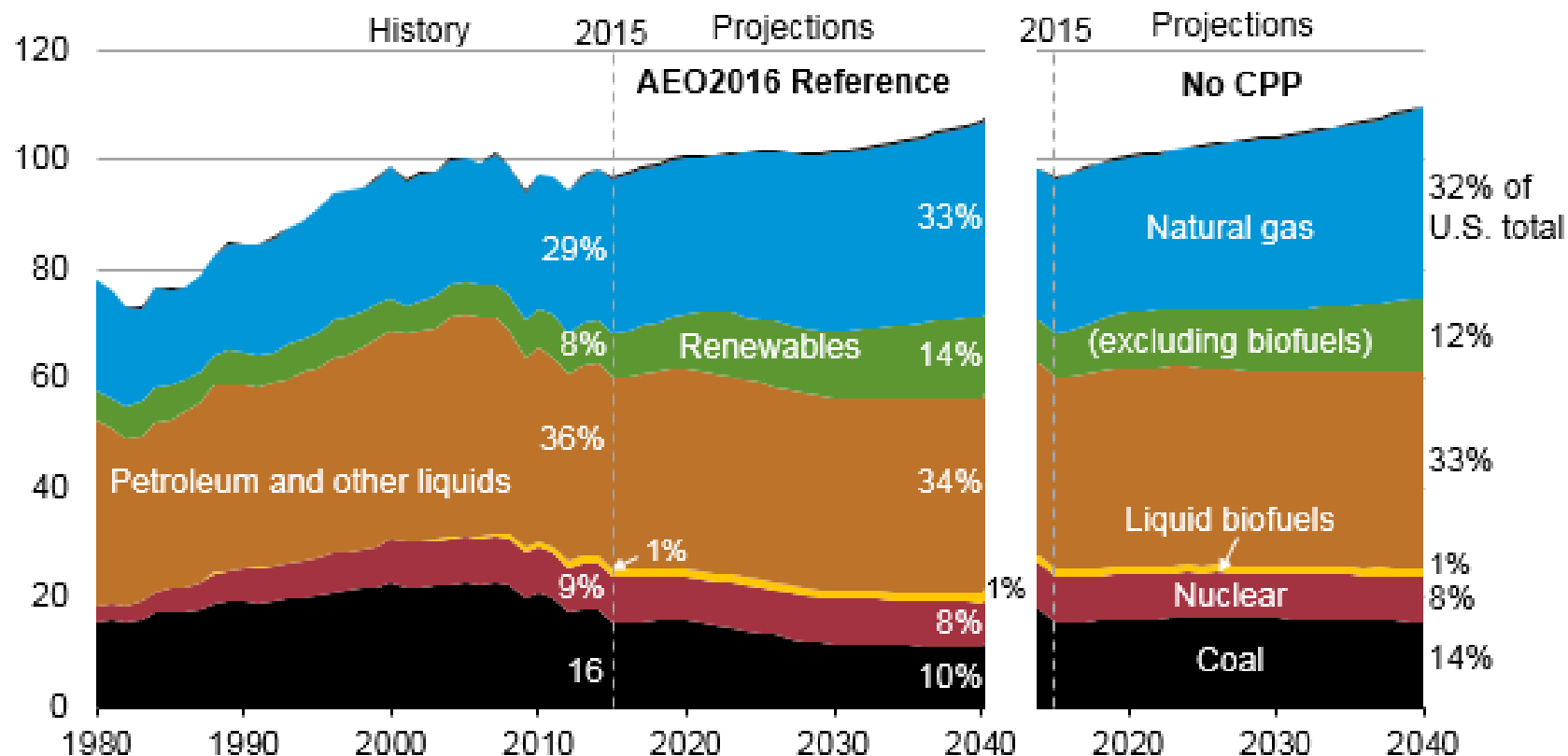
- > 100 MW of solar PV going in
- ~ 500 households with roof-top solar
- Two PV panel manufacturing facilities (thin film; mono and polycrystalline)
- One corn-based ethanol plant
- One advanced biofuels plant
- Two biodiesel plants
- Four landfill gas plants
- Three wood pellet plants
- One torrefied wood pellet plant
- Four bio-digesters (two operational)
- University research

# **MARKET PROJECTIONS**



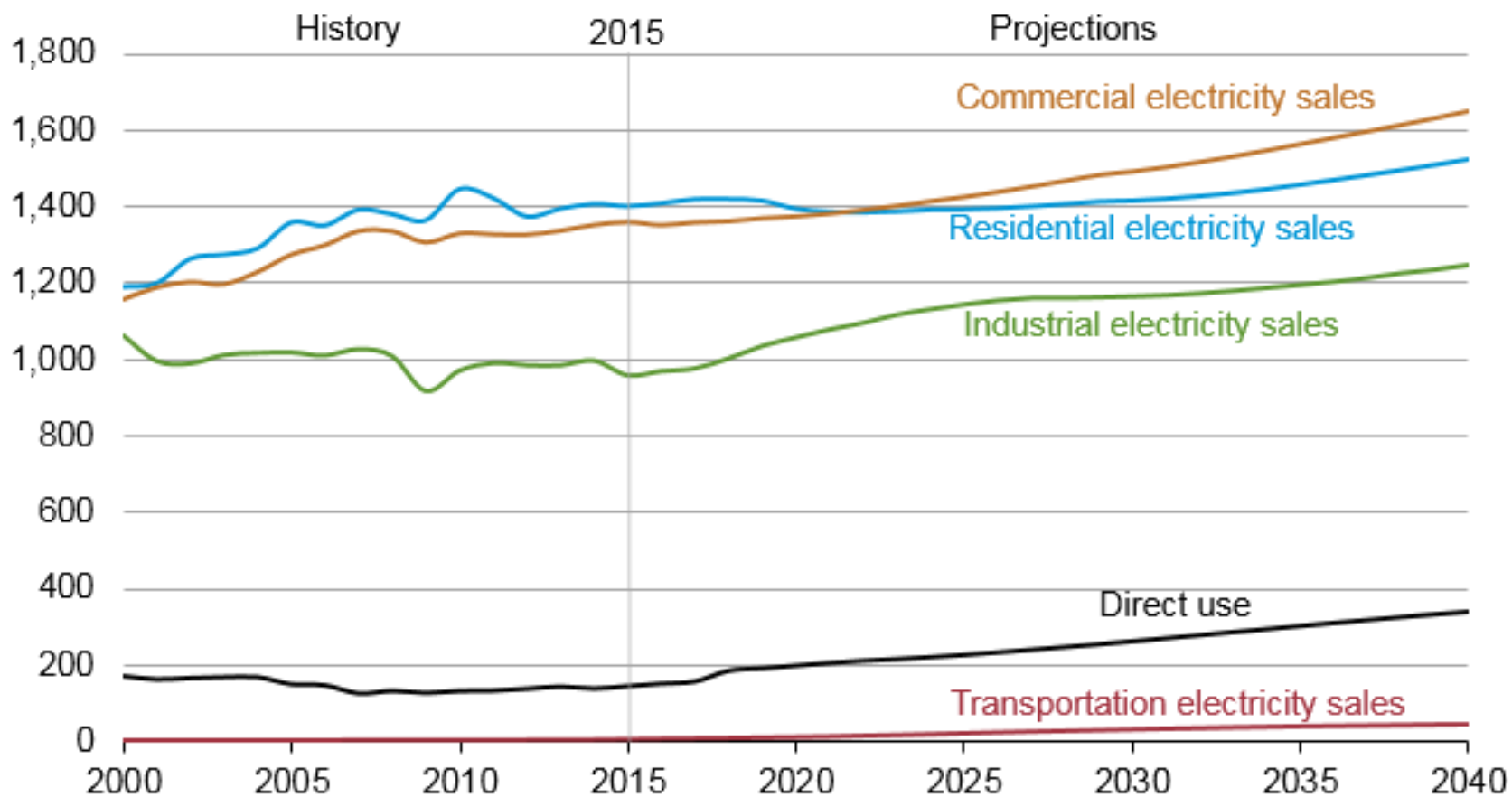
# USDOE-EIA; Annual Energy Outlook, Early Release, May 2016

U.S. primary energy consumption  
quadrillion Btu



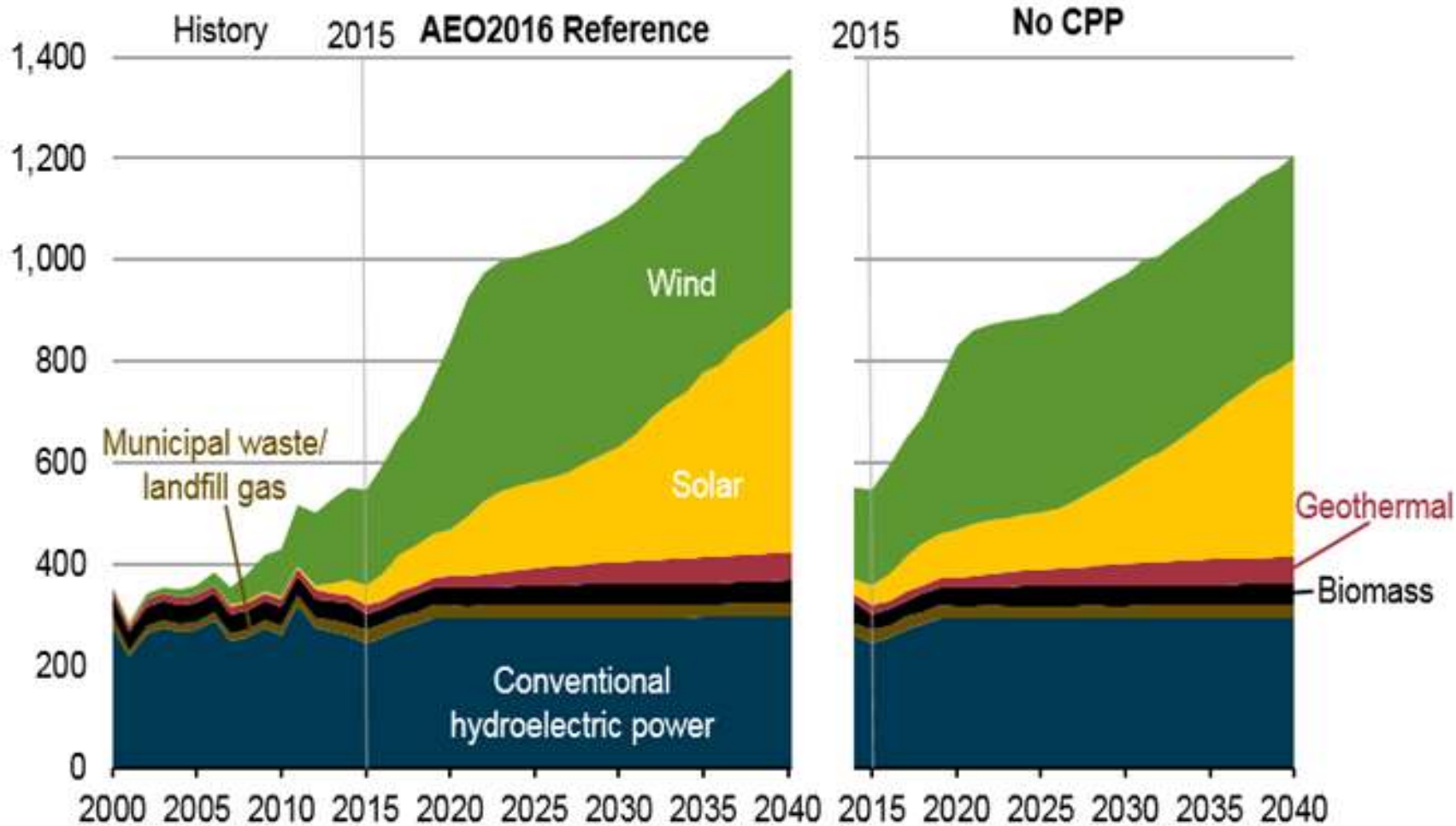
Source: EIA, Annual Energy Outlook 2016

electricity consumption including direct use  
billion kilowatthours



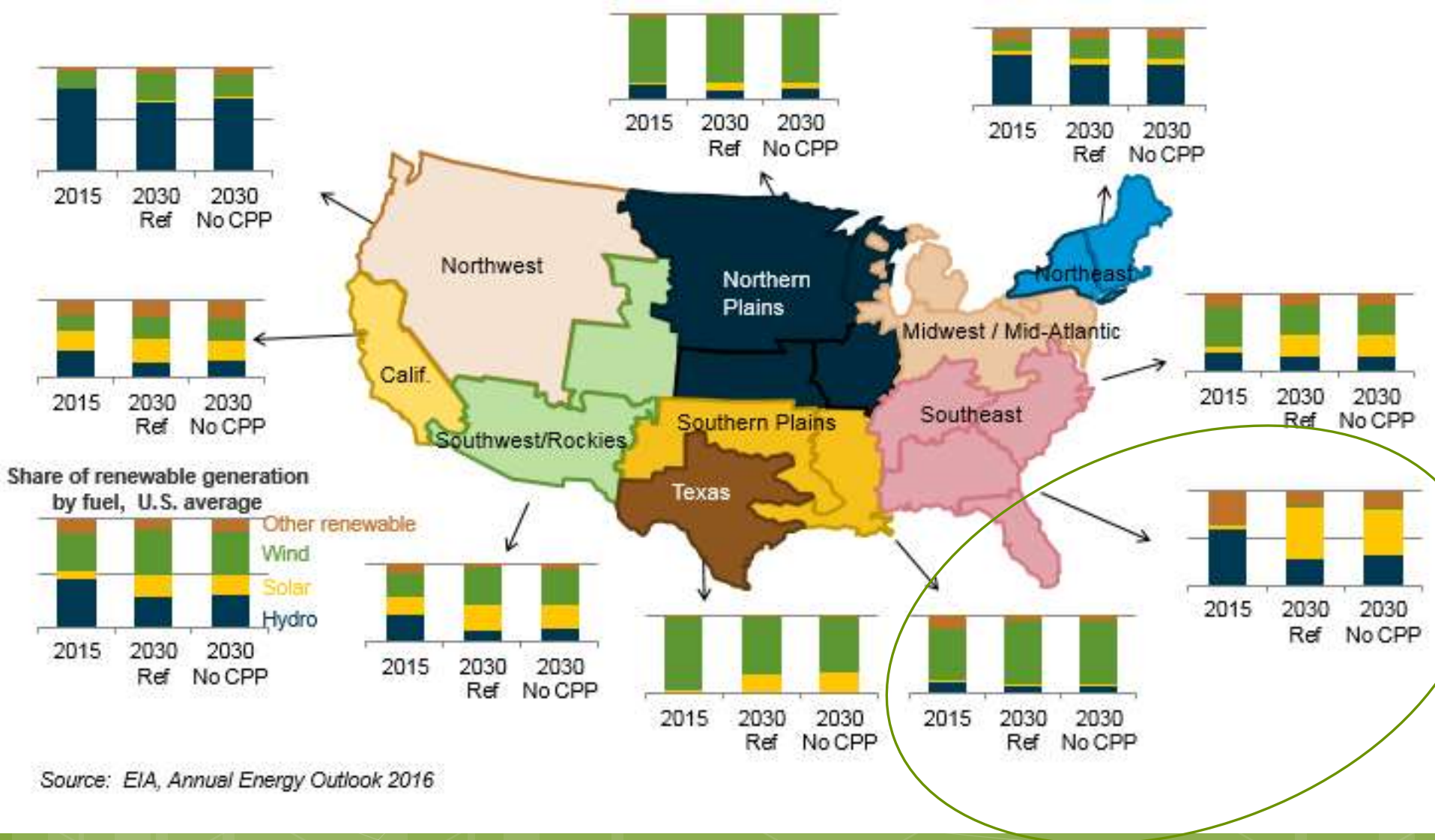
Source: EIA, Annual Energy Outlook 2016

renewable electricity generation by fuel type  
billion kilowatthours



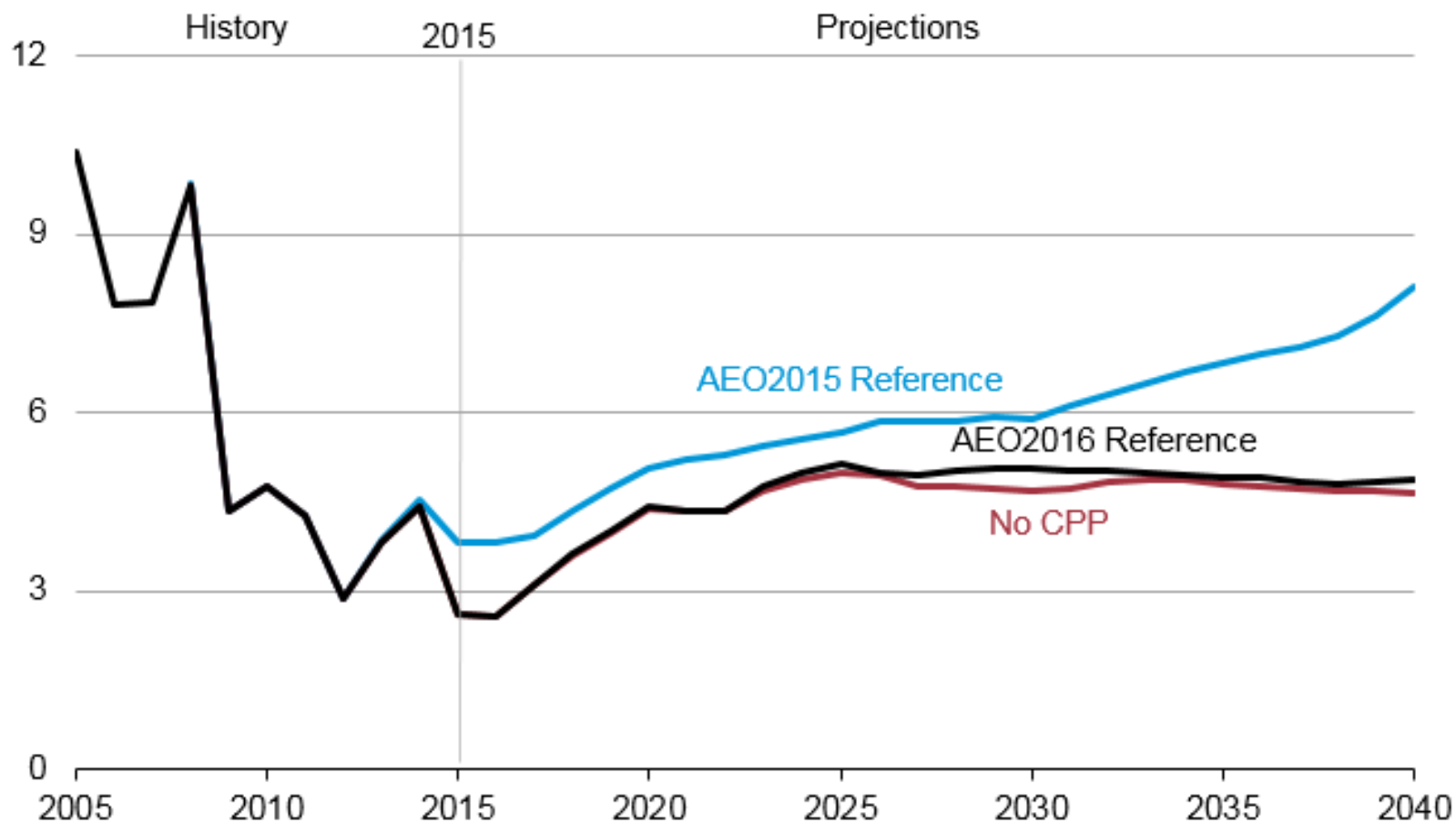
Source: EIA, Annual Energy Outlook 2016

# Renewable Energy Generation Patterns by Regions



average Henry Hub spot prices for natural gas  
2015 dollars per million Btu

## Natural Gas Price Trends

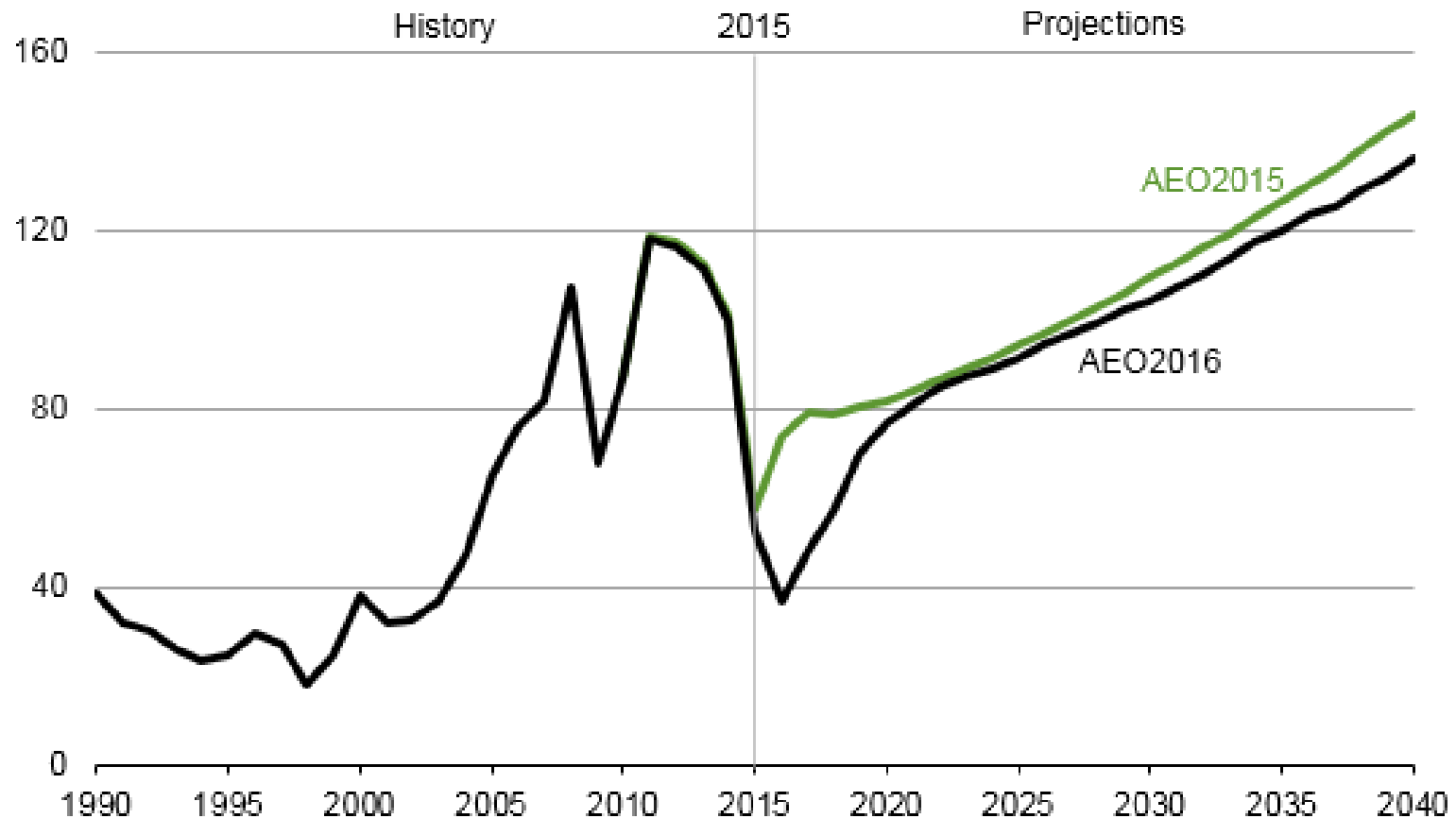


Source: EIA, Annual Energy Outlook 2016



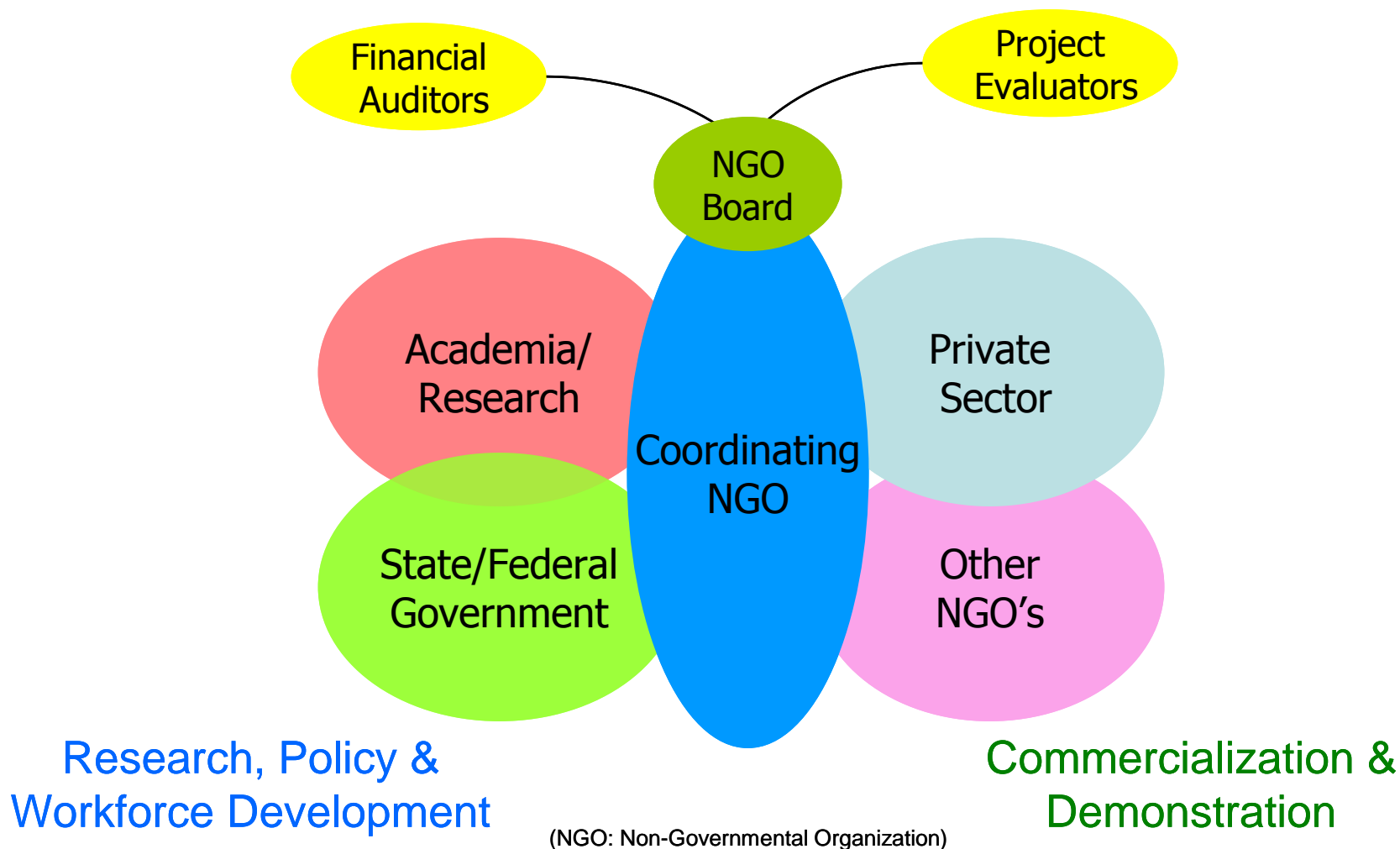
# Crude Oil Price Trends

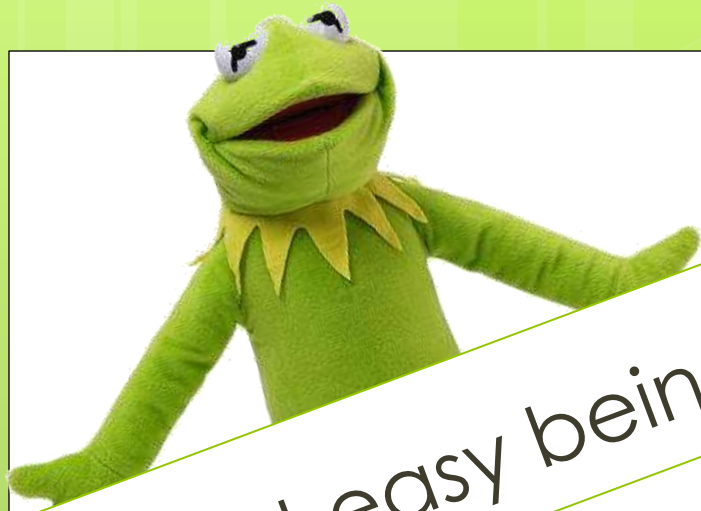
Brent crude oil spot price  
2015 dollars per barrel



Source: EIA, Annual Energy Outlook 2016 Reference case and Annual Energy Outlook 2015 Reference case

# Butterfly Model of Collaboration<sup>©</sup>





“It is not easy being **GREEN**”



**E3: ECONOMY • ENERGY • ENVIRONMENT**

A SUSTAINABLE GROWTH STRATEGY

**How can we work together?**

**Sumesh Arora, PhD**

Vice President

Innovate Mississippi

Ridgeland, MS

601-960-3610

[sarora@innovate.ms](mailto:sarora@innovate.ms)