Workshop Testimony
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Case No. 21-902-GE-BRO

OHIO POWER SITING BOARD'S REVIEW OF OHIO ADM.CODE CHAPTERS 4906-1, 4906-2, 4906-3, 4906-4, 4906-5, 4906-6, AND 4906-7

Thank you for the opportunity to provide input into the rule-making process. I would like to speak to the need for utility solar rules that are protective of the community and the local ecology. Industrial scale solar facilities are relatively new and very little is known about the impacts which could be felt 35 to 50 years in the future. Many express opinions but they are just that – opinions. Our only alternative today is to adopt careful and conservative siting rules to safeguard the future.

* **What additional information, if any, should be included in a proposed project summary?**

A cursory review of the summaries presented in utility scale solar projects pending before the Ohio Power Siting illustrates that there is little consistency in the information provided. The usefulness of the summary, which is intended as a reference for the public and local officials, could be improved by requiring, at a minimum:

- The name of the developer and its headquarters location. The name of the project is generally not meaningful where it only indicates ownership by a limited liability company. This makes it difficult to evaluate the record of the developer.

- In addition to a statement as to whether or not the applicant intends to construct the project and maintain it or whether those responsibilities will be contracted to a third party, a statement as to whether the developer will be the long-term owner of the facility would be helpful. If the developer will not be the long-term owner operator, the intention of the developer with respect to long term ownership should be stated.

- A more factual description of the facility would be helpful. This should include the proposed size of the project including estimated metrics such as the number of MW's, the acreage required, the number of panels, the number of piles or posts which will support the panels, whether the panels will be bi-facial or monofacial, whether the panels will be on a tracking system to follow the sun, whether battery storage is planned and the capacity of the battery, and the anticipated length of the gen-tie line.

- Factual information should be included upfront in the project summary. It can be further described in project description narrative.

* **In regard to project siting, what information should an applicant file to support its consideration of public involvement as to the site/route selection process?**

All information provided to County Commissioners and county agencies should be publicly accessible. Senate Bill 52 will go far in the improving public involvement since the Commissioners are directly accountable to the public.

A continuing problem with both utility wind and solar is the ability of some local landowners to comprehend a proposed lease or lease option agreement. The lease agreements are real estate transactions and should allow for a right of recission early in the process.

* **Consistent with R.C. 4906.221 to 4906.222, what information should a wind or solar facility applicant file regarding its decommissioning plans?**

Decommissioning plans should be described in detail and should not presume that there will be any scrap value. Attached to my remarks is a June 18, 2021, article from the Harvard Business Review that raises the prospect of early replacement of panels due to efficiency gains as the technology evolves. The disposal of panels, including outmoded panels should early replacement occur, should be addressed in the application. The HBR notes that solar panel recycling infrastructure is practically non-existent. The exception is First Solar whose recycling program only applies to its own products at a global capacity of two million panels per year. "With the current capacity, it costs an estimated $20-$30 to recycle one panel. Sending that same panel to a landfill would cost a mere $1-$2." SInce the recycling infrastructure is practically non-existent, applicants should specify what local landfills will accept the decommissioned panels.

In addition to panel disposal, the steps that will be taken to return agricultural land to productive use should be defined and funded. Some soil experts believe restoration could take intensive remediation over a period of years after solar panels are removed. The OPSB should consider the adoption of rules which will ensure remediation. The responsibility for who should oversee the remediation requirement and how it should be funded should be included in the decommissioning plan.

* **What information should an applicant file in support of its compliance with environmental and aviation regulations?**

Compliance with environmental regulations is often a subject of dispute and the local community often lacks the resources to fund independent studies. Sole reliance on the developer's representations and studies has been an issue in utility wind and there is no reason to believe there will not be disputes with utility scale solar. Independent review is needed, and funding should be made available for OPSB or locally sponsored studies.

* **What information should an applicant file in regard to its planned management of noxious weeds, irrigation system mitigation, field drainage system mitigation, and storm water runoff management?**

The applicant should file a detailed plan for site management. Quarterly reports should be required to be filed with the OPSB or its designee at the County. Quarterly reports should be publicly accessible. If the applicant defaults on site management commitments, a successor manager should be provided for and funded.

* **The Board is considering implementing a rule to address solar facilities. General areas for consideration include setbacks, landscape and lighting design, perimeter fencing requirements, and operational noise. What requirements should exist as to these issues? What other issues, if any, should be considered for inclusion in this rule?**

The Board should adopt minimum required setbacks from neighboring property lines. At a minimum, the setbacks should ensure that noise levels at the property line do not exceed 5 decibels above current background levels. It is an established fact that inverters, transformers and tracking mechanisms generate noise. I have attached a report from Robert Rand of Rand Acoustics which describes the noise characteristics of solar facilities. Rand recommends that developers be required to use Best Available Technology to ensure the lowest noise emissions.

A deficiency in current wind siting noise regulations should be addressed in developing solar noise rules. Traditionally, the developer selects sample sites to measure ambient noise levels. The sample sites are generally located on leaseholder property. These readings are then averaged across the project footprint to establish a baseline noise level.   This method penalizes those residents who live in extremely quiet areas.   It may be more beneficial to take the sample noise readings at the property lines of non-participating property owners.   It is recommended that the OPSB undertake these readings with its own independent acoustical experts.

With respect to fencing, all fencing should facilitate travel by wildlife in and out of the project area. Lighting should be minimal to protect the remaining insect population. In introduction of lights into a dark rural area is a disamenity that reduces the value of non-participating property.

Sustainability

The Dark Side of Solar Power

by Atalay Atasu
Serasu Duran
Luk N. Van Wassnhove

June 18, 2021

Summary: Solar energy is a rapidly growing market, which should be good news for the environment. Unfortunately, there's a catch. The replacement rate of solar panels is faster than expected and given the current very high recycling costs, there's a real danger that all used panels will go straight to landfill (along with equally hard-to-recycle wind turbines). Regulators and industry players need to start improving the economics and scale of recycling capabilities before the avalanche of solar panels hits

It's sunny times for solar power. In the U.S., home installations of solar panels have fully rebounded from the Covid slump, with analysts predicting more than 19 gigawatts of total capacity installed, compared to 13 gigawatts at the close of 2019. Over the next 10 years, that number may quadruple, according to industry research data. And that's not even taking into consideration the further impact of possible new regulations and incentives launched by the green-friendly Biden administration.

Solar's pandemic-proof performance is due in large part to the Solar Investment Tax Credit, which defrays 26% of solar-related expenses for all residential and commercial customers (just down from 30% during 2006-2019). After 2023, the tax credit will step down to a permanent 10% for commercial installers and will disappear entirely for home buyers. Therefore, sales of solar will probably burn even hotter in the coming months, as buyers race to cash in while they still can.

Tax subsidies are not the only reason for the solar explosion. The conversion efficiency of panels has improved by as much as 0.5% each year for the last 10 years, even as production costs (and thus prices) have sharply declined, thanks to several waves of manufacturing innovation mostly driven by industry-dominant Chinese panel producers. For the end consumer, this amounts to far lower up-front costs per kilowatt of energy generated.

This is all great news, not just for the industry but also for anyone who acknowledges the need to transition from fossil fuels to renewable energy for the sake of our planet's future. But there's a massive caveat that very few are talking about.

Panels, Panels Everywhere

Economic incentives are rapidly aligning to encourage customers to trade their existing panels for newer, cheaper, more efficient models. In an industry where circularity solutions such as recycling remain woefully inadequate, the sheer volume of discarded panels will soon pose a risk of existentially damaging proportions.

To be sure, this is not the story one gets from official industry and government sources. The International Renewable Energy Agency (IRENA)'s official projections assert that "large amounts of annual waste are anticipated by the early 2030s" and could total 78 million tonnes by the year 2050. That's a staggering amount, undoubtedly. But with so many years to prepare, it describes a billion-dollar opportunity for recapture of valuable materials rather than a dire threat. The threat is hidden by the fact that IRENA's predictions are premised upon customers keeping their panels in place for the entirety of their 30-year lifecycle. They do not account for the possibility of widespread early replacement.

Our research does. Using real U.S. data, we modeled the incentives affecting consumers' decisions whether to replace under various scenarios. We surmised that three variables were particularly salient in determining replacement decisions: installation price, compensation rate (i.e., the going rate for solar energy sold to the grid), and module efficiency. If the cost of trading up is low enough, and the efficiency and compensation rate are high enough, we posit that rational consumers will make the switch, regardless of whether their existing panels have lived out a full 30 years.

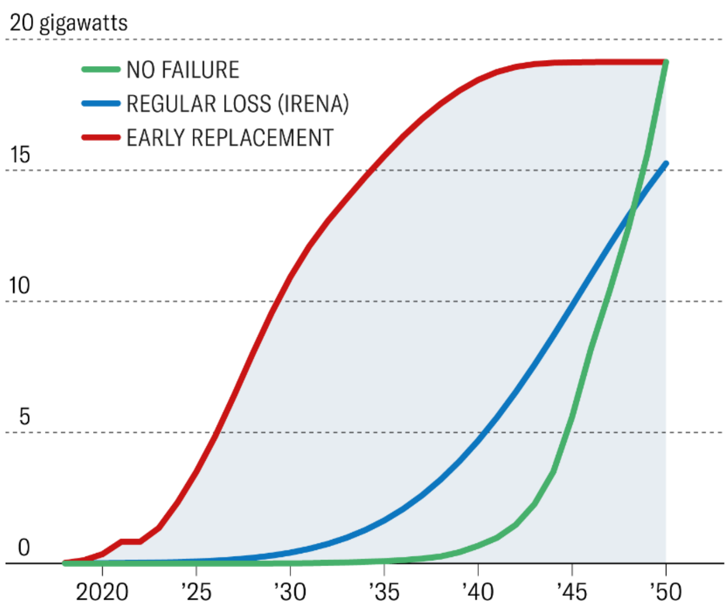
As an example, consider a hypothetical consumer (call her "Ms. Brown") living in California who installed solar panels on her home in 2011. Theoretically, she could keep the panels in place for 30 years, i.e., until 2041. At the time of installation, the total cost was $40,800, 30% of which was tax deductible thanks to the Solar Investment Tax Credit. In 2011, Ms. Brown could expect to generate 12,000 kilowatts of energy through her solar panels, or roughly $2,100 worth of electricity. In each following year, the efficiency of her panel decreases by approximately one percent due to module degradation.

Now imagine that in the year 2026, halfway through the lifecycle of her equipment, Ms. Brown starts to look at her solar options again. She's heard the latest generation of panels are cheaper and more efficient — and when she does her homework, she finds that that is very much the case. Going by actual current projections, the Ms. Brown of 2026 will find that costs associated with buying and installing solar panels have fallen by 70% from where they were in 2011. Moreover, the new-generation panels will yield $2,800 in annual revenue, $700 more than her existing set-up when it was new. All told, upgrading her panels now rather than waiting another 15 years will increase the (net present value) NPV of her solar rig by more than $3,000 in 2011 dollars. If Ms. Brown is a rational actor, she will opt for early replacement. And if she were especially shrewd in money matters, she would have come to that decision even sooner — our calculations for the Ms. Brown scenario show the replacement NPV overtaking that of panel retention starting in 2021.

The Solar Trash Wave

According to our research, cumulative waste projections will rise far sooner and more sharply than most analysts expect, as the below graph shows. The green "no failure" line tracks the disposal of panels assuming that no faults occur over the 30-year life cycle; the blue line shows the official International Renewable Energy Agency (IRENA) forecast, which allows for some replacements earlier in the life cycle; and the red line represents waste projections predicted by our model.

Cumulative capacity



Source: International Renewable Energy Agency, Electricity Data Browser, Global Solar Atlas

HBR

If early replacements occur as predicted by our statistical model, they can produce 50 times more waste in just four years than IRENA anticipates. That figure translates to around 315,000 metric tonnes of waste, based on an estimate of 90 tonnes per MW weight-to-power ratio.

Alarming as they are, these stats may not do full justice to the crisis, as our analysis is restricted to residential installations. With commercial and industrial panels added to the picture, the scale of replacements could be much, much larger.

The High Cost of Solar Trash

The industry's current circular capacity is woefully unprepared for the deluge of waste that is likely to come. The financial incentive to invest in recycling has never been very strong in solar. While panels contain small amounts of valuable materials such as silver, they are mostly made of glass, an extremely low-value material. The long lifespan of solar panels also serves to disincentivize innovation in this area.

As a result, solar's production boom has left its recycling infrastructure in the dust. To give you some indication, First Solar is the sole U.S. panel manufacturer we know of with an up-and-running recycling initiative, which only applies to the company's own products at a global capacity of two million panels per year. With the current capacity, it costs an estimated $20-30 to recycle one panel. Sending that same panel to a landfill would cost a mere $1-2.

The direct cost of recycling is only part of the end-of-life burden, however. Panels are delicate, bulky pieces of equipment usually installed on rooftops in the residential context. Specialized labor is required to detach and remove them, lest they shatter to smithereens before they make it onto the truck. In addition, some governments may classify solar panels as hazardous waste, due to the small amounts of heavy metals (cadmium, lead, etc.) they contain. This classification carries with it a string of expensive restrictions — hazardous waste can only be transported at designated times and via select routes, etc.

The totality of these unforeseen costs could crush industry competitiveness. If we plot future installations according to a logistic growth curve capped at 700 GW by 2050 (NREL's estimated ceiling for the U.S. residential market) alongside the early replacement curve, we see the volume of waste surpassing that of new installations by the year 2031. By 2035, discarded panels would outweigh new units sold by 2.56 times. In turn, this would catapult the LCOE (levelized cost of energy, a measure of the overall cost of an energy-producing asset over its lifetime) to four times the current projection. The economics of solar — so bright-seeming from the vantage point of 2021 — would darken quickly as the industry sinks under the weight of its own trash.

Who Pays the Bill?

It will almost certainly fall to regulators to decide who will bear the cleanup costs. As waste from the first wave of early replacements piles up in the next few years, the U.S. government — starting with the states, but surely escalating to the federal level — will introduce solar panel recycling legislation. Conceivably, future regulations in the U.S. will follow the model of the European Union's WEEE Directive, a legal framework for the recycling and disposal of electronic waste throughout EU member states. The U.S. states that have enacted electronics-recycling legislation have mostly cleaved to the WEEE model. (The Directive was amended in 2014 to include solar panels.) In the EU, recycling responsibilities for past (historic) waste have been apportioned to manufacturers based on current market share.

A first step to forestalling disaster may be for solar panel producers to start lobbying for similar legislation in the United States immediately, instead of waiting for solar panels to start clogging landfills. In our experience drafting and implementing the revision of the original WEEE Directive in the late 2000s, we found one of the biggest challenges in those early years was assigning responsibility for the vast amount of accumulated waste generated by companies no longer in the electronics business (so called orphan-waste).

In the case of solar, the problem is made even thornier by new rules out of Beijing that shave subsidies for solar panel producers, while increasing mandatory competitive bidding for new solar projects. In an industry dominated by Chinese players, this ramps up the uncertainty factor. With reduced support from the central government, it's possible that some Chinese producers may fall out of the market. One of the reasons to push legislation now rather than later is to ensure that the responsibility for recycling the imminent first wave of waste is shared fairly by makers of the equipment concerned. If legislation comes too late, the remaining players may be forced to deal with the expensive mess that erstwhile Chinese producers left behind.

But first and foremost, the required solar panel recycling capacity has to be built, as part of a comprehensive end-of-life infrastructure also encompassing uninstallation, transportation, and (in the meantime) adequate storage facilities for solar waste. If even the most optimistic of our early-replacement forecasts are accurate, there may not be enough time for companies to accomplish this alone. Government subsidies are probably the only way to quickly develop capacity commensurate to the magnitude of the looming waste problem. Corporate lobbyists can make a convincing case for government intervention, centered on the idea that waste is a negative externality of the rapid innovation necessary for widespread adoption of new energy technologies such as solar. The cost of creating end-of-life infrastructure for solar, therefore, is an inescapable part of the R&D package that goes along with supporting green energy.

It's Not Just Solar

The same problem is looming for other renewable-energy technologies. For example, barring a major increase in processing capability, experts expect that more than 720,000 tons worth of gargantuan wind turbine blades will end up in U.S. landfills over the next 20 years. According to prevailing estimates, only five percent of electric-vehicle batteries are currently recycled – a lag that automakers are racing to rectify as sales figures for electric cars continue to rise as much as 40% year-on-year. The only essential difference between these green technologies and solar panels is that the latter doubles as a revenue-generating engine for the consumer. Two separate profit-seeking actors — panel producers and the end consumer — thus must be satisfied in order for adoption to occur at scale.

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None of this should raise serious doubts about the future or necessity of renewables. The science is indisputable: Continuing to rely on fossil fuels to the extent we currently do will bequeath a damaged if not dying planet to future generations. Compared with all we stand to gain or lose, the four decades or so it will likely take for the economics of solar to stabilize to the point that consumers won’t feel compelled to cut short the lifecycle of their panels seems decidedly small. But that lofty purpose doesn’t make the shift to renewable energy any easier in reality. Of all sectors, sustainable technology can least afford to be short-sighted about the waste it creates. A strategy for entering the circular economy is absolutely essential — and the sooner, the better.

As interest in clean energy surges, used solar panels are going straight into landfill.

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November 11, 2020

To: Kevon Martis

Re: Noise Impact Assessment Overview
Solar Facility Inverters and Transformers

I respectfully submit this general overview of noise emissions, control, and recommended noise design guidelines for grid-scale solar facilities which contain inverters and transformers.

Design basis

INCE Rules of Practice require approving only noise control engineering studies, reports, or work which, to the best of the reviewer's knowledge and belief, is safe for public health, property, and welfare and in conformance with accepted practice. From years of work in power generation noise control including ten years at Stone & Webster Engineering Corporation, accepted practice includes planning to protect communities from unwanted sound and assuring facilities comply with regulatory requirements with an adequate margin of safety. Noise complaints indicate developers, regulators, and consultants failed to protect from unwanted sound.

Background: Solar Facility Noise Overview

1. Noise is unwanted sound; sound that is annoying, interfering with activities such as sleep, degrading of amenity. Zoning and regulations establish noise limit standards on the predicate to protect people from unwanted sound and prevent high annoyance.

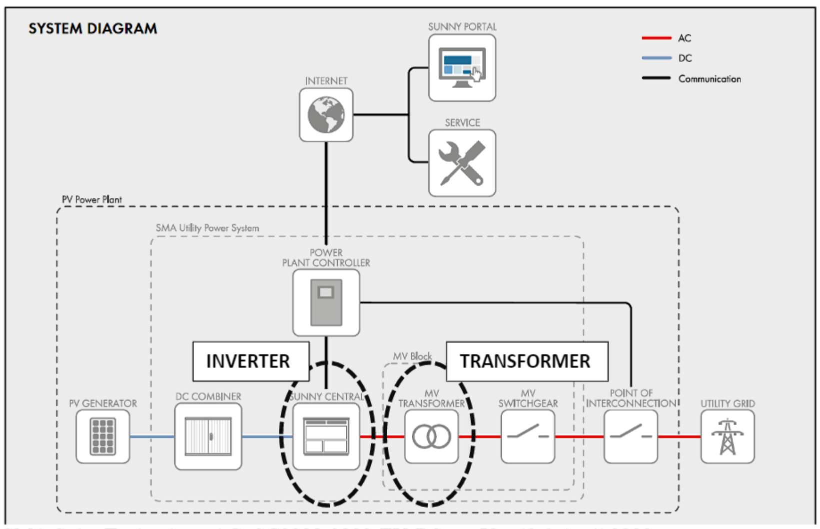
2. Grid-scale solar facilities contain inverters and transformers. Solar inverters convert DC voltage from panels to AC voltage. Transformers step that voltage up to grid voltages. Inverters and transformers emit tonal noise due to magnetostriction, and emit broadband fan noise where components are fan-cooled. Typical A-weighted noise levels for each grid-connect system component are in the range of 65-68 dBA at 10 meters.

3. Transformer noise consists of primary tonal components at 120, 240, 360 and 480 Hz. Additional harmonics continue at higher frequencies but are generally not considered in noise control planning. Fan noise is broadband in nature and is generally not objectionable with sufficient distance provided the fans do not emit significant tonal noise themselves. Quiet transformers (Best Available Technology) can be purchased at up to 15 to 20 dB below normal NEMA ratings. If a quieter transformer is incorporated in a facility design, the lowered sound level rating should be used in place of the regular NEMA rating during noise impact estimates.

4. Inverter noise emissions include unfamiliar-sounding chopped tonal noise components at approximately 3000, 6000 and 9000 Hz [video for inverter SMA Type TCS 1600 MV-2F at https://www.youtube.com/watch?v=H-_G2p0y31I accessed 10 Nov 2020].

5. Cost-effective noise controls for transformer and inverter noise are readily available and used worldwide for decades. These include full building enclosures, industrial site noise barriers, acoustic slotted masonry block barriers, and reactive barrier panels.

6. Facility components: An example system diagram is shown from SMA, a world-around solar component supplier headquartered in Germany. The SMA design overview below shows the components used in a large facility (inverter and transformer components are outlined with ovals).



SMA Solar Technology AG, SC2200-3000-EV-DS-en-59.pdf, 1 April 2020.

Review of Noise Criteria

1. Regulations should state a permitting predicate to prevent annoyance by prohibiting audible excessive tonal sounds from solar components within residential property lines. "A prohibition on producing any audible prominent tones, as defined by using the constant level differences listed under ANSI S12 .9-2005/Part 4 Annex C (sounds with tonal content), at the outside of any existing nonparticipating residence or at any point on residential property where audible tonal sound would result in activity interference." Regulations should require that audible prominent tones shall be flagged and reduced in level with noise control implemented as required to drop below prominent tone thresholds.

2. ANSI Standards provide a neutral consensus-body reference for noise guidelines for compatibility with land use. Environmental noise compatibility for land use can be formally assessed using ANSI S12.9 Parts 4 & 5 which establish guidelines for compatibility of a new intrusive noise source for various land uses including rural residential land use. See this letter's Supplement A.

3. ANSI S12.9 establishes by tabular computation that day-time and night-time intrusive noise levels are compatible with quiet rural residential land use when total intrusive long-term average sound levels do not exceed 40 and 30 dBA, respectively.

4. Tonal noise is assigned a 5-dB penalty in many jurisdictions to account for its highly objectionable noise character. However, when evaluating compatibility to land use with ANSI S12.9 Part 5, pure tone/impulse corrections should be ignored, since this factor is already incorporated into the present standard.

5. Noise criteria and regulations should be established at the property line, which is in accordance with standard practice for zoning.

6. Individual noise producing components should be assessed for contribution to a total noise level using a noise "budget" to assign noise controls as required to meet noise criteria with an adequate margin of safety. Decades of best practices established margins of safety for power generation noise in the range of 2-5 decibels depending on site specifics including the fluctuations in facility noise, effects of site layout, topography and atmospherics on noise propagation to nearby residential properties, and factoring sound meter tolerances.

7. Appropriate noise criteria then fall in the range of 35 to 38 dBA daytime and 25 to 28 dBA at night. These criteria are consistent with ANSI Standards for land use compatibility in quiet rural residential properties and prevent unwanted sound from intrusive tonal noise with an adequate margin of safety.

8. Regulations should require use of Best Available Technology to ensure the lowest practical noise emissions. Facility applicants should be required to show their equipment is Best Available Technology and that facility designs shall not impact people with unwanted sound and shall not create high annoyance.

9. Given the many readily available and time-proven noise control options for transformers and inverters, there should be no objection to applying these criteria and safety margins to protect people from unwanted sound.

Thank you for your consideration of this letter. If you have any questions, please contact me.

Respectfully Submitted,

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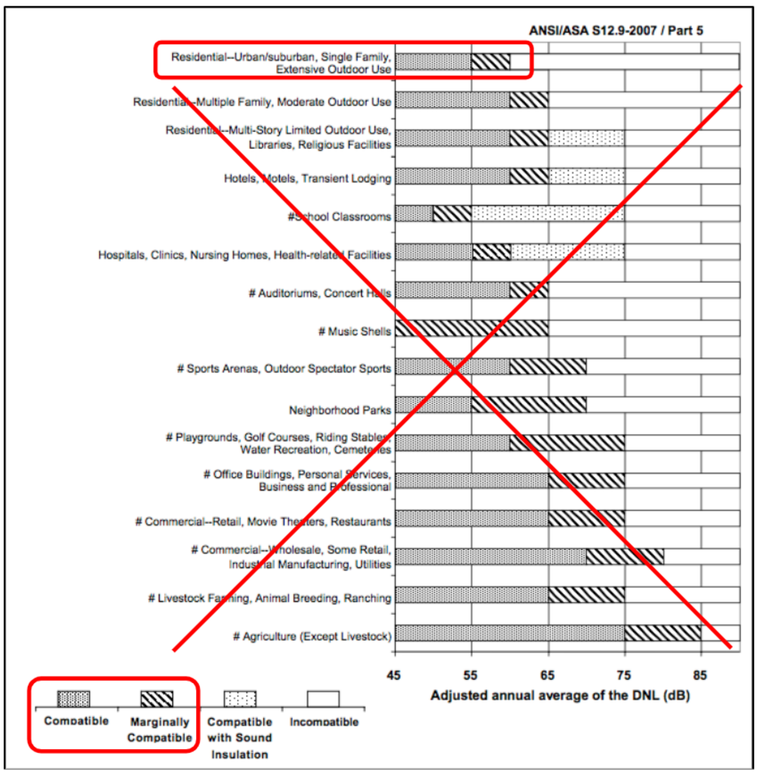
Robert W. Rand, ASA, INCE (Member Emeritus)

Attached:
- Supplement A: ANSI Siting Criteria For Compatibility, Rural Residential Land Use

Supplement A: ANSI Siting Criteria For Compatibility, Rural Residential Land Use

ANSI S12.9 Parts 4 & 5 provides methods for determining noise level thresholds for compatibility with land use. Part 5 Annex A provides that "compatibility of a land use with the outdoor noise environment is assessed by comparing the predicted or measured annual average of the total day-night adjusted sound exposure or the annual average of the adjusted day-night average sound level at a site with the guidance criteria given in Figure A.1."



ANSI S12.9 Part 5 Figure A.1, with markups. Lists a range of land uses, including at the top, "Residential-Urban/suburban, Single Family, Extensive Outdoor Use". This category was selected as a basis for evaluation of compatibility for rural residential land use.

This analysis evaluates compatibility for rural residential land use (homes), similar to the top category in Figure A.1, and does not evaluate for compatibility in farm fields proper (agricultural use). Part 5 Annex A Figure A.1 includes a footnote, "For residences in quiet rural areas (e.g., not near busy roads, busy railroads, grain elevators, etc.), the +10-dB adjustment in ANSI S12.9 Part 4 clause F.3.4.2 should be used." This adjustment was applied in this analysis to be conservative for homes away from busy roads and rail.

For each category a range of acceptable annual average day-night sound levels are listed for Compatible, Marginally Compatible, Compatible with Sound Insulation, and Incompatible. For the Residential-Urban/suburban, Single Family category, "Compatible" ranges up to 55 Ldn, and "Marginally Compatible" extends to 60 Ldn. Intrusive noise levels above 60 Ldn are "Incompatible".

Compatible land use is defined in ANSI S12.9 Part 5:

> ***3.1 compatible land use***. *Land use consistent with the outdoor noise environment such that the annual average of the total day-night adjusted sound exposure or the annual average of the adjusted day-night average sound level at a site is not greater than the compatibility limit designated for that land use.*
>
> ***3.2 land use***. *Existing or intended use of a specifically delineated land area or parcel.*
>
> ***3.3 land use category***. *A logical grouping of a set of related land uses.*

The ANSI S12.9 Part 4 adjustment from urban to quiet rural local conditions is a reduction of 15 dBA, including 10 dB for "quiet rural settings" (ANSI S12.9 Part 4 Section F.3.4.2) and 5 dB for unfamiliar intrusive noise (ANSI S12.9 Part 4 Section F.3.4.1). These two factors are additive (ANSI S12.9 Part 4 Section F.3.4.3). In practice, these factors may be used to either 1) adjust measured or predicted levels upward to assess against ANSI land use compatibility ratings, or 2) adjust ANSI land use compatibility ratings downward to assess measured or predicted sound levels. The comparative result is the same. For this calculation, the compatibility noise ratings were adjusted downward *for direct comparison to facility long term average (Leq) noise predictions*.

The tables below summarize the calculation utilized to determine land use compatibility noise criteria for rural residential land use, using ANSI S12.9 Parts 4&5 assuming a quiet rural area. "Criteria" means the level that should not be exceeded- the highest allowable long-term average (Leq) noise level. The more stringent "Night" criteria are highlighted.

Criteria for "Compatibility" per ANSI S12.9:

Factor	**Day-Night Sound Level (DNL)**	***Day Sound Level:***	***Night Sound Level:***	***Average Level (Leq*):***
Part 5 Figure A.1 Residential Urban/suburban, Single Family Compatible, at the edge of Marginal Compatibility:	55	*55*	*45*	*49*
Adjust: 10 dB for quiet rural settings (Part 4 F.3.4.1):	-10	*-10*	*-10*	*-10*
Adjust: 5 dB for unfamiliar intrusive noise (Part 4 F.3.4.3):	-5	*-5*	*-5*	*-5*
Criteria for "Compatibility", dBA:	**40**	***40***	***30***	***34***

(continued)

Criteria for "Marginal Compatibility" per ANSI S12.9:

Factor	**Day-Night Sound Level (DNL)**	***Day Sound Level:***	***Night Sound Level:***	***Average Level (Leq*):***
Part 5 Figure A.1 Residential Urban/suburban, Single Family Marginal Compatibility, at edge of Incompatible:	60	*60*	*50*	*54*
Adjust: 10 dB for quiet rural settings (Part 4 F.3.4.1):	-10	*-10*	*-10*	*-10*
Adjust: 5 dB for unfamiliar intrusive noise (Part 4 F.3.4.3):	-5	*-5*	*-5*	*-5*
Criteria for "Marginal Compatibility", dBA:	**45**	***45***	***35***	***39***

* The energy-equivalent average level (Leq) equivalent to a 24-hour day-night level (DNL) is computed as 6.4 dB less than the day-night level due to level weighting of -10 dB from 10 pm to 7 am.

The ANSI S12.9 calculation concludes that for unfamiliar intrusive noise in quiet rural areas, long-term average (Leq) noise levels lower than 30 dBA are "*compatible*"; long-term Leq noise levels between 30 and 35 dBA are "*marginally compatible*"; long-term Leq noise levels exceeding 35 dBA at night are "*incompatible*".