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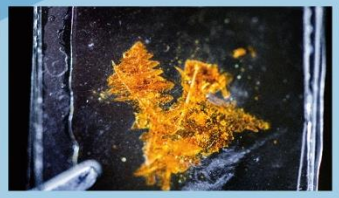
NATIONAL RENEWABLE ENERGY LABORATORY




# The Renewable Energy Zones Transmission Planning Process

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# Agenda and learning objectives

1. ***What is the Renewable Energy Zones (REZ) Transmission Planning process?***
   - Understand how the REZ process is different from traditional transmission planning
   - Understand the value of the REZ process to a power system

2. ***Steps for Implementing the REZ process***
   - Understand the real-world process for moving from planning to construction

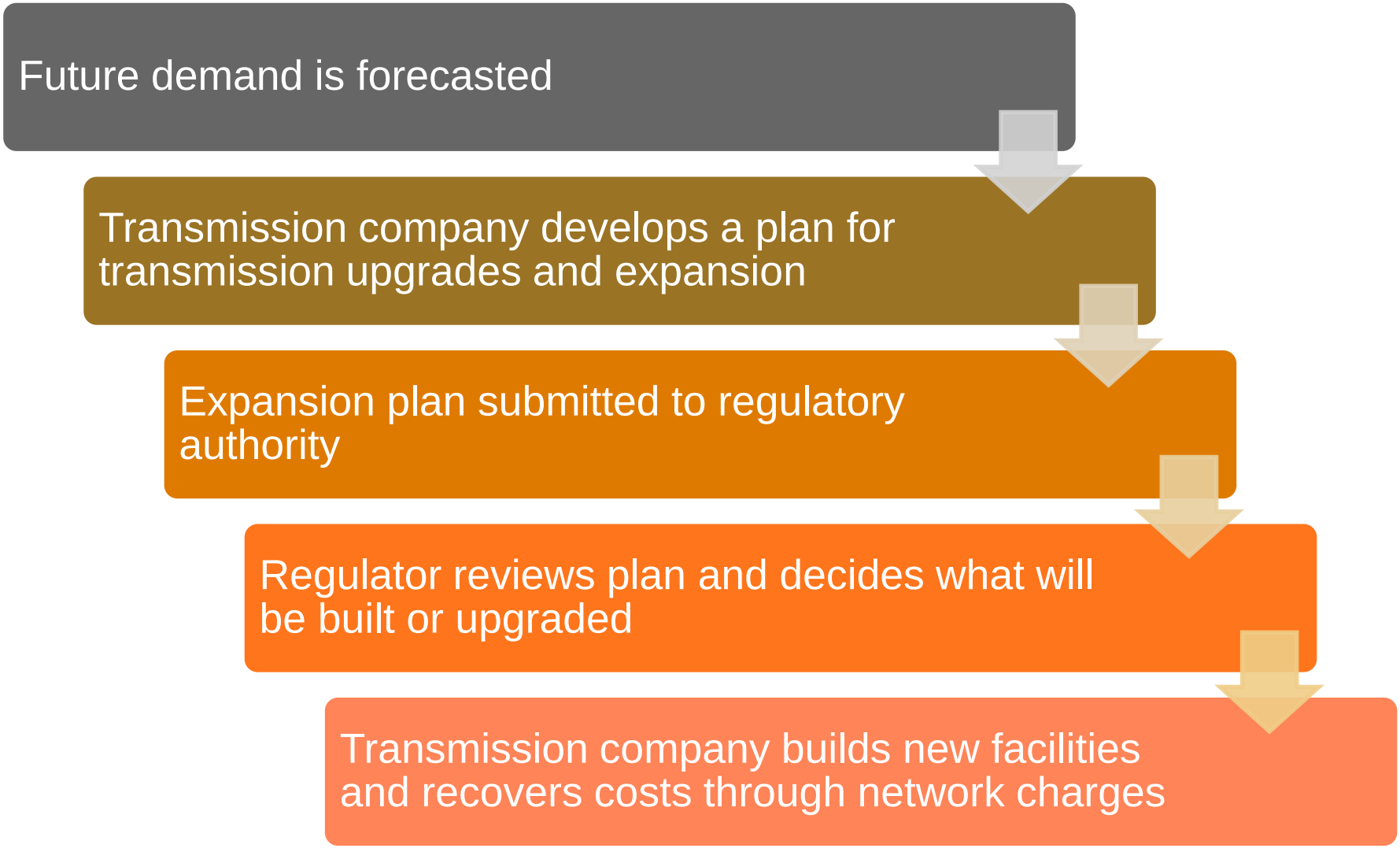
3. ***Case Study: Texas Competitive Renewable Energy Zones (CREZ)***
   - Identify key lessons learned from successful REZ process implementation

4. ***Renewable Energy Data Explorer***
   - Tool that that can inform the REZ process

5. ***Questions and Discussion***

# 1. WHAT IS THE RENEWABLE ENERGY ZONES (REZ) TRANSMISSION PLANNING PROCESS?

# Example of a traditional approach: Cost-based transmission expansion

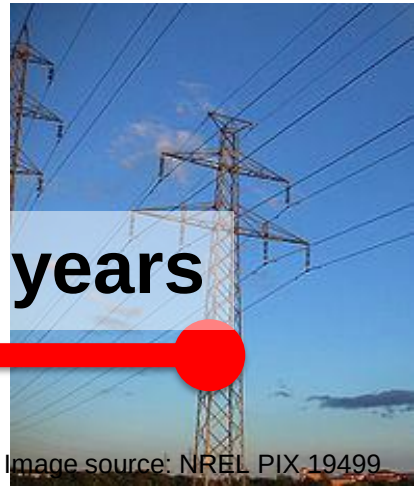


# Traditional approach: Implications for wind and solar

**Timescale misalignment**

**2-3 years**

**5-10 years**



**10-20 years**

Image source: NREL PIX 19499

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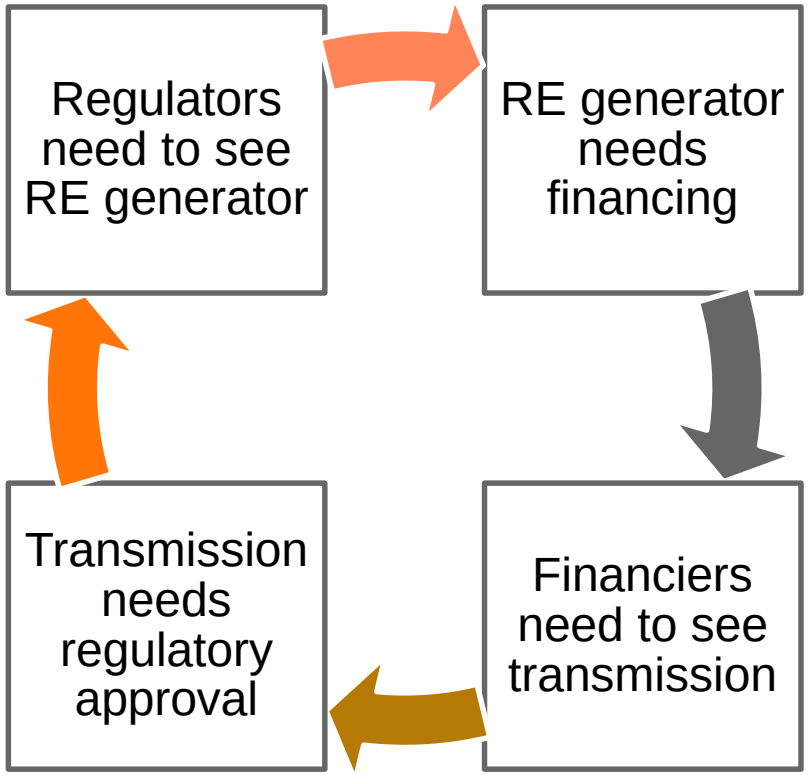
**Approximate Planning and construction time [years]**

# Traditional approach: Implications for wind and solar




**Circular Dilemma**

**Undesired Outcomes:**

1) RE projects are sited in sub-optimal locations (best resources are not exploited)
2) Transmission congestion (and curtailment of existing RE resources) occurs due to over-development in some areas

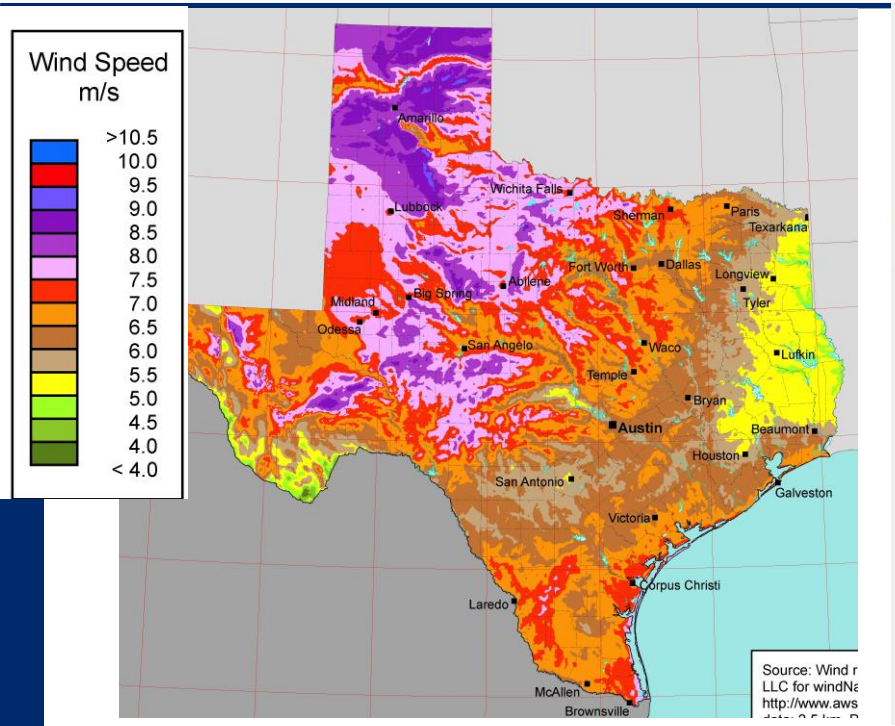
# A different approach: Transmission planning to enable clean energy

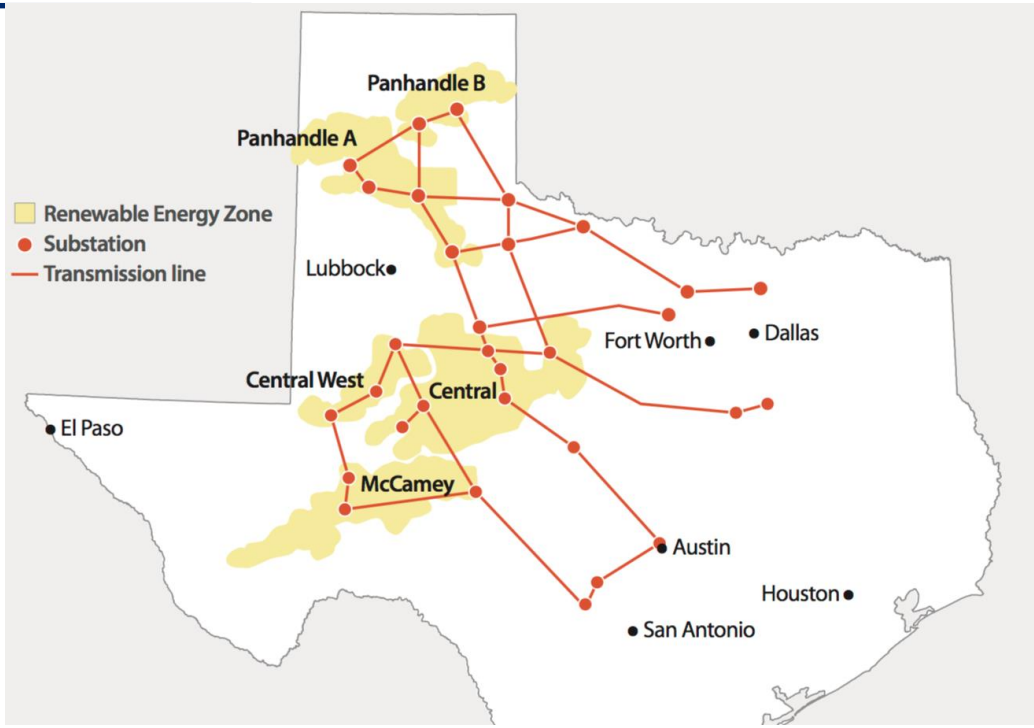
***RE development follows transmission*—so, why not direct transmission development and upgrades to the best RE resources (high capacity factor) areas?**

- High capacity factors mean high utilization of transmission assets.
- RE projects with high capacity factors have lower cost per MWh.
- Most MWh for the amount of capital invested, for both generation and transmission.

Image source: NREL PIX 19499

# The Renewable Energy Zone (REZ) process



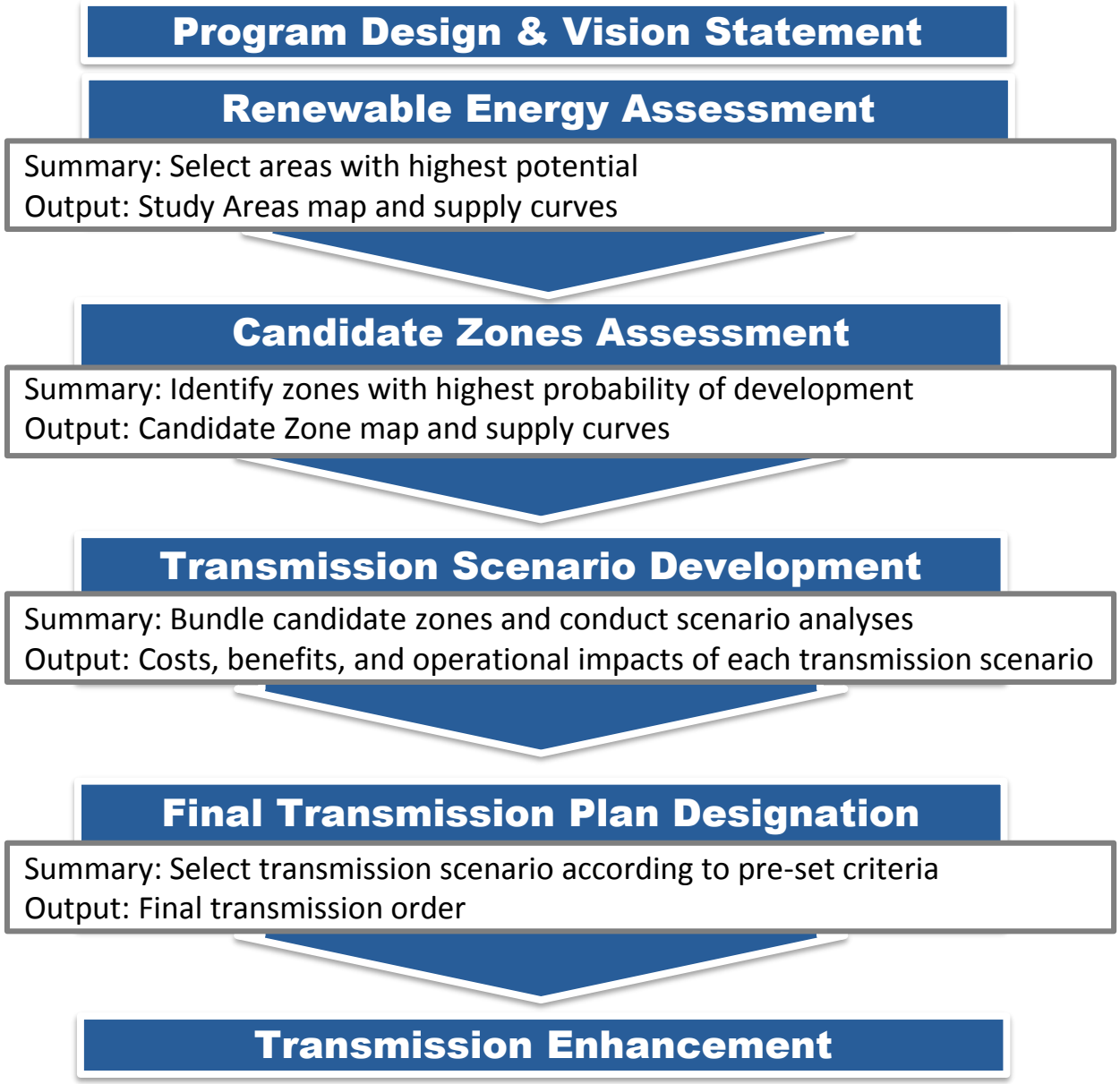

**A *renewable energy zone* (REZ) is a geographic area characterized by high-quality, abundant RE resources, suitable topography, and strong developer interest.**

**The *REZ transmission planning process* customizes transmission planning and approval for renewables.**

Source: Hurlbut, D., Chernyakhovskiy, I., Cochran, J. (2016). Renewable Energy Zones: Delivering Clean Power to Meet Demand. NREL/FS-6A20-65988.

# 2. STEPS FOR IMPLEMENTING THE REZ PROCESS

# REZ process steps



# Step 1: Program design and vision statement

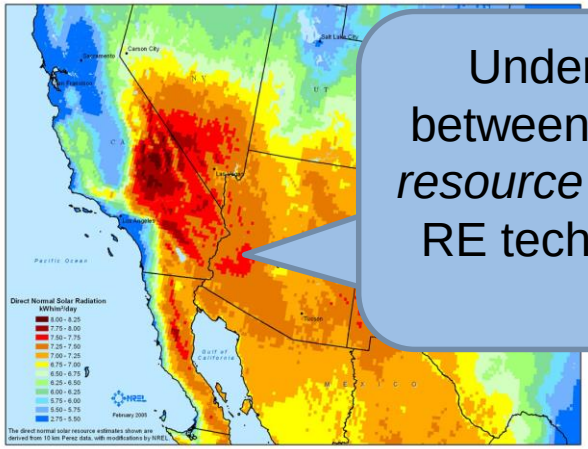
## Who will lead the REZ process?

- What entities are authorized to conduct transmission planning and development?
- Are there regulatory or institutional barriers?

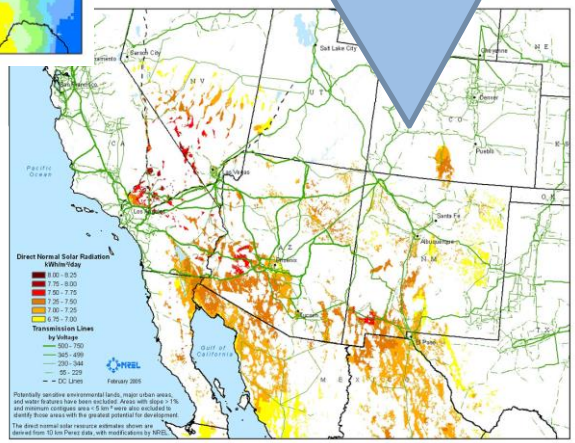
## Is REZ applicable?

- Are there well-concentrated RE resources?
- Is there demand for RE development?
- Are RE projects bankable? Do incentives align with REZ development goals?

# Step 2: Renewable energy assessment

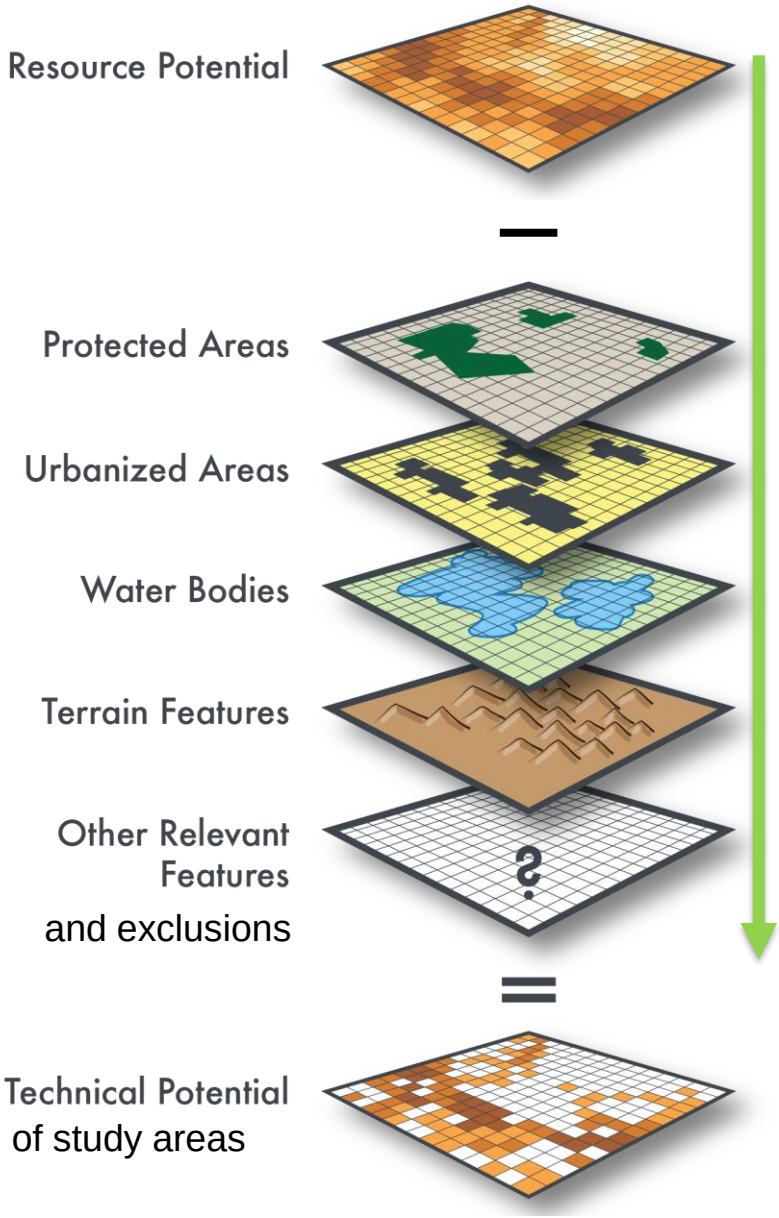



Understand the difference between locations with *high RE resource* and locations where an RE technology *actually can* be implemented




Source: NREL

Resources for concentrating solar power (CSP) for the Southwestern United States



# Step 3: Candidate zones assessment

- **Input:** Renewable energy screening to clearly identify areas for consideration

- **Output:** Prioritize areas based on highest developer interest
  - Demonstrations of Commitment: existing/pending projects, lease agreements, letters of credit, etc.
  - Areas with low commercial interest are dropped from consideration

- **Final Results:**
  - Designate areas for REZ
  - Generate stakeholder buy-in and commercial interest

# Step 4: Transmission scenario development

**Main analytical questions:**

- What is the best transmission plan for interconnecting the zones?
- Network plan or high-voltage trunk lines?
- What additional actions are needed to maintain reliability (e.g., ancillary services, contingency studies)?

**Ultimate objective:** identify “no regrets” options for transmission expansion that are robust across several scenarios, e.g.,

- Accelerated carbon reduction
- High/low natural gas prices
- Accelerated distributed generation and demand response

# Steps 5 - 6: Designate zones, approve transmission plan and enhance transmission system

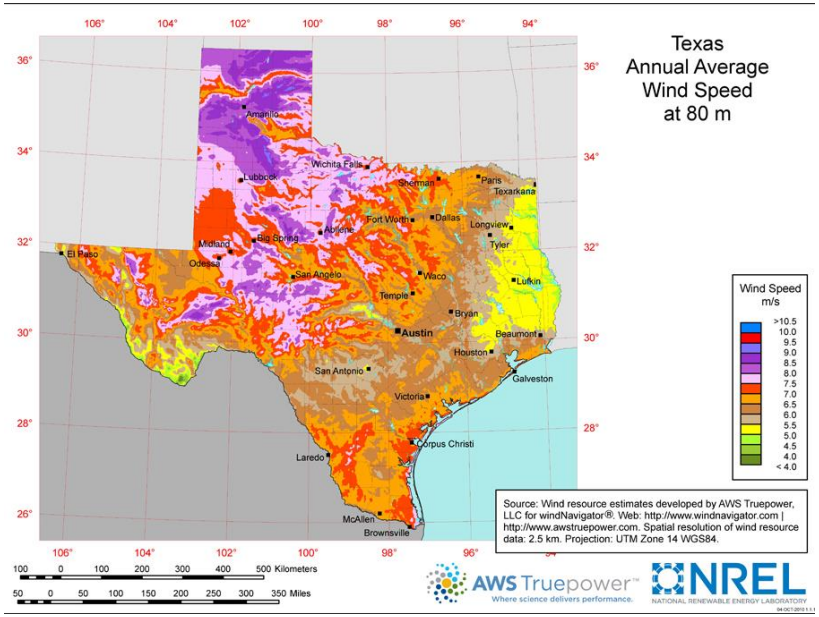
**Assuming each step is sufficiently completed:**

- ✓ Zones are the best and most developable areas, with demonstrated commercial interest
- ✓ Grid impacts are modeled and reasonably known
- ✓ Regulators have information necessary to select and approve a transmission plan
- ✓ Cost recovery authorized, construction begins
- ✓ Renewable energy is delivered at the lowest possible cost

# 3. CASE STUDY: TEXAS CREZ

# Context: Restructuring of the Texas power market

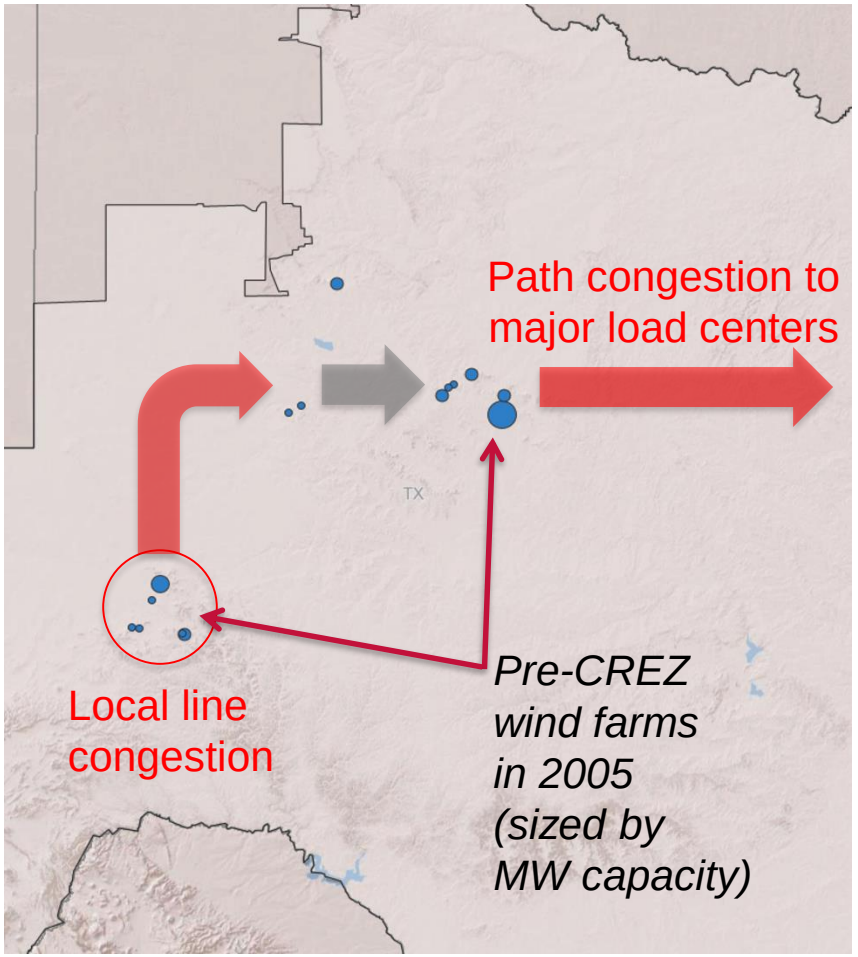
- Wholesale power market had been reformed and restructured, with market opening in 2001
- Transmission ownership separated from generation ownership
  - Transmission owners were financially indifferent to which generators used their systems.
- Transmission remained regulated
  - State decided cost recovery based on whether new lines were needed
  - All transmission costs socialized across all load
- **Open access transmission**




(Wind resource estimates developed by AWS Truepower, LLC for windNavigator)

# Wind responded — But too much

- First wave of wind power development was in West Texas
  - **760 MW** of installed wind power by 2002
  - Only **400 MW** of total transmission capability
- Operator-ordered curtailments degraded wind's effective annual capacity factor
  - Limited financial attractiveness for further wind development




(GtG 2015)

# Texas CREZ philosophy: Harnessing the power of competition

**Transmission plan directs developer interest to the largest geographic concentrations of high-quality wind resources with low investment risks**

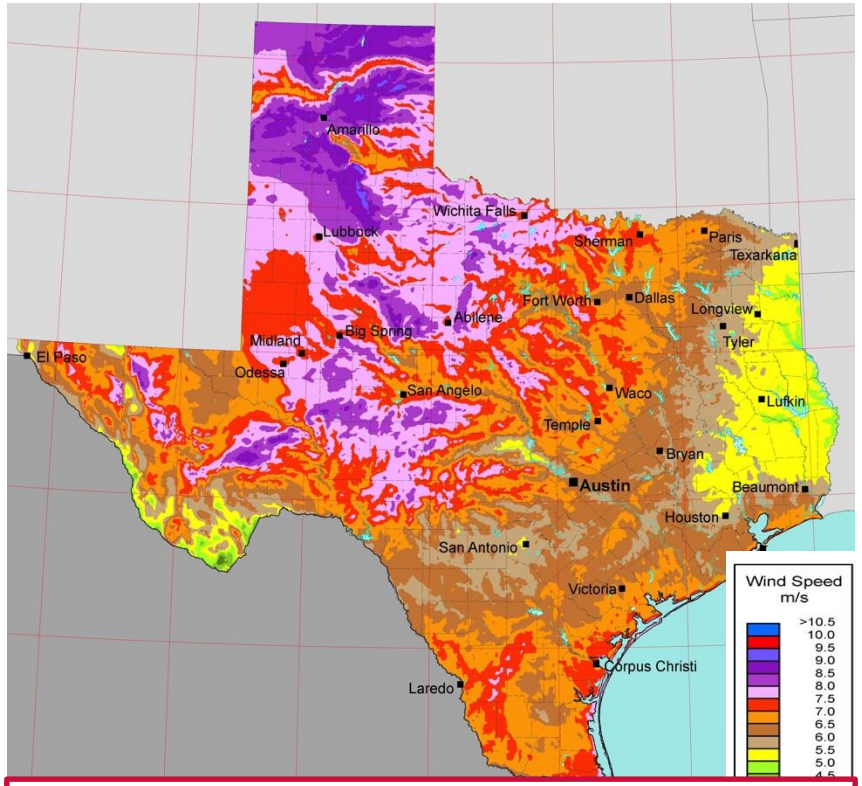
**The raw potential of the wind resource exceeds the capacity of the new line**

**Competitive market decides who actually builds wind projects**

*How does a system get to a transmission plan that drives competitive RE development?*

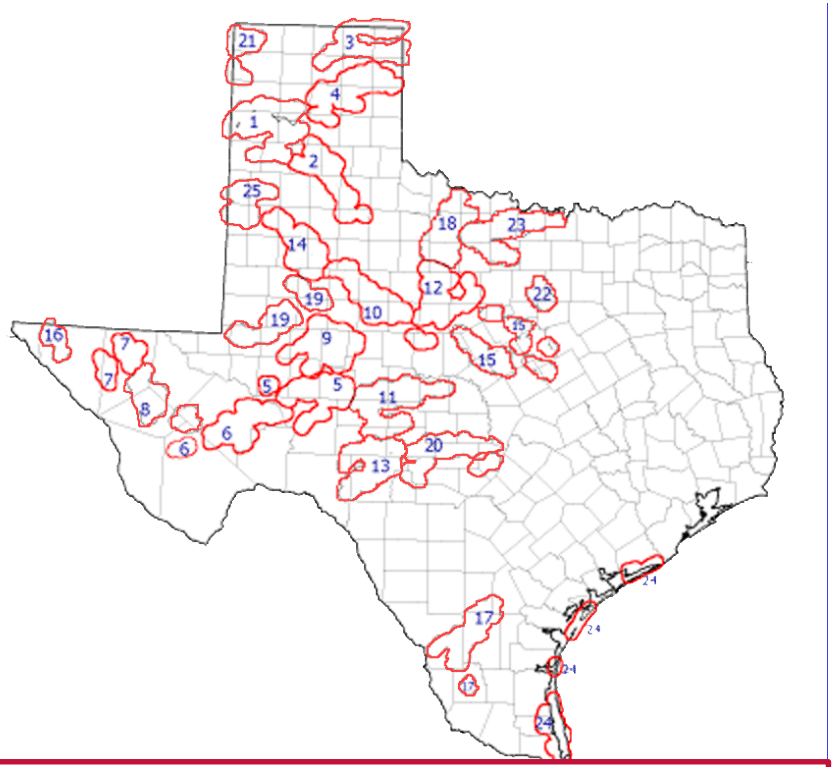
# Transmission planning with CREZ

**Texas wind resource**




First step: identify zones with a high concentration of high quality, easily developed RE potential.

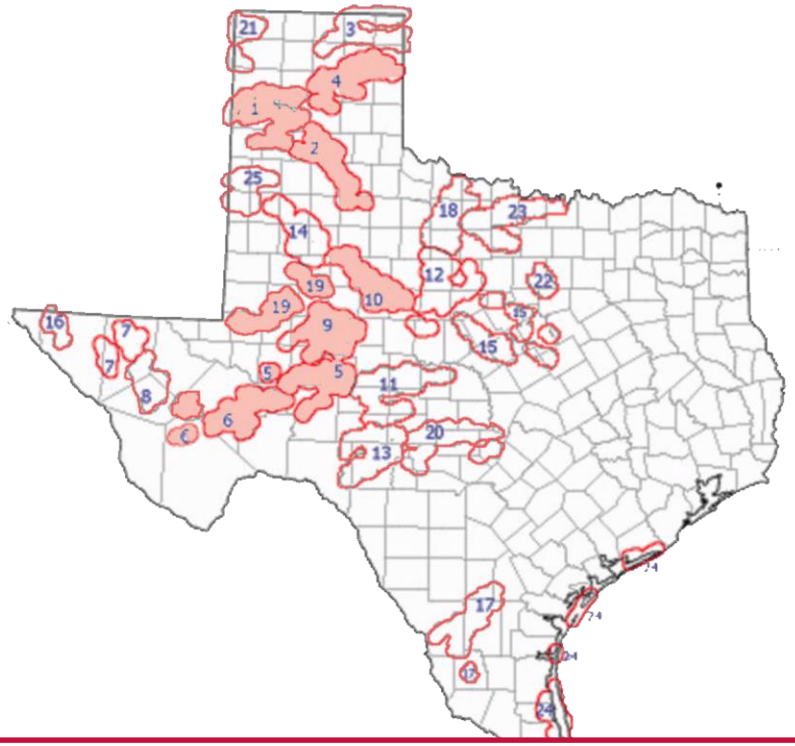
**Study zones designated by system operator based on RE screening**



Areas with 4,000 MW of potential each, screened to identify 25 with the highest productive potential.

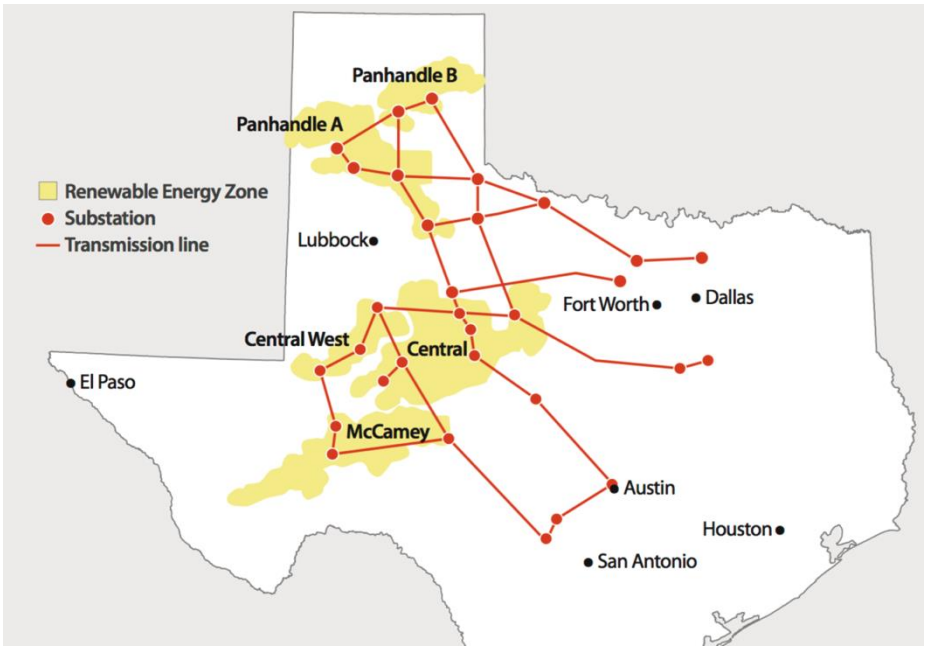
# Transmission planning with CREZ

**Zones designated by regulators as REZs based on developer input**




Wind developers demonstrated financial interest only in certain zones.

**The transmission system was expanded to access these zones**



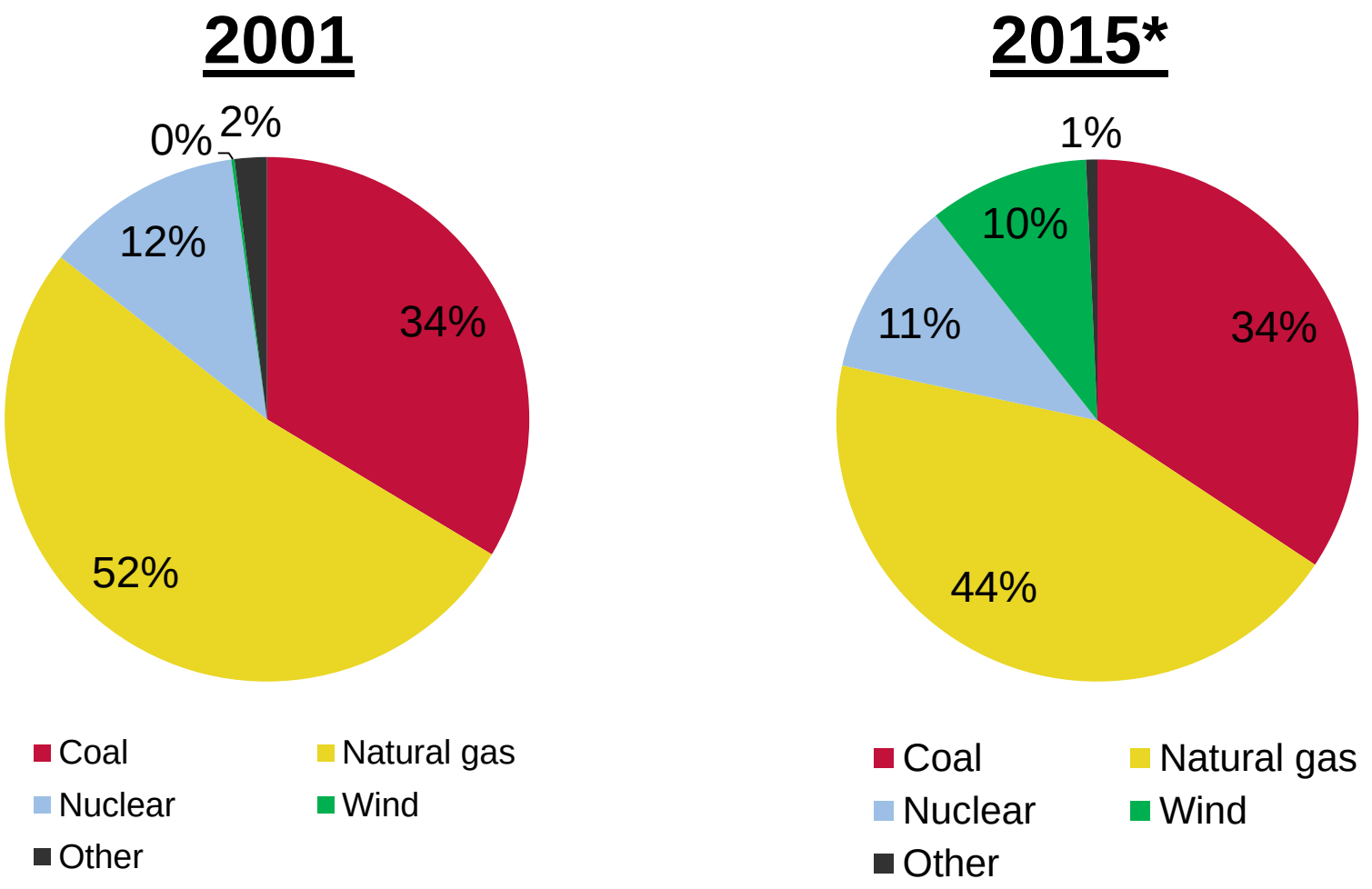

2,400 line miles
$7 billion (costs rolled into rate base)
>18 GW wind interconnected

# Did it work?: Improved capacity factors as a result of CREZ

| | Zone | Year sampled | Average capacity factor |
|---|---|---|---|
| **Old turbines** ***(on line 2001-2002)*** | **McCamey** | **2003** | **26%** |
| | | **2014** | **30%** |
| ***Conclusion: Older wind turbines performed better because of reduced transmission congestion and less curtailment*** | | | |
| **New turbines** ***(on line 2007-2013)*** | **McCamey** | **2014** | **35%** |
| | **Panhandle** | | **45%** |
| ***Conclusion: New transmission opened up more productive wind areas*** | | | |

Source: Hurlbut, D. and Getman, D. (2015). "Greening the Grid: Implementing Renewable Energy Zones for Integrated Transmission and Generation Planning." Webinar, December 1, 2015. http://greeningthegrid.org/trainings-1/webinars/gtg-implementing-renewable-energy-zones-integrated-transmission-generation-planning.

# Did it work?: Wind share of generation in Texas




**12 months ending August 2015*

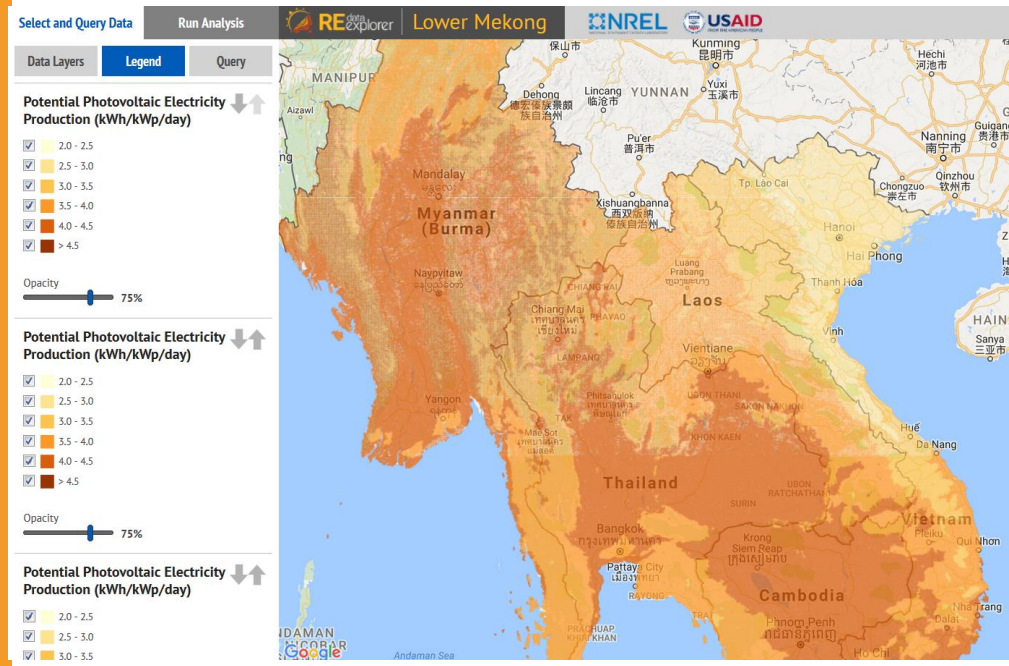
# Applicability of CREZ model elsewhere

- **Development follows transmission**
  - Intent of CREZ was to geographically direct new development to where cost per MWh would be lowest
- **Authority to order new transmission construction comes before zone designation**
  - When analysis begins, question is “where” not “whether”
  - Analysis without authority is advisory
- **REZ focus is on renewable technologies that are already competitive**

# 4. RENEWABLE ENERGY DATA EXPLORER

# What is the RE Data Explorer (RED-E)?

- No-cost, web-based tool for energy resource exploration and decision-making
- Platform for exploring energy resource and other base and infrastructure data visually, and with targeted quantitative geospatial analysis functionality
- Tool that wraps complex spatial analysis techniques in an easy-to-use interface targeted at non-specialists
- Platform for distributing publicly available GIS data (many layers are downloadable)




**Online at http://re-explorer.org**

REexplorer | REdataexplorer

# THANK YOU!

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**www. greeningthegrid.org**