Sample Grid
TRANSMISSION



SAMPLE · ILLUSTRATIVE TEMPLATE
CONCEPT
USW-A-004 · Template version 1.60
SUBSTATION (AIS/GIS)

CONCEPT · SUBSTATION (AIS/GIS)

Concept study substation (site, type, voltage level)

Assessment and selection of a suitable site and of a technically and economically viable plant concept for a 400/132 kV substation. The study forms the basis for deciding on the preferred variant and approving the preliminary design.

1 Document type

Discipline / cluster	Substation (AIS/GIS)
Document class	Concept
Standard reference	BS EN 50522; BS EN IEC 62271-1; BS EN IEC 62271-203; BS EN IEC 60071-1

2 Document control (to be completed · • = mandatory)

• Project number	**• Project title**
e.g. P-4711	*e.g. substation North 400/132 kV*
Plant / site / bay	**Component / designation (KKS / RDS-PP)**
e.g. substation North, preferred site South Corridor	*e.g. primary technology 400/132 kV*
• Document number	**• Revision / version**
suggested automatically	*e.g. 00*
Document status (draft/…)	**• Date**
Draft / under review / approved	*DD.MM.YYYY*
• Client / operator	**• Contractor / author**
e.g. Sample Network Operator	*e.g. design office ElektroPlan Ltd*

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1 Key data

• Document number	*e.g. P-4711-UW-KST-001*
• Project phase	*e.g. concept phase / variant decision*
• Network levels	*e.g. 400/132 kV, 50 Hz*
• Transmission capacity	*e.g. 2 × 300 MVA, expansion to 3 × 300 MVA*
• Plant concepts	*e.g. AIS / GIS / H-GIS*
• Sites examined	*e.g. North Field, East Business Park, South Corridor*
• Recommended variant	*e.g. South Corridor / H-GIS*
• Processing status	*e.g. revision 01 of 23.10.2026*

The chapter texts are fully worded sample versions for the consistent sample project; adapt contents, values and responsibilities to the project.

2 Task and planning boundary conditions

Project P-4711 envisages a new 400/132 kV substation to strengthen the regional grid connection in the northern supply area. The plant is to accommodate two 400/132 kV transformers of 300 MVA each and be structurally expandable by a third transformer. The connection to the 400 kV transmission grid is made via two line systems; on the 132 kV side, six feeders are initially planned. The design takes into account the preliminary network calculations of the network planning department, the requirements of plant operation and the prospective expansion. The concept study assesses three site and plant variants with regard to technical suitability, permitting risk, area requirement, investment and implementation time.

- Planning objective: additional transformation capacity of 600 MVA
- Expansion reserve: third transformer with 300 MVA
- Operating concept: remote control from the network control center
- Security of supply: (n-1) check according to network planning
- Planning horizon: commissioning target year 2032

Parameter	Planning approach	Source	Status
Extra-high voltage	*400 kV; equipment 420 kV*	*Network planning P-4711*	*Provisional*
High voltage	*132 kV; equipment 145 kV*	*Network planning P-4711*	*Provisional*
Transformation	*2 × 300 MVA*	*Load flow study LF-01*	*To be confirmed*

3 Site options and land availability

For the new substation, the sites North Field, East Business Park and South Corridor were examined using a uniform set of criteria. North Field offers a short 400 kV connection but has an increased area requirement and conflicts with agricultural use. East Business Park has an industrial site that is suitable in principle, but requires longer line connections and additional noise protection measures. South Corridor is close to both voltage levels and allows a compact plant arrangement with expansion area. Land availability for South Corridor is assessed positively on the basis of non-binding owner information, but is not yet secured.

- Scope of review: ownership, land use, access and ground
- Check regional planning, land-use planning and protected areas
- Take line connections and protective strips into account
- Pre-assess noise, landscape and drainage
- Secure availability through a reliable land review

Site	Area	400 kV connection	Main risk	Assessment
North Field	*8,5 ha*	*approx. 0.8 km*	*Agriculture*	*Conditionally suitable*
East Business Park	*4,2 ha*	*approx. 3.1 km*	*Noise / route*	*Conditionally suitable*
South Corridor	*5,0 ha*	*approx. 1.4 km*	*Land acquisition*	*Preferred*

4 Plant concepts AIS, GIS and H-GIS

For the North Field site, an air-insulated outdoor switchgear (AIS) with conventional bay arrangement is examined. At the East Business Park site, a gas-insulated metal-enclosed switchgear (GIS) is considered, which has the lowest area requirement but requires a switchgear building and a more complex plant concept. For South Corridor, a hybrid solution (H-GIS) with compact switch bays and air-insulated connections to the transformers and line terminations is planned. The H-GIS variant allows a compact 400 kV arrangement and allows for later expansion without fundamental change to the plant layout. The final selection of switchgear technology requires a product-neutral technical specification and the review of available switching media.

- AIS: high area requirement, established outdoor technology
- GIS: small footprint, building and system integration required
- H-GIS: compact bays with air-insulated interfaces
- Assess switching medium including F-gas requirements
- Verify maintenance access and replacement routes

Feature	AIS	GIS	H-GIS
Arrangement	*Outdoor*	*Building*	*Outdoor / hybrid*
Area requirement	*High*	*Low*	*Medium*
Expandability	*Area-dependent*	*Module-dependent*	*Layout-dependent*

5 Voltage levels, transformation and grid connection

The basic technical concept comprises a 400 kV double busbar with two line bays, two transformer bays and one coupler bay. On the 132 kV side, a double busbar with initially six line bays, two transformer bays and one coupler is also planned. The two transformers each have a rated apparent power of 300 MVA and an adjustable voltage ratio of 400/132 kV. Operation in the event of failure of one transformer is verified separately on the basis of the relevant load cases and permissible overload conditions. Short-circuit strength, insulation coordination, reactive power demand and earthing are dimensioned in the preliminary design on the basis of the confirmed network parameters.

- 400 kV bays: 5 in initial expansion, 1 reserve for a third transformer
- 132 kV bays: 9 in initial expansion, 1 reserve for a third transformer
- Additional line reserves according to confirmed expansion concept
- Auxiliary power: provide redundant auxiliary supply
- Design protection and control systems according to TSO standards

Assembly	Initial expansion	Expansion reserve	Remark
400 kV switchgear	*5 bays*	*1 transformer bay*	*Double busbar*
132 kV switchgear	*9 bays*	*1 transformer bay*	*Double busbar*
Transformers	*2 × 300 MVA*	*1 × 300 MVA*	*Adjustable transformation*

6 Outline sizing and area concept

For the preferred South Corridor variant, a plot area of around 50,000 m² is assumed. Of this, roughly 16,000 m² are allotted to the switchgear areas, 9,000 m² to transformer locations including reserve and associated auxiliary plants and 8,000 m² to traffic and operating areas. The remaining 17,000 m² serve for landscaping, drainage, required clearances and further area reserves. The transformers are arranged with suitable collection and

retention facilities, fire protection clearances and secured transport routes. The area balance must be verified by a scaled site plan; manufacturer dimensions, protective clearances and ground requirements have not yet been fully taken into account.

- Plot size: approx. 5.0 ha
- Access via public road with heavy-load access
- Take transformer transport and set-up areas into account
- Secure route corridors for cables, lines and earthing system
- Keep the expansion area free of permanent third-party use

Area type	Approach	Share	Evidence
Switchgear	*16.000 m²*	*32 %*	*Preliminary layout V01*
Transformers / auxiliary plants	*9.000 m²*	*18 %*	*Preliminary layout V01*
Traffic, green areas, drainage, reserve	*25.000 m²*	*50 %*	*Area balance FB-01*

7 Variant assessment and decision matrix

The site and plant variants are compared using six weighted assessment criteria. The weightings were agreed for project P-4711 between network planning, project development and plant operation and add up to 100 %. Assessment is on a scale from 1 to 5, where 5 is the most favorable rating, and only variants that are technically suitable in principle are included in the comparison. The weighted total score is the sum of the products of individual rating and weighting share; site and plant concept are each assessed as a combined variant. With 4.00 out of 5.00 points, South Corridor with H-GIS achieves the highest value and is recommended as the preferred variant, subject to the open investigations.

- Rating scale: 1 = unfavorable, 5 = very favorable
- Weighted contribution = rating × weighting / 100
- Total score = sum of all weighted contributions
- Check reasons for exclusion separately before the utility value analysis
- Document the result on the basis of technical evidence and assumptions

Criterion	Weight	North Field AIS	Business Park GIS	South Corridor H-GIS
Grid connection / technology	*25 %*	*3*	*4*	*4*
Area / expandability	*20 %*	*3*	*5*	*4*
Investment	*20 %*	*4*	*3*	*4*
Permitting risk	*15 %*	*3*	*4*	*4*
Implementation time	*10 %*	*4*	*3*	*4*
Operation / maintenance	*10 %*	*3*	*3*	*4*
Overall assessment	*100 %*	*3.30*	*3.80*	*4.00*

8 Cost and schedule indication

The investment indication is based on a rough quantity estimate, project-related cost assumptions and benchmark values from comparable plant projects. For the South Corridor variant with H-GIS, investment costs of around €140m net result at 2026 prices, including defined incidental project costs and risk provision. The alternatives North Field with AIS and East Business Park with GIS are estimated at around €130m and €155m net respectively. The schedule framework envisages completion of the preliminary design in 2027, the subsequent permitting and procurement phases and commissioning in 2032. Costs and dates are conceptual estimates without firm quotations and will be updated on the basis of a consolidated work breakdown structure and schedule model before an investment decision.

- Cost basis: 2026 prices, net, excluding land acquisition
- Included in the cost estimate: primary technology, secondary technology, construction, installation, incidental project costs and risk provision
- Calculate external 400/132 kV line connections separately

- Cost uncertainty: according to the project cost estimating method (e.g. ±30 %)
- Critical schedule path: permit, transformer procurement and grid integration

Variant / milestone	Cost / schedule	Basis	Status
North Field / AIS	*€130m*	*Concept estimate*	*Provisional*
Business Park / GIS	*€155m*	*Concept estimate*	*Provisional*
South Corridor / H-GIS	*€140m*	*Concept estimate*	*Preferred variant*
Preliminary design completed	*Q4/2027*	*Master schedule*	*Planned*
Permits / building law	*Target Q4/2029*	*Master schedule*	*Uncertain*
Commissioning	*Target Q4/2032*	*Master schedule*	*Provisional*

9 Recommendation, decisions required and open points

On the basis of the preliminary technical, spatial and economic assessment, the South Corridor variant with 400/132 kV H-GIS is proposed as the preferred plant concept. It achieves the highest weighted score and, under the assumed boundary conditions, offers a favorable combination of space efficiency, expandability and operational suitability. Approval of the preliminary design is recommended, including ground investigation, further network studies, securing of the land and preliminary consultation with the authorities. The recommendation constitutes neither a building permit nor a technical execution approval or investment approval. The final variant decision must be confirmed after clarification of the remaining uncertainties regarding permits, network engineering and economics.

- Proposed resolution: approve South Corridor / H-GIS for preliminary design
- Open: securing of land – project development – Q2/2027
- Open: geotechnical report – civil design – Q3/2027
- Open: short-circuit and load flow check – network planning – Q2/2027
- Open: permitting route / environmental issues – permit planning – Q2/2027
- Open: switching media and supplier review – primary technology – Q3/2027

Decision	Proposal	Responsibility	Due date	Status
Preferred site	*South Corridor*	*Project management*	*Q1/2027*	*For approval*
Plant concept	*H-GIS 400/132 kV*	*Primary technology*	*Q2/2027*	*Provisional*
Preliminary design budget	*according to budget request*	*Project control*	*Q1/2027*	*Open*

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10 Approval criteria

No.	Test characteristic	Target / tolerance (source)	Evidence	Actual / finding	OK	In case of deviation
1	**Task and network requirement confirmed**	Grid connection requirement, voltage levels, capacity and expansion target agree with the approved network planning order.	Network planning order, load flow study	*2 × 300 MVA, network planning confirmation pending; expansion reserve provided*	☐	Correct the network parameters and repeat the outline sizing and variant assessment.
2	**Site alternatives examined traceably**	At least three realistic options or a justified smaller number; assessment according to site assessment plan.	Site profiles, site plans	*Three sites with main risks documented*	☐	Add missing site data and document reasons for exclusion.
3	**Plant concepts assessed comparably**	AIS, GIS and H-GIS assessed for identical functional scope and according to the technical requirements catalog.	Concept variants, single-line diagrams	*Three concepts with a uniform expansion target*	☐	Eliminate unequal scopes of services and standardize the assessment basis.
4	**Number of bays and area requirement checked for plausibility**	Bay balance and area total consistent; required reserves according to expansion concept (e.g. third transformer).	Bay list, preliminary layout, area balance	*5 + 9 bays; 5.0 ha including reserve*	☐	Correct layout, bay count and area balance; check effects on site selection.
5	**Assessment matrix arithmetically correct**	Weightings add up to 100 %; individual ratings 1–5; sum of weighted contributions arithmetically correct.	Assessment matrix with calculation	*100 %; preferred variant achieves 4.00 points*	☐	Correct the calculation, review the assessment and update the decision recommendation.
6	**Cost and schedule indication documented**	Uniform scope of services, price basis, exclusions, cost uncertainty and schedule assumptions according to project specifications.	Cost estimate, master schedule	*€140m net; target commissioning Q4/2032*	☐	Harmonize the cost basis, add missing services and disclose schedule dependencies.
7	**Risks and open points assigned**	Decision-relevant risks recorded with owner, measure and target date according to the risk management plan.	Risk list, measure tracking	*Six open points with responsibilities*	☐	Add missing measures and responsibilities; record the decision reservation.
8	**Decision technically ready for approval**	Recommendation justified; technical reservations named; review notes and approvals according to the project approval matrix.	Review notes, approval decision	*Preferred variant recommended for preliminary design*	☐	Defer approval and close out decision-relevant findings.

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11 Completion notes

- All project, site, area, assessment, cost and schedule values are sample data and must be replaced with project-specific values before use.
- The study serves to select a preferred variant; it does not replace network calculation, ground investigation, environmental assessment or specialist design suitable for permitting.
- H-GIS here denotes a hybrid switchgear concept; specific designs, insulating media and interfaces are to be defined by manufacturer and project.
- The cost assumptions are neither market prices nor binding procurement estimates. Comparability requires an identical scope of services and documented exclusions.
- Permitting route, environmental requirements, noise limits and technical design values must be defined according to project requirements and the responsible specialist planning.

12 Applicable documents

- Network planning order P-4711
- Load flow and short-circuit study LF-01
- Technical requirements catalog substation North
- Site profiles North Field, East Business Park and South Corridor
- Single-line diagram 400/132 kV, concept status
- Preliminary layout and area balance FB-01
- Variant assessment with calculation record
- Cost estimate, 2026 prices
- Master schedule P-4711
- Risk register and list of measures

13 Standards and regulations

Rules (edition)	Application in this document
BS EN 50522	Fundamentals of earthing design and assessment of step and touch voltages.
BS EN IEC 62271-1	Common specifications for high-voltage switchgear and controlgear.
BS EN IEC 62271-203	Technical requirements for gas-insulated metal-enclosed switchgear above 52 kV.
BS EN IEC 60071-1	Fundamentals of insulation coordination and selection of insulation levels.

The edition agreed in the project is authoritative; deviations in the contract or in the grid operator's technical specifications take precedence.

Approval / signatures

Role	Name	Date	Signature
Prepared: substation project development		*DD.MM.YYYY*	
Technically reviewed: network planning / primary technology		*DD.MM.YYYY*	
Operationally reviewed: substation operation		*DD.MM.YYYY*	
Reviewed: project management		*DD.MM.YYYY*	
Approved: TSO technical decision body		*DD.MM.YYYY*	

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Revision history

Rev	Date	Description	Author	Approval
00	*DD.MM.YYYY*	Initial issue (template)		

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