



Wyoming Collector and Transmission System Conceptual Design

Presented to:

Wyoming Infrastructure Authority

Board Meeting - January 25, 2010

Jackson (Teton Village), Wyoming

Presentation Outline

- Study Status
- Study Background and Goals
- Study Limitations
- Starting Point for Collector System Design
- Subtask 1.1
- Subtask 1.2
- Subtask 1.4
- Subtask 1.5
- Study Conclusions
- Recommended Additional Technical Analyses
- Schedule

Study Status

<u>Task/Subtask</u>	<u>Status</u>
Task 1 - Technical Analysis	Complete
1.1 Develop Analysis Scenarios	Complete
1.2 Perform Reliability Analysis	Complete
<i>1.3 Update Energy Corridor Map</i>	<i>Not funded</i>
1.4 Estimate Costs	Complete
1.5 Summarize Collector System Design Alternatives	Complete
<i>Task 2 – Develop Commercial Structure Options</i>	<i>Not funded</i>
<i>Task 3 – Administrative/Outreach/Facilitation Support</i>	<i>Not funded</i>

Study Background and Goal

Background

- Wyoming has a substantial wind resource and distant load centers have a substantial need (demand) for renewable energy.
- Multiple wind farms have been built or proposed in Wyoming; however, the existing transmission system has limited capacity.
- Multiple transmission export lines are proposed in Wyoming.
- The “missing piece” is a collector system that connects the transmission export lines with the wind farms.

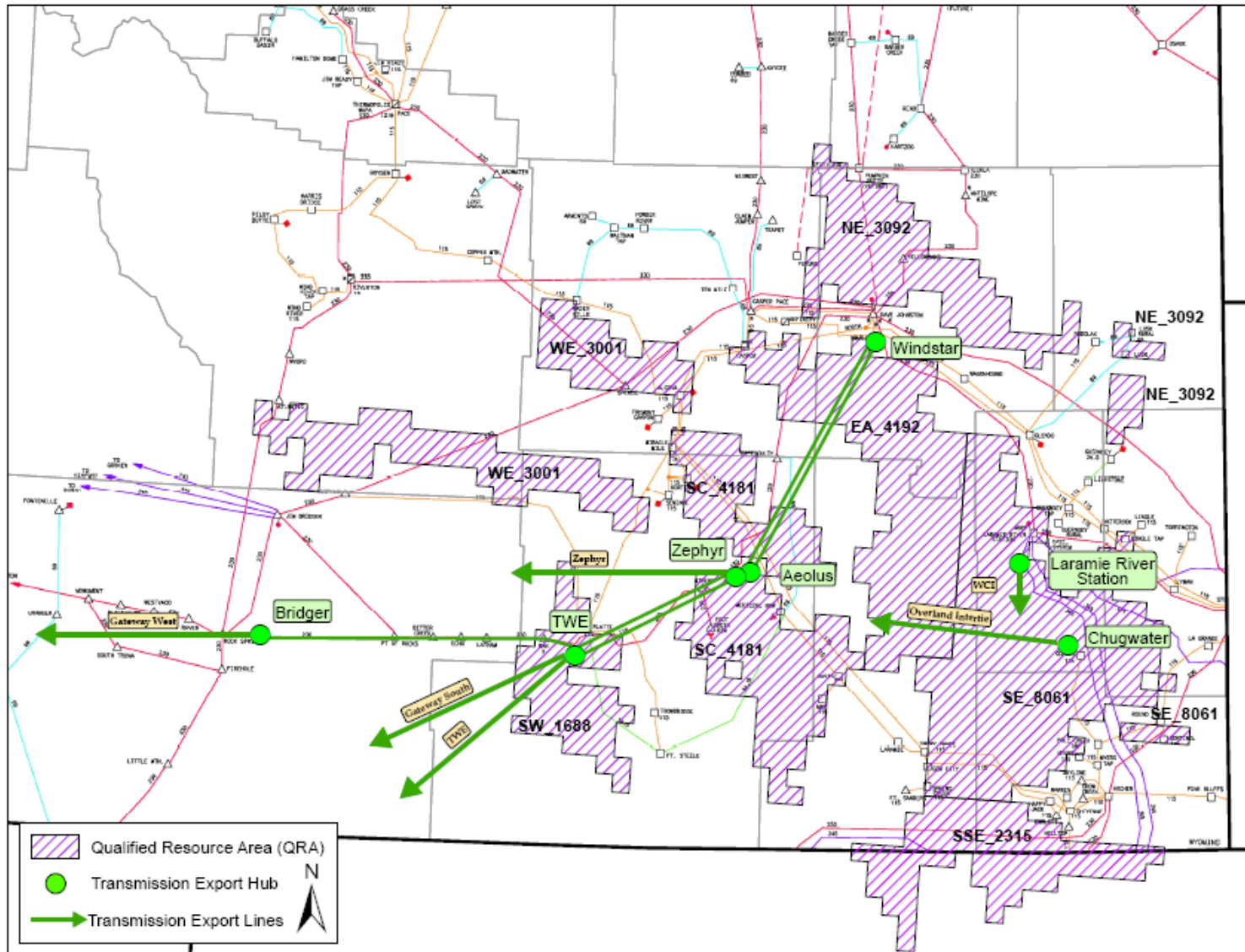
Goal

- Develop conceptual design for collector system and test reliability of connecting up to 12 gigawatts (GW) of wind generation in Wyoming to proposed transmission export lines.

Study Limitations

- Conduct a “reasonable first look” at conceptual collector designs.
 - This is the *first* – not the *final* collector system study
- Wind development scenarios in the report are conceptual.
- Reliability analysis includes collector system components (e.g., lines, transformers) and planned interconnections; the outage analysis does not include performing contingencies on the existing transmission system or the export lines out of Wyoming
- Study does not attempt to predict or recommend where, when, or how much wind energy will be developed in Wyoming.
- Cost estimates are high-level based on material and labor and do not include financing, ROW acquisition, or permitting.
- Upgrading existing transmission lines to build the collector system could be disruptive to power delivery.

Starting Point for Collector System Development

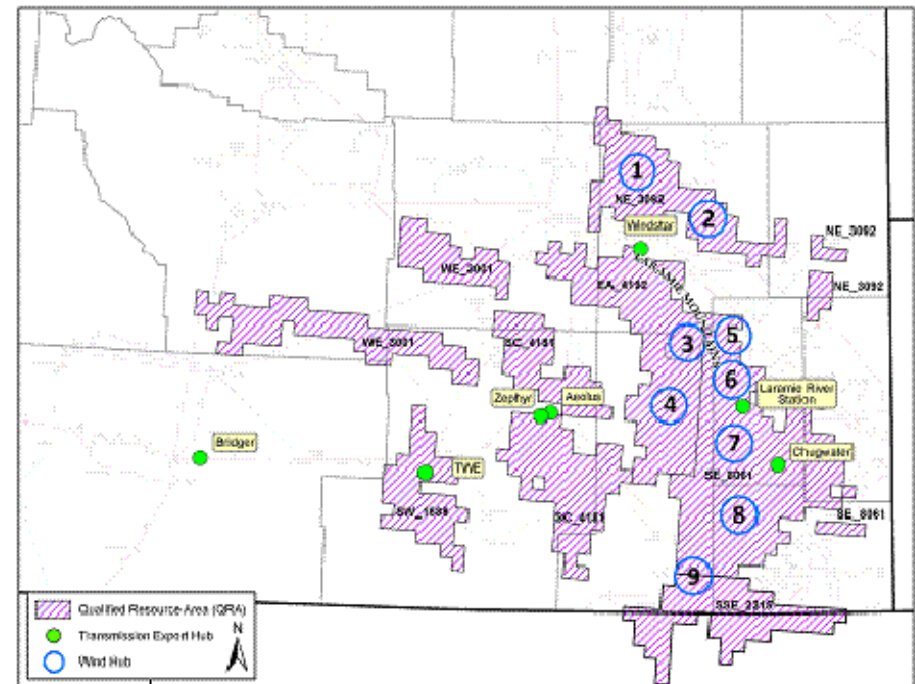
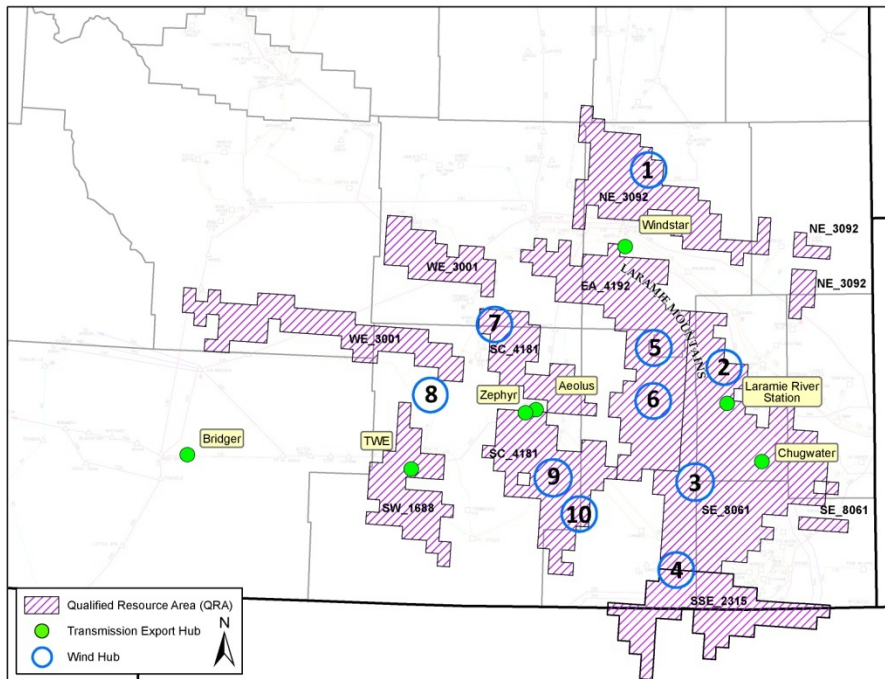


Subtask 1.1 – Develop Analysis Scenarios

- Two Resource Development Scenarios:

#1 - West of Laramie Range

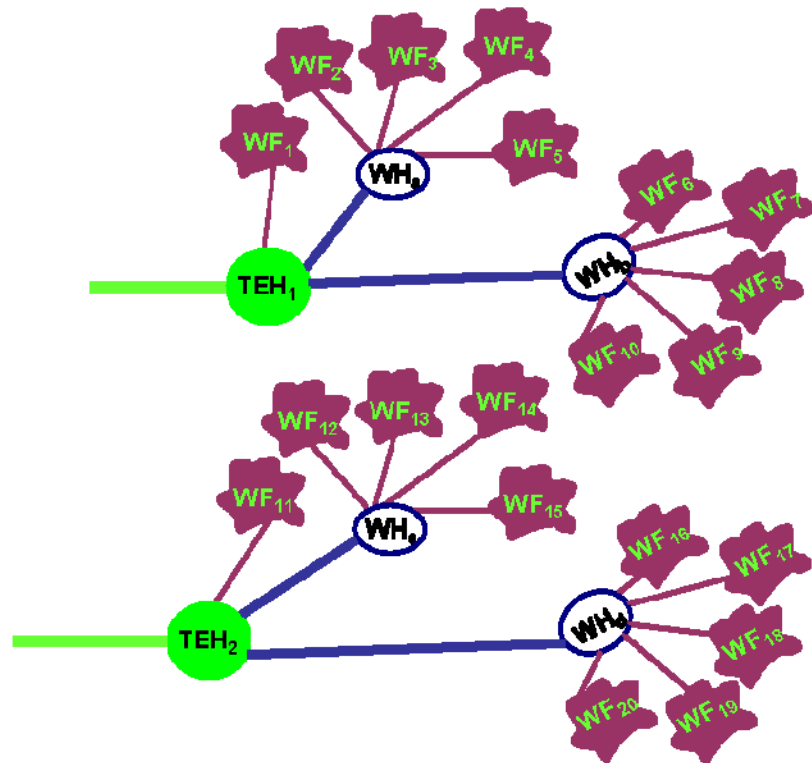
#2 - East of Laramie Range



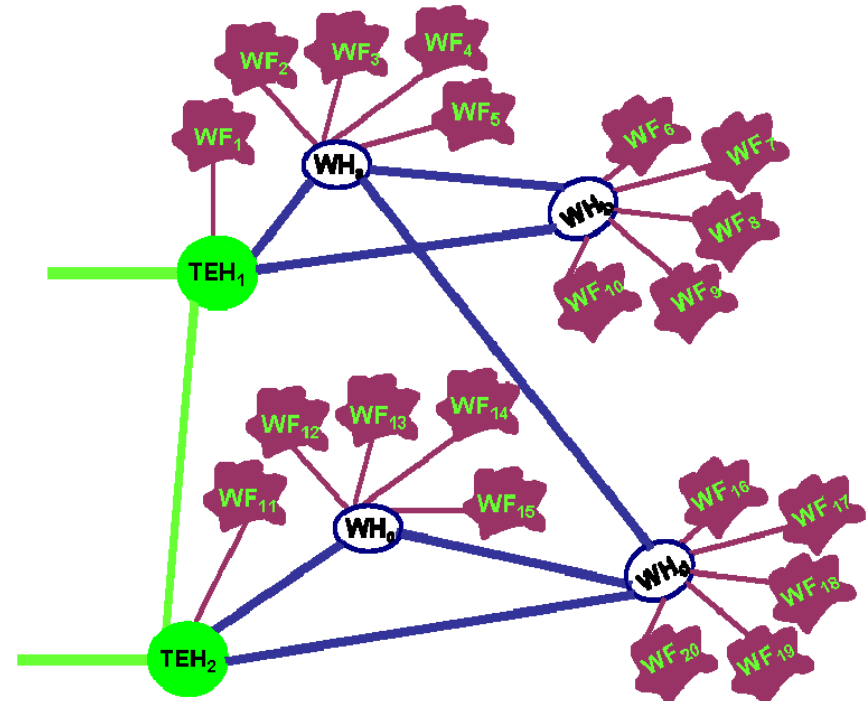
Subtask 1.1 – Develop Analysis Scenarios

- Two Primary Collector System Designs:

Radial



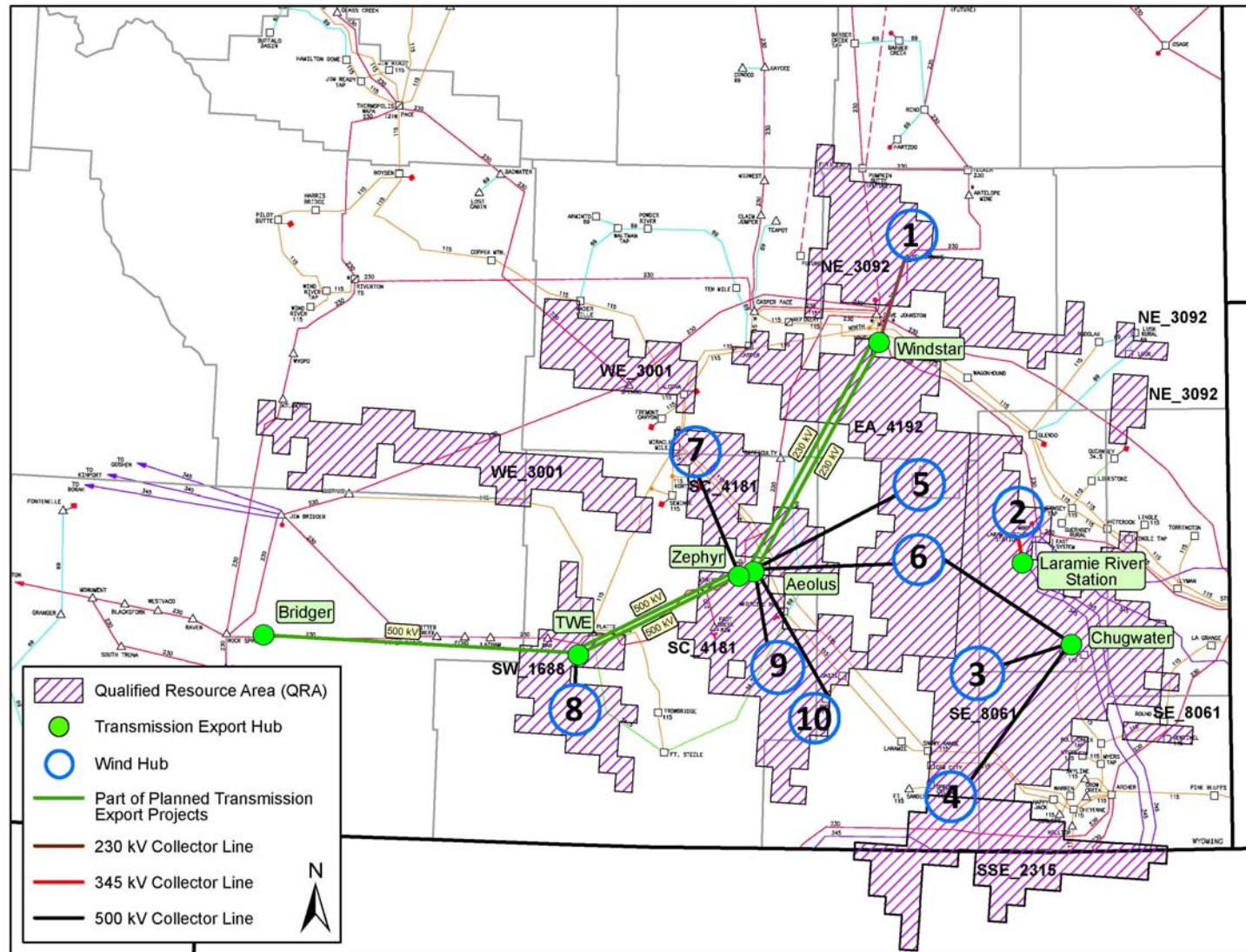
Networked



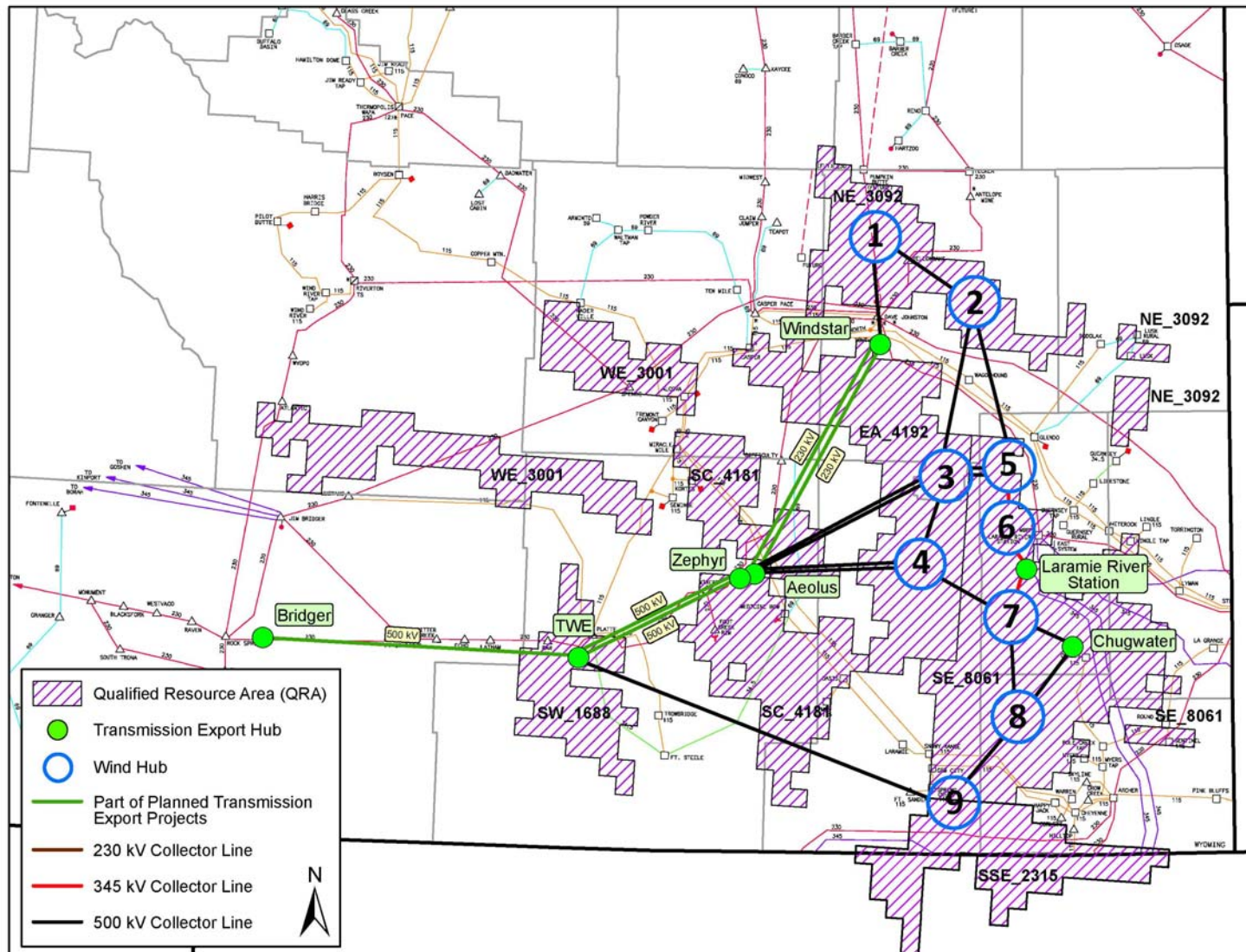
Subtask 1.2 –Reliability Analyses

- Preliminary collector system configurations for six different combinations of 2 resource scenarios and 3 collector system designs were developed.
 - Radial Design of Wind Hubs
 - Network Design of Wind Hubs
 - Network Design of Wind Hubs and Transmission Export Hubs
- For each of 6 combinations, multiple radial and networked designs were analyzed = dozens of designs.
- Two example designs appear on following slides.

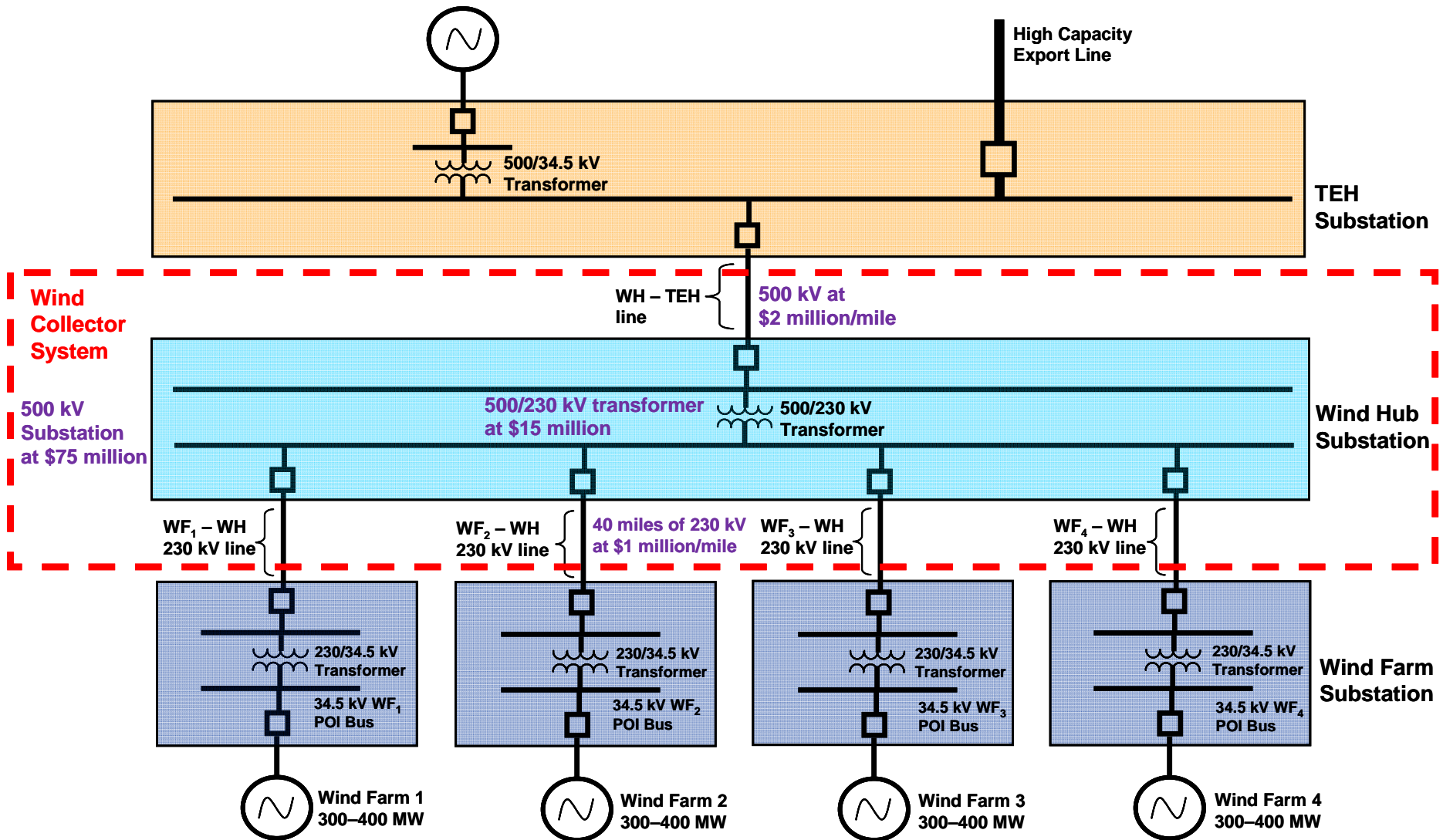
Illustrative Collector System Design - Radial



Illustrative Collector System Design - Networked



Subtask 1.4 – Preliminary Cost Estimates



Subtask 1.4 –Comparing Collector System Configuration Alternatives

- Collector system design candidates for collecting up to 12 GW of wind based on reliability characteristics and preliminary costs.

Collector System Configuration	Design Type	Cost Estimates (nominal \$ Billions)		Approximate Total Line Miles	
		Resource Scenario #1	Resource Scenario #2	Resource Scenario #1	Resource Scenario #2
Radial	Single Circuit	\$2.48	\$2.84	1,460	1,709
	Double Circuit	\$3.34	\$3.90	1,840	2,178
Networked WHs	Minimal Double Circuit	\$2.93	\$3.39	1,683	1,914
Networked WHs & TEHs	Minimal Double Circuit – Version 1	\$3.07	\$3.55	1,721	2,039

Notes:

- Costs are preliminary estimates of material and labor; costs do not include financing, right-of-way acquisition, or permitting.
- Costs could vary widely based on refinement of collector system designs, additional studies, and (or) level of wind generation curtailment deemed acceptable.

Subtask 1.5 – Selection of Collector System Configuration Alternatives

Design	Resource Scenario #1				Resource Scenario #2			
	Radial – Single Circuit	Radial – Double Circuit	Networked WHs	Networked WHs & TEHs	Radial – Single Circuit	Radial – Double Circuit	Networked WHs	Networked WHs & TEHs
Cost Estimate (\$ Billions)	\$2.48	\$3.34	\$2.93	\$3.07	\$2.84	\$3.90	\$3.39	\$3.55
Estimated Curtailment (MW)	1,400	400	400	400	1,800	400	400	400
Total outlet paths	11	22	26	23	9	18	30	25
Number of closed loops	0	0	5	4	0	0	6	5

Subtask 1.5 – Summarize Collector System Design Alternatives

Factors Affecting Collector System Phasing

- Location, amount, and timing of wind energy developed.*
- Potential to use existing ROW for some collector system transmission lines.
- Potential to upgrade existing transmission system in lieu of building new collector system lines.
- Common elements between the collector system designs for the two resource scenarios.

*Not considered in ICF study

Conclusions

- Reliable collector systems capable of transferring 12 GW of wind out of Wyoming were designed in concept.
- The designed systems will withstand rigorous contingencies of the collector network elements without significant overloads on the existing network.

Recommended Additional Technical Analyses

- One or two candidate hybrid collector designs from this study can be selected and analyzed in greater detail to refine and fine-tune the design and cost estimates.
- More rigorous contingency analyses of existing transmission system and export transmission line outages need to be performed to assess the impact on the collector system.
- Dynamic stability studies should be performed to determine possible voltage and stability impacts.
- Conduct a geospatial constraint and opportunity analysis to support preliminary collector system corridor planning.

Schedule

- January 25, 2010 – Presentation to WIA Board
- January 31, 2010 – Target date for Final Report