Designing Solar Modules for High Snow Loads: A Guide for Scandinavian Markets

A Technical Guide for Scandinavian Markets

Content Partner: J. v. G. technology GmbH

Turnkey solar module production lines — since 1997

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Technical Overview: Designing Solar Modules for High Snow Loads in Scandinavian Markets

Created as part of the PVKnowHow Knowledge Network

Prepared by J.v.G. Technology GmbH

European specialists in turnkey solar module production lines

Key Project Data

100–3…	€6–10M	8–12 mo	2
Target Capacity	**Investment Range**	**Ramp-Up Time**	**Line Types**
Typical niche production volume for Nordic-spec modules	Semi-automated to automated high-spec production line	From line commissioning to certified production output	Semi-automated and fully automated high-spec configurations

Region: Scandinavia / Nordic markets · Author: J.v.G. Technology GmbH · Based on composite project scenarios

What Is Mechanical Load — and Why Does It Matter?

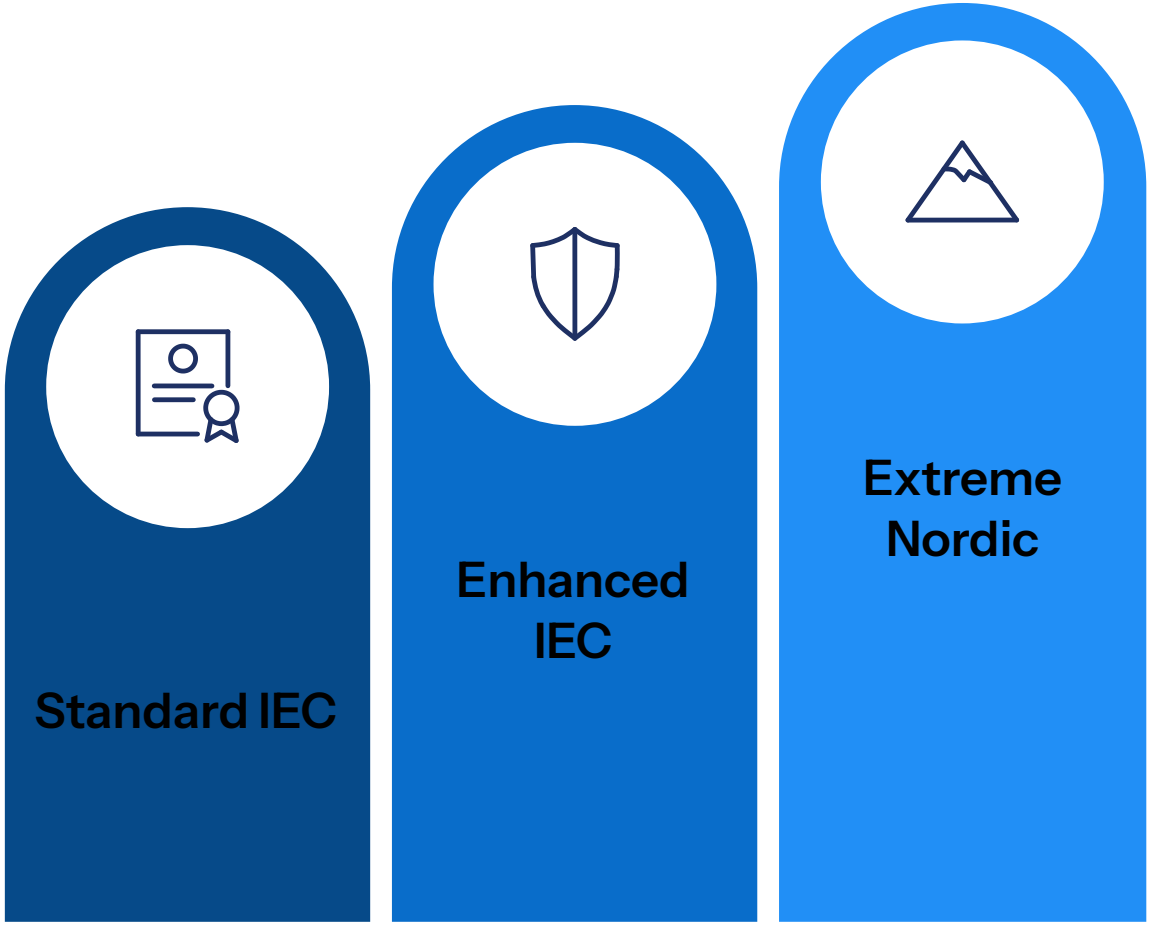
Definition: Pascal (Pa)

- Mechanical load = force per unit area, measured in Pascals (Pa)
- 1 Pa = 1 Newton per square metre of module surface
- Snow load is a *static* downward pressure on the module front face
- Load accumulates with snow depth, density, and roof pitch

Real-World Reference Points

- 2,400 Pa ≈ ~0.5–0.8 m of fresh snow on a flat surface
- 5,400 Pa ≈ ~1.0–1.5 m of compacted snow accumulation
- 8,000 Pa ≈ extreme alpine or Nordic worst-case conditions
- Wet, compacted snow is significantly denser than fresh powder

Standard vs. Nordic Requirement: The Load Gap



Failure Risks: What Happens Below the Required Load Rating

Cell Microcracks

- Invisible fractures in silicon cells under excessive flex
- Cause progressive power loss — not detectable visually
- Triggered by frame deflection transferring stress to laminate

Frame Bending & Separation

- Aluminium frame deforms under sustained high load
- Corner joints and mitre cuts are primary failure points
- Frame separation exposes laminate edge to moisture ingress

Glass Breakage

- Tempered glass can shatter under non-uniform snow load
- Non-uniform load (sliding snow) creates point stress concentrations
- IEC 62938 specifically addresses non-uniform snow load failure modes

Delamination & Moisture Ingress

- Repeated load cycling weakens encapsulant adhesion at edges
- Water penetration accelerates corrosion of cell interconnects
- Leads to accelerated degradation well below 25-year lifetime target

Engineering Solution 1: Frame Design

Frame Specifications for High Load

- Increased wall thickness: ≥1.8 mm (vs. standard 1.2–1.4 mm)
- Wider profile height: ≥40 mm to resist bending moment
- Reinforced corner key design — mechanical lock, not adhesive-only
- Alloy grade: EN AW-6063 T6 or equivalent high-strength aluminium

Design Validation

- FEA (Finite Element Analysis) simulation before physical prototyping
- Frame deflection limit: ⩽L/200 under maximum rated load
- Corner joint pull-out strength tested to rated load + safety factor
- Frame design is module-specific — standard catalogue profiles are insufficient

Engineering Solution 2: Glass Specification

Glass Thickness

- Standard: 3.2 mm tempered low-iron glass
- High-load Nordic spec: 4.0 mm or dual-glass (glass-glass) construction
- Glass-glass eliminates backsheet flex — distributes load more uniformly

Tempering & Surface Treatment

- Full heat tempering mandatory — no heat-strengthened glass
- Anti-reflective coating must not compromise mechanical strength
- Edge quality critical: chips or micro-cracks initiate fracture under load

Non-Uniform Load Resistance (IEC 62938)

- Sliding snow creates asymmetric load — more critical than uniform pressure
- Glass-glass construction significantly outperforms glass-backsheet in IEC 62938
- Module orientation and mounting clamp position affect stress distribution

Engineering Solution 3: Mounting System

1

Clamp Position

Mounting clamp location relative to module edge determines bending span — critical input to load rating calculation

2

Rail Spacing

Reduced rail spacing (closer cross-rails) lowers unsupported span and dramatically reduces glass and frame stress under load

3

System Certification

Module load rating is only valid for the tested clamp–rail–module combination; substituting components invalidates the certified rating

⚠ A module certified at 5,400 Pa on a specific mounting configuration may fail at lower loads if installed with non-specified clamps or rail spacing. System-level validation is mandatory.

Certification Process: Proving the Load Rating

1

1 — Module Mounting

Module fixed to test rig exactly per manufacturer installation manual

Clamp position and rail spacing must match production specification

2

2 — Load Application

Uniform pressure applied via vacuum cups or inflatable bladder

Load increased incrementally to target level (e.g. 5,400 Pa, 6,000 Pa, or higher)

3

3 — Load Cycling

Pressure held for one hour, then released — repeated three times

Simulates repeated seasonal load events over module lifetime

4

4 — Post-Test Inspection

Visual check: no cell cracks, no glass fracture, no frame separation

Electrical test: power degradation must remain ⩽5% vs. pre-test baseline

5

5 — TÜV Certification Issued

Independent body (e.g. TÜV Rheinland) issues load certification report

Certified load rating is stated on module datasheet and installation manual

Certification Standards Reference

Standard	Scope	Relevance for Nordic Markets
IEC 61215	Module design qualification — static mechanical load test at 2,400 Pa (baseline) and 5,400 Pa (enhanced)	Minimum entry requirement; 5,400 Pa variant mandatory for Scandinavia
IEC 62938	Non-uniform snow load test — addresses sliding snow and asymmetric pressure	Critical for pitched roof installations in heavy snow regions
IEC 62782	Dynamic mechanical load — 1,000 pressure cycles simulating wind and repeated snow events	Recommended for full Nordic certification package
TÜV Rheinland	Third-party test body — issues independent mechanical load certification report	Required by most Nordic project developers and grid operators

Business Strategy: Premium Niche vs. Commodity Market

Commodity Market

- 2,400 Pa standard modules — global volume production
- Extreme price competition; margin erosion at scale
- No regional differentiation — product is interchangeable
- High capital requirement to compete on cost per watt

Nordic Premium Niche

- 5,400–8,000 Pa certified modules — limited global supply
- Higher ASP justified by engineering differentiation and TÜV certification
- Strong regional loyalty: installers and developers prefer proven local supply
- 100–300 MW niche volume is viable and defensible

Strategic Entry Path

- Design to 5,400 Pa minimum; target 6,000 Pa for competitive margin
- Obtain TÜV certification before market launch — non-negotiable
- Partner with an experienced European turnkey provider for line setup
- Ramp-up: 8–12 months from line commissioning to certified production

Strategic Importance: Engineering for the Nordic Environment

1

Design Integrity

Frame, glass, and mounting system must be co-engineered — no single component alone achieves the required load rating

2

Certification as Market Entry

TÜV-certified load rating is the commercial prerequisite — Nordic project developers will not specify uncertified modules

3

Turnkey Production Advantage

An experienced European turnkey provider integrates high-spec BOM, process know-how, and certification support into a single project delivery

A proven turnkey manufacturing concept reduces the engineering and certification learning curve for new entrants — from line design through first TÜV-certified production batch.

About the Content Partner

J. v. G. technology GmbH — The DESERT Company

Founded in 1997 in Bavaria, Germany. Family-owned engineering company specializing in turnkey solar module production lines.

More than 90 factory projects delivered worldwide.
On-site team training included — no prior manufacturing experience required.

Key areas:

Turnkey PV manufacturing lines | DESERT Technology® | TÜV-certified module designs | Factory planning to production

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