Product Overview

Enterprise Software Solution for Electrical Power Systems

ETAP® is the most comprehensive electrical engineering software platform for the design, simulation, operation, and automation of generation, transmission, distribution, and industrial systems.

As a fully integrated model-driven enterprise solution, ETAP extends from modeling to operation to offer a Real-Time Power Management System.
ETAP Base Package is a set of core tools, embedded analysis modules, and engineering libraries that allow you to create, configure, customize, and manage your system model. Core tools allow you to quickly and easily build 3-phase and 1-phase AC and DC network one-line diagrams with unlimited buses and elements including detailed instrumentation and grounding components.

**Embedded Analysis Modules**
- **Cable Ampacity**
- **Cable Sizing**
- **Cable Manager**
- **Transmission Line Constants**

**Application**
- 64-bit Application
- Local SQL Database Platform

**One-Line Diagram**
- Built-in intelligent graphics
- Automatic equipment connection mode
- Network nesting
- Integrated 1-phase, 3-phase, & DC systems
- Integrated AC, DC, & grounding systems
- Multiple generators & grid connections
- Display results on one-line diagrams
- Customizable font types, styles, & colors
- Customizable display of ratings & results
- Graphical display of equipment grounding
- Graphical alert of overstressed devices
- Hide & show protective devices & equipment grounding
- Propagation of nominal & rated voltage
- Propagation of phase connection
- Automatic display of energized & de-energized elements using dynamic continuity check
- Text box editor with dynamic link to properties
- OLE object & ActiveX control integration
- Intelligent text box & hyperlink bookmarks
- Customizable output reports via Crystal Reports
- Batch printing with view-dependent printer settings
- User-friendly plotting
- Keyword based element search
- Multiple display layers including anti-aliasing & transparency
- Orthogonal or diagonal equipment connections
- User-defined connector & symbol thickness
- Preview multiple equipment symbol sets
- Intelligent tri-state units for small or large equipment sizes
- MS Excel style data sorting & filtering
- Composite Network thumbnails
- Zoom & Pan windows
- Circuit tracing - source, load, point-to-point
- Color contouring based on results

**Auto-Build**
- Intelligent rule-based diagram creation & spacing
- Eliminate drag & drop
- Auto-build without leaving equipment palette
- Automatic alignment tools

**System Elements**
- Unlimited AC & DC elements
- 1-phase (2 & 3 Wire), 2-phase (2 & 3 Wire), 3-phase (3 & 4 Wire)
- Unlimited buses: license dependent at run-time
- Nested views (composite networks & MCC)
- Power grid
- Synchronous & induction generators
- Photovoltaic array (PV Interconnection Study)
- DC Photovoltaic array
- Wind Turbine Generator
- MOV, synchronous, & induction motors
- Excitors, governors, & stabilizers
- Voltage & frequency dependent lumped load
- Cable, line, reactor, & impedance branches
- 2W & 3W transformers with voltage regulators
- 2W & 3W transformers with buried delta winding
- Open-Delta transformer
- Remote connectors
- Harmonic filter
- Static Var Compensator (SVC)
- Instrument transformers (CT & VT)
- Protective devices & meters
- Single & double throw switches
- Grounding switch
- Bus duct
- Batteries, DC motors, DC loads & branches
- Battery Chargers, Rectifiers & Inverters
- Uninterruptible Power Supply (UPS)
- DC-DC converters
- Variable Frequency / Speed Drive (VFD / VSD)
- ANSI, IEC, & user-defined symbols
- Series Capacitor

**Switching Device Interlock Enforcer**
- Auto enforcement of switching interlock logics
- Automatic ‘pre’ & ‘post’ switching logic verification
- Interlock based on circuit breaker positions or meter readings
- Automatic interlock conflict checking
- Ability to model cascade switching control
- Active monitoring of switching interlock violations
- Switching plan validation

**Cable Manager**
- Batch cable management
- Customizable cable reports
- Multi-cable sizing & shock protection evaluation
- Intelligent search / filtering

**Configuration Manager**
- Tabulate & control different status configurations
- Compare source, load, & switching device status
- Flag changed data with checker capability
- Copy, merge, export, import, & print

**Data Manager**
- View / edit Base & Revision Data
- View equipment properties for individual fields
- View equipment State & Service
- Display & filter data based on study type
- Graphical data management & merge per individual equipment

**Theme Manager**
- Display color coding based on:
  - Phase
  - Voltage level
  - Area
  - Feeder
  - Grounding (Solid, Low-Z, High-Z, Ungrounded)
  - Earthing (TT, TN, IT, NEC)
- Display faulted buses by symbol or color
- Change result display precision per unit
- Apply theme to individual view or globally
- Decluttering options based on zoom levels

**Datablock**
- Customize input data & study results
- Display results, tags, and/or properties
- Define templates & share
- Automatically apply templates per device type
- Instant preview of Datablock

**One-Line Diagram Templates**
- Create & utilize unlimited one-line templates
- Template sharing
- Use default project ID or template ID
- Use properties from default project or templates
- Instant preview of templates

**Output Report Comparator**
- Built-in output report comparison tool
- Compare hundreds of study reports in one action
- Verify study results against benchmark reports
Base Package

Base Package includes an intelligent one-line diagram, element editors, verified and validated engineering device libraries, configuration manager, report manager, project and study wizards, multi-dimensional database, theme manager, data exchange, and user access management. Embedded analysis modules, such as Cable Ampacity, Cable Sizing, and Transmission Line Constants, provide integrated as well as stand-alone capabilities to design, analyze, and size equipment.

Multi-Dimensional Database
- Orthogonal multi-dimension database
- Unlimited independent graphical views
- Unlimited status configurations
- Unlimited property revisions
- Multiple loading & generation conditions
- Lock & unlock element properties
- Multiple States to track equipment conditions
- Utilize real-time operating data
- Unlimited study solutions
- ODBC – MS Access, SQL Server connectivity
- Dumpster with unlimited cells: copy & paste
- User access security with password protection
- Edited-by & checked-by with date stamping
- Merge project files via clipboard

Project Management
- Manage studies with scenarios & macros
- Record scenarios based on study settings
- Macro-controlled scenario execution
- Automatically compare & verify plots
- Export output data & plots to MS Excel
- Dynamic update of preferences

License Manager
- Stand-Alone
- Concurrent User LAN & WAN
- Network license checkout
- License borrowing manager
- Flexible license borrowing duration
- License configuration wizard

Libraries
- Comprehensive library (over 100,000 devices)
- ANSI & IEC devices libraries
- Verified & Validated (V&V) library data
- V&V locked data
- Add, copy, merge, & delete capabilities
- User-defined & controlled libraries
- User-access control & security
- Edited-by & checked-by with date stamping
- User-controlled library merge

Network Simulation
- Unlimited buses (license dependent) & elements
- Looped & radial systems
- Automatic error checking
- User interface for all network analysis modules
- Customizable ETAP preference properties
- Multi-level user access management

Built-In Calculators
- MVA, MW, Mvar, kV, Amp, & PF conversion
- Motor nameplate & dynamic parameter data
- Generation nameplate
- Power grid short circuit impedances
- Motor & generation inertia

System Manager
- Project equipment & study summary in one convenient location
- Distribution Load Flow alert summary
- Switching Optimization summary
- Fault Management summary
- Contingency Analysis summary

Plot Manager*
- Stand-alone application to view ETAP plots
- Load plots from multiple projects
- Compare plots from multiple studies
- Save plot style as templates
- Zoom, pan, crosshair & many more functions
- Customize legend, grid lines, plot options, etc.

Data Exchange (DataX) Base
- Legacy program conversion to ETAP
- Automatic one-line creation
- Protective device library mapping
- Convert using native file formats
- Database conversion from legacy software
- WMF / EMF / DXF / PDF exporting
- Import RAW / IEEE / CSV files
- Export to AutoCAD using DXF format
- Import ground grid plans from AutoCAD
- Load Ticket for induction machines
- Import SKM project files
- Import EasyPower project files

Report Manager
- Customizable output reports & plots
- Input, results, alerts, & summary reports
- Reports via Crystal Reports viewer
- PDF, Microsoft Word, & Excel reports
- Element ID & text search capability
- Multi-Language Report

Download a Free Demo at etap.com
Network Analysis includes a powerful set of analytical tools that allow for simulation, prediction, design and planning of system behavior utilizing an intelligent one-line diagram and the flexibility of a multi-dimensional database. Network Analysis includes Arc Flash, Short Circuit, Load Flow, Motor Acceleration, and Load Analyzer modules.

**Network Analysis**

**Load Flow**
- Power flow & demand load
- Voltage drop & power factor correction
- Automatic device evaluation
- Automatic temperature correction
- 2W & 3W transformer LTC / regulator actions
- Real & reactive power losses
- Extensive violation alerts
- Multi-report Result Analyzer
- Auto-Run load flow based on system changes
- Adaptive Newton-Raphson method
- Fast convergence for systems with negligible impedance

**Short-Circuit - ANSI / IEEE**
- ANSI / IEEE C37 Standards
- IEEE 141 & 399 Standards
- UL® 489 Standard
- Integrates with protective device coordination
- Automatic device evaluation for 3-phase, 1-phase, & panel systems
- Generator circuit breaker evaluation
- Phase-shifting transformer
- Load terminal short circuit calculation
- Multi-report Result Analyzer

**Short-Circuit - IEC**
- IEC 60909, 60282, 60781, & 60947 Standards
- Transient fault analysis - IEC 61363 Standard
- Integrates with protective device coordination
- Automatic device evaluation for 3-phase, 1-phase, & panel systems
- User-definable voltage c factor
- Load terminal short circuit calculation
- Multi-report Result Analyzer

**Motor Acceleration**
- Dynamic motor acceleration
- Voltage flicker
- Motor & load dynamic models
- Static motor starting
- Multi-sequence starting
- Conventional starting devices
- Soft starter devices
- VFD frequency control motor starting
- Load & generation transitioning
- Motor Operated Valve (MOV) simulation
- Comprehensive alarm & warning
- Start motor individually or based on groups
- Consider individual or global bus voltage alert limits

**Panel Systems**

**Panel ANSI & IEC**
- Intelligent panel design & analysis
- 3-phase (3 & 4 Wire) panels
- 1-phase (2 & 3 Wire) panels
- 1-phase (A, B, C, AB, BC, CA, & 3 Wire) panels
- ANSI & IEC Standards
- National Electric Code load factors
- Load flow with graphical per phase display
- Automatic device duty evaluation & alerts
- Automatic updating of upstream panels
- Export panel schedules to Microsoft Excel
- Panel with internal & external feeders & loads

**AC Arc Flash**
- CSA Z462 2008 Standard
- ASTM D 120-02a Standard
- OSHA 29 CFR 1910 Standard
- National Electric Code® (NEC) 110.6
- National Electric Safety Code® (NESC)
- Embedded short circuit & device coordination
- 3 & 1-phase Arc Flash Sequence-of-Operation
- Graphical display of device trip sequence
- Automatic verification of device duty
- User-defined incident energy correction factor
- Current Limiting Fuse (CLF) modeling
- Incident Energy plots
- LV transformer arc flash limit
- Maintenance mode switch
- Relay actions (49, 50, 51, 67, 79, 87)
- Panels & single-phase systems
- Multi-report Result Analyzer
- Labels, work permits & data sheets

**DC Arc Flash**
- Maximum Power Method
- Stokes & Oppenlander Method
- Paukert Method
- Determine incident energy
- Assess arc flash protection boundary
- Arc Flash Viewer
- Multi-report Result Analyzer
- Labels & work permits

**Reduce Risk, Improve Safety, Enforce Compliance**
Star - Coordination & Selectivity
- AC & DC coordination
- Graphically adjustable device settings
- Extensive device library (verified & validated)
- Embedded short circuit analysis
- Embedded motor acceleration analysis
- Multi-axis time current curves
- Comprehensive plot options
- Adjustable magnifying-glass zoom view
- Time difference calculator
- Multi-function / level relays
- Device setting reports
- Automatic detection of protection zones
- Protection & coordination zone viewer
- Screen capture utility
- Library enhancements
- Relay test set interface
- Export to COMTRADE format

Sequence-of-Operation
- View device operation sequence graphically
- Device failure & backup operation
- Sequence viewer
- Normalized (shifted) curves
- Current summation
- Relay actions (27, 49, 50, 51V, 59, 79, 87)

Star - Auto Protection & Coordination
- Automated evaluation of zones for overcurrent protection & coordination
- Reference Rule Book for evaluation
- Automated display of TCC curves & equipment damage curves
- Automatic selection of worst case fault location
- Tabular presentation of evaluation results
- Dynamic update of the evaluation results
- Summary of protection evaluation results
- Study result report in spreadsheet format

StarZ Distance Relay Protection*
- In-depth evaluation of impedance relays
- Characteristic Plotting
- Single & Sliding Fault Analysis
- Voltage & Current Injection Testing
- User-Editable Scheme Logic
- Distance Relay Element & Library
- Automatically calculate voltage & current injection based on line parameters
- Fault distance versus fault resistance plotting

Transient Stability
- Synchronous & induction machine models
- Comprehensive excitation system models
- Comprehensive governor-turbine models
- Power System Stabilizer (PSS) models
- GE, Westinghouse, & Solar gas turbines
- User-Defined Dynamic Models (UDM)
- Unlimited Sequence-of-Events & actions
- Typical & common disturbances & operations
- Automatic actions based on relay settings
- Short-time & long-time simulation
- Variable total simulation time & simulation step
- 3-phase & line-to-ground fault actions
- Auto-sync check action
- Embedded Newton-Raphson initial load flow
- VFD / VSD dynamic modeling
- Lumped Load user-defined dynamic modeling
- UPS parallel operation modeling
- PV Array source modeling
- Inverter source modeling
- Automatically compare & verify plots

Generator Start-Up
- Cold-state generator starting
- Load generators prior to synchronous speed
- Frequency-dependent machine models
- Frequency-dependent network models
- An expansion to the Transient Stability module
- User-defined dynamic model interface

User-Defined Dynamic Model
- Full graphical model builder
- Library of pre-built models
- Integrated with transient stability models
- Wide variety of blocks for building models
- Import & Export Simulink® models
- Various model testing methods
- Real-time compiling & linking of model
- Automatic UDM links to components
- Compile & test directly from the UDM builder

Motor Parameter Estimation & Tuning
- Estimate induction machine equivalent circuit parameters based on readily available manufacturer data
- Single-cage models
- Rotor deep-bar effects

Dynamic Parameter Estimation & Tuning
- Tune dynamic models w/ multiple inputs & outputs
- Estimate model parameters using field measurements
- Utilize UDM to build custom models
- Combinations of Models: Generators, Governors, Exciters, PSS, etc.
- Utilize field data from recorders & PMUs
- Compliance with NERC MOD Standards
- Automatically exclude data errors & noise
- Multi-objective stochastic optimization method
- View parameter sensitivity
- DPET Result Analyzer for comparing multiple estimation results
Reliable Ampacity & Sizing
- IEEE 399
- NFPA 70 - National Electric Code
- IEC 60364-4-40
- IEC 60364-4-43
- IEC 60364-5-52
- IEC 60502-2
- BS 7671, British Standard
- NF C 15-100, French Standard
- Ampacity / Current Carrying Capacity Calculator
- Sizing based on ampacity, voltage drop, short circuit, harmonics, & overload protection
- Maximum or average operating current
- Armor & Sheath thermal calculation
- Grounding conductor selection based on NEC
- Cable Library with neutral, grounding / protective earthing (PE) conductor
- Add auxiliary neutral & PE conductors
- Optimal & alternative sizes
- Model Forms: BS & user-definable
- Reports in Crystal Reports & Excel

Underground Thermal Analysis
- Neher-McGrath Method
- IEC 60287 Standard
- Steady-state temperature
- Ampacity optimization
- Automatic cable sizing
- Transient temperature
- Intelligent rule-based alignment & spacing tools
- Automatic conduit distribution & spacing
- Uniform & non-uniform conduit arrangements
- Custom, NEC, or IEE rule-based spacing
- Wizard for creating raceways

Cable Pulling
- Integrated with one-line diagram cables
- Integrated with underground raceways cables
- Pull multiple cables
- Completely flexible pull geometry
- Full ETAP cable library integration
- Display 3-D pulling path geometry

Ground Grid Systems
- Finite Element Method
  - 3-D plots for step, touch, & absolute potentials
  - 3-D irregular configurations
  - 3-D graphical interface views
  - Rods & conductors in any direction
  - Graphical display of over limits
- IEEE 80 & 665 Standards
  - Conductor & rod optimization
  - 3-D graphical interface views

Quickly & Easily Evaluate Results & Make Decisions
Integrated

**Power Quality**

- **Harmonic Load Flow**
  - IEEE 519 Standard
  - Harmonics spectrum up to 250th order
  - Automatic distortion evaluation (THD & IHD)
  - Telephone influence factors (TIF & I*TR)
  - Calculate & report I*TB (Balanced) & I*TR (Residual)
  - VFD harmonic modeling
  - UPS AC input & output modeling for harmonic orders
  - PV Array modeling for harmonic orders
  - Automatic alerts of violations
  - Harmonic sources library
  - Embedded Adaptive Newton-Raphson Method
  - Embedded Accelerated Gauss-Seidel Method

- **Interharmonics**
  - Interharmonic modeling & simulation
  - Perform voltage flicker limitation studies
  - Interharmonic distortion indices calculation based on IEC 61000-4-7
  - Adjustable harmonic current base
  - Automatic harmonic spectrum generation
  - Automatic interharmonic frequency generation

- **Frequency Scan**
  - User-definable frequency range
  - Resonance condition identification & alerting
  - User-customizable plots

- **Harmonic Filters**
  - Filter design & sizing
  - Single-tuned, high-pass, & band-pass filters
  - Automatic filter overloading alert
  - Interharmonic filter modeling

**Load Flow**

- IEEE 946 Standard
- Integrated AC & DC systems
- Embedded Newton-Raphson Method
- Voltage drop
- Power losses
- Battery auto-activation
- Charger / UPS current limit
- Charger / UPS mode auto-switching
- DC converter modeling
- Motor model auto-switching

**Short Circuit**

- IEEE 946 Standard
- Integrated AC & DC systems
- Total bus & branch contribution fault currents
- Fault current rising time
- Battery modeling per ANSI / IEC Standard
- Charger modeling per ANSI / IEC Standard

**Battery Discharge & Sizing**

- IEEE 308, 485, & 946 Standards
- Integrated AC, DC, & Control System Diagram
- Battery discharge simulation
- Battery sizing
- Discharge via DC load flow or duty cycle summation
- Voltage drop & loss consideration
- Class 1E DC power & control system models
- Simulation of control system with battery discharge voltage
- Duty cycle diversity factor
- Load model type per operating characteristics
- Battery duty cycle calculated from individual loads
- Options for battery & load duty cycle 1 minute span
- Multiple user selected options for battery characteristic interpolation
- Multiple diversity & correction factors
- Battery sizing report in IEEE 485 Standard format
- Plot battery capacity, voltage, & current
- Plot bus voltage & load & branch flow
- Detailed battery library

**Transformer**

- **MVA Sizing**
  - Sizing based on connected or operating load
  - ANSI & IEC standard types, classes, & ratings
  - Considers ambient temperature, altitude, load growth, & load factors
  - MVA Sizing based on cooling stages

- **Tap Optimization**
  - ANSI / IEEE C57.116 Standard
  - Optimize unit transformer turns ratio
  - Considers system voltage variation
  - Considers generation station auxiliary load
  - Generator reactive capacity vs. voltage plots
DataX Plus

Microsoft® Excel Interface
- Bi-directional Excel data exchange (Open & Fixed Formats)
- Map Excel worksheets to ETAP elements
- Synchronize data to ETAP projects
- Perform consistency checks during data exchange
- Substitute missing information with ETAP defaults & library data

Bi-directional Excel data exchange
• Map Excel worksheets to ETAP elements
• Synchronize data to ETAP projects
• Perform consistency checks during data exchange
• Substitute missing information with ETAP defaults & library data

Project Merge
- Parallel ETAP project development
- Merge Base & Revision Data
- Merge TCCs Views
- Multi-user management of project merge

Universal Mapping*
- User defined properties & elements to map any 3rd party electrical package
- Map ETAP elements & properties for Import & Export
- User-defined logics & functions as part of the mapping for electrical attributes
- Incorporates mathematical functions & simplified C# language based logics
- Intelligent functions based on the required attributes for mapping
- Categorization of power system devices for easy recognition

MultiSpeak Interface*
- Import & export power system data using MultiSpeak XML standard
- User-Defined Mapping of elements & properties using Universal Mapping
- Supports MultiSpeak v3.0 & v4.0

Common Information Model (CIM)*
- Import & Export data from ETAP using CIM XML
- User-Defined Mapping of elements & properties using Universal Mapping
- IEC 61970 standard
- IEC 61968 standard

Import from Legacy Software
ETAP offers conversion tools from other power system analysis software that will automatically generate a multi-layered graphical one-line diagram in conjunction with the electrical data and associated TCC studies.

SmartPlant® Electrical Interface
- Bi-directional data exchange
- Map attributes of SPEL with ETAP elements & properties using Universal Mapping
- Looped / radial system connectivity

AVEVA Electrical™ Interface
- Bi-directional data exchange
- Map attributes of AVEVA Electrical with ETAP elements & properties using Universal Mapping
- Looped / radial system connectivity

e-DPP® Interface
- Map attributes of e-DPP to ETAP elements
- Synchronize e-DPP data to ETAP projects
- Database mapping via graphic user interface

ESRI ArcGIS™ Import & Export
- Import ESRI ArcGIS electrical information
- Map ArcGIS attributes with ETAP elements & properties
- Database mapping via graphic user interface
- Export ETAP GIS electrical data to XML

GIS Map
- Intelligent Geospatial Diagram
- Display analysis results on GIS maps
- Synchronize GIS data to ETAP projects
- Graphical user interface for data mapping
- Control modification & accept / reject actions
- Check consistency for data synchronization
- GIS handling of 1-phase systems
- Synchronize GIS with single-line diagram
- Include transmission & distribution networks
- Run studies for millions of customers directly on GIS Map
- Supports millions of electrical components
- Geospatial graphics using multiple layers
- ETAP MapServer for background map tiles
- Automatic network reduction
- Circuit Tracing & Distance Measurement

Feeder & Substation Diagram
- Electrical GIS diagram synchronized with graphical feeder & substation diagram
- Model 1,000s of components as an equivalent feeder
- Millions of electrical junctions convert to 1,000s of buses making the system solution fast & manageable

Data Manager
- Display & locate elements with incorrect electrical parameters
- Graphical select & view properties for multiple devices in a spreadsheet format
- Reconductoring & Rephasing
- Sorting, Filtering & Find & Replace functions

Circuit Tracing & Distance Measurement
- Trace route upstream & downstream
- Trace route to source & laterals
- Trace route from point to point
- Trace GIS & Active Feeder
- Measure distance between elements
- Measure distance for selected elements
- Measure total feeder length

Multi-Language Editions

English ✓ ✓
Chinese ✓ ✓
Japanese ✓ ✓
Russian ✓ ✓
Spanish ✓ ✓
Portuguese ✓ ✓
Korean ✓ ✓
German ✓

Localized Output Reports in Every Release

Data Exchange

Microsoft® Excel Interface
• Bi-directional Excel data exchange (Open & Fixed Formats)
• Map Excel worksheets to ETAP elements
• Synchronize data to ETAP projects
• Perform consistency checks during data exchange
• Substitute missing information with ETAP defaults & library data

Project Merge
• Parallel ETAP project development
• Merge Base & Revision Data
• Merge TCCs Views
• Multi-user management of project merge

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• User defined properties & elements to map any 3rd party electrical package
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• Intelligent functions based on the required attributes for mapping
• Categorization of power system devices for easy recognition

MultiSpeak Interface*
• Import & export power system data using MultiSpeak XML standard
• User-Defined Mapping of elements & properties using Universal Mapping
• Supports MultiSpeak v3.0 & v4.0

Common Information Model (CIM)*
• Import & Export data from ETAP using CIM XML
• User-Defined Mapping of elements & properties using Universal Mapping
• IEC 61970 standard
• IEC 61968 standard

Import from Legacy Software
ETAP offers conversion tools from other power system analysis software that will automatically generate a multi-layered graphical one-line diagram in conjunction with the electrical data and associated TCC studies.
ETAP GRID™ Distribution is an integrated power system simulation, planning, protection, and real-time distribution management system software for visualizing, managing, optimizing and automating distribution networks from state-wide to city-wide power distribution networks.

System Elements*
- Distribution segment & junctions
- Distribution feeders, lines & cables
- Substations & Switching Stations
- Jumper, cut, open point & splice
- Distribution transformers – pole, pad & vault
- Open delta transformer
- Fuse links & fuse cutouts
- Load break switches
- Switched shunt capacitor banks
- Distribution line pole configurations
- Distribution line constants calculation
- Distributed load
- Spot load
- Numerical relays including overcurrent relays & distance relays
- Multiple generator dynamic models
- Complete synchronous & induction machine models
- Comprehensive dynamic load modeling
- Comprehensive excitation system & turbine/engine-governor models
- AC & DC Photovoltaic & inverter modeling
- Voltage regulators
- Phase shifting transformers
- Multiple types of harmonic filters

Unbalanced Load Flow
- Single-phase & unbalanced 3-phase modeling
- Unbalanced & nonlinear load modeling
- Open-delta transformer modeling
- Center-tap transformer modeling
- Three 1-phase transformer modeling
- Isolated sub-systems with voltage-control source modeling
- Isolated 1-phase source & system modeling
- Series fault or open phase condition modeling
- Phase & sequence voltage, current, & power
- Voltage & current unbalance factors
- Transmission line coupling
- Automatic device evaluation
- Report voltage & power in multi-units
- Optimized for multi-core CPU

Time Domain Unbalanced Load Flow*
- Loading & generation profile library
- User-defined profile intervals (hr or min)
- Create standard profiles such as “8760 profile”
- Seasonal variations including holidays
- Multi-year load growth
- Mixed customer classes or composite sectors
- Simulate daily, monthly or yearly output from PV farm
- Place devices in or out of service during the planning period
- Plot power generation, consumption, losses, & energy demand for a specified period

Unbalanced Short Circuit*
- Include prefault loading
- Shunt faults – 3PG, 3P, LL, LG, LLG
- Series faults – A, B, C, AB, BC, CA, ABC
- Simultaneous fault
- Display phase or sequence results on one-line

Switching Optimization*
- Improve system losses
- Minimize voltage violations
- Minimize overload
- Balance feeder loads
- Graphically display recommended switching operations
- Network summary before & after optimization
- Automatic creation & saving of optimal switching configuration
- Optimal switch placement

Single-Phase Distribution
- ANSI & IEC Standards
- Load flow with graphical per phase display
- Voltage drop & power losses
- Voltage & current unbalance factors
- Automatic device duty evaluation & alerts

Fault Location, Identification, Isolation & Service Restoration*
- Identify & locate faults based on waverforms
- Identify fault types - 3P, LL, LG, LLG, etc.
- Predict location based on customer outages
- Single or consecutive faults
- Identify isolation points based on protective device location
- Restoration based on multiple objectives: minimize power losses, minimize overloading, optimize voltage
- Automatically create & test network topology configuration
- Looped & radial systems

Voltage Stability*
- Sensitivity Analysis
- Modal Analysis (Eigenvalue Analysis)
- PV QV Analysis or Continuation Load Flow Analysis
- P-V curves, V-Q curves, dV/dQ self-sensitivities
- Eigenvalues, eigenvectors
- Bus, branch & generator participation factors
- Minimum distance to instability
- Graphical results & plots

Optimal Capacitor Placement
- Optimal location & bank size
- Minimize installation & operation costs
- Individual source or average energy cost
- Voltage & power factor objectives
- Minimum, maximum, & average loading
- Branch capacity release & cost savings
- Review capacitor impact on the system
- Capacitor control method
- Flexible constraints

Volt / Var Optimization & Control*
- Solve multiple objectives simultaneously
- Conservative voltage reduction
- Optimize voltage profile
- Minimize losses
- Determine voltage regulator & switched capacitor setpoints
- Optimal voltage regulation placement
- Looped & radial systems

Reliability Assessment
- System reliability
- Customer oriented indices
- Energy (cost) indices
- Sensitivity analysis
- Single & double contingency
- Looped & radial systems
ETAP GRID™ Transmission provides an intelligent Network Topology Builder integrated with ETAP’s Base and Network Analysis modules such as Transmission Line Model, SVC Model, HVDC Link, Load Flow, Fault Analysis, Capacitor Placement, Dynamic Stability, Reliability Assessment, Distance Protection, Substation Automation, Energy Management, and eSCADA system.

### Transmission Systems

#### Line Constants
- Conductor & ground wire libraries
- Built-in configurations: horizontal, vertical, etc.
- General configuration: X, Y, & Z coordinates
- Multi-line mutual coupling
- Phase & sequence impedance matrix
- Transposed & un-transposed lines
- Short & long line models
- Multiple layer soil model
- Calculated or user-defined impedances

#### Line Ampacity
- Conductor ampacity vs. temperature
- IEEE 738 Standard
- Determine maximum operating temperature for various loading conditions
- Derated ampacity based on temperature limit
- Consider weather, solar heat, & geographical location

#### Optimal Power Flow
- Solve multiple objectives simultaneously
- Interior point method with barrier functions
- Minimize power losses
- Active power optimization
- Reactive power optimization
- Optimal dispatch

#### Sag & Tension
- Sag / tension vs. temperature
- Multiple spans between dead-end structures
- Level spans of unequal length
- Solve spans of unequal length on different horizontal planes
- Include effects of wind, temperature, & k factor

#### HVDC Transmission Link
- Detailed rectifier & converter modeling
- Composite AC / DC & DC / AC systems
- Built-in control schemes
- Inclusive transformer model
- Automatic harmonic spectrum calculation
- Easy-to-use integrated model
- VSC-HVDC model*

### The future of power systems engineering & operation - today

### eTraX™ - Rail Traction Systems*

ETAP Traction Power software includes the most accurate, highly developed, and flexible software tools for analyzing and managing LV and MV rail power systems. eTraX provides a state-of-the-art design and management solution for the electrical network life-cycle of the rail traction power system.

#### Rail Traction Power
- Traction substation capacity planning based on existing or planned train operations
- Evaluate energy demand & cost using various train timetables
- Centralize GIS, planning, protection & operations in single application
- Traction power supply design, configuration & equipment ratings
- Determine impact of various rolling stock
- Determine capacity restrictions & analyze mitigation methods
- Determine impact of unplanned events on traction power system using real-time data
- Geospatial asset information for overhead catenary system synchronized with one-line diagram
- Traction power equipment templates
- Unbalanced load flow simulation for 1-phase 2 or 3 wire systems

#### Elements
- Track & node
- Traction substation
- Train station & platform
- Section insulator, insulated overlap, PTFE & isolator
- Auto & booster transformers
- Signal, speed limit, level crossing markers
- Distance, elevation & bend radius markers

#### Interface
- Equipment warehouse
- Railway track
- Overhead catenary
- Route editor
- Timetable editor

#### Analysis
- Train Performance Calculation
- Time Domain Unbalanced Load Flow
- Unbalanced Short Circuit
ETAP Real-Time™ technology allows you to predict, control, visualize, optimize, summarize and automate your power system. Distributed and web-based technologies provide the tools to make informative decisions based on planned or unplanned events from any location.

**SCADA & Monitoring**

<table>
<thead>
<tr>
<th>Model-Driven Power Management Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Common network connectivity model</td>
</tr>
<tr>
<td>• Integrated SCADA functionality</td>
</tr>
<tr>
<td>• Smart Grid &amp; Microgrid Master Controllers</td>
</tr>
<tr>
<td>• Real-Time decision making applications</td>
</tr>
<tr>
<td>• Predictive Simulation &amp; Optimization</td>
</tr>
<tr>
<td>• Operator training simulator</td>
</tr>
<tr>
<td>• Online &amp; archive data trending</td>
</tr>
<tr>
<td>• Web-based SCADA architecture</td>
</tr>
<tr>
<td>• Built-in server redundancy platform</td>
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<tr>
<td>• Integrated historian for both data &amp; events</td>
</tr>
<tr>
<td>• Integrated alarm &amp; event management</td>
</tr>
<tr>
<td>• Wide array of standard drivers</td>
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<table>
<thead>
<tr>
<th>Network Connectivity Analysis</th>
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</thead>
<tbody>
<tr>
<td>• Network topology builder &amp; processor</td>
</tr>
<tr>
<td>• Intelligent graphical user interface</td>
</tr>
<tr>
<td>• Multiple model views: logical &amp; geospatial</td>
</tr>
<tr>
<td>• Color coding based on network state</td>
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<tr>
<td>• Graphical display of results &amp; abnormal conditions</td>
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<tr>
<td>• Foundation of real-time applications</td>
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<thead>
<tr>
<th>SCADA Integrator</th>
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<tbody>
<tr>
<td>• Quick creation of standardized &amp; reusable templates</td>
</tr>
<tr>
<td>• Human Machine Interface (HMI)</td>
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<tr>
<td>• template library</td>
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<tr>
<td>• Efficient system integration &amp; rapid deployment</td>
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<table>
<thead>
<tr>
<th>Native Communication Protocols</th>
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<tbody>
<tr>
<td>• Wide array of standard drivers</td>
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<tr>
<td>• Direct Modbus RTU &amp; TCP communication</td>
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<tr>
<td>• Direct DNP3 communication</td>
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<tr>
<td>• Automatic download of COMTRADE &amp; SOE files</td>
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<tr>
<td>• Integrated historian for both data &amp; events</td>
</tr>
<tr>
<td>• Integrated alarm &amp; event management</td>
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<table>
<thead>
<tr>
<th>IEC 61850 Substation Automation</th>
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<tbody>
<tr>
<td>• Direct IEC 61850 connectivity from ETAP Server</td>
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<tr>
<td>• IEC 61850 environmental compliant gateway for distributed control &amp; data collection</td>
</tr>
<tr>
<td>• Automatic download of ICD &amp; CID configuration files</td>
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<tr>
<td>• Automation logic</td>
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<tr>
<th>Visualization &amp; Dashboards</th>
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<tbody>
<tr>
<td>• Thin client based monitoring &amp; control</td>
</tr>
<tr>
<td>• WPF dashboards &amp; views</td>
</tr>
<tr>
<td>• Automatically generate electrical diagrams from ETAP views</td>
</tr>
<tr>
<td>• Intelligent web graphical user interface</td>
</tr>
<tr>
<td>• Geospatial maps for situational awareness</td>
</tr>
<tr>
<td>• Configurable web interface &amp; control</td>
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<tr>
<td>• Alarm &amp; warning displays</td>
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<tr>
<td>• Customizable trending</td>
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<tr>
<td>• Flexibility to create “what if” scenarios</td>
</tr>
<tr>
<td>• Execution of ETAP scenarios remotely</td>
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<tr>
<td>• Process &amp; performance monitoring</td>
</tr>
<tr>
<td>• Multi-state breaker monitoring &amp; control</td>
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<thead>
<tr>
<th>Web &amp; Mobile Views</th>
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<tbody>
<tr>
<td>• Safe &amp; secure communication</td>
</tr>
<tr>
<td>• User &amp; machine Access Management</td>
</tr>
<tr>
<td>• Perform “what if” simulations remotely</td>
</tr>
<tr>
<td>• Customizable views</td>
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<tr>
<th>Data Trending</th>
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<tbody>
<tr>
<td>• User-friendly and flexible trending application</td>
</tr>
<tr>
<td>• Supports real-time and archived data trending</td>
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<table>
<thead>
<tr>
<th>Alarming &amp; Notification</th>
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<tbody>
<tr>
<td>• Prioritizes events via graphical and tabular views</td>
</tr>
<tr>
<td>• Enables early detection &amp; announcement of problems</td>
</tr>
<tr>
<td>• Alerting for non-telemetered devices</td>
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<table>
<thead>
<tr>
<th>Event Logging</th>
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</thead>
<tbody>
<tr>
<td>• Event log of all activities in the system to the nearest millisecond</td>
</tr>
<tr>
<td>• Complete history of power system’s operation when played back</td>
</tr>
<tr>
<td>• Retrieve sequence of equipment operation and maintenance records</td>
</tr>
<tr>
<td>• Tabular or graphical views - hourly, daily, monthly, or yearly basis</td>
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**Mission critical power management solutions from modeling to operation**

- **IEC 61850**
- **OPC**
- **Modbus**
- **OPC UA**
- **DNP3**

Direct connectivity to any industry compliant system
ETAP Real-Time

**State Estimation & Load Allocation**
- Dependable and fast convergence unobservable subsystems
- State-of-the-art techniques
- Includes essential tools for model validation
- Compare telemetry, estimation, and power flow results

**Predictive Simulation**
- Simulate circuit breaker operation
- Identify potential operating problems
- Simulate motor starting & load change
- Predict operating time of protective devices
- Predict system response based on operator actions
- Perform “what if” operating scenarios
- Web-based simulation & alerts
- Simulate real-time & archived data
- Operator assistance & training

**Preventive Simulation**
- Automated alarms based on events that may potentially occur
- Suggest remedial actions

**Operator Training Simulator**
- Dynamic graphical simulation of the power system
- Simulate sequence-of-operation using real-time data
- Explore Alternative Actions
- Virtual test of operator / controller actions

**Event Playback**
- Replay archived historian data
- Investigate cause & effect
- Explore alternative actions
- Replay “what if” scenarios
- Playback of event views
- Historical alarm database

**Energy Accounting**
- Energy tariff builder
- Customizable reports
- Real-time energy cost tracker
- Cost & consumption summary

**Automatic Generation Control**
- Multi-area control
- Load frequency control
- Minimize Area Control Error (ACE)
- MW & Mvar sharing
- NERC performance standard

**Economic Dispatch**
- Incremental generator heat-rate
- Generation constraints
- Minimize fuel costs
- Optimize energy costs
- Detailed nonliner cost functions
- Fast solution
- Robust algorithms

**Unit Commitment**
- Real-Time validation & optimization
- Forecast based commitment
- Maintenance schedules

**Interchange Scheduling**
- Tariff analyzer
- Rate structure builder
- Transaction scheduling
- Transaction contract
- Transaction reports
- Fuel cost schedule reports

**Reserve Management**
- Operating reserve analysis
- Reserve capacity monitoring
- Notification of inadequate reserve
- Predict operating reserve

---

**Power Management**

**Generation Management**
Energy Management

Network Security Analysis
- Online security analysis
- Situational awareness support
- Perform “what if” operating scenarios
- Contingency Analysis, Short Circuit Analysis, Voltage Stability, etc.

Equipment Outage Scheduling
- Schedule equipment outages and consider in network security
- Generators, transmission lines, transformers, breakers, switches, loads, and compensation devices
- Schedule equipment derating

Supervisory Control
- System optimization
- Supervisory & advisory control system
- Optimal power flow
- Programmable logic editor

Economic Dispatch
- Minimize fuel costs
- Optimize energy costs
- Consider network security constraints
- Robust algorithms

Substation Automation
- Flexible automation
- Programmable logic editor
- Online control
- Remote control - enable & disable commands
- Control inhibition based on system operational constraints

Switching Management
- Switching sequence management
- Safety & security procedures
- Interlock logic evaluator
- Switching plan validation
- Control inhibition based on switching operations
- Safety ground switch
- Pre-switch & post-action interlock
- Enforced interlock logic in simulation mode
- Supervisory control for real-time switching operation

Load Management
- Demand-side management
- Time-of-use load shifting
- Intelligent load management

Intelligent Substation

Load Preservation
- Steady-state & transient response
- Optimal load preservation
- Fast response time
- Reliable operation
- Minimum load shedding
- Proactive contingency analysis
- System islanding logic
- VFD load reduction control

System Restoration
- Restart inhibition
- Logical load sequencer
- Load & source restoration priority

Load Shedding Validation
- Automatic generation of transient study cases
- Confirm load shedding actions
- Simulate ILS recommendation
- Integrated stability knowledge base

Intelligent Load Shedding

Faster than Real-Time
ILS dynamically manages the stability of the system to respond faster to disturbances

1. Simulate Triggers
2. Evaluate Actions
3. Update Logic
4. Analyze Recommendations
ETAP ADMS™ is an integrated electrical system design and real-time power distribution management system. ETAP ADMS incorporates SCADA, Distribution Management Applications & Outage Management System (OMS) functionality in a single solution.

Advanced Distribution Management System

Intelligent Geospatial Diagram*
- Animated flows and alerts
- Flexible use of all analysis modules
- Multi-layer graphical display of GIS & data
- Use background maps for spatial awareness
- Substation & Feeder Diagrams
- Synchronized GIS & Logical views

Distribution Network Applications
- Real-time assessment of network status
- Allows prediction of unbalanced system behavior
- Utilize real-time or archived data
- Solve for any voltage level from transmission to low voltage
- Solve radial or meshed networks
- Auto run or manual modes
- Save solution control parameters for each scenario
- Multi-CPU calculation capability

State Estimation & Load Allocation
- Estimation of unbalanced distribution systems
- Unobservable system estimation from substation meter to individual customer
- Utilize customer sector load profile library
- Apply load profile from meter data management system
- Support for Temporary Network Elements such as jumpers and cuts

Fault Detection, Identification, Location, Isolation & Service Restoration*
- Prediction and Rule Engine
- Utilize substation waveform for fault detection
- Utilize fault passage indicators for fault detection
- Fault type identification – 3P, LG, LL, LLG, etc.
- Identify one or more probable locations of fault
- Predict fault isolation switching actions to clear network faults
- Integrated with Outage Management System
- Integrated with Switching Management

Short-Term Load Forecasting
- Adaptive bus load forecasting
- Load profile library
- Forecasting scenario archiving
- Predict loading seven days ahead
- User-adjustable weather profile

Volt / Var Optimization & Control*
- Reactive power & var optimization
- Controls LTCs, capacitor banks & var support devices
- Conservative voltage reduction
- Optimize voltage profile
- Minimize reactive power losses

Feeder Balancing & Loss Minimization*
- Improve system kW losses
- Minimize voltage violations
- Minimize overload
- Balance feeder loads
- List of recommended switching operations
- Tie Point Optimization
- Feeder Reconfiguration
- Automatic creation and saving of optimal configuration

Outage Management System*
- Predict location of protective device that opened upon failure
- Prioritize restoration efforts & manage resources
- Provide information on extent of outages & number of customers impacted
- Measure & reduce outage frequency due to use of outage statistics

System Interfaces
- Outage Management Systems (OMS)
- Customer Information Systems (CIS)
- Meter Data Management Systems (MDM)
- GIS Systems
- MultiSpeak XML
- Common Information Model (CIM)
- Esri ArcGIS
- GE Smallworld™ Electric Office GIS
- Intergraph® InService OMS

* Certain features and capabilities are available in ETAP Beta release.

++ Via EMTP-RV™ / PSCAD™ Interface
ETAP is used by microgrid developers and engineers for detailed analyses and sizing of distributed energy resources and associated equipment. Microgrid Master Controller brings the design to life by connecting the system model with real-time data.

**Microgrid Central Controller**

**Generation Optimization**
- Supervisory control regulates generation levels
- Maintain power exchanges with neighboring areas
- Automatically detect loss of grid and switch control strategies
- Regulate voltage and frequency
- Minimize energy costs, fuel costs, etc.
- Consider renewable energy in generation mix

**Energy Storage Management***
- Compensate for voltage & frequency fluctuations
- Regulate active and reactive power produced or consumed

**Demand Side Management**
- Move on-peak usage into off-peak periods
- Shift rate schedules
- Identify costly variations in load profile
- Shed non-critical loads to save on energy cost

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**Model-Driven Real-Time Solutions**

- Power Management System
- Energy Management System
- Generation Management System
- Distribution Management System
- Intelligent Load Shedding
- Smart Grid & Microgrid Solutions
Quality Assurance Commitment

ETAP is Verified and Validated (V&V) against field results, real system measurements, established programs, and hand calculations to ensure its technical accuracy. Each release of ETAP undergoes a complete V&V process using thousands of test cases for each and every calculation module. ETAP Quality Assurance program is specifically dedicated to meeting the requirements of:

- ISO 9001:2008
- 10 CFR 50 Appendix B
- ANSI / ASME N45.2
- 10 CFR Part 21
- 10 CFR Part 50.55
- ANSI / IEEE 730.1
- CAN / CSA-Q396.1.2
- ANSI N45.2.2

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