DEPLOYMENT HANDBOOK

PROJECT DEVELOPER'S GUIDE.

SITE → PERMIT → BUILD → INCENTIVES

A comprehensive guide to deploying Tobe electrolyzer systems. Covers site selection, permitting, balance of plant integration, renewable pairing, and 45V tax credit compliance.

25–2,500	$3.00	12–18	95%
KG H_2/DAY RANGE	MAX 45V CREDIT/KG	MONTH DEPLOY (TYPICAL)	BUY AMERICA CONTENT

Version 1.1 · January 2026

CONTENTS

1. Executive Summary 03
2. System Overview 05
3. Site Requirements 07
4. Permitting Roadmap 10
5. Balance of Plant Integration 13
6. Renewable Integration 16
7. 45V Compliance & Carbon Intensity 18
8. Project Economics with Incentives 22
9. Deployment Timeline 25
10. Tobe Support Services 27
11. Checklists & Next Steps 28
Appendix A: Site Data Request Form 30
Appendix B: Permit Package Index 31
Appendix C: 45V Evidence Binder 32
Appendix D: Codes & Standards 33
Appendix E: Electrical Data Sheet 34

HOW TO USE THIS GUIDE

This guide answers five critical questions every project developer faces:

Can I Site It?	Can I Permit It?	Can I Integrate It?	Can I Monetize It?	What's the Risk?
SECTIONS 2–3	SECTION 4	SECTIONS 5–6	SECTIONS 7–8	SECTION 9

1. EXECUTIVE SUMMARY

This guide provides everything a project developer needs to deploy Tobe electrolyzer systems—from initial site screening through permitting, construction, commissioning, and 45V tax credit compliance.

WHO THIS GUIDE IS FOR

- **Project Developers** — evaluating sites and building project pro formas
- **EPCs & Owner's Engineers** — designing and constructing hydrogen facilities
- **Offtakers** — industrial users, fleet operators, utilities planning hydrogen procurement
- **Investors & Lenders** — conducting technical and financial due diligence

TOBE ELECTROLYZER AT A GLANCE

PARAMETER	T-25	T-125	T-2500
H_2 Output	~25 kg/day	~125 kg/day	~2,500 kg/day
Nameplate Power	50 kW	250 kW	~3.7 MW
Specific Energy	**~42 kWh/kg H_2 (system, AC input)**		
Electrical Efficiency	~94% (HHV basis) | ~79% (LHV basis)		
Footprint	Compact skid	20-ft container	Multi-container
Turndown	**10–100%**		
Operating Temp	<50°C (near ambient)		

TIMELINE AT A GLANCE

PHASE	DURATION	KEY OUTPUT
Site Screening	1–3 months	Site shortlist, offtake term sheet
FEED & Permitting	3–9 months	Permit package, AFC drawings
Procurement	3–6 months	Equipment ordered, lead times secured
Construction	4–8 months	Civil, mechanical, electrical complete
Commissioning	2–4 weeks	SAT closeout, performance test

GO / NO-GO DECISION CHECKLIST

Use this checklist before committing capital. All items should be "Yes" or "In Progress" before proceeding to FEED.

SITE & OFFTAKE

- ☐ Site control secured (LOI, option, or lease)
- ☐ Zoning compatible with hydrogen production
- ☐ Offtake path defined (pipeline, trucking, on-site use)
- ☐ Offtake volume and pricing term sheet in place

UTILITIES

- ☐ Electrical service confirmed (capacity, voltage, interconnect path)
- ☐ Utility interconnect queue position secured (if applicable)
- ☐ Water source confirmed (municipal, well, industrial supply)
- ☐ Wastewater discharge path confirmed

PERMITTING & SAFETY

- ☐ AHJ jurisdiction identified (fire, building, hazmat, environmental)
- ☐ Pre-application meeting scheduled or completed
- ☐ Code basis confirmed (NFPA 2, local amendments)
- ☐ Hazard review approach defined (PHA, HAZOP, LOPA scope)

INCENTIVES & FINANCE

- ☐ 45V vs. 48(a)(15) election strategy determined
- ☐ Electricity procurement plan supports target CI tier
- ☐ EAC sourcing strategy defined (if applicable)
- ☐ Third-party verification contractor identified
- ☐ Begin construction deadline accommodated in schedule

⚠ REGULATORY SNAPSHOT (JAN 2026)

Begin construction deadline: Confirm current eligibility requirements with qualified tax counsel before project commitment. Legislative changes in 2025 may have altered the original IRA timeline (Dec 31, 2032). Projects that established "begin construction" via the 5% safe harbor or physical work test before any deadline change remain grandfathered.

Strategic imperative: If your project has not yet safe-harbored, prioritize confirming the current deadline and eligibility pathway with counsel immediately.

DISCLAIMER

This guide provides general information only and does not constitute tax, legal, or financial advice. Incentive eligibility, credit amounts, and compliance requirements are subject to change. Confirm all 45V-related decisions with qualified tax counsel and the latest IRS/Treasury guidance.

2. SYSTEM OVERVIEW

Tobe Energy's electrolyzer platform uses proprietary isothermal electrolysis to achieve industry-leading efficiency without platinum-group metals, membranes, or caustic electrolytes.

PRODUCT LINE

MODEL	OUTPUT	POWER	FOOTPRINT	APPLICATION
T-25	~25 kg/day	50 kW	35" × 24" × 30"	Pilot, R&D, distributed
T-125	~125 kg/day	250 kW	20' ISO container	Commercial, fleet fueling
T-2500	~2,500 kg/day	~3.7 MW	Multi-container	Industrial, hub-scale

CORE SUBSYSTEMS

Electrolyzer Stack

304 stainless steel construction. Membrane-free, caustic-free design. Near-ambient operation (<50°C). Integrated power electronics with LLC resonant topology.

Water Treatment

Integrated RO + deionization polishes feedwater to <0.1 µS/cm. Accepts municipal or industrial water sources. Net consumption: 9–10 L DI water per kg H_2.

Gas Processing

Hydrogen dryer/purifier achieves ≥99.9995% purity. PSA dryer with dual-train beds for continuous operation.

Controls & Safety

Allen-Bradley or Siemens PLC. OPC-UA and Modbus TCP protocols. SIL 2-capable safety instrumented system. Integrated gas detection and ESD.

KEY PERFORMANCE SPECIFICATIONS

~42	10–100%	<50°C	≥95%
KWH/KG (SYSTEM)	TURNDOWN RANGE	OPERATING TEMP	DESIGN AVAILABILITY

EFFICIENCY METRICS EXPLAINED

Specific energy consumption: ~42 kWh per kg H_2 produced (AC input to system boundary, including BOP).
Electrical efficiency: ~94% on HHV basis (39.4 kWh/kg ÷ 42 kWh/kg); ~79% on LHV basis (33.3 kWh/kg ÷ 42 kWh/kg).
HHV = Higher Heating Value (39.4 kWh/kg). LHV = Lower Heating Value (33.3 kWh/kg). kWh/kg is energy input; efficiency % varies by reference.

SYSTEM BOUNDARY & SCOPE SPLIT

Understanding what's included in Tobe's supply vs. what's the EPC/owner's scope is critical for project planning.

ITEM	TOBE SUPPLY	EPC/OWNER	NOTES
Electrolyzer stack + power electronics	✓		Core system
Integrated RO/DI water treatment	✓		On-skid, containerized
Hydrogen dryer/purifier	✓		PSA system
PLC/HMI controls	✓		SCADA-ready
Safety instrumented system	✓		SIL 2 capable
Site preparation & foundations		✓	
Electrical service & switchgear		✓	To Tobe disconnect
Water supply piping		✓	To Tobe connection
H_2 compression (if >350 psig)	Optional	✓	Depends on storage/use
H_2 storage vessels	Optional	✓	Configuration-dependent

UTILITY TIE-IN POINTS

Electrical

- 480V 3-phase, 60 Hz (standard)
- Capacitive load behavior, low THD
- Minimal inrush current
- Single point of connection per system

Water

- Municipal or industrial supply acceptable
- 15–20 L raw water per kg H_2
- RO reject: ~50% of raw intake
- Connection: 1" NPT typical

INSTRUMENT AIR

Clean, dry compressed air at ~7 bar (100 psi) for valve actuators and purge sequences. Demand is approximately 0.3 SCMM (~10 scfm) for a 500 kg/day installation.

3. SITE REQUIREMENTS

Use this section to quickly screen whether a site is "electrolyzer-friendly" before committing to detailed engineering.

3.1 PHYSICAL & CIVIL REQUIREMENTS

REQUIREMENT	T-25 (PILOT)	T-125 (COMMERCIAL)	T-2500 (INDUSTRIAL)
Minimum pad area	200 ft² (20 m²)	800 ft² (75 m²)	5,000+ ft² (500 m²)
With BOP + storage	500 ft² (50 m²)	2,500 ft² (230 m²)	15,000+ ft² (1,400 m²)
Crane access	Forklift sufficient	Mobile crane or forklift	Crane + laydown area
Vehicle access	Standard truck	Container delivery	Heavy haul + tube trailers

3.2 CODES & SAFETY-DRIVEN LAYOUT

Layout is governed primarily by NFPA 2 (Hydrogen Technologies Code) and local AHJ requirements. Key drivers:

- **Storage quantity and pressure** — larger/higher pressure = greater setbacks
- **Vent/relief discharge locations** — must be away from air intakes, property lines
- **Occupancy classification** — proximity to occupied buildings
- **Electrical area classification** — Class I, Division 2 zones around potential leak points

> **SEPARATION DISTANCE GUIDANCE**
>
> Separation distances are **configuration-dependent** and determined by NFPA 2 Chapter 6 and NFPA 55 tables based on: storage quantity, operating pressure, ventilation design, and occupancy classification. Do not assume a single setback value applies to all configurations. Work with your AHJ to confirm applicable distances for your specific design.

3.3 ENVIRONMENTAL & STRUCTURAL DESIGN BASIS

PARAMETER	SPECIFICATION	NOTES
Ambient temperature	**-15°C to +45°C (5°F to 113°F)**	Derating above 40°C
Extended range	–30°C to +50°C	Available on request
Structural codes	ASCE 7-22, IBC 2024	Risk Category III

3.4 WATER REQUIREMENTS

Water is the feedstock for electrolysis. The stoichiometric minimum is ~9 liters per kg H_2 produced.

PARAMETER	VALUE	NOTES
DI water to stack	9–10 L/kg H_2	After RO/DI polishing
Raw water makeup	**15-20 L/kg H_2**	Including RO reject stream
DI water quality	<0.1 µS/cm	Integrated RO/DI achieves this
RO recovery rate	~50% typical	Varies with feedwater quality

Feedwater Quality Limits

The integrated RO/DI system accepts a range of feedwater quality. Exceedances may require pretreatment.

PARAMETER	ACCEPTABLE RANGE	IF EXCEEDED
TDS	<2,000 mg/L	Add softener or additional RO stage
Hardness (as $CaCO_3$)	<250 mg/L	Add water softener
Chloride	<250 mg/L	Evaluate materials compatibility
Silica	<25 mg/L	Add silica-specific pretreatment
TOC	<5 mg/L	Add activated carbon filtration
Iron	<0.3 mg/L	Add iron removal system
pH	6.5–8.5	Add pH adjustment

RO REJECT DISCHARGE

The RO system produces a reject stream (~50% of raw intake) with concentrated dissolved solids. Discharge options include: sanitary sewer (check local limits), evaporation pond, or haul-off. For TDS >5,000 mg/L in reject, an industrial user permit may be required. Confirm discharge pathway during site screening.

Daily Water Demand Examples

SYSTEM	H_2 OUTPUT	RAW WATER	RO REJECT
T-25	25 kg/day	~100 gal/day	~50 gal/day
T-125	125 kg/day	~500 gal/day	~250 gal/day
T-2500	2,500 kg/day	~10,000 gal/day	~5,000 gal/day

3.5 ELECTRICAL REQUIREMENTS

SYSTEM	NAMEPLATE	TYPICAL SERVICE	NOTES
T-25 (×2)	100 kW	200A @ 480V 3φ	Behind-the-meter feasible
T-125 (×2)	500 kW	800A @ 480V 3φ	Dedicated feeder typical
T-2500	~3.7 MW	Medium voltage + transformer	Utility coordination required

GRID-FRIENDLY LOAD BEHAVIOR

Tobe's resonant LLC power electronics exhibit **capacitive load behavior**, providing inherently smoother power draw than traditional rectifier-based electrolyzers. Low THD, minimal inrush current.

4. PERMITTING ROADMAP

Permitting is often the longest lead-time item in hydrogen projects. Front-loading this work reduces schedule risk.

4.1 TYPICAL PERMITTING STAKEHOLDERS

AUTHORITY	SCOPE	KEY CODES
Building Department	Structural, mechanical, plumbing	IBC, IMC, IPC
Fire Marshal	Fire protection, hazardous materials	NFPA 2, NFPA 55, IFC
Electrical Inspector	Electrical installation, area classification	NFPA 70 (NEC)
Utility	Interconnection, service upgrades	Utility standards, IEEE
Environmental Agency	Water discharge, stormwater, air	State/local regulations

4.2 PERMITTING SEQUENCE

1. **Pre-Application Meeting**
   Week 1–2
   Meet with fire, building, planning to confirm code basis
2. **Code Compliance Narrative**
   Week 3–4
   Document how project meets NFPA 2, NEC, local codes
3. **Submit Permit Package**
   Week 5–6
   Complete drawings, equipment data, hazard analysis
4. **Plan Check & Comments**
   Week 7–16
   AHJ review, respond to comments
5. **Permits Issued**
   Week 12–36
   Construction permits in hand

4.3 TYPICAL TIMELINE RANGES

SCENARIO	DURATION	CHARACTERISTICS
Fast Track	2–4 months	Industrial zone, experienced AHJ, small storage
Typical	4–9 months	Standard AHJ, moderate storage
Complex	9–18+ months	Large storage, contested zoning, environmental review

4.4 BUILT-IN SAFETY SYSTEMS

Tobe systems include multiple layers of engineered safety aligned with NFPA 2, ASME, and ISA/IEC standards.

SYSTEM	FUNCTION	STANDARD
H_2 Gas Detection	Fixed detectors at all potential leak points, calibrated to 1% H_2	NFPA 2
Forced Ventilation	Continuous dilution airflow, interlocked with gas detection	NFPA 2 §7.1
Emergency Shutdown	Manual pushbuttons + automated PLC logic; depressurization, isolation	ISA 84
Pressure Relief	PRDs sized per ASME VIII, routed to vertical vent stacks	ASME, CGA S-1
Safety Instrumented System	SIL 2-capable PLC with segregated safety logic	IEC 61511

CAUSTIC-FREE ADVANTAGE

Unlike alkaline electrolyzers, Tobe systems require **no caustic chemical handling**. This eliminates secondary containment requirements, chemical spill plans, and HAZMAT placarding.

4.5 ISO 22734 LISTING STATUS

CERTIFICATION STATUS (JAN 2026)

Current stage: In-process with NRTL (CSA/TÜV/UL pathway under evaluation).
Target completion: Q2-Q3 2026.
Scope: T-25, T-125, and T-2500 models per ISO 22734 (Hydrogen generators using water electrolysis).

Interim permitting path: For projects requiring NTP before certification completion, Tobe supports NRTL field evaluation or special inspection by the AHJ. This approach provides an alternative compliance pathway per NFPA 2 §1.5 (equivalency provisions). Typical field evaluation scope and duration: 4-8 weeks; cost shared per project agreement.

4.6 TOBE'S PERMITTING SUPPORT

- **BIM-compatible 3D models** — Revit format or IFC
- **Equipment datasheets** — Pressures, volumes, relief device sizing
- **Code basis report** — NFPA 2, 70, 55; IFC; ASME BPVC; ISO 22734
- **Hazard narrative support** — ESD philosophy, detection philosophy
- **AHJ meeting participation** — Code interpretation support

5. BALANCE OF PLANT INTEGRATION

A complete hydrogen production facility requires more than just the electrolyzer. This section covers typical BOP systems.

5.1 WATER TREATMENT

Tobe-Supplied (Integrated)

- RO membrane system
- EDI or DI polishing
- Product water distribution
- Controls and instrumentation

Site-Provided

- Raw water supply piping
- Feed tank (optional buffer)
- RO reject handling/discharge
- Pretreatment (if high TDS)

5.2 HYDROGEN GAS HANDLING

1. **Dryer/Purifier** — Tobe-supplied PSA achieves ≥99.9995% purity
2. **Buffer Storage** — Low-pressure storage to smooth production/demand
3. **Compression** — If storage or delivery pressure exceeds ~350 psig
4. **High-Pressure Storage** — Cascade banks, tube trailers, or pipeline

5.3 THERMAL MANAGEMENT

Tobe's isothermal design generates minimal waste heat. The system operates at <50°C with passive or minimal active cooling. For most installations, integrated air cooling is sufficient—no external chiller required.

5.4 CONTROLS & SCADA INTEGRATION

INTERFACE	PROTOCOL	NOTES
Primary control	OPC-UA, Modbus TCP	Standard industrial protocols
Data historian	CSV export, REST API	For compliance reporting
Remote monitoring	Outbound MQTT tunnel	MFA, customer-controlled
Cybersecurity	ISA/IEC 62443	Industrial automation standard

6. RENEWABLE INTEGRATION

Pairing electrolyzers with renewable power is essential for achieving the lowest 45V credit tiers and true green hydrogen.

6.1 ELECTRICITY PROCUREMENT OPTIONS

APPROACH	DESCRIPTION	45V IMPLICATIONS
On-site generation	Dedicated solar/wind behind-the-meter	**Best for Tier 1 (<0.45 kg CO_2e)**
Physical PPA	Direct wire from renewable project	**Excellent for Tier 1**
Sleeved PPA	Renewable PPA with utility delivery	Good; requires EAC documentation
Virtual PPA + EACs	Financial hedge + separate EAC procurement	Acceptable; hourly matching from 2030
Grid only	Standard utility power	Typically does not qualify for 45V

6.1.1 THE "THREE PILLARS" FOR EAC-BASED COMPLIANCE

For projects using Energy Attribute Certificates (EACs) to demonstrate clean electricity use, final Treasury regulations require satisfaction of three requirements:

PILLAR	REQUIREMENT	WHAT IT MEANS
Incrementality	Clean electricity source placed in service within 36 months of electrolyzer	EACs must come from "new" generation, not existing facilities
Deliverability	Same grid region as hydrogen facility	Generator and electrolyzer must be in the same eGRID subregion (or equivalent)
Temporal Matching	Electricity generation matched to consumption	Annual matching through 2029; **hourly matching from Jan 1, 2030**

> **EAC COMPLIANCE WORKFLOW**
>
> 1. Design electricity procurement strategy → 2. Confirm incrementality, deliverability, temporal matching → 3. Implement compliant metering → 4. Procure and retire EACs → 5. Run 45VH2-GREET model → 6. Third-party verification → 7. Support Form 7210 filing

6.2 TOBE'S RENEWABLE COMPATIBILITY

10–100%	Seconds	None	Capacitive
TURNDOWN RANGE	STARTUP TIME	COLD START PENALTY	GRID BEHAVIOR

Why This Matters

- **No warm-up energy wasted** — Instant on/off during cloud transients or wind lulls
- **No thermal cycling stress** — Near-ambient operation eliminates hot/cold fatigue
- **Wide turndown** — Follow solar/wind curves without shutdown/restart cycles
- **Grid-friendly** — Capacitive load behavior reduces grid stress

DESIGN METERING NOW

Even if your project will be placed in service before 2030, design metering and data systems to support **hourly granularity**. This future-proofs 45V compliance over the 10-year credit period.

7. 45V COMPLIANCE & CARBON INTENSITY

The Section 45V Clean Hydrogen Production Tax Credit is the most significant incentive for U.S. hydrogen projects.

7.1 THE 45V CREDIT AT A GLANCE

TIER	LIFECYCLE EMISSIONS	PTC (FULL RATE)	ITC (FULL RATE)
Tier 1	<0.45 kg CO_2e/kg H_2	**$3.00/kg**	30%
Tier 2	0.45 – 1.5 kg CO_2e/kg H_2	$1.00/kg	10%
Tier 3	1.5 – 2.5 kg CO_2e/kg H_2	$0.75/kg	7.5%
Tier 4	2.5 – 4.0 kg CO_2e/kg H_2	$0.60/kg	6%

Full rates require PWA compliance. Base rates (without PWA) are 20% of full rate.

7.2 CRITICAL DEADLINES & SAFE HARBOR

⚠ REGULATORY SNAPSHOT (JAN 2026)

Begin construction deadline: Verify the current deadline with qualified tax counsel. The original IRA deadline was Dec 31, 2032, but legislative action in 2025 may have accelerated this.

Safe harbor methods (per IRS guidance):
1. *Physical Work Test* — Begin significant physical work on-site or on custom equipment under binding contract.
2. *5% Safe Harbor* — Incur ≥5% of total project cost under binding written agreements (most common for large projects).

Once begun, projects typically have 4 years to be placed in service to satisfy continuity requirements. Confirm all details with counsel.

7.3 CARBON INTENSITY WITH TOBE

Hydrogen lifecycle CI depends primarily on electricity source. The following table shows illustrative scenarios using Tobe's system efficiency of ~42 kWh/kg.

CI CALCULATION FORMULA

H_2 CI (kg CO_2e/kg) ≈ (kWh/kg H_2) × (grid emissions, kg CO_2e/kWh) + upstream factors
Note: Full lifecycle CI from 45VH2-GREET includes additional pathway terms. Values below are simplified estimates.

ELECTRICITY SOURCE	GRID EMISSIONS (KG CO_2E/KWH)	EST. H_2 CI (KG CO_2E/KG)	45V TIER
100% Renewable (on-site/direct PPA)	~0	**<0.45**	**Tier 1 ($3.00)**
Wind/Solar PPA + EACs	~0.01–0.02	0.4–0.8	Tier 1–2
Low-carbon grid (nuclear, hydro mix)	~0.02–0.04	0.8–1.7	Tier 2
Average U.S. grid (unmatched)	~0.40	~17	Does not qualify

Values are illustrative. Run 45VH2-GREET for your specific electricity procurement pathway to confirm tier eligibility. Unmatched grid power typically does not qualify for 45V.

7.4 VERIFICATION REQUIREMENTS

45V requires annual third-party verification of production volumes and emissions intensity. The verification report is required for tax filings.

What Gets Verified

- Total hydrogen production volume (kg)
- Lifecycle GHG emissions rate (kg CO_2e/kg H_2)
- Electricity consumption and source documentation
- EAC retirement records (if applicable)
- Consistency with GREET model inputs

7.5 THE 45V EVIDENCE BINDER

Start collecting documentation on Day 1:

Design & Commissioning

- Site single-line diagram
- Metering architecture
- Equipment specifications
- Commissioning reports
- Performance test results

Operations (Ongoing)

- Electricity procurement contracts
- EAC retirement records
- Hourly power and H_2 data
- Water input records
- GREET model runs

7.6 45V QUICK REFERENCE

ITEM	SPECIFICATION
Credit period	10 years from placed in service
Begin construction deadline	Confirm current deadline with tax counsel (original: Dec 31, 2032)
Maximum credit (Tier 1 + PWA)	**$3.00/kg (inflation-adjusted)**
Emissions model	45VH2-GREET (Argonne)
Hourly matching required	For electricity from Jan 1, 2030 onward
Verification	Annual, by unrelated third party

8. PROJECT ECONOMICS WITH INCENTIVES

Understanding how 45V incentives interact with project economics is critical for investment decisions.

8.1 LCOH WITH TOBE SYSTEMS

ELECTRICITY PRICE	LCOH (PRE-45V)	45V CREDIT (TIER 1)	NET LCOH
$0.02/kWh	$1.15/kg	–$3.00/kg	**–$1.85/kg**
$0.04/kWh	$1.99/kg	–$3.00/kg	**–$1.01/kg**
$0.06/kWh	$2.84/kg	–$3.00/kg	**–$0.16/kg**
$0.08/kWh	$3.68/kg	–$3.00/kg	$0.68/kg

Assumptions: Tobe CAPEX ($446/kW prototype), 90% CF, 8% WACC, 20-year life.

UNDERSTANDING "NEGATIVE LCOH"

With Tier 1 45V credits and low electricity costs, modeled net LCOH can be negative **during the 10-year credit period**. This indicates strong project economics but does *not* guarantee profit at any hydrogen price. Actual returns depend on: capacity factor achieved, credit tier qualification (verified annually), monetization pathway (direct use vs. credit transfer), and O&M and other project costs not captured in LCOH. See sensitivity tables for impact of key variables.

8.2 ECONOMIC SENSITIVITY

Project economics are sensitive to capacity factor, electricity price, and 45V tier achieved:

SCENARIO	CAPACITY FACTOR	ELEC. PRICE	TIER	NET LCOH (CREDIT PERIOD)
Base Case	90%	$0.04/kWh	Tier 1	**–$1.01/kg**
Lower utilization	70%	$0.04/kWh	Tier 1	–$0.50/kg
Higher elec. cost	90%	$0.08/kWh	Tier 1	$0.68/kg
Tier 2 achieved	90%	$0.04/kWh	Tier 2	$0.99/kg

Post-credit period (years 11–20): Add ~$3.00/kg to net LCOH when 45V credits expire. Long-term economics depend on hydrogen market prices at that time.

8.3 PTC VS. ITC ELECTION

FACTOR	FAVORS PTC (45V)	FAVORS ITC (48)
Utilization	**High (>70% CF)**	Low (<50% CF)
CAPEX intensity	Lower CAPEX/kg	**Higher CAPEX/kg**
Timing preference	Spread over 10 years	**Front-loaded**
CI confidence	**Confident in tier**	Uncertain/variable CI

9. DEPLOYMENT TIMELINE

The following provides a default timeline that developers can adapt to their specific project.

9.1 TYPICAL PROJECT PHASES

PHASE	DURATION	KEY OUTPUTS	PRIMARY RISKS
Site Screening	1–3 mo	Site shortlist, offtake term sheet	Unclear use case
Power & Water Feasibility	1–4 mo	Utility letters, water source plan	Interconnect delays
FEED & Permitting	3–9 mo	Permit package, AFC drawings	AHJ iterations
Procurement	3–6 mo	Equipment ordered, delivered	Long-lead items
Construction	4–8 mo	Civil, mech, elec complete	Labor, weather
Commissioning	2–4 wk	SAT closeout, performance test	Integration issues

9.2 TOTAL TIMELINE RANGES

6–9
MONTHS (FAST TRACK)

12–18
MONTHS (TYPICAL)

18–24+
MONTHS (COMPLEX)

9.3 TOBE EQUIPMENT LEAD TIMES

ITEM	LEAD TIME	NOTES
T-25 system	**12–16 weeks**	From PO to ship-ready
T-125 system	**16–20 weeks**	From PO to ship-ready
T-2500 (MW-scale)	20–28 weeks	Custom engineering required

> **45V SCHEDULE GATING**
>
> If targeting 45V, explicitly track the "Begin Construction" milestone. Build schedule margin for the December 31, 2027 deadline (or December 31, 2025 if proposed legislation passes).

10. TOBE SUPPORT SERVICES

Tobe provides comprehensive support from project concept through operations.

10.1 DEVELOPER-READY DELIVERABLES

DELIVERABLE	DESCRIPTION	WHEN PROVIDED
Site screening support	Utility and code red flag identification	Pre-FEED
Budget-grade design	Preliminary layout, CAPEX estimate (±30%)	30 days from data
BIM models / GA drawings	Revit or IFC format	FEED
Equipment datasheets	Pressures, volumes, electrical for permitting	FEED
Hazard narrative support	ESD philosophy, detection philosophy	Permitting
Commissioning plan	FAT/SAT procedures, acceptance criteria	Pre-delivery
Operator training	On-site training, operations manual	Commissioning
45V support pack	GREET inputs, metering plan, evidence templates	Operations

10.2 ENGAGEMENT TIERS

Equipment Only

- Electrolyzer system(s)
- Standard documentation
- FAT and remote SAT support
- 12-month warranty

Turnkey Package

- Everything in Equipment Only, plus:
- Compression and storage
- Containerized integration
- On-site commissioning
- Extended warranty options

10.3 CONTACT

Ready to start your project?

Email:

Web: tobe.energy

Request: Site data form, budget-grade design, pilot scoping

11. CHECKLISTS & NEXT STEPS

BUDGET-GRADE DESIGN (30 DAYS)

Provide the following to receive a preliminary layout and ±30% CAPEX estimate:

- ☐ Site address and parcel information
- ☐ Zoning classification
- ☐ Target H_2 production rate (kg/day)
- ☐ Offtake specification (pressure, purity, delivery method)
- ☐ Available electrical service (voltage, capacity)
- ☐ Water source and quality (if known)
- ☐ Expected electricity price ($/kWh)
- ☐ 45V intent (yes/no) and target tier

PERMIT-READY PACKAGE (90–120 DAYS)

Additional information required for permit-level engineering:

- ☐ Geotechnical report
- ☐ Survey / topographic information
- ☐ Utility interconnect confirmation
- ☐ Water quality analysis
- ☐ AHJ contacts and any preliminary discussions
- ☐ Storage configuration requirements
- ☐ Integration requirements (SCADA, controls)

NEXT STEPS

1. **Complete Site Screening**
   Use Section 3 checklist to identify viable sites
2. **Request Site Data Form**
   Email for Appendix A template
3. **Submit Completed Form**
   Tobe will provide budget-grade design within 30 days
4. **Review & Refine**
   Iterate on layout, scope, and economics
5. **Proceed to FEED**
   Engage EPC, finalize permitting approach, place equipment order

APPENDIX A: SITE DATA REQUEST FORM

Complete and return to for budget-grade design.

CATEGORY	DATA NEEDED	YOUR INPUT
Site	Address / Parcel ID	
	Zoning classification	
	Available area (ft² or m²)	
Power	Available service (voltage, capacity)	
	Expected electricity price ($/kWh)	
	Renewable/PPA intent (Y/N)	
Water	Source (municipal, well, other)	
	Discharge path (sewer, permit)	
H_2 Offtake	Target production (kg/day)	
	Required pressure (psig)	
	Delivery method (pipeline, truck, on-site)	
Storage	On-site storage needed (Y/N)	
	Storage quantity (kg)	
Incentives	45V intent (Y/N)	
	Target CI tier (1/2/3/4)	
Schedule	Target COD date	
	Safe harbor deadline sensitivity	
Contact	Name, email, phone	

APPENDIX B: PERMIT PACKAGE INDEX

Typical submittal package for AHJ review. Actual requirements vary by jurisdiction.

DRAWINGS

- ☐ Plot plan with property lines, setbacks, separation distances
- ☐ General arrangement drawings (plan, elevation, sections)
- ☐ Process Flow Diagram (PFD)
- ☐ Piping & Instrumentation Diagrams (P&IDs)
- ☐ Electrical one-line diagram
- ☐ Electrical area classification drawings
- ☐ Vent stack location and design basis
- ☐ Fire protection layout (if applicable)

EQUIPMENT DOCUMENTATION

- ☐ Equipment list with tag numbers
- ☐ Datasheets (pressures, volumes, materials, ratings)
- ☐ Relief device sizing calculations and set pressures
- ☐ Electrical load list
- ☐ Hazardous area equipment certifications

SAFETY & COMPLIANCE NARRATIVES

- ☐ Code compliance narrative (NFPA 2, NEC, local codes)
- ☐ Hazard analysis summary (PHA/HAZOP/what-if)
- ☐ Emergency shutdown (ESD) cause & effect matrix
- ☐ Fire protection narrative
- ☐ Ventilation design basis
- ☐ Emergency response plan outline

THIRD-PARTY DOCUMENTATION

- ☐ Equipment listing certificates (ISO 22734, UL, CSA)
- ☐ Pressure vessel certifications (ASME U-stamp)
- ☐ Electrical panel certifications (UL 508A)
- ☐ Structural calculations (stamped by PE)

APPENDIX C: 45V EVIDENCE BINDER CHECKLIST

Maintain this documentation throughout the 10-year credit period.

DESIGN & COMMISSIONING PHASE

- ☐ Site single-line electrical diagram
- ☐ Metering architecture documentation
- ☐ Meter calibration certificates
- ☐ Equipment specifications (as-built)
- ☐ Commissioning reports
- ☐ Performance test results (efficiency verification)
- ☐ Begin construction documentation (5% safe harbor evidence)
- ☐ Placed in service date documentation

ELECTRICITY SOURCING

- ☐ Power purchase agreements (PPAs)
- ☐ Utility interconnection agreements
- ☐ EAC purchase contracts
- ☐ EAC retirement records (with timestamps)
- ☐ Grid region documentation (eGRID subregion)

EAC Data Fields Checklist

Each EAC record must include:

FIELD	PURPOSE
Generator facility ID	Links to specific generation source
Generator COD (commercial operation date)	Verifies incrementality (within 36 months)
eGRID subregion	Verifies deliverability
Generation timestamp (hourly from 2030)	Verifies temporal matching
MWh quantity	Volume reconciliation
EAC certificate/serial number	Audit trail
Retirement record and date	Proves retirement on behalf of project

OPERATIONAL DATA (ONGOING)

- ☐ Hourly electricity consumption data
- ☐ Hourly hydrogen production data
- ☐ Water input records
- ☐ Outage and downtime logs
- ☐ Efficiency calculations and trends

Metering & Data Retention Requirements

PARAMETER	REQUIREMENT
Power meter accuracy	Revenue-grade (ANSI C12.20, Class 0.2 or better)
H_2 flow measurement	Coriolis or thermal mass with ±1% accuracy
Sampling interval	≤15 minutes (aggregate to hourly for reporting)
Timestamp sync	NTP or PTP synchronized, UTC reference
Data retention	≥12 years (10-year credit + 2-year buffer)
Audit trail	Immutable logs, version control on data exports

GREET MODELING

- ☐ 45VH2-GREET model version documentation
- ☐ Model input parameters
- ☐ Model run outputs
- ☐ GREET version lock-in election (if applicable)

VERIFICATION & COMPLIANCE

- ☐ Third-party verifier contract
- ☐ Annual verification reports
- ☐ PWA compliance documentation
- ☐ IRS Form 7210 filings

APPENDIX D: CODE & STANDARDS REFERENCE

PRIMARY CODES

CODE	TITLE	APPLICATION
NFPA 2	Hydrogen Technologies Code	Primary code for H_2 systems
NFPA 55	Compressed Gases and Cryogenic Fluids	Storage quantities, separation
NFPA 70	National Electrical Code (NEC)	Electrical installation
IBC	International Building Code	Building/structural
IFC	International Fire Code	Fire protection, hazmat

EQUIPMENT & DESIGN STANDARDS

STANDARD	TITLE	APPLICATION
ISO 22734	Hydrogen generators using water electrolysis	Electrolyzer product standard
ASME BPVC	Boiler and Pressure Vessel Code	Pressure vessels, piping
ASME B31.3	Process Piping	Piping design
ASME B31.12	Hydrogen Piping and Pipelines	H_2-specific piping
SAE J2719	Hydrogen Fuel Quality	Fuel cell grade purity
ISO 14687	Hydrogen fuel quality	Purity specifications

SAFETY & CONTROLS STANDARDS

STANDARD	TITLE	APPLICATION
IEC 61511	Functional safety - SIS	SIS design
NFPA 68	Explosion Protection by Deflagration Venting	Enclosure protection
IEC 60079-10-1	Classification of areas - Explosive gas	Zone classification
ISA/IEC 62443	Industrial automation cybersecurity	Control system security

ELECTRICAL STANDARDS

STANDARD	TITLE	APPLICATION
IEEE 519	Harmonic Control in Electric Power Systems	Power quality, THD limits
IEEE 1547	Interconnection of Distributed Energy Resources	Grid interconnection (where applicable)
UL 508A	Industrial Control Panels	Electrical panel listing

Note: Code editions vary by jurisdiction. Confirm AHJ-adopted versions (e.g., IBC 2021 vs. 2024, NEC 2020 vs. 2023) during pre-application meetings.

APPENDIX E: ELECTRICAL DATA SHEET

Use this data for utility interconnection studies, EPC design, and power quality analysis.

POWER SUPPLY REQUIREMENTS

PARAMETER	T-25	T-125	T-2500
Nominal voltage	480V 3φ 60Hz	480V 3φ 60Hz	4.16kV or 480V 3φ 60Hz
Voltage tolerance	±10%		
Frequency tolerance	±2 Hz		
Nameplate power	50 kW	250 kW	~3.7 MW
Full load current (480V)	~65 A	~320 A	N/A (MV service)

POWER QUALITY CHARACTERISTICS

PARAMETER	TYPICAL VALUE	NOTES
Power factor	0.95–0.99 (leading)	Capacitive load behavior
PF at 10% load	~0.90 (leading)	
PF at 50% load	~0.96 (leading)	
PF at 100% load	~0.98 (leading)	
THD (current)	<5%	Compliant with IEEE 519
THD (voltage)	<3%	At point of common coupling
Inrush current	<1.2× FLA	Soft-start via LLC topology

DYNAMIC BEHAVIOR

PARAMETER	VALUE	NOTES
Ramp rate (up)	10–100% in <10 sec	Limited by controls, not power electronics
Ramp rate (down)	100–10% in <5 sec	
Step change limit	25% per second	Configurable in PLC
Cold start to full power	<60 seconds	No thermal warmup required

PROTECTION REQUIREMENTS

ITEM	REQUIREMENT
Main disconnect	Lockable, load-break rated
Overcurrent protection	Breaker or fused disconnect per NEC 240
Ground fault protection	Per NEC 230.95 (where required)
Short-circuit withstand	Coordinate with upstream SCCR

INTERCONNECT STUDY INPUTS CHECKLIST

Provide to utility/EPC: (1) Nameplate kW and voltage; (2) Full load amps; (3) PF at operating points; (4) THD levels; (5) Inrush and step-change behavior; (6) Desired interconnect location and metering point.

TOBE.ENERGY

GET STARTED

Ready to Deploy Green Hydrogen?

Contact Tobe Energy to discuss your project requirements, receive a budget-grade design, or schedule a site assessment.

Email: