

ADDING ELECTRICAL BOOST TO A FURNACE

Practical Considerations for Increasing Electrical Usage in a Glass Furnace

From Concept to Operation

GMIC Glass Problems Conference 2026



1. Electrical Boost

- 1.1 The Basics
- 1.2 The Business Case

2. Project Details

- 2.0 Existing Conditions
- 2.1 Power
- 2.2 Transformers
- 2.3 Electrodes
- 2.4 Cooling
- 2.5 Controls

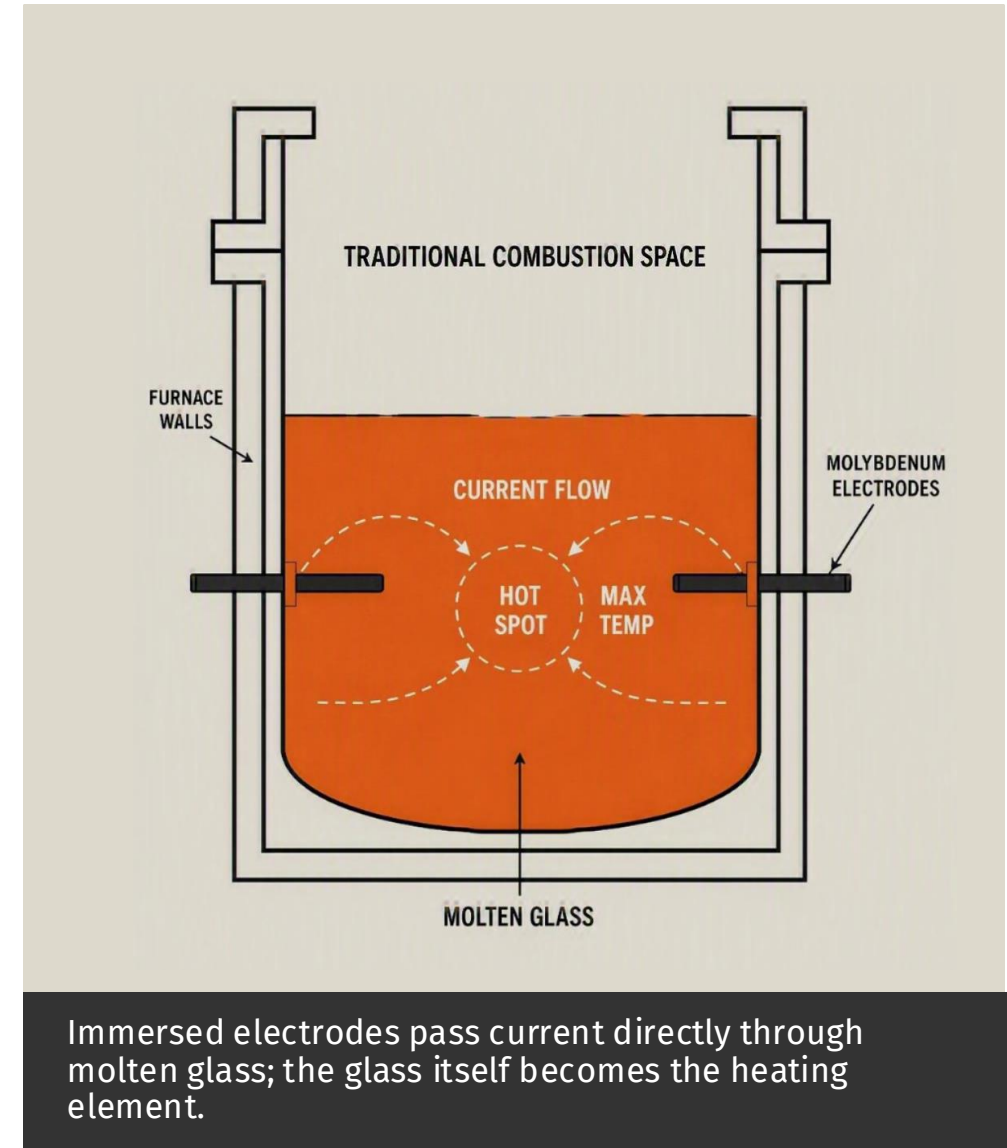
3. Safety and Operational Considerations

4. Example Project Timeline

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The Basics - What Is Electric Boost?

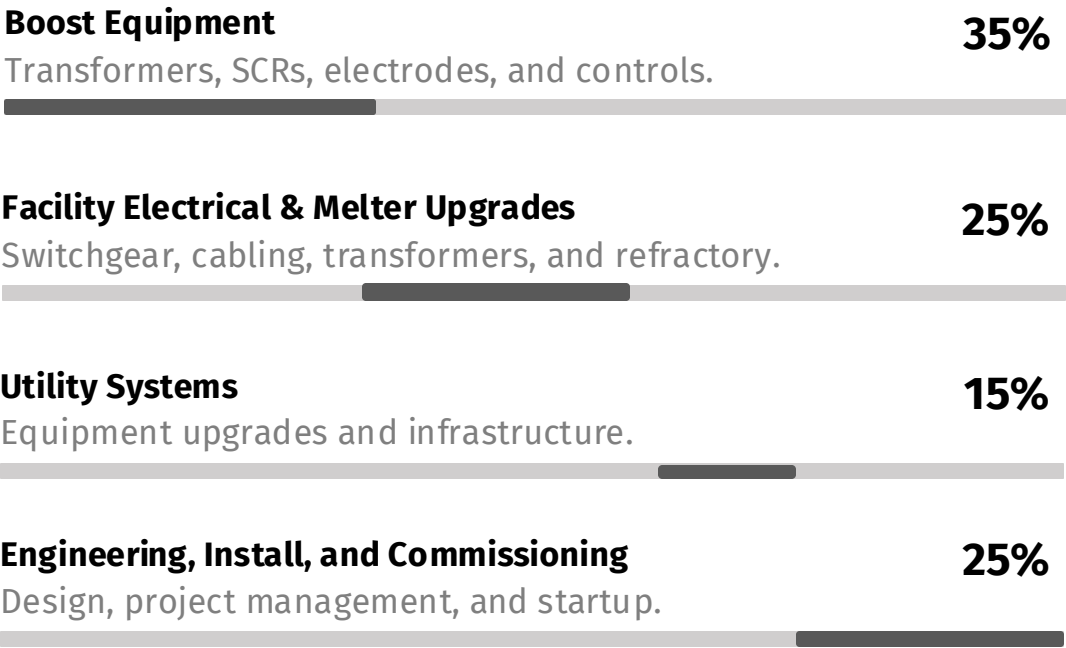
-  **Electrodes immersed:** Molybdenum or tin oxide electrodes enter the melt through basin walls or the bottom.
-  **Current flows through glass:** Molten glass conducts electricity, and its resistance generates heat internally.
-  **Supplements combustion:** Electric boost typically provides 5–25% of energy input, while hybrid designs can reach a 60–80% electric share.



The Business Case

Capital Expenditure (CAPEX) / Operating Expense (OPEX)

Where the Capital Goes



Offset: Boost can help increase yield and quality but requires more space required for electrical equipment.

High upfront cost, multi-lever payback.

Return on Investment Levers

-  **Energy price spread:** Electricity compared to gas relative cost is the dominant operating expense lever.
-  **Throughput:** Higher tonnage from the same footprint creates direct revenue uplift.
-  **Carbon pricing:** Avoided carbon dioxide becomes financial value as carbon prices rise.
-  **Yield improvement:** Better quality lowers rejection rates and waste.
-  **Asset life extension:** Lower thermal load can extend superstructure life.

Decision: Consider the total cost of ownership across campaigns, including diminished refractory life and increased maintenance costs

Project Details

Each system has interdependencies.

2.0

Existing Site Conditions

- ☐ Evaluate
- ☐ Estimate
- ☐ Project execution planning

2.1

Power

- ☐ Utility availability
- ☐ Substation equipment
- ☐ Cable routing

2.2

Transformers

- ☐ Pads and containment
- ☐ Rooms
- ☐ Perimeter fencing
- ☐ Types

2.3

Electrodes

- ☐ Power control equipment
- ☐ Cable routing
- ☐ Refractory systems

2.4

Cooling

- ☐ HVAC and electrical rooms
- ☐ Chilled water capacity
- ☐ Cooling water capacity
- ☐ Electrode holders

2.5

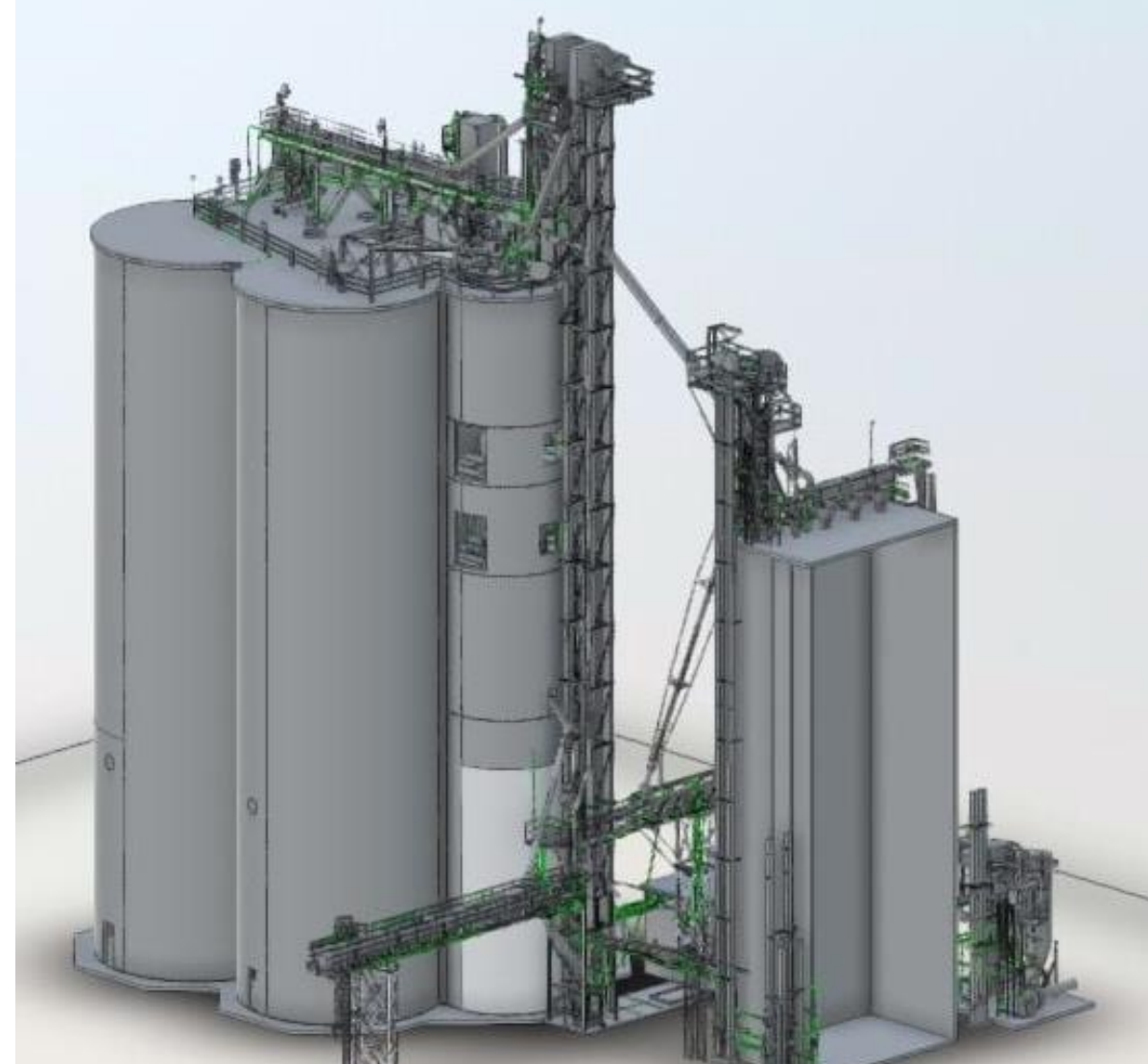
Controls

- ☐ PLCs and SCADA
- ☐ Cooling interlocks
- ☐ Safety interlocks

Existing Site Conditions: 3D Laser Scanning and Site Data Collection

An accurate digital representation of existing equipment becomes the source of truth for every later phase.

-  **Capture as-built reality:** Existing structure, piping, cable trays, and clearances.
-  **Power & Utilities:** Basic load studies and capacity assessments
-  **FEL / downstream design:** Direct handoff to engineering and construction teams.
-  **Eliminates field surprises:** Interference checks before construction



Point cloud → as-built building information modeling (BIM) → discipline models

Power: Utility Availability and Substations

Utility Availability

- ⚡ **Demand:** Electric boost adds 2 - 10+ MW of new load; verify available capacity.
- 🏠 **Utility coordination:** 18 - 24 months is typical, so start early.
- 📶 **Power quality:** A harmonic impact study is required because SCR firing creates flicker.

Substation Design, Switchgear, and Routing

- ⊕ **Expansion:** Additional load requires new equipment.
- 🏠 **Equipment:** Transformers, structures, switchgear, protection relays, and metering.
- 🏠 **Containment:** For oil-filled transformers, review NFPA 850 requirements.
- 📶 **Routing from the substation:** Existing pipe racks, underground, new structures, and other considerations.



Transformers

 Pads and Containment

Pad and structural: Reinforced concrete pad rated for transformer weight and seismic loads; grout-leveled mounting surface; anchor bolt pattern per manufacturer.

Secondary containment: Oil-filled transformers require a containment berm or sump for 110% of oil volume. NFPA 850 requirements apply. Drain to an oil-water separator, not a storm drain.

 Perimeter Fencing

Perimeter fencing: 8 ft. chain-link fence with barbed wire topping around transformer yard; lockable gate; posted ANSI / NFPA warning signs; no unauthorized access.

 **Restricted access zone:** Only authorized, qualified electrical personnel permitted inside fenced area during energized conditions.

 Transformer Room

Indoor units require: A fire-rated room with a two (2)-hour minimum rating, natural or forced ventilation, temperature monitoring, smoke / heat detection, and sprinklers if NFPA 13 applies.

Clearances: NEC Table 110.34 clearances maintained for all voltage levels; working space unobstructed; no permanent storage; no overhead obstructions.



Transformers

Transformer Types for Electric Boost

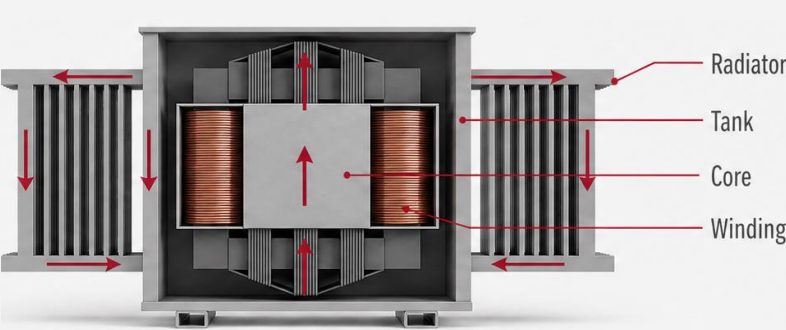
Melt / boost transformer: Custom-designed low-voltage / high-current transformer. Secondary voltage: 80–600 V AC. Multiple taps for current adjustment. Forced oil or forced air cooling, including Single Phase, Three Phase and Scott-T configurations

Regulation method: On-load tap changer (OLTC) for voltage adjustment under load, or a separate voltage regulator upstream of the fixed-ratio furnace transformer.

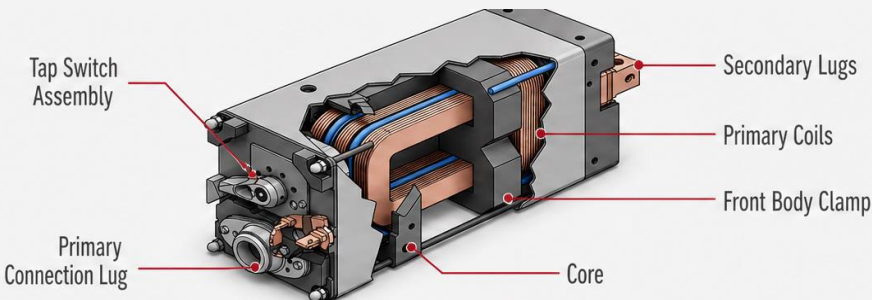
kVA / MVA sizing: Sized to electrode current multiplied by voltage and power factor. Typical range: 0.5–5 MVA per transformer, with multiple units for large arrays.

Short-circuit impedance: Specified to limit electrode fault current to safe levels for SCR protection and to limit mechanical forces on electrode holder assemblies.

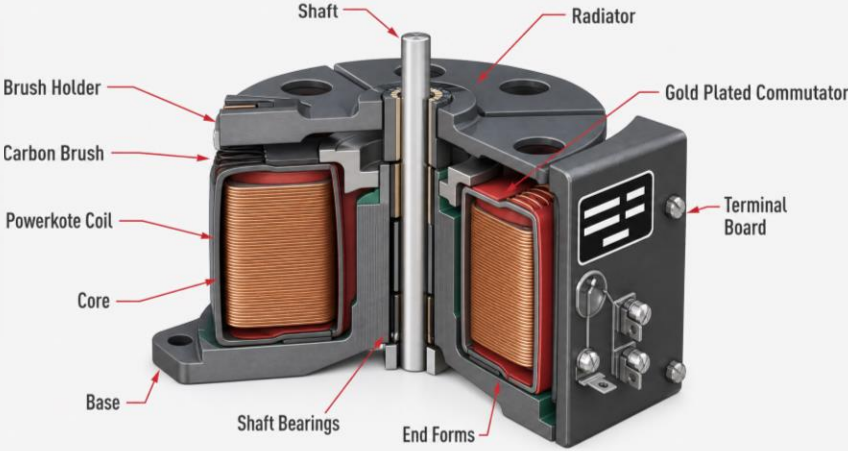
Oil-Cooled Typically, Voltages Greater than 4160v



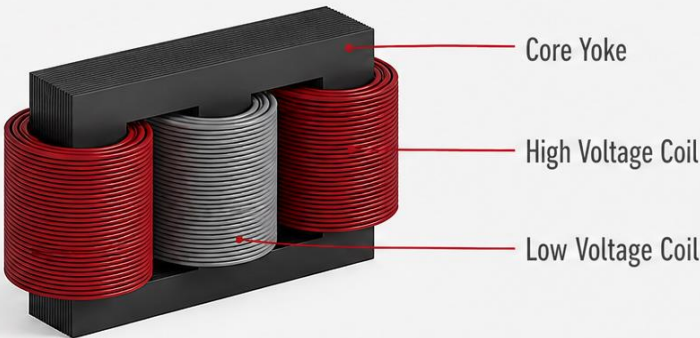
Water-Cooled Best in Applications >500 A on Secondary



Mechanical Control



Air-Cooled



Electrodes: Power Control Equipment

Electrical Control Types

SCR (Single or Three Phase)



- **Phase Angle** — Varies power by chopping each sine wave cycle
- **Burst Fired (zero cross)** — Full cycles switched on/off in groups
- **Synchronized Firing** — Minimizes harmonic distortion

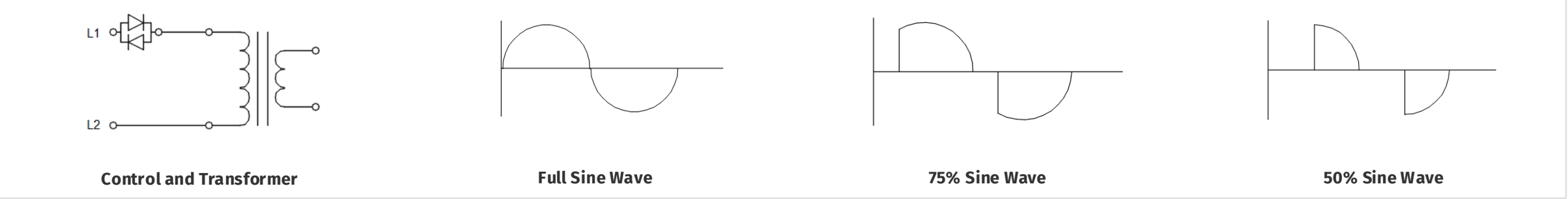
IGBT



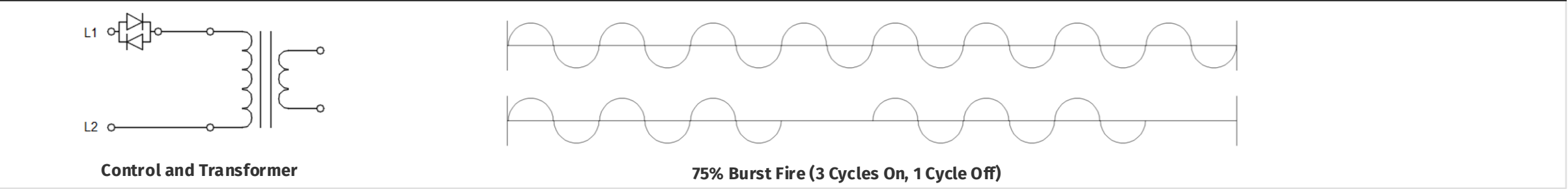
- **40–200 Hz** — Medium frequency range for flexible power control
- **400–2000 Hz** — High frequency range enabling precise current distribution

Electrodes: Silicon Controlled Rectifier (Thyristor)

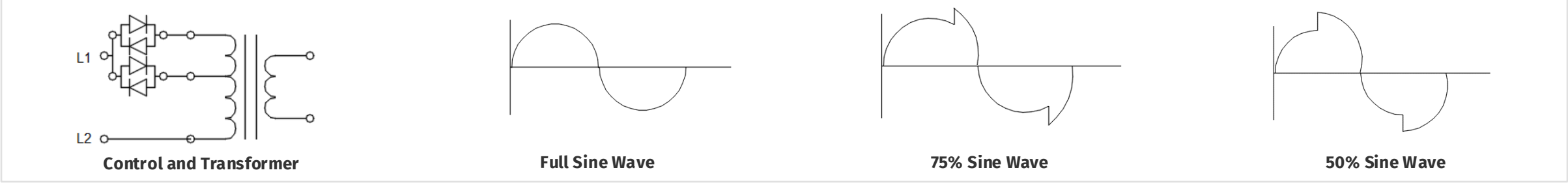
Control and Transformer Configurations and Corresponding Power Waveforms



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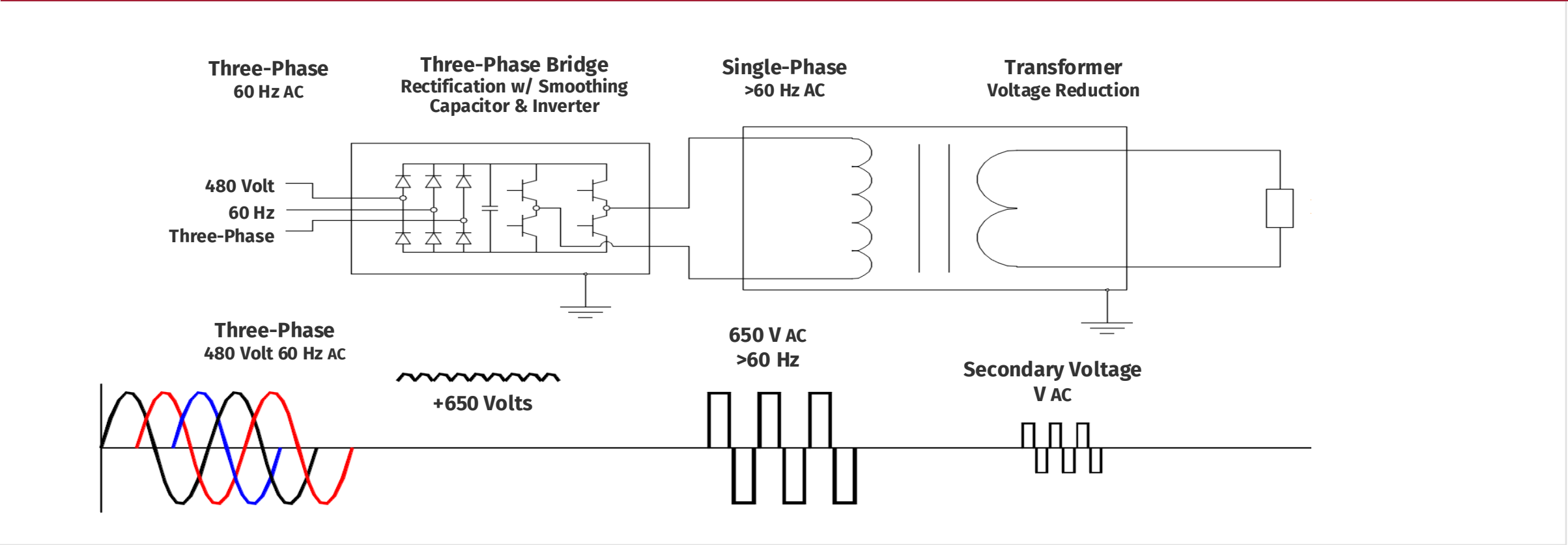


Control and Transformer Configurations and Corresponding Power Waveforms



Electrodes: IGBT System Schematic (AC Output)

Control and Transformer Configurations and Corresponding Power Waveforms



Electrodes: Refractory and Cable Routing

Refractory Systems

- **Type:** refractory type changes around the electrodes.
- **Inspections:** no changes to best practices but a little more important.
- **Super structure / binding steel:** no significant impact but can create interferences.
- **Throat electrodes:** do not add continuous boost.
- **Positioning:** bottom electrodes have more perceived risk than sidewall electrodes.

Cable Routing

- **Quantity:** parallel feeds and electrode count increases quantity – substantial amount of cables.
- **Cable types:** high temp and high flex - short and large gauge cabling is best.
- **Separation:** spacing is important to reduce reactive electromagnetic fields and shielding from heat.
- **Magnetism:** nonferrous supports and tray systems.



Cooling Systems: Process Cooling and Electrical Rooms

⚠️ These are critical systems!



⇒ Facility Cooling (HVAC)

Electrical room configuration: Transformers and power controllers.

Room ventilation and cooling: Heat load from transformers and SCRs.

Ambient conditions: Temperature and humidity impact.

Fire protection: Detection and suppression.

💧 Electrode Process Cooling

Capacity increases: Based on evaluations and estimates.

Closed-loop water system: Prevents mineral scale.

Temperature range monitoring: Critical for electrode integrity.

Flow loss interlock: Any flow sensor fault results in a shutdown.

Flow rate: Sized for electrode power dissipation.

Controls and Integration

Control System Architecture

1

SCADA / Human Machine Interface (HMI):

- Rockwell, Wonderware, Ignition, etc.
- Historians, data collection, and trending.
- Dash boards and remote monitoring options.

2

PLC / Distributed Control System (DCS):

- Allen Bradley, Siemens, ABB, etc.
- Safety assessment and ratings.

3

Field devices:

- Electrode power controllers.
- Flow switches and transmitters.
- Current transducers.

Critical Interlocks

- 🔥 Cooling water flow loss trips electrode power.
- 🔥 Ground faults open the isolation breakers.
- ⚡ Energy reducing maintenance switch (ERMS).
- 🔥 Furnace crown temperature & reducing boost power.
- ⚠️ Emergency stops hardwired to electrode contactors.
- 🚫 Physical barriers /access around electrodes.



Safety Considerations

Molten glass at 1,500°C meets thousands of amps. Containment, not luck, keeps people safe.



Glass Leaks

Holder failure or refractory erosion can release the melt.

- High-integrity holders with back-up cooling.
- Thermographic refractory inspection schedule.
- Containment dike around furnace perimeter.



Metal Contamination

Metal in the batch can short-circuit bottom electrodes and create runaway heating.

- Magnetic separation of cullet and raw materials.
- Rigorous incoming material quality control.



High-Voltage Exposure

Personnel access to energized equipment during operation.

- Additional arc flash requirements.
- Grounding, insulation, and LOTO procedures.
- Energy-reducing maintenance switches.



Physical Guarding and Interlocks

- Restricted-access for transformer and switchgear rooms.
- Safety cages and physical access barriers around electrical equipment.
- Shunt trips, gates, and guards.



Training

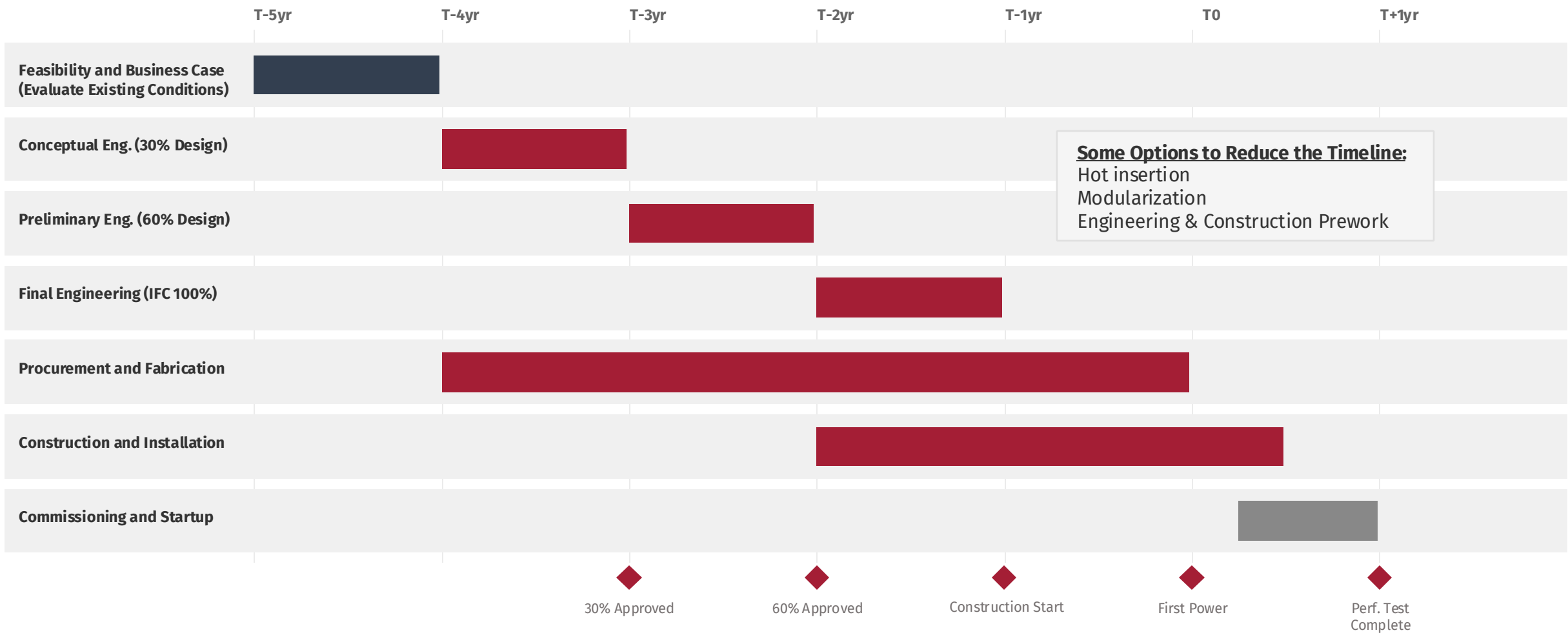
- Increased operator training.
- Misread alarms or unsafe shutdown sequences.
- Hybrid-furnace-specific training.
- Documented, regularly drilled emergency procedures.



Example Project Timeline

Long-lead items, utility coordination, transformers, and switchgear govern the critical path.

Utility interconnect > Lead time of 18 – 24 months
Transformers > Lead time of 12 – 18 months
Switchgear > Lead time of 9 – 14 months



Summary and Q&A

🔧 **Proactive scoping pays dividends:** 3D laser scanning, site assessments, and early design coordination consistently reduce field conflicts and change order exposure.

⚡ **Electrical engineering and early coordination:** Utility interconnect, transformer procurement, and switchgear lead times are project-critical. Grid capacity is limited - data center demand is leading to higher prices.

🛡️ **Safety is engineered in:** Arc flash analysis, perimeter guarding, cooling interlocks, lockout-tagout procedures, and training programs must be in place before commissioning begins.

✅ **Electric boost is proven technology:** Deployed globally across container, float, and fiberglass furnaces. Lifecycles are well-understood and having good project plans and designs ensure a quality outcome.

Thank You!

Any Questions?

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