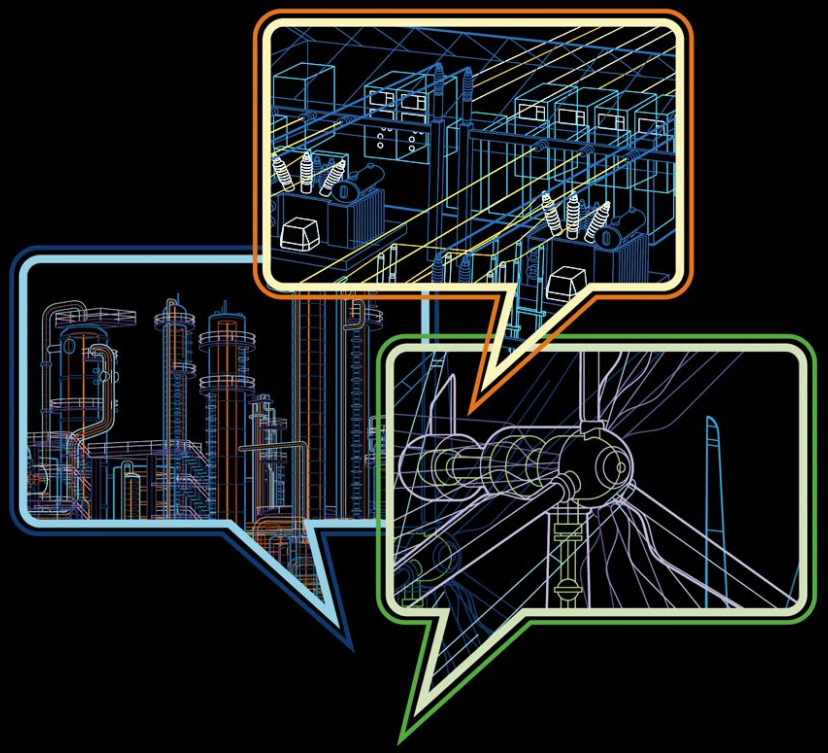

ABB Automation & Power World: April 18-21, 2011

WRE-102
Electrical Balance of Plant for Renewable Energy

WRE-102
Electrical Balance of Plant for Renewable Energy

- Speaker name: Melvin Brown
- Speaker title: Business Development Manager
- Company name: ABB Inc.
- Location: Raleigh, NC

Your safety is important to us
Please be aware of these emergency procedures

- In the event of an emergency please dial ext. 55555 from any house phone. Do not dial 9-1-1.
- In the event of an alarm, please proceed carefully to the nearest exit. Emergency exits are clearly marked throughout the hotel and convention center.
- Use the stairwells to evacuate the building and do not attempt to use the elevators.
- Hotel associates will be located throughout the public space to assist in directing guests toward the closest exit.
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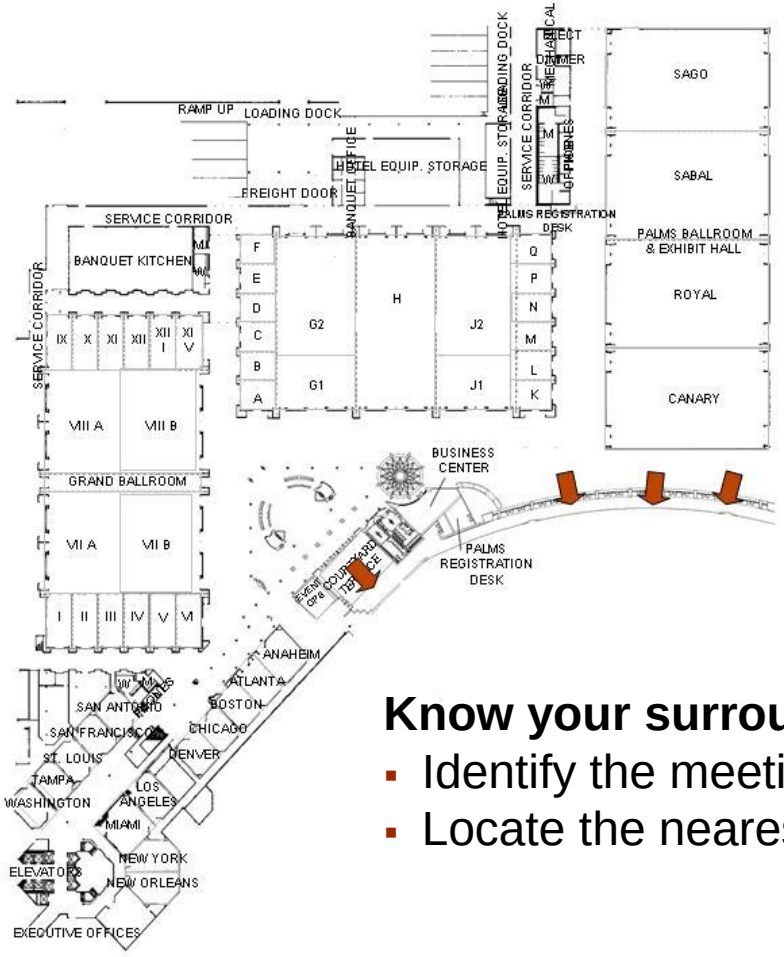
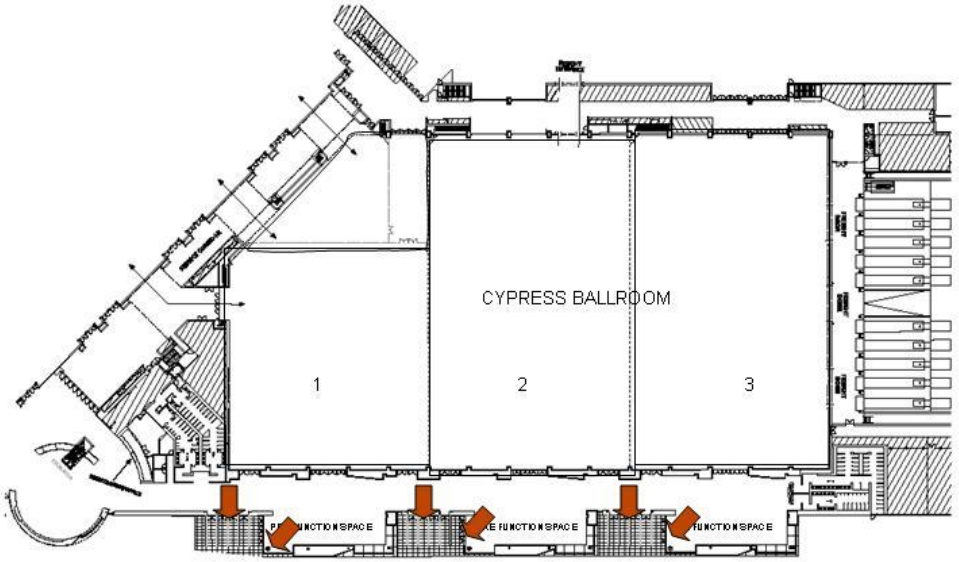
Your safety is important to us
Convention Center exits in case of an emergency





Know your surroundings:

- Identify the meeting room your workshop is being held in
- Locate the nearest exit

Introduction
WRE-102 Electrical Balance of Plant for Renewable Energy

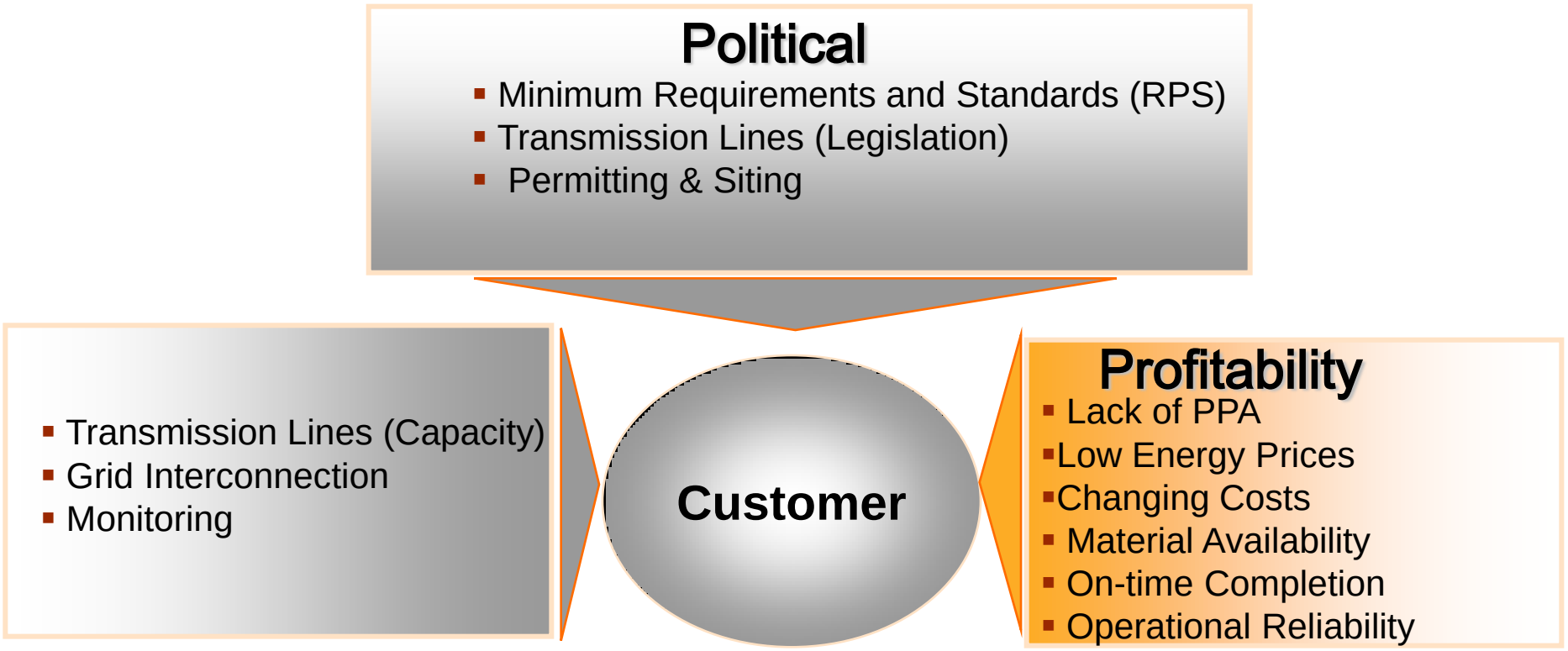
The demand for comprehensive electrical solutions in renewable energy plant projects is increasing. The electrical balance of Plant (eBop) is a way to bring all of these demands together and supply one plan for the entire electrification of such projects. ABB will demonstrate how this approach for a total project electrification solution will reduce your time in project execution while improving delivery and installation effort. This approach will allow you to place responsibility for all of your electrical needs in one source and reduce overall project risk.

Systems approach!

Electrical Balance of Plant (eBOP) for Renewable Energy Agenda

- Customer Challenges
- Overview of ABB in Renewable Energy
- Overview of ABB
  - Power Systems
  - Substations Business
- Capabilities
- eBOP Technical and Commercial Approaches
- References
- Summary

Customer Challenges



Renewable energy sources
ABB project role

- Intermittent Sources
  - Solar PV – EPC Role
  - Wind – Gen Terminals to Grid
- Non-Intermittent Sources
  - Hydroelectric – Water to Wire
  - Geothermal – Gen Terminals, BOP, Grid
  - Biomass – Gen Terminals, BOP, Grid

Considerations in Connecting a Renewable Energy Plant to Grid

- Collector System Design and Layout
  - Terrain and Climate Conditions
  - Reliability
  - Economics
- Substation
  - Location
  - Reliability, Operability, Maintainability
  - # of Substations and Bus Configurations
- Transmission Line and Point of Interconnection
  - Interconnection Requirements and Regulations
    - FERC
    - ISO
    - Local Utility Standards

ABB Portfolio for the Renewable Energy Industry

Power Panels

- Controller panel
- LVD-Low voltage
- Distribution panel
- Dynamic phase – Compensation panel

Balance of Plant and Grid Connection Systems

- Control and Protection systems
- Substations (BOP)
  - Onshore and offshore
- Compact Substations
- FACTS (SVC & STATCOM)
- HVDC
- HV cables

Transformers

- Main Power
- Padmount
- Instrument

SCADA Systems

- SCADA PC software package
- Advanced data handling and remote real-time operation & analysis

Protection

- Protection system
- Breakers and Switches
- Contactors
- Motor Starters
- Miniature Circuit Breakers
- Supervision relays
- Smiss Line
- Surge arresters

Communications

- communication both between wind turbines & between wind farm & owners / manufacturers
- Data and telecommunication
- Product line Fox
- PLC controller

Drive Train systems

- Converter, Transformers and generators

Switch gear

- Air insulated Switchgear
- Gas insulated Switchgear
- 36 KV Switchgear

Power Systems Division

Business Scope

- **Turnkey power systems**
  - AC and DC power systems
  - HVDC, HVDC Light and FACTS
  - Substations and Substation Automation
  - Network management systems
  - Instrumentation, electrification and control for power generation
- **Power systems services**
  - Repair, retrofit, refurbishment
  - Software and hardware upgrades
  - Asset management and diagnostics
- **Sites**
  - Raleigh, North Carolina (US) - Headquarters
  - Allentown, Pennsylvania (US)
  - Montreal, Quebec (CA)
  - Burlington, Ontario (CA)
  - San Luis Potosi, Mexico

Overview of ABB Substations Business

- ~ 200 employees
- HQ in Raleigh, NC
- Full turnkey capabilities (EPC)
  - Consulting
  - Engineering
  - Procurement
  - Project Management
  - Civil Works
  - Electrical Installation,
  - Testing and Commissioning
  - Warranty & Service
- AC Transmission & Distribution Substations from 5 kV to 765 kV
- FACTS, HVDC and BESS Projects
- 25+ years providing turnkey solutions
- ~ 75 % of projects from repeat customers

ABB EPC Project Capabilities and Experience

- ABB Executes ~ 40 EPC Substation Projects Per Year in North America
- Customers
  - Utilities
  - Cooperatives
  - Industrial
  - Developers and Independent Power Producers
  - Balance of Plant Contractors (BOP)
- Project Types
  - Air Insulated Substations (AIS)
  - Gas Insulated Substations (GIS)
  - Greenfield, Brownfield, Retrofit
- Consulting
  - System Planning
  - Facility Studies
  - System Impact Studies
  - System Studies
  - Design Studies

ABB EPC Project Capabilities and Experience

Power System Engineering

System Studies

Power System Analysis
- Load Flow
- Short Circuit
- Voltage Regulation
- Motor Starting
- Reliability & Availability
- Power System Stability

System Protection & Coordination
- Insulation Coordination
- Lightning Protection
- System Grounding
- AC Interference analysis
- Switching Surges

Electrical Design

- One-line Development
- Equipment sizing
- Cable Engineering
- Lighting
- Grounding

Physical Design

- Control House Design
- Specification Preparation
- Cost Estimating
- Control House Layout
- Substation layout

Power Quality

- Harmonic Analysis
- Filter Design
- Voltage Sags/Interruptions
- Flicker
- Reactive Power Compensation
- Capacitor Systems

Site & Commissioning

- HV / MV equipment
- Control & Protection
- Grounding
- Power Quality
- Site Survey
- Monitoring & Testing

Project Engineering

- Specification Preparation
- Scheduling & Cost Control
- Inspection & Factory Test
- Multi-Lingual

Power Electronics

FACTS Devices

Advanced Control Methods

Active Power Conditioning

Industrial Applications

Design Software Tools

System Studies

ETAP - load flow and short-circuit analysis, motor starting, harmonic analysis

SKM - load flow, fault & motor starting current

PSCAD/EMTDC – time domain analysis, TRV, SSR, switching

CYME-PSAF - load flow and short-circuit analysis

Power Delivery Optimizer – reliability & availability

PSSE - load flow and short-circuit analysis

Electrical Engineering

WinIGS – grounding design

CDEGS – AC interference - grounding design

SKM - HiWave – harmonics analysis

CYME-HARMO – harmonics analysis

MathCAD –numerical calculations, complex arithmetic

ETAP – cable pulling calculations

ACAD ELECTRICAL

Cable Schedules

Schematics

Design & Drafting

AutoCAD – drafting 3D

CAD Overlay – Overlaying CAD information on PDF or other scanned docs

Microstation **V8 –** drafting tool 2-way compatible with AutoCAD

MS Access

Cable schedules

Termination lists

MS Excel

Termination lists

Cable schedules

AutoCAD El

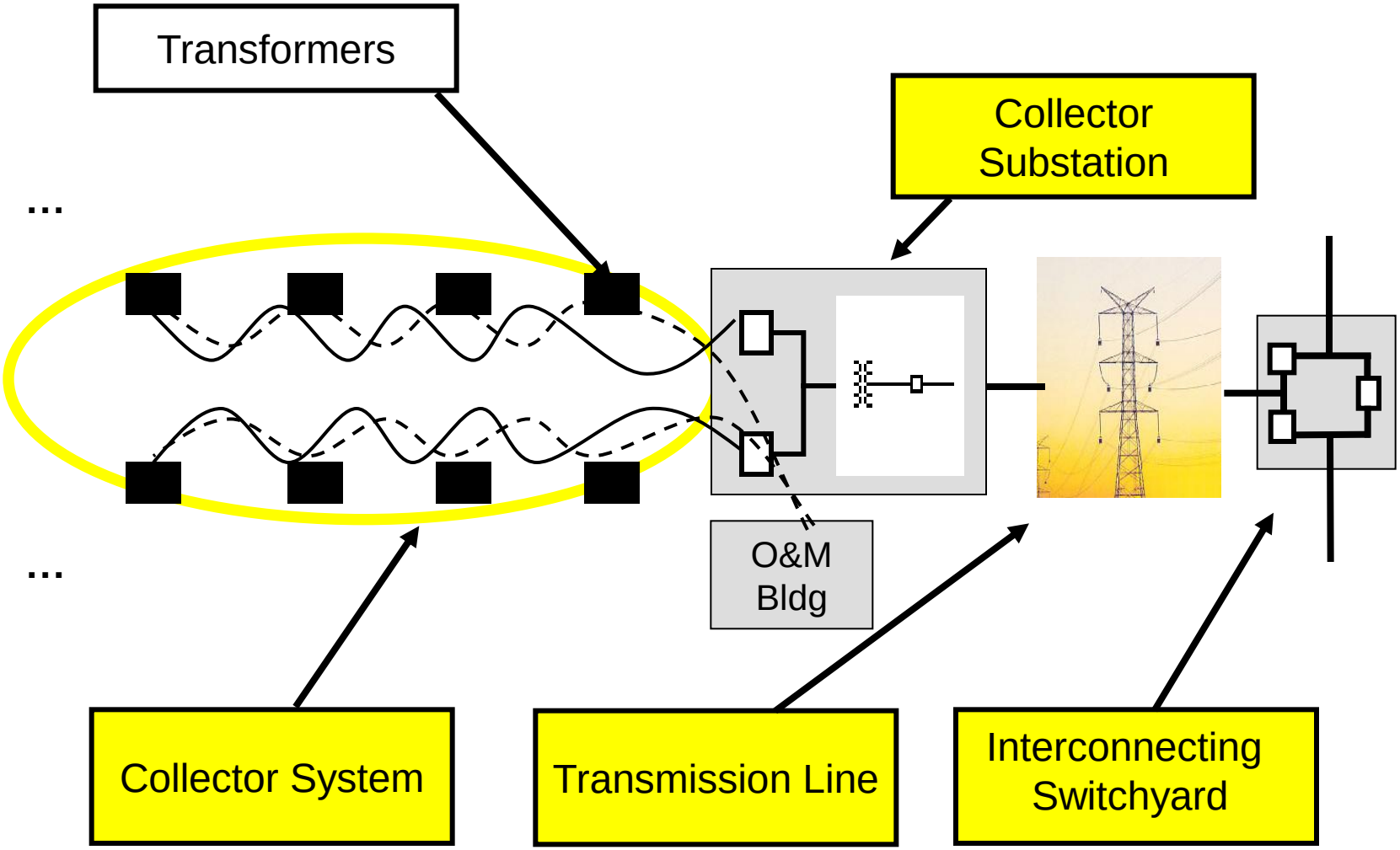
Civil Engineering

- Civil design
  - foundations & steel,
  - dynamic seismic

What is Included In a Turnkey Project?

- What is Turnkey?
  - Engineering, Procurement and Construction project (EPC)
- What is included?
  - Project Management
  - Basic design, preliminary and detail engineering of the entire electrical balance of plant. This includes civil, electromechanical, electrical and control/protection engineering
  - Required studies such as illumination, grounding and lightning protection
  - Civil Works. This typically includes all foundations, fencing, conduits, stone and ground grid installation
  - Procurement and installation of all structures, equipment, cables and control enclosures. We do not have to use 100% ABB equipment –some customer specified equipment is OK!
  - Complete substation commissioning
  - Complete system warranty
  - Service

Electrical Balance of Plant – “Padmounts to Grid”



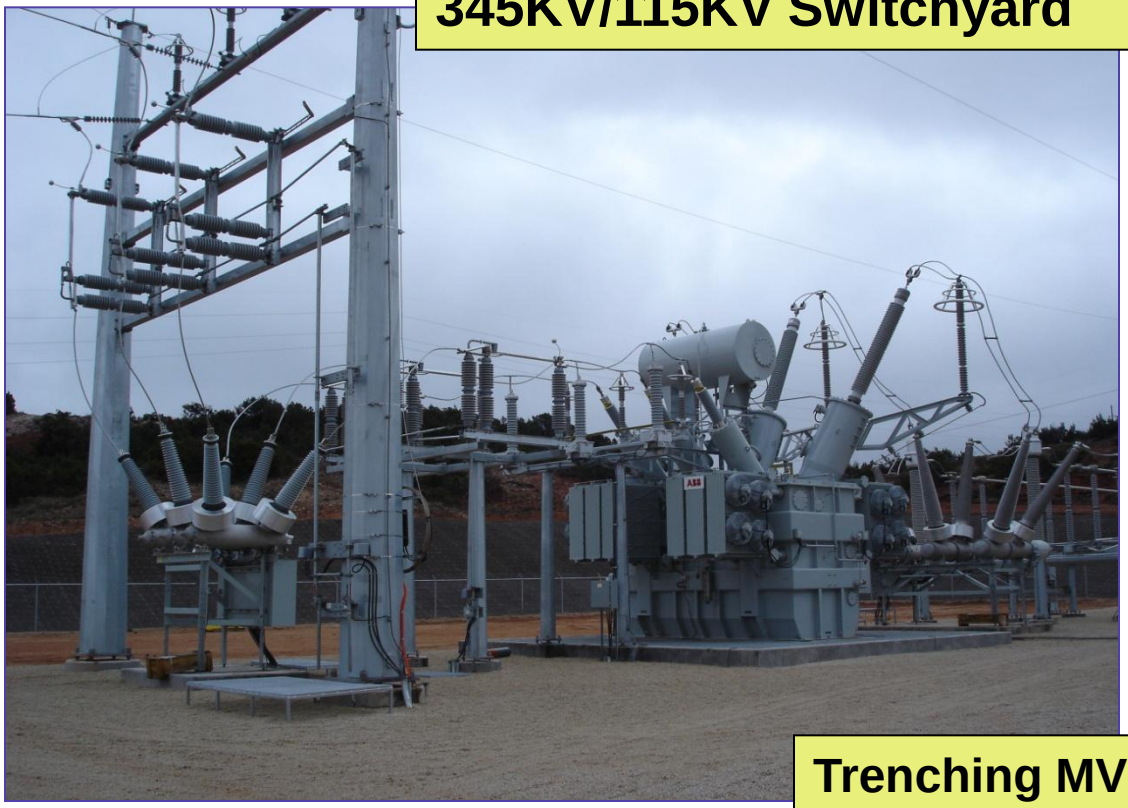
Turnkey Electrical Balance of Plant Scope

Everything electrical from the padmounts to the grid

- Electrical Scope
  - Engineering (From system integration to plant design)
  - Substation only
  - Substation & associated collector system
  - Substation, collector system, and transmission line interconnect
- Civil work
  - Site grading, ground grid & fencing
  - Foundations for all electrical equipment
- Project management
- Testing & commissioning services
- Documentation & training
- Long term maintenance agreements
- Optimized spare parts programs
- Field support, 24/7/365

Interconnect Switchyard & Collector System

345KV/115KV Switchyard



Trenching MV Cables for Collector System

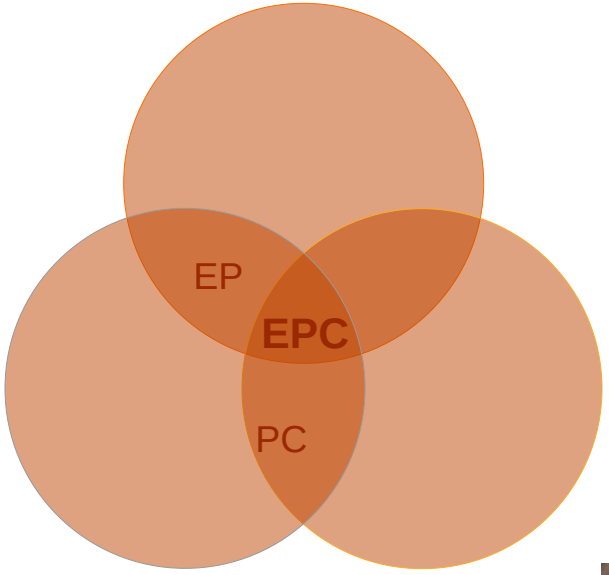
Commercial

Flexibility

ENGINEERING

Business Model Options

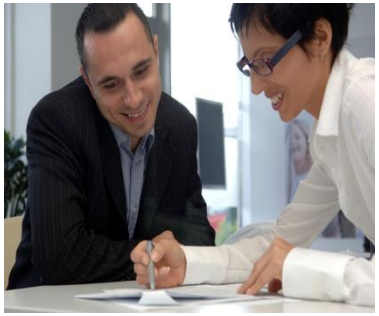
- EP(c)
- ePC
- E→PC



Contractual Options

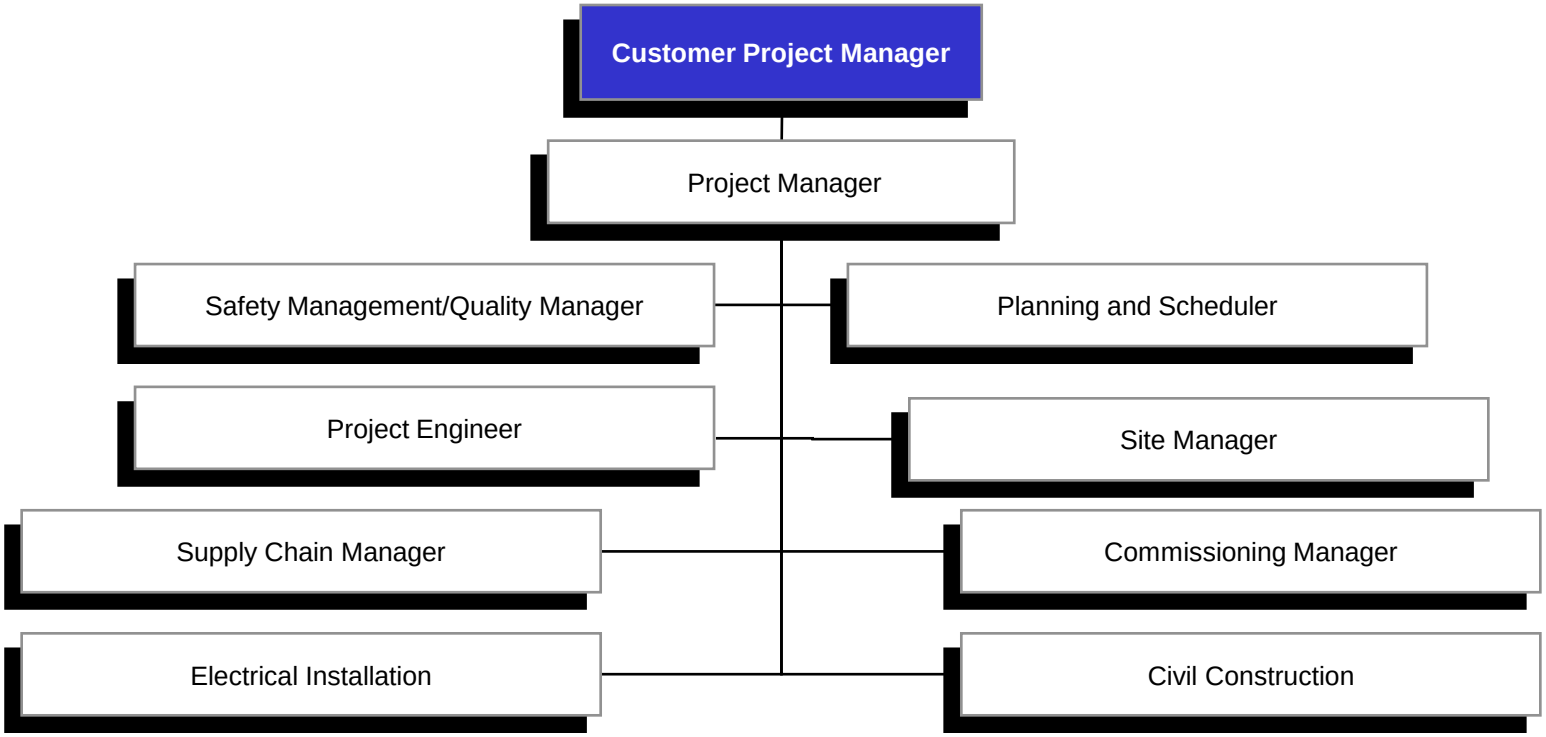
- Prime / Sub
- Sub / Prime
- Consortium (Int./Ext.)
- Joint Ventures (Contractual)
- Split Orders

PROCUREMENT



CONSTRUCTION

ABB “One Company” OEM EPC Approach



Every Lead Position
On an ABB EPC Project is
Staffed by an ABB Employee

Pre-engineered Designs

- Pre-engineered/Modular substation offering
  - Standardized designs with a focus on functionality, safety, and quality
    - Three basic designs based on AIS, GIS, and Metal-clad Switchgear
    - Standardized High Voltages and Power Ratings
  - Value-engineered to minimize footprint, structural steel, and concrete
  - Reconfigurable for different topologies

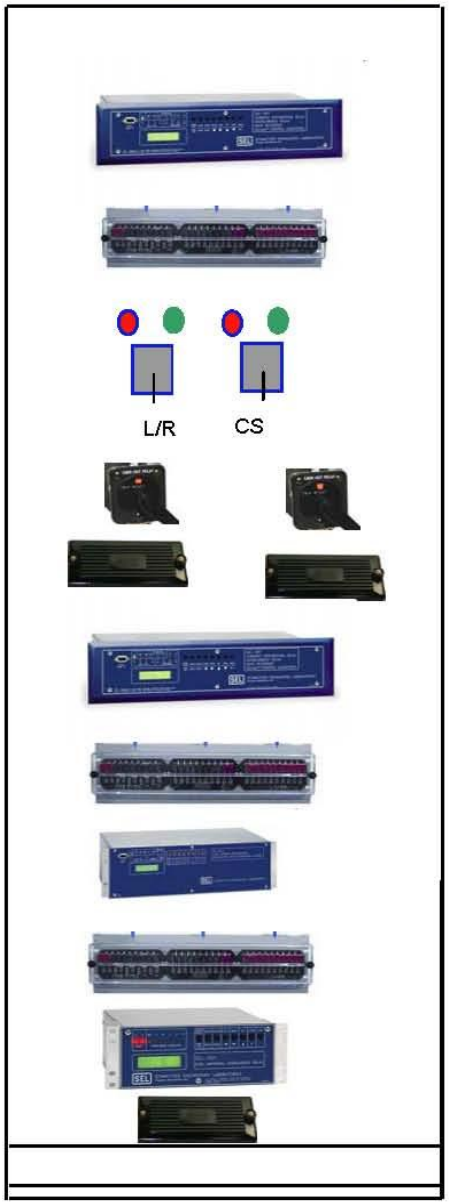

EXIT

36 kV Incomer protection panel

- Major equipment
  - SEL 311L Line differential protection
  - SEL 311C Line distance protection
  - SEL 501 CB protection
  - SEL 279H recloser relay
  - LOR lock out relays
  - Control switches, lamps
  - FT switches

LOD 1

35/13 kV transformer protection panel



- Major equipment
  - SEL 387 transformer protection Sets A & B
  - SEL 351 directional protection
  - SEL 501 CB protection
  - LOR lock out relays
  - Control switches, lamps
  - FT switches

LOD 2


SKY TRAK

Gas-Insulated Switchgear
vs.
Air-Insulated Switchgear

PDC Applications

Why use GIS on Medium Voltage Distribution Systems?

- Safety
  - Arc-Resistant
- Reliability
  - Hermetically sealed
- Longer Life
  - 40+ years
- Compact design
  - Space savings (up to 60 % smaller)
- Lower Total Ownership Costs
  - Lower (or similar) first cost
  - Less space / smaller building (PDC)
  - Lower installation costs
  - Lower maintenance costs
  - Lower replacement costs

138KV/13.8KV 16/22.5 MVA Substation

138kV/13.8KV 16/22.5 MVA

Need

- 138 kV/13.8KV 16/22.5 MVA dual transformer installation needed in 6 months
- Compact design due to limited site space
- Flexibility to add for future

Solution

- ABB substation based upon standardized PS -1 design
- Total turnkey, flexible design and short installation time frame

Benefit

- Completely designed, installed, and commissioned in 6 months

Wind Farm Substation in Texas

Need

- Energize Multiple138/34.5kV substations in 12 months

Solution

- ABB's pre-designed modular substation concept met the budget and schedule

Benefit

- Developer completed wind farms in time to energize on schedule and receive tax credits

345 kV GIS interconnect switchyard

- Utility Interconnect to Multiple Wind Farms
- High Reliability, Low O&M Cost Approach Taken
- GIS Ring Bus Expandable to BAAH
- Switchyard Designed and Built to Utility Standards

Miller Mountain, Canada – Northland power / Vestas

Customer's need

- Electrical BOP (30x1,8 MW units): 161kv/34.5kv substation and connection to the Hydro Quebec 161kv lines with complete integration of collector system. Substation included 161 kV HV breaker and switches, step-up transformer , revenue metering , protection and control. The 34.5 kV modular feeders are associated to the complete Wind collector systems, based on XLPE cables , directly buried with connection to all the wind turbines.

ABB's response

- Complete electrical and civil engineering, including Control and Protection, grounding
- Complete civil works for the substation and collector systems including road construction.
- Foundations for the Wind turbines in conjunction with subcontractor
- Full general contractor responsibilities for all aspects of the work included security and site support facilities and winter roadway maintenance and clearing. Wind tower locations were by others.
- ABB included all connections to incoming breakers of the wind turbines

Customer's benefits

- Fast tract construction.
- One main contractor with complete responsibility and expertise for the Substation and collector systems
- Manufacturing slot priority and ABB's expertise.

Key ABB EPC Project Benefits for Renewable Customers

- World's Largest OEM (Original Equipment Manufacturer) EPC Firm
  - World Wide EPC Reputation Means Every Project is Important
  - Extensive North America Utility Experience Means Lowest Interconnect Technical Risk
  - Extensive North America EPC Project Experience Means Lowest Schedule and Project Execution Risk
  - FACTS Expertise Means Lowest Power Quality Risks
- World Leader in T&D Technology
  - Ability to Develop Optimal AIS, GIS or Hybrid Technology for Any Application
  - Ability to Deploy Standard Designs Where Appropriate
  - Preferential Access to Factory Experts and Production Slots
- World Class Safety Record
  - EMR of 0.52

eBOP Concept and Rationale
What challenges can ABB help you overcome?

- Mitigating risk associated with project schedule
  - Managing multiple subcontractors
  - Equipment delivery
  - Site conditions
  - Field commissioning
- Resource Constraints
  - Engineering
  - Project Management
  - Procurement
- Mitigating risk associated with grid compliance
  - ISO and Utility Standards

Reminders
Automation & Power World 2011

- Please be sure to complete the workshop evaluation
- Professional Development Hours (PDHs) and Continuing Education Credits (CEUs):
  - You will receive a link via e-mail to print certificates for all the workshops you have attended during Automation & Power World 2011.
  - BE SURE YOU HAVE YOUR BADGE SCANNED for each workshop you attend. If you do not have your badge scanned you will not be able to obtain PDHs or CEUs.

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