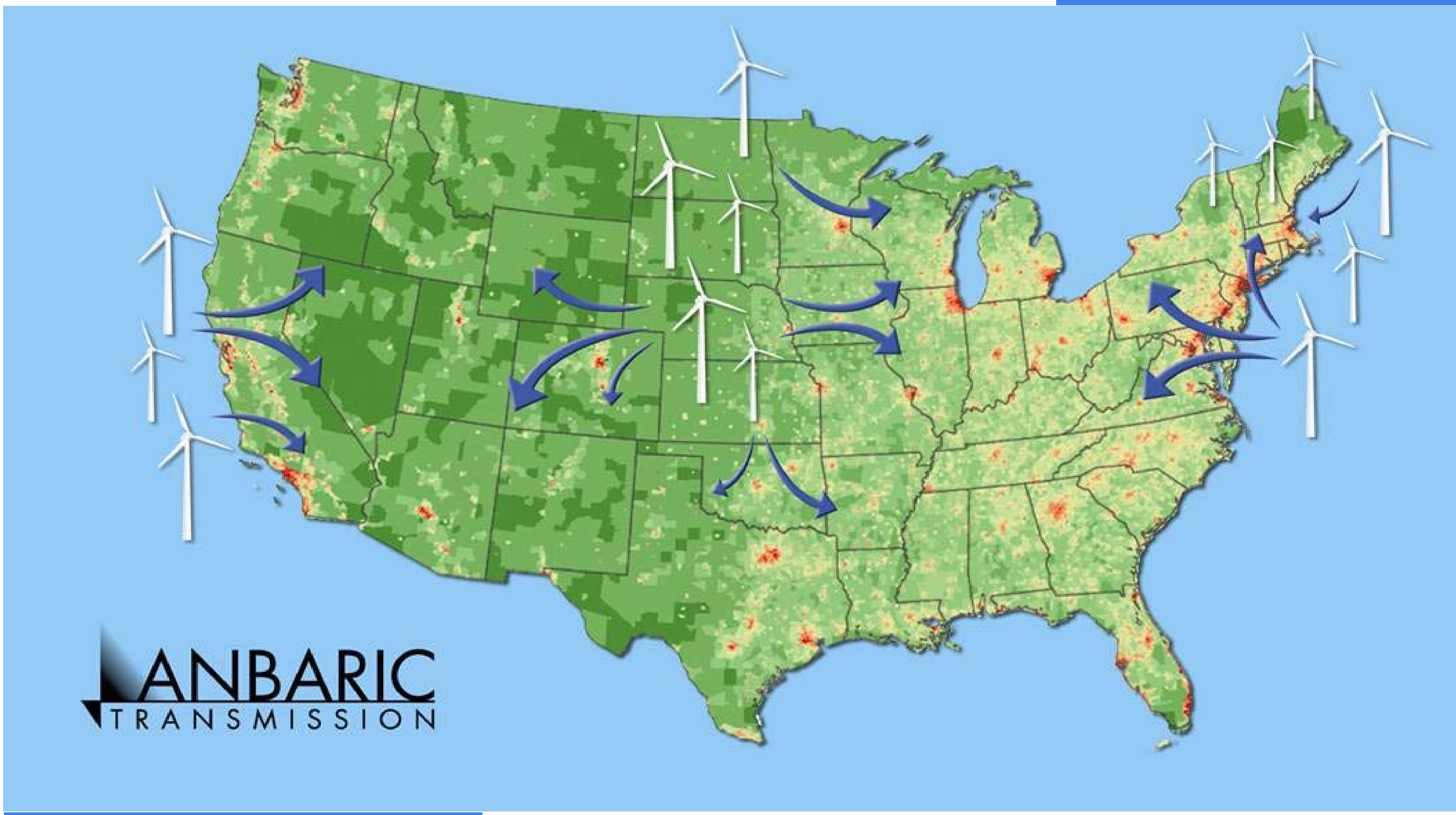
# INTEGRATING 200,000 MWs of RENEWABLE ENERGY INTO THE US POWER GRID:

## A Practical Proposal




ANBARIC TRANSMISSION

By Edward N. Krapels
February 2009

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## Executive Summary

With the inauguration of Barack Obama, the federal government will likely follow the states in one important area of environmental regulation: imposing both national Renewable Portfolio Standards (RPS) and Greenhouse Gas Initiatives (GGIs) on electricity generation. Many state governments have already enacted reasonably clear and ambitious environmental regulations to reduce the enormous carbon emissions of our electricity industry.[1] These proposals reflect a heartfelt commitment to buy more and more electricity from renewable and low-carbon sources. We don't yet know what the new Administration and the Congress have in mind for the nation as a whole, but, building on the efforts of the states, numbers like 25 percent RPS by 2025 are in the air. These are ambitious goals, but they are doable and would certainly make a huge contribution towards the fight against global warming.

Achieving these goals will require changes in how business is done in the electric power sector. At the enormous scale they will be needed, Renewable resources are not typically available in close proximity to populated areas. Therefore, over the next twenty years, in spite of the resistance to new infrastructure development, the United States will need to make an intensive effort to expand its currently underdeveloped electricity transmission system. That system was shaped, one hundred years ago, by local needs. Fifty years ago, regional needs began to be taken into account. In the next 20 years, national environmental needs will have to take priority.

Fortunately, environmentally desirable energy resources also ameliorate energy security concerns. Increasing the generation of electricity via Renewable sources will simultaneously decrease the emissions our country produces and our dependence on imported sources of energy, creating a wholesome congruence between sound environmental and energy security policies.

This White Paper – revised and expanded from the Paper we published in April 2008 -- advocates the development of Renewable Energy and of the interstate and offshore extra-high voltage (EHV) transmission systems that will be needed to meet the nation's renewable and energy security challenges.[2] A wholesome debate is now emerging about the best way achieve our Renewable Portfolio Standards. Do we need a "national coast-to-coast Electric Superhighway" that installs an extra-high voltage system on top of the existing grid? Or are regional solutions better?

A national RPS requirement mandating that between 20 and 25 percent of national electric consumption come from Renewables will create a massive new source of demand for Renewable generation that has not yet been constructed. Because national electricity generation capacity is almost 1,000,000 MWs, the emerging Renewables mandate would amount to the need for at least 200,000 MWs of wind, solar, and biomass facilities. This mandate would require the investment of hundreds of billions of dollars in generating facilities, as well as a substantial investment – perhaps an additional several hundred billion dollars – in the transmission systems needed to take the renewable energy to market. This mandate presents an unprecedented challenge to the American power industry, the scope of which is only beginning to be understood.[3]

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[1] For a review of state policies, see DSIRE: http://www.dsireusa.org

[2] In these pages, we will refer to extra-high voltage (EHV) AC transmission systems of 500 and 765kV, and to high voltage direct current systems (HVDC) of up to 800kV.

[3] Very little has been written on the scope of this challenge. For an excellent review published in late 2008, see Susan Tierney, "A 21st Century 'Interstate Electric Highway System' – Connecting Consumers and Domestic Clean

One thing, however, is clear: while the goal may be national in scope, the structure and governance of the power industry in the United States falls along regional lines, strongly suggesting efforts to meet the environmental goals should be regional. We should not waste time, effort or capital forcing square pegs into round holes. New nuclear plants will not be built in New England, huge wind farms will not emerge in the South (where there is not enough wind), and new coal plants will not appear in California. American states have such a diversity of interests, political appetites, and resources that federal electricity policy should continue its long-standing practice of articulating broad policy objectives and letting states and regions determine how to achieve them.

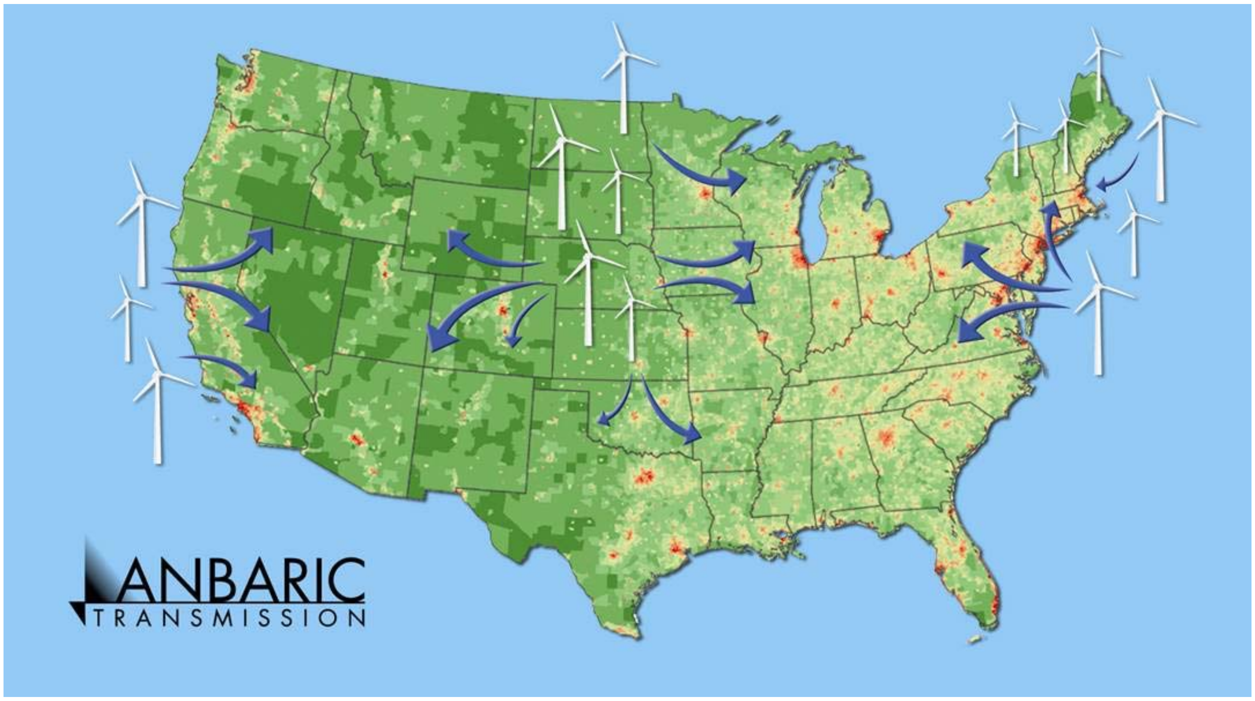


**Figure 1: Anbaric's Suggested Configuration of National Wind Development Strategy**

In this spirit, our White Paper will attempt to distill a huge and complex issue into a short and coherent argument that is summarized in Figure 1:

> The United States must build new transmission systems that accomplish the following objectives:
>
> (1) On the East and West coasts, connect nearby terrestrial and offshore wind resources to the population centers;
>
> (2) In the Midwest and Southwest, connect the highest quality wind to inland population centers on both sides of the Continental Divide;

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Power Supplies," (The Analysis Group: Boston, MA. 2008), available at http://www.analysisgroup.com/analysisgroup/uploadedFiles/Publishing/Articles/Tierney_21st_Century_Transmission.pdf; and "Integrating Locationally-Constrained Resources into Transmission Systems: A Survey of U.S. Practices," by the Working Group for Investment in Reliable and Economic Electric Systems and CRA International (October, 2008), available at http://www.wiresgroup.com/.

(3) In Texas, connect the wind and solar in the north and west to the population centers in the center and south;

(4) And in the South, where wind resources are meager, allow nuclear power plants to meet RPS and carbon targets.

Can we follow these guidelines and achieve a 25 percent U.S. Renewable Portfolio Standard and substantially reduce carbon emissions from the power sector? Yes we can. But we must start from where we are. Rather than re-invent the wheel or put too much decision-making power in the hands of a single federal agency, we should use the best instruments we have. The Federal Energy Regulatory Commission, where the federal government's deepest expertise about electric markets resides, should be tasked with preparing a "Renewable Development Order," similar in scope and importance to its open access orders.

The 2009 "FERC Renewables Order" that we propose here should empower regional system planners to use compliance with RPS and carbon standards as legitimate criteria for causing transmission to be developed. With FERC oversight, state regulators, utilities, and public authorities should use long-term and competitively awarded Power Purchase Agreements to help finance both Renewables and transmission.

With these simple principles, the United States is eminently capable of revolutionizing its electricity sector. We need to build a lot of transmission to accomplish America's new energy vision. But we can do it. All it takes is common sense, diligence, and a willingness to work together.

## The Increase in Demand for Renewable Energy

Renewable Energy generating capacity – including hydroelectric capacity – accounts for about 10 percent of total electricity generation.[4] Where that number will be in 2028 depends, in large part, on what the Obama Administration and Congress decide to adopt in the widely anticipated "Energy Bill of 2009." Reports circulating at the time of this writing (February 2009) indicated a national Renewable Portfolio Standard ranging between 20 and 25 percent, to be achieved by 2025.

The pursuit of these objectives marks a huge change in American energy policy. In the past twenty years, most policy attention has been focused on developing competitive wholesale energy markets. By and large, that effort has succeeded, with workably competitive markets in oil, natural gas, and wholesale electric trade. Now, with a growing public awareness, a consensus has emerged to combat global warming and reduce our environmental footprint.

Were there an abundance of natural gas, one step in that direction would be to continue to convert more and more of America's power generating fleet to that clean and convenient fuel. This conversion has been under way since the 1990s, but it put significant pressure on domestic and Canadian gas resources. The price of gas quadrupled in recent years to more than $10/MMBTU, then settled back down to $5/MMBTU. It is anyone's guess what natural gas prices will be in the future, but there are clear risks in becoming increasingly dependent on this volatile fuel. Continued conversion of electricity generation to gas-fired power is likely to require greater and greater dependence on imported Liquefied Natural Gas (or LNG). Such import dependence carries with it similar energy security risks to those that America bears with crude oil and petroleum product import dependence.[5]

How, then, can we reduce the U.S. power sector's contributions to global warming without massively increasing our dependence on imported LNG? Clearly, the starting point is to implement much more aggressive electricity demand conservation programs. Demand for electricity nationwide has been increasing between 1 and 2 percent per year, and with aggressive conservation measures that growth may be slowed and perhaps even reversed. In the next twenty years, high-tech devices may make enormous contributions towards reducing either the growth in electricity demand or even the level of electricity demand itself.[6]

Notwithstanding those contributions, the fact remains that we will continue to be an electrified society with a need to generate massive amount of power. We will need to do so, however, in ways that are environmentally acceptable and do not exacerbate our energy security problems.

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[4] From the Energy Information Administration's *2008 Annual Energy Outlook*, pages 10-11. "Total electricity consumption…3,814 billion kilowatthours in 2006… renewable generation in the AEO2008 reference case…385 billion kilowatthours in 2006." Available at http://www.eia.doe.gov/oiaf/aeo/index.html

[5] Boone Pickens has proposed a "Pickens Plan" (see www.PickensPlan.com) that involves expanding US wind resources much as we propose to do in this White Paper, and simultaneously move a substantial portion of automobile fuel consumption from oil to natural gas. While we endorse the wind objectives, we are agnostic on the question of the adequacy of U.S. natural gas resources to meet a substantial portion of transportation fuel demand.

[6] It is fundamentally unclear whether it is possible to reduce the absolute level of electricity demand. There is intense interest in the development of electric automobiles, whose demand for power (albeit offpeak) may be a substantial factor in demand.

Returning briefly to the bedrock fundamentals of electric energy, aside from natural gas, the United States has four large potential sources of domestically produced low-carbon input fuels for electricity generation:

1. The cleanest sources are wind, geothermal, solar and energy from biomass sources.
2. Next in the order of general environmental desirability is energy from large and small scale hydroelectric facilities whose net carbon efficiency is at acceptable levels; whether or not large-scale hydro counts as desirable has been and will remain a much-discussed topic.
3. Energy from nuclear power plants; as with large-scale hydro, whether or not nuclear energy counts as desirable will remain a much-discussed topic.
4. Energy from clean coal with carbon sequestration.

For many parts of the United States, wind energy will have to meet the bulk of the demand for renewable electricity. In the South, Southwest, and California, solar energy can play a substantial role. In the South, nuclear energy can be counted on. Coal – the fuel that drives the economy of the Midwest – faces an enormous challenge to become carbon-neutral, and it is unclear today whether or not it can meet that challenge.

## Transmission Implications of Rising Demand for Renewable Electricity

For all these reasons, the overarching transmission challenge posed by a federal RPS requirement is to bring wind energy to market. The question is how we get there, given the difficulties of building transmission. In recent years, the Federal Energy Regulatory Commission (FERC) has imposed a series of important changes compelling that most state transmission systems be open to wholesale competition and development by new entities. As a result, more transmission is being considered today – and being built today – than at any time in American history. Nevertheless, on a national level, transmission investment remains inadequate and much more is needed.

**Figure 2: Existing High Voltage (345kV and Up) in the United States**

Why is it so hard to build transmission? The answer is rooted in a century of history. Transmission began as a means of taking locally supplied generation across town to local loads. As time passed and utilities began investing in larger (sometimes shared) generation resources, the transmission system again evolved to transport energy across the state or within the region. Again, the design and voltage class was driven by the need to move power within the region.[7]

As is evident from the gaps in Figure 2, no "Master Plan" directed the development of the grid. The result is a loosely integrated transmission system which has been developed with a focus on local needs rather than national needs and national synergies.[8] Each utility area has developed over time its own "native mix" of generating assets, which were optimal in the context of the historic transmission system the utilities built to take power from those generators to their load areas. Individual, project-by-project choices over time have created hundreds of power markets with their own idiosyncrasies, each with substantial differences in electric prices. [9]

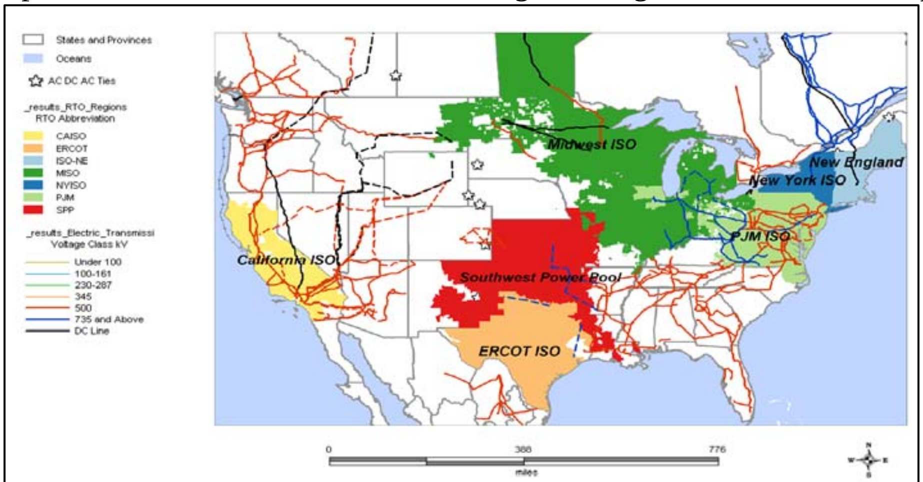


**Figure 3: Organized and Traditional Power Markets in the United States**

In a perfect system, all markets would be able to receive the cheapest energy from a diverse pool of fuel sources all the time. But our Grid is far from perfect. [10] While perfection may

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[7] Transmission ratings are essentially capacity designations: the higher the number (theoretically up to 1000kV, though not in the United States, where 765kV represents our limit), the greater the carrying capacity of the line. Think of 230kV lines as basic 4-lane roads, 345kV as four lane interstates, 500 and 765kV as six and eight lane superhighways.

[8] Although the US electric system has been organized into two large grids -- the Eastern Intertie (largely the area west of the Rocky Mountains), the Western Intertie (with Texas a conspicuous island between the southern edges of the two) – transmission planning has not been optimized at this level. Within the Eastern Intertie, there are a number or "reliability councils" and there is a National Electricity Reliability Council (NERC) which provides vital reliability standards and protocols. But these are aimed at what should be considered a minimal optimization objective: to keep the lights on. None of these organizations attempts to optimize the Grid for economic or environmental purposes.

[9] The most extreme example of congestion cost in the United States is in the difference in energy prices between New York City and surrounding areas. In 2008, for example, the average price of electric energy in New York City was $96.25/MWh, while in neighboring New Jersey it was approximately $79.77/MWh. New York City consumes 54.8 million megawatt hours (MWhs) per year. Thus, the $16.48/MWh difference – a.k.a., "congestion cost" – is $900 million per year.

[10] There are increasing concerns about the state of America's infrastructure. The New York Times reported that "How large a challenge the country is facing can be seen in a report by the American Society of Civil Engineers, grading the nation's infrastructure. The latest report, issued in 2005, assigned a cumulative grade of D, down from D+ four years earlier. Near-failing grades of D- applied to drinking water, sewage treatment and navigable waterways. The highest grade, C+, went for landfills and the recycling of solid waste." Energy infrastructure, including

not be achievable, based on what we know today, it is prudent to rethink how we are planning the system from a national perspective. Given our desire to increase the diversity of our fuel portfolio and the desire to ensure that we are maximizing the overall efficiency of the system, we need to move away from a project-by-project approach to infrastructure development. Not all transmission is created equal, and therefore it is prudent to ensure that the full benefits of EHV investments are encouraged and considered.

Unfortunately, participants in the electric sector often remain embroiled in bitter disputes about who will pay for transmission. The disputes often pit state against state, or states against the federal regulators. Transmission lines to bring Renewables to market will have to cross the boundaries of different utility service areas and different states, and therefore affect the power prices of incumbent utilities and states who do not want their customers to feel these effects.

Put bluntly, existing transmission planning procedures will not allow Renewables to get built at the scale we need. The planning processes of the ISOs and RTOs (shown in Figure 3), or of traditional utilities where an ISO does not exist, are out of date and must be reformed. Even though each region and (in traditional areas) each utility has its own planning principles and practices, we need to change the rules of the game. We will return to the question of how after we review where the best Renewable resources are.

transmission, got a D grade. See http://www.asce.org/reportcard/2005/page.cfm?id=25, and "A Bridge Collapses," *New York Times*, August 5th, 2007, Editorial, available at http://www.nytimes.com/2007/08/05/opinion/05sun1.html

## **Where is the Most Cost-Effective Wind?** A Review of Wind Quality and Relative Costs

Figure 4 presents a summary picture developed by the National Renewable Energy Laboratory (NREL) on the geographic differences in the quality of wind resources. The best wind, according to NREL, is offshore, and the wind there is very good indeed. It ranges from excellent in the near-offshore to superb further out to sea. On land, wind of similar quality is found in only a few locations, mostly in the Dakotas, Montana, and Wyoming. The effects of the differences in the quality of the wind regime are expressed in the electricity concept of "capacity factors," or the ratio of the electrical energy produced by a generating unit for the period of time compared with the electrical energy that could have been produced at continuous full power operation during the same period. Offshore wind will tend to have a higher capacity factor, terrestrial wind a lower capacity factor.

On the other hand, it is clear that the cost of building and maintaining offshore will be much higher than terrestrial wind facilities. While the exact differences will vary by location (for both terrestrial and offshore wind), in general, we expect the cost of building offshore wind generation – excluding the transmission lines needed to bring it to market -- to be roughly double that of terrestrial wind[11].

That said, it has been reported that the

> "trend in Europe has been to move wind turbines offshore because of higher wind speeds, smoother, less turbulent air flows, larger amounts of open space and the ability to build larger turbines that are more cost effective in the ocean, offshore. The wind offshore tends to flow at higher speeds, thus allowing turbines to produce more electricity… The potential energy produced from the wind is directly proportional to the cube of the wind speed, meaning a few mile an hour increase in wind speed would produce a significantly larger amount of electricity. For instance, a turbine at a site with an average wind speed of 16 mph would produce 50% more electricity than at a site with the exact same turbine with average wind speeds of 14 mph. The power of the wind is significantly less on land."[12]

This overview of terrestrial versus offshore wind, furthermore, must also take into account the relative cost of transmission. As indicated in Figure 4 below, the distance from excellent offshore wind resources to shore is likely to be less than 100 miles; while the distance from the best terrestrial wind (the Dakotas, Montana, and Wyoming) to the urban areas of the East and West Coasts is thousands of miles.[13] We need to evaluate carefully whether it will make sense to

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[11] The US Department of Energy's *Annual Report on U.S. Wind Power, Installation, Cost and Performance Trends 2007* provides a useful review of differences in costs of wind projects in various parts of the United States. There is thus far scant experience, however, with offshore wind in the United States.

[12] From OffshoreWind.Net. See http://offshorewind.net/Other_Pages/Questions.html.

[13] In Figure 4, wind development potential is rated on a scale of 1 to 7. Class 1 areas are considered to have poor development potential; Class 7 areas are considered to have superb development potential. Wind speed is the key differentiator in the cost of wind energy production. Projects located in Class 5 areas or higher are considered to be cost competitive. The map indicates that, on a state-by-state basis, North Dakota, South Dakota, Texas, Kansas, and Montana are the five highest ranked states in terms of energy production from wind. Within states like California

build EHV AC transmission from the Midwest all the way to New York City, for example, when wind resources also exist in upstate New York and offshore wind is available only 100 miles (or less) away.

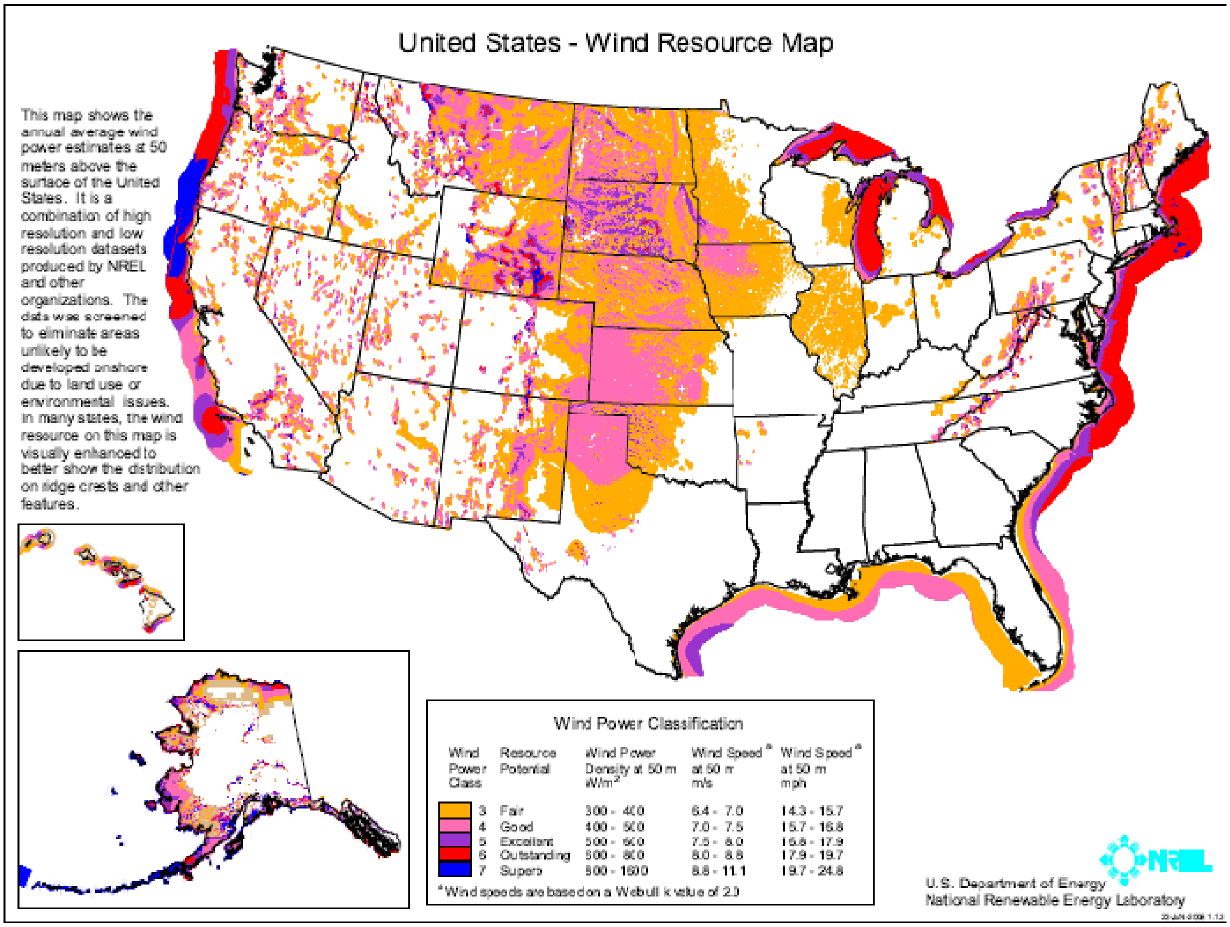


**Figure 4: NREL Wind Resource Map**

The calculation of the relative cost of wind resources, therefore, is anything but simple. We have to balance four critical variables:

1. ***The cost of building and maintaining the wind turbines.*** Offshore is more expensive than terrestrial. Inland sites will also have significant differences, with turbines built on or near mountaintops substantially more expensive than turbines built on flat land.
2. ***The capacity factors of the different wind farms.*** Offshore facilities may have 60 percent capacity factors (thereby offsetting some of the higher capacity cost). Terrestrial facilities far from urban centers (for example, those in South Dakota) may have

and Maine, there are also excellent wind opportunities. In all cases, a substantial amount of transmission development will be required to bring the energy to market.

45 percent capacity factors, while "near terrestrial" facilities (for example, those in California, Maine, and upstate New York) may have 30 percent capacity factors.

3. ***The cost of terrestrial, overhead AC transmission:*** Overhead lines will be the technology and installation method of choice in some parts of the United States. The challenge will be to create an EHV network that spans states and electric regions. The cost of such an undertaking is not readily apparent, but will be measured in scores, if not hundreds, of billions of dollars of infrastructure.
4. ***The cost of DC transmission (both overhead and under water):*** Offshore wind, and some near-terrestrial wind resources, will be best accessed via waterborne, DC transmission lines.
    a. On the East and West Coasts, DC projects are used to connect asynchronous systems (New York and PJM, for example), or to bring hydroelectric power from large facilities in Quebec and the Northwest to load centers in the Northeast and California respectively. These are tried and true projects and applications of DC technology that are likely to be adopted to access renewable energy.
    b. Offshore wind – if developed on a very large scale – is likely to be harvested by large, offshore HVDC transmission networks. As we have seen from our maps, the distances from wind farm to shore in this case will be small (probably less than 100 miles). However, the transmission will have to be carefully developed to interconnect in ways that do not compromise the reliability of the Grid. DC technology is well suited to this task.

The table below provides a hypothetical example illustrating how the most economic choice of wind resources depends upon these variables.[14] [15]

**Hypothetical Example of Drivers of All-In Wind Cost**

| | Near Terrestrial | Offshore | Distant Terrestrial |
|---|---|---|---|
| **Comparison: All-In Cost ($/MWh)** | **$ 103** | **$ 130** | **$ 141** |
| Transmission Cost ($/MWh) | $ 15 | $ 15 | $ 46 |
| Wind ($/MWh) | $ 87 | $ 115 | $ 96 |
| ***Assumptions:*** | | | |
| *Capacity cost ($/kW)* | *$ 2,000* | *$ 4,500* | *$ 2,500* |
| *Capacity factor* | *35%* | *60%* | *40%* |
| *Transmission cost ($/kW)* | *$ 1,000* | *$ 1,000* | *$ 3,000* |

Note: These are notional figures that we believe are roughly representative of cost differences for these resources. Each project will have its own unique and distinct variations on these costs.

[14] In the interest of keeping the comparisons fairly simple, we have not included another important operational requirement: the resources needed to "firm up" the wind, or to provide energy when the wind does not blow. Each proposed wind project will have its own, often unique, firming requirements.
[15] For more information on capacity factors and the capital costs of wind, see the Off-Shore Wind Blue Ribbon Panel conducted by the state of New Jersey: http://www.state.nj.us/njwindpanel/docs/genweinf.pdf

Whichever Renewables path we decide to follow, there is no doubt it will requires hundreds of billions of dollars in transmission investment. Our Grid was simply not designed to accommodate 200,000MW of Renewables. In the coming months and years, therefore, transmission projects will compete for capital and selection on the basis of the differences in these components of all-in cost of getting the wind to market. In many cases, the cost of transmission will determine which wind resources are most cost-effective.

## What is the Most Cost-Effective Transmission Strategy?

Wind cannot reach the market without major new transmission investment. As it has become clearer just how much more Renewable Energy and associated transmission we will need, a host of independent transmission development companies (including ourselves), established utilities, independent system operators, state governments, and federal agencies have put forward dozens of transmission proposals, studies, plans, and processes. Out of this maelstrom of activity, we believe two major transmission visions have emerged.

1. A coast-to-coast Electricity Superhighway, in the form of a (largely) 765kV EHV system that radiates from the Midwestern wind states (from Kansas north to the Dakotas and Wyoming).
2. A series of initiatives from coastal states that essentially confines that superhighway to a smaller area <u>and</u> complements it with a system that enables coastal states to harvest near-terrestrial and offshore wind. This coastal complement eliminates the need for and interest in the wind resources from the Midwest delivered via the proposed national Electricity Superhighway.

Throughout 2007 and 2008, the New England Independent System Operator (NE-ISO), the New York Independent System Operator (NYISO), the Southwest Power Pool (SPP), the Midwest Independent System Operator (MISO), the Pennsylvania-New Jersey-Maryland Interconnection (PJM), the Tennessee Valley Authority (TVA) and the U.S. Department of Energy (DOE) held a series of meetings to discuss the development of a coordinated system plan to bring wind energy from west to east.[16] In essence, this was an evaluation of the feasibility of the eastern half of the 765kV Electricity Superhighway.

In February 2008, this "Joint Coordinated System Planning" process (or, JCSP) issued a study whose results indicated more than $100 billion of investment for East Coast states:

> "If the U.S. wants to get 20% of its electricity from renewable energy by 2024, the study says, it would be necessary to build a new electricity circulatory system, including 15,000 circuit miles of extremely high voltage lines. The system, which would be laid alongside the existing electric grid infrastructure, would start in the Great Plains and Midwest -- where the bulk of the nation's wind resources are located -- and terminate in big cities along the East Coast.
>
> The transmission system would cost up to $100 billion. Building the wind turbines needed to generate the desired amount of power would cost about $720 billion, the study estimates -- making the total investment about equal to the size of the current stimulus bill. The money would be spent over a 15-year period, and would be financed primarily by utilities and investors.

[16] For the web site that monitors progress made in these complex proceedings, see http://www.jcspstudy.org/.

> The purpose of the study was "to make clear that if you need large sums of energy that's not carbon-based, these are the kinds of numbers involved" to achieve it, said Clair Moeller, head of transmission planning for the Midwest Independent System Operator.[17]"

Meanwhile, the Eastern coastal states were increasingly taking the initiative to expand access to the outstanding wind resources that exist in the nearby terrestrial as well as the offshore. In Maine, Massachusetts, Rhode Island, New York, Delaware, Maryland and New Jersey, dozens of terrestrial and offshore projects have emerged and been pushed to various stages of development, most with substantial encouragement and assistance from state governments that are increasingly aware of the economic development opportunities that renewable energy mandates will create.[18]

This rising tide of support from the coastal states signaled an end to their support for the concept of importing wind from the Midwest via a national Electricity Superhighway. Put another way, the national superhighway changes character from a 765kV system that delivered renewables from the Midwest to the East to a more complex system that would also deliver renewables from the East's own resources to its major metropolitan areas. This emerging Eastern interest in exploiting its own high quality Renewable resources culminated in a letter sent on February 7, 2009 by the CEOs of the New York and New England ISOs to other participants that they would no longer participate in all of the facets of the Joint Coordinated System Planning process.[19]

Disappointing as this Eastern expression must have been to the proponents of the coast to coast Electric Superhighway, we believe it is based on sound economic thinking and planning. Based on our analysis and experience, we suggest developments in the East indicate a new, simple and effective general rule about the sequence and scope of Renewables-enabling transmission development. Spurred by the immense, 200,000 MW challenge of the national Renewable Portfolio Standard, a sensible U.S. transmission strategy and sequence of actions can be summarized as follows:

(1) On the East and West coasts, connect near-terrestrial and offshore wind resources to the population centers. The specifics of this rule vary slightly depending on the "neighborhood" quality of the wind regime, and the availability of on-land transmission routes. Here are a couple of specific examples.

   a. In New England, there is accessible and large scale on-shore wind potential in Maine, and it can be connected to the population centers of

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17 Rebecca Smith, "New Grid for Renewable Energy Could be Costly," *Wall Street Journal*, February 9th, 2009.

18 For example, the New Jersey Energy Master Plan requires 30% energy to come from renewable sources by 2020. As part of the plan, a minimum of 1000 Megawatts of offshore wind capacity must be developed by 2012, increasing to 3000 MW by 2020. Rhode Island aspires to meet 15% of the state's electricity requirement with offshore wind. Governor Carcieri announced an agreement with Deepwater Wind to develop an offshore site to provide that energy. Sources: New Jersey http://www.njcleanenergy.com/files/file/Committee%20Meeting%20Postings/OSW%20Board%20Order%2010-23-08-8D.pdf, Rhode Island: http://www.ri.gov/press/view.php?id=7202

19 http://www.iso-ne.com/pubs/pubcomm/corr/2009/2009-2-4_jcsp.pdf

Massachusetts and Connecticut via modest-length terrestrial and submarine DC transmission lines.[20]

b. In New York, there is ample "upstate" wind but north-south transmission into the New York metropolitan area has been stymied for decades by intra-state cost allocation disputes and fierce opposition in the Hudson Valley to terrestrial transmission. New and creative transmission solutions are beginning to emerge, however, that could provide a solution to delivering massive amounts of clean energy into New York City and Long Island.

c. In New Jersey, there is little inland wind potential but enormous offshore potential that can efficiently be handled within the rules of the massive PJM system. There is no need to bring wind from PJM's western fringe (the Dakotas) to New Jersey: much more can be accomplished by building offshore facilities. Such wind diversification improves system reliability and creates a wider dispersion of economic development benefits. Mid-Atlantic offshore resources could produce ample wind energy from within the region to supply population centers along the East Coast.

d. California is a coastal state with impressive terrestrial resources (Tehachapi), offshore wind resources, and the best solar and geothermal potential in the country. It probably does not need wind from the Rockies.

(2) In the Midwest, connect the highest quality wind to inland population centers. It makes sense to connect the best resources to the large Midwestern cities on both sides of the Continental Divide;

a. The JCSP plan should indeed move forward, but with its eastern terminus in the great cities of the Midwest (Chicago, Cincinnati, Cleveland, St. Louis) and its western terminus in Boise, Reno, Phoenix, or even Las Vegas.[21]

(3) Texas, long an electricity island, will remain so. It has huge wind and solar potential and it has already taken the lead nationally with a coherent transmission strategy that connect the wind and solar in the north and the west to the population centers in the center and the south.

(4) In the South, where wind resources are meager, there is a willingness to build additional nuclear power plants. National RPS legislation may have to account for

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[20] There are multiple projects competing to connect northern Maine and the Canadian Maritimes to Southern New England, including the Green Line, promoted by New England Independent Transmission Co., LLC, of which the author of this White Paper is Chairman. For more information, see http://greenlineproject.com/news/presentations/, "NEITC Presentation to ISO-NE Planning Advisory Committee at "HVDC Day"", December 17th, 2007.

[21] On February 9, the Independent Transmission Company proposed a project to move Renewable Energy into Chicago. See Jason Fordney, "ITC unveils $12 bil Green Power Express line," *Platt's Energy Trader*, February 10th, 2009.

the nuclear preference in the few places it exists, even if this does not fit conventional RPS prescriptions.

## How We Get There: Regulated Competition

The approach outlined above is a more practical and achievable mission for the U.S. transmission system than a coast-to-coast Electric Superhighway. It gives nearly every state a stake in the boom times that will come to the Renewables industry if national policy mandates Renewable Portfolio Standards and carbon reductions. It reduces the excessive reliance on one place, or one wind regime, that sometimes accompanies discussions of a national Electric Superhighway. And it allows our various states and regions to do what they do best – plan their own Renewables destinies – under the prodding of a national RPS and carbon requirement.

Finally, we have to give some thought to how we get there. There is a real danger that these laudable environmental goals will be undermined by the emergence of ***environmental mercantilism*** – actions by individual states to subsidize their own renewables industries. If state regulators and legislators go too far -- under the intense pressure to help out home-grown renewables even when cheaper alternatives are available next door – then sound regional solutions will be undermined by the very states that should be leading the regional effort.

Two practices from the past – but improved with what we have learned over the last twenty years – can prevent such mercantilism from undermining effective action. First, we need to plan regionally to meet environmental goals. In the last 10 years, the various Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) have improved transmission planning, making it much more regional in scope. The ISOs and RTOs have not been leaders, however, in developing transmission solutions to meet renewables objectives because they have not been allowed to incorporate those objectives into their planning processes. Instead, they have been empowered to commission transmission projects only to maintain system reliability.[22] We now need to empower them to incorporate environmental objectives into their regional planning.

Second, we need to revive on a national scale the use of regulated, competitive procurements of Renewables and the transmission by which they are delivered. These procurements should be organized around open and competitive requests for proposals (RFPs) that lead to long-term power purchase agreements (PPAs).[23] In the transmission responses to these PPAs, both the incumbent "home" utilities and independent transmission developers should be invited to compete. In transmission, as in generation, the competitive power industry has demonstrated

[22] The Federal Energy Regulatory Commission, in its Order 890, has prodded the ISOs and RTOs to incorporate economics more aggressively into their transmission planning. The Eastern ISOs have uniformly failed to do so, while Texas and California's ISOs have been much more successful in this endeavor, because it has morphed into allowing environmental criteria to become the basis for transmission planning.

[23] In many states, PPAs fell out of favor when we began our experiment in electricity restructuring. That experiment gave rise to a number of market mechanisms (now including "RECs" or renewable energy credits) that do a good job in pointing out the immediate value of shortages and surpluses in the power sector. Thus, there is a financial spot market for "RECs," as there is for the carbon credits that will issue from the other important new environmental initiatives (such as the Regional Greenhouse Gas Initiative, or RGGI in the Northeast), that tell us pretty clearly the cost of non-compliance with nascent but growing environmental requirements. Useful as they are for immediate purposes, however, RECs and carbon credits provide only limited support to the financing of wind, transmission and other green energy projects.

repeatedly its ability to deliver more innovation and greater efficiencies than traditional cost of service regulated generation development.

This recommendation for updated regional integrated planning with federal oversight, and reliance on RFPs and long-term PPAs, is simply to call for ***regulated competition***[24]**.**

The collapse in liquid financial markets in the power sector in 2008 makes it even more critical that PPAs come back to the fore. For that reason, the December 2008 proposal by Northeast Utilities and NStar to use a PPA to finance a multi-billion dollar transmission-plus-hydroelectric project that they themselves would own with Hydro Québec is a small step in the right direction.[25] To make it a big step in the right direction, this opportunity must be opened up to competition from others. There are wind, transmission, and other renewable developers in New England that believe they can do a better job to meet New England's energy and environmental objectives, and consumers deserve to hear from them.

## The Energy Independence Bill of 2009

We can now wrap all this up into a coherent set of recommendations for those participating in the national debate to develop the Energy Independence Bill of 2009:

1. We can achieve a 25 percent U.S. Renewable Portfolio Standard and substantial carbon reductions from the power sector if we build enough transmission.
2. Rather than re-invent the wheel or put too much decision-making power in the hands of a single federal agency, we should use the best instruments we have. The Federal Energy Regulatory Commission is where the federal government's deepest expertise about electric market resides. FERC should be tasked with preparing a "Renewable Development Order," similar in scope and importance to its open access orders.
3. FERC's new Renewables Order should empower ISOs, RTOs and traditional system operators to use compliance with RPS and carbon standards as legitimate criteria for causing transmission to be developed. As suggested in Figure 1, we believe their economic and technical analyses will show that coastal states should develop nearby inland and then offshore resources, in that order. Many of these projects will use High Voltage Direct Current rather than the EHV AC technology.
4. There are other states, from Idaho to Illinois, Michigan to Oklahoma, that are likely to find it cost-effective to participate in the national Electric AC Superhighway.
5. With FERC oversight, state regulators, utilities and public authorities should use long-term and competitively awarded Power Purchase Agreements to help finance both renewables and transmission.

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[24] Not a new idea, but one long ago advocated in the utility industry by Nobel Prize winning economist (and lawyer) R.H. Coase in *The Firm, the Market, and the Law* (Chicago: University of Chicago Press, 1990).

[25] See Federal Energy Regulatory Commission, "Petition of Northeast Utilities Service Co and NSTAR Electric Co for Declaratory Order in EL09-20. " Docket EL09-20-000, January 12, 2009.

If we make these changes, transmission will no longer remain the backwater it has been. Transmission development will have a renaissance, as happened when FERC opened up generation development to competition in the 1980s. Private companies will invest billions of dollars in transmission, take risks that utilities cannot, and establish new benchmarks of efficiency in construction and management of transmission projects. To get that kind of building boom and innovation in transmission, to harness the productive forces of competition, we must go "back to future" and allow utilities and others to issue RFPs and PPAs for long-term projects, with federal and state regulators ensuring the process be competitive, and keep the transmission sector open to new entrants.

There is much, much more to do, of course. Those who maintain the reliability standards need to figure out how to prevent intermittent resources like wind and solar from blowing up the Grid, which will be a difficult, but not impossible, assignment.

Tom Friedman, in *Hot, Flat and Crowded*, calls wind, solar and other renewables "Fuels from heaven," and so they are. Since we are far more accustomed to getting our fuels from below the ground, we have to change our way of thinking. With fossil fuels, we have become accustomed to making modest capital investments to build the power plant, and then pay (sometimes exorbitantly) for the fuels that drive them. With renewables, we will pay more to build the plant, but then we won't have to pay any fuel costs. In the long run, given the finite nature and political risk of fossil fuels, renewables are a safer bet.

Can we meet our ambitious renewables objectives, create domestic jobs, build renewables inside the United States, and protect ratepayers from exposure to cost overruns? Yes we can, but only if we harness the best of regulation and competition. Federal RPS and carbon rules, regional planning, and an open and competitive process leading to long term PPAs, overseen by state and federal regulators, can get the job done.