Denmark Grid Connection: Technical & Regulatory Requirements

A comprehensive roadmap for integrating new production facilities

Content Partner: J. v. G. technology GmbH

Turnkey solar module production lines — since 1997

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Strategic Analysis: Connecting a New Production Facility to Denmark's Grid

Created as part of the PVKnowHow Knowledge Network

Prepared by J.v.G. Technology GmbH

European specialists in turnkey solar module production lines

Why Grid Connection Is a Strategic Project

Not a Utility Decision — A Business Decision

- Grid access determines whether a facility can operate at planned capacity
- Wrong voltage level = insufficient power delivery and regulatory non-compliance
- Location selection must factor in grid proximity and connection feasibility

Long Lead Times With Hard Consequences

- Connection process: 12–24 months from first inquiry to commissioning
- Delays are common and directly impact factory ramp-up schedules
- Multi-million DKK infrastructure investment — not reversible

Regulatory and Technical Complexity

- Subject to Danish Energy Agency rules and EU network codes
- Technical compliance (harmonics, reactive power, SCADA) is mandatory
- Requires formal agreements with the national transmission operator

Denmark Grid Structure: TSO vs. DSO

TSO — Transmission System Operator

- **Energinet** is Denmark's sole TSO — state-owned, non-profit
- Operates the national high-voltage grid at 100, 132, 150, and 400 kV
- Manages cross-border interconnections and 24/7 grid balance
- Sole counterpart for large industrial grid connection agreements
- Regulated under Danish Energy Agency (Energistyrelsen)

DSO — Distribution System Operator

- DSOs own and operate medium- and low-voltage local networks
- Regulated monopoly for power delivery to homes and businesses
- Handle local grid access, maintenance, and metering
- **Not the correct contact point** for high-voltage industrial connections
- Large factories connect directly to Energinet — bypassing the DSO level

ⓘ Key distinction: industrial facilities requiring high-voltage connections engage with Energinet (TSO) directly — not with local distribution operators.

Role of Energinet (TSO)

Grid Owner & Operator

Owns and operates approximately 7,000 km of high-voltage transmission infrastructure across Denmark

System Balance Responsibility

Ensures 24/7 supply-demand balance; procures ancillary reserve services (FCR, AFRR, mFRR)

Connection Agreement Authority

Issues feasibility studies, connection agreements, and sets all technical compliance requirements for new connections

EU Integration

Part of European balancing markets (PICASSO); Denmark is member of Nordic and Hansa capacity calculation regions

Energinet is an independent public enterprise wholly owned by the Danish state under the Ministry of Climate, Energy, and Utilities.

High-Voltage Requirement for Industrial Factories

Why High Voltage Is Required

- Large industrial facilities require power volumes that cannot be served at medium or low voltage
- High-voltage connection ensures the stability and capacity required for large-scale industrial processes
- A large factory introduces a powerful and potentially disruptive load to the grid
- Energinet enforces strict technical requirements to maintain stability for all grid users

Voltage Levels in Denmark

- **400 kV** — bulk transmission backbone; major industrial / energy hubs
- **150 / 132 kV** — regional transmission; large industrial connections
- **100 kV** — entry-level high-voltage industrial connection
- New 132–150 kV connections mandated as underground cables per Danish policy
- 400 kV connections also required underground where technically feasible

100–400

Voltage Range (kV)

Operating range for industrial high-voltage grid connections in Denmark

12–24

Months Ramp-Up

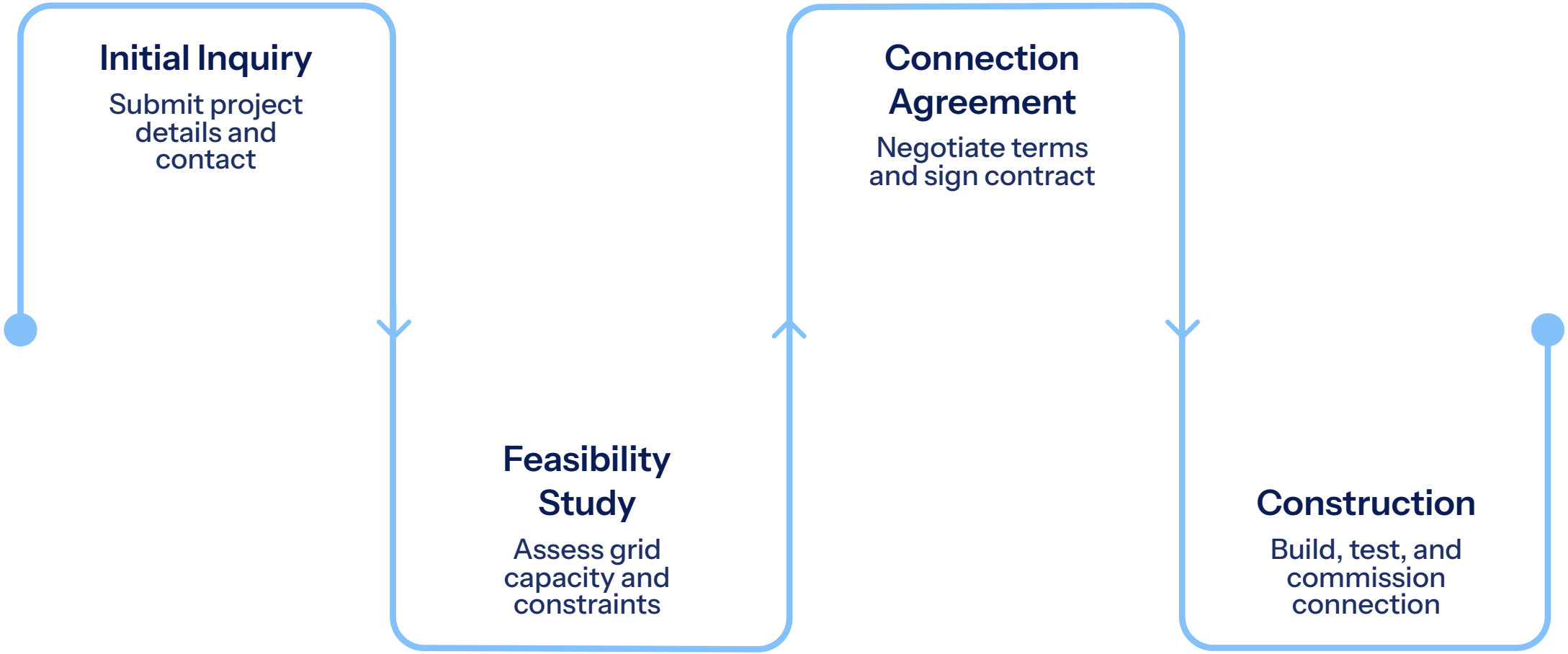
Typical timeline from initial inquiry to commissioning

7,000

km Grid (Denmark)

Total high-voltage transmission network operated by Energinet

4-Stage Process Overview



Each stage is sequential and gate-controlled — a positive outcome at each stage is required before proceeding to the next. The full process typically spans 12–24 months from first contact to energization.

Source: PVKnowHow / J.v.G. Technology GmbH · Region: Denmark · Grid level: 100–400 kV industrial connection

Stage 1: Initial Inquiry

01

Contact Energinet

Initiate formal contact with Energinet to notify of planned industrial facility and estimated power demand

02

Preliminary Grid Assessment

Energinet performs an initial assessment of grid availability and capacity in the relevant region

03

Location Data Submission

Applicant provides site location, load profile estimates, and planned commissioning schedule

04

Outcome: Go / No-Go

If the preliminary assessment is positive, Energinet will propose a formal Feasibility Study — the gateway to Stage 2

⚠ Location choice directly influences grid availability. Sites near existing high-voltage infrastructure significantly reduce connection costs and timelines.

Stage 2: Feasibility Study

What the Study Covers

- Identifies the optimal connection point on the high-voltage grid
- Analyzes the impact of the facility's load on grid stability
- Outlines required construction work — new substations or transmission lines
- Provides a preliminary cost estimate for the connection

Cost & Timeline

- Paid service commissioned by the applicant
- Typical cost: **DKK 200,000 – DKK 500,000**
- Duration: several months depending on grid complexity
- Output: technical analysis and preliminary infrastructure cost estimate
- Results form the basis of the formal Connection Agreement (Stage 3)

The feasibility study is a paid service — costs typically ranging from DKK 200,000 to DKK 500,000. Investing in a thorough study de-risks the multi-million DKK infrastructure commitment that follows.

Stage 3: Connection Agreement

Legal Basis

- Legally binding document between applicant and Energinet
- Forms the contractual foundation for the entire grid connection project
- Cannot be substituted by informal arrangements

Technical Specifications

- Final technical specifications for the connection point
- Agreed performance parameters (voltage, harmonics, reactive power)
- SCADA integration requirements and communication protocols

Commercial & Timeline Terms

- Definitive construction and commissioning timeline
- Detailed cost breakdown and payment schedules
- Defined responsibilities for both the applicant and Energinet

Stage 4: Construction & Commissioning

1. **Infrastructure Construction**

   Dedicated substation built on applicant's property; high-voltage cables laid to the connection point

2. **Parallel Public Grid Work**

   Energinet conducts corresponding work on the public transmission grid — coordinated with on-site construction

3. **SCADA Integration**

   Real-time supervisory system installed; gives Energinet visibility and control over the connection point

4. **Testing & Commissioning**

   Rigorous testing ensures connection is safe, stable, and compliant with all technical standards before energization

Technical Challenges: Harmonics, Voltage & Reactive Power

Large industrial facilities introduce complex electrical demands that must be actively managed to protect grid stability.

Harmonic Distortion

- Electrical noise generated by modern industrial equipment (drives, converters, rectifiers)
- Can interfere with grid operations and damage sensitive equipment
- Harmonic filters required — specified in connection agreement
- Must comply with EN 50160 and IEC 61000 standards

Voltage Fluctuations

- Sudden changes in power demand cause voltage dips or swells
- Large motor starts and process switching are primary triggers
- Facility must demonstrate controlled load ramp-up profiles
- Voltage regulation systems required at connection point

Reactive Power Management

- Industrial loads are inherently reactive — leading to transmission losses
- Efficient balance of active and reactive power is a mandatory requirement
- Power factor correction equipment must be installed and maintained
- Reactive power capability must be reported via SCADA to Energinet

⚠ A SCADA (Supervisory Control and Data Acquisition) system is mandatory — it provides Energinet real-time visibility and control over the connection point.

Regulatory Complexity: Denmark & EU

Danish National Framework

- All grid connections governed by the Danish Energy Agency (Energistyrelsen)
- Energinet sets technical connection requirements (grid codes)
- New 132–150 kV lines mandated underground; 400 kV underground where feasible
- Substation and cable works require separate planning and construction permits
- Environmental impact assessments may be required depending on site location

EU Regulatory Layer

- EU Network Code on Requirements for Generators (RfG) — EC 2016/631
- EU Network Code on Demand Connection (DCC) — EC 2016/1388
- EU guideline on electricity transmission system operation — EC 2017/1485
- European balancing market integration (PICASSO) affects imbalance pricing
- Denmark participates in Nordic and Hansa capacity calculation regions

Regulatory compliance spans two layers: Danish national rules administered by Energistyrelsen and Energinet, plus binding EU network codes. Both must be satisfied before the connection is energized.

Timeline & Cost Risks

Schedule Overruns

- Overall process: 12–24 months is typical; delays are structurally common
- Grid upgrade works by Energinet on the public side can extend timelines independently
- Permit processes and environmental reviews add non-controllable lead time
- Any design change after Connection Agreement may require re-assessment

Cost Escalation Factors

- Feasibility study: DKK 200,000–500,000 (sunk cost if project does not proceed)
- Infrastructure investment: multi-million DKK — scale depends on distance to connection point
- Additional substation equipment, SCADA, and harmonic mitigation systems add cost
- Construction cost risk increases if grid upgrades are required on Energinet's side

Mitigation Strategies

- Early engagement with Energinet reduces uncertainty before site commitment
- Selecting sites near existing high-voltage infrastructure significantly reduces costs
- Engaging experienced turnkey project partners reduces technical and procedural errors
- Parallel planning of factory and grid connection avoids schedule conflicts

Strategic Importance of Location Choice

1

Proximity to Grid Infrastructure

Sites close to existing 100–400 kV substations drastically reduce cable length, connection cost, and approval timelines

2

Regional Grid Capacity

Not all regions have equal available capacity — areas with planned grid expansion (Energinet LUP24) offer better prospects

3

Permit & Planning Environment

Industrial zones with established planning permissions reduce environmental review timelines and regulatory friction

⚠ Location selection must happen **before** property commitments — grid feasibility data from Energinet should inform the site decision, not follow it.

Conclusion: Grid Strategy as Core Infrastructure

Not an Afterthought

Grid connection must be treated as a core infrastructure workstream — initiated at the same time as factory planning, not after it

A 4-Stage Managed Process

Each stage — inquiry, feasibility, agreement, construction — is sequential, formal, and cannot be accelerated by bypassing steps

Location Is a Grid Decision

Site selection must integrate grid proximity analysis; the wrong location can add millions in cost and a year in schedule

Key project data: Scale: 100–400 kV · Feasibility study: DKK 200,000–500,000 · Infrastructure: multi-million DKK · Ramp-up: 12–24 months · Region: Denmark · Source: PVKnowHow / J.v.G. Technology GmbH

An experienced European turnkey provider integrates grid connection strategy into full-facility planning methodology — reducing procedural risk and ramp-up time for new industrial entrants.

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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