

**System for shadow impact monitoring and species conservation
for wind turbine generators**





Light sensor unit (heated) on top of the nacelle

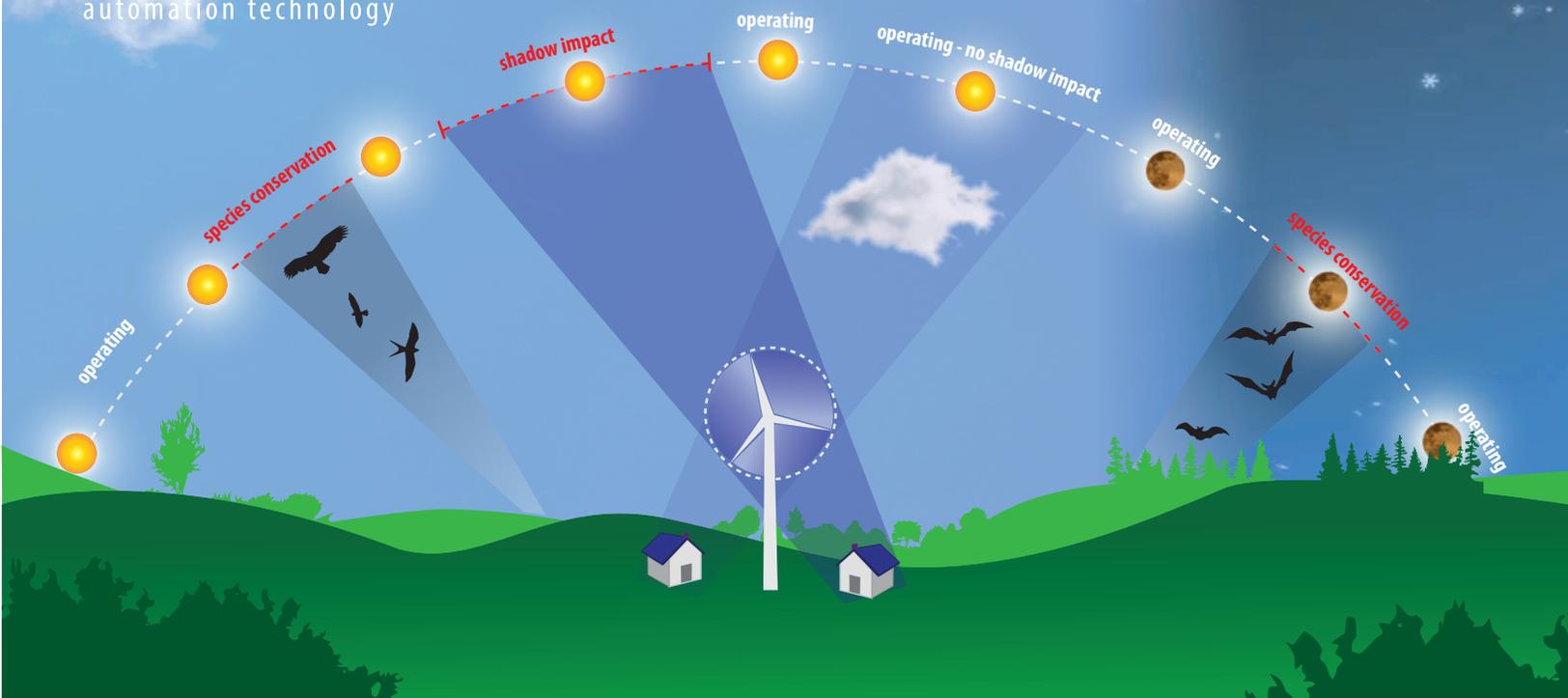


System for shadow impact monitoring and species conservation

Our system for shadow impact monitoring and species conservation enables you to comply with a large number of permit conditions applying to wind turbine generators (WTG). The system's main focus is on compliance with maximum permissible shadow impact periods for surrounding buildings, the places of immission (PI), as well as on shutting down the WTGs while bats or rare bird species are flying. Shutdowns for certain sectors or for sound protection as well as shutdown calendars can also be implemented. Our system for shadow impact monitoring and species conservation is deployed in more than 2,000 wind farms of the leading manufacturers all over Europe.

The system comprises a master unit and a project-related number of light sensors and meteorological instruments. Using our Shadow Manager software, the master unit is provided with all data specific to a project (e.g. coordinates of WTGs and buildings, permissible shadow impact periods or shutdown conditions for species conservation). During operation, the master unit will calculate the shadow impact periods, communicate with connected sensors, retrieve the current operational data of the WTGs, send stop/start commands as well as alarm messages to the WTGs and log all relevant events.

The master unit can monitor up to 100 wind turbine generators. To be able to take into account current operational data, such as nacelle position, rotor speed, wind speed or outside temperature, when monitoring the WTGs and PIs, the master unit features integrated interfaces for many WTG types.



Functional pattern of the system for shadow impact monitoring and species conservation

Shadow impact monitoring

Approving authorities usually require that daily and annual shadow impact limits are complied with for buildings located in the vicinity of wind farms. The system can monitor the shadow impact immission for up to 2,000 buildings. The system depicts the buildings as walls and areas.

To enable the master unit to determine if shadow impact effects are possible generally, the light sensor of the system measures the sunlight's intensity of illumination. Furthermore, the light sensor uses a GPS receiver to provide the master unit with the exact current time. Light sensors are mounted on the nacelle of a WTG.

To be able to optimally take into account any preloads caused by existing WTGs, a forecast is made for the current day. This allows the system to make the most of available daily budgets without exceeding the daily limit.

Shadow impact monitoring

Limit values for the permissible daily and annual shadow impact can be set for each building individually. As soon as a limit value is exceeded, the responsible WTG is shut down until the shadow impact ends.

The periods during which shadow impact is monitored for a building can be restricted depending on how the respective building is used. Example: with commercially used buildings, certain days of the week, holidays or time periods can be excluded from monitoring.

Since it may take some time for a WTG shutdown process to be completed, it is possible to define a shutdown delay for each WTG so that the process can be initiated well enough in advance. This is to ensure that a set limit value will not be exceeded.

It is also possible to define a start-up time for each WTG – as a result, the start-up command will be send early (to reflect the duration of the start-up process).

No.	Name from Shadow Forecast	POI Name	Street	City	PC	Height a. S.	Max. Perm. Daily Load	Max. Perm. Annual Load (Switch)	Max. Perm. Annual Load (Switch)	Annual Counter	Reset Date	Building Type	Phone Mode	Ignore Light Sensor	Walls	Areas	Phones	Without Monst.	With Monst.
1	30 06	30 06												<input type="checkbox"/>	2	1	0	0	1
2	30 09	30 09												<input type="checkbox"/>	2	0	0	0	1
3	30 12-1	30 12-1												<input type="checkbox"/>	2	0	0	0	1
4	30 12-2	30 12-2												<input type="checkbox"/>	1	0	0	0	1
5	30 13	30 13												<input type="checkbox"/>	1	0	0	0	1
6	30 25-1	30 25-1												<input type="checkbox"/>	2	0	0	0	1
7	30 25-2	30 25-2												<input type="checkbox"/>	2	0	0	0	1
8	30 25-3	30 25-3												<input type="checkbox"/>	2	0	0	0	1
9	30 25-4	30 25-4												<input type="checkbox"/>	1	0	0	0	1
10	30 25-5	30 25-5												<input type="checkbox"/>	1	0	0	0	1
101	30 26	30 26												<input type="checkbox"/>	4	1	0	0	1
102	30 19	30 19												<input type="checkbox"/>	4	2	0	0	1
103	30 20	30 20												<input type="checkbox"/>	4	1	0	0	1
104	30 21	30 21												<input type="checkbox"/>	3	0	0	0	1
105	30 22	30 22												<input type="checkbox"/>	3	0	0	0	1
106	30 23	30 23												<input type="checkbox"/>	5	0	0	0	1
107	30 24	30 24												<input type="checkbox"/>	4	1	0	0	1
108	30 25	30 25												<input type="checkbox"/>	4	1	0	0	1
109	30 26-1	30 26-1												<input type="checkbox"/>	4	0	0	0	1
110	30 26-2	30 26-2												<input type="checkbox"/>	3	1	0	0	1
111	30 26-3	30 26-3												<input type="checkbox"/>	3	1	0	0	1
112	30 27	30 27												<input type="checkbox"/>	1	0	0	0	1
113	30 36	30 36												<input type="checkbox"/>	2	0	0	0	1
114	30 44	30 44												<input type="checkbox"/>	4	1	0	0	1
201	30 22-1	30 22-1												<input type="checkbox"/>	4	1	0	0	1
202	30 23-1	30 23-1												<input type="checkbox"/>	5	1	0	0	1
203	30 23-2	30 23-2												<input type="checkbox"/>	3	1	0	0	1
204	30 24-1	30 24-1												<input type="checkbox"/>	5	0	0	0	1
205	30 24-2	30 24-2												<input type="checkbox"/>	4	0	0	0	1
206	30 24-3	30 24-3												<input type="checkbox"/>	5	1	0	0	1
207	30 27R1	30 27R1												<input type="checkbox"/>	4	1	0	0	1
208	30 27R2	30 27R2												<input type="checkbox"/>	2	1	0	0	1
209	30 27R3	30 27R3												<input type="checkbox"/>	4	0	0	0	1
210	30 28P	30 28P												<input type="checkbox"/>	3	0	0	0	1
211	30 36-1	30 36-1												<input type="checkbox"/>	5	1	0	0	1
212	30 37-1	30 37-1												<input type="checkbox"/>	2	0	0	0	1
213	30 37-2	30 37-2												<input type="checkbox"/>	3	0	0	0	1
314	30 38	30 38												<input type="checkbox"/>	4	0	0	0	1

Depicting a building in Shadow Manager



Optimal use of the shadow impact budget

By taking into account the current nacelle position and rotor speed when calculating the shadow impact periods, the shutdown periods of each WTG can be reduced to the required minimum.

Setting a power output limit for each combination of WTG and PI is another way of reducing the loss of earnings. If a WTG operates below said power output limit while causing shadow impact at a building, this WTG is stopped immediately. If it operates above the power output limit, the permitted periods of shadow impact will be exploited. Thus, the shadow impact budget will be conserved for times when the WTG can operate at a higher power output.

The system's phone option can be used by residents of a PI to activate shadow impact monitoring for their building by calling a dedicated number. Once such an activation has been carried out, a WTG causing shadow impact at the building concerned will be shut down immediately. An activation is only valid for the current day. On the one hand, this functionality helps to prevent WTGs from being shut down even though nobody is feeling disturbed (because nobody is present). On the other hand, it allows residents to stop shadow impact effects immediately even though the permitted limit values have not yet been reached. The phone option can be enabled for each PI individually.

Logs

The master unit logs the periods during which theoretical and actual shadow impact has occurred at the monitored buildings as well as the periods during which the WTG was shut down. In addition to the daily and yearly counter readings of the PIs, the system also saves current operational data of the WTGs as well as the intensity of illumination.

The logs are stored redundantly on two USB media. The logs can be retrieved via a secure network connection using Shadow Manager.

Advanced sorting and filtering functions are available for the evaluation of the logs. It is possible to output the logs as PDF or CSV documents.

If a more accurate monitoring of certain measurements is necessary further logs could be set up to save the chosen measurements cyclically.

Based on a created project it is possible to calculate the shadow impact periods in advance, for example for one year. This feature could be helpful if the loss of earnings by shadow shut down periods should be calculated or if a complaint by residents should be handled.

* Info	Timestamp - Local		Event	Values							
* Index	Date Local	Time Local	Reason	POI Number	WTG	Daily Counter	Annual Counter	Rotor Speed [rpm]	Nacelle Angle [°]	Power [kW]	Light Value [lx]
931	04/06/2018	06:45:05 AM	Sunrise								
1160	04/06/2018	06:04:43 PM	Shadow impact geometrically possible occurs	2	300597	0:00:00	4:25:34	6,55	99,4	69	69327,1
1161	04/06/2018	06:04:43 PM	Shadow impact possible occurs	2	300597	0:00:00	4:25:34	6,55	99,4	69	69327,1
1162	04/06/2018	06:04:43 PM	Shadow impact occurs	2	300597	0:00:00	4:25:34	6,55	99,4	69	69327,1
1163	04/06/2018	06:06:43 PM	Shadow impact stop due to daily counter occurs	2	300597	0:02:00	4:27:34	6,73	95,5	195	60374,5
1164	04/06/2018	06:06:43 PM	WTG stop due to shadow impact occurs		300597			6,73	95,5	195	60374,5
1165	04/06/2018	06:07:30 PM	Shadow impact leaves	2	300597	0:02:41	4:28:15	1,53	94	-16	51581,5
1181	04/06/2018	06:41:52 PM	Shadow impact geometrically possible leaves	2	300597	0:02:47	4:28:21	0,01	80,7	-9	20154,4
1182	04/06/2018	06:41:52 PM	Shadow impact possible leaves	2	300597	0:02:47	4:28:21	0,01	80,7	-9	20154,4
1183	04/06/2018	06:41:52 PM	Shadow impact stop due to daily counter leaves	2	300597	0:02:47	4:28:21	0,01	80,7	-8	20154,4
1184	04/06/2018	06:41:52 PM	WTG stop due to shadow impact leaves		300597			0,01	80,7	-8	20154,4
1218	04/06/2018	08:07:51 PM	Sunset								

Shadow impact log (extract)



Species conservation

In order to prevent bats or rare bird species from colliding with rotating blades of WTGs, the authorities require that WTGs are shut down under certain meteorological conditions.

In order to comply with requirements of this kind, you can set date ranges and time periods within the system. Time periods may be defined by time of day or by position of the sun.

It is also possible to divide the period from sunrise to sunset into identical time slices. In addition, you can define one time slice each for the time prior to sunset and the time after sunrise.

Each time range defined in this way can then be assigned individual shutdown conditions, such as limit values for wind speed, outside temperature, precipitation amount or humidity.

Each shutdown condition can be assigned a hysteresis or delay.

If all conditions for an increased risk of collision are met, the WTGs concerned will be shut down.

Information on shutdowns as well as start, change and end of the monitoring periods will be logged in separate bat and bird protection logs.

The system can obtain the meteorological readings via the communication interface to the WTGs. However, it is also possible to connect other measuring instruments to the master unit of the system (to measure e.g. precipitation amount, humidity, temperature or wind speed).

Info		Timestamp - Local		Event	Values				
Index	Date Local	Time Local	Reason	WTG Number	Rotor Speed [rpm]	Power [kW]	Temperature [°C]	Wind [m/s]	Precipitation [mm/h]
19	08/07/2017	09:07:42 PM	Sunset						
20	08/07/2017	09:07:45 PM	Monitoring period for bat protection occurs	1	7.1	377	22.1	4.4	0
21	08/07/2017	09:07:45 PM	Monitoring period for bat protection occurs	2	6.1	0	22.6	2.2	0
22	08/07/2017	09:07:45 PM	Monitoring period for bat protection occurs	3	6.9	194	22.1	3.2	0
23	08/07/2017	09:07:45 PM	Monitoring period for bat protection occurs	4	6.9	165	22.5	3.1	0
24	08/07/2017	09:07:45 PM	Monitoring period for bat protection occurs	5	7.1	387	22.2	3.9	0
25	08/07/2017	09:07:45 PM	WTG stop due to bat protection occurs	1	7.1	377	22.1	4.4	0
26	08/07/2017	09:07:45 PM	WTG stop due to bat protection occurs	2	6.1	0	22.6	2.2	0
27	08/07/2017	09:07:45 PM	WTG stop due to bat protection occurs	3	6.9	194	22.1	3.2	0
28	08/07/2017	09:07:45 PM	WTG stop due to bat protection occurs	4	6.9	160	22.4	3.1	0
29	08/07/2017	09:07:45 PM	WTG stop due to bat protection occurs	5	7.1	384	22.2	3.9	0
30	08/07/2017	10:15:12 PM	WTG stop due to bat protection leaves	2	0.3	0	21.7	6.7	0
31	08/07/2017	10:18:00 PM	WTG stop due to bat protection leaves	1	0.2	0	21.5	6.7	0
32	08/07/2017	10:47:22 PM	WTG stop due to bat protection leaves	5	0.2	0	21.5	6.7	0
33	08/07/2017	11:58:43 PM	WTG stop due to bat protection occurs	2	9	1324	21.4	5.9	0
34	08/08/2017	12:08:30 AM	WTG stop due to bat protection leaves	4	0.2	0	21.1	6.7	0
35	08/08/2017	12:14:47 AM	WTG stop due to bat protection leaves	2	0.2	0	21.1	6.7	0
36	08/08/2017	12:19:05 AM	WTG stop due to bat protection occurs	1	7.7	599	21.1	5.8	0
37	08/08/2017	12:34:27 AM	WTG stop due to bat protection occurs	5	8.6	941	21.5	5.9	0
38	08/08/2017	01:08:17 AM	WTG stop due to bat protection occurs	2	8.3	756	20.2	5.9	0
39	08/08/2017	01:09:59 AM	WTG stop due to bat protection occurs	4	7.7	756	19.9	5.9	0
40	08/08/2017	06:06:53 AM	Monitoring period for bat protection leaves	1	0.2	0	18.3	4.8	0
41	08/08/2017	06:06:53 AM	Monitoring period for bat protection leaves	2	0.3	0	17.8	5.4	0
42	08/08/2017	06:06:53 AM	Monitoring period for bat protection leaves	3	0.2	0	18.1	4.7	0
43	08/08/2017	06:06:53 AM	Monitoring period for bat protection leaves	4	0.2	0	17.6	4.7	0
44	08/08/2017	06:06:53 AM	Monitoring period for bat protection leaves	5	0.2	0	18	5.1	0
45	08/08/2017	06:06:54 AM	WTG stop due to bat protection leaves	1	0.2	0	18.3	4.8	0
46	08/08/2017	06:06:54 AM	WTG stop due to bat protection leaves	2	0.3	0	17.8	5.4	0
47	08/08/2017	06:06:54 AM	WTG stop due to bat protection leaves	3	0.2	0	18.1	4.7	0
48	08/08/2017	06:06:54 AM	WTG stop due to bat protection leaves	4	0.1	0	17.6	4.7	0
49	08/08/2017	06:06:54 AM	WTG stop due to bat protection leaves	5	0.2	0	18	5.1	0
50	08/08/2017	06:06:54 AM	Sunrise						

Bat log (extract)



Our company

NorthTec is an owner-operated business that has developed and manufactured measuring and control systems for various applications since 1999. Our team of more than 35 employees will solve the most complicated tasks and turn your ideas into reality. Guiding our customers through the entire process, we offer full service – from concept development to production and commission through to professional servicing – to ensure your projects deliver maximum results.

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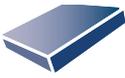
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Our services

- Individual consulting and preparation of offers for your wind farm projects
- Creation of shadow impact concepts for overlapping wind farm layouts
- Installation and commissioning of systems for shadow impact monitoring and species conservation
- Surveying the coordinates of wind turbines and places of immission
- Shadow impact calculations based on surveyed coordinates
- Creation of documents for approving authorities
- Changing the system configuration in accordance with permit changes
- Backup and evaluate logs
- System repair and maintenance



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