Solar Energy for Louisiana

UNIVERSITY of LOUISIANA LAFAYETTE®

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Bottom Line Up Front

- University Resources
  - University has the facilities and expertise to help
- Solar Energy Market
  - Solar is now the cheapest form of new generation capacity
  - Market is rapidly growing
  - Solar will not completely replace traditional fuels
- Solar Issues for Louisiana
  - Solar is safe and effective
  - Stakeholders have many valid concerns
  - Many common concerns are myths
- Economic Development
  - Renewable energy is required to attract large companies to Louisiana
  - Opportunities for Louisiana businesses – JOBS!
  - Revenue for local governments
- Sustainability
  - Solar can help Louisiana meet its sustainability goals

UNIVERSITY RESOURCES

ENERGY EFFICIENCY AND SUSTAINABLE ENERGY (EESE) CENTER

Clean Energy Research, Education, Workforce Development, Economic Development, Outreach

https://eese.louisiana.edu/

Concentrating Solar Power (CSP)

The Solar Thermal Applied Research and Testing (START) Lab is one of the largest university-owned CSP test facilities in the nation and one of only a few in the southeast

Pilot-scale CSP plant with thermal storage (Fall 2022)

Test new technologies

- CSPV, new reflector materials, reducing trough costs, ORCs
- Thermal Energy Storage

Microgrid test facility (4Q 2022)

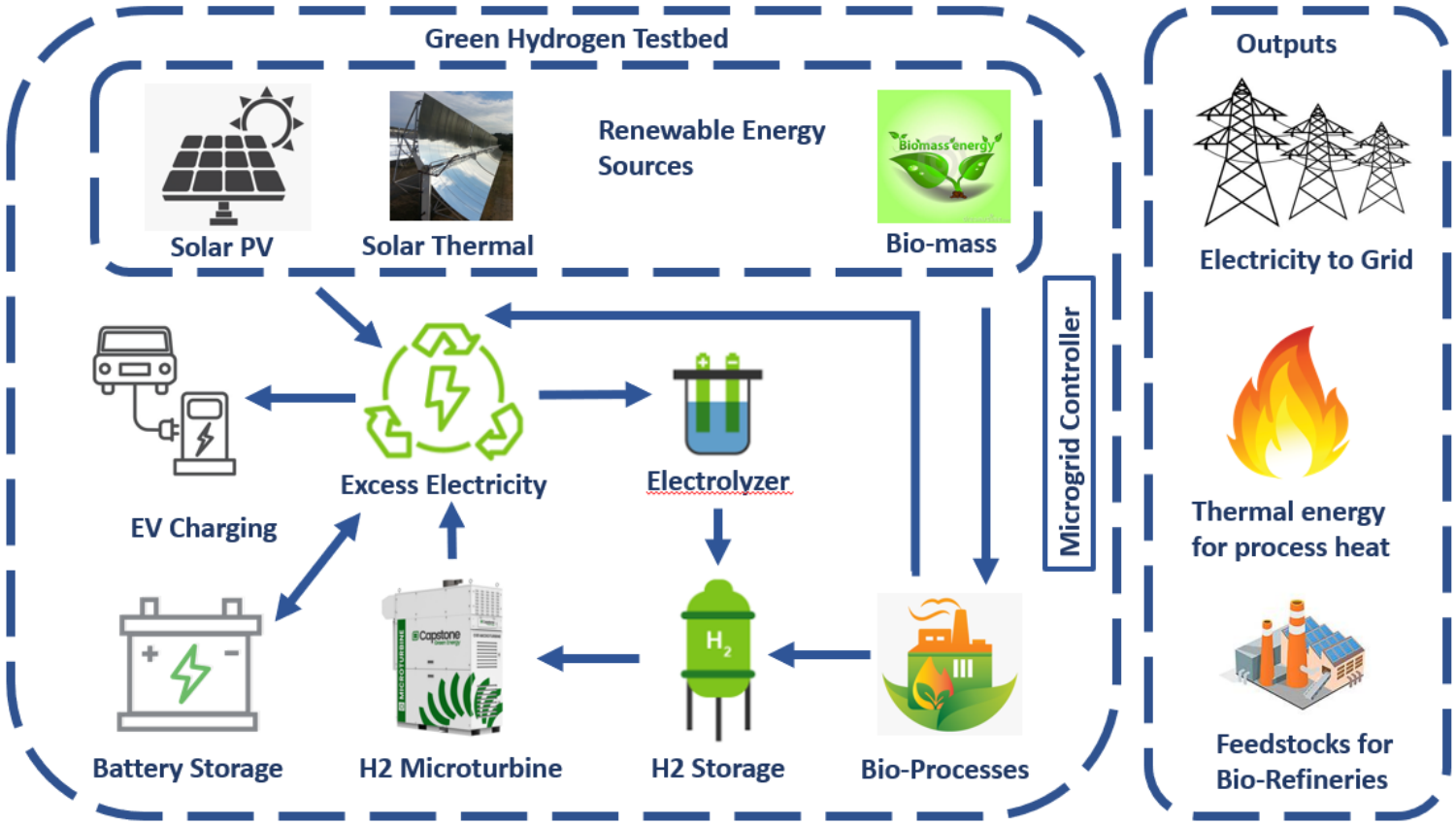
- EV's, battery storage, controls systems, real-time simulator, effect of renewables on the grid

Future interests

- geothermal and geologic energy storage, hydrogen, hydrogen turbines

H2theFUTURE

ENERGY TRANSFORMATION IN SOUTH LOUISIANA



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Photovoltaic

The 1.1 MW Louisiana Solar Energy Lab is one of the largest outdoor test facilities in the southeast United States

Degradation, soiling, performance modeling, solar resource and power forecasting

Extensive Outdoor Test Facilities

New Building w/ indoor test facilities

Used for research, education workforce development, economic development, and outreach

Research and Training Test Beds

Single-Axis Tracker (FS6)

Dual-Axis Tracker

Bi-Facial Test Stand

Commercial Roof

Residential Roof

Conical Dish Receiver

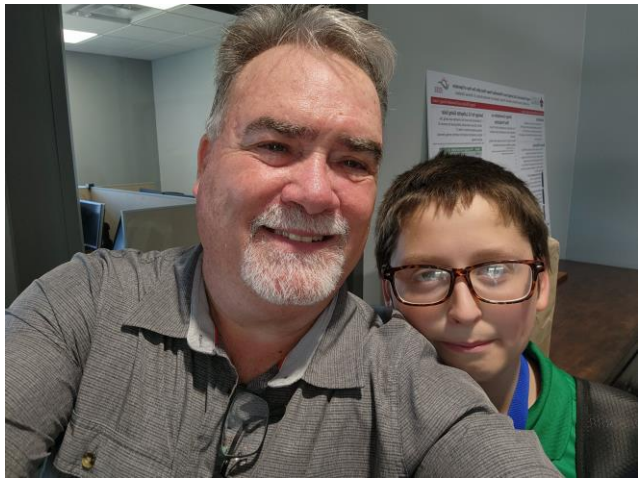
Engineering Education

- Renewable Energy Minor and Two Degree Concentrations
- New solar-related courses (4 courses created in last 2 years)
  - ENGR 400G – Energy Systems and Sustainability
  - ENGR 430 – Introduction to Solar Energy System Design
  - ENGR 431 – Utility-Scale Solar Energy System Design
  - ENGR 432 – Modeling and Simulation of Solar Energy Systems (planned)
  - ENGR 400G - Solar Thermal System Design
  - ENGR 695 – Sustainable Energy System Design
- Internships
  - Establishing industry partners so that students can get design experience to obtain the NABCEP PV Design Specialist Certificate
- MCHE Department has added a solar energy representative to their Industrial Advisory Board as a mechanism for receiving industry input on curriculum
  - David Spieldenner – First Solar/Terrabase

Workforce Training

- Solar Certificate Program
  - PV101: Intro to Grid-Direct Photovoltaic Solar Energy System Design and Installation (60 PDH)
  - PV202: Intermediate Grid-Direct Photovoltaic Solar Energy System Design and Installation (40 PDH)
  - PV203: Intro to Battery-Based Solar Electric Design (40 PDH)
  - PV206: Solar Business and Technical Sales (60 PDH)
  - PV350: Tools and Techniques for Operations and Maintenance (40 PDH)
- NABCEP Certification
- Registered Apprentice Program in Process

Outreach



Inspiring the next generation of renewable energy workers

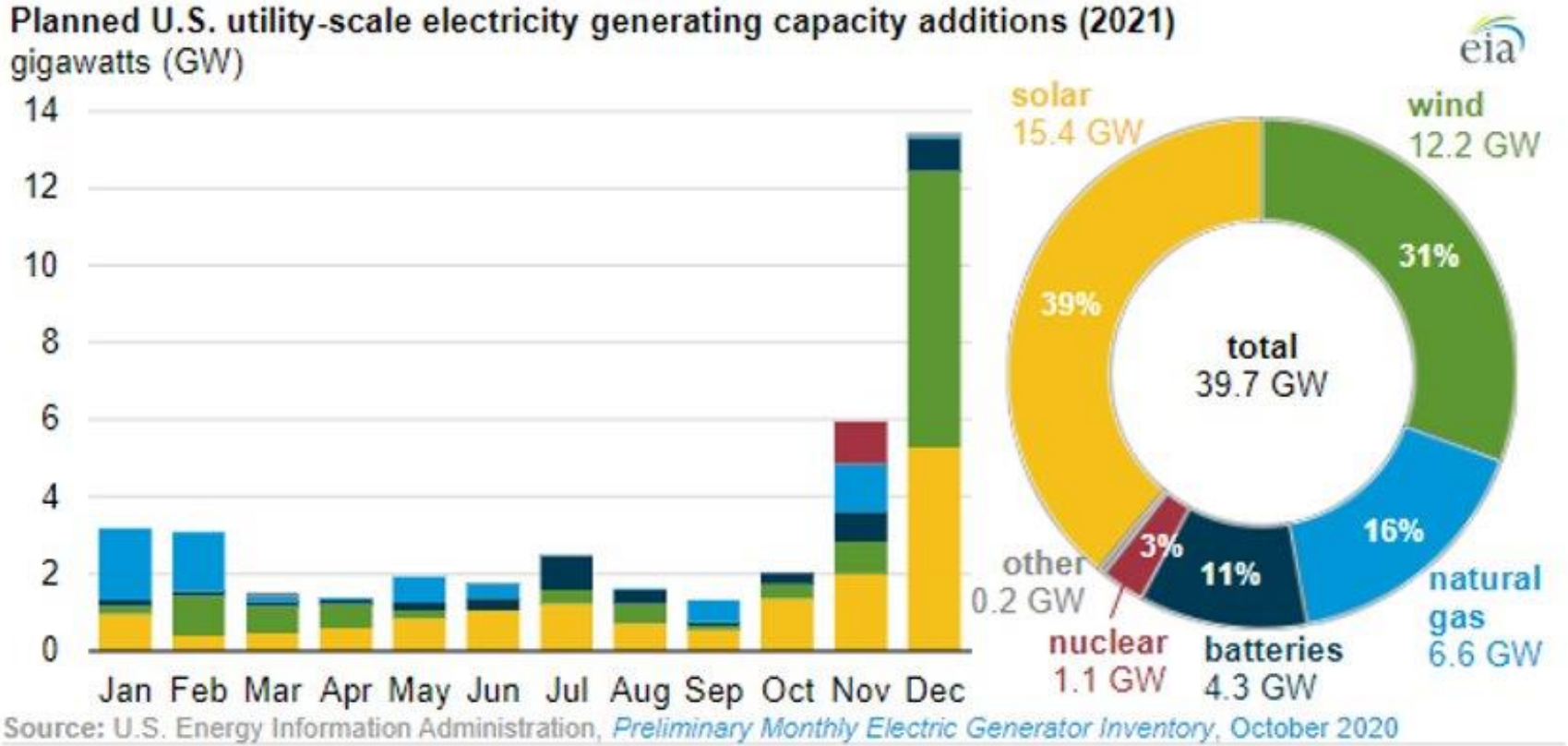
We reach thousands of K-12 students per year

SOLAR ENERGY MARKET

Most New Generation Now From Solar

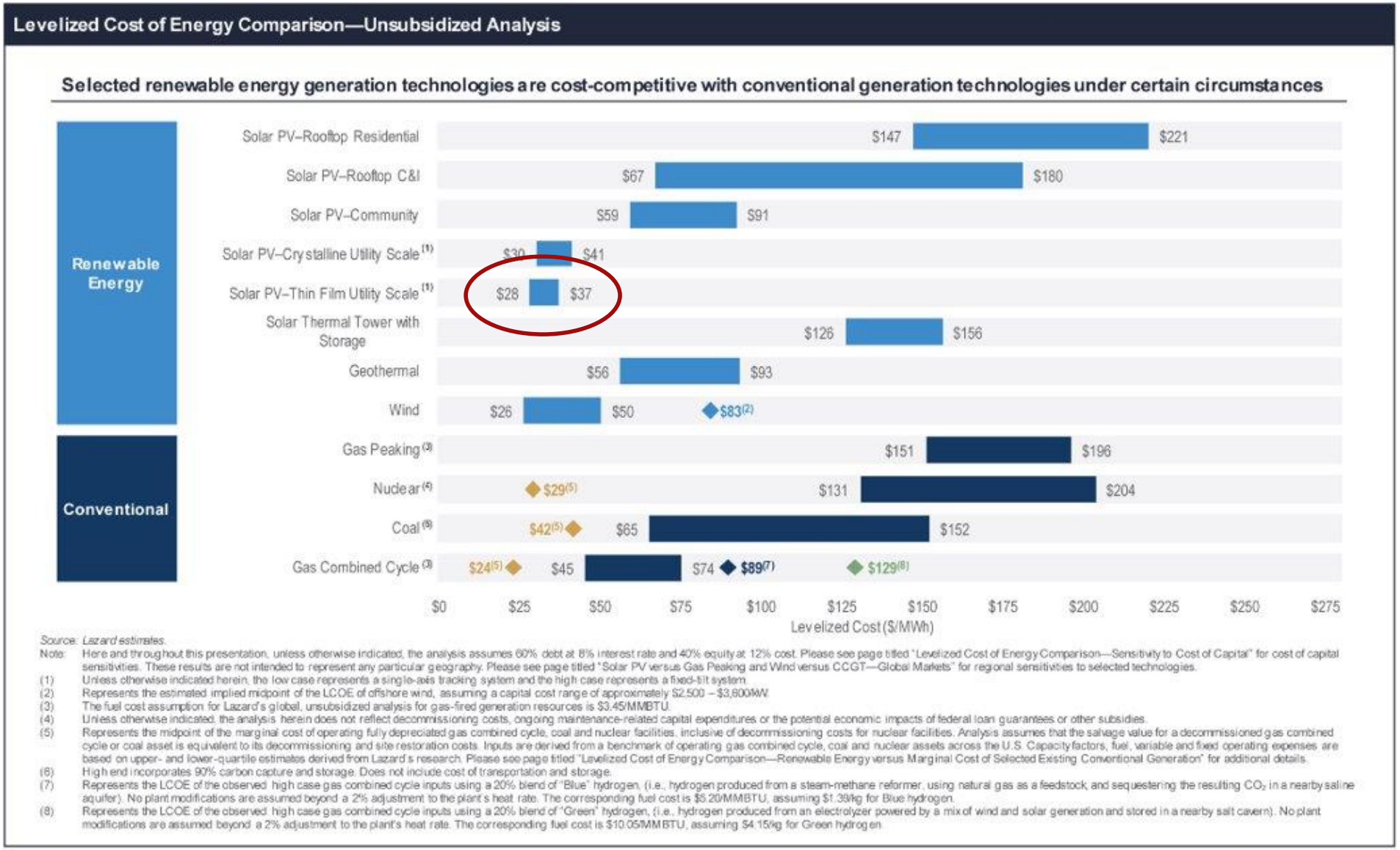
JANUARY 11, 2021

Renewables account for most new U.S. electricity generating capacity in 2021



Source: U.S. Energy Information Administration, *Preliminary Monthly Electric Generator Inventory*, October 2020

LCOE of Solar vs. Other Generation



Source: Lazard estimates.

Note: Here and throughout this presentation, unless otherwise indicated, the analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital" for cost of capital sensitivities. These results are not intended to represent any particular geography. Please see page titled "Solar PV versus Gas Peaking and Wind versus CCGT—Global Markets" for regional sensitivities to selected technologies.

(1) Unless otherwise indicated herein, the low case represents a single-axis tracking system and the high case represents a fixed-tilt system.

(2) Represents the estimated implied midpoint of the LCOE of offshore wind, assuming a capital cost range of approximately $2,500 – $3,600/kW.

(3) The fuel cost assumption for Lazard's global, unsubsidized analysis for gas-fired generation resources is $3.45/MMBTU.

(4) Unless otherwise indicated, the analysis herein does not reflect decommissioning costs, ongoing maintenance-related capital expenditures or the potential economic impacts of federal loan guarantees or other subsidies.

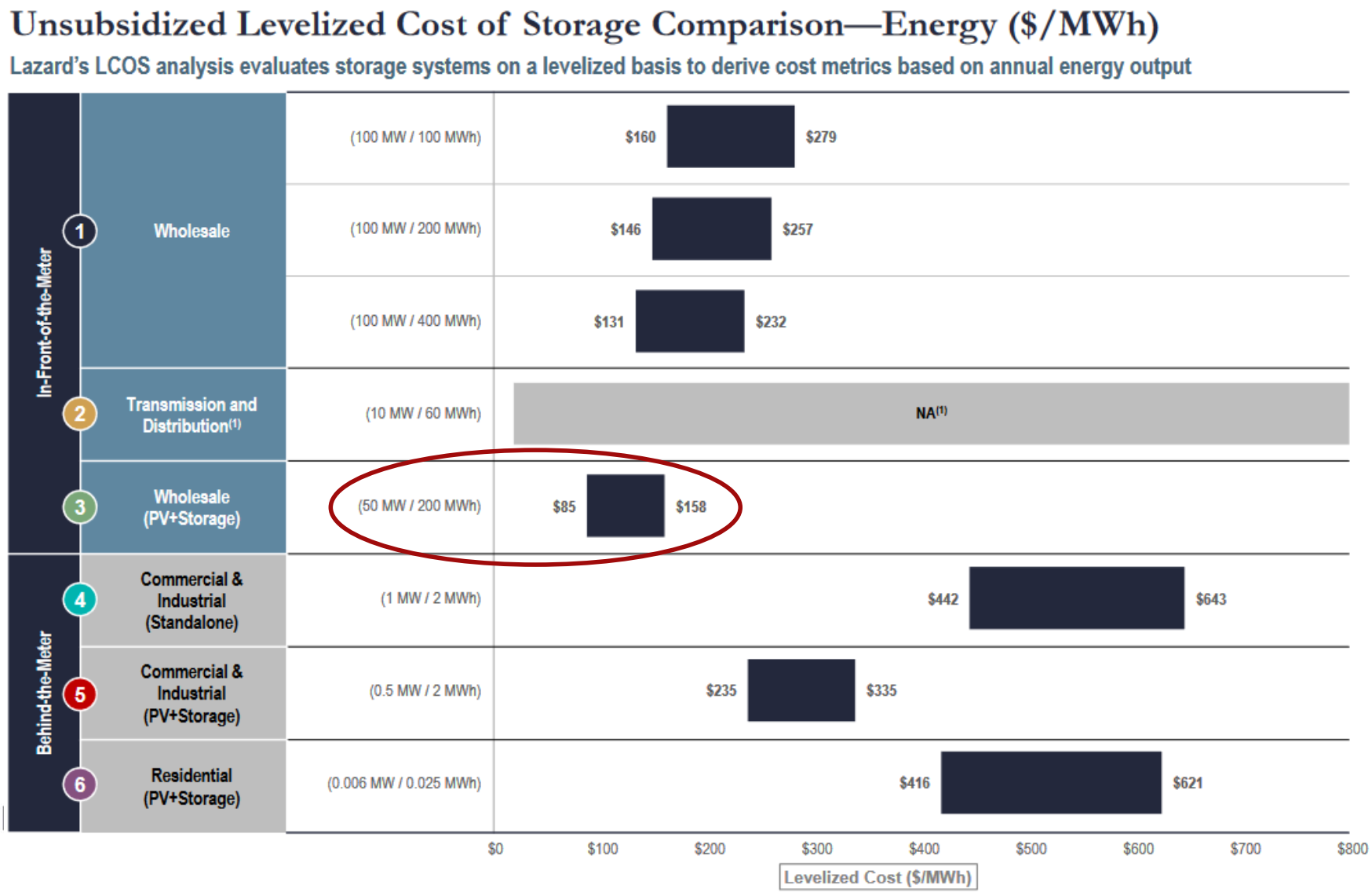
(5) Represents the midpoint of the marginal cost of operating fully depreciated gas combined cycle, coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned gas combined cycle or coal asset is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating gas combined cycle, coal and nuclear assets across the U.S. Capacity factors, fuel, variable and fixed operating expenses are based on upper- and lower-quartile estimates derived from Lazard's research. Please see page titled "Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation" for additional details.

(6) High end incorporates 90% carbon capture and storage. Does not include cost of transportation and storage.

(7) Represents the LCOE of the observed high case gas combined cycle inputs using a 20% blend of "Blue" hydrogen, (i.e., hydrogen produced from a steam-methane reformer, using natural gas as a feedstock, and sequestering the resulting CO_2 in a nearby saline aquifer). No plant modifications are assumed beyond a 2% adjustment to the plant's heat rate. The corresponding fuel cost is $5.20/MMBTU, assuming $1.39/kg for Blue hydrogen.

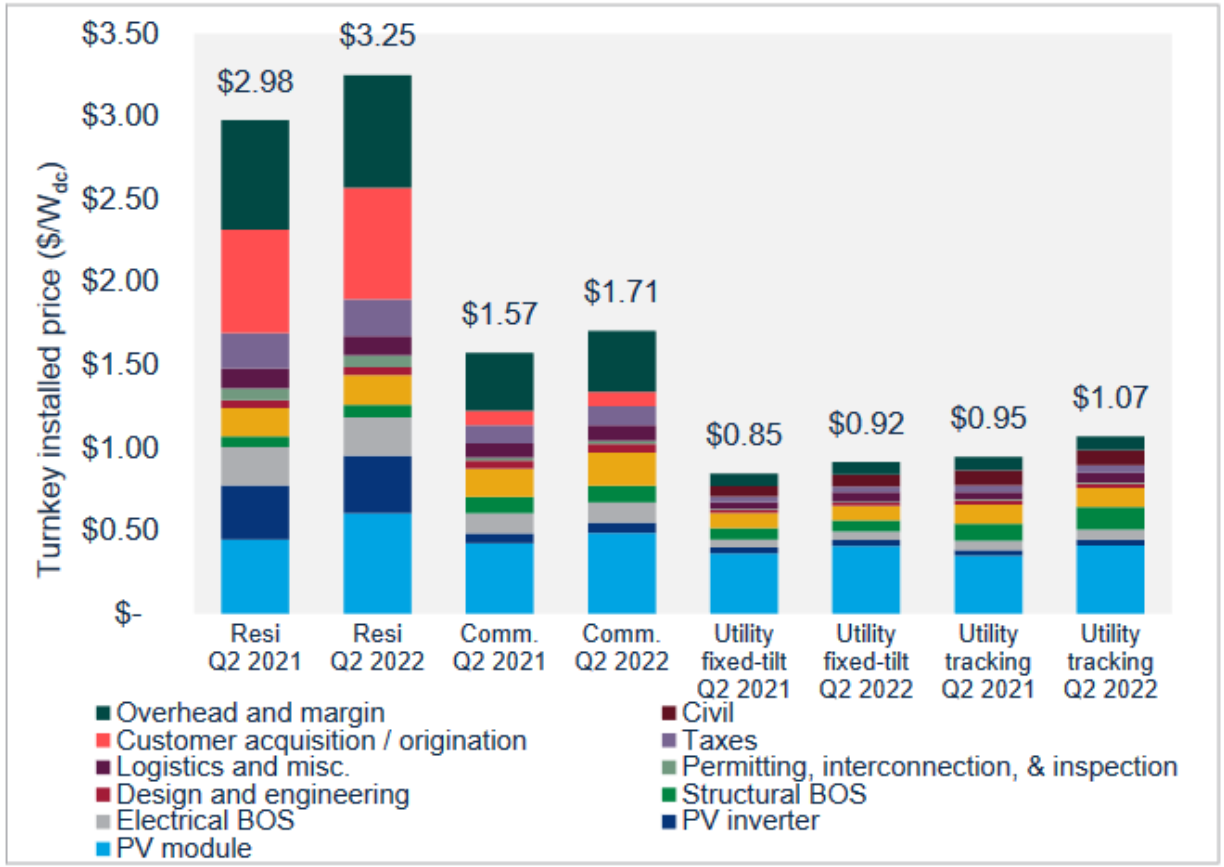
(8) Represents the LCOE of the observed high case gas combined cycle inputs using a 20% blend of "Green" hydrogen, (i.e., hydrogen produced from an electrolyzer powered by a mix of wind and solar generation and stored in a nearby salt cavern). No plant modifications are assumed beyond a 2% adjustment to the plant's heat rate. The corresponding fuel cost is $10.05/MMBTU, assuming $4.15/kg for Green hydrogen.

LCOE of Storage



Capital Costs of Solar

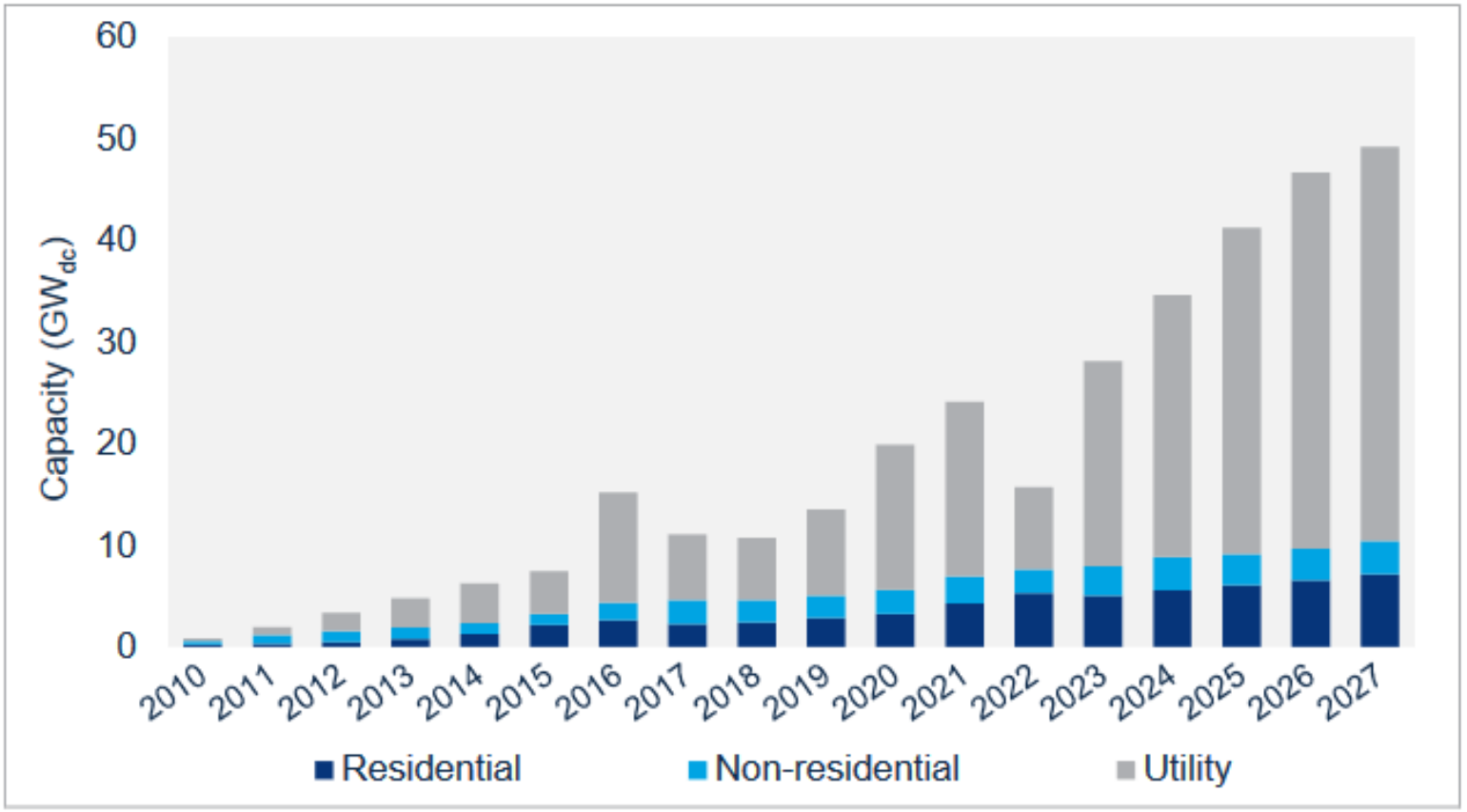
Modeled US national average system prices by market segment, Q2 2021 and Q2 2022



Source: Wood Mackenzie

US Solar Market

US PV installation historical data and forecast, 2010-2027



Source: Wood McKenzie, US Solar Market Insight

SOLAR ISSUES FOR LOUISIANA

How Much Farmland Could Solar Use?

2020 STATE AGRICULTURE OVERVIEW

Louisiana

† Survey Data from Quick Stats as of: Feb/09/2022

Farms Operations†

Farm Operations - Area Operated, Measured in Acres / Operation	292
Farm Operations - Number of Operations	27,400
Farm Operations - Acres Operated	8,000,000

Livestock Inventory †

Cattle, Cows, Beef - Inventory (First of Jan. 2021)	445,000
Cattle, Cows, Milk - Inventory (First of Jan. 2021)	10,000
Cattle, Incl Calves - Inventory (First of Jan. 2021)	775,000
Goats, Meat & Other - Inventory (First of Jan. 2021)	15,000
Hogs - Inventory (First of Dec. 2020)	6,000

Milk Production †

Milk - Production, Measured in Lb / Head	13,400
Milk - Production, Measured in $	24,924,000
Milk - Production, Measured in Lb	134,000,000

https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=LOUISIANA

7000 MW of projects in MISO Queue X 7 acres/MW = 49,000 acres
49,000 acres/8M acres of farmland = 0.6% of farmland (max)

Issues for Stakeholders

- Landowners
  - Supplement their income, allow to keep farming
  - Equity issues
  - Right to use their land how they want
  - Is the lease offered a good deal?
- Neighboring Landowners
  - May have legitimate concerns
- Tenant Farmers
  - Can't compete with solar lease prices
- Authorities Having Jurisdiction (Cities, Parishes)
  - Economic Development
    - Increased tax base, with consistent revenue stream
    - Require few services (fire, police, water)
  - Solar ordinances/permits that consider issues important to their constituents
  - Inspections
- Utilities
  - Interconnection issues
  - Grid stability
- Solar Developers
  - Must make a decent rate of return or they won't invest

Is Solar Safe?

- Yes, if Done Correctly
  - How will you know if it is being done right?
- Model Solar Ordinance (DNR/CPEX)
  - Must Comply with National Electric Code (NEC)
  - Stamped Drawings for Electrical, Civil, and Racking (structure)
  - All Equipment Listed by Nationally Recognized Testing Lab (i.e. UL)
  - Site Plan, Drainage Plan
  - Setbacks
  - Vegetative Barriers
  - Decommissioning Plan (DNR rulemaking)
  - Third-Party Inspection and Verification

Common Concerns

- Hurricanes
  - Rated for same ASCE design windspeed as other structures
    - 110 – 140 mph in Louisiana
- Hazardous Materials
  - No toxic materials leach from modules during use
  - No toxic materials used for cleaning or vegetation management
- Electromagnetic Fields (EMF's)
  - Similar to background EMF's in homes and power lines along roads
  - Will not interfere with pacemakers
- Decommissioning
  - Land CAN be restored for other uses, including farming
  - Modules can and should be recycled
    - Don't permit them to go to a landfill

Common Concerns

- Sound
  - Very quiet. At a distance of 10 ft, sound level is 48 dB to 72 dB
  - Same level of sound from a normal conversation
  - At the road you wouldn't be able to hear it at all
- Electric Shock and Arc Flash
  - Similar Hazard Level as an Electrical Substation
  - NEC Requires Fences and Signage to Prevent Access
- Fire Hazards
  - Most Equipment Non-Flammable
  - NEC has Requirements to Make Solar Farms Safe for Firefighters
- Property Values
  - In general, no reduction in nearby property values

Capacity Factors for Solar In Louisiana

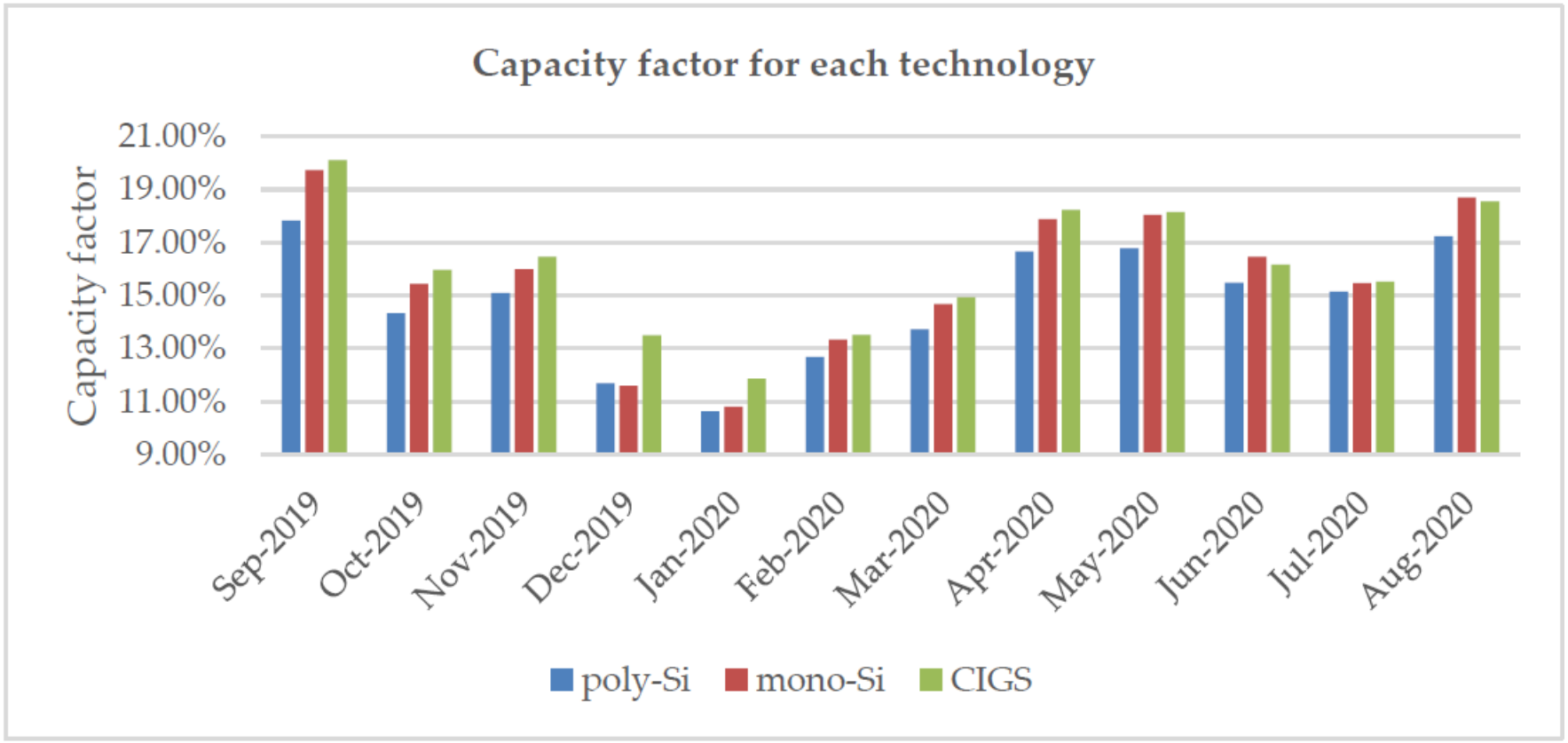


Figure 11. Capacity factor for each technology.

Capacity factors shown are for fixed-tilt. Higher for tracking.

ECONOMIC DEVELOPMENT

Opportunities for Louisiana in Clean Energy

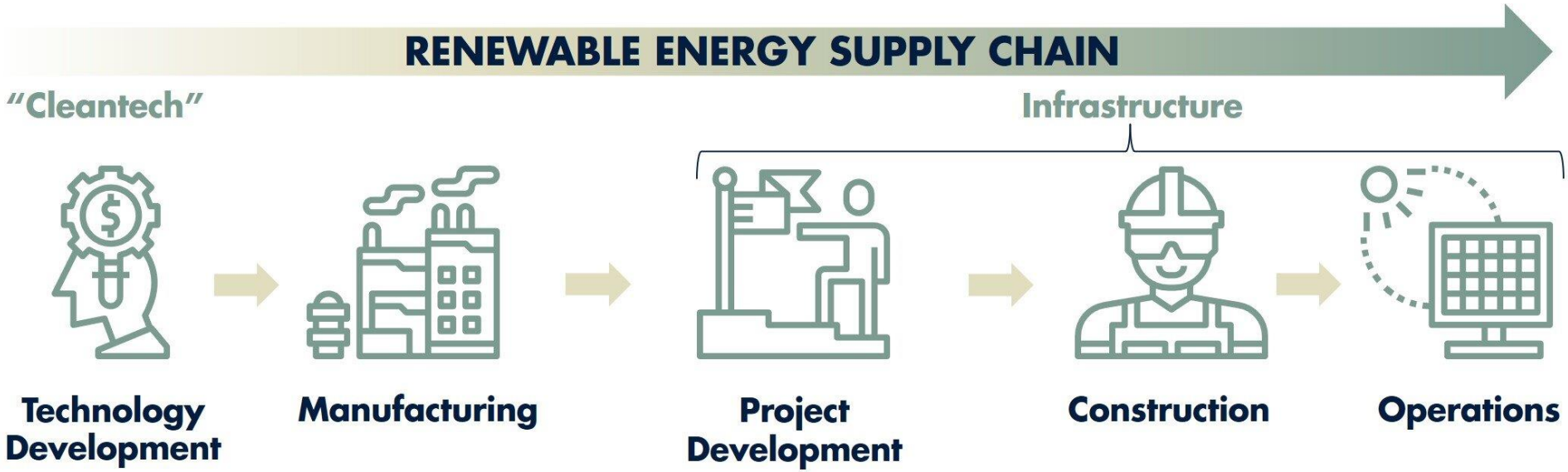
Oil and Gas

- Financing of traditional energy
- Project development
- Landman activities
- Off-shore oil and gas platforms
- Offshore service vessels
- Natural gas pipelines
- Enhanced oil recovery
- Refining fossil fuels
- Export of fossil fuels
- Manufacturing of tools and products to support oil and gas

Clean Energy

- Financing of clean energy
- Solar and wind developers
- Solar and wind leases
- Off-shore wind platforms
- Offshore service vessels
- CO2 pipelines
- CO2 sequestration
- Renewable fuels and chemicals
- Export of renewable energy
- Manufacturing of tools and products to support renewable energy

BUSINESS OPPORTUNITIES ACROSS SOLAR VALUE CHAIN



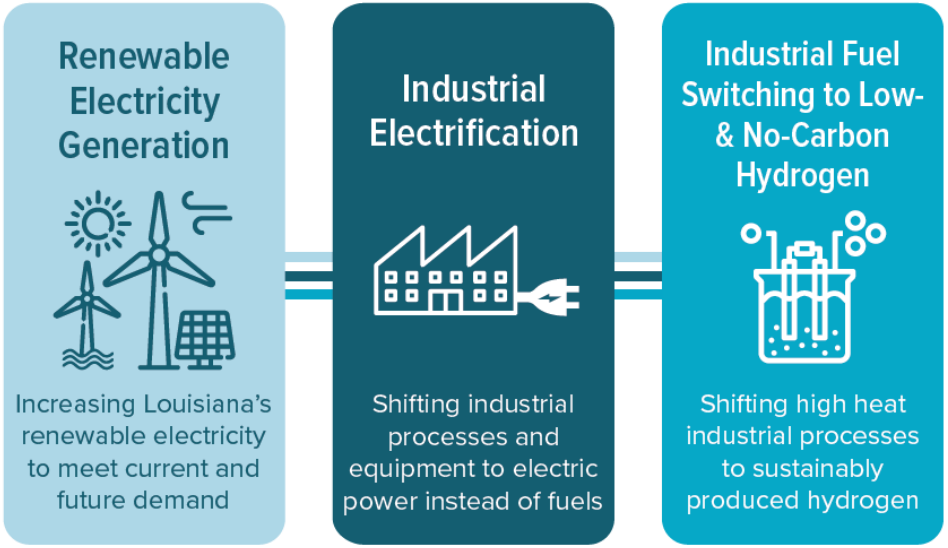
Economic Development

- Most large companies have sustainability goals and won't locate here without renewable energy

- Revenue for local governments
  - Recommend Requiring an Economic Impact Study
    - Dr. Greg Upton, LSU Energy Institute
  - Most materials sourced from out-of-state
  - Not much money in construction or O&M
  - Main impact will be through increased property taxes
    - Example: Nominal 50 MW Solar Farm
      - 350 Acres, average property taxes for state
      - 80% ITEP for 10 years
      - $50M initial investment
      - Property taxes $150K first year, declining to $80K in year 10
      - Tax revenue jumps to $350K in year 11, declining to $220K in year 20
      - $220K/year years 21 - 30

SUSTAINABILITY

Louisiana Climate Action Plan



LOUISIANA'S KEY CLIMATE POLICY PILLARS

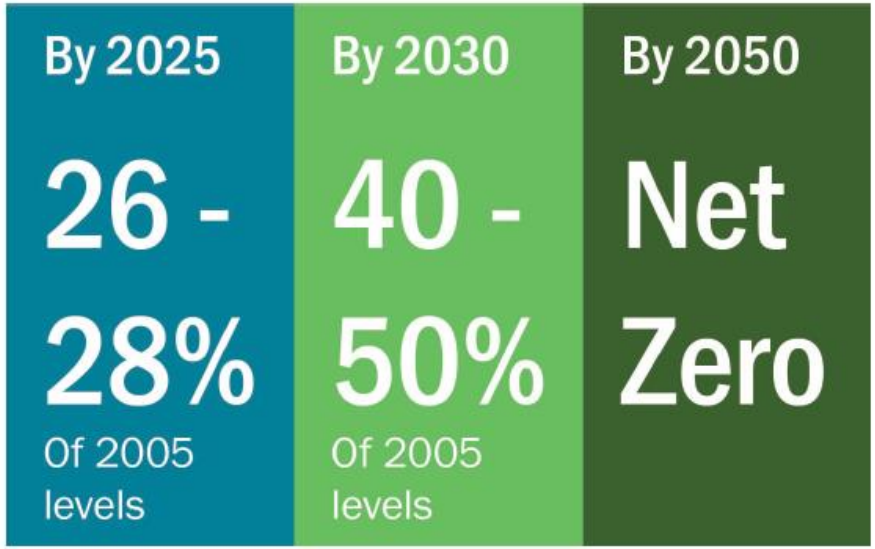


FIGURE 1. LOUISIANA'S GHG EMISSIONS REDUCTION GOALS.

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Thank you for attending today's presentation.