Wind Energy Developments on Forested Landscapes

Visual Quality: The Public Response

March 2015

Ministry of
Forests, Lands and
Natural Resource Operations

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Executive Summary

Wind energy is becoming an increasingly popular power-producing alternative in British Columbia. Although five developments have been completed and several more are going through the provincial Environmental Assessment process, the public response to the visual impacts of these developments is not well understood. To gain a better understanding of the public response to wind energy developments, the B.C. Ministry of Forests, Lands and Natural Resource Operations' Resource Practices Branch undertook a visual perception survey involving 591 participants in eight communities across the province. Conducted between January and June 2014, this survey asked participants to assign an acceptance rating and visual quality class to 70 scenes that contained various wind energy developments on forested landscapes under different viewing conditions.

Specific objectives were: (1) to determine the public response to scenes with and without wind turbine generators, and (2) to determine whether an attribute, or combination of attributes, can be used to predict public acceptance ratings (PARs) and visual quality classes.

Statistical analysis of the survey data produced the following key results.

- In all cases, respondents preferred natural appearing scenes over developed wind energy scenes, with a 21% drop in mean PAR between natural appearing scenes and developed scenes.
- Strong trends were evident between respondent-assigned PARs and various site attributes For example, public acceptance increases as the viewing distance increases and decreases as the number of wind turbines increases; in addition, aggregated wind turbines receive a lower mean PAR than dispersed turbines.
- Best individual predictors of mean PAR were wind turbine position, viewing distance, and viewing position. The number of wind turbine generators was also identified as a significant predictor but only in combination with viewing distance or turbine position in the landscape. Viewing distance, wind turbine position, and viewing position were also identified as the best individual predictors of modal visual quality class.

Although any visual perception study is influenced by many variables, such as the questions asked, the photographs selected, the classification scheme and statistical analysis employed, this study concludes that there are several factors that influence the public perceptions of wind energy developments.

Further analysis of the survey findings and socio-demographic data led to the development of two decision support tools that will help to both inform proponents and provincial government project reviewers engaged in future proposal assessments, and to convey some design guidance in reducing the visual effects of future wind energy installations in the province.

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- Gerrard Olivotto (Olivotto Forest Research), for administering the perception survey in eight communities and for inputting the data into the project spreadsheet.
- Jacquie Louie, for completing quality assurance checks on the public acceptance data and inputting data for two special-interest groups.
- Amanda Nemec (International Statistics and Research Corporation) for carrying out the statistical analysis on public perception survey data and summarized this aspect of the survey. Her work comprises the body of this report.
- Regional Visual Resource Specialists Luc Roberge, Lloyd Davies, and Peter Rennie for providing expert public acceptance ratings, and assisting with attribute coding, class assignment, and the subsequent peer review of the report.
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- All the organizations who contributed images and provided permission for their use: Zero Emissions Energy Development Inc., Vermont Environmental Research Associates, Appalachian Trail Conservancy, Vermont Environmental Research Associates, and Saratoga Associates.
- All the non-profit groups who participated in this survey (see Appendix 1).

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March 2015

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1 Introduction

Wind energy is becoming an increasingly popular power-producing alternative in British Columbia. Although five developments have been completed and several more are going through the provincial Environmental Assessment process, the public response to the visual impacts of these developments is not well understood. To gain a better understanding of the public response to wind energy developments, the B.C. Ministry of Forests, Lands and Natural Resource Operations' Resource Practices Branch, with financial assistance from the Environmental Assessment Office, undertook this visual perception survey.

The overall project goal was to provide the general public, wind energy proponents, and government staff with guidance on public responses to the visual impacts of wind energy developments. Specifically, it examined how the public responds to various developments on forested landscapes under different viewing conditions. The results presented here will help to both inform proponents and provincial government project reviewers engaged in future proposal assessments, and to convey some design guidance in reducing the visual effects of future developments.

The survey's detailed objectives were to:

- Match the wind energy sample group with the socio-demographic statistics for British Columbia as closely as possible.
- Determine the "public acceptance rating" (PAR; i.e., a measure of the public's acceptance of visual quality[1]) for each of the 70 images used in the study and rank them from highest to lowest PAR.
- Determine the public response to scenes with and without wind turbine generators.
- Examine PAR trends relative to different wind energy image/site attributes.
- Determine whether an attribute, or combination of attributes, will predict PAR.
- Determine the public visual quality class[2] for each of the 70 images used in the study.
- Examine the average PAR values by visual quality class for different groups (public, visual experts, First Nations, forest sector, wind sector, and Green Party) and by community.
- Examine visual quality class in relation to developed wind energy site attributes.
- Determine whether an attribute, or combination of attributes, can be used to predict visual quality class.

2 Survey Methodology

This survey involved:

- taking photographs;
- collecting and recording site data;
- selecting, editing, and classifying photographs;
- choosing survey participants;
- administering the survey;
- inputting the data; and
- analyzing the results to determine public acceptance trends and relationships.

[1] Visual quality is defined as the character, condition, and quality of a scenic landscape or other visual resource and how it is perceived, preferred, or otherwise valued by the public. The visual resource refers to the quality of the environment as perceived through the visual sense only.

[2] Visual quality class (VQC) is a classification that refers to the character and (or) condition of the visual resource.

2.1 Site Photography and Field Data Collection

To complete this survey, photographic fieldwork was conducted in the spring of 2012 and 2013 at the four developed wind energy sites in British Columbia (Bear Mountain, Dokie, Quality, and Cape Scott). Photographs taken from the ground and from the air tried to replicate how wind energy developments would be viewed travelling along a highway or from a community. Where possible, a 50–60 mm lens was used to capture the same perspective as seen by the human eye. Multiple photographs of each site were taken from different viewpoints; all photographs included the GPS location. At least 70 photographs were required to capture different wind energy layouts, distance zones, colour schemes, and numbers of wind turbine generators.

2.2 Selecting, Editing, and Classifying Photographs

Representative photographs were selected by choosing those that had the best lighting and that most closely represented the scene as a viewer might observe it outdoors. Some images contained foreign objects or structures (e.g., power lines) that could distract the viewer. In these cases, the photographs were processed with photo-editing software to remove the extraneous objects. Because the photographs of developed sites did not cover a full range of situations, photo editing was also used to simulate a greater range of variables, such as increasing or decreasing the number of wind turbine generators on the landscape. Finally, when all the selected photographs had been edited, the slide order for presentation was determined by entering the number of slides (n = 70) into an online randomizer (www.randomizer.org) that produced a random sequence for the slide show.

To correlate public response to the site attributes of wind energy developments, each attribute in each scene required identification and rating. For each image, 11 attributes were identified: viewing distance, viewer position, number of wind turbine generators, distribution of wind turbine generators, spacing between wind turbine generators, position, linearity, skyline, colour, lighting, and visible gap. Section 3.2.4 describes each of these attributes more fully.

Determining the rating for some attributes was mechanical. For example, the viewing distance to the development was measured on a map, whereas determining the number of turbines involved a visual count. In other cases, it was necessary to derive a rating for an attribute. To do this, each of the 70 selected images was shown to four provincial visual experts and consensus was used to identify the most appropriate rating for each attribute.

2.3 Choosing Participants

One of the challenges in public perception studies is to obtain an unbiased sample by soliciting participation from non-political, non-aligned groups or individuals. For this study, the goal was to sample approximately 80–90 people in each of seven communities across the province for a total sample size of 600 respondents. The communities

Figure 1. *Locations of communities sampled for wind energy visual perception survey.*

chosen (Dawson Creek, Prince George, Williams Lake, Kamloops, Nelson, Vancouver, and Port Hardy) represented the North, South, and Coast Areas of the B.C. Ministry of Forests, Lands and Natural Resource Operations (the "Ministry"), as well as various rural and urban settings. Victoria was added to the survey as an eighth community after we experienced difficulty in getting the necessary number of participants in Vancouver.

To initiate the survey, a list of non-profit organizations was developed for each community that targeted service and professional clubs, outdoor activity and hobby clubs, and seniors' and First Nations centres. The groups were contacted by telephone to determine their interest in participating in the study. After initial contact with each group, a follow-up email provided the group with details about the survey. As an incentive, the non-profit groups were offered a $10 honorarium for each participant. Alternatively, other incentives such as refreshments and lunch for the group were provided. In cases where it was difficult to get the required number of participants from non-profit organizations, staff members at local Ministry offices were sampled.

Table 1. *Number of sample groups (community organizations) and respondents*

Community	No. groups	No. people per group Minimum	Maximum	Mean	Total
Dawson Creek	8	3	12	7.5	**60**
Prince George	9	3	23	11.2	**101**
Williams Lake	11	4	11	6.7	**74**
Kamloops	8	4	28	14.0	**112**
Nelson	9	2	14	6.9	**62**
Vancouver	5	4	34	15.2	**76**
Port Hardy/ Port McNeill	10	2	16	7.3	**73**
Victoria	1	14	14	14.0	**14**
Subtotal	**61**				**572**
Green Party[a]	2	5	14	9.5	**19**
Total	**63**[b]	**2**	**34**	**9.4**	**591**

[a] *Note: The Green Party of Canada (a political entity) was inadvertently sampled as part of the Vancouver population, which was an error. These samples have been excluded from the analysis except where group comparisons were made.*

[b] *The number of organizations on this list will not match those presented in Appendix 1, as some random public groups were surveyed in addition to organized groups.*

2.4 Survey Delivery

To ensure a professional and unbiased delivery of information regarding the survey intent and content, a standardized introduction was given to each group. After a survey package (see Appendix 2) and pen was handed out to each participant, survey administrators introduced themselves to the group and explained the purpose of the study and how it will help the Ministry understand residents' responses to wind energy developments.

Participants were informed that: "This survey seeks your preference about the visual quality of 70 landscape scenes that contain wind energy developments."[3] It was then explained that the survey consisted of the following three parts.

1. A practice session in which participants were asked to view six landscape scenes and become familiar with the survey form and rating criteria.[4]
2. Participants were asked to view and evaluate 70 colour PowerPoint® slides, each showing a different wind energy development. Each participant was asked to assign one of the following descriptive visual quality classes to each scene:
   - Turbines are indistinct and form minor insignificant elements.
   - Turbines are clearly visible but not intrusive.
   - Turbines appear fairly large in scale, and are a distinct element in the landscape.
   - Turbines appear large in scale and dominate the field of view.

[3] It should be noted that five of the 70 slides were natural appearing scenes without any wind energy developments.

[4] Data from the practice slides were not used in subsequent data analysis.

Participants were also asked to assign a numerical public acceptance rating (PAR), based on the following seven-point Likert scale:

−3	−2	−1	0	+1	+2	+3
Very Unacceptable	*Moderately Unacceptable*	*Slightly Unacceptable*	*Neutral*	*Slightly Acceptable*	*Moderately Acceptable*	*Very Acceptable*

3. After rating the wind energy developments, respondents were asked to provide basic demographic information: gender, age, education, occupation, income, and place of residence. This enabled comparisons between the survey population and census profiles for British Columbia and Canada.

Figure 2. *Survey in progress at the University of Northern British Columbia in Prince George.*

After the introduction and practice slides, the main slide show was started. The slides were projected on a large screen (~2 × 2 m) in a darkened room. The number of each slide was present in the bottom right of each projection and was introduced with the changing of each slide to ensure that participants did not lose their place in the slide show. In addition, periodic reminders were made to confirm that each participant was rating the proper slide and that they were not getting ahead or behind in the presentation.

The contractor received the slides for presentation in random order. Each of the slides was shown for 15–20 seconds to allow for a public acceptance Likert rating, a visual quality class rating, and a brief comment. To control for "order effects" (i.e., the potential for slide order to influence outcome), approximately every second group was shown the slides in reverse order.

The evaluation form included a space for comments so participants could make notes about any physical qualities in each photo that elicited a reaction (see Appendix 2). Additional space for paragraph-format comments was provided at the end of the survey form for those willing to write more extensive remarks after the slide presentation.

Following the survey and after the evaluation forms had been collected, an optional 5-minute slide presentation was provided to the group to explain the mechanics of wind turbines and the opportunities existing in British Columbia. This presentation resulted in conversational feedback from participants that included wide-ranging discussions about wind energy specifics and concerns in the local community. No data or comments from this optional session were included in the survey analysis.

2.5 Statistical Methods

2.5.1 Socio-demographic profile of survey participants

The distribution of survey participants (number and percentage of respondents) by gender, age, education, occupation, income, and place of residence (urban or rural) was compared graphically with the corresponding demographic profiles for British Columbia and Canada. Chisquared tests,[5] where all respondents were assumed to be drawn independently from a common population (i.e., ignoring intra-community and intra-group correlations), were used to assess the statistical significance of differences between the survey sample and the general populations of British Columbia and Canada.

2.5.2 Public Acceptance Ratings (PAR)

Assessments of individual scenes were summarized by tabulating the number and percentage of respondents who assigned the seven-point Likert scale ratings. Results were plotted in a series of (70) histograms sorted in order of decreasing mean PAR.

To investigate how socio-demographic factors influence an individual's opinion of wind energy developments, scores for wind turbine generator (n = 65) and natural appearing (n = 5) scenes were averaged separately for each respondent and the mean difference (i.e., mean PAR for wind turbine generator scenes minus mean PAR for natural appearing scenes) was calculated as a measure of the respondent's relative acceptance of the wind turbine generator scenes. Results were compared across socio-economic classes by applying a one-way analysis of variance[6] (ANOVA; factors tested one at a time) and by plotting the class means to illustrate trends.

2.5.3 Predictors of mean public acceptance ratings

A preliminary investigation of site trends in PARs was carried out by plotting mean PAR (and frequency distribution of individual values) versus the following 11 variables: viewing distance, viewer position, number of wind turbine generators, distribution of wind turbine generators, spacing between wind turbine generators, position, linearity, skyline, colour, lighting, and visible gap. Regression[7] models with all possible combinations of predictors (excluding wind turbine colour[8]) were fitted using the following equation:

$$\overline{PAR}i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_q x_{iq} + \varepsilon_i \qquad \textbf{(1)}$$

where: $\overline{PAR}_i$ is the mean PAR for Slide i; $\{x_{i1}, x_{i2}, \ldots, x_{iq}\}$ are (dummy) variables representing the predictor values (or class levels); and the random errors $\{\varepsilon_i\}$ were assumed to be independent and normally distributed with mean 0 and constant variance σ_ε^2. The "best" combination of predictors was selected by comparing the adjusted R^2 and estimates of σ_ε^2, and by plotting C_p versus p (p = number of estimated parameters = $q + 1$), for all fitted models. Model parameters were estimated by the maximum likelihood method (using PROC MIXED in SAS[9]).

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5 Any statistical hypothesis test in which the sampling distribution of the test statistic is a Chi-square distribution when the null hypothesis is true, or any in which this is asymptotically true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a Chi-square distribution as closely as desired by making the sample size large enough.

6 ANOVA is a collection of statistical models used to analyze the differences between group means and their associated procedures (such as "variation" among and between groups).

7 Regression analysis includes any techniques for modelling and analyzing several variables when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied while the other independent variables are held fixed.

8 Wind turbine generator colour was excluded from the list of potential predictors because each colour scheme (except "off white") was represented only by a single slide.

9 SAS is a software suite developed by SAS Institute for advanced analytics, business intelligence, data management, and predictive analytics.

2.5.4 Visual quality class

Site trends in visual quality class were assessed informally by comparing the distribution of responses for the wind turbine generator colour sequence (nine slides) and for wind turbine generator scenes (65 slides) classified according to the 10 candidate predictors: turbine number, position, spacing, and distribution; linearity of turbine arrangement; viewing position; viewing distance; skyline; lighting; and the presence/absence of a visible gap.

2.5.5 Predictors of modal visual quality class (VQC)

Candidate predictors of visual quality class (listed above) were evaluated by fitting the following multinomial model[10]:

$$p(VQC_i \leq k) = \frac{e^{\alpha_k + \beta_1 x_{i1} + \beta_{i2} + \ldots + \beta_q x_{iq}}}{1 + e^{\alpha_k + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_q x_{iq}}} \qquad (2)$$

where: the dependent variable *VQCi* is the modal VQC (i.e., class most frequently assigned) to Slide i by the survey respondents; $k = 1, 2, 3, 4$ correspond to the classes A, B, C, and D respectively[11]; and $\{x_{i1}, x_{i2}, ..., x_{iq}\}$ are one or more predictor variable(s) describing the scene in Slide i. Predictors were selected by fitting models with all combinations of predictors and selecting the model that had the fewest parameters and did not differ significantly (based on likelihood ratio test) from the model that included all predictors. Model parameters α_k ($k = 1, 2, 3, 4$) and $\{\beta_1, \beta_2, ..., \beta_q\}$ were estimated by maximizing the likelihood function (PROC GLIMMIX in SAS).

3 Survey Results

3.1 Socio-demographic Profile of Survey Participants

Response rates (including Green Party respondents) exceeded 99% for all socio-demographic questions. Ninety-seven percent of the respondents lived in British Columbia and the remaining 3% resided in another Canadian province (n = 10) or another country (n = 6). Figures 3–6 compare the gender, age, education, and occupation of survey respondents with the corresponding profiles for British Columbia and Canada.[12,13,14]

Figure 7 shows the income distribution of the survey respondents compared with the 2011 provincial and national income distributions.[15] Figure 8 shows the sample breakdown into

[10] A regression model that generalizes logistic regression by allowing more than two discrete outcomes. That is, a model used to predict the probabilities of the different possible outcomes of a categorically dependent variable, given a set of independent variables.

[11] Probabilities for individual classes can be obtained by subtraction: $p(VQC_i = 1) = p(VQC_{ik} \leq 1)$;

$p(VQC_i = k) = p(VQC_i \leq k) - p(VQC_k \leq k - 1)$ $k = 2, 3$;

$p(PAR_i = 4) = 1 - p(PAR_i \leq 3)$.

[12] Statistics Canada. Table 051-0001. Estimates of population, by age group and gender for July 1, Canada, provinces and territories (annual table). Canadian Socioeconomic Database from Statistics Canada (CANSIM) database. www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0510001&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid= (Accessed Aug. 04, 2014).

[13] Statistics Canada. Table 282-0003. Labour force survey estimates, by educational attainment, gender, and age group, unadjusted for seasonality (monthly table). CANSIM database. www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2820003&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid= (Accessed July 29, 2014).

[14] Statistics Canada. Table 282-0009. Labour force survey estimates, by National Occupational Classification for Statistics and gender, unadjusted for seasonality (monthly table). CANSIM database. www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2820009&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid= (Accessed July 29, 2014).

[15] Statistics Canada. Table 202-0402. Distribution of total income of individuals, 2011 constant dollars, (annual table). CANSIM database. www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2020402&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid= (Accessed July 29, 2014).

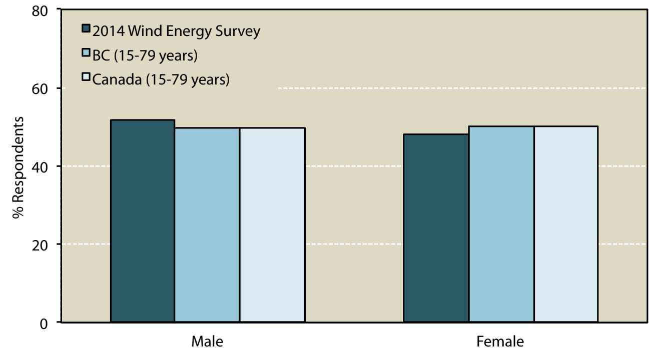


Figure 3. *Gender of survey respondents.*

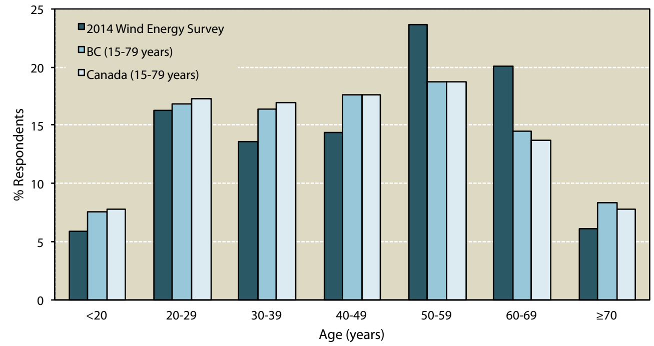


Figure 4. *Age of survey respondents.*

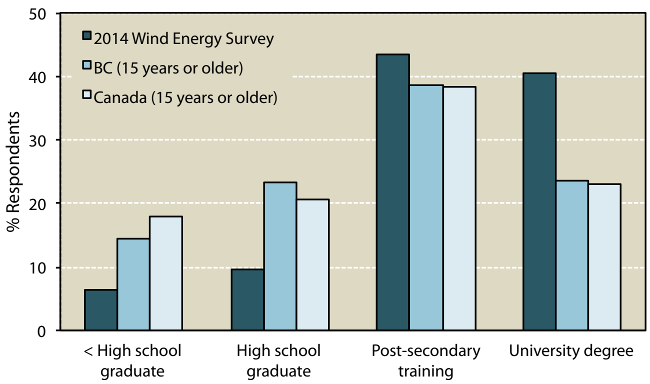


Figure 5. *Highest level of education attained by survey respondents, 15 years or older.*

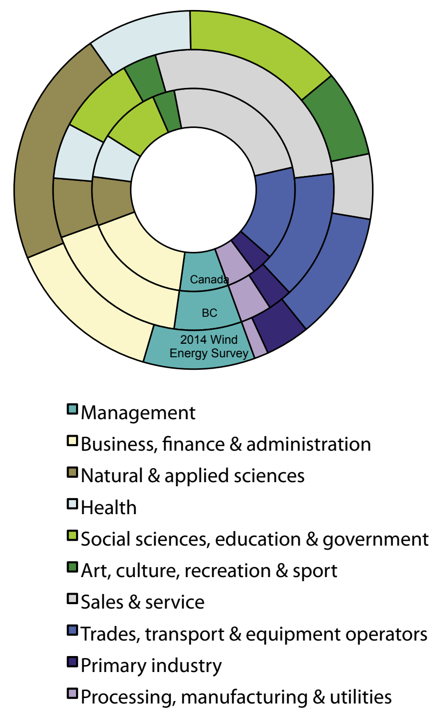


Figure 6. *Occupation of survey respondents.*

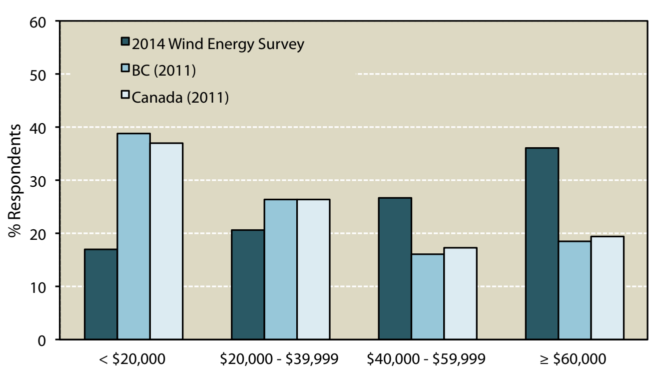


Figure 7. *Total personal income of survey respondents.*

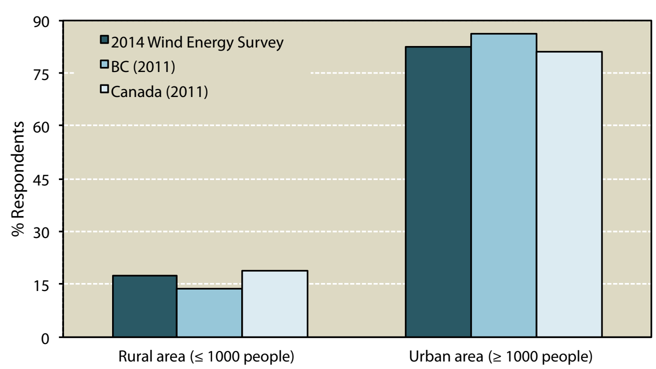


Figure 8. *Survey respondents from urban and rural areas.*

residents of urban (town, city, or large city) and rural areas, and the comparison with the provincial and national breakdowns in 2011.

3.2 Public Acceptance Ratings (PARs)

In this study, the participants were asked to rate each image regarding how acceptable the scene was to them. The mean PAR for each slide was calculated and is presented with its overall rank in Appendix 3. "Rank 1" is highest mean PAR, whereas "Rank 70" is lowest mean PAR. Appendix 4 provides photographs of each of the landscapes and bar graphs illustrating the PAR distributions for the 70 scenes.

The mean PARs are based on the main sample of 572 individuals for which response rates were near 100% (i.e., no fewer than 571 out of 572 individuals rated each scene). In general, there was good agreement among respondents in their assessment of the highest-ranking scenes. For instance, the four scenes with the highest mean PAR (> 2.2) were rated as "very acceptable" (PAR = +3) by more than 69% of respondents, and assigned visual quality class of "turbines are indistinct and form minor insignificant elements" (VQC = A) by more than 95% of respondents.

In contrast, a lack of agreement was evident for the lowest-ranking scenes. The PAR scores for the five scenes with the lowest mean PAR (< –0.2) were approximately uniformly distributed over the range –3 to +3, even though more than 70% of the respondents were in agreement that the "turbines appear large in scale and dominate the field of view" (VQC = D).

Mean PAR correlates strongly with the estimated log odds of a positive (PAR^+) rather than negative (PAR^-) rating (i.e., the ratio of the respective percentage response frequencies for [+1, +2, +3] and [–3, –2, –1]). To further facilitate interpretation,[16] these log odds have been converted to probabilities in Figure 9. For example, a mean PAR of 1.5 corresponds to an 87% probability that a scene will receive a positive rather than negative rating, whereas a mean PAR of 0 corresponds to a 50% probability that a scene will receive a positive rather than negative rating.

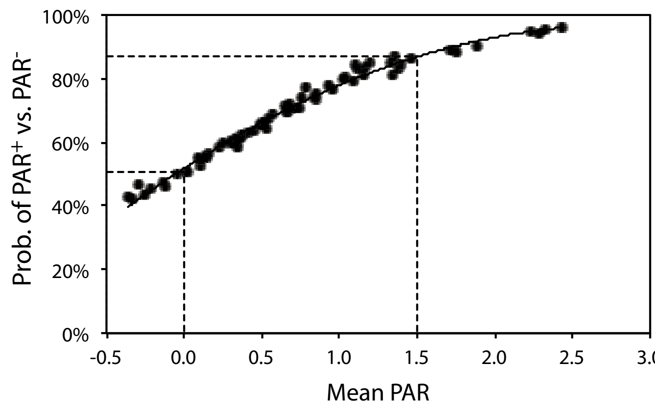


Figure 9. *Relationship between mean PAR and the estimated probability of PAR^+ (+1, +2, +3) versus PAR^- (–3, –2, –1). The vertical (dashed) line shows the correspondence between a mean PAR of 0 and 1.5 with probabilities of 50% and 87% of a positive rather than negative response.*

3.2.1 Viewing order

The PowerPoint presentation was shown forward and in reverse to determine whether slide order influenced PAR ratings. The analysis revealed an order effect, whereby average PAR values were lower for the slides shown in the forward direction compared with those shown in the reverse direction (Table 2).

[16] Use of the sample mean to summarize Likert-scale data has been criticized because the mean cannot be interpreted on the same scale as the data. In the present application, interpretation of mean PAR is facilitated through its correlation with the odds of PAR^+ relative to PAR^- (Figure 9)—a number that is easy to interpret.

Table 2. *Mean public acceptance ratings by slide show direction*

Slide order direction	**No. participants**	**% participants**	**Average PAR**
Forward	314	54.9	0.62
Reverse	258	45.1	0.79

The difference in mean PAR (reverse order minus standard order) and corresponding change in position (e.g., slide in position 1 moves to position 70 when the order is reversed, resulting in a change in position of –69) were calculated and plotted for each slide (Figure 10). The fitted (orange) trend line shows a significant downward trend in PAR when slides were viewed sooner rather than later and a significant offset between the two groups. The former effect may be related to viewer fatigue, whereas the latter suggests that the two groups differ in one or more characteristics (e.g., age) that influence public acceptance ratings (see Section 3.2.3).

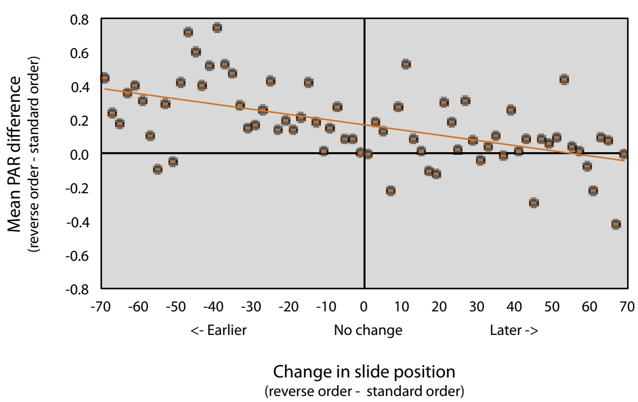


Figure 10. *Effect of viewing order on mean public acceptance rating.*

3.2.2 Paired comparison of scenes in natural appearing and developed states

To determine how wind turbine generator development affects the assessment of a scene, five scenes were shown in their natural appearing and developed states to survey participants (Table 3). The results indicate that the PAR distribution for the natural appearing scene in each pair is skewed towards +3 (mean PAR = 2.2 ± 0.05). The wind turbine generator distribution, although shifted towards less favourable scores (mean PAR = 0.72 ± 0.06), shows a lesser degree of consensus (i.e., scores are more uniformly distributed across the PAR range). This change translated into an average mean PAR (turbine development minus natural appearing state) difference of –1.47 ± 0.06 for the five pairs. Figures 11–15 present the actual pre- and post-development slides shown to participants.

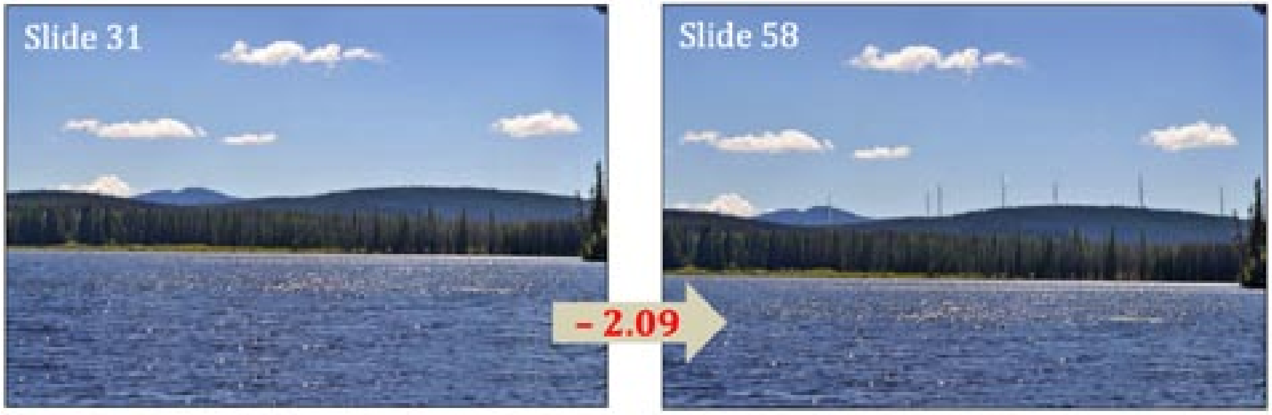
Table 3. *Mean public acceptance ratings for natural appearing scenes versus developed scenes*

Scene name	**Natural appearing versus Developed**	**Mean PAR**
Rim Rock Viewpoint	Natural appearing (Slide 6)	1.71
	With wind turbines (Slide 40)	0.66
Hatheume Lake	Natural appearing (Slide 31)	2.43
	With wind turbines (Slide 58)	0.34
Dokie Siding	Natural appearing (Slide 34)	2.32
	With wind turbines (Slide 55)	1.40
Quality Viewpoint 3	Natural appearing (Slide 44)	2.23
	With wind turbines (Slide 8)	0.37
CESA Figure 12 Appalachian Trail	Natural appearing (Slide 46)	2.29
	With wind turbines (Slide 3)	0.85
Natural appearing (mean)		**2.20**
With wind turbine generators (mean)		**0.72**

3.2.3 Socio-demographic trends in public acceptance ratings

Analysis of variance of the difference between mean PAR for wind turbine generator scenes and for natural appearing scenes suggests that age ($p < 0.01$, Figure 16), education ($p < 0.01$, Figure 17), and income ($p < 0.01$, Figure 18) are all factors that influence an individual's opinion of wind energy developments.

A significant community effect ($p < 0.01$, Figure 19) is also evident. Reductions in mean PARs for wind turbine generator scenes versus natural appearing scenes were similar (~ –0.75) for respondents from Victoria and Dawson Creek, and tended to be smaller than those for



Hatheume Lake pre-development PAR = 2.43   Hatheume Lake post-development PAR = 0.34

Figure 11. *Hatheume Lake pre- and post-development public acceptance ratings.*

Quality Viewpoint 3 pre-development PAR = 2.23   Quality Viewpoint 3 post-development PAR = 0.37

Figure 12. *Quality Viewpoint 3 pre- and post-development public acceptance ratings.*

CESA Figure 12 pre-development PAR = 2.29   CESA Figure 10 post-development PAR = 0.85

Figure 13. *Clean Energy States Alliance Figure 12 pre- and post-development public acceptance ratings.*

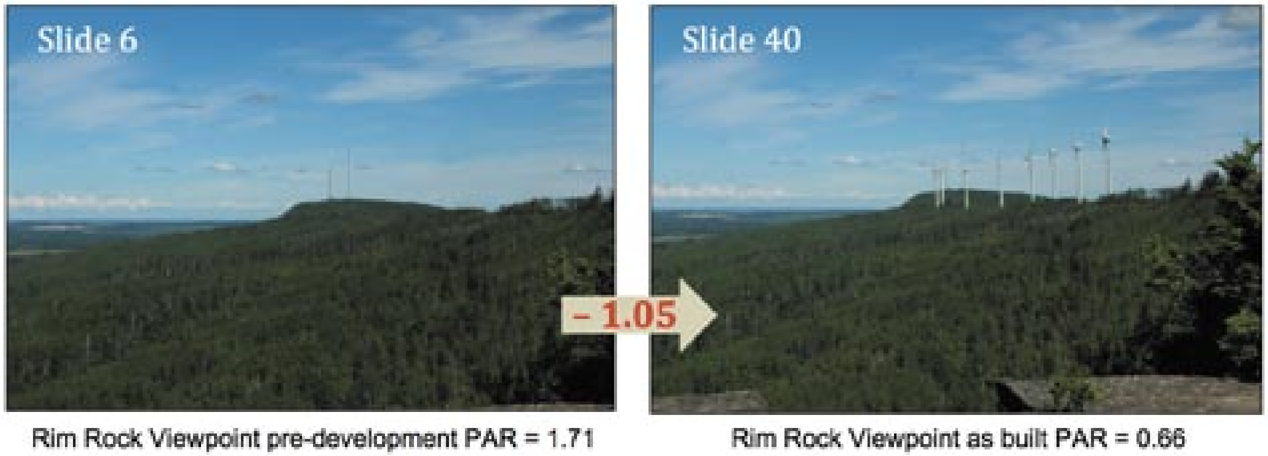


Figure 14. *Bear Mountain Rim Rock Viewpoint pre- and post-development public acceptance ratings.*

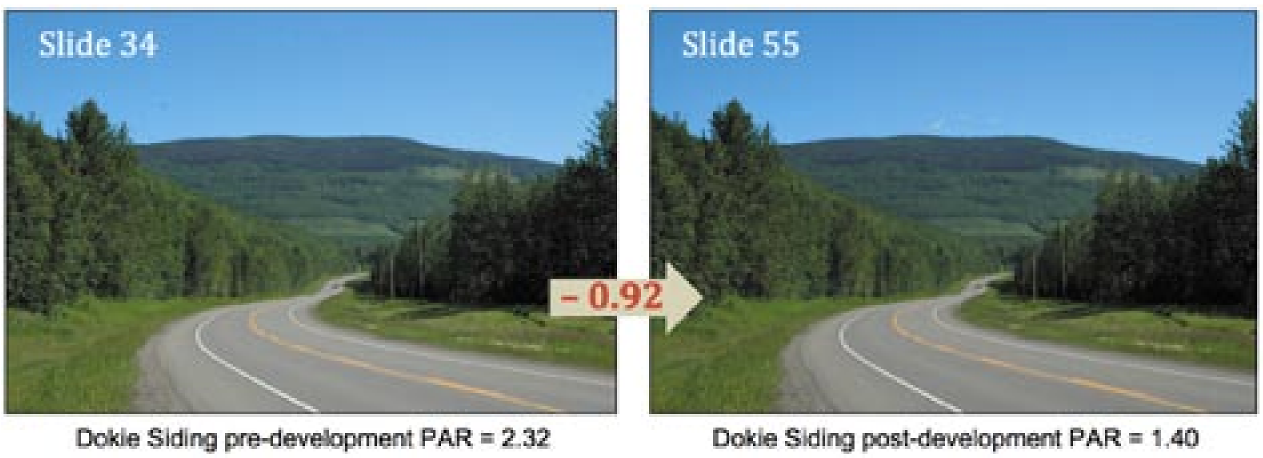


Figure 15. *Dokie Siding pre- and post-development public acceptance ratings.*

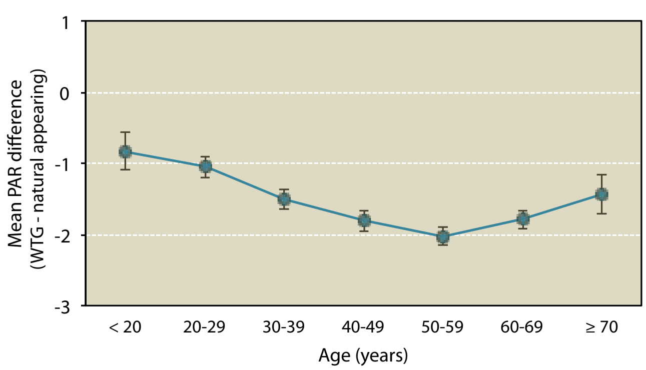


Figure 16. *Effect of age class on respondents' relative rating of wind turbine generator scenes (i.e., mean PAR for 65 wind turbine generator scenes minus mean PAR for five natural appearing scenes). Points are class averages with error bars representing ± 1 standard error.*

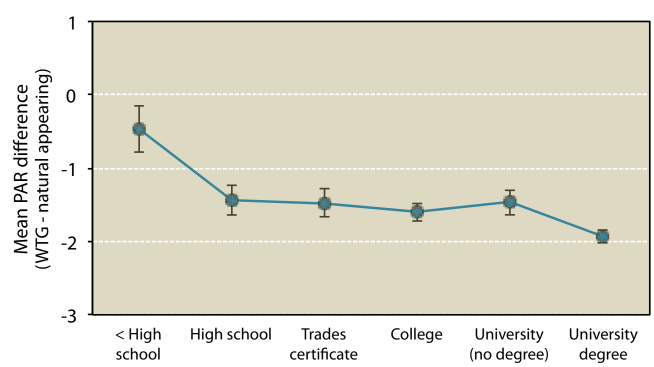


Figure 17. *Effect of education class on respondents' relative rating of wind turbine generator scenes (i.e., mean PAR for 65 wind turbine generator scenes minus mean PAR for five natural appearing scenes). Points are class averages with error bars representing ± 1 standard error.*

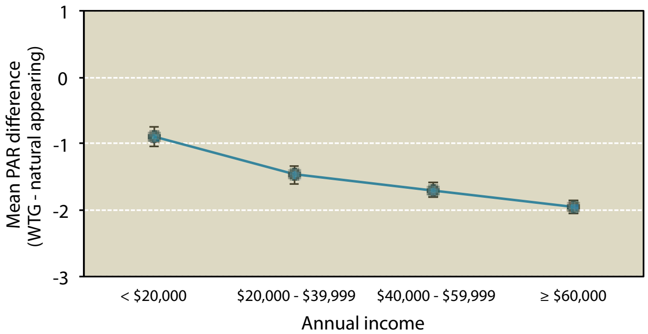


Figure 18. *Effect of income class on respondents' relative rating of wind turbine generator scenes (i.e., mean PAR for 65 wind turbine generator scenes minus mean PAR for five natural appearing scenes). Points are class averages with error bars representing ± 1 standard error.*

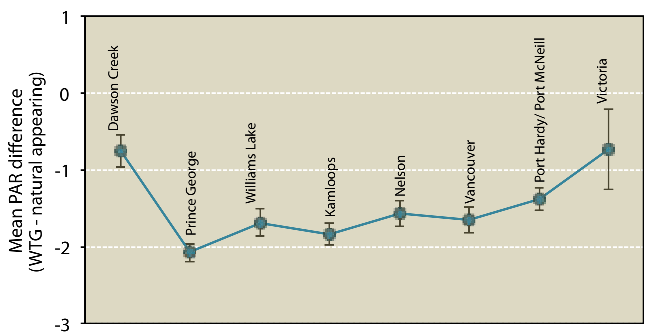


Figure 19. *Community effect on respondents' relative rating of wind turbine generator scenes (i.e., mean PAR for 65 wind turbine generator scenes minus mean PAR for five natural appearing scenes). Points are class averages with error bars representing ± 1 standard error.*

the remaining six communities, which were similar to each other and in the range (~ –2 to –1). Figure 20 illustrates differences (p < 0.01) between four subgroups—forest sector, First Nations, wind sector, Green Party—and the remaining respondents (other). Differences between the First Nations group and the other

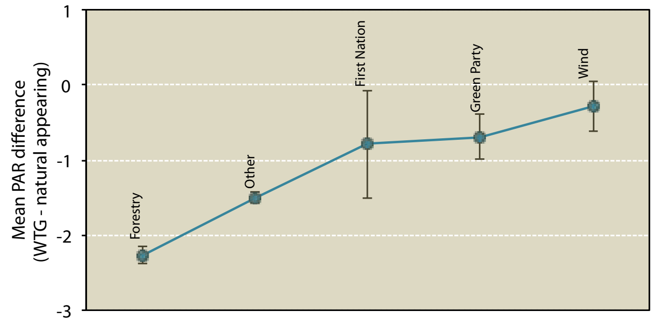


Figure 20. *Effect of group membership on respondents' relative rating of wind turbine generator scenes (i.e., mean PAR for 65 wind turbine generator scenes minus mean PAR for five natural appearing scenes). Points are class averages with error bars representing ± 1 standard error.*

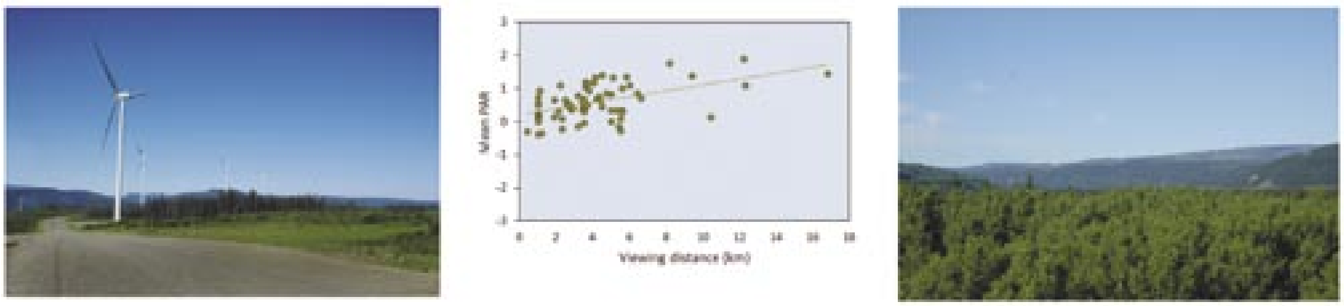
groups were not statistically significant owing to a large margin of error related to the small sample size (n = 9) for the First Nations group; similarly, the difference between the wind sector group (n = 7) and the Green Party (n = 19) was not statistically significant. The reduction (–2.2) in mean PARs for the wind turbine generator scenes versus the natural appearing scenes was significantly greater in magnitude for the forest sector group than the reductions seen in other groups (excluding the First Nations group).

3.2.4 Trends in public acceptance ratings relative to wind energy site attributes

This section examines the trends in public acceptance ratings relative to the 11 attributes for developed wind energy sites, specifically: viewing distance, viewer position, number of wind turbine generators, distribution of wind turbine generators, spacing between wind turbine generators, position, linearity, skyline, colour, lighting, and visible gap. (Figures 21–31).

Viewing distance

Viewing distance affects how much of the landscape you can see and the detail within it. The closer you are, the more detail you see; at greater distance, detail blends together (Figure 21).



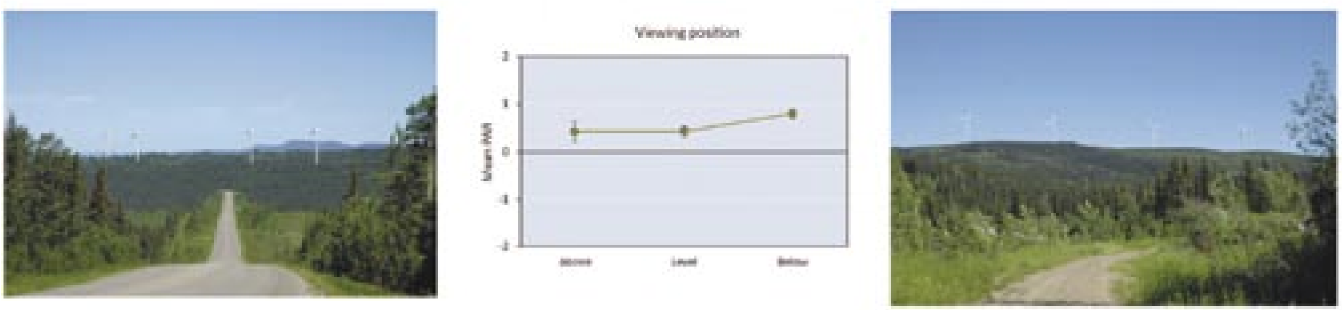
Slide 61: Distance 1.2 km, PAR –0.34

Slide 68: Distance 16.8 km, PAR 1.46

Figure 21. *Mean public acceptance ratings versus viewing distance.*

Viewing position

Viewing position relates to the manner in which the public views wind energy developments. Three scenarios were examined: (1) above, looking down on development; (2) level with development; or (3) below, looking up at development (Figure 22).



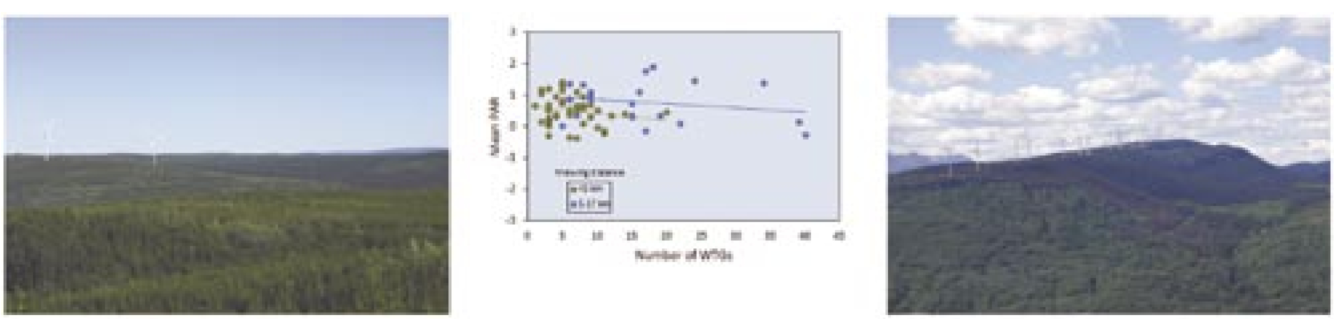
Slide 8: Viewer level, PAR 0.37

Slide 50: Viewer below, PAR 0.79

Figure 22. *Mean public acceptance ratings versus viewing position.*

Number of wind turbine generators

Figure 23 shows the survey participants' mean public acceptance ratings related to the numbers of visible wind turbine generators in the scene.



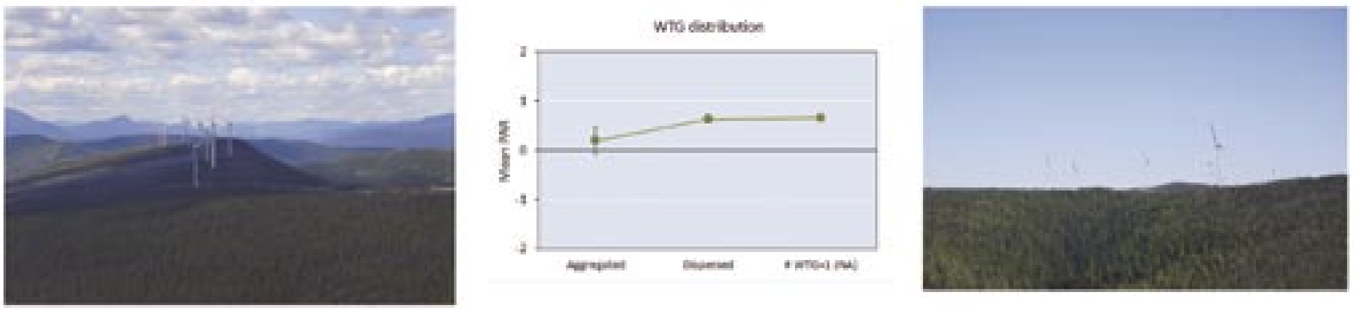
Slide 56: two turbines, PAR 1.03

Slide 53: 22 turbines, PAR 0.10

Figure 23. *Mean public acceptance ratings versus number of visible wind turbine generators.*

Distribution of wind turbines

Two parameters were considered when examining the distribution of wind turbine generators on the landscape: (1) a dispersed distribution of turbines; and (2) an aggregated distribution, in which turbines are clustered or concentrated in a limited area (Figure 24).

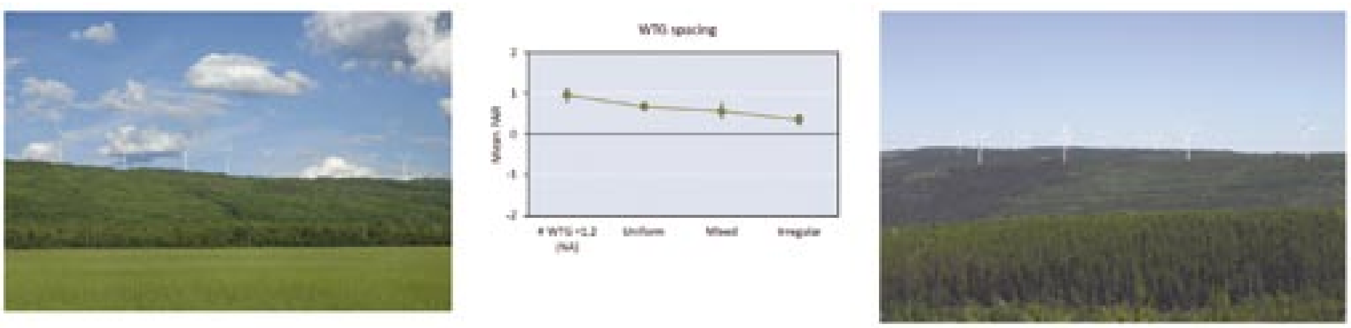


Slide 12: Aggregated turbines, PAR –0.04 **Slide 7: Dispersed turbines, PAR 0.54**

Figure 24. *Mean public acceptance ratings versus wind turbine distribution. If the number of turbines = 1 (#WTG=1), then distribution is recorded as not applicable in data set.*

Spacing of wind turbines

At wind energy developments, the spacing or interval between wind turbine generators can vary from uniform (where the same spacing is repeated) to a wide range of irregular, variable, or random spacings (Figure 25).

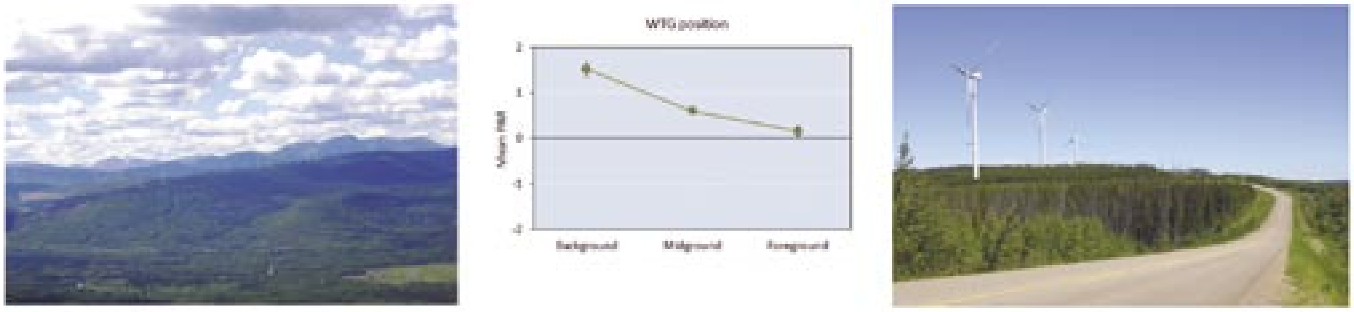


Slide 52: Uniform spacing, PAR 0.68 **Slide 37: Irregular spacing, PAR 0.36**

Figure 25. *Mean public acceptance ratings versus wind turbine spacing. If the number of turbines = 1–2 (#WTG=1,2), then spacing is recorded as not applicable in data set.*

Position of wind turbines

Three parameters were considered when examining the relative position of wind turbines within the landscape: (1) foreground, 0–2 km; (2) mid-ground, 2–8 km; and (3) background, 8 km and beyond (Figure 26).

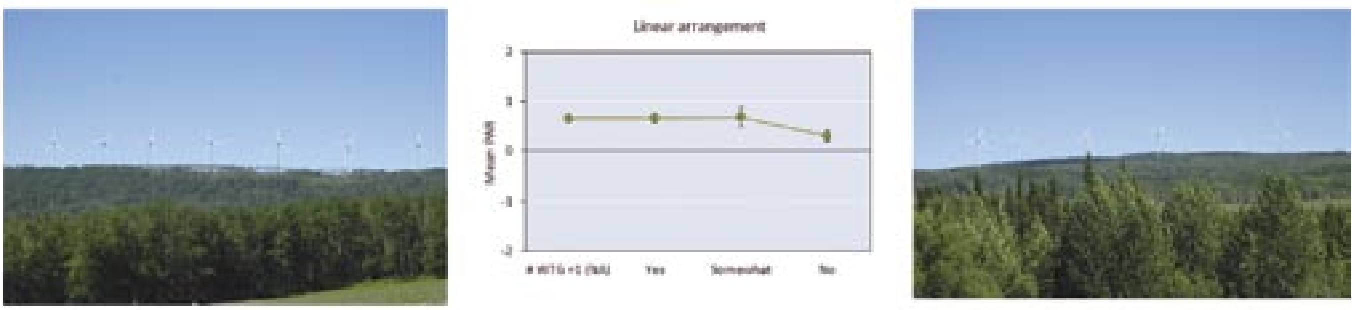


Slide 35: Background, PAR 1.38 **Slide 20: Foreground, PAR 0.22**

Figure 26. *Mean public acceptance ratings versus position of wind turbines in landscape.*

Linearity of wind turbine generators

The concept of linearity relates to the organization of wind energy developments. Linear developments consist of wind turbines organized along an axis or line. Non-linear developments consist of more varied or random patterns, as would happen in nature (Figure 27).

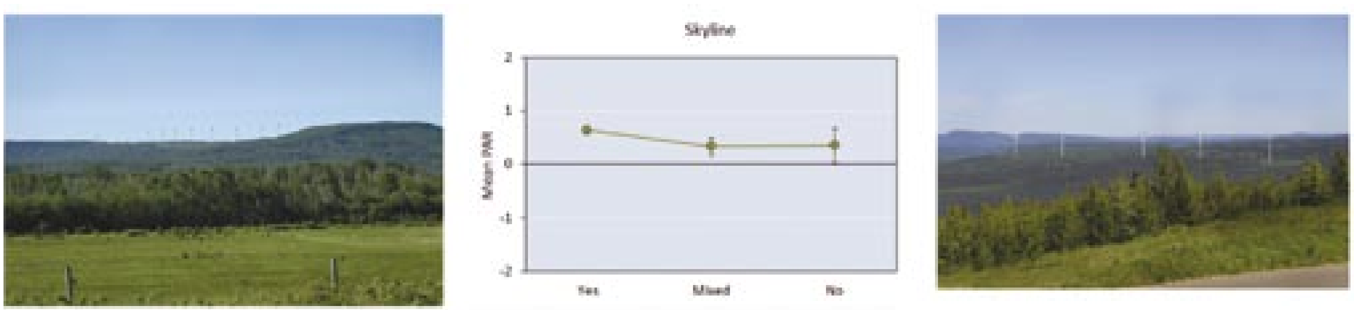


Slide 15: Linear, PAR 0.50 **Slide 24: Non-linear, PAR 0.50**

Figure 27. *Mean public acceptance ratings versus linear arrangement of wind turbines. If the number of turbines = 1 (#WTG=1), then linearity is recorded as not applicable in data set.*

Wind turbines relative to skyline

Figure 28 shows the survey participants' mean public acceptance ratings related to the landscape position of wind turbine generators. In some cases, turbines will be visible on the skyline; in other cases, the turbines will be viewed against a plateau-like environment or forested backdrop.



Slide #36 On skyline PAR 1.10 **Slide #22 Not on skyline PAR 0.76**

Figure 28. *Mean public acceptance ratings versus skyline position of wind turbine generators.*

Wind turbine generator colour

Contrasting colours on forest-green landscapes are difficult to accommodate. In most wind energy developments, the turbines are painted a flat, off-white colour. This attribute was included in the survey to determine whether some turbine colours might act to better tie the developments in with their forested backdrops (Figure 29).

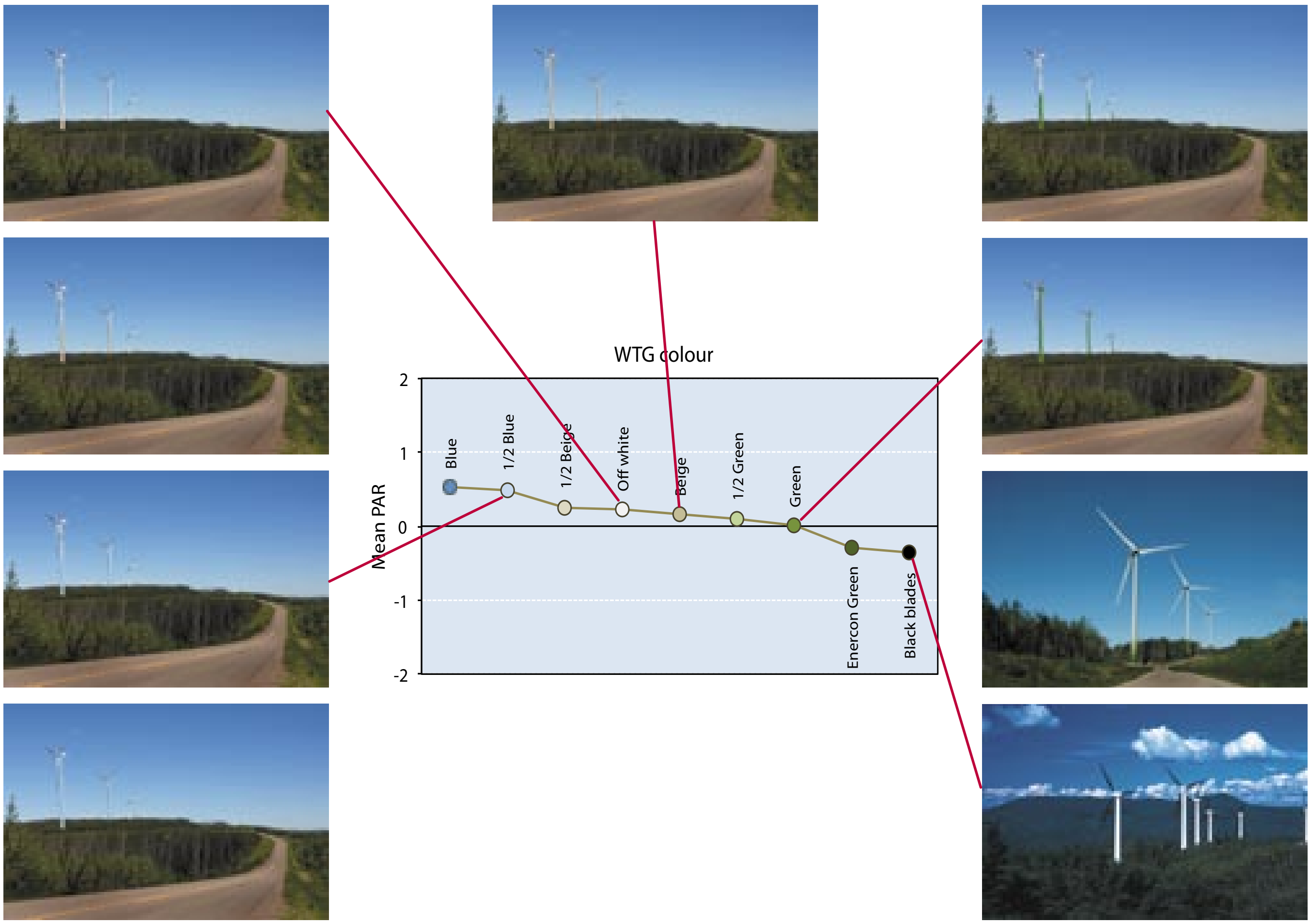
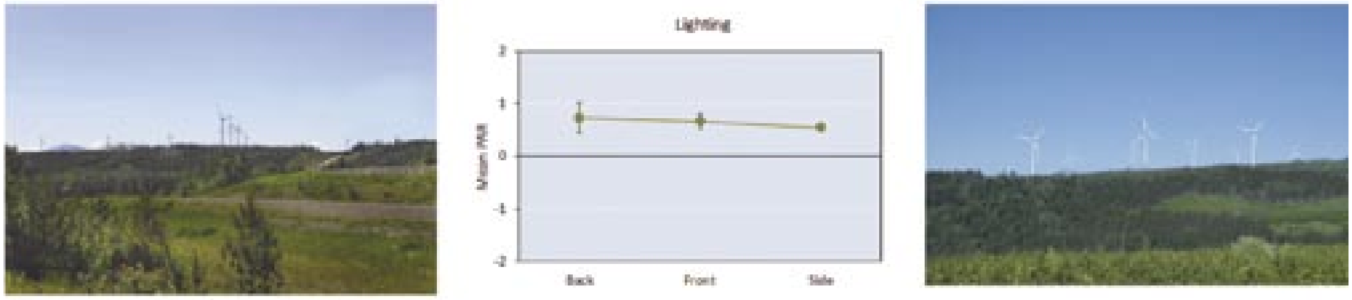


Figure 29. *Mean public acceptance ratings versus colour of wind turbine generators.*

Lighting effects

Figure 30 shows the survey participants' mean public acceptance ratings related to landscape lighting effects. In landscapes with back lighting (i.e., sun in your face), detail is lost because everything is in shadow and wind turbines become silhouettes against the sky. In landscapes with side lighting, shadows create strong relief, accentuating the details of turbines. Landscapes with front lighting (i.e., sun coming from behind) appear flat, but the colour and texture of turbines can be dominant.

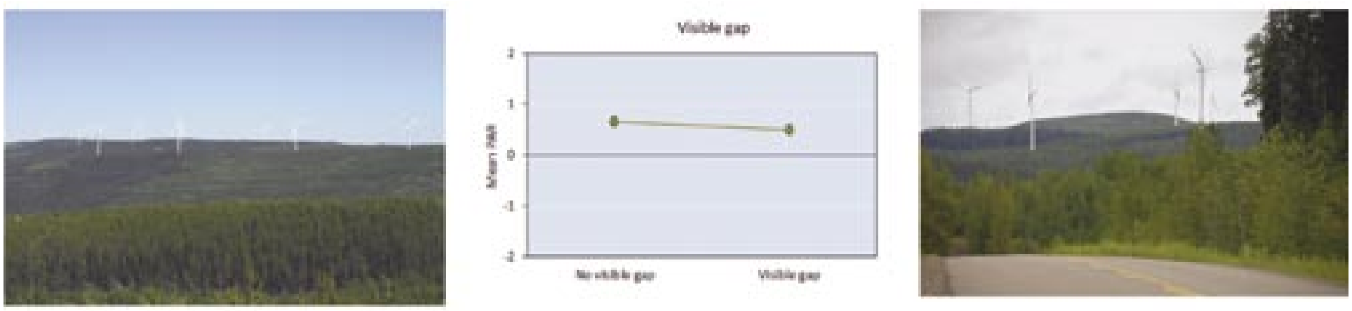


Slide 33: Back lighting, PAR 0.57 **Slide 42: Front lighting, PAR 0.30**

Figure 30. *Mean public acceptance ratings versus lighting effects.*

Visible gap

Figure 31 shows the survey participants' mean public acceptance ratings related to visible gaps in wind energy developments. The existence of visible gaps allows the retention of unobstructed views, enabling viewers to see features beyond the wind energy development.



Slide 37: No visible gap, PAR 0.36 **Slide 68: Visible gap, PAR 0.03**

Figure 31. *Mean public acceptance ratings versus presence of visible gaps in wind energy developments.*

3.2.5 Predictors of mean public acceptance ratings

The best individual predictors of mean PAR were: wind turbine position (adjusted $R^2 = 35\%$, Figure 26); viewing distance (adjusted $R^2 = 25\%$, Figure 21), and viewing position (adjusted $R^2 = 10\%$, Figure 22). The number of wind turbines (Figure 23) was also identified as a significant predictor but only in combination with viewing distance or wind turbine position in the landscape. The two best overall combinations of predictors (based on a comparison of adjusted R^2 and estimated σ_ε^2 for those models with $C_p \sim p$) were:

- Model 1, with four predictors: viewing position, and the number, spacing, and position of wind turbine generators; and
- Model 2, with the same four predictors as Model 1 plus viewing distance.

Estimated model parameters for the two models are given in Table 4.

3.3 Visual Quality Class

In this survey, the bottom of each slide (photograph) included four boxes labelled "A," "B," "C," and "D." Each of these contained a short visual quality statement that described a

Table 4. *Two models for predicting mean public acceptance rating. Predicted values are obtained by substituting the parameter estimates for Model 1 or Model 2 into Equation 1 on page 5.*

Model 1

Predictor (x)	Parameter (β)	Estimate	Std. err.	t	Prob ≥ |t|
Intercept (β_0)		-0.151	0.147	-1.03	0.31
Distance (km)		0.094	0.031	3.04	0.004
# WTG		-0.032	0.007	-4.58	<.0001
WTG spacing	# WTG =1,2 (NA)	0.402	0.216	1.86	0.07
	Uniform	0.383	0.111	3.45	0.001
	Mixed	0.035	0.136	0.26	0.80
	Irregular	0	.	.	.
WTG position	Background	1.076	0.334	3.22	0.002
	Midground	0.457	0.141	3.24	0.002
	Foreground	0	.	.	.
σ_e^2 = 0.108	adj. R^2 = 61%	n = 65 slides			

Model 2

Predictor (x)	Parameter (β)	Estimate	Std. err.	t	Prob ≥ |t|
Intercept		-0.018	0.167	-0.11	0.91
Viewing position	Above	-0.500	0.183	-2.73	0.0084
	Level	-0.120	0.111	-1.08	0.28
	Below	0	.	.	.
# WTG		-0.019	0.006	-3.03	0.004
WTG spacing	# WTG =1,2 (NA)	0.426	0.219	1.94	0.06
	Uniform	0.403	0.109	3.7	0.001
	Mixed	0.160	0.136	1.17	0.25
	Irregular	0	.	.	.
WTG position	Background	1.908	0.231	8.27	<.0001
	Midground	0.855	0.179	4.71	<.0001
	Foreground	0	.	.	.
σ_e^2 = 0.102	adj. R^2 = 63%	n = 60 slides			

degree of wind energy development, ranging from insignificant to dominant (Stevenson and Griffiths 1994). Participants were asked to identify the statement that best described what they could see in each photograph. The 70 slides were analyzed and assigned a mean and mode[17] class based on the responses from the 572 participants (see Appendix 2). For comparative purposes, provincial visual experts also assigned a visual quality class to each slide.

3.3.1 Visual quality classes assigned by participants versus visual quality experts

The visual quality classes assigned by the survey participants were compared to those assigned by the experts to determine the degree to which they agreed (see Table 5).

Table 5. *Matrix showing participant- versus expert-assigned visual quality classes(VQCs)*

	Participant VQCs (%)				
Expert VQCs (%)	A	B	C	D	No.slides
A	90.1	6.8	1.8	1.3	6
B	30.5	52.8	14.7	2.0	9
C	5.4	35.5	47.4	11.7	38
D	1.5	11.1	42.8	44.6	17

When predicting a class "A" landscapes, a 90.1% agreement existed between the participants and visual experts. The degree of agreement for class "B," "C," and "D" landscapes was 52.8, 47.4, and 44.6%, respectively.

17 The mode is the value that appears most often in a set of data.

3.3.2 Relationship between public acceptance ratings, visual quality classes, and various groups

The participant-assigned visual quality classes were analyzed against the PARs of various subgroups to determine the public preference for each class and to determine trends amongst groups. Figure 32 shows, for different groups of respondents and for three experts, the relationship between mean PAR and the visual quality class, where the class is the mode based on all respondents, excluding the Green Party (politically aligned) sample (and experts, outside the data set), and mean PAR is the average for all slides in a class. Agreement between the groups was greatest for the scenes in visual quality class A and least for class D, whereas the variation in mean PAR across classes was greatest for the experts and least for the wind energy sector group.

In all cases except the wind energy sector group, the trend lines show that class A landscapes (least developed) were preferred over class B, which were preferred over class C, which were preferred over class D landscapes (most developed). The wind energy sector group provided the highest ratings for all classes, whereas the visual experts provided the lowest ratings. The "Public" group was about halfway between these high and low anchors.

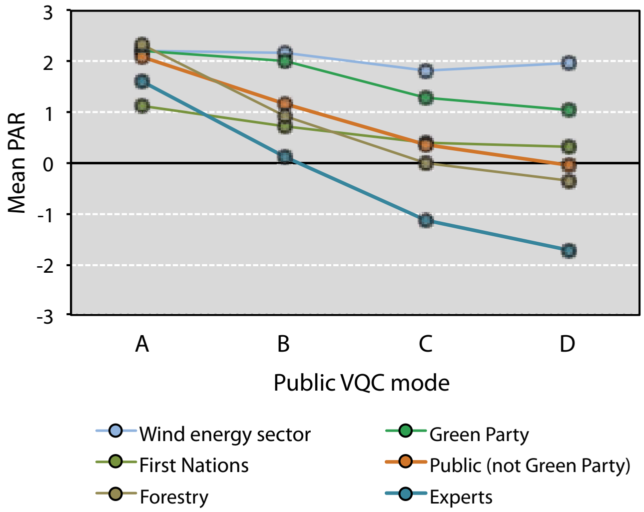


Figure 32. *Relationship between mean public acceptance ratings and visual quality classes for different groups. The visual quality class is the mode for all respondents, excluding Green Party (and experts), and the mean PAR is the average for all slides in a class. The group labelled "Public" comprises all groups, excluding "Green Party" and "Experts."*

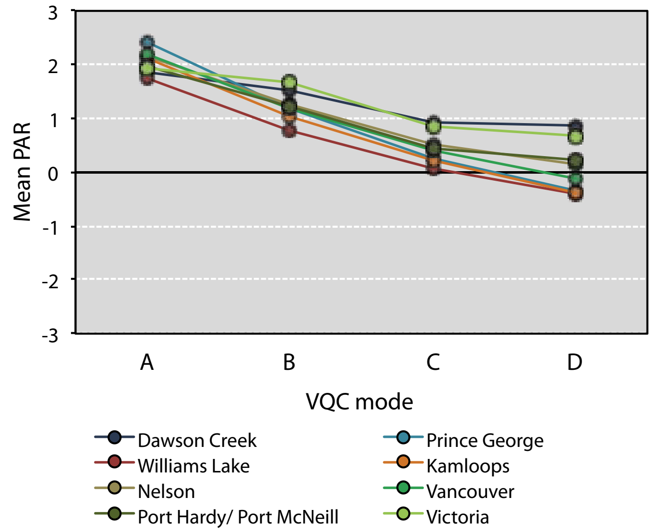


Figure 33. *Relationship between mean public acceptance ratings and visual quality classes for different communities. The visual quality class is the mode for all respondents, excluding Green Party (and experts), and the mean PAR is the average for all slides in a class.*

3.3.3 Relationship between public acceptance ratings, visual quality classes, and various communities

The participant-assigned visual quality classes were analyzed against the PARs of various communities to determine the public preference for each class and to determine trends amongst communities. Figure 33 compares the relationship between mean PARs and visual quality classes for the eight surveyed communities (where VQC and mean PAR are as described for Figure 32). Similar trends were observed for all communities. The only noticeable deviations from the main trend were Dawson Creek and Victoria, where discrimination among the visual quality classes was less pronounced—an observation consistent with the pattern illustrated in Figure 19.

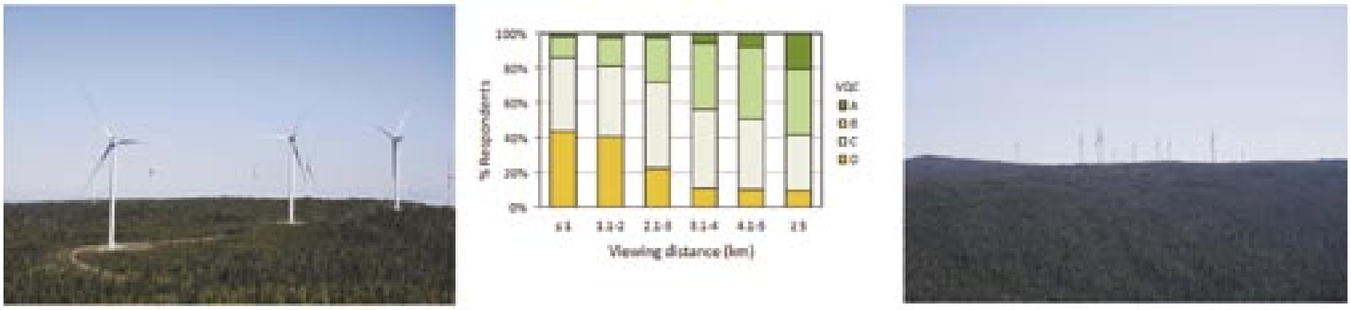
3.3.4 Site trends in visual quality classes

This section examines participant-assigned visual quality classes in relation to developed wind energy site attributes (Figures 34–44).

One of the most noticeable trends was a clear shift (away from class D and towards class A) in the visual quality class distribution as viewing distance increased (Figure 34), or as the position of the wind turbine generator changed from the foreground to background (Figure 39). Other trends were less easy to interpret.

3.3.5 Predictors of modal visual quality class

Viewing distance, wind turbine generator position (foreground, mid-ground, background), and viewing position (below, level, above) were identified as the best (i.e., most statistically significant) individual predictors of modal visual quality class (Table 6). Several combinations of variables appeared to have similar predictive power. The model that included viewing position, viewing distance, wind turbine number, and wind turbine spacing was selected because it required one fewer predictor and seemed easier to interpret than the next best combination of variables (i.e., viewing distance, wind turbine position, wind turbine spacing, skyline, and visible gap).



Slide 57: Distance 0.7 km, VQC D

Slide 68: Distance 3.5 km, VQC C

Figure 34. Relationship between visual quality class and viewing distance.

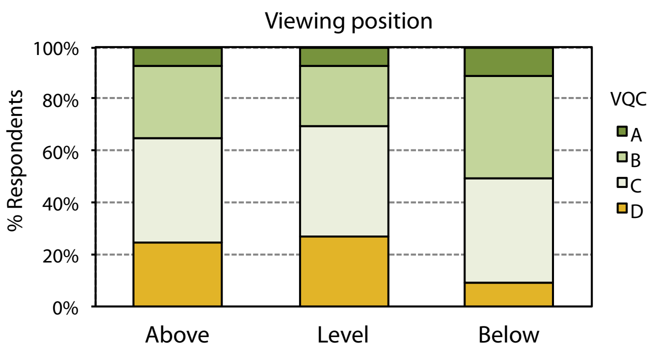


Figure 35. Relationship between visual quality class and viewing position.

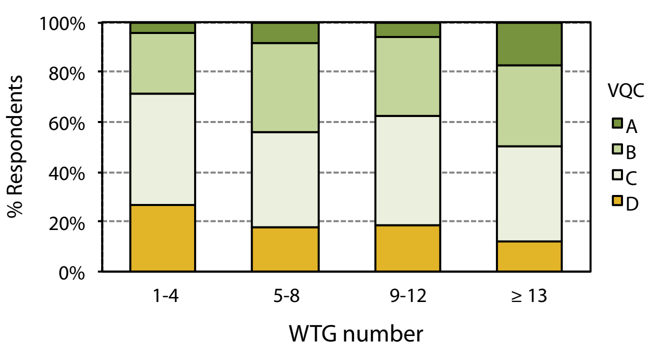


Figure 36. Relationship between visual quality class and number of wind turbine generators in the scene.

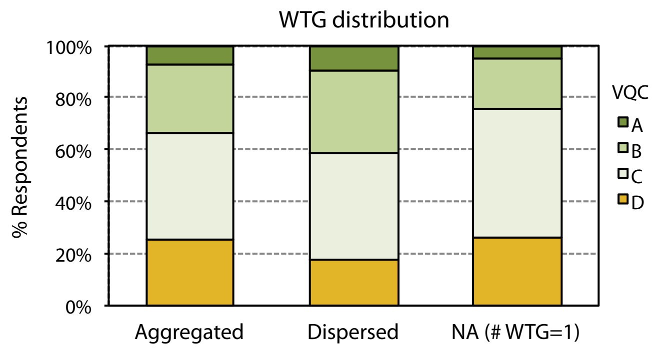


Figure 37. Relationship between visual quality class and spatial distribution of wind turbine generators. If the number of turbines = 1 (#WTG=1), then distribution is recorded as not applicable in data set.

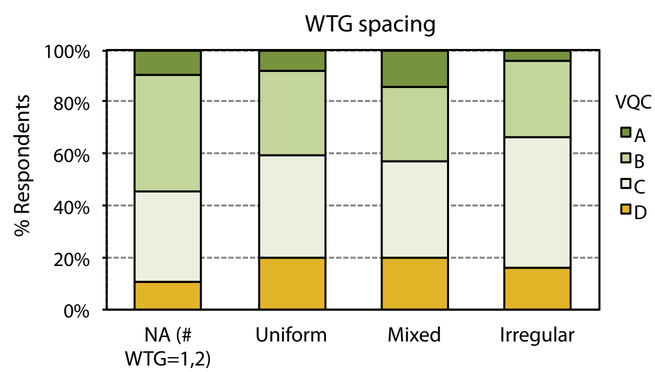


Figure 38. Relationship between visual quality class and wind turbine spacing. If the number of turbines = 1–2 (#WTG=1,2), then spacing is recorded as not applicable in data set.

Table 6. *Model for predicting modal visual quality class*

Predictor (x_i)	**Level**	**Parameter (β_i)**	**Std. err.**	**Prob ≥ |t|**
Intercepts (α*k*)	A	−9.625	2.125	< .0001
	B	−4.513	1.155	0.0003
	C	1.379	0.985	0.17
Viewing position	Above	−2.491	1.160	0.04
	Level	−1.868	0.876	0.04
	Below	0	.	.
Viewing distance (km)		1.087	0.253	< .0001
No. wind turbines		−0.118	0.051	0.02
Wind turbine spacing	NA (# WTG =1,2)	3.411	1.712	0.05
	Uniform	1.152	0.822	0.17
	Mixed	−0.752	1.053	0.48
	Irregular	0	.	.

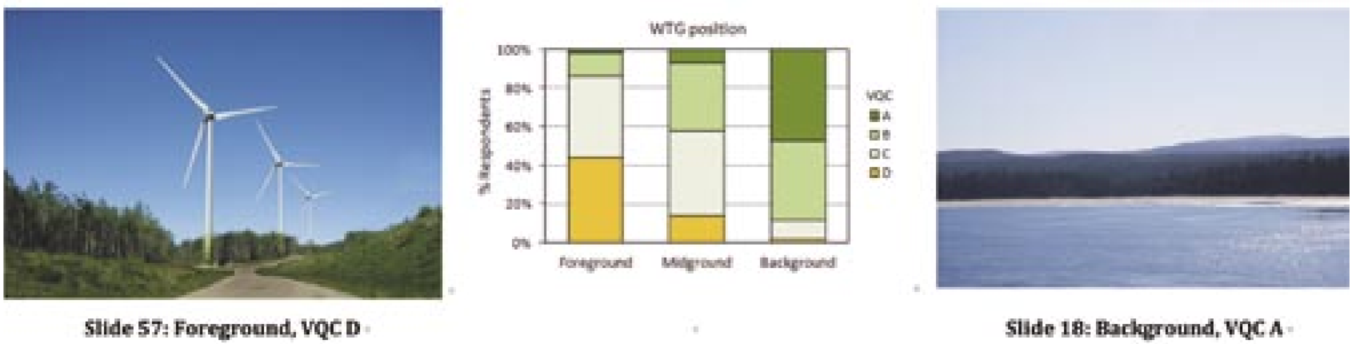


Figure 39. *Relationship between visual quality class and position of wind turbine generators in the scene.*

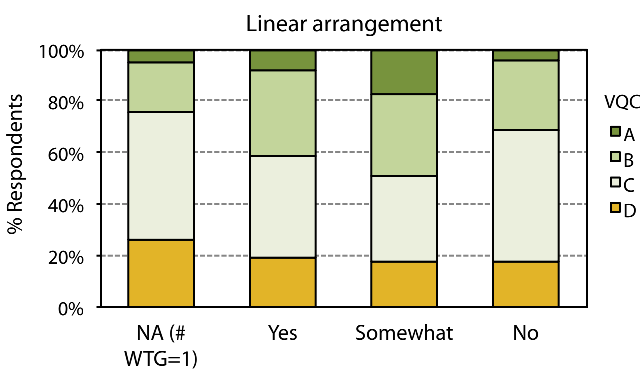


Figure 40. *Relationship between visual quality class and linearity of wind turbine generators. If the number of turbines = 1 (#WTG=1), then linearity is recorded as not applicable in data set.*

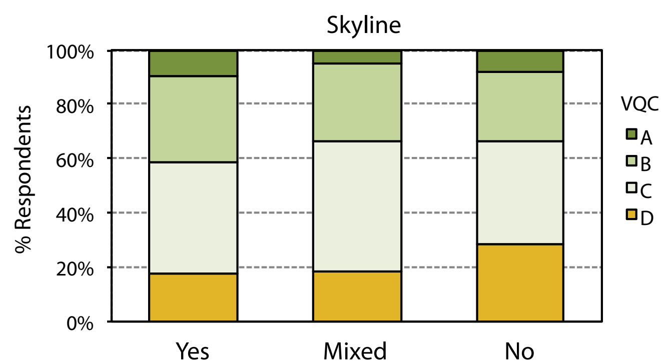


Figure 41. *Relationship between visual quality class and skyline.*

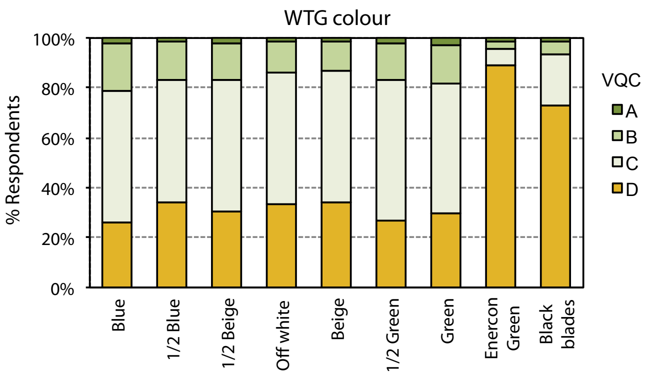


Figure 42. Relationship between visual quality class and wind turbine colour.

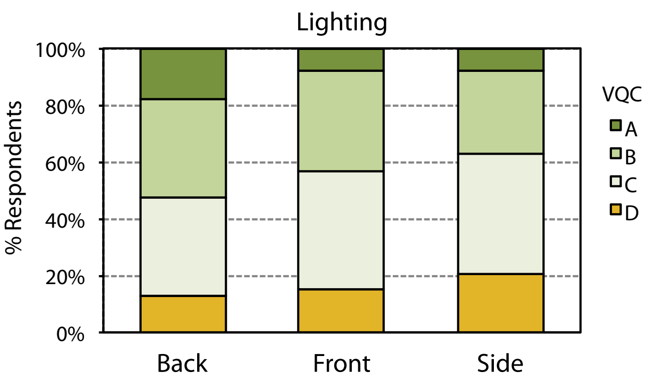


Figure 43. Relationship between visual quality class and direction of lighting.

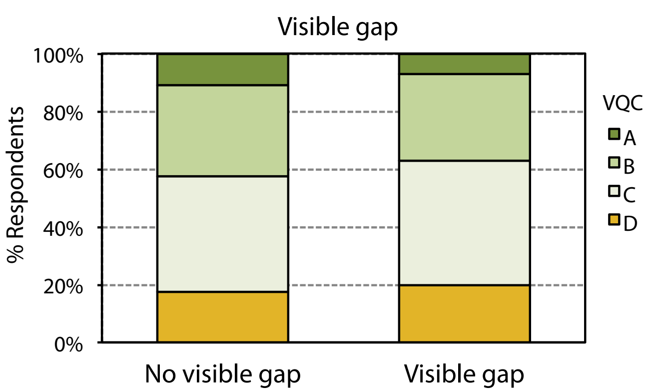


Figure 44. Relationship between visual quality class and presence of a visible gap.

4 Survey Conclusions

The findings presented here are based on the foregoing statistical analyses of the data collected for the B.C. Ministry of Forests, Lands and Natural Resource Operations' survey of visual quality in forested landscapes containing wind energy developments. The discussion below frames these conclusions around the survey's detailed objectives.

1. **Match the wind energy sample group with the socio-demographic statistics for British Columbia as closely as possible.**

- The male/female ratio of the survey sample was comparable to both British Columbia and Canada and the distribution over urban and rural areas was comparable to Canada.
- Other characteristics of the respondents differed from the provincial and national profiles.
- The population in this study was found on average to be older, better educated, have occupations in natural and applied sciences, and more likely to have a higher annual income than in the province or country as a whole.

2. **Determine the public acceptance rating (PAR) for each of the 70 images used in the study.**

- The public acceptance ratings for the 70 slides used in the study are presented in Appendix 3 and are listed in order of decreasing mean PAR, with rank 1 the most acceptable and rank 70 the least acceptable.
- Photographs of each of the landscapes and bar graphs illustrating the PAR distributions for the 70 scenes are provided in Appendix 4.

3. **Determine the public response to scenes with and without wind turbine generators.**

- In all cases, natural appearing scenes were preferred over developed scenes. The mean drop in PAR between natural appearing scenes and developed scenes was 1.47 points.

- The middle-aged audience (40–69 years) were less tolerant of wind turbine generators, whereas young people and older people were more accepting of them.
- Participants with a university education were less accepting of wind turbine generators, whereas participants who had grade 12 or less were more accepting of them.
- Higher-income earners were less accepting of wind turbine generators, whereas low-income earners were more accepting.
- The communities of Victoria and Dawson Creek were more accepting of wind turbine generators, whereas the community of Prince George was less accepting.
- Of the four subgroups surveyed (wind energy sector, Green Party, First Nations, and forest sector), the wind energy sector audience was the most tolerant of wind turbine generators, whereas the forest sector group was the least tolerant.
- Middle-aged respondents (40–69 years) with a university degree and annual income of at least $60 000 appeared to be least accepting of wind energy developments, whereas the youngest (≤ 39 years) and oldest (≥ 70 years) respondents, and those who were the least well educated and had the smallest annual income, appeared to be most accepting.

4. **Examine trends in public acceptance ratings relative to different wind energy attributes.**

- Public acceptance ratings increase as the viewing distance to wind turbine generators increases.
- Wind turbines viewed from below received a slightly higher PAR than those viewed on the level or from above.
- Public acceptance ratings decrease as the number of wind turbine generators increase.
- A dispersed distribution of wind turbines received a higher PAR than an aggregated distribution.
- Uniform spacing between wind turbine generators produced a marginal increase in PAR.
- Scenes with wind turbine generators in the foreground received a decreased PAR.
- Linear wind energy developments received a slightly higher PAR.
- Wind turbine generators occurring on skylines received higher PARs.
- The sky blue wind turbine generators received the highest PAR, relative to a blue sky background. The wind turbines with white towers and black blades received the lowest PAR.
- Side-lit wind turbines received lower PARs.
- Wind energy developments with a visual gap received higher PARs.

5. **Determine whether an attribute, or combination of attributes, will predict PAR.**

- The best individual predictors of mean PAR were wind turbine position (foreground, mid-ground, and background), viewing distance, and viewing position.
- Number of wind turbine generators was also identified as a significant predictor but only in combination with viewing distance or turbine position in the landscape.
- Table 7 in Section 5 was developed to predict mean PAR, using five predictors: viewing position; number, spacing, and position of wind turbine generators; and viewing distance.

6. **Determine the public visual quality class for each of the 70 images used in the study.**

- Appendix 3 presents the expert- and participant-assigned visual quality class for each of the 70 slides used in this survey.

7. Compare the visual quality classes assigned by both visual resource experts and the public.

- The participants and experts agreed on the visual quality classification for 49 of the 70 slides. For slides of class A, a strong 90% agreement was achieved but only 45% agreement on slides of class D.

8. Examine the average PAR values by visual quality class for different groups (public, visual experts, First Nations, forest sector, wind energy sector, and Green Party) and by community.

- Agreement between the groups was greatest for the scenes in visual quality class A and least for class D, whereas variation in mean PAR across classes was greatest for the experts and least for the wind energy sector group, based on slopes of respective trend lines.
- Similar trends were observed for all communities: Visual quality class A was preferred over class B, which was preferred over class C, which was preferred over class D.
- The communities of Dawson Creek and Victoria assigned a higher PAR to each visual quality class, whereas Williams Lake assigned the lowest PAR to each class.

9. Examine visual quality class in relation to developed wind energy site attributes.

- The most noticeable trend was a clear shift (away from class D and towards class A) in the visual quality class distribution as viewing distance increased, or as the wind turbine position changed from the foreground to background.
- Although other trends were less easy to interpret, dispersed wind turbine generators were more likely to be classed A or B, whereas aggregated turbines were more likely to be classed C or D. Also, wind turbines viewed from below were more likely to be classed B or C.

10. Determine whether an attribute, or combination of attributes, can be used to predict visual quality class.

- Viewing distance, wind turbine generator position, and viewing position were identified as the best (i.e., most statistically significant) individual predictors of modal visual quality class (see Table 5).
- Table 8 in Section 5 was developed as a tool to predict modal visual quality class. This model, which includes viewing position, viewing distance, and the number and spacing of wind turbines was selected because it requires one fewer predictor and seemed easier to interpret than the next best combination of variables.

5 Discussion

The overall goal of this visual perception study was to provide the general public, wind energy proponents, and government staff with guidance on public responses to the visual impacts of wind energy developments. Specifically, it examined how the public responds to various developments on forested landscapes in British Columbia under different viewing conditions.

5.1 Understanding and Using the Survey Results

Some of the more notable findings from this survey included:

- Wind turbine generators occurring in the mid-ground (2–8 km) and background (8 km +) of scenes were preferred; viewing turbines from below was also preferred.
- The most preferred scenes contained lower numbers of turbines or a dispersed distribution of turbines.

- All wind turbine generator colour schemes tested received favourable PARs, except slides 38 and 47, which were foreground images and contained a different number of turbines.

These findings can help to develop visual effect assessments and to provide design guidance for wind energy installations in the province.

5.2 Decision Support

Following on from the initial survey analysis, further analysis work resulted in the development of two decision support tools. The first tool makes it possible for practitioners who are developing or reviewing visual effect assessments to predict the public response to a potential wind energy installation using specific attributes such as viewing position, number of wind turbine generators, spacing, position of the wind turbines, and viewing distance. Table 7 (Model 2) provides the predicted mean PAR values, prediction errors, and estimated odds of PAR^+/PAR^- using five site attributes. Model 1, which was derived using four site attributes, was considered less robust.

The second decision support tool (see Table 8), developed using four site attributes, enables the prediction (with confidence rating) of the visual quality class that a wind energy installation will achieve.

5.3 Study Limitations

The fundamental limitation of any visual perception study is that the results depend on many variables, including the questions asked, the photographs selected, the classification scheme, the attributes analyzed, the statistical analysis employed, and the representativeness of the sample population. In this study, the following instructions were given to participants.

> *During the survey we will show you photographs of different wind energy developments. The photos are taken of mid-ground views that represent landscapes that you might see travelling along a highway in BC. Part 1: for each slide please choose the description (A, B, C or D) appearing at the bottom of each slide that best describes what you see. Part 2: please rate each of the scenes on a scale from –3 (Very Unacceptable) to +3 (Very Acceptable). The midpoint is 0. For the purpose of this survey, visual quality can be considered the attractiveness of the scenery as it would affect your enjoyment of it.*

Some terms in these instructions may not have been completely understood or may mean different things to different people.

Static photographs were used in this study as a surrogate to actually taking all participants to each location in the field. The photographs were taken of wind energy developments as you would potentially see them travelling along the highway or from a community. Every effort was made to take the photographs of the developments during good weather and under clear skies but some variability in clarity and sharpness is unavoidable. A different medium (e.g., video imagery) may yield responses somewhat different from the static photographs used in this survey.

Although attribute data were collected when each photograph was taken, it is possible that not all predictor attributes were recognized and recorded.

Despite the best efforts of researchers, the make-up of the respondent sample differed slightly from the general population of British Columbia. The population in this study was found on average to be older, be better educated, have occupations in natural and applied sciences, and be more likely to have a higher annual income than in the province or country as a whole. Based on the findings, this group may rate wind energy developments more conservatively than the general population of British Columbia.

Table 7. *Predicting mean public acceptance ratings, using five site attributes from Model 2*

			Viewing position								
			Above			Level			Below		
No. wind turbines	**Turbine spacing**	**Turbine position, viewing distance**	**Mean PAR**	**Predicted error**	**Odds**	**Mean PAR**	**Predicted error**	**Odds**	**Mean PAR**	**Predicted error**	**Odds**
1	NA	Foreground, 1 km	−0.02	0.37	1.2	0.30	0.34	1.7	0.42	0.36	2.0
		Mid-ground, 5 km	0.74	0.35	3.0	1.07	0.33	4.2	1.18	0.33	5.1
		Background, 10 km	1.91	0.37	10.8	2.24	0.36	15.4	2.35	0.36	18.7
2	NA	Foreground, 1 km	−0.05	0.37	1.1	0.28	0.34	1.6	0.39	0.36	1.9
		Mid-ground, 5 km	0.72	0.35	2.9	1.04	0.33	4.1	1.16	0.33	5.0
		Background, 10 km	1.88	0.37	10.5	2.21	0.36	14.8	2.32	0.36	18.0
5	Uniform	Foreground, 1 km	−0.16	0.32	0.9	0.17	0.29	1.3	0.28	0.31	1.6
		Mid-ground, 5 km	0.61	0.31	2.4	0.94	0.30	3.3	1.05	0.29	4.1
		Background, 10 km	1.78	0.33	8.6	2.10	0.34	12.2	2.22	0.32	14.8
	Mixed	Foreground, 1 km	−0.48	0.34	0.6	−0.15	0.30	0.9	−0.04	0.33	1.1
		Mid-ground, 5 km	0.29	0.32	1.6	0.61	0.30	2.3	0.73	0.30	2.8
		Background, 10 km	1.45	0.33	5.9	1.78	0.33	8.4	1.89	0.33	10.2
	Irregular	Foreground, 1 km	−0.56	0.33	0.5	−0.23	0.31	0.8	−0.12	0.32	0.9
		Mid-ground, 5 km	0.21	0.31	1.4	0.54	0.31	1.9	0.65	0.29	2.4
		Background, 10 km	1.37	0.34	5.0	1.70	0.35	7.1	1.81	0.33	8.6
10	Uniform	Foreground, 1 km	−0.29	0.32	0.8	0.04	0.29	1.1	0.15	0.31	1.3
		Mid-ground, 5 km	0.48	0.30	2.0	0.81	0.29	2.8	0.92	0.29	3.4
		Background, 10 km	1.64	0.32	7.2	1.97	0.33	10.2	2.08	0.32	12.4
	Mixed	Foreground, 1 km	−0.61	0.34	0.5	−0.28	0.31	0.8	−0.17	0.33	0.9
		Mid-ground, 5 km	0.16	0.31	1.4	0.48	0.29	1.9	0.60	0.30	2.4
		Background, 10 km	1.32	0.33	5.0	1.65	0.33	7.0	1.76	0.32	8.6
	Irregular	Foreground, 1 km	−0.69	0.33	0.5	−0.36	0.31	0.6	−0.25	0.32	0.8
		Mid-ground, 5 km	0.08	0.31	1.2	0.40	0.30	1.6	0.52	0.29	2.0
		Background, 10 km	1.24	0.34	4.2	1.57	0.34	5.9	1.68	0.33	7.2
15	Uniform	Foreground, 1 km	−0.42	0.32	0.7	−0.09	0.30	0.9	0.02	0.32	1.1
		Mid-ground, 5 km	0.35	0.30	1.7	0.67	0.29	2.4	0.79	0.29	2.9
		Background, 10 km	1.51	0.32	6.1	1.84	0.33	8.6	1.95	0.32	10.4
	Mixed	Foreground, 1 km	−0.74	0.34	0.5	−0.42	0.31	0.6	−0.30	0.34	0.8
		Mid-ground, 5 km	0.02	0.31	1.2	0.35	0.29	1.6	0.46	0.30	2.0
		Background, 10 km	1.19	0.32	4.2	1.51	0.32	5.9	1.63	0.32	7.2
	Irregular	Foreground, 1 km	−0.82	0.33	0.4	−0.49	0.31	0.5	−0.38	0.32	0.7
		Mid-ground, 5 km	−0.05	0.31	1.0	0.27	0.30	1.4	0.39	0.29	1.7
		Background, 10 km	1.11	0.33	3.5	1.44	0.34	5.0	1.55	0.33	6.1

Note: Odds = probability of positive PAR / probability of negative PAR;
for example, odds = 2 implies that a respondent is 2 x more likely to assign PAR =1,2,3 than PAR = -3,-2,-1.

***Table 8.** Probabilities (%) of visual quality class (A, B, C, D) using four site attributes*[a]

No. wind turbines	Turbine spacing	Viewing distance (km) 1 – Viewing position: Above	Level	Below	5 – Viewing position: Above	Level	Below	10 – Viewing position: Above	Level	Below	15 – Viewing position: Above	Level	Below
1	NA	C	C	C	B	B	B	A	A	A	A	A	A
		90	86	53	82	85	70	89	94	99	100	100	100
2	NA	C	C	C	B	B	B	A	A	A	A	A	A
		90	87	56	80	85	72	87	93	99	100	100	100
5	Uniform	C	C	C	C	C	B	B	B	A	A	A	A
		63	75	90	73	59	79	65	51	86	99	100	100
	Mixed	D	D	C	C	C	C	B	B	B	A	A	A
		80	68	75	90	88	60	86	84	52	95	97	100
	Irregular	D	C	C	C	C	B	B	B	A	A	A	A
		65	50	85	87	81	57	83	75	66	97	99	100
10	Uniform	D	C	C	C	C	B	B	B	A	A	A	A
		51	63	89	82	72	70	76	65	77	99	99	100
	Mixed	D	D	C	C	C	C	B	B	B	A	A	A
		88	79	63	89	90	73	83	86	65	91	95	99
	Irregular	D	D	C	C	C	C	B	B	A	A	A	A
		77	64	77	90	87	56	86	82	52	95	97	100
15	Uniform	D	D	C	C	C	B	B	B	A	A	A	A
		66	50	85	88	81	57	83	76	65	97	99	100
	Mixed	D	D	D	C	C	C	B	B	B	A	A	A
		93	87	51	84	89	82	77	84	76	84	91	99
	Irregular	D	D	C	C	C	C	B	B	B	A	A	A
		86	76	66	89	90	69	84	85	62	92	95	99

[a] Predicted probabilities that visual quality class mode = A, B, C, D are obtained by substituting the respective parameter estimates into Equation 2 (page 6).

5.4 Future Work

This research provides a first look at public responses to wind energy developments on forested landscapes. It is clear from these results that not all site attributes were good predictors of public acceptance ratings or visual quality classes. It is possible that this study did not contain enough samples of some site attributes and viewing conditions to produce statistically significant trends. As more wind energy sites are developed, it would be useful to repeat this study with a larger number of samples, representing a wider range of site and viewing variables.

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Appendix 1. Non-profit organizations that participated in the wind energy visual perception survey

Number of participants appears in brackets.

Dawson Creek

- Bear Mountain Nordic Ski Association (8)
- Peace Energy Co-op (7)
- Northern Lights College (11)
- Toastmasters (6)
- Horticultural Society (5)
- FLNRO Peace Resource District (12)
- Non Aligned Individuals Group 1 (3)
- Non Aligned Individuals Group 2 (8)

Kamloops

- Kamloops Naturalists Club (4)
- TRU Werewolf Club (6)
- Kamloops Hiking Club (7)
- Kamloops Photo Arts Club (22)
- Interior Indian Friendship Society (4)
- Kamloops Rugby Club (28)
- High Country Achievers Toast Masters (28)
- FLNRO Southern Interior Region (13)

Nelson

- Mountain Shred Club (8)
- Community Futures (10)
- Italian Society (3)
- City of Nelson Councillors (5)
- Beta Sigma Phi (2)
- Ski White Water (4)
- Kootenay School of the Arts (14)
- FLNRO Selkirk Resource District (12)
- Non Aligned Individuals (4)

Port Hardy/Port McNeill

- A-Frame Church Port McNeill (5)
- Port McNeill Seniors Club (2)
- Port Hardy Chamber of Commerce (3)
- North Island Secondary School (16)
- Port Hardy Team Five (5)
- Port Hardy Mayor and Council (4)
- Sointula Community (15)
- Port McNeill Town Council and Staff (2)
- Strategic Group (10)
- FLNRO Resource District Office (11)

Prince George

- University of Northern British Columbia (9)
- Prince George Search and Rescue (10)
- Prince George Fibre Arts Guild (3)
- Caledonia Ramblers (5)
- BC Cancer Agency (12)
- Cantata Singers (45)
- Industrial Forestry Service (3)
- FLNRO Omineca Region (14)

Vancouver/Victoria

- Burnaby Lake Rugby Club (34)
- UBC Students (6)
- Evergreen Rugby Club (14)
- FREP Group (18)
- The Hive (4)
- Dead in the Water Dragon Boat Team (14)

Williams Lake

- Council of Canadians (5)
- FLNRO Central Cariboo Resource District (11)
- Cariboo Chilcotin Coast Tourism Assoc. (9)
- Thompson Rivers University Students (11)
- Cariboo Friendship Society (10)
- Cariboo Arts Society (4)
- Williams Lake Gardening Club (4)
- Williams Lake Walking Club (4)
- Downtown Business Improvement Assoc. (4)
- Williams Lake Field Naturalists (7)
- Williams Lake Indian Band (5)

Appendix 2. Response form and questionnaire for wind energy visual perception survey

Group: ______________________

Location: ______________________

Date: ______________________

Ministry of Forests, Lands and Natural Resource Operations – Visual Quality Survey

The intent of this survey is to help the Ministry of Forests, Lands and Natural Resource Operations understand the public response to the visual quality of different forested landscapes containing wind energy developments.The survey results will be used to incorporate public preferences into future visual resource management policy.

During the survey we will show you photographs of different wind energy developments. The photos are taken of mid-ground views that represent landscapes that you might see travelling along a highway in BC. Part 1: for each slide please choose the description (A,B,C or D) appearing at the bottom of each slide that best describes what you see. Part 2: please rate each of the scenes on a scale from –3 (Very Unacceptable) to +3 (Very Acceptable). The midpoint is 0.

To start we will view six slides to assist you to understand the visual rating format. These six slides will not be part of the formal survey data. After viewing and discussing these six slides, another seventy slides will be shown that make up the survey.

FOR THE PURPOSE OF THIS SURVEY, ***VISUAL QUALITY*** *CAN BE CONSIDERED THE ATTRACTIVENESS OF THE SCENERY AS IT WOULD AFFECT YOUR ENJOYMENT OF IT.*

Calibration Slides

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
i	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
ii	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
iii	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
iv	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
v	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
vi	A B C D	-3	-2	-1	0	+1	+2	+3	______________________

The Survey

Assume that you are viewing the scene from your automobile travelling along a highway in B.C. Part 1: for each slide please choose the description (A,B,C or D) appearing at the bottom of each slide that best describes what you see. Part 2:please rate each of the scenes on a scale from –3 (Very Unacceptable) to +3 (Very Acceptable). The midpoint is 0. Circle your rating.

Next to each line there is a blank space for comments to describe what influenced your rating. Repeating words or phrases is okay, and if nothing comes to mind then just leave the space blank.

FOR THE PURPOSE OF THIS SURVEY, **VISUAL QUALITY** CAN BE CONSIDERED THE ATTRACTIVENESS OF THE SCENERY AS IT WOULD AFFECT YOUR ENJOYMENT OF IT.

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
1	A B C D	-3	-2	-1	0	+1	+2	+3	____________
2	A B C D	-3	-2	-1	0	+1	+2	+3	____________
3	A B C D	-3	-2	-1	0	+1	+2	+3	____________
4	A B C D	-3	-2	-1	0	+1	+2	+3	____________
5	A B C D	-3	-2	-1	0	+1	+2	+3	____________
6	A B C D	-3	-2	-1	0	+1	+2	+3	____________
7	A B C D	-3	-2	-1	0	+1	+2	+3	____________
8	A B C D	-3	-2	-1	0	+1	+2	+3	____________
9	A B C D	-3	-2	-1	0	+1	+2	+3	____________
10	A B C D	-3	-2	-1	0	+1	+2	+3	____________
11	A B C D	-3	-2	-1	0	+1	+2	+3	____________
12	A B C D	-3	-2	-1	0	+1	+2	+3	____________

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
13	A B C D	-3	-2	-1	0	+1	+2	+3	______________
14	A B C D	-3	-2	-1	0	+1	+2	+3	______________
15	A B C D	-3	-2	-1	0	+1	+2	+3	______________
16	A B C D	-3	-2	-1	0	+1	+2	+3	______________
17	A B C D	-3	-2	-1	0	+1	+2	+3	______________
18	A B C D	-3	-2	-1	0	+1	+2	+3	______________
19	A B C D	-3	-2	-1	0	+1	+2	+3	______________
20	A B C D	-3	-2	-1	0	+1	+2	+3	______________
21	A B C D	-3	-2	-1	0	+1	+2	+3	______________
22	A B C D	-3	-2	-1	0	+1	+2	+3	______________
23	A B C D	-3	-2	-1	0	+1	+2	+3	______________
24	A B C D	-3	-2	-1	0	+1	+2	+3	______________
25	A B C D	-3	-2	-1	0	+1	+2	+3	______________
26	A B C D	-3	-2	-1	0	+1	+2	+3	______________
27	A B C D	-3	-2	-1	0	+1	+2	+3	______________
28	A B C D	-3	-2	-1	0	+1	+2	+3	______________
29	A B C D	-3	-2	-1	0	+1	+2	+3	______________
30	A B C D	-3	-2	-1	0	+1	+2	+3	______________

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
31	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
32	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
33	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
34	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
35	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
36	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
37	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
38	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
39	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
40	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
41	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
42	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
43	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
44	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
45	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
46	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
47	A B C D	-3	-2	-1	0	+1	+2	+3	______________________
48	A B C D	-3	-2	-1	0	+1	+2	+3	______________________

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
49	A B C D	-3	-2	-1	0	+1	+2	+3	______________
50	A B C D	-3	-2	-1	0	+1	+2	+3	______________
51	A B C D	-3	-2	-1	0	+1	+2	+3	______________
52	A B C D	-3	-2	-1	0	+1	+2	+3	______________
53	A B C D	-3	-2	-1	0	+1	+2	+3	______________
54	A B C D	-3	-2	-1	0	+1	+2	+3	______________
55	A B C D	-3	-2	-1	0	+1	+2	+3	______________
56	A B C D	-3	-2	-1	0	+1	+2	+3	______________
57	A B C D	-3	-2	-1	0	+1	+2	+3	______________
58	A B C D	-3	-2	-1	0	+1	+2	+3	______________
59	A B C D	-3	-2	-1	0	+1	+2	+3	______________
60	A B C D	-3	-2	-1	0	+1	+2	+3	______________
61	A B C D	-3	-2	-1	0	+1	+2	+3	______________
62	A B C D	-3	-2	-1	0	+1	+2	+3	______________
63	A B C D	-3	-2	-1	0	+1	+2	+3	______________
64	A B C D	-3	-2	-1	0	+1	+2	+3	______________
65	A B C D	-3	-2	-1	0	+1	+2	+3	______________

Slide #	Description	Very Unacceptable			Neutral			Very Acceptable	COMMENTS
66	**A B C D**	-3	-2	-1	0	+1	+2	+3	________________________________
67	**A B C D**	-3	-2	-1	0	+1	+2	+3	________________________________
68	**A B C D**	-3	-2	-1	0	+1	+2	+3	________________________________
69	**A B C D**	-3	-2	-1	0	+1	+2	+3	________________________________
70	**A B C D**	-3	-2	-1	0	+1	+2	+3	________________________________

Demographic Information

Please take a few minutes to fill out this page. We need this information so that we can compare responses from different groups. All answers will be kept confidential and anonymous.

1. **What is your Age?**
Less than 20 20-29 30-39 40-49 50-59 60-69 70 Plus.

2. **Are you?**
Male Female

3. **What is the highest level of education that you have attained?**
Check the highest level.

Less than High School Graduation	College (grad or not)
High School Graduation Certificate	University – certificate, diploma, and no degree
Trades Certificate	University – Bachelor’s or higher

4. **Place of Residence?**

British Columbia
Other Canadian Province
Outside Canada

5. **Where do you live?**

Rural Area	less than 2500 people.
Town	2500 – 24,999
City	25,000 – 249,999
Large City	250,000 or more people

6. **What is your occupation?**

Management	Art, Culture, Recreation, and Sport
Business, Finance, and Administration	Sales and Service
Natural and Applied Sciences	Trades, Transport, and Equipment Operators
Health	Primary Industry
Social Sciences, Education, and Government	Processing, Manufacturing, and Utilities

Other:_______________________________________

7. **What is your total annual income? *not combined marital (Optional)**

Less than $20,000	$40,000 to $59,999
$20,000 to 39,999	$60, 000 +

Thank you for taking time to participate in this survey.

Appendix 3. Wind energy visual perception survey data

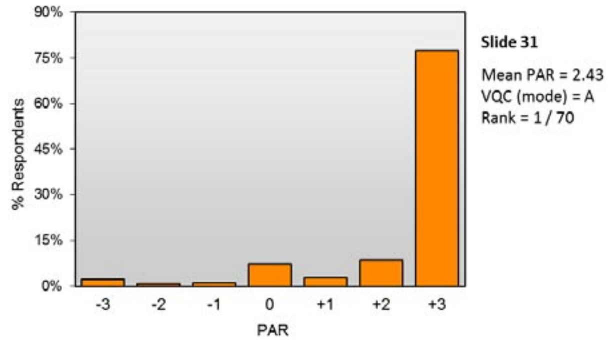
(**Slides are listed in order of decreasing mean PAR)**

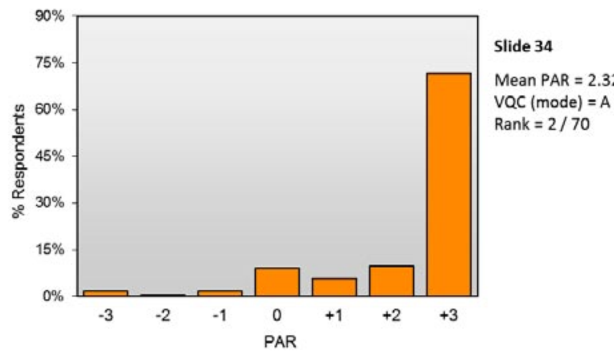
		VQC		VQC frequencies for all respondents excluding Green Party					PAR frequencies for all respondents excluding Green Party								Mean PAR												
Rank	Slide no.	Experts	Public (mode)	A	B	C	D	n	-3	-2	-1	0	+1	+2	+3	n	Main sample	Experts	Viewing position	Viewing distance	# WTG	WTG distribution	WTG spacing	WTG position	Linearity of WTGs	WTG colour	Skyline	Lighting	Visual gap
1	31	A	A	96.5%	1.4%	1.0%	1.0%	572	2.3%	0.7%	0.9%	7.3%	2.8%	8.6%	77.4%	572	2.43	2.33	Level	5	0								
2	34	A	A	96.3%	1.9%	0.9%	0.9%	572	1.8%	0.5%	1.6%	9.1%	5.6%	9.8%	71.6%	571	2.32	1.33	Below	4.5	0							Front	
3	46	A	A	96.0%	1.7%	1.2%	1.0%	572	1.9%	1.0%	2.3%	9.3%	4.0%	9.6%	71.9%	572	2.29	2.33	Level	6.4	0								
4	44	A	A	95.5%	1.9%	0.7%	1.9%	572	2.1%	0.9%	1.9%	10.1%	5.6%	10.3%	69.1%	572	2.23	2	Level	3.4	0								
5	18	A	A	75.7%	20.1%	2.6%	1.6%	572	1.7%	2.4%	4.5%	9.8%	9.1%	23.1%	49.3%	572	1.88	1.33	Level	12.2	18	D	M	B	SW	OW	YES	Back	NO
6	49	B	A	65.4%	27.6%	5.2%	1.7%	572	0.9%	2.4%	7.2%	9.3%	12.1%	26.0%	42.1%	572	1.76	0.67	Below	8.2	17	D	U	B	YES	OW	YES	Side	NO
7	6	A	A	80.6%	14.0%	4.4%	1.0%	572	1.9%	2.3%	5.1%	14.0%	10.0%	23.8%	43.0%	572	1.71	1.33	Level	2.5	0								
8	67	B	B	43.8%	45.2%	9.5%	1.6%	571	0.9%	2.4%	9.1%	9.8%	20.8%	29.5%	27.4%	572	1.46	0	Below	16.8	24	D	M	B	SW	OW	YES	Side	NO
9	55	B	B	31.8%	54.9%	12.2%	1.0%	572	1.0%	3.3%	9.4%	10.5%	21.0%	26.4%	28.3%	572	1.40	0.67	Below	4.5	5	A	I	M	NO	OW	YES	Front	YES
10	35	B	B	33.6%	51.9%	12.9%	1.6%	572	2.1%	4.5%	8.6%	11.4%	15.7%	26.7%	30.9%	572	1.38	0.33	Above	9.4	34	D	U	B	YES	OW	NO	Side	NO
11	48	C	B	42.5%	46.9%	8.9%	1.7%	572	1.0%	4.5%	5.9%	13.1%	22.6%	27.6%	25.2%	572	1.35	0.67	Level	5.8	6	D	M	M	SW	OW	YES	Side	YES
12	70	B	B	29.5%	51.9%	16.3%	2.3%	572	2.4%	5.1%	9.6%	8.7%	17.0%	27.4%	29.7%	572	1.34	0.67	Below	5.1	8	D	U	M	SW	OW	YES	Back	NO
13	32	B	B	19.9%	61.4%	16.8%	1.9%	572	0.5%	4.5%	7.7%	12.8%	21.3%	29.9%	23.3%	572	1.33	0	Below	4.1	5	D	U	M	YES	OW	YES	Front	YES
14	19	B	B	15.7%	64.9%	18.0%	1.4%	572	1.2%	4.0%	8.0%	12.6%	26.7%	29.2%	18.2%	572	1.20	0	Below	3.6	3	D	U	M	YES	OW	YES	Side	YES
15	43	C	B	12.9%	64.9%	20.5%	1.7%	572	1.4%	4.4%	7.9%	14.5%	24.1%	30.2%	17.5%	572	1.16	0.33	Below	4	2	D	NA	M	YES	OW	YES	Side	YES
16	26	B	B	18.0%	56.5%	21.7%	3.8%	572	2.1%	5.6%	8.7%	11.9%	24.0%	25.9%	21.9%	572	1.15	-0.33	Below	3.7	5	D	U	M	YES	OW	YES	Side	NO
17	45	C	B	9.4%	58.9%	28.3%	3.3%	572	1.2%	4.2%	8.9%	14.3%	25.4%	31.5%	14.5%	572	1.11	0	Below	2.2	7	D	U	M	YES	OW	YES	Front	NO
18	36	C	B	10.5%	62.9%	25.0%	1.6%	572	1.2%	4.5%	7.5%	15.4%	27.3%	28.8%	15.2%	572	1.10	0.33	Below	6	9	D	U	M	YES	OW	YES	Back	YES
19	10	B	B	17.1%	60.7%	19.6%	2.6%	572	2.8%	5.1%	10.0%	13.3%	21.9%	25.5%	21.5%	572	1.09	1	Above	12.3	16	D	M	B	SW	OW	M	Side	YES
20	56	C	B	11.0%	51.6%	33.2%	4.2%	572	0.5%	4.7%	10.8%	17.8%	24.5%	24.0%	17.7%	572	1.03	0	Level	3.6	2	D	NA	M	YES	OW	YES	Side	YES
21	39	C	B	16.5%	53.9%	26.6%	3.0%	571	1.1%	6.3%	9.1%	16.5%	24.7%	25.2%	17.2%	571	1.02	-0.67	Below	5.6	9	D	U	M	YES	OW	YES	Side	NO
22	14	C	C	2.6%	32.7%	55.6%	9.1%	572	2.6%	5.6%	12.1%	13.5%	23.8%	25.0%	17.5%	572	0.95	-0.67	Below	1.1	4	D	U	M	YES	OW	YES	Side	NO
23	11	C	B	3.8%	54.0%	38.8%	3.3%	572	1.0%	6.5%	10.8%	17.0%	24.0%	26.0%	14.7%	572	0.93	0	Below	3.8	8	D	U	M	YES	OW	YES	Front	YES
24.5	3	C	B	15.9%	53.0%	26.9%	4.2%	572	2.4%	8.9%	11.4%	14.3%	21.2%	24.7%	17.1%	572	0.85	-0.67	Level	6.4	9	D	U	M	YES	OW	YES	Front	NO
24.5	23	C	C	3.1%	43.7%	47.2%	5.9%	572	1.4%	5.9%	13.5%	16.3%	25.0%	24.0%	14.0%	572	0.85	0	Below	4.7	6	D	U	M	YES	OW	YES	Side	NO
26	54	C	B	4.9%	53.5%	37.6%	4.0%	572	1.0%	5.9%	14.7%	16.8%	23.3%	24.5%	13.8%	572	0.84	-0.67	Below	5	6	D	I	M	NO	OW	YES	Side	NO
27	50	C	C	1.7%	38.3%	53.8%	6.1%	572	2.6%	6.6%	9.3%	18.7%	26.6%	25.9%	10.3%	572	0.79	-0.67	Below	3.2	5	D	U	M	YES	OW	YES	Side	NO
28	22	C	C	2.3%	44.1%	47.9%	5.8%	572	2.1%	6.5%	12.8%	18.0%	24.7%	25.2%	10.8%	572	0.76	-0.33	Above	4.3	5	D	U	M	YES	OW	NO	Side	NO
29	29	D	D	1.2%	8.7%	33.4%	56.6%	572	6.3%	8.6%	10.7%	12.6%	20.5%	23.6%	17.8%	572	0.74	-1	Level	1	5	D	U	F	YES	OW	YES	Side	NO
30	1	C	C	6.8%	41.1%	43.0%	9.1%	572	3.5%	8.7%	12.8%	14.5%	22.6%	23.4%	14.5%	572	0.72	-2	Level	6.6	15	D	U	M	YES	OW	M	Side	NO
31	52	C	C	1.4%	23.3%	63.3%	12.1%	572	2.6%	7.5%	14.2%	16.6%	24.3%	23.6%	11.2%	572	0.68	-1.67	Below	3.5	9	D	U	M	YES	OW	YES	Front	NO
32	64	C	C	4.0%	35.5%	52.3%	8.2%	572	1.0%	5.6%	15.0%	22.0%	25.7%	20.6%	10.0%	572	0.67	-0.33	Level	4.2	3	D	U	M	YES	OW	YES	Side	NO
33	40	C	C	1.0%	23.3%	61.9%	13.8%	572	3.0%	7.9%	15.0%	14.7%	24.8%	22.9%	11.7%	572	0.66	-1	Level	2.5	8	D	U	M	YES	OW	YES	Side	YES
34	16	C	C	4.7%	19.2%	50.0%	26.0%	572	3.3%	7.0%	14.5%	18.7%	21.3%	22.6%	12.6%	572	0.66	0	Level	1.9	1	NA	NA	M	NA	OW	YES	Side	YES
35	27	C	C	2.8%	38.5%	52.3%	6.5%	572	1.4%	6.5%	15.6%	18.5%	26.4%	23.4%	8.2%	572	0.65	-1	Below	4.4	7	D	M	M	SW	OW	YES	Front	NO

36	33	C	C	2.8%	45.1%	48.6%	3.5%	572	1.9%	7.2%	16.6%	18.2%	26.0%	22.4%	7.7%	572	0.57	-0.67	Level	3.4	8	D	M	M	SW	OW	YES	Back	NO
37	7	C	C	3.0%	30.8%	56.3%	10.0%	572	1.9%	7.0%	16.4%	21.5%	24.1%	21.0%	8.0%	572	0.54	-0.67	Below	2.7	6	D	I	M	NO	OW	YES	Side	YES
38	41	D	C	2.1%	19.4%	52.4%	26.0%	572	4.2%	9.4%	16.8%	14.3%	21.2%	22.7%	11.4%	572	0.52	-0.33	Level	1	3	D	U	F	YES	Blue	YES	Side	YES
39	24	C	C	1.0%	30.2%	58.7%	10.0%	572	3.1%	8.6%	16.4%	18.5%	23.1%	20.8%	9.4%	572	0.50	-0.67	Below	3.7	10	D	I	M	NO	OW	YES	Side	NO
40	15	C	C	1.0%	19.4%	58.9%	20.6%	572	4.0%	9.3%	14.3%	18.5%	22.4%	22.0%	9.4%	572	0.50	-1.67	Below	2.6	7	D	U	M	YES	OW	YES	Side	NO
41	63	D	C	1.7%	15.4%	48.8%	34.1%	572	5.9%	9.3%	14.0%	15.2%	23.1%	20.8%	11.7%	572	0.49	-1	Level	1	3	D	U	F	YES	1/2 Blue	YES	Side	YES
42	17	C	C	3.0%	33.2%	50.2%	13.6%	572	4.4%	9.1%	16.8%	16.8%	22.9%	20.5%	9.6%	572	0.45	-1.33	Below	4.5	20	D	U	M	YES	OW	YES	Back	NO
43	66	C	C	2.1%	42.1%	49.1%	6.6%	572	2.1%	8.6%	19.6%	18.9%	24.5%	19.2%	7.2%	572	0.41	-0.33	Level	2.9	14	A	I	M	NO	OW	YES	Side	YES
44	13	C	C	2.4%	25.5%	54.0%	18.0%	572	4.9%	10.5%	16.3%	16.6%	23.1%	19.6%	9.1%	572	0.38	-1.33	Below	2.8	6	D	I	M	NO	OW	YES	Front	YES
45	8	C	C	1.2%	15.2%	59.3%	24.3%	572	4.0%	11.5%	17.0%	14.9%	24.1%	20.8%	7.7%	572	0.37	-0.67	Level	3.4	4	D	M	M	SW	OW	YES	Side	YES
46	37	C	C	1.9%	26.8%	58.1%	13.1%	571	3.2%	9.6%	17.5%	20.5%	23.1%	19.4%	6.7%	571	0.36	-2	Level	5.3	15	D	I	M	NO	OW	YES	Front	NO
47	28	D	C	1.6%	22.0%	52.3%	24.1%	572	8.0%	11.7%	14.7%	12.6%	19.9%	21.9%	11.2%	572	0.35	-2	Above	5.6	19	D	U	M	YES	OW	M	Side	NO
48	60	C	C	4.5%	38.5%	47.6%	9.4%	572	3.3%	9.4%	18.7%	19.4%	24.0%	17.3%	7.9%	572	0.35	-1.33	Below	3.5	12	D	I	M	SW	OW	YES	Side	YES
49	58	C	C	7.3%	36.5%	43.5%	12.6%	572	8.7%	10.7%	16.6%	13.5%	16.8%	19.6%	14.2%	572	0.34	-2	Level	5	7	D	M	M	YES	OW	YES	Side	NO
50	62	C	C	1.2%	16.8%	62.1%	19.9%	572	2.6%	10.1%	18.9%	18.7%	25.0%	19.4%	5.2%	572	0.33	-0.67	Level	2.1	4	D	M	F	SW	OW	YES	Side	NO
51	42	D	C	0.5%	11.4%	65.6%	22.6%	572	4.0%	11.5%	18.0%	14.9%	25.2%	20.8%	5.6%	572	0.30	-1.67	Below	3.5	9	D	I	M	NO	OW	YES	Front	NO
52	4	C	C	1.4%	20.3%	57.5%	20.8%	572	6.5%	11.9%	15.0%	16.8%	22.0%	17.5%	10.3%	572	0.30	-1	Below	5.6	15	D	M	M	NO	OW	M	Front	YES
53	5	D	C	2.1%	14.5%	53.1%	30.2%	572	6.5%	10.7%	16.4%	16.1%	24.8%	19.6%	5.9%	572	0.25	-0.33	Level	1	3	D	U	F	YES	1/2 Beige	YES	Side	YES
54	20	D	C	1.2%	12.8%	52.3%	33.7%	572	5.9%	11.5%	17.3%	16.3%	23.8%	18.7%	6.5%	572	0.22	-1	Level	1	3	D	U	F	YES	OW	YES	Side	YES
55	2	D	C	1.6%	11.2%	52.8%	34.4%	572	7.5%	11.0%	18.2%	15.9%	22.2%	19.6%	5.6%	572	0.15	-1.33	Level	1	3	D	U	F	YES	Beige	YES	Side	YES
56	65	C	C	1.7%	24.3%	55.1%	18.9%	572	6.0%	12.3%	19.1%	16.6%	21.4%	18.9%	5.8%	571	0.15	-2	Level	10.4	39	D	M	M	NO	OW	M	Side	NO
57	9	D	D	1.0%	10.8%	36.4%	51.7%	572	8.0%	12.1%	17.7%	14.5%	22.0%	19.2%	6.5%	572	0.14	-1.33	Level	1.9	2	D	U	M	YES	OW 1/2	YES	Side	YES
58.5	51	D	C	1.9%	15.0%	55.9%	27.1%	572	6.3%	12.8%	22.0%	13.8%	20.1%	18.9%	6.1%	572	0.10	-2	Level	1	3	D	U	F	YES	Green	YES	Side	YES
58.5	53	C	C	1.4%	26.9%	55.6%	16.1%	572	6.1%	14.5%	17.5%	16.1%	23.3%	16.3%	6.3%	572	0.10	-1	Below	5.5	22	D	I	M	SW	OW	YES	Side	YES
60	25	D	C	0.9%	8.4%	54.2%	36.5%	572	7.0%	16.1%	14.3%	16.3%	21.7%	19.1%	5.6%	572	0.09	-2.33	Above	2.3	8	D	U	M	YES	OW	NO	Side	NO
61	68	D	C	0.9%	7.2%	49.0%	43.0%	572	5.9%	14.5%	18.9%	20.1%	17.3%	18.5%	4.7%	572	0.03	-1	Below	5	5	D	I	M	NO	OW	YES	Back	YES
62	59	D	C	2.6%	15.9%	51.7%	29.7%	572	10.3%	13.3%	18.7%	14.3%	18.4%	16.3%	8.7%	572	0.01	-2	Level	1	3	D	U	F	YES	Green	YES	Side	YES
63	12	C	C	1.2%	12.9%	55.9%	29.9%	572	8.7%	15.6%	17.5%	16.8%	18.4%	16.4%	6.6%	572	-0.04	-1.33	Above	3.5	10	A	I	M	NO	OW	M	Side	YES
64	21	C	C	2.6%	25.5%	53.7%	18.2%	572	7.9%	15.9%	20.5%	17.7%	17.5%	16.3%	4.4%	572	-0.13	-0.67	Below	3.2	11	A	I	M	NO	OW	YES	Side	YES
65	30	C	C	2.3%	18.5%	54.7%	24.5%	572	7.9%	18.2%	18.4%	15.2%	20.5%	14.9%	5.1%	572	-0.13	-1.33	Above	5.4	17	A	I	M	NO	OW	NO	Side	YES
66	57	D	D	1.7%	4.0%	22.9%	71.3%	572	11.9%	17.7%	15.9%	16.4%	16.8%	15.4%	5.9%	572	-0.22	-3	Above	2.3	11	D	M	M	SW	OW	YES	Side	NO
67	69	C	C	3.0%	20.6%	50.0%	26.4%	572	10.1%	18.7%	19.8%	14.0%	16.8%	16.6%	4.0%	572	-0.26	-2	Level	5.5	40	D	M	M	NO	OW	M	Back	NO
68	47	D	D	1.2%	2.8%	6.8%	89.2%	572	22.7%	14.2%	9.3%	12.8%	16.8%	12.9%	11.4%	572	-0.29	-1.33	Level	0.4	3	D	U	F	YES	Enercon	YES	Side	NO
69	61	D	D	1.4%	3.5%	20.6%	74.5%	572	16.8%	17.7%	15.4%	13.6%	14.3%	13.8%	8.4%	572	-0.34	-2	Level	1.2	6	D	U	F	YES	OW	YES	Front	NO
70	38	D	D	1.7%	5.1%	19.9%	73.3%	572	16.8%	16.6%	15.2%	15.2%	17.0%	11.9%	7.3%	572	-0.36	-1.67	Level	1	7	A	M	F	SW	Black Blades	NO	Side	YES

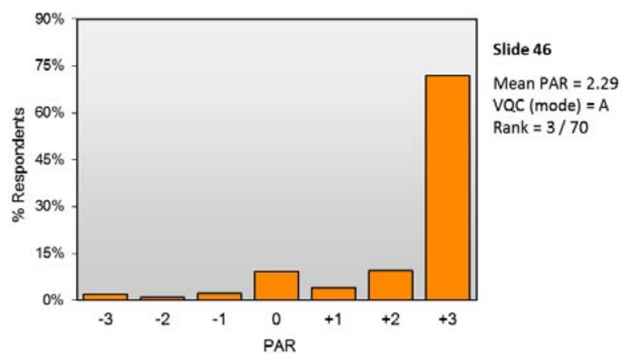
Appendix 4. Photographs used in wind energy visual perception survey

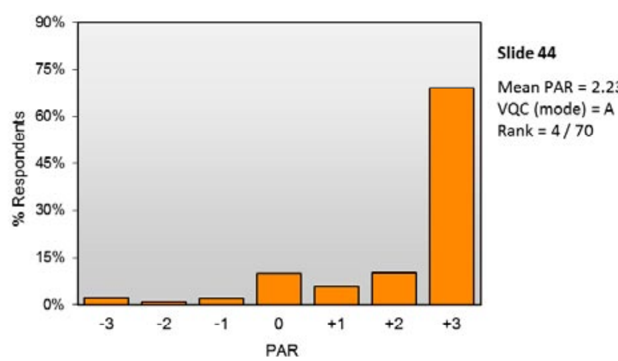
Zero Emission Energy Developments Inc.

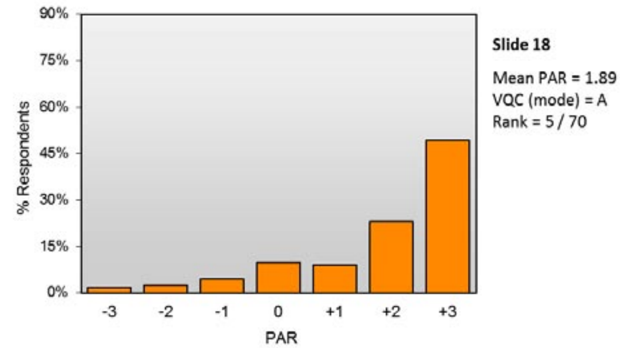


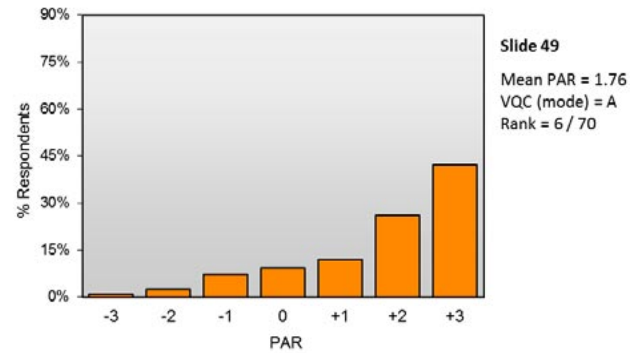


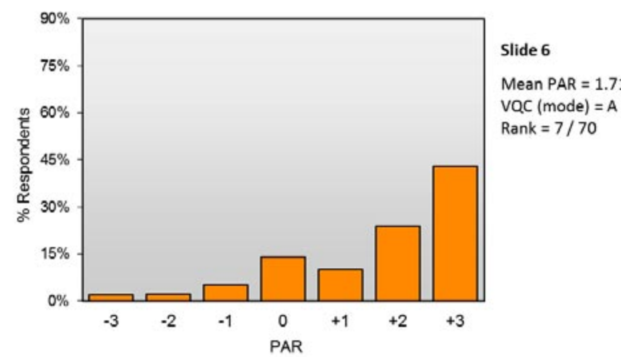
Appalachian Trail Conservancy

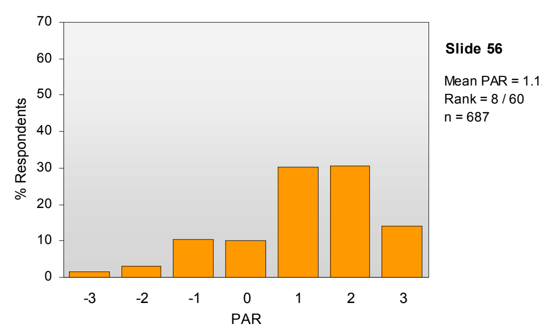


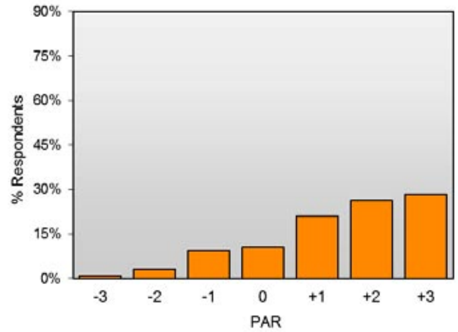



90%
75%
60%
45%
30%
15%
0%
% Respondents
-3
-2
-1
0
+1
+2
+3
PAR
Slide 18
Mean PAR = 1.89
VQC (mode) = A
Rank = 5 / 70


90%
75%
60%
45%
30%
15%
0%
% Respondents
-3
-2
-1
0
+1
+2
+3
PAR
Slide 49
Mean PAR = 1.76
VQC (mode) = A
Rank = 6 / 70

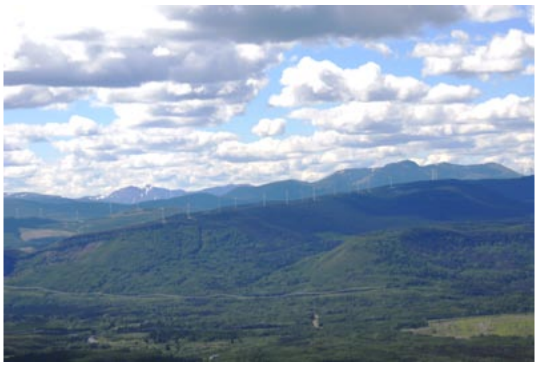

90%
75%
60%
45%
30%
15%
0%
% Respondents
-3
-2
-1
0
+1
+2
+3
PAR
Slide 6
Mean PAR = 1.71
VQC (mode) = A
Rank = 7 / 70

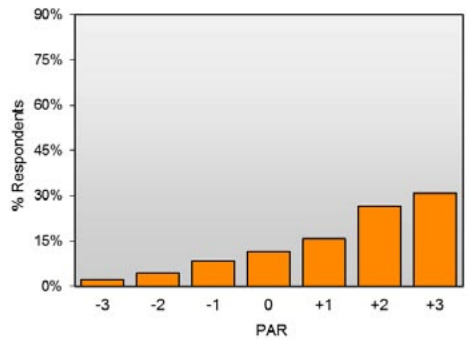

70
60
50
40
30
20
10
0
% Respondents
-3
-2
-1
0
1
2
3
PAR
Slide 56
Mean PAR = 1.12
Rank = 8 / 60
n = 687



Slide 55

Mean PAR = 1.40
VQC (mode) = B
Rank = 9 / 70

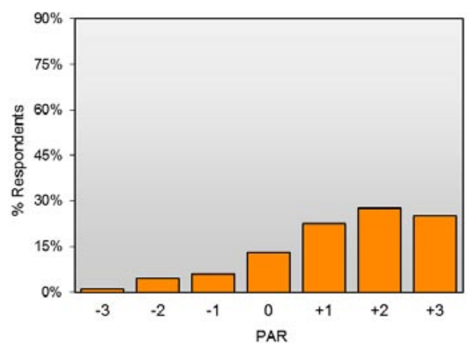




Slide 35

Mean PAR = 1.38
VQC (mode) = B
Rank = 10 / 70

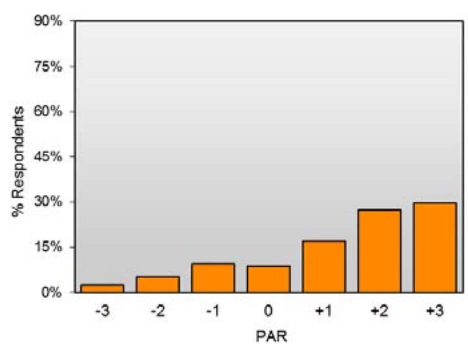
Zero Emission Energy Developments Inc.



Slide 48

Mean PAR = 1.35
VQC (mode) = B
Rank = 11 / 70

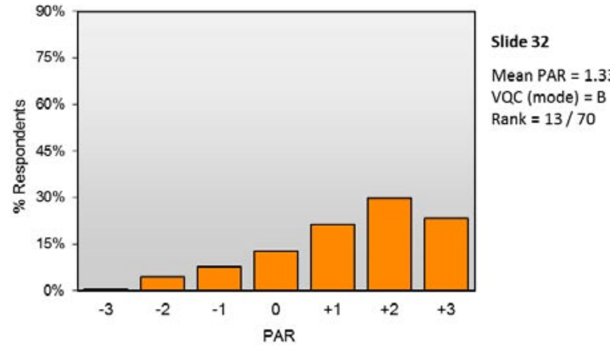
Jean Vissering & Vermont Environmental Research Assoc.

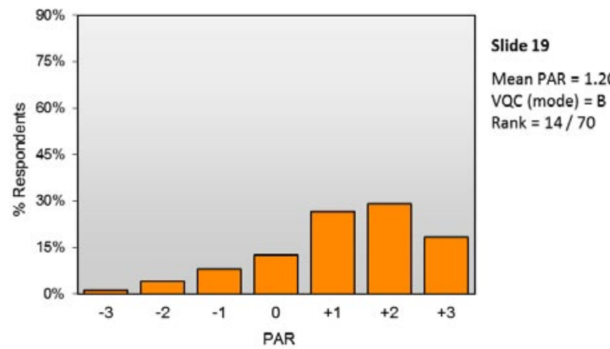


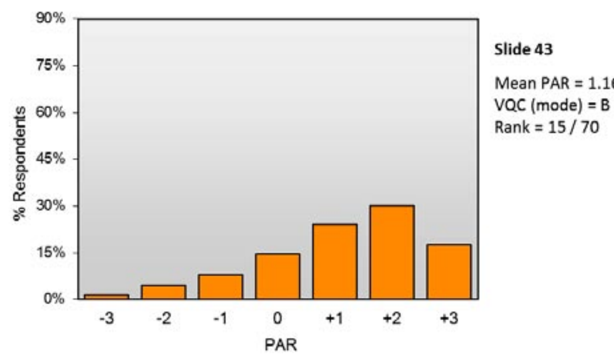
Slide 70

Mean PAR = 1.34
VQC (mode) = B
Rank = 12 / 70

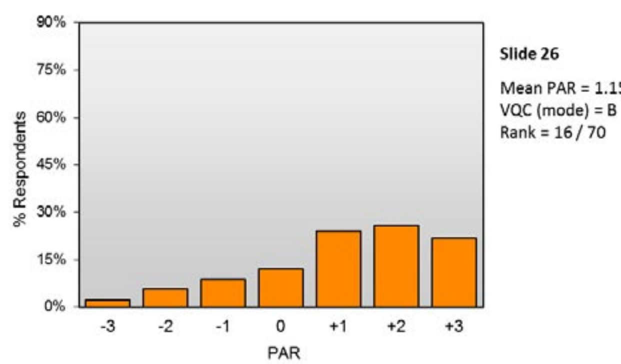
Vermont Environmental Research Associates

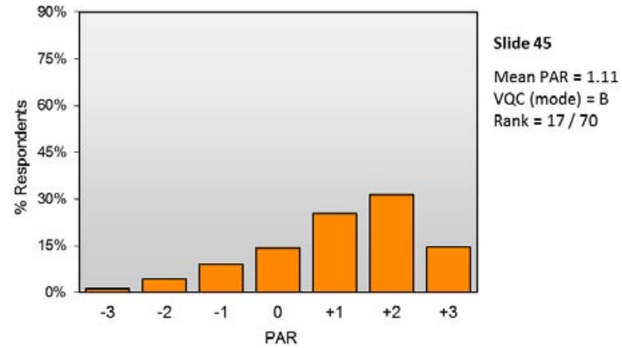


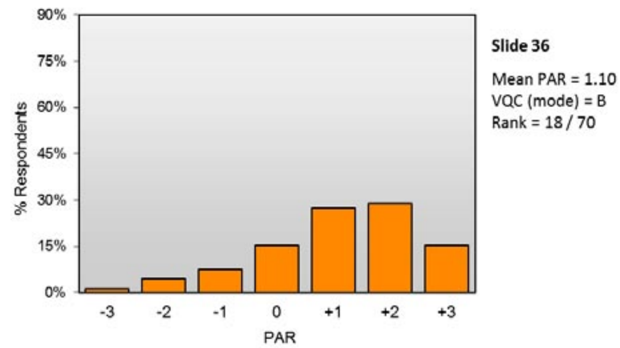




Jean Vissering & Vermont Environmental Research Assoc.




90%
75%
60%
45%
30%
15%
0%
% Respondents
-3
-2
-1
0
+1
+2
+3
PAR
Slide 45
Mean PAR = 1.11
VQC (mode) = B
Rank = 17 / 70


90%
75%
60%
45%
30%
15%
0%
% Respondents
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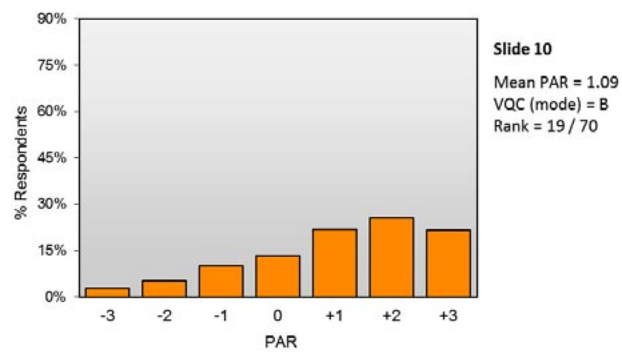
-2
-1
0
+1
+2
+3
PAR
Slide 36
Mean PAR = 1.10
VQC (mode) = B
Rank = 18 / 70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60%
45%
30%
15%
0%
% Respondents
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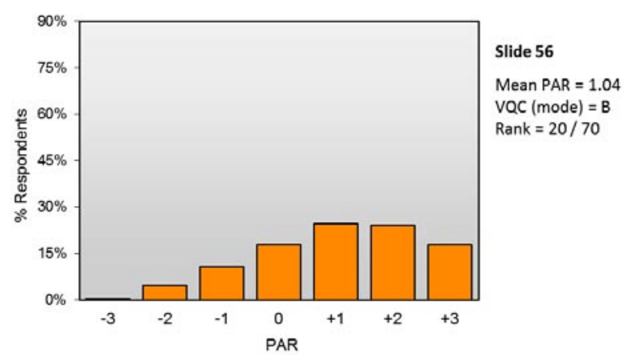
-2
-1
0
+1
+2
+3
PAR
Slide 10
Mean PAR = 1.09
VQC (mode) = B
Rank = 19 / 70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45%
30%
15%
0%
% Respondents
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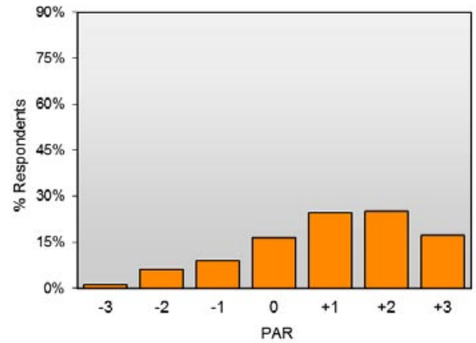
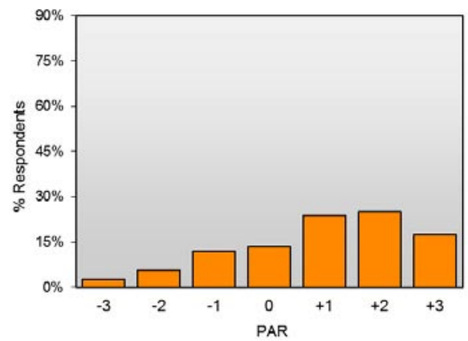
-1
0
+1
+2
+3
PAR
Slide 56
Mean PAR = 1.04
VQC (mode) = B
Rank = 20 / 70



Slide 39

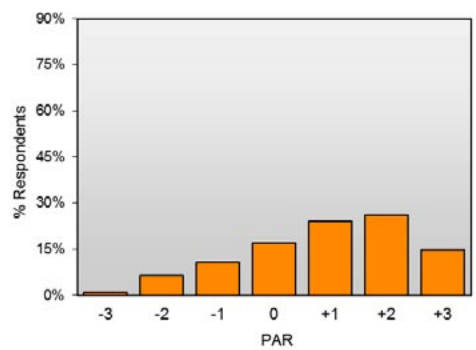
Mean PAR = 1.02
VQC (mode) = B
Rank = 21 / 70

Jean Vissering & Saratoga Associates



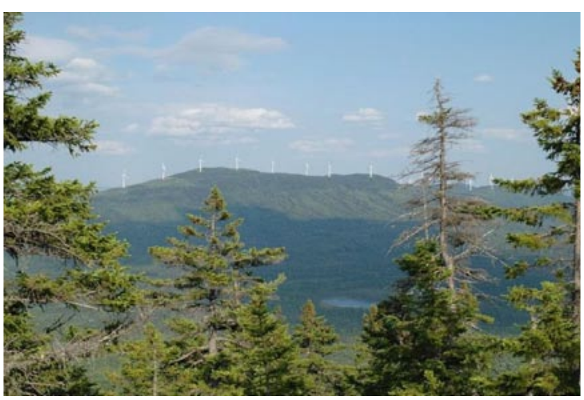
Slide 14

Mean PAR = 0.95
VQC (mode) = C
Rank = 22 / 70

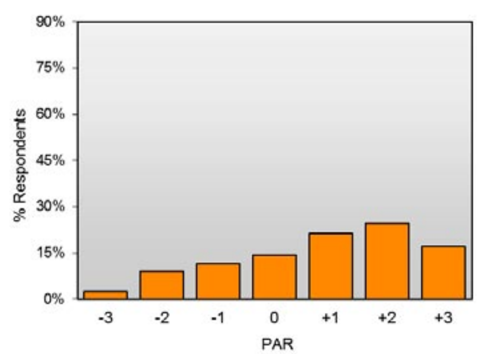


Slide 11

Mean PAR = 0.93
VQC (mode) = B
Rank = 23 / 70

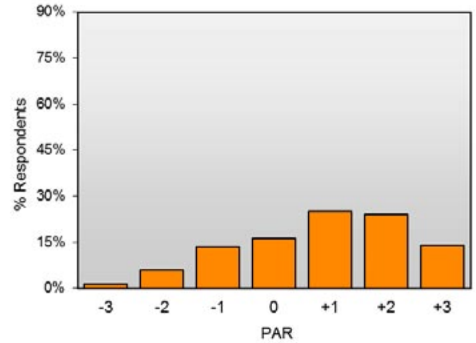


Appalachian Trail Conservancy



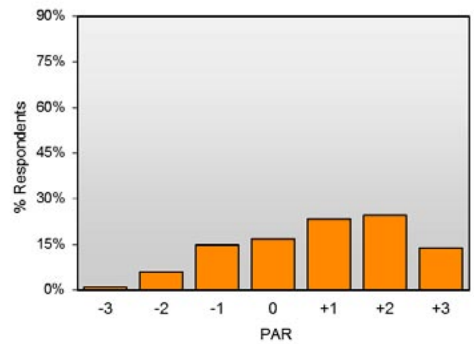
Slide 3

Mean PAR = 0.85
VQC (mode) = B
Rank = 24.5 / 70



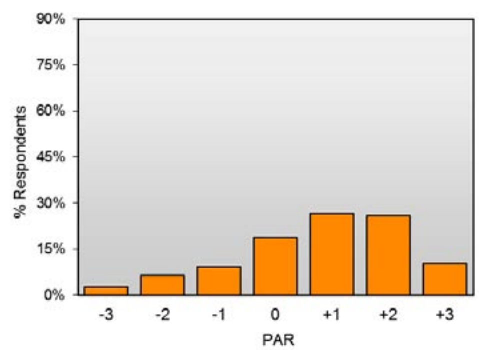
Slide 23

Mean PAR = 0.85
VQC (mode) = C
Rank = 24.5 / 70



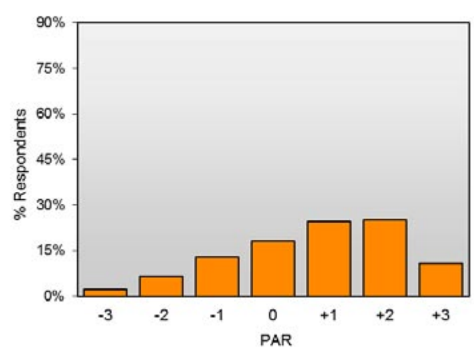
Slide 54

Mean PAR = 0.84
VQC (mode) = B
Rank = 26 / 70



Slide 50

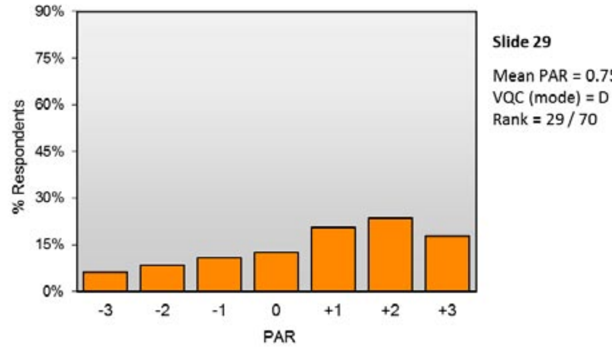
Mean PAR = 0.79
VQC (mode) = C
Rank = 27 / 70

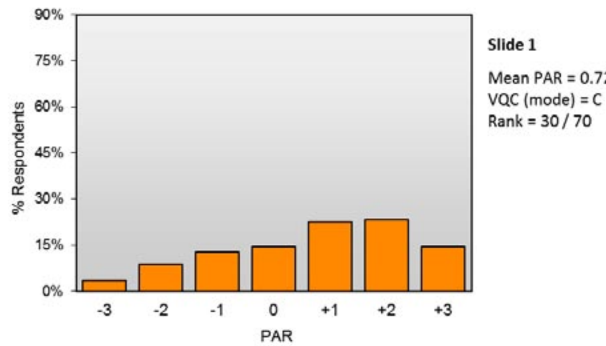


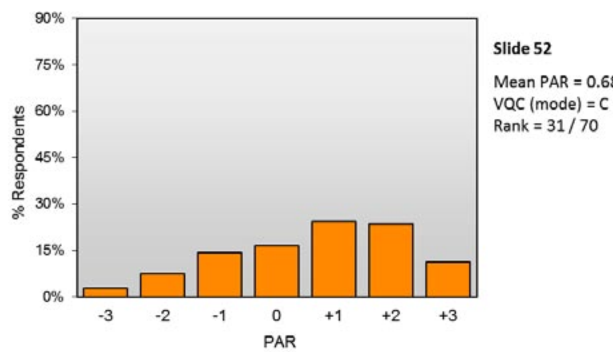
Slide 22

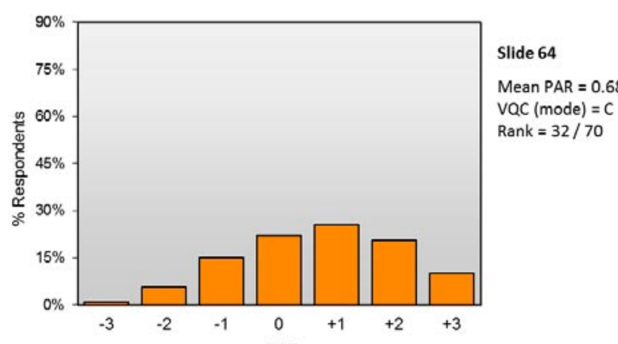
Mean PAR = 0.76
VQC (mode) = C
Rank = 28 / 70

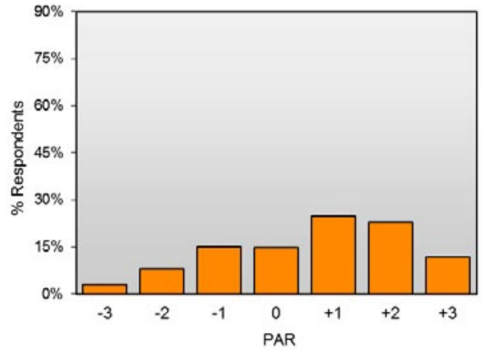
Tomorrow is Greener.com





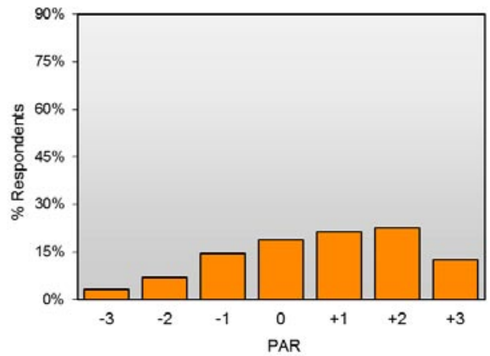






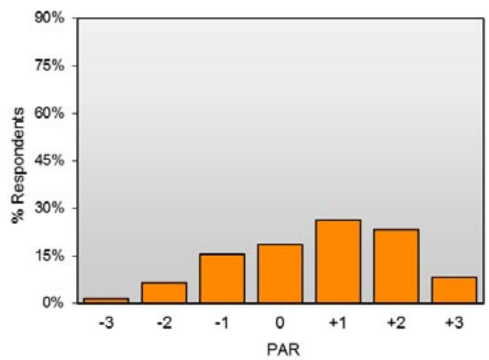
Slide 40

Mean PAR = 0.66
VQC (mode) = C
Rank = 33 / 70



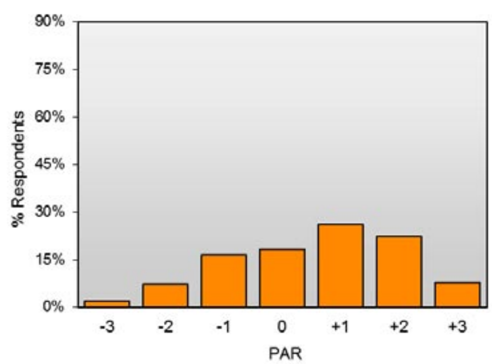
Slide 16

Mean PAR = 0.66
VQC (mode) = C
Rank = 34 / 70



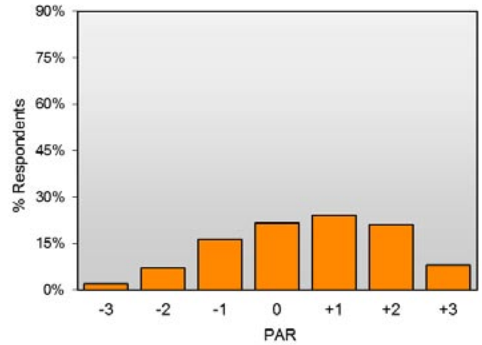
Slide 27

Mean PAR = 0.65
VQC (mode) = C
Rank = 35 / 70



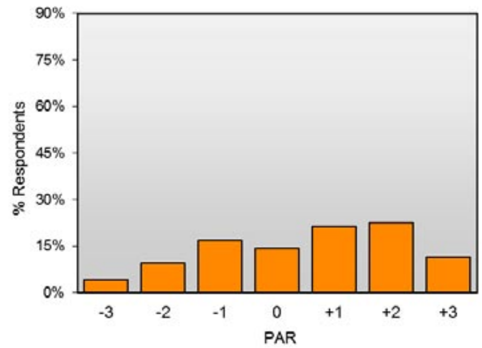
Slide 33

Mean PAR = 0.57
VQC (mode) = C
Rank = 36 / 70



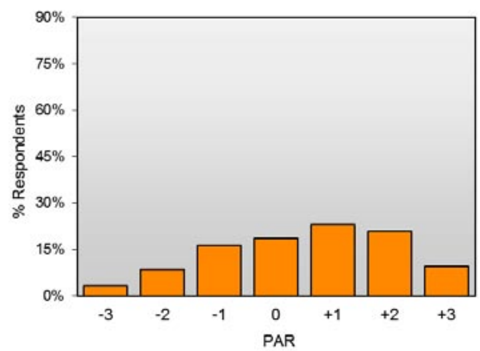
Slide 7

Mean PAR = 0.54
VQC (mode) = C
Rank = 37 / 70



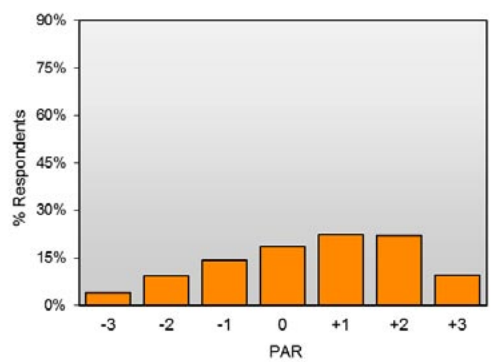
Slide 41

Mean PAR = 0.52
VQC (mode) = C
Rank = 38 / 70



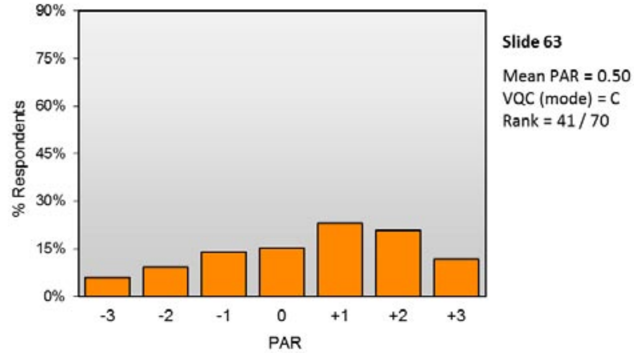
Slide 24

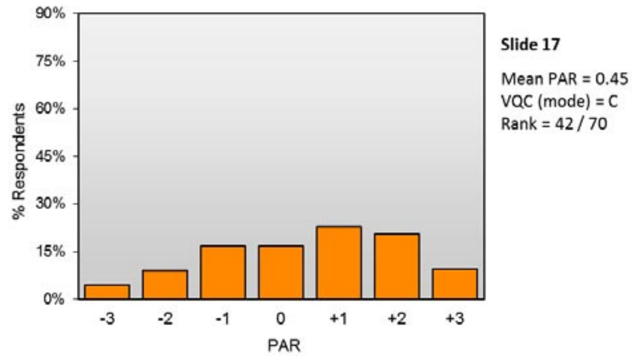
Mean PAR = 0.50
VQC (mode) = C
Rank = 39 / 70

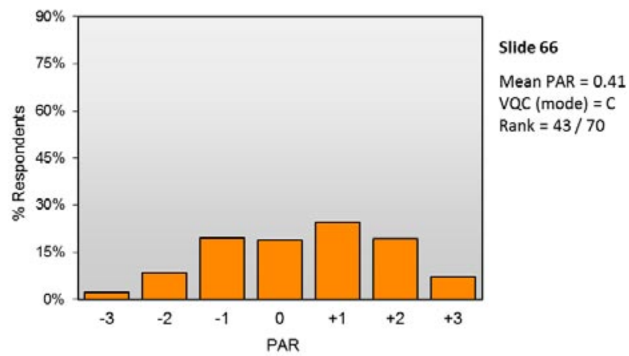


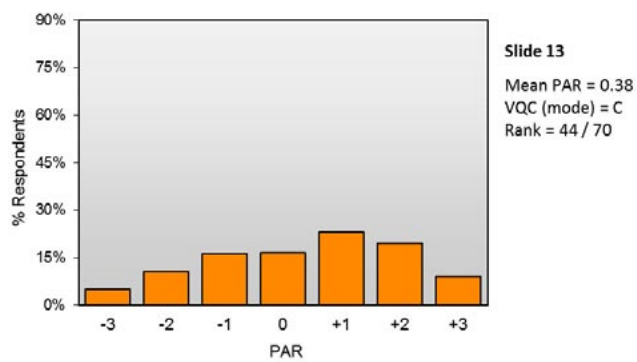
Slide 15

Mean PAR = 0.50
VQC (mode) = C
Rank = 40 / 70









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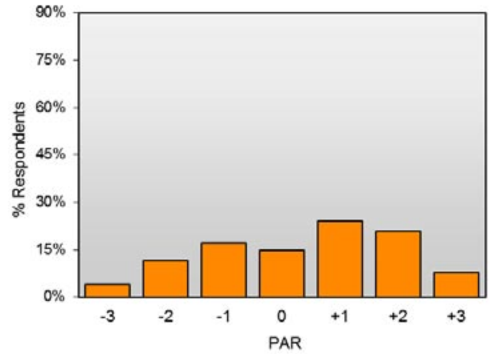
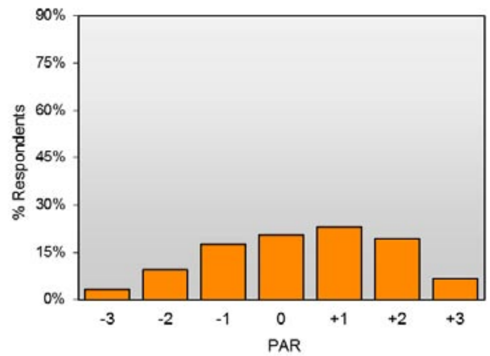


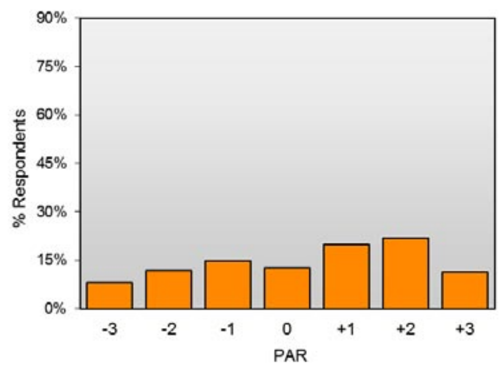
Slide 8

Mean PAR = 0.37
VQC (mode) = C
Rank = 45 / 70



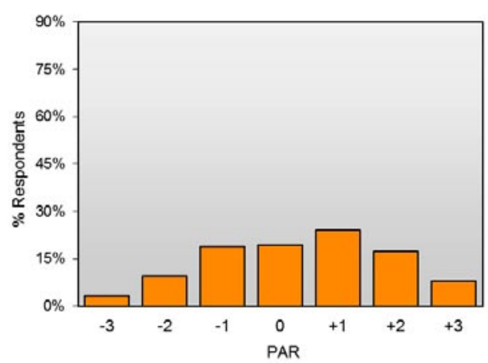
Slide 37

Mean PAR = 0.36
VQC (mode) = C
Rank = 46 / 70



Slide 28

Mean PAR = 0.35
VQC (mode) = C
Rank = 47 / 70



Slide 60

Mean PAR = 0.35
VQC (mode) = C
Rank = 48 / 70

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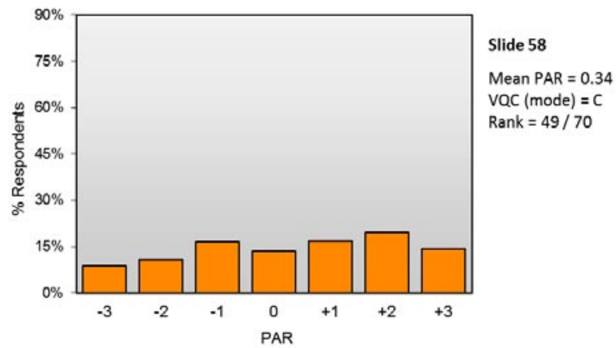

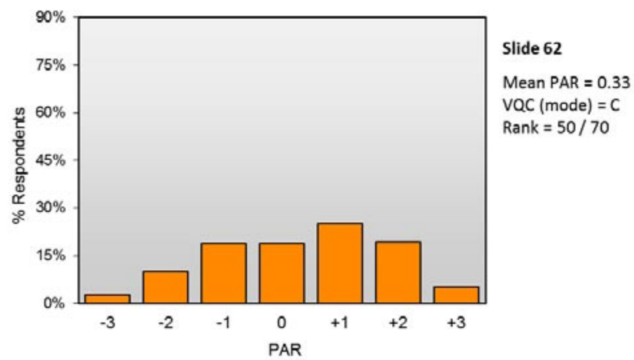

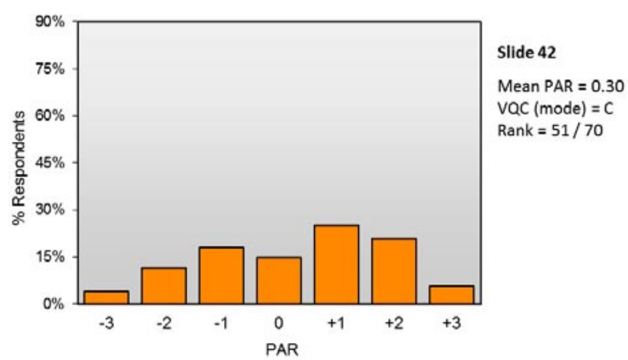

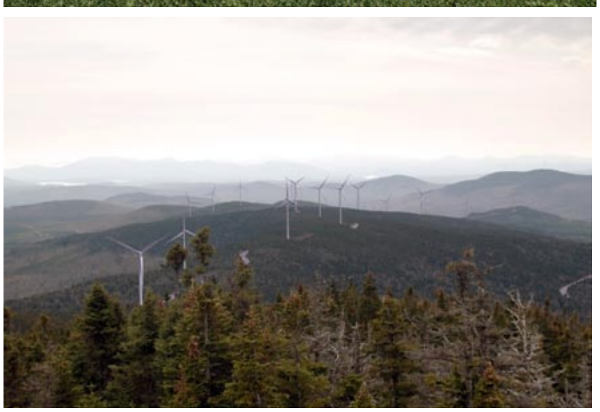

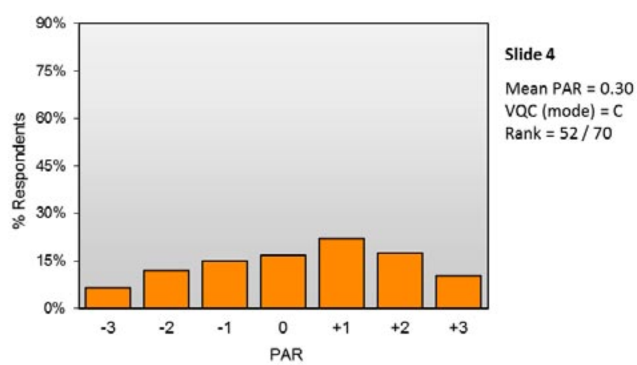

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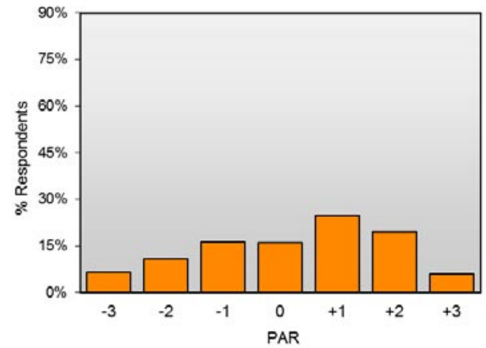
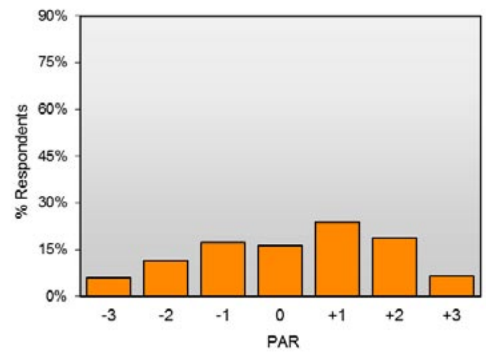


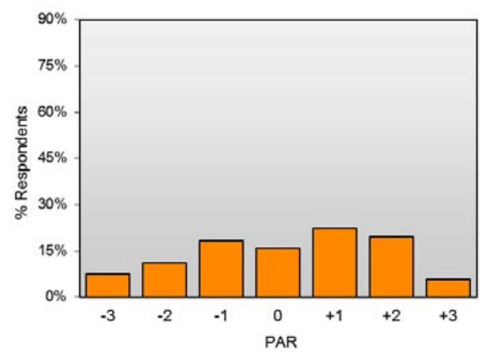
Slide 5

Mean PAR = 0.25
VQC (mode) = C
Rank = 53 / 70



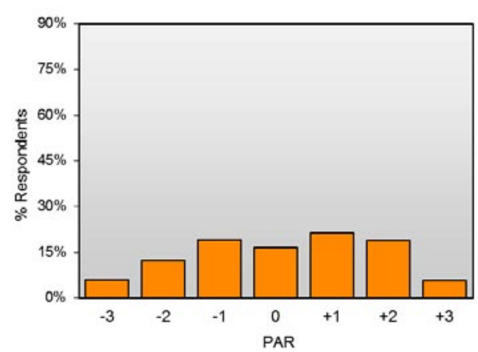
Slide 20

Mean PAR = 0.22
VQC (mode) = C
Rank = 54 / 70



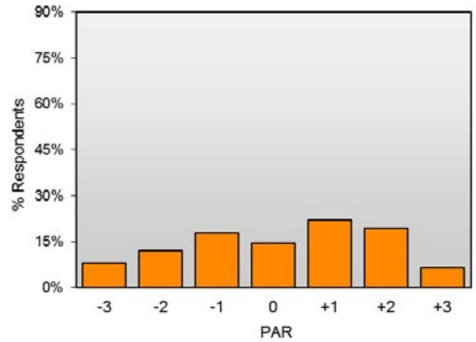
Slide 2

Mean PAR = 0.15
VQC (mode) = C
Rank = 55 / 70



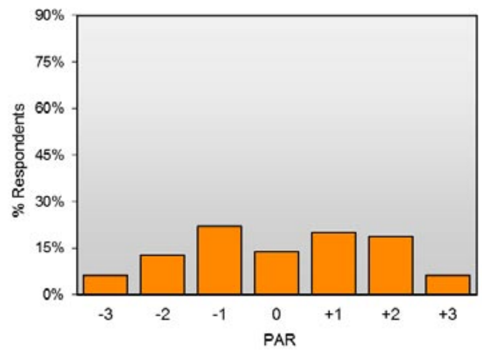
Slide 65

Mean PAR = 0.15
VQC (mode) = C
Rank = 56 / 70



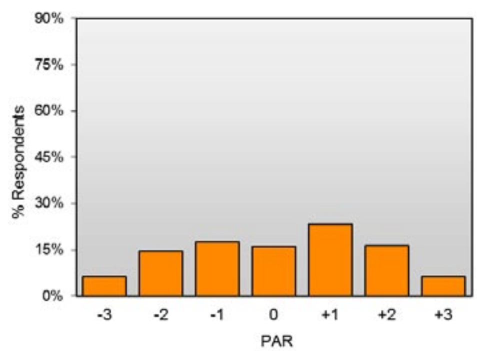
Slide 9

Mean PAR = 0.14
VQC (mode) = D
Rank = 57 / 70



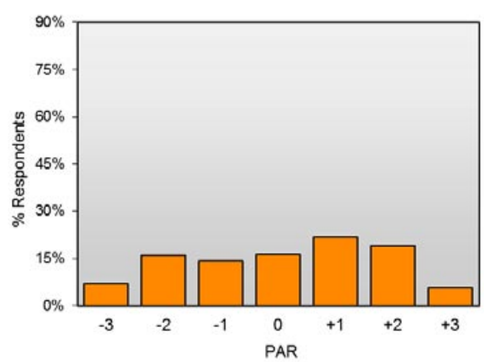
Slide 51

Mean PAR = 0.10
VQC (mode) = C
Rank = 58.5 / 70



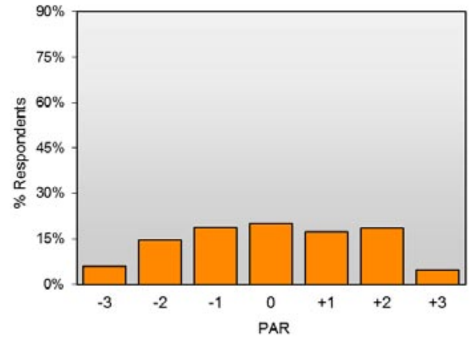
Slide 53

Mean PAR = 0.10
VQC (mode) = C
Rank = 58.5 / 70



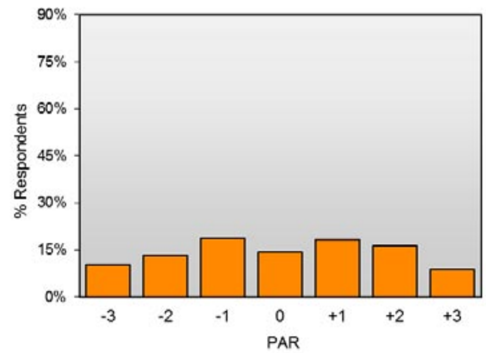
Slide 25

Mean PAR = 0.09
VQC (mode) = C
Rank = 60 / 70



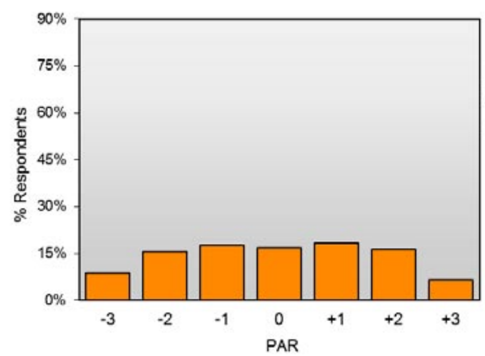
Slide 68

Mean PAR = 0.03
VQC (mode) = C
Rank = 61 / 70



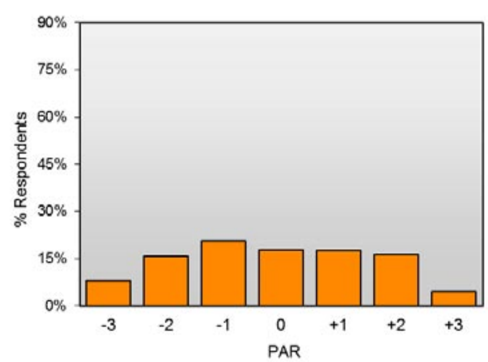
Slide 59

Mean PAR = 0.01
VQC (mode) = C
Rank = 62 / 70



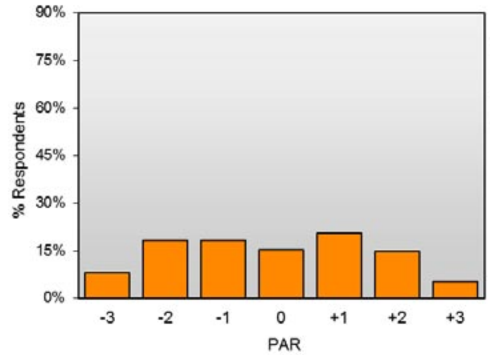
Slide 12

Mean PAR = -0.04
VQC (mode) = C
Rank = 63 / 70



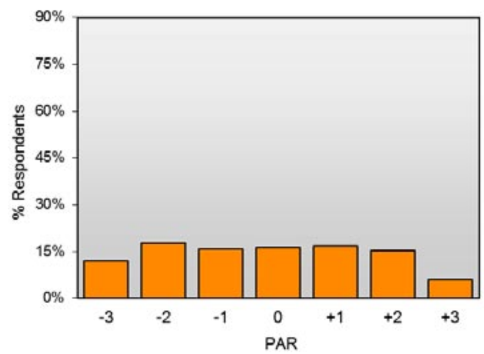
Slide 21

Mean PAR = -0.13
VQC (mode) = C
Rank = 64 / 70



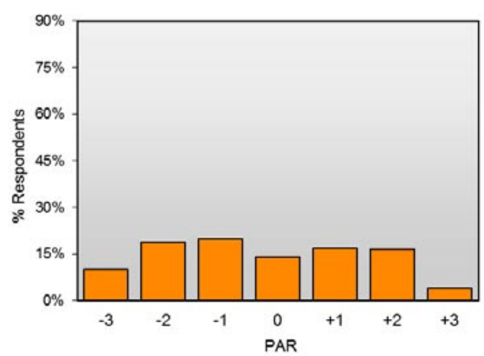
Slide 30

Mean PAR = -0.13
VQC (mode) = C
Rank = 65 / 70



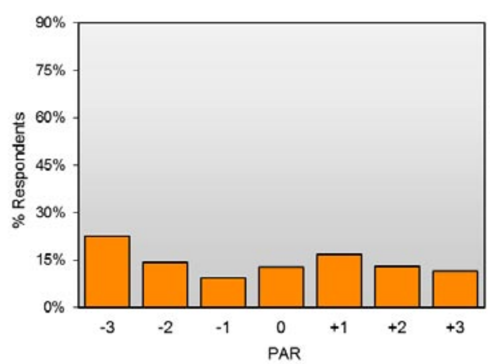
Slide 57

Mean PAR = -0.22
VQC (mode) = D
Rank = 66 / 70



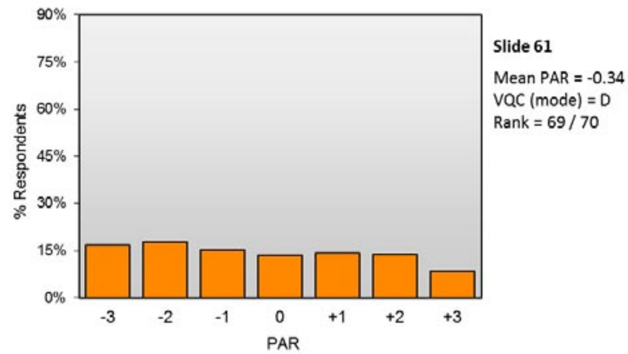
Slide 69

Mean PAR = -0.26
VQC (mode) = C
Rank = 67 / 70



Slide 47

Mean PAR = -0.29
VQC (mode) = D
Rank = 68 / 70

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