Selecting the right clean energy project sites can maximize IRA benefits

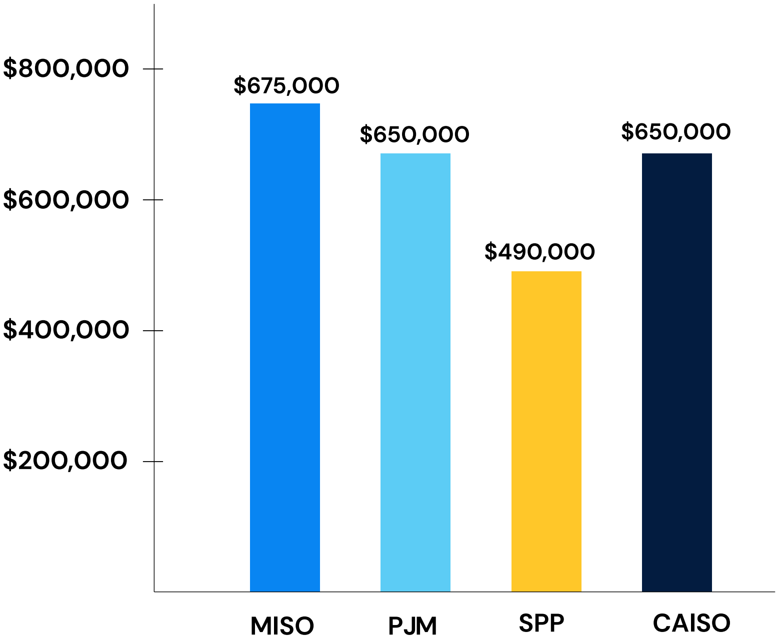
By Himali Parmar, Shankar Chandramowli, and Divya Boddu, ICF

The Inflation Reduction Act (IRA) is poised to transform the U.S. energy landscape. The law offers significant long-term tax incentives that will lower the cost of solar (20%-35%), wind (38%-49%), storage (52%-67% for green hydrogen) and other zero-emissions technologies.[1] Vast swaths of available land stretching across the country appear to be ideal locations for these new clean energy projects. However, only a fraction of that land is suitable for development. Siting power projects presents a host of challenges that could limit how much clean energy is brought to market and how fast the transition happens.

To ensure the IRA succeeds in bringing a massive amount of clean energy to the grid, major expansion and modernization of U.S. transmission infrastructure is necessary. Nearly 1.3 TW of clean energy projects have applied for grid interconnection, but many projects languish for years waiting for interconnection approval and others are canceled due to insurmountable transmission upgrade costs.

The stakes are high for clean energy developers. They need clarity around siting, the assurance that clean energy projects are being developed in locations that are feasible and maximize their return on investment. Transmission and distribution utilities also have a vested interest in helping developers site projects where they have the best chance to be fully realized, given ambitious state clean energy targets they must meet. Finally, federal and state policymakers want to reach clean energy goals and maximize the impact of IRA funds. They can be informed stakeholders who help developers with key project site decisions.

Figure 1: Estimated cost for a 100 MW solar project to enter interconnection queue across regions



(Does not include deposits for network upgrades)

---

[1] Clean Energy Economic Benefits in the New US Climate Law | ICF

[2] Major Energy Transition Underway | Energy Technology Area (lbl.gov)

The crucial role of siting in clean energy project development

Due to limitations on the current power grid, clean energy project developers face increasingly high barriers to interconnect and the potential for long delays. That means identifying sites with favorable development attributes—especially grid capacity—is a critical early step on the path to project completion.

When siting clean energy projects on undeveloped land, or greenfields, several critical factors impact the economics and feasibility of the project:

- Grid access and available capacity
- Economic viability
- Land use and resource availability
- Policies and incentives

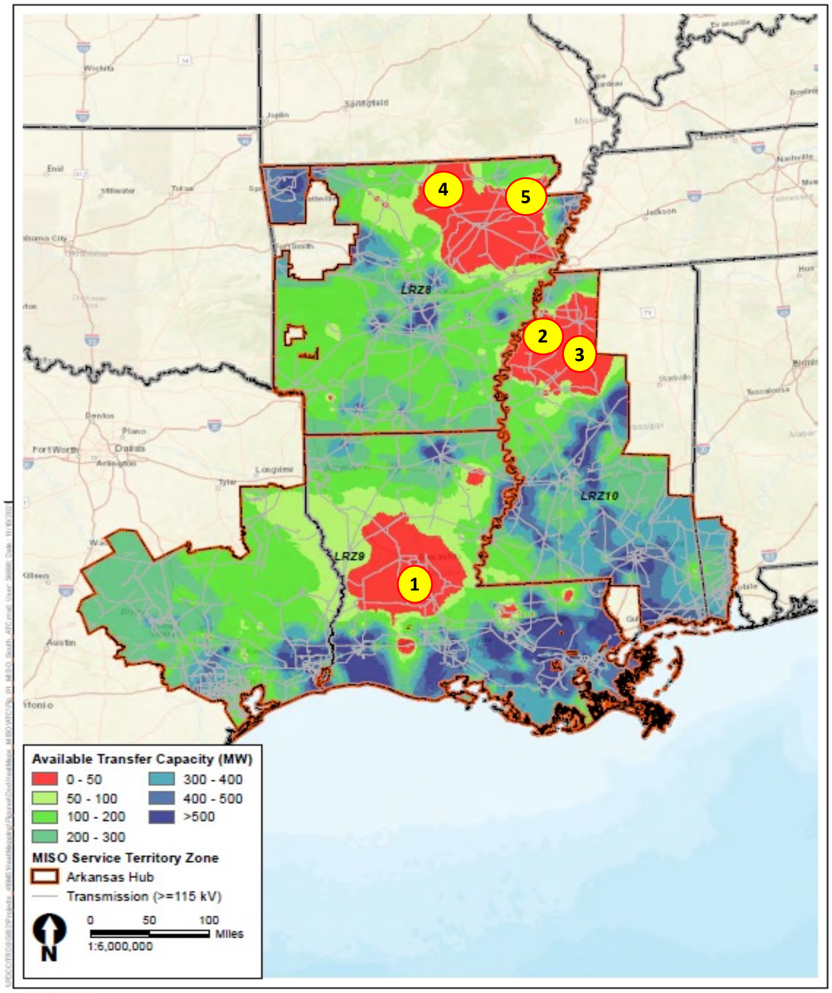
Performing due diligence around all these considerations simultaneously allows organizations to score and rank individual sites or substations. Developing a ranking framework positions clean energy developers, utilities, and other stakeholders to evaluate individual sites across the grid on an equal footing and come up with a list of sites with optimal attributes for development.

Grid access and available capacity

Available grid capacity helps determine how much generation can be added at a given site or point of interconnection on the grid. Given steep upfront costs to take queue positions and the potential for significant delays in processing time, access to this information is a crucial first step in the screening process.

In the MISO South region, for example, this grid capacity heat map visualizes transmission capacity available at each substation in the region. The map plots the available headroom on the grid for incremental injection for the year 2025 with around 7 gigawatt of firm buildout across MISO South (roughly 6.3% of total active queue in MISO South as of date). Red indicates almost no available capacity, green indicates moderate availability, and blue represents ample grid capacity. Grid capacity data can also provide deeper insights, such as showing the most restrictive constraints in low-capacity pockets and the number of points of interconnection impacted by the constraint, as seen here in Figure 2.

Figure 2: Heat map of available injection capacity in MISO South



Source: ICF EnergyInsite

Figure 3: Top recurring constraints in MISO South

Index Number	Limiting Constraint (Monitored/overloaded element)	Number of substations impacted
1	Ville Platte to Westfork 230kV	89
2	Batesville to Tallahatchie Valley Industrial Park 161kV	28
3	Batesville to East Batesville 161 kV line	21
4	Moorefield to Independence 161 kV line	20
5	Marked Tree to Harrisburg 161 kV line	19

It is also good practice to assess available grid capacity assuming applicable constraints are relieved. Having this information helps determine incremental capacity for adding new generation to a point of interconnection if certain network upgrades are implemented. This assessment helps developers size their projects and estimate interconnection upgrade costs.

Economic viability

Identifying grid nodes that frequently yield high wholesale market prices for electricity allows developers to pursue clean energy projects at sites that can generate more revenue.

A metric known as "nodal basis relative to hub" is key to assess locational pricing as well as congestion on the grid. Grid nodes with high prices relative to the relevant regional hub offer upside potential for merchant generators selling electricity to the market. Using the ERCOT region as an example, these economic viability heat maps show the nodal basis[3] and energy arbitrage[4] for all substations using actual 2020 and 2021 and future 2025 nodal pricing data.

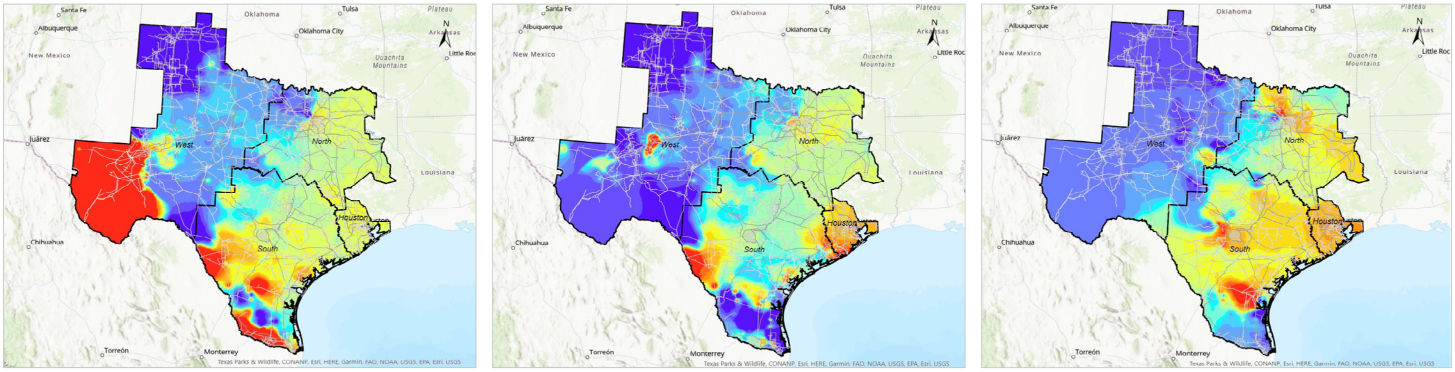
With new investment tax credits available for battery energy storage system (BESS) projects under the IRA, BESS deployments should accelerate across all markets. Battery storage developers have an opportunity to capitalize on market price arbitrage, given proper siting. Developers can buy energy when it's cheap, store it with BESS, and discharge it during peak energy usage at a higher price. Available data can be used to create a battery dispatch optimization model that highlights opportunities for price arbitrage at each node. The optimization model used for the ERCOT case (Figure 4) captures the price volatility at each node based on hourly real-time price projections, then determines the potential storage unit's charging and discharging profile and plausible revenue.

---

[3] Nodal basis is the difference between power price at a given node and a reference zone/hub ($/MWh). In Figure 4, the basis($/MWh) is calculated relative to ERCOT's North trading hub.

[4] Arbitrage potential refers to average revenue potential ($/kw-yr) that a battery resource can earn by optimizing its dispatch to charge during off-peak/low priced hours and discharge during peak/high priced hours. Figure 4 reports the average energy potential ($/kw-yr) for a unit capacity assuming historic and projected price strips.

Figure 4: Heat map of node–hub basis and energy arbitrage potential in ERCOT



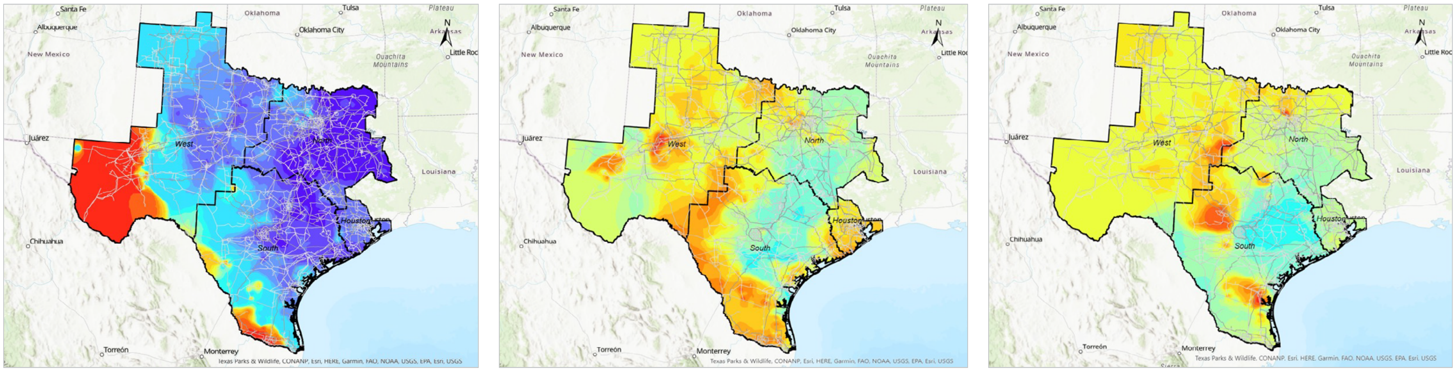
Historical Basis - 2020 **Historical Basis - 2021** **Projected Basis - 2025**

Legend

Historical (2020 & 2021) and Projected (2025) Basis ($/MWh)

🟪 < -5 🟪 -5 – -4 🟦 -4 – -3 🟦 -3 – -2 🟦 -2 – -1.5 🟦 -1.5 – -1 🟩 -1 – -0.5

🟩 -0.5 – -0 🟩 0 – 0.5 🟨 0.5 – 1 🟨 1 – 1.5 🟨 5 – 2 🟧 1.5 – 3 🟧 3 – 4 🟧 4 – 5 🟥 >5



Historical energy arbitrage - 2020 **Historical energy arbitrage - 2021** **Historical energy arbitrage - 2021**

Legend

Historical (2020 & 2021) and Projected (2025) Energy Arbitrage ($/kW-yr)

🟪 < 38 🟪 38.1 – 40 🟦 40.1 – 42 🟦 42.1 – 44 🟦 44.1 – 46 🟦 46.1 – 56 🟦 56.1 – 60

🟩 60.1 – 62 🟩 62.1 - 63 🟩 63.1 - 64 🟨 64.1 - 66 🟨 66.1 - 68 🟨 68.1 - 70 🟧 70.1 - 75

🟧 75.1 - 80 🟧 80.1 - 90 🟥 90.1 - 110 🟥 > 110

Source: ICF EnergyInsite

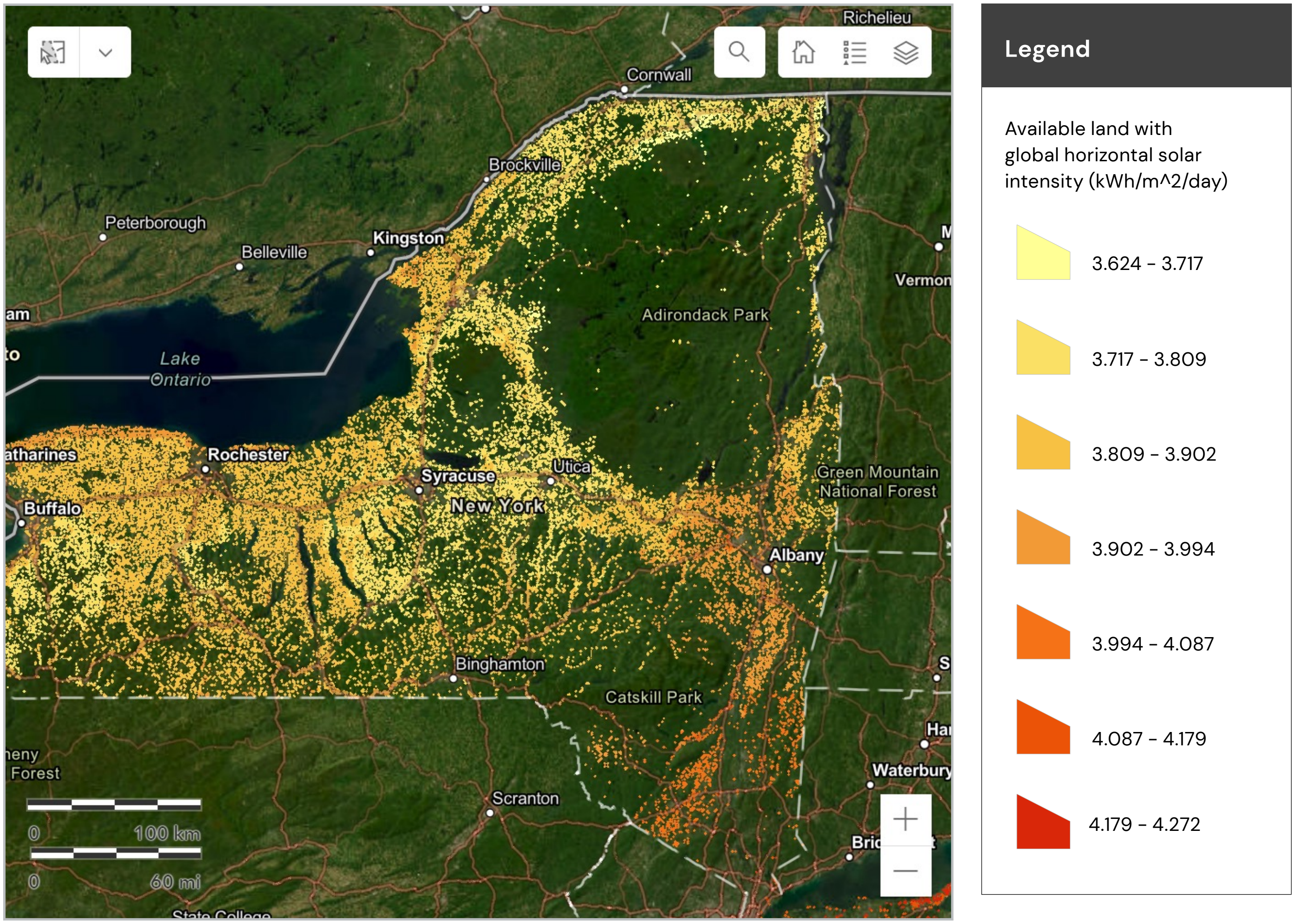
Land use and resource availability

Screening potential sites for geographic constraints is critical for many clean energy projects.

Siting decisions need to weigh the relative ease of developing on private lands versus public lands with national conservation easements or other limitations. Environmental screening can flag issues with endangered species habitats. And there are many other variables to screen including proximity to the grid, special management areas, land ownership, water crossings, and culturally sensitive areas. Terrain screening is also crucial and helps identify potential issues with land gradients. For example, utility scale solar projects are typically not sited in terrain with more than 5° gradient.

Figure 5 shows the available land in New York for potential utility-scale solar development categorized by global horizontal solar irradiance potential (measured in kilowatt-hour of solar energy available per square meter per day). The shaded part of the map shows the overall land availability for potential solar projects that is not encumbered by any land-use or terrain restrictions. Generally, higher irradiance potential translates to a higher capacity factor for solar plants (i.e., areas in downstate New York are more favorable for solar project development from a purely resource potential perspective). Conversely, land availability is not a key issue for siting BESS projects since land requirements are minimal.

Figure 5: land availability map for utility-scale solar in New York



Source: ICF EnergyInsite

Policies and incentives

Project economics are also driven by policy considerations and financial incentives like renewable portfolio standards, clean energy targets, and the IRA's energy communities bonus adder.

The IRA offers an additional 10% tax credit for clean energy projects developed in energy communities. The IRA provides specific guidance defining energy communities, and public data sources make it possible to map these communities for consideration with siting decisions. We have highlighted the impact of energy community bonus adders on project siting in Louisiana as an example in Figure 6. Energy communities are plotted based on publicly available employment and coal asset data. Around 80%—or 400 total—potential points of interconnection would qualify as "energy communities" under the bonus adder.

Figure 6: IRA energy communities in Louisiana

Source: ICF EnergyInsite

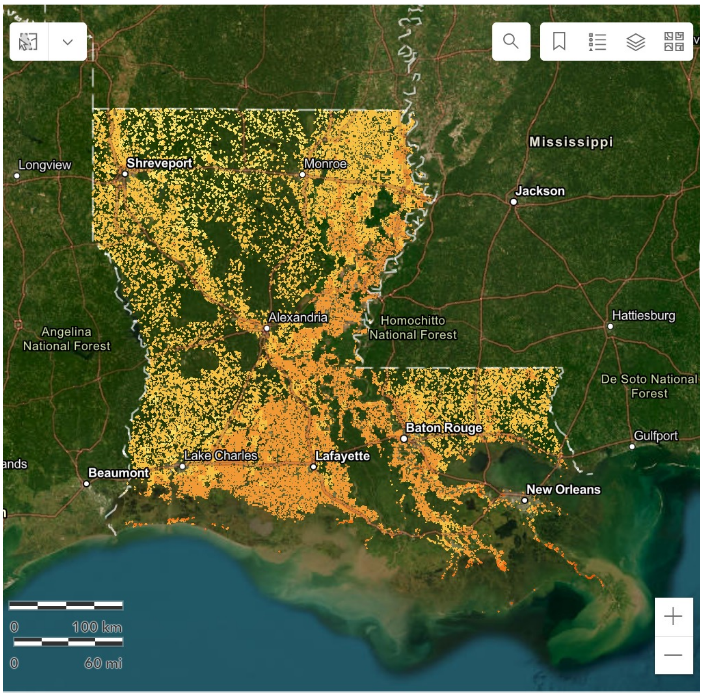
Bringing it all together to make optimal siting decisions

While development considerations vary based on the technology type, an ideal site for any kind of clean energy project should offer strong nodal pricing and positive nodal basis with respect to the liquid hubs in the market, no or limited network upgrade scope and costs, strong resource potential, and land available for development.

The four maps shown in Figure 7 illustrate the various metrics considered for ranking points of interconnection for utility-scale solar development in Louisiana. Map 1 visualizes land availability and resource potential for solar, graded in orange. Map 2 illustrates the available capacity for adding new generation (i.e., injection capacity) throughout the region. Map 3 is a heatmap of projected nodal basis. Map 4 shows the energy communities eligible for the IRA bonus along with the final ranked substations considering all these metrics. Together, Map 4 shows the ideal location for siting clean energy projects.

Figure 7: Siting variables in Louisiana

Map 1: Available lands with global horizontal solar intensity

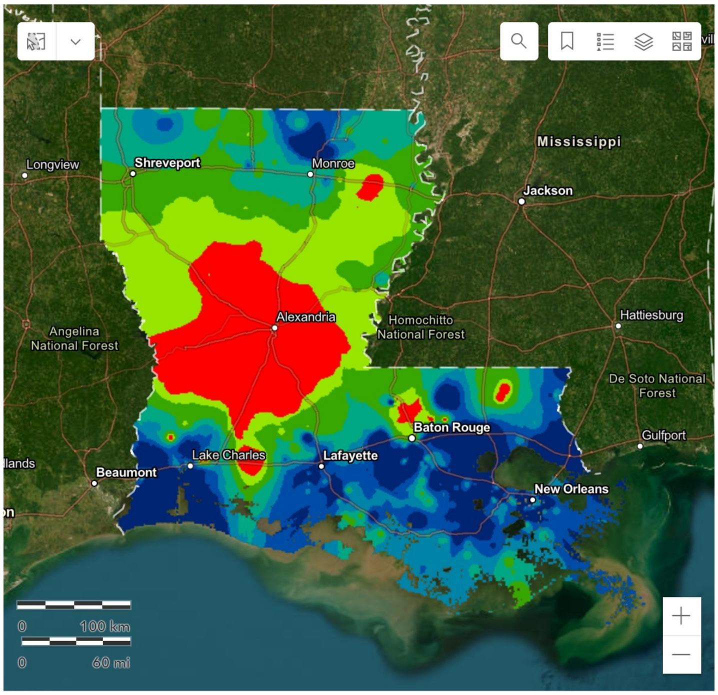


Legend

Available land with global horizontal solar intensity

- 🟨 4.553 - 4.666
- 🟨 4.666 - 4.779
- 🟧 4.779 - 4.892
- 🟧 4.892 - 5.005
- 🟧 5.005 - 5.118
- 🟧 5.118 - 5.232

Map 2: Available injection capacity



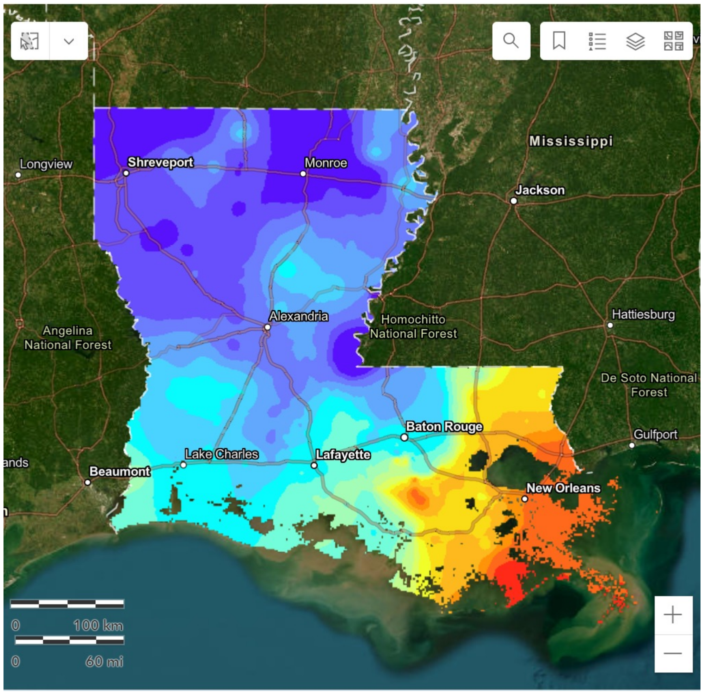
Legend

Heatmap

Available injection capacity (MW)

- 🟥 1 - 50
- 🟩 51 - 100
- 🟩 101 - 200
- 🟩 201 - 300
- 🟦 301 - 400
- 🟦 401 - 500
- 🟦 401 - 500
- 🟦 501 - 999

Map 3: Pricing (projected basis for 2025)



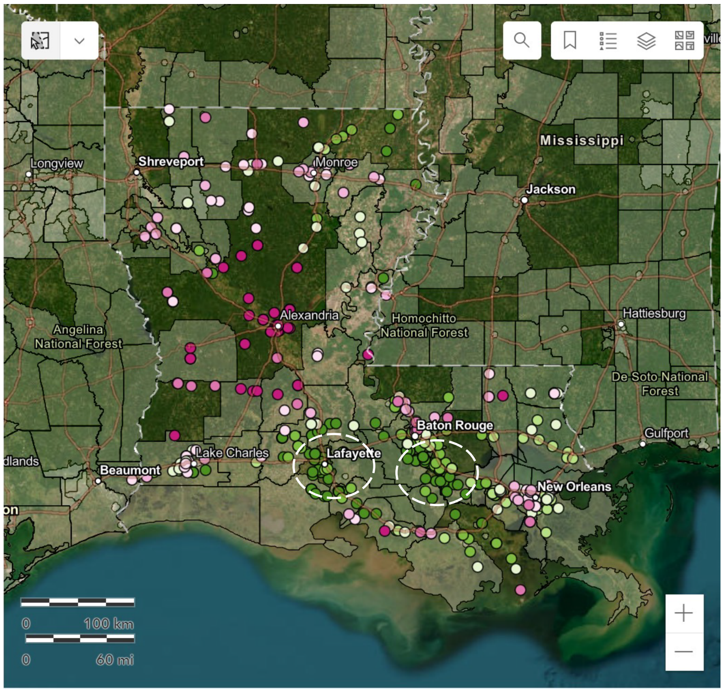
Legend

Future basis heatmap

Future Basis w.r.t. MISO AR Hub All Hour ($/MWh)

- 🟪 < 0.2
- 🟪 0.2 - 0.4
- 🟦 0.4 - 0.6
- 🟦 0.6 - 0.8
- 🟦 0.8 - 1
- 🟦 1 - 1.2
- 🟩 1.2 - 1.4
- 🟩 1.4 - 1.6
- 🟩 1.6 - 1.8
- 🟨 1.8 - 2
- 🟨 2 - 2.2
- 🟨 2.2 - 2.4
- 🟧 2.4 - 2.6
- 🟥 2.6+

Map 4: Ranking of substations and energy community bonus



Legend

Point of interest ranking

Final ranking

- ● 1400 - 1600
- ● 1200 - 1400
- ● 1000 - 1200
- ○ 800 - 1000
- ○ 600 - 800
- ● 400 - 600
- ● 200 - 400
- ● 1 - 200

Energy community with bonus 2022

- 🟩 IRA energy communities
- 🟩 Non-IRA energy communities

Note that load centers in southern Louisiana have high injection capacity potential. Available land is limited close to the load pocket in New Orleans, though there are some sites (shown in dotted circles) with good grid capacity, resource potential, land availability and favorable market pricing. The data also make apparent that development opportunities are limited in central Louisiana due to the lack of available injection capacity (note the red shades on the injection capacity heat map) and limited land availability (note the lack of orange shading on the land availability and resource potential map).

Considering multiple siting variables simultaneously can help developers maximize the benefits of clean energy development while avoiding many risks.

Conclusion

Thanks to the tax incentives created through the IRA, the prospects are promising for a wave of large-scale deployment of clean energy. However, only a fraction of that land is ripe for development. Suboptimal siting challenges can result in higher costs, development delays, and lower revenue generating potential.

Developers, utilities, state and federal government offices, and all other stakeholders of clean energy development can leverage data and technology to make siting decision that are feasible and deliver the greatest return on investment.

Ultimately, simplifying siting considerations could have a profound impact on the speed and scale of the clean energy transition across the country.

About the authors

Himali Parmar

Vice President, Energy Advisory Services, Interconnection and Transmission

Himali.Parmar@icf.com

Himali Parmar joined ICF in 2002 and is a vice president in the Energy Advisory practice. Himali assists clients with greenfield renewable siting and interconnection, production cost modeling, and forecasting transmission congestion and losses and their effect on locational power prices and asset valuation. She also supports clients as an expert witness on interconnection and transmission issues.

Shankar Chandramowli

Senior Manager, Energy and Power Markets

Shankar.Chandramowli@icf.com

Shankar Chandramowli joined ICF in 2015 and is a senior manager in the Energy Advisory practice. He has over 10 years of experience in energy market consulting, with deep expertise in energy policy research, transmission due diligence assessments, economic analysis of energy systems, and public stakeholder engagement. He has supported due diligence assessment of over 45 GW of renewable assets in the last two years across major markets in the U.S.

Divya Boddu

Senior Energy Markets Consultant

Divya.Boddu@icf.com

Divya Boddu joined ICF in 2018 and is a senior energy markets consultant in the Energy Advisory practice. Divya has a wide range of energy markets consulting experience and advises clients on transmission planning, generation interconnection studies, renewable asset due-diligence, offtake agreements, energy regulations, transmission congestion, energy market strategy, and renewable siting. She has experience in both regulated and de-regulated markets in the U.S.

Himali Parmar
Himali.Parmar@icf.com
+1.703.934.3497

Shankar Chandramowli
Shankar.Chandramowli@icf.com
+1.703.251.0874

Divya Boddu
Divya.Boddu@icf.com
+1.703.251.0868

icf.com/energy

twitter.com/ICF
linkedin.com/company/icf-international
facebook.com/ThisIsICF
#thisisicf

About ICF

ICF is a global consulting services company, but we are not your typical consultants. We help clients navigate change and better prepare for the future.

Our experts have been embedded in every corner of the energy industry for over 40 years, working at the intersection of policy and practice. We work with the top global utilities, plus all major federal agencies and relevant energy NGOs, to devise effective strategies, implement efficient programs, and build strong relationships with their customers. From creating roadmaps to meet net zero carbon goals to advising on regulatory compliance, we provide deep industry expertise, advanced data modeling, and innovative technology solutions, so the right decisions can be made when the stakes are high.