Future 1	**Business as Usual (BAU)**
Brief description	Continue the present trends forward into the future based on historical indices.
Narrative: • What will the world look like in 2030? • What are the 3 -5 most defining characteristics of this Future? • What are the greatest uncertainties?	This future is defined by the status quo. • No new federal or state legislation or programs. • State policies and/or regulations existing as of 2010 are fully realized and continued into the future at prescribed rates. For those states that have policies and/or regulations that "ramp" in the future, the "ramp" values will be taken into account. • Existing regional programs including but not limited to RGGI (Regional Green House Gas Initiative) continue. • Currently proposed EPA regulations including the Transport Rule, Utility MACT Rule, Utility NSPS Rule, Coal Combustion Residuals Rule, and Cooling Water Intake Structures Rule are assumed to be implemented. (List to be finalized with input from EPA.) • The economy continues its rise out of the recession at currently projected rates. • Policies and/or regulations with an expiration/sunset date will be renewed on a case-by case basis. • Fuel prices remain stable. • No major technological advances. • New generation added based on regional capital and variable O&M costs from database and limited by legal mandates (i.e. no nuclear in WI).
Starting point for generation and transmission topology	Baseline infrastructure
Key drivers	**Driver Behavior**
1. Policy Goals	Existing state RPS, EE/DR and emission mandates modeled in full, as well as EPA non-carbon regulations (NO_x, SO_x, etc.)
2. Policy Implementation	As is in 2010 policy and regulations.
3. Economy	Average/mid-range levels based on historical ranges.
4. Load/Demand Growth	Continues based on historic patterns. The states in each region will review the PA's growth rates and provide input prior to finalization. EE/DR will be considered separately from growth rates if feasible within the time frame allowed.
5. Technology	Incremental technological advances (no major breakthroughs).

6. Fuel Prices & Availability	Fuel prices and availability are projected to remain stable at historical indices.	
Rationale for inclusion How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?	Plausibility	High
	Diverse range of policy outcomes	Moderate
	Diverse range of transmission outcomes	Moderate
Sensitivity Ideas **(Actual sensitivities TBD)**	**Sensitivities approved by EISPC** 1. Revised transfer capability 2. Interregional fee/dispatch barriers reduced 3. High load growth 4. Low load growth 5. High gas prices 6. Increase state EE/RPS requirements by 5% in absolute terms 7. Higher PHEV levels 8. Increased generation costs 9. No new non-carbon EPA regulations 10. (EM) 11. (EM) 12. (EM) 13. Free Market #1: No policies/regulations continued past current expiration (PTC/ITC, etc.); RPS requirements removed. 14. Free Market #2: No policies/regulations continued past current expiration (PTC/ITC, etc.); RPS requirements removed; Fixed fuel price of $4.00/mmbtu adjusted for forecasted inflation. 15. Free Market #3; Free Market #1 with high load growth.	
Modeling Questions	Do we want to use AEO provided curves for load growth and gas prices (etc.), or be more specific?	

<table>
<tr><td>Future 2</td><td>Federal Carbon Constraint: National Implementation</td></tr>
<tr><td>Brief description
(2-3 sentences)</td><td>Full EPA compliance with the Clean Air Act and Clean Water Act and growing public concern about air, water, and global warming pollution drives a significant near-term reduction in CO2 and other pollutants such as SO2, NOx, and mercury. Congress legislates and the EPA moves to put the United States on track for no less than 42% reduction by 2030 economy-wide, and 80% reductions in CO2 economy-wide by 2050.</td></tr>
<tr><td>Narrative
What will this world look like in 2030?
What are the 3-5 most defining characteristics of this Future?
What are the greatest uncertainties?</td><td>The primary driving characteristic of this future is a substantial reduction - both in the short and long term - of CO2 emissions and other pollutants such as SO2, NOx, and mercury, with a majority of the reductions in the electric sector through 2030.

This will be modeled based on carbon cost, by selecting a cost that would achieve 80% economy-wide by 2050 and 42% economy wide by 2030 as an intermediate linear target. Use existing studies to help determine what carbon price is necessary to achieve these percentages.

Assumption for this future:
Mid-level capital costs for nuclear. Nuclear allowed to build or upgrade (in the entire Eastern Interconnect regardless of state restrictions).
Carbon capture and sequestration (CCS) viable at some point in the duration of the study, with cost assumptions that are agreed to be reasonable.
Significant efficiency gains in multiple sectors driven by CO2 cap
Costs for renewable technologies continue on their historical trajectory (generally decrease).
Natural gas availability consistent with new shale gas extraction techniques
No offsets since the cap is economy-wide, but trading allowed
Increase access to Canadian exports into the US (priced appropriately including needed transmission and commodity cost; will receive input from Canadian reps)</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">It is an anticipated outcome of this future that most existing coal plants except the ones built since 2000 are replaced by 2030.

Uncertainties:
• Capital costs and availability of energy technologies (particularly solar, offshore wind, geothermal, nuclear, and CCS)
• Long-term natural gas availability/price.</td></tr>
<tr><td>Starting point for generation and transmission topology</td><td colspan="2">Baseline Infrastructure (to be developed)</td></tr>
<tr><td>Key drivers</td><td colspan="2">Driver Behavior</td></tr>
<tr><td>1. Policy goals</td><td colspan="2">CO2 reductions</td></tr>
<tr><td>2. Policy implementation</td><td colspan="2">Existing laws including EPA regulations through 2015, federal CO2 regs increased</td></tr>
<tr><td>3. Economy</td><td colspan="2">Moderate</td></tr>
<tr><td>4. Load/demand growth</td><td colspan="2">Moderate</td></tr>
<tr><td>5. Technology</td><td colspan="2">No major technology advancements.</td></tr>
<tr><td>6. Fuel prices and availability</td><td colspan="2">Natural gas and nuclear prices and availability are stable. Let the model solve for coal prices. Incentives for low and no carbon generation.</td></tr>
<tr><td rowspan="3">Rationale for inclusion
How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?</td><td>Plausibility</td><td>If the United States gets serious about climate change this is a path the electric sector could take.</td></tr>
<tr><td>Diverse range of policy outcomes</td><td>Replacing the vast majority of the existing coal plants with less CO2 emitting sources is likely to result in a diverse outcome.</td></tr>
<tr><td>Diverse range of transmission outcomes</td><td>A good sensitivity would be how this develops with less transmission constraints.</td></tr>
<tr><td>Recommended Sensitivities</td><td colspan="2">1. Revised transfer capabilities
2. Interregional fee/dispatch barriers reduced
3. High load growth
4. Low load growth
5. High gas prices</td></tr>
</table>

	6. Low gas prices 7. Higher carbon costs 8. Lower carbon costs OR reduced carbon reduction targets to achieve 42% level (depends on how modeled)
Modeling Questions	• Will the model substitute electricity in other sectors? If the answer is no, may need to make adjustments to reflect how substitution will make electricity prices higher. • Can the model get to the levels of reduction using the price lever? Or do we need to put in a cap?

Future 3	**Federal Carbon Constraint: State and regional implementation and choice**
Brief description	Federal carbon constraint levels no less than 42% reduction by 2030 economy-wide, and 80% reductions in CO_2 economy-wide by 2050. Federal carbon constraint is implemented on regional/state level. Resources that can be used to meet the federal carbon constraint goal are nuclear, wind, Canadian exports of wind and hydro, hydro, solar, natural gas, aggressive EE, carbon sequestration, and biomass. Existing hydro, wind, and solar assumptions will be derived for determining how existing Canadian exports to the U.S. of wind and hydro counts towards future carbon constraint goal, while ensuring that imports to the U.S. of Canadian hydro are accurately modeled, given Canadian demand, transfer limits, capital costs and practical limits for hydro expansion. States will use local resources first to meet the goals, and if local resources are not economic/sufficient then they will look to neighboring states or regions.
Narrative • What will this world look like in 2030? • What are the 3-5 most defining characteristics of this Future? What are the greatest uncertainties?	The national carbon policy establishes a framework for low-carbon options, leaving fundamental resource decisions and policy at the state and or regional level (regions need to be defined). National energy strategy that recognizes the need for federal and state collaboration but no national RPS specified; start with existing state carbon constraint programs. Modeling will be based on carbon cost. Select a cost that would achieve 80% economy-wide by 2050 and approx. 40% economy wide as an intermediate linear target. Use existing studies to help determine what carbon price is necessary to achieve these percentages. For implementation of the Federal carbon constraint: • States/Regions allocate the carbon allowances to contribute to preserving the integrity of the internal state/regional markets and to avoid distortions of competition • The states / regions may administer individual CO_2 auctions for individual states/regions. (Not mandatory.) • States/regions keep any auction revenues and redirect these revenues into the state/regional economy for further clean energy development. • States/Regions issue and monitor permits of operators of certain specified activities that receive allowances.

	• States/Regions set and levy penalties for infringements of the Federal Carbon Constraint and redirect those revenues back into the state/regional economies for clean energy development. • States/Regions report on the State/Regions compliance to the Federal Carbon Constraint. • For a Carbon tax–based implementation states handle the tax revenues and redirect them to clean energy projects. • States maintain siting authority and set ROW transmission constraints. **Electricity sector:** Aggressive EPA policies drive older coal retirements. CO2 prices will be high leading to a decline in coal generation. There will be substantially less dependence on foreign oil and substantially more dependence on electricity for the transportation sector. The underlying basis for this future is the anticipation that carbon emissions must be reduced because of federal regulation (either by Congress or the EPA). Implemented as follows: • No less than 42 percent reduction by 2030 • 80 percent reduction by 2050 • In addition, a specific focus will be given to incentives and technologies that lead to low or no carbon generation. Any existing moratoriums for nuclear construction are lifted. • Energy efficiency and Demand Response can be used to meet carbon limitations. • Mid-level capital costs assumed for nuclear. Nuclear allowed to build or upgrade as specified by state/regional implementation plans. • Canadian hydro and wind can be imported from Eastern Canada and Manitoba. • New high capacity transmission connections are in place or will be built to access Eastern and mid-west Canadian Hydro and wind; Hydro imports may serve as load following generation to maximize wind energy capacity during high production hours and produce power during low production periods. • Regional electricity markets remain the same as they are today.

	Other: • Energy consumption grows despite increased efficiency and resistance to higher electricity prices. • Natural turnover of appliances and resulting improvements in efficiency makes up part of EE. Assumptions are required for the level of EE funding state by state. • Energy consumption drop due to implementation of smart grid should be modeled in the load forecast. With smart grid price impact on peak demand and regional differences should be incorporated. • Assumptions of market mechanisms for compensation for DR are developed to incent expanded use of DR. • Federal policy continues to incent transmission • New investment return assumptions are assumed to drive additions of future assets.
Starting point for generation and transmission topology	Baseline infrastructure
Key drivers	**Driver Behavior**
1. Policy	• National 80 percent carbon reduction by 2050 with target of no less than 42 percent by 2030; • EPA Air Regulations Stringent; drive down coal generation • - States favor and incent local resources
2. Reduction in Carbon Generation	• Incentives for low/no carbon generation provided; • Carbon capture/sequestration (CCS) with defined availability based on cost assumptions that are agreed to be reasonable; • allow for carbon offsets (if can be modeled) • Incentivize improved efficiency of fossil fuel plants
3. Technology Advances	Modest progress on all fronts, i.e. improvements around heat rates, renewable energy costs, storage, modular nuclear, PHEV
4. Canadian Exports of Electricity to the United States	• Increased access (priced appropriately including transmission and commodity cost) • High imports, transmission in place
5. Energy Efficiency/Demand Response	
6. PHEV/EV Penetration	• Allow model to determine PHEV/EV levels
7. Coal Generation	• Carbon capture and sequestration modeled as viable at some point in duration of study, with cost assumptions that are agreed

	to be reasonable. • Refueling of coal plants.	
8. Nuclear Generation	• Mid-level capital costs for nuclear. Nuclear allowed to build or upgrade as specified by state/regional implementation plans.	
9. Natural Gas Generation	• High gas availability in some regions. • Possible natural gas price assumption of staying stable given shale gas discoveries, then beginning to climb up at some point.	
Rationale for inclusion How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?	Plausibility	In order to get a federal carbon constraint to succeed a regional/state implementation is likely necessary. European Union Carbon constraint is implemented on a member state by member state level.
	Diverse range of policy outcomes	Explores what would happen if policies being discussed and advocated at the federal level were implemented on a regional or state by state level. It fits well as an anticipated policy that will produce informative results to guide policy makers that vary from the BAU, RPS, and other futures.
	Diverse range of transmission outcomes	This future will likely result in low to moderate transmission investment and thus will stand in contrast to several of the other futures being proposed. There will likely be regional differences in required levels of transmission investment.
Recommended Sensitivities	1. Revised transfer capability 2. High load growth 3. High gas prices 4. Low gas prices 5. High carbon costs 6. Lower carbon costs OR reduced carbon reduction targets to achieve the 42% level (depending on how modeled) 7. Limited new/upgraded nuclear 8. Increased imported Canadian hydro	
Modeling questions	• Can the model get to the levels of reduction using the price lever? Or do we need to put in a cap?	

Future 4	**Aggressive Energy Efficiency, Demand Response, Distributed Generation and Smart Grid**
Brief description (2-3 sentences)	Economically achievable efficiency, demand response, distributed generation and smart grid resources used to meet power needs. These are the first resources evaluated and deployed by the model.
Narrative • What will this world look like in 2030? • What are the 3-5 most defining characteristics of this Future? • What are the greatest uncertainties?	• Overall energy demand is drastically reduced and new technologies are available for customers and utilities to manage demand to meet power needs in real time. • Demand Resources, including Demand Response and Efficiency, would meet 20% of energy resource needs annually by 2030. • Distributed generation, which would be a mix of CHP, solar and small wind (sourced locally on the distribution system), used to meet some of residual annual electricity needs. • Limited centralized generation as well as transmission infrastructure built to serve such generation. • Limited new transmission for serving new technology. • Preference for local resources. May include offshore wind. • Preference for “shorter” or more local transmission over longer-haul transmission. May include Canadian imports. • Uncertainties are level of development and cost of new technologies, including the extent to which technically available resources will be cost effective, and whether distributed resources are fully called upon to meet system resource needs.
Starting point for generation and transmission topology	Baseline infrastructure (to be developed) Current EE, DR, DG & Smart Grid
Key drivers	**Driver Behavior**
1. Policy goals	Cleaner, lower cost power from low and zero emissions distributed generation and demand resources augmented by efficient grid operations.

<table>
<tr><td>2. Policy implementation</td><td colspan="2">Compensation and planning parity between distributed resources (both low and zero carbon generation and Demand Resources) and centralized generation including consideration of all applicable externalities.</td></tr>
<tr><td>3. Economy</td><td colspan="2">Medium.</td></tr>
<tr><td>4. Load/demand growth</td><td colspan="2">Assume a 1% annual reduction in energy consumption through 2030. The 1% applies to the entire eastern interconnect, not each region. If the model cannot accommodate the most economic solution over the entire interconnection, then model it by region.</td></tr>
<tr><td>5. Technology</td><td colspan="2">Lower EE, DR & DG costs. No reduction in nuclear, wind, biomass or CCS costs. Lower costs for storage technology.</td></tr>
<tr><td>6. Fuel prices and availability</td><td colspan="2">Natural gas prices stable due to reduced uses. Coal down due to decreased demand. Nuclear stable.</td></tr>
<tr><td rowspan="3">Rationale for inclusion
How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?</td><td>Plausibility</td><td>Resources currently underutilized and available at lower cost and lower environmental impact. Benefits local economies and consumers.</td></tr>
<tr><td>Diverse range of policy outcomes</td><td>Results driven by policy initiative to improve efficiency and renewables and reduce carbon.</td></tr>
<tr><td>Diverse range of transmission outcomes</td><td>Potentially relies less on long distance transmission than other futures. Provides economic advantage and reliability benefits of greater reliance on local distributed resources.</td></tr>
<tr><td>Recommended Sensitivities</td><td colspan="2">1. Revised transfer capability
2. High load growth
3. High gas prices
4. Mid-range costs for DR, EE, smart grid, storage OR lower DR/EE performance (depending on how modeled)
5. Increased base load growth including higher PHEV levels
6. Increased imported Canadian hydro
7. Increased economic activity as modeled by changing AEEI metric in model
8. Low gas prices
9. Additional 1% mandated energy consumption reductions</td></tr>
<tr><td>Modeling Questions</td><td colspan="2">• How would costs for increased EE, DR and DG be reflected in NEEM? Who will define these costs?
• How to reflect reduced D&D losses (and costs of loss reduction)?
• How would DG be modeled?</td></tr>
</table>

Future 5	**National RPS - Top-Down Implementation**
Brief description (2-3 sentences)	A national Renewable Portfolio Standard (RPS) is established requiring each load-serving entity to obtain 30% of its electricity from renewable resources by the year 2030, with the option for a load-serving entity to meet the requirement by purchasing renewable energy credits from other entities. The renewable requirement will gradually increase to reach 30% in the year 2030.
Narrative • What will this world look like in 2030? • What are the 3-5 most defining characteristics of this Future? • What are the greatest uncertainties?	A national 30% RPS has been established, and to comply it is assumed that 30% of the 2030 electricity consumption of the Eastern Interconnection will be met through the output of qualified renewable facilities. The definition of qualified renewable facilities will include wind, solar, geothermal, biomass, landfill gas, fuel cell using renewable fuels, marine hydrokinetic and hydropower. The renewable resources deployed will be selected based on the lowest cost of electricity delivered to the electric busbar at the generator's location. Selection should therefore correspond to the capacity factors and capital costs for wind and solar resources. Variability of the aggregate power system will be evaluated in this scenario as in other scenarios, and flexibility resources such as but not limited to peaking plants, demand response, and storage will be deployed and dispatched in order of lowest cost within reliability parameters. The main defining characteristic of this scenario is the deployment of significant amounts of renewable energy at the locations with the lowest cost renewable resources. The scenario will result in significant displacement of fossil generation on an energy basis as well as a capacity basis. As a result, there will be significant declines in carbon dioxide emissions. There is also likely to be a need for significant enhancements to the nation's electric transmission system to achieve this scenario. Extension of tax credits equalized for all new renewable resources Uncertainties are similar to the Business As Usual case. They include load growth and generation fuel prices.

Starting point for generation and transmission topology	Baseline infrastructure	
Key drivers	**Driver Behavior**	
1. Policy goals	Development of sufficient renewable generation to supply 30% of the electricity consumed in the U.S. from renewable energy sources.	
2. Policy implementation	The implementation of the policy will occur through least cost resources evaluated on an Eastern Interconnection-wide basis. Extension of tax credits equalized for all new renewable resources.	
3. Economy	Medium	
4. Load/demand growth	Medium	
5. Technology	Current plus reasonably foreseeable advancements, with a reasonable trajectory for decreasing costs over time and due to increased scale of deployment.	
6. Fuel prices and availability	Current fuel price forecast with normal escalation	
7. Other policies	Include the implementation of the currently contemplated EPA emission requirements	
Rationale for inclusion How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?	Plausibility	President Obama has advocated for a 25% by 2025 renewable requirement. Recent rates of wind deployment, including the 10 GW of wind deployed in 2009, are on a trajectory to reach a 30% penetration by 2030, indicating that there are no supply chain or deployment barriers to reaching that penetration. NREL wind and solar resource estimates indicate that the supply of cost effective renewable resources exceed the amount needed for 30% renewables by an order of magnitude or more.
	Diverse range of policy outcomes	Explores what would happen if policies being discussed and advocated at the federal level were implemented. It fits well as an anticipated policy that will produce informative results that vary from the BAU, carbon constrained, and energy conservation futures.
	Diverse range of transmission outcomes	This future will likely result in significant transmission investment and thus stand in contrast to several of the other futures being proposed.

Recommended Sensitivities	1. Revised transfer capability 2. Interregional fee/dispatch barriers reduced 3. High load growth (including higher PHEV levels) 4. Low load growth 5. High gas prices 6. Low gas prices 7. Low cost of renewable resources 8. High cost of renewable resources 9. Increased deployment of flexible resources (DR, storage)
Modeling Questions	

Future 6	**National RPS – State/Regional Implementation**
Brief description (2-3 sentences)	A national RPS is established requiring each load serving entity to obtain 30% of its electricity from renewable resources by the year 2030, with the option for a load serving entity to meet the requirement by purchasing renewable energy credits from other entities. The renewable requirement will gradually increase to reach 30% in the year 2030. Implementation of the national RES will be designated to state legislatures to determine: (1) how to meet the national policy, (2) limits on in-state/out-of-state requirements, (3) specific production from different types of renewable generation.
Narrative • What will this world look like in 2030? • What are the 3-5 most defining characteristics of this Future? • What are the greatest uncertainties?	A national 30% RPS has been established, and to comply it is assumed that 30% of the 2030 electricity consumption of the Eastern Interconnection will be met through the output of qualified renewable facilities. The definition of qualified renewable facilities will include wind, solar, geothermal, biomass, landfill gas, fuel cell using renewable fuels, marine hydrokinetic and hydropower. While the preference is for renewable resources to be selected regionally based on the lowest cost of electricity delivered to the electric busbar at the generator's location, a state may impose generation type minimums that could cause some variations to this. Generally, selections should correspond to the capacity factors and capital costs for wind and solar resources. Variability of the aggregate power system will be evaluated in this scenario as in other scenarios, and flexibility resources such as but not limited to peaking plants, demand response, and storage will be deployed and dispatched in order of lowest cost within reliability parameters. The main defining characteristic of this scenario is the deployment of significant amounts of local renewable energy. States use local renewable resources first to meet national requirements, and if not sufficient then they will look to neighboring states or regions to fulfill requirements. The scenario will result in displacement of local fossil generation on an energy basis as well as a capacity basis. As a result, there will be significant declines in carbon dioxide emissions. There is likely to be a need for moderate enhancements to the nation's electric transmission system to achieve this scenario.

	Uncertainties are similar to the business as usual case. They include load growth and generation fuel prices and capital cost for renewable generation, especially between renewable generation types.	
Starting point for generation and transmission topology	Baseline infrastructure	
Key drivers	**Driver Behavior**	
1. Policy goals	Development of sufficient renewable generation to supply 30% of the electricity consumed in the US from renewable energy sources.	
2. Policy implementation	The implementation of the policy will occur through least cost resources evaluated on a state by state basis. States each issue a plan to meet national requirements and submit their plans to the appropriate federal agency. There will be a need to determine how existing state RES are aligned with national standards and to predict how states without an existing RES would implement one. Extension of tax credits equalized for all new renewable resources.	
3. Economy	Medium	
4. Load/demand growth	Medium	
5. Technology	Current plus reasonably foreseeable advancements, with a reasonable trajectory for decreasing costs over time due to increased scale of deployment	
6. Fuel prices and availability	Current Fuel price forecasts with normal escalation	
7. Other Policies	Include the implementation of the currently contemplated EPA emission requirements	
Rationale for inclusion How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?	Plausibility	President Obama has advocated for a 25% by 2025 renewable requirement. Recent rates of wind deployment, including the 10 GW of wind deployed in 2009, are on a trajectory to reach a 30% penetration by 2030, indicating that there are no supply chain or deployment barriers to reaching that penetration. NREL wind and solar resource estimates indicate that the supply of cost effective renewable resources exceed the amount needed for 30% renewables by an order of magnitude or more. More than 20 states already have renewable energy requirements and would expect to be involved in the implementation of national requirements.

	Diverse range of policy outcomes	Explores what would happen if policies being discussed and advocated at the federal level were implemented through local means exemplifying regional diversity. It fits well as an anticipated policy that will produce informative results that vary from the BAU, carbon constrained, and energy conservation futures.
	Diverse range of transmission outcomes	This future will likely result in moderate transmission investment and thus stand in contrast to several of the other futures being proposed.
Recommended Sensitivities	1. Revised transfer capability 2. High load growth (including higher PHEV levels) 3. Low load growth 4. High gas prices 5. Low gas prices 6. Low cost of renewable resources 7. High cost of renewable resources 8. Increased deployment of flexible resources (DR, storage) 9. Increased imported Canadian	
Modeling Questions	The group is still examining this future to determine to what extent it might result in a hybrid type of build-out, with a mix of generation near and far from load – regional, as opposed to being too local, similar to “hybrid” scenario similar to No. 2 in EWITS study. May need to revisit or redefine.	

<table>
<tr><td>Future 7</td><td>Nuclear Resurgence</td></tr>
<tr><td>Brief description
(2-3 sentences)</td><td>This future represents the possibility that there will be a significant number of nuclear facilities developed in the Eastern Interconnection. This includes the extension of existing plants, the construction of new large facilities and the development of small, modular nuclear facilities.</td></tr>
<tr><td>Narrative
What will this world look like in 2030?
What are the 3-5 most defining characteristics of this Future?
What are the greatest uncertainties?</td><td>In many respects, the 2030 world would look similar to the Business As Usual case. Any nuclear plant that has a pending application today would be forced in to the system.

The top characteristics of this future:
Low capital costs and/or increased subsidies for new nuclear generation
Any existing limitations (i.e., moratoriums) would be eliminated.
Additional nuclear facilities would become available as early as 2020 with shorter lead times assumed due to streamlined regulations)
Gas costs would be assumed to be high
Uranium costs would assumed to be low
Canadian nuclear construction would be assumed (price to include transmission and commodity costs)
Life extensions of existing nuclear plants are implemented and up-rates of existing facilities are allowed
Modular nuclear facilities are available starting in 2025
The greatest uncertainties include whether plants in planning/permitting stages will be constructed and whether new nuclear technologies (such as modular nuclear) will be available.</td></tr>
<tr><td>Starting point for generation and transmission topology</td><td>Baseline infrastructure (to be developed).</td></tr>
<tr><td>Key drivers</td><td>Driver Behavior</td></tr>
<tr><td>1. Policy</td><td>Desire to develop new nuclear to meet the nation’s energy needs and to develop new low carbon generation.</td></tr>
<tr><td>2. Economy</td><td>Economy is generally growing at the same rate as a business as usual case.</td></tr>
</table>

<table>
<tr><td>3. Load/demand growth</td><td colspan="2">See answer to economy.</td></tr>
<tr><td>4. Technology</td><td colspan="2">Many aspects of this future are based on development of new technologies that will make existing nuclear technologies less expensive and allow for the development of new types of nuclear facilities.</td></tr>
<tr><td>5. Fuel prices and availability</td><td colspan="2">Gas and coal prices would be at high prices. Uranium prices would be at low prices.</td></tr>
<tr><td>6. Regional differences</td><td colspan="2">Some regional differences will be allowed to account for the fact that some areas may be more willing to accept large nuclear facilities and others may not accept small nuclear facilities.</td></tr>
<tr><td>7. Transmission costs</td><td colspan="2">Mid-level transmission costs.</td></tr>
<tr><td rowspan="4">Rationale for inclusion
How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?</td><td>Plausibility</td><td>This future has a moderate plausibility since there has been a push for new nuclear facilities by many policy makers.</td></tr>
<tr><td>Diverse range of policy outcomes</td><td>This would not have a significant diversity in policy outcomes since the future is based on the development of one technology.</td></tr>
<tr><td>Diverse range of transmission outcomes</td><td>This may provide an interesting transmission outcome, since much of the new generation may be located in certain regions of the country.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Recommended Sensitivities</td><td colspan="2">1. Revised transfer capability
2. Low load growth
3. High load growth
4. Low coal, low gas prices
5. EPA Carbon limitations
6. High uranium and disposal costs, and high capital costs (if all can be modeled as one sensitivity)
7. Remove nuclear plants without loan guarantees (force in only those with loan guarantees)
8. Restrictions on Canadian hydro, heavy variable resource penetration (need clarification)</td></tr>
</table>

<table>
<tr><td>Future 8</td><td>Combined Federal Climate and Energy Policy Future</td></tr>
<tr><td>Brief description
(2-3 sentences)</td><td>A combination of federal climate and energy policies put the U.S. on a path to reduce global warming emissions by at least 80 percent from 2005 levels. Emissions cuts driven by a federal cap on carbon emissions combined with a suite of policies primarily designed to advance efficiency and renewable technologies. The electricity sector is responsible for nearly 60 percent of the total emission reductions by 2030 as a result of investments in energy efficiency, renewable energy, distributed generation, smart grid and other low-carbon technologies by 2030.</td></tr>
<tr><td>Narrative

• What will this world look like in 2030?

• What are the 3-5 most defining characteristics of this Future?

• What are the greatest uncertainties?</td><td>Federal policies (either Congress or EPA) lower U.S. heat-trapping emissions to meet a cap set at:
• 20 percent reduction by 2020
• 50 percent reduction by 2030
• More than 80 percent by 2050

Actual year-by-year emissions reductions may differ from the levels set in the cap because firms have the flexibility to over-comply with the cap in early years, bank allowances, and then use them to meet the cap requirements in later years. To meet the cap, the cumulative actual emissions must equal the cumulative tons of emissions set by the cap.

The most defining characteristics of this future include:
• A cap-and-trade program that sets declining limits on emissions of carbon dioxide and other heat-trapping gases
• More energy-efficient buildings, industries, appliances and vehicles
• Wider use of renewable energy technologies to include a 25% national RPS; technologies to include wind, solar, hydro, biomass, etc. and further supported by an extension of tax credits
• Greater use of natural gas for combined heat and power
• Smart grid implementation
• Investment in research, development, and deployment of other low-carbon technologies (CCS and nuclear) in the electricity sector.

The greatest uncertainties include:
• timing and scope of federal climate and energy rules
• natural gas availability and cost
• rate of economic growth
• smart grid implementation to enable high levels of EE/DR
• commodity and technology prices/breakthrough</td></tr>
</table>

Starting point for generation and transmission topology	Baseline infrastructure to be developed.
Key drivers	**Driver Behavior**
1. Policy goals	Mitigate effects of climate change, increase energy independence, advance clean energy technologies.
2. Policy implementation	**National** **Climate Policies** • Economy-wide cap-and-trade program with: • Auctioning of all carbon allowances • Recycling of auction revenues to consumers and businesses • Limits on carbon “offsets” to encourage “decarbonization” of the capped sectors • Flexibility for capped businesses to over-comply with the cap and bank excess carbon allowances for future use **Industry and Buildings Policies** • An energy efficiency resource standard requiring retail electricity and natural gas providers to meet efficiency targets • Minimum federal energy efficiency standards for specific appliances and equipment • Advanced energy codes and technologies for buildings • Programs that encourage more efficient industrial processes • Wider reliance on efficient systems that provide both heat and power • R&D on energy efficiency **Electricity Policies** • A renewable electricity standard for retail electricity providers • R&D on renewable energy and other advanced low carbon technologies. • Use of advanced coal technology, with a carbon-capture-and-storage demonstration program and loan guarantees for a limited number of nuclear reactors • Smart Grid implementation **Transportation Policies** • Standards that limit carbon emissions from vehicles • Standards that require the use of low-carbon fuels • Requirements for deployment of advanced vehicle technology • Smart-growth policies that encourage mixed-use development, with more public transit • Smart-growth policies that tie federal highway funding to more efficient transportation systems

<table>
<tr><td></td><td colspan="2">• Pay-as-you-drive insurance and other per-mile user fees</td></tr>
<tr><td>3. Economy</td><td colspan="2">Moderate. Based on EIA AEO 2010 reference case scenario. The model chooses technology outcomes based on policy drivers and costs for all major low-carbon technologies utilizing a baseline of moderate economic growth.</td></tr>
<tr><td>4. Load/demand growth</td><td colspan="2">Declining to moderate. The energy efficiency and smart grid policies are expected to lead to an overall reduction in electricity demand below current consumption levels under low and moderate economic futures.</td></tr>
<tr><td>5. Technology</td><td colspan="2">• Electric vehicles are viable and accepted by the public.
• Smart grid is widely deployed.
• Cost and performance assumptions for specific electric sector technologies would be based on actual projects, to the extent available, and input from experts from the national labs.
• Learning assumptions for the electricity sector based largely on EIA assumptions. While some learning is expected, the base case for this scenario is not dependent on game-changing technology costs or breakthrough developments, although these could be included as sensitivities, i.e., modular reactors, CCS, large-scale storage, etc.</td></tr>
<tr><td>6. Fuel prices and availability</td><td colspan="2">Reflect (with some modifications) EIA’s assumptions from latest AEO Reference Energy Price case for oil, natural gas, and coal prices. Any changes would account for recent cost increases and for expectations of higher/lower prices compared with AEO Reference case forecast.</td></tr>
<tr><td rowspan="3">Rationale for inclusion
How does the inclusion of this Future contribute to the development of a range of Futures that meets the selection criteria?</td><td>Plausibility</td><td>This scenario uses reasonable technology cost and fuel price drivers, combined with a comprehensive suite of complementary policies, to model a low carbon energy future. This scenario reflects an expansion of policies in place today in the leading states. For example, 29 states already have adopted renewable energy standards and 27 states representing two-thirds of U.S. electricity demand have adopted or have pending energy efficiency resource standards and smart grid requirements. The analysis relies on technologies that are available today or are projected to become available on a commercial scale within the next two decades.</td></tr>
<tr><td>Diverse range of policy outcomes</td><td>Outside boundary case if all policies come to fruition.</td></tr>
<tr><td>Diverse range of transmission outcomes</td><td>This could be a mid-range to large size build out as the scenario requires aggressive implementation of both efficiency and renewable energy policies.</td></tr>
</table>

Recommended Sensitivities	1. Revised transfer capability 2. Interregional fee/dispatch barriers reduced 3. Increased economic activity as modeled by changing AEEI metric in model 4. EITHER a) Increase RPS to 40% OR b) lower gas prices
Modeling Questions	