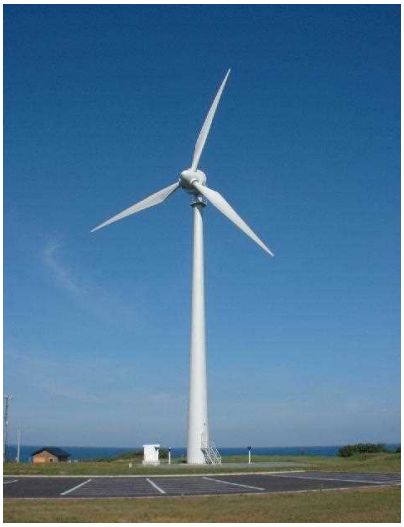
Investigation, Prediction and Evaluation of Wind Turbine Noise in Japan

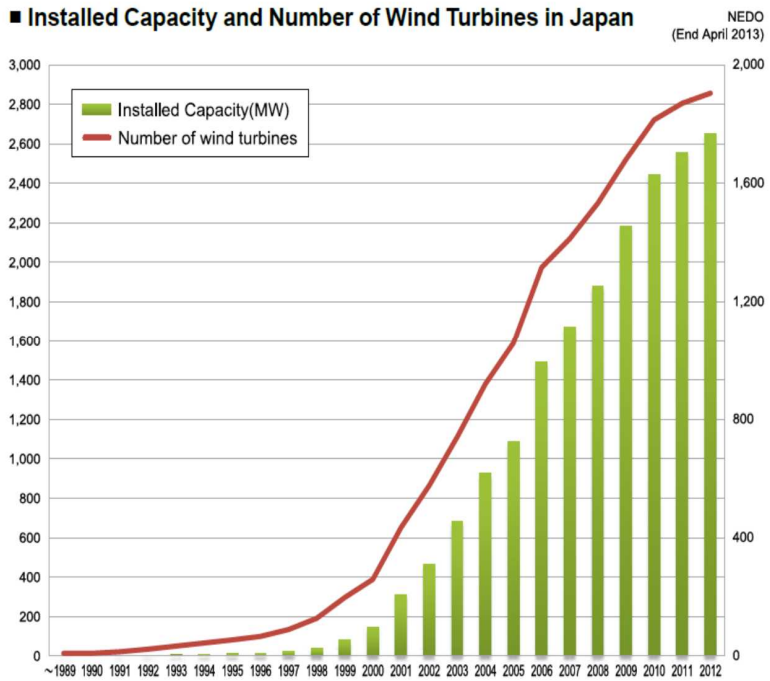


Final Report by
Expert committee on Wind Turbine Noise
Nov. 2016

Office of Odor, Noise and Vibration
Ministry of the Environment
Government of Japan

Background 1

- Number of Wind Power Facilities (WPFs) has been increased in Japan.

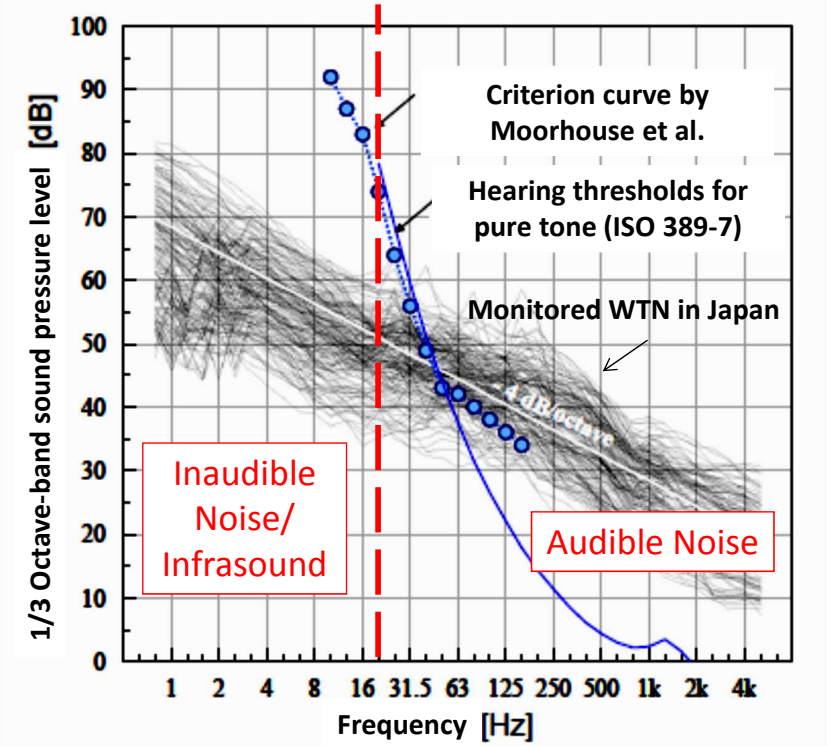


- About four-fold increase is expected by 2030

Background 2

- With the increase in number of WPFs, Wind Turbine Noise (WTN) has caused complaints.
- While WTN is usually not significantly large, WTN attracts public attention as WPFs are often constructed in quiet rural areas
- Ministry of the Environment, Japan (MOEJ) funded WTN related researches from 2010-2012. MOEJ established an expert committee on WTN in 2013.

Results of WTN survey in Japan 2010-2012 Scientific Findings 1: Infrasound of WTN

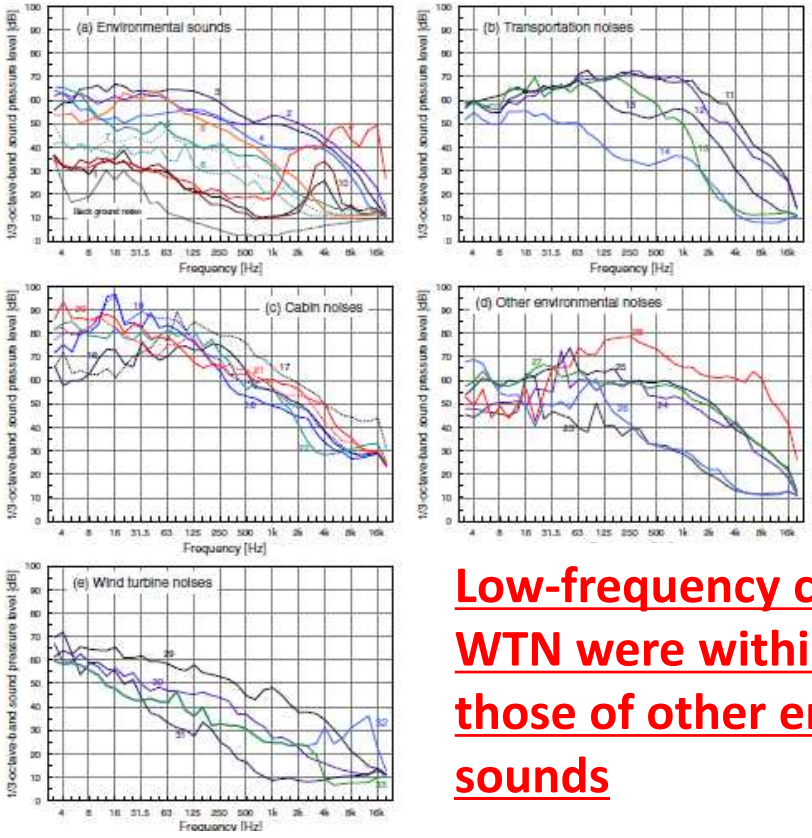


※WTN measured at 164 points near 29 WPFs in Japan

WTN below 20 Hz did not exceed the hearing thresholds of ISO 389-7 or Criterion curve

WTN should be taken as audible noise (sound), not as inaudible one

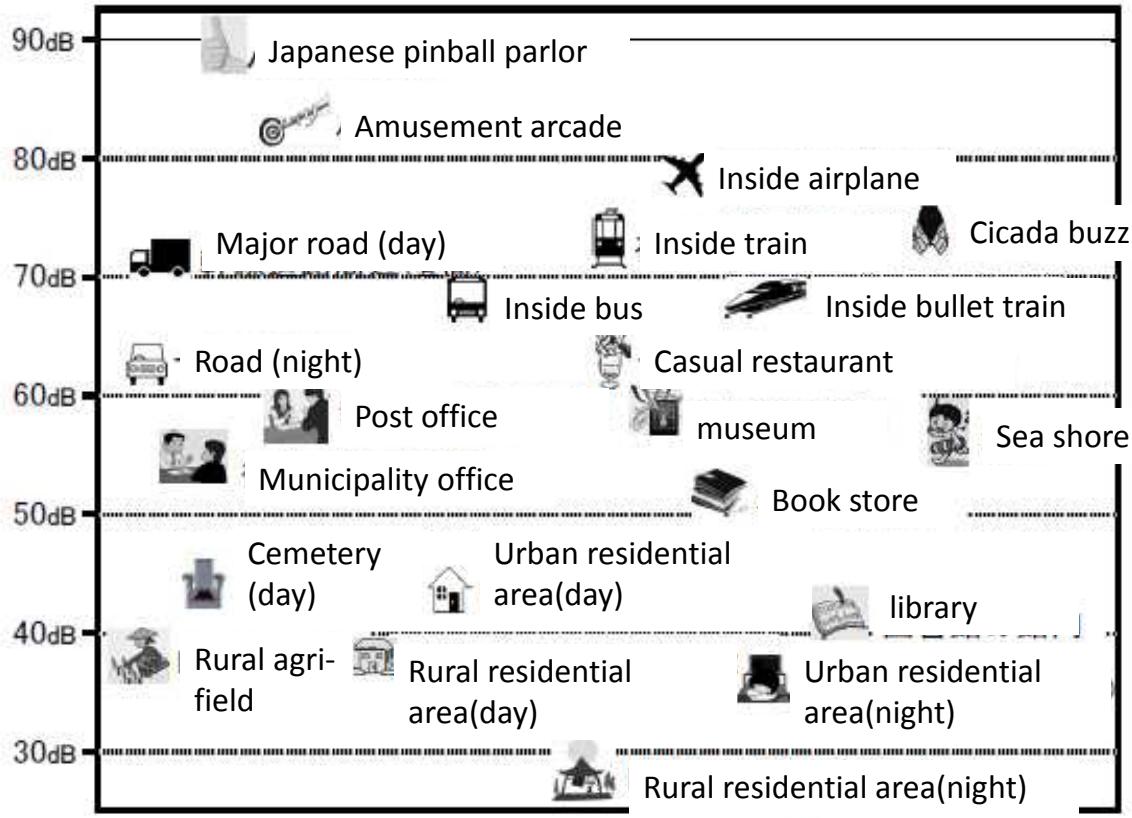
Scientific Findings 2: Comparison of WTN and Other Environmental Noise



* Monitored WTN and other environmental sounds in Japan

Low-frequency components of WTN were within the range of those of other environmental sounds

Environment Noise in Japan



Scientific Findings 3: Characteristics of WTN

WTN exposure levels (L_{Aeq}) of nearby residents were distributed in the range of 26 - 50 dB. These levels are often observed in museums or book stores in Japan.

However,

- WTN includes amplitude modulation (AM) sound or swish sound generated by the blades of a wind turbine
- WTN sometimes also includes tonal sound generated by accelerator or cooling devices

⇒ WTN is often more noticeable and sometimes more annoying than other environmental sounds

Scientific Findings 4: WTN and human health

- After careful assessment of the evidence obtained from peer reviewed research results from around the world, it is concluded that WTN has likely no negative effects to human health.
- However, AM and tonal sounds of WTN tend to increase annoyance. Existing research results indicate that WTN over 35 – 40dB raises annoyance and that the risk of sleep disturbance may increase accordingly.
- No clear association is seen between infrasound or low-frequency noise of WTN and human health.
- WTN related annoyance is also affected by other issues such as visual aspects or economical benefits.

Examples of Noise limits/guideline values for WTN

	Noise Limit	Areal Typology			
		Rural area	Residential area	Residential area near Industrial area	Other area
Denmark	L_r(6 m/s) L_r(8 m/s)	42 dB(6 m/s) 44 dB(8 m/s)	37 dB(6 m/s) 39 dB(8 m/s)	—	—
Sweden	L_{Aeq}(8 m/s)	35 dB	40 dB		
Belgium/ Wallonia	L_{Aeq}	45 dB			
France	L_{Aeq}	daytime(07:00-22:00):background noise+5 dB Night time(22:00-07:00):background noise+3 dB			
Germany	L_r	day:60 dB night:45 dB	day:50-55 dB night:35-40 dB	day:60 dB night:45 dB	day:45-70 dB night:35-70 dB
The Netherlands	L_{den} L_{night}	L_{den}: 47 dB L_{night}: 41 dB			
United Kingdom	$L_{A90,10min}$	day:background noise+5 dB(lower limits 35 - 40 dB) night:background noise+5 dB(lower limits 43 dB)			
New Zealand	$L_{A90,10min}$	35 dB or background noise+5dB (whichever is the greater)	40 dB or background noise+5 dB (whichever is the greater)		
Australia/ Victoria	$L_{A90,10min}$	35 dB or background noise+5dB (whichever is the greater)	40 dB or background noise+5 dB (whichever is the greater)		
Canada/ Manitoba	L_{Aeq}	40 dB(4 m/s)-53 dB(11 m/s)			
USA/ Maine	L_{Aeq}	Low noise environment: day:55 dB, night:45 dB At any property line: 75 dB			

Investigation, Prediction and Evaluation 1

3 major issues:

- Sound source characteristics (e.g. pure tonal sound)
- Propagation characteristics (e.g. ground surface)
- Sound receiving points' characteristics (e.g. Configuration)

- the A weighted sound pressure levels should be used.
- When measuring noise, transitory noise (e.g. noise by passing cars) and non-stationary sound (e.g. animals' cries, ambulance siren) should be excluded.

※L_{A90}+2dB can be used as an alternative estimation

Investigation, Prediction and Evaluation 2

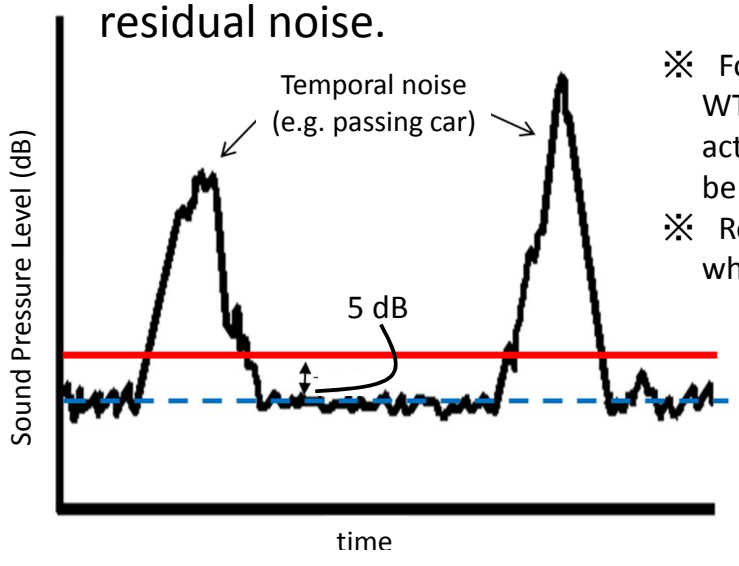
- When conducting a survey, areas that are susceptible to an environmental impact by WTN should be targeted (e.g. residential areas in the vicinity of a WPF)

  ※generally within a radius of about 1 km from a wind turbine

- In order to grasp conditions throughout the year, the survey should be conducted in each period of the year for typical meteorological conditions under which a WPF operates (basically each season).
- Proper wind screen is essential.
- Residual noise (background noise) should be measured at both daytime (6:00 - 22:00) and night time (22:00 - 6:00).

Proposed WTN Evaluation Method: 1

- Applied when WPF will be newly built or WPF will be retrofitted to add a power generation facility.
- To conserve indoor environment, evaluation is made based on outside noise data (both day and night).
- WTN should be limited to within 5dB increase from residual noise.



※ For WTN evaluation, locations where WTN might affect residents' daily activities (e.g. nearest dwellings) should be selected.

※ Residual noise should be measured when wind is steady.

Proposed WTN Evaluation Method: 2

Proposed guideline value : Residual noise + 5dB

※In low noise environments, lower limit for WTN should be set since there is no acoustic benefit. WTN should be limited to 35dB in the areas where background noise is lower than 30 dB and where some noise sensitive locations exist. For the other areas, 40 dB should be set as lower limit of WTN.