Will Seuffert
Executive Secretary
Minnesota Public Utilities Commission 121 7th Place East, Suite 350
Saint Paul, MN 55101
will.seuffert@state.mn.us

MN Docket 17-410

13.0 PERMIT AMENDMENT

This permit may be amended at any time by the Commission in accordance with Minn. R. 7854.1300, subp. 2. Any person may request an amendment of the conditions of this permit by submitting a request to the Commission in writing describing the amendment sought and the reasons for the amendment. The Commission will mail notice of receipt of the request to the Permittee. The Commission may amend the conditions after affording the Permittee and interested persons such process as is required.

I am asking for the adoption of an amendment to help mitigate the negative consequences of shadow flicker on my property and other impacted landowners.

My wife and I have been active participants throughout the permitting process via participation in the contested hearing and submission of comments via the eDockets filing system. In the site permit, our residence is represented by Receptor #337. Shadow flicker data has been included with this request.

Based upon the developers projected “conservative estimate”, my family and I are projected to receive around 63.15 hours of shadow flicker (3,811 minutes) or 2.1 times the limit established by Freeborn County Ordinance 26-56. The “Real Case” estimate reduces that total by a staggering 61.8% (1.456 minutes) based upon a modification of modeling parameters. A change of this magnitude should produce serious questions about the validity of the modifications made by the developer.

**Support for Amendment**

1. Modeling Based Upon Unprovided Data and Biased Fundamentals

The shadow flicker modeling used in the Freeborn Wind project is built upon data that has never been presented for validation and basic modeling fundamentals that are biased against landowners.

*Data*

The data used by Freeborn Wind is based upon two primary sources:

1. Data collected at a National Climatic Data Center in Minneapolis, MN (closest station to the project area)
2. Wind speed and direction data gathered by the company at sites in the project area

The data being used possesses many possible flaws that could negatively impact the landowners of the area. First, the distance between Minneapolis and the project area (around 100 miles) introduces a considerable margin of error into the data set. This issue is further compounded by the use of data from the project area, which has not been shared for validation and may not represent wind characteristics of this area that do not align with average meteorological conditions because of the relatively small snapshot it provides. In fact, Freeborn Wind admits in their initial permit application that their data could produce model results that underrepresent the shadow flicker impact (Freeborn Wind Farm: Site Permit Application - June 2017, p 39).

*Modeling Assumptions*

Compounding the data-related issues in the modeling are some of the assumptions built into modeling used by Freeborn Wind. First, the model creates a "shadow receptor" that measures the impact of shadow flicker on "a 1m x 1m window located 1m off the ground" (Freeborn Wind Site Permit Amendment Application - Attachment F, p 7). This "window" is presented as a conservative estimate because of the "greenhouse" modeling used, but in fact, represents a very minimalistic model that significantly favors the developer. This 1 square meter "window" represents a tiny percentage of a landowner's property. On a five-acre property, the "window" of

modeling represents 1/20234th of a landowner's entire property. In the case of our property, the "window" is located roughly in my garage which means that the primary area of my residence and the portions of my property used by my family (side patio, playground, etc.) could receive higher amounts of shadows flicker creating a more significant margin of error.

By accepting this modeling parameter, the developer is failing to present the real impact of shadow flicker on a landowner's entire property. In accepting this as a valid modeling practice, the Commission is sanctioning that a landowner's protection under shadow flicker ordinances (and noise standards/special conditions) only apply to a minuscule portion of a landowner's property identified by the developer and not to the entire property of the landowner. Thus, landowners are having their property rights stripped from them.

2. Compliance with Freeborn County Ordinance

While the state of Minnesota has not yet established rules/criteria for the acceptable levels of shadow flicker, Freeborn County created an ordinance, and Freeborn Wind has acknowledged that their project will adhere to said regulation. The Freeborn County Ordinance Chapter 26, Section 56, states that a shadow flicker "at any receptor shall not exceed 30 hours per year" (Freeborn County Ordinance, Chapter 26, Section 56). The ordinance allows for the modeling to determine this to consider topography but limits other possible reduction factors. At no point in the Freeborn County ordinance, does the county give the developer the right to reduce shadow flicker estimates to a "Realistic Case" through the use of estimated reductions based upon operational time, wind direction, etc.

The developer's decision to utilize a "Realistic Case" model is another example helping to confirm the trend of the developer moving the proverbial "goalposts" to ensure that their project could be compliant with existing standards and ordinances. As in the case of significantly changing the ground factor of their noise modeling, the developer has elected to make assumptions that will dramatically reduce the projected impact of shadow flicker. By doing so, the developer even admits that this could result in an underestimation of the effects.

3. Burdensome Mitigation Plan

When unable to redefine modeling parameters to show compliance, the developer has used the promise of mitigation to achieve compliance. According to the developer's shadow-flicker plan, the following mitigation methods would be utilized:

- Communication with adjacent landowners on when shadow flicker is possible and how to minimize the shadow flicker effects
- Installation of indoor screening, such as curtain or blinds in windows, where appropriate and reasonable
- Provide exterior screening, such as a vegetation buffer or awnings over windows, where appropriate and reasonable; and
- Turbine Control Software programmed to shut down specific turbine or turbines for an appropriate amount of time to reduce flicker to below 30 hours per year at each home (Freeborn Wind Site Permit - June 2017, p 40).

The first three steps of the mitigation plan do not comply with the Freeborn County ordinance. The ordinance does not allow for a residence to be subject to over 30 hours of shadow flicker as long as the developer talks to the homeowner, pays for the installation of some curtains (if the developer finds it reasonable), or plants some saplings (again, if the developer finds it reasonable). In fact, the ordinance clearly states that shadow flicker modeling cannot take into account obstacles such as "accessory structures and trees." (Freeborn County Ordinance 26-56). Immediately, it can be seen that the mitigation steps provided by the developer run into direct conflict with the county ordinance and should be considered insufficient and invalid.

The last remaining mitigation step is the use of "Turbine Control Software" to limit shadow flicker. This utilization of this mitigation step rests entirely with the managing entity of the project. The developer has made it clear that the mitigation of any shadow flicker issues will only occur once a resident complains to the managing entity. (Freeborn Wind Site Permit - June 2017, p 40). This methodology of mitigation runs into stark contrast with the idea that mitigation is

supposed to represent practices by the applicant to limit damages to the aggrieved. Instead, this method ensures that the impacted landowners will suffer greater than 30 hours of shadow flicker before the managing entity even acts. The mitigation plan's danger is even more apparent when the managing body has not fulfilled step one of the mitigation plan by communicating with the impacted landowners. As currently written, the mitigation plan would require that the managing entity violate the current Freeborn County ordinance (while subjecting landowners to illegal amounts of shadow flicker) and continue to be in violation for weeks or months while the impacted landowners lodge a compliant and the managing entity reviews its "reasonable" response to the complaint.

Based upon the above factors, it is clear that the permit requires amended conditions, including the following:

1. Developer must re-site a limited number of turbines into a configuration that will prevent adjacent landowners from receiving more than 30 hours of shadow flicker on their property.
2. Refinement of the mitigation process to ensure that mitigation steps are compliant with the Freeborn County Ordinance Chapter 26, Section 56 and do not require violation of the ordinance before the initiation of mitigation practices thus ensuring that landowners in the project are never subjected to shadow flicker exceeding the 30 hour standards established by Freeborn County Ordinance 26-56.
3. Following the ALJ recommendation, the developer agrees to a limit of 27 hours of modeled shadow flicker to ensure that no residents are subjected to more than 30 hours of shadow flicker, especially during the initial operation of the project.

Sincerely,

Sean Gaston
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Glenville, MN 56036
sean.p.gaston@gmail.com

Project:
**Freeborn**

Description:
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Calculated:
8/19/2019 3:07 PM/3.1.633

## SHADOW - Calendar

**Calculation:** LO79 Clipped w/263 Houses **Shadow receptor:** 337 - Non-Participant

**Assumptions for shadow calculations**

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.53 | 0.59 | 0.57 | 0.56 | 0.62 | 0.67 | 0.74 | 0.69 | 0.62 | 0.51 | 0.37 | 0.38 |

Operational time

| N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 607 | 364 | 349 | 399 | 598 | 1,082 | 1,220 | 632 | 491 | 661 | 1,202 | 943 | 8,548 |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | | | May | | | June | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 07:46 | 07:30 | 06:51 | 06:56 | | | 06:07 | | 06:27 (T-39) | 05:35 | | 05:58 (T-38) |
| | 16:47 | 17:24 | 18:00 | 19:38 | | | 20:13 | 6 | 06:33 (T-39) | 20:46 | 45 | 06:43 (T-38) |
| 2 | 07:46 | 07:29 | 06:49 | 06:54 | | | 06:06 | | 06:26 (T-39) | 05:35 | | 05:58 (T-38) |
| | 16:48 | 17:25 | 18:01 | 19:39 | | | 20:15 | 8 | 06:34 (T-39) | 20:47 | 45 | 06:43 (T-38) |
| 3 | 07:46 | 07:28 | 06:48 | 06:53 | | | 06:04 | | 06:25 (T-39) | 05:34 | | 05:57 (T-38) |
| | 16:49 | 17:27 | 18:03 | 19:40 | | | 20:16 | 10 | 06:35 (T-39) | 20:48 | 46 | 06:43 (T-38) |
| 4 | 07:46 | 07:27 | 06:46 | 06:51 | | | 06:03 | | 06:24 (T-39) | 05:34 | | 05:58 (T-38) |
| | 16:50 | 17:28 | 18:04 | 19:41 | | | 20:17 | 12 | 06:36 (T-39) | 20:48 | 46 | 06:44 (T-38) |
| 5 | 07:46 | 07:26 | 06:44 | 06:49 | | | 06:01 | | 06:22 (T-39) | 05:34 | | 05:58 (T-38) |
| | 16:51 | 17:29 | 18:05 | 19:43 | | | 20:18 | 13 | 06:35 (T-39) | 20:49 | 46 | 06:44 (T-38) |
| 6 | 07:46 | 07:25 | 06:42 | 06:47 | | | 06:00 | | 06:21 (T-39) | 05:33 | | 05:58 (T-38) |
| | 16:52 | 17:31 | 18:06 | 19:44 | | | 20:19 | 15 | 06:36 (T-39) | 20:50 | 45 | 06:43 (T-38) |
| 7 | 07:46 | 07:23 | 06:41 | 06:46 | | | 05:59 | | 06:20 (T-39) | 05:33 | | 05:58 (T-38) |
| | 16:53 | 17:32 | 18:08 | 19:45 | | | 20:20 | 16 | 06:36 (T-39) | 20:51 | 46 | 06:44 (T-38) |
| 8 | 07:46 | 07:22 | 07:39 | 06:44 | | | 05:58 | | 06:19 (T-39) | 05:33 | | 05:59 (T-38) |
| | 16:54 | 17:33 | 18:09 | 19:46 | | | 20:22 | 17 | 06:36 (T-39) | 20:51 | 45 | 06:44 (T-38) |
| 9 | 07:46 | 07:21 | 07:37 | 06:42 | | | 05:56 | | 06:17 (T-39) | 05:32 | | 05:59 (T-38) |
| | 16:55 | 17:35 | 19:10 | 19:47 | | | 20:23 | 18 | 06:35 (T-39) | 20:52 | 46 | 06:45 (T-38) |
| 10 | 07:46 | 07:19 | 07:36 | 06:40 | | | 05:55 | | 06:16 (T-39) | 05:32 | | 05:59 (T-38) |
| | 16:56 | 17:36 | 19:11 | 19:49 | | | 20:24 | 19 | 06:35 (T-39) | 20:53 | 45 | 06:44 (T-38) |
| 11 | 07:45 | 07:18 | 07:34 | 06:39 | | | 05:54 | | 06:15 (T-39) | 05:32 | | 05:59 (T-38) |
| | 16:57 | 17:37 | 19:13 | 19:50 | | | 20:25 | 20 | 06:35 (T-39) | 20:53 | 45 | 06:44 (T-38) |
| 12 | 07:45 | 07:17 | 07:32 | 06:37 | | | 05:53 | | 06:14 (T-39) | 05:32 | | 05:59 (T-38) |
| | 16:58 | 17:39 | 19:14 | 19:51 | | | 20:26 | 21 | 06:35 (T-39) | 20:54 | 45 | 06:44 (T-38) |
| 13 | 07:45 | 07:15 | 07:30 | 06:35 | | | 05:51 | | 06:13 (T-39) | 05:32 | | 06:00 (T-38) |
| | 16:59 | 17:40 | 19:15 | 19:52 | | | 20:27 | 22 | 06:35 (T-39) | 20:54 | 45 | 06:45 (T-38) |
| 14 | 07:44 | 07:14 | 07:28 | 06:34 | | | 05:50 | | 06:12 (T-39) | 05:32 | | 06:00 (T-38) |
| | 17:01 | 17:42 | 19:16 | 19:53 | | | 20:28 | 24 | 06:36 (T-38) | 20:55 | 45 | 06:45 (T-38) |
| 15 | 07:44 | 07:13 | 07:27 | 06:32 | | 19:32 (T-37) | 05:49 | | 06:11 (T-38) | 05:31 | | 06:00 (T-38) |
| | 17:02 | 17:43 | 19:18 | 19:55 | 1 | 19:33 (T-37) | 20:29 | 26 | 06:37 (T-38) | 20:55 | 45 | 06:45 (T-38) |
| 16 | 07:43 | 07:11 | 07:25 | 06:30 | | 19:30 (T-37) | 05:48 | | 06:10 (T-38) | 05:31 | | 06:00 (T-38) |
| | 17:03 | 17:44 | 19:19 | 19:56 | 4 | 19:34 (T-37) | 20:30 | 28 | 06:38 (T-38) | 20:56 | 45 | 06:45 (T-38) |
| 17 | 07:43 | 07:10 | 07:23 | 06:29 | | 19:29 (T-37) | 05:47 | | 06:09 (T-38) | 05:32 | | 06:01 (T-38) |
| | 17:04 | 17:46 | 19:20 | 19:57 | 6 | 19:35 (T-37) | 20:32 | 29 | 06:38 (T-38) | 20:56 | 44 | 06:45 (T-38) |
| 18 | 07:42 | 07:08 | 07:21 | 06:27 | | 19:28 (T-37) | 05:46 | | 06:08 (T-38) | 05:32 | | 06:01 (T-38) |
| | 17:05 | 17:47 | 19:21 | 19:58 | 8 | 19:36 (T-37) | 20:33 | 31 | 06:39 (T-38) | 20:57 | 44 | 06:45 (T-38) |
| 19 | 07:41 | 07:07 | 07:20 | 06:25 | | 19:27 (T-37) | 05:45 | | 06:07 (T-38) | 05:32 | | 06:01 (T-38) |
| | 17:07 | 17:48 | 19:22 | 19:59 | 10 | 19:37 (T-37) | 20:34 | 32 | 06:39 (T-38) | 20:57 | 44 | 06:45 (T-38) |
| 20 | 07:41 | 07:05 | 07:18 | 06:24 | | 19:27 (T-37) | 05:44 | | 06:06 (T-38) | 05:32 | | 06:01 (T-38) |
| | 17:08 | 17:50 | 19:24 | 20:00 | 11 | 19:38 (T-37) | 20:35 | 34 | 06:40 (T-38) | 20:57 | 44 | 06:45 (T-38) |
| 21 | 07:40 | 07:04 | 07:16 | 06:22 | | 19:27 (T-37) | 05:43 | | 06:05 (T-38) | 05:32 | | 06:02 (T-38) |
| | 17:09 | 17:51 | 19:25 | 20:02 | 12 | 19:39 (T-37) | 20:36 | 35 | 06:40 (T-38) | 20:57 | 44 | 06:46 (T-38) |
| 22 | 07:39 | 07:02 | 07:14 | 06:20 | | 19:27 (T-37) | 05:42 | | 06:04 (T-38) | 05:32 | | 06:02 (T-38) |
| | 17:11 | 17:52 | 19:26 | 20:03 | 14 | 19:41 (T-37) | 20:37 | 36 | 06:40 (T-38) | 20:58 | 44 | 06:46 (T-38) |
| 23 | 07:39 | 07:01 | 07:12 | 06:19 | | 19:27 (T-37) | 05:42 | | 06:04 (T-38) | 05:32 | | 06:02 (T-38) |
| | 17:12 | 17:53 | 19:27 | 20:04 | 14 | 19:41 (T-37) | 20:38 | 37 | 06:41 (T-38) | 20:58 | 44 | 06:46 (T-38) |
| 24 | 07:38 | 06:59 | 07:11 | 06:17 | | 19:28 (T-37) | 05:41 | | 06:03 (T-38) | 05:33 | | 06:02 (T-38) |
| | 17:13 | 17:55 | 19:28 | 20:05 | 15 | 19:43 (T-37) | 20:39 | 38 | 06:41 (T-38) | 20:58 | 44 | 06:46 (T-38) |
| 25 | 07:37 | 06:57 | 07:09 | 06:16 | | 19:29 (T-37) | 05:40 | | 06:02 (T-38) | 05:33 | | 06:03 (T-38) |
| | 17:14 | 17:56 | 19:30 | 20:06 | 14 | 19:43 (T-37) | 20:40 | 39 | 06:41 (T-38) | 20:58 | 44 | 06:47 (T-38) |
| 26 | 07:36 | 06:56 | 07:07 | 06:14 | | 19:31 (T-37) | 05:39 | | 06:02 (T-38) | 05:33 | | 06:03 (T-38) |
| | 17:16 | 17:57 | 19:31 | 20:08 | 11 | 19:42 (T-37) | 20:41 | 40 | 06:42 (T-38) | 20:58 | 44 | 06:47 (T-38) |
| 27 | 07:35 | 06:54 | 07:05 | 06:13 | | 19:33 (T-37) | 05:38 | | 06:01 (T-38) | 05:34 | | 06:03 (T-38) |
| | 17:17 | 17:59 | 19:32 | 20:09 | 6 | 19:39 (T-37) | 20:42 | 41 | 06:42 (T-38) | 20:58 | 45 | 06:48 (T-38) |
| 28 | 07:34 | 06:53 | 07:03 | 06:11 | | | 05:38 | | 06:00 (T-38) | 05:34 | | 06:03 (T-38) |
| | 17:18 | 18:00 | 19:33 | 20:10 | | | 20:43 | 42 | 06:42 (T-38) | 20:58 | 45 | 06:48 (T-38) |
| 29 | 07:33 | | 07:02 | 06:10 | | | 05:37 | | 06:00 (T-38) | 05:35 | | 06:03 (T-38) |
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| 30 | 07:32 | | 07:00 | 06:08 | | 06:29 (T-39) | 05:37 | | 05:59 (T-38) | 05:35 | | 06:04 (T-38) |
| | 17:21 | | 19:36 | 20:12 | 3 | 06:32 (T-39) | 20:44 | 43 | 06:42 (T-38) | 20:58 | 44 | 06:48 (T-38) |
| 31 | 07:31 | | 06:58 | | | | 05:36 | | 05:59 (T-38) | | | |
| | 17:22 | | 19:37 | | | | 20:45 | 44 | 06:43 (T-38) | | | |
| Potential sun hours | 290 | 294 | 369 | 402 | | | 455 | | | 461 | | |
| Total, worst case | | | | | 129 | | | 839 | | | 1344 | |
| Sun reduction | | | | | 0.56 | | | 0.62 | | | 0.67 | |
| Oper. time red. | | | | | 0.98 | | | 0.98 | | | 0.98 | |
| Wind dir. red. | | | | | 0.67 | | | 0.57 | | | 0.57 | |
| Total reduction | | | | | 0.37 | | | 0.35 | | | 0.37 | |
| Total, real | | | | | 48 | | | 289 | | | 501 | |

**Table layout: For each day in each month the following matrix apply**

| Day in month | Sun rise (hh:mm)<br>Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker<br>Last time (hh:mm) with flicker | (WTG causing flicker first time)<br>(WTG causing flicker last time) |
|---|---|---|---|---|

Project:
**Freeborn**

Description:
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Calculated:
8/19/2019 3:07 PM/3.1.633

## SHADOW - Calendar

**Calculation:** LO79 Clipped w/263 Houses **Shadow receptor:** 337 - Non-Participant

**Assumptions for shadow calculations**

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.53 | 0.59 | 0.57 | 0.56 | 0.62 | 0.67 | 0.74 | 0.69 | 0.62 | 0.51 | 0.37 | 0.38 |

Operational time

| N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 607 | 364 | 349 | 399 | 598 | 1,082 | 1,220 | 632 | 491 | 661 | 1,202 | 943 | 8,548 |

Idle start wind speed: Cut in wind speed from power curve

| | July | | August | | September | October | November | December |
|---|---|---|---|---|---|---|---|---|
| 1 | 05:36 | | 06:03 (T-38) | 06:02 | | 06:25 (T-39) | 06:36 | 07:10 | 06:48 | 07:26 |
| | 20:58 | 45 | 06:48 (T-38) | 20:38 | 21 | 06:46 (T-39) | 19:51 | 18:56 | 17:05 | 16:38 |
| 2 | 05:36 | | 06:04 (T-38) | 06:03 | | 06:26 (T-39) | 06:37 | 07:11 | 06:49 | 07:27 |
| | 20:58 | 45 | 06:49 (T-38) | 20:37 | 20 | 06:46 (T-39) | 19:50 | 18:54 | 17:04 | 16:38 |
| 3 | 05:37 | | 06:03 (T-38) | 06:04 | | 06:27 (T-39) | 06:38 | 07:12 | 06:50 | 07:28 |
| | 20:58 | 46 | 06:49 (T-38) | 20:35 | 19 | 06:46 (T-39) | 19:48 | 18:52 | 17:03 | 16:38 |
| 4 | 05:37 | | 06:04 (T-38) | 06:05 | | 06:28 (T-39) | 06:40 | 07:13 | 06:52 | 07:29 |
| | 20:58 | 45 | 06:49 (T-38) | 20:34 | 18 | 06:46 (T-39) | 19:46 | 18:50 | 17:01 | 16:37 |
| 5 | 05:38 | | 06:05 (T-38) | 06:06 | | 06:29 (T-39) | 06:41 | 07:14 | 06:53 | 07:30 |
| | 20:57 | 45 | 06:50 (T-38) | 20:33 | 17 | 06:46 (T-39) | 19:44 | 18:48 | 17:00 | 16:37 |
| 6 | 05:38 | | 06:04 (T-38) | 06:07 | | 06:30 (T-39) | 06:42 | 07:16 | 06:54 | 07:31 |
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| | 20:57 | 45 | 06:50 (T-38) | 20:30 | 14 | 06:45 (T-39) | 19:41 | 18:45 | 16:58 | 16:37 |
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| | 20:55 | 44 | 06:50 (T-38) | 20:23 | 5 | 06:41 (T-39) | 19:32 | 18:36 | 16:52 | 16:37 |
| 13 | 05:44 | | 06:07 (T-38) | 06:15 | | 06:37 (T-39) | 06:50 | 07:24 | 07:03 | 07:37 |
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| 14 | 05:44 | | 06:08 (T-38) | 06:16 | | | 06:51 | 07:25 | 07:05 | 07:38 |
| | 20:54 | 43 | 06:51 (T-38) | 20:21 | | | 19:28 | 18:33 | 16:50 | 16:37 |
| 15 | 05:45 | | 06:09 (T-38) | 06:17 | | | 06:52 | 07:26 | 07:06 | 07:39 |
| | 20:53 | 42 | 06:51 (T-38) | 20:19 | | | 19:26 | 18:31 | 16:49 | 16:37 |
| 16 | 05:46 | | 06:10 (T-38) | 06:18 | | 19:39 (T-37) | 06:53 | 07:28 | 07:07 | 07:40 |
| | 20:52 | 42 | 06:52 (T-38) | 20:18 | 8 | 19:47 (T-37) | 19:25 | 18:29 | 16:48 | 16:38 |
| 17 | 05:47 | | 06:11 (T-38) | 06:19 | | 19:37 (T-37) | 06:54 | 07:29 | 07:09 | 07:40 |
| | 20:52 | 41 | 06:52 (T-38) | 20:16 | 12 | 19:49 (T-37) | 19:23 | 18:28 | 16:47 | 16:38 |
| 18 | 05:48 | | 06:11 (T-38) | 06:21 | | 19:35 (T-37) | 06:55 | 07:30 | 07:10 | 07:41 |
| | 20:51 | 40 | 06:51 (T-38) | 20:15 | 15 | 19:50 (T-37) | 19:21 | 18:26 | 16:46 | 16:38 |
| 19 | 05:49 | | 06:12 (T-38) | 06:22 | | 19:34 (T-37) | 06:56 | 07:31 | 07:11 | 07:42 |
| | 20:50 | 39 | 06:51 (T-38) | 20:13 | 15 | 19:49 (T-37) | 19:19 | 18:25 | 16:45 | 16:39 |
| 20 | 05:50 | | 06:13 (T-38) | 06:23 | | 19:33 (T-37) | 06:57 | 07:33 | 07:12 | 07:42 |
| | 20:50 | 38 | 06:51 (T-38) | 20:11 | 14 | 19:47 (T-37) | 19:17 | 18:23 | 16:45 | 16:39 |
| 21 | 05:51 | | 06:14 (T-38) | 06:24 | | 19:32 (T-37) | 06:58 | 07:34 | 07:14 | 07:43 |
| | 20:49 | 37 | 06:51 (T-38) | 20:10 | 13 | 19:45 (T-37) | 19:16 | 18:21 | 16:44 | 16:39 |
| 22 | 05:52 | | 06:15 (T-38) | 06:25 | | 19:32 (T-37) | 07:00 | 07:35 | 07:15 | 07:43 |
| | 20:48 | 36 | 06:51 (T-38) | 20:08 | 12 | 19:44 (T-37) | 19:14 | 18:20 | 16:43 | 16:40 |
| 23 | 05:53 | | 06:16 (T-38) | 06:26 | | 19:31 (T-37) | 07:01 | 07:36 | 07:16 | 07:44 |
| | 20:47 | 34 | 06:50 (T-38) | 20:07 | 11 | 19:42 (T-37) | 19:12 | 18:18 | 16:42 | 16:40 |
| 24 | 05:54 | | 06:17 (T-38) | 06:27 | | 19:31 (T-37) | 07:02 | 07:38 | 07:17 | 07:44 |
| | 20:46 | 33 | 06:50 (T-38) | 20:05 | 9 | 19:40 (T-37) | 19:10 | 18:17 | 16:42 | 16:41 |
| 25 | 05:55 | | 06:18 (T-38) | 06:28 | | 19:31 (T-37) | 07:03 | 07:39 | 07:19 | 07:45 |
| | 20:45 | 32 | 06:50 (T-38) | 20:03 | 8 | 19:39 (T-37) | 19:08 | 18:15 | 16:41 | 16:42 |
| 26 | 05:56 | | 06:19 (T-38) | 06:29 | | 19:31 (T-37) | 07:04 | 07:40 | 07:20 | 07:45 |
| | 20:44 | 30 | 06:49 (T-38) | 20:02 | 6 | 19:37 (T-37) | 19:06 | 18:14 | 16:41 | 16:42 |
| 27 | 05:57 | | 06:20 (T-38) | 06:31 | | 19:32 (T-37) | 07:05 | 07:41 | 07:21 | 07:45 |
| | 20:43 | 29 | 06:49 (T-38) | 20:00 | 3 | 19:35 (T-37) | 19:05 | 18:12 | 16:40 | 16:43 |
| 28 | 05:58 | | 06:21 (T-38) | 06:32 | | 19:33 (T-37) | 07:06 | 07:43 | 07:22 | 07:46 |
| | 20:42 | 27 | 06:48 (T-38) | 19:58 | 1 | 19:34 (T-37) | 19:03 | 18:11 | 16:40 | 16:44 |
| 29 | 05:59 | | 06:22 (T-38) | 06:33 | | | 07:08 | 07:44 | 07:23 | 07:46 |
| | 20:41 | 25 | 06:47 (T-38) | 19:57 | | | 19:01 | 18:09 | 16:39 | 16:44 |
| 30 | 06:00 | | 06:23 (T-39) | 06:34 | | | 07:09 | 07:45 | 07:24 | 07:46 |
| | 20:40 | 23 | 06:46 (T-38) | 19:55 | | | 18:57 | 18:08 | 16:39 | 16:45 |
| 31 | 06:01 | | 06:24 (T-39) | 06:35 | | | | 07:47 | | 07:46 |
| | 20:39 | 21 | 06:45 (T-39) | 19:53 | | | | 18:07 | | 16:46 |
| Potential sun hours | 467 | | | 433 | | | 377 | 342 | 292 | 279 |
| Total, worst case | | 1200 | | | 299 | | | | | |
| Sun reduction | | 0.74 | | | 0.69 | | | | | |
| Oper. time red. | | 0.98 | | | 0.98 | | | | | |
| Wind dir. red. | | 0.57 | | | 0.62 | | | | | |
| Total reduction | | 0.41 | | | 0.41 | | | | | |
| Total, real | | 494 | | | 124 | | | | | |

**Table layout: For each day in each month the following matrix apply**

| Day in month | Sun rise (hh:mm)<br>Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker<br>Last time (hh:mm) with flicker | (WTG causing flicker first time)<br>(WTG causing flicker last time) |
|---|---|---|---|---|