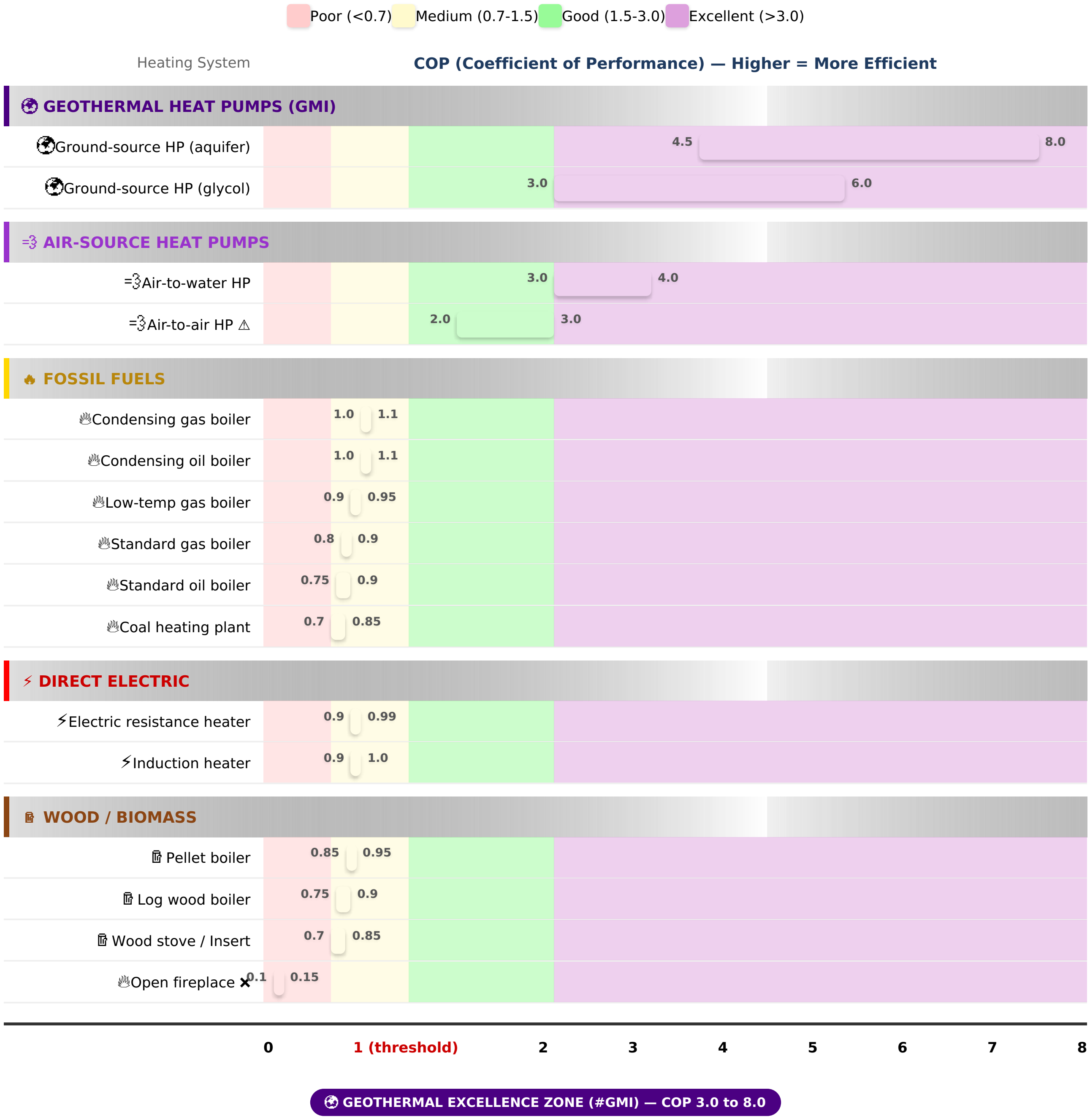
# COP Efficiency Ranges by Heating System

Coefficient of Performance Comparison Chart

**CENTRAL UNION – Energy Efficiency Africa-Europe**




## 💡 Key Insights

🏆 **Best performer:** Ground-source HP (aquifer) with COP 4.5-8.0 delivers up to **8× more heat** than electricity consumed. Stable year-round performance.

⚠ **Air-source warning:** Advertised COPs measured at +7°C. Real-world performance drops significantly in cold weather + defrost cycles reduce efficiency further.

🌡 **Geothermal advantage:** Source temperatures remain stable (10-15°C) regardless of outdoor weather. No defrost cycles needed.

✕ **Worst performer:** Open fireplace at COP 0.10-0.15 loses **70-90% of energy** up the chimney! Even wood stoves are 5× better.

**Technical notes:** COP values per EN 14511 / EN 14825 standards. For combustion systems, efficiency (%) is shown as "equivalent COP" where 100% = COP 1.0. Color coding follows NF P98-332 (French underground utility standard): Red = Electricity, Yellow = Gas/Hydrocarbons, Violet = Heating/Cooling networks, Brown = Biomass.

**"Two continents, one physics, one common energy future"**

CENTRAL UNION – Energy Efficiency Africa-Europe | Reference Document January 2026

# CENTRAL UNION

*Africa – Europe*

## Reference Guide: Energy Efficiency and COP

*"Two continents, one physics, one common energy future"*

**Color code based on NF P98-332 standard:** Red=Electricity | Yellow=Gas/Hydrocarbons | Violet=Heating/Cooling (Geothermal)

## Founding Conviction

**Energy is not infinite.** The main criterion that should guide our energy choices is the **COP (Coefficient of Performance)** – the ratio between useful energy produced and energy consumed to produce it.

## 1. Understanding COP and Efficiency

COP (Coefficient of Performance) is a ratio measuring the efficiency of a heating system. A COP of 4 means that for 1 kWh of electricity consumed, the system produces 4 kWh of heat.

For combustion systems (oil, gas, wood), we use **efficiency** expressed as a percentage. 90% efficiency means 90% of the fuel energy is converted to useful heat.

**Important note:** For comparison purposes, efficiency is expressed here as "equivalent COP" where 100% = COP 1.0.

## 1.1 COP and Efficiency of Heating Systems

| Heating System | COP / Efficiency | Equivalent COP | Observation |
|---|---|---|---|
| **FOSSIL FUELS** | | | |
| Standard oil boiler | 75-90% | 0.75 - 0.90 | Flue losses |
| Low-temperature oil boiler | 93-95% | 0.93 - 0.95 | Adapted radiators required |
| Condensing oil boiler | 100-110% (GCV) | 1.00 - 1.10 | Steam recovery |
| Standard gas boiler | 80-90% | 0.80 - 0.90 | Old standard |
| Low-temperature gas boiler | 90-95% | 0.90 - 0.95 | Notable improvement |
| Condensing gas boiler | 100-110% (GCV) | 1.00 - 1.10 | Best fossil technology |
| Coal heating plant | 70-85% | 0.70 - 0.85 | Highly polluting |
| **WOOD HEATING** | | | |
| Open fireplace | 10-15% | 0.10 - 0.15 | 70% goes up the chimney! |
| Closed insert / Wood stove | 70-85% | 0.70 - 0.85 | Much better |
| Log wood boiler | 75-90% | 0.75 - 0.90 | Manual loading |
| Pellet boiler | 85-95% | 0.85 - 0.95 | Automated |
| **DIRECT ELECTRIC HEATING** | | | |
| Electric resistance heater | 90-99% | 0.90 - 0.99 | Direct Joule effect |
| Oil-filled radiator | 90-99% | 0.90 - 0.99 | Thermal inertia |
| Induction heater (e.g. Pereko - Poland) | 90-100% | 0.90 - 1.00 | Effective gas backup replacement |
| **HEAT PUMPS (HP) – heating with cooling bonus** | | | |
| Air-to-air HP | COP 2 - 3 | 2.0 - 3.0 | ⚠️ Performance drops with cold + defrost cycles |
| Air-to-water HP | COP 3 - 4 | 3.0 - 4.0 | Feeds central heating |
| Geothermal HP ground-water (glycol) – GMI-GSHP | COP 3.0 - 6.0 | 3.0 - 6.0 | Vertical probes 10-200m. ~1m/1m² to heat |
| Geothermal HP water-water (aquifer) – GMI-GSHP | COP 4.5 - 8.0 | 4.5 - 8.0 | Depends on aquifer flow, often very economical |

**Legend:** Red = low efficiency (<0.7) | Yellow = medium (0.7-1.5) | Green = good (>2.0) | Violet = geothermal excellence

⚠️ **Critical note on air-source heat pumps:** Advertised COPs are measured at +7°C. In real conditions, performance collapses with cold weather and defrost cycles. Geothermal – even shallow – provides stable temperatures year-round, independent of seasonal and daily variations. Actual COPs are significantly higher and more reliable.

# 2. Geothermal Types and Performance

Geothermal energy exploits subsurface heat. Several types are distinguished by depth, temperature, and technology used.

| Type | Depth | Temperature | Typical COP | Technology | Example |
|---|---|---|---|---|---|
| **TYPE 1 – Very low and low enthalpy geothermal (non-hot zones)** | | | | | |
| Very low energy (surface glycol) | 0-10 m | 10-15°C | 3.0 - 3.5 | Horizontal collectors | Lower cost, climate independent |
| Low energy (probes glycol) | 10-200 m | 12-25°C | 3.0 - 6.0 | Vertical probes glycol-water | Small footprint (1m/1m²) |
| Low energy (aquifer) | 10-100 m | 10-20°C | 4.5 - 6.0 | Doublet on aquifer water-water | District heating |
| **TYPE 2 – Medium and high enthalpy geothermal (hot zones, sedimentary basins)** | | | | | |
| Medium energy (Dogger) | 1,500-2,000 m | 60-85°C | Direct (no HP) | "Lobster antenna" doublet | Paris Basin |
| High enthalpy (deep) | 2,000-3,000 m | 90-150°C | Direct + electricity | Long-distance doublet | Alsace, Rittershoffen |
| Eavor-Loop™ System | 2,000-4,000 m | 100-150°C | Direct | Interconnected multilaterals | Closed loop, controlled |
| **TYPE 3 – EGS (Enhanced Geothermal Systems) with stimulation** | | | | | |
| EGS / Hot rocks | 3,000-5,000 m | 150-200°C | Electricity + heat | Hydraulic stimulation | Soultz-sous-Forêts |
| Very high enthalpy | >3,000 m | >200°C | Electricity | Volcanic zones | Guadeloupe, Iceland |

### Focus: Eavor-Loop™ System

The Eavor system uses multilateral boreholes that intersect at great depth, creating a closed loop where the heat transfer fluid circulates without contact with subsurface contaminants. This approach (advanced Type 2) combines the advantages of deep geothermal with simplified maintenance: no geothermal water pumping, no brine corrosion, extended lifespan.

# 3. EROI: Energy Return on Investment

EROI (Energy Return On Investment) measures how much energy is obtained for each unit of energy invested in extracting and processing a resource.

**Formula: EROI = Energy produced / Energy invested**

⚠️ **Beware of fossil fuel bias:** Hydrocarbon EROI may seem advantageous because it compares invested energy (barrels for drilling, transport, refining) to very dense extracted energy (billions of barrels). This exceptional energy density masks externalities: $CO_2$ emissions, pollution, resource depletion. EROI alone does not capture the real environmental cost.

## 3.1 EROI by Energy Source

| Energy Source | Historical EROI | Current/Projected | Trend |
|---|---|---|---|
| Conventional oil (1950) | 50-100 | 4-30 (2022) | ↓ Rapid decline |
| Natural gas (1950) | ~140 | 16-40 (2022) | ↓ Decline |
| Coal | 50-80 | 8-30 | → Stable, reserves |
| Oil sands | 1-5 | 3-5 | ↑ Slow (technology) |
| Shale oil | - | 1.4-5 | Very energy-intensive |
| Nuclear | 40-80 | 20-80 | → Stable |
| Hydroelectricity | 50-200 | 30-110 | Best EROI |
| Onshore wind | - | 16-25 (no storage) | ↑ Improving |
| Wind (with storage) | - | 4-8 | Intermittency cost |
| Photovoltaic | 2-10 | 8-34 (no storage) | ↑↑ Strong rise |
| PV (with storage) | - | 1.6-5 | Battery cost |
| Corn ethanol | - | 0.8-1.6 | Near zero |
| Sugarcane ethanol | - | 5-9 | Best biofuel |
| **GEOTHERMAL (#GMI)** | | | |
| GMI-GSHP (low enthalpy geothermal HP) | - | 20-40 | ↑↑ Excellent, COP 4-5 |
| Paris doublets (Dogger, med. enthalpy) | 15-25 | 15-30 | → Stable, 40 years experience |
| Soultz-sous-Forêts (stimulated EGS) | - | 9-15 | ↑ Improving |
| Eavor-Loop™ (closed multilateral) | - | 15-25 | ↑ Promising, no contamination |

*Critical threshold: An EROI < 7 is considered insufficient to maintain a complex modern economy.*
***Geothermal exceeds this threshold significantly with EROIs of 15 to 40.***

# 4. Efficiency Erosion Through Successive Transformations

Each energy transformation causes losses. The longer the conversion chain, the more overall efficiency decreases. This is why direct energy use is always preferable.

## 4.1 Energy Chain Comparison

| Conversion Chain | Efficiency per Step | Overall Efficiency |
|---|---|---|
| **HOT WATER PRODUCTION** | | |
| Solar thermal panel → Direct hot water | 70-80% | 70-80% |
| PV → Battery → Electric water heater | 20% × 90% × 95% = | ~17% |
| PV → Grid → Water heater (no battery) | 20% × 95% × 95% = | ~18% |
| **HYDROGEN VECTOR** | | |
| PV → Electrolysis → $H_2$ → Fuel cell → Electricity | 20% × 70% × 50% = | ~7% |
| PV → Electrolysis → $H_2$ → $H_2$ boiler → Heat | 20% × 70% × 85% = | ~12% |
| Wind → Electrolysis → $H_2$ → Fuel cell → Elec. | 45% × 70% × 50% = | ~16% |
| **BATTERY STORAGE** | | |
| PV → Li-ion battery → Electric use | 20% × 90% = | ~18% |
| PV → Direct use (self-consumption) | 20% | ~20% |
| **GEOTHERMAL** | | |
| Direct geothermal (doublet) → Heat | ~95% (pumping) | ~95% |
| Geothermal + HP → Amplified heat | COP 4 equivalent | ~400% |

✓ **Fundamental principle:** A solar thermal panel for direct hot water use (70-80% efficiency) is 4 times more efficient than a PV panel charging a battery that powers an electric water heater (~17%). Always favor the shortest path between source and use!

# 5. Conclusion: Energy Choice Criteria

To evaluate an energy solution, consider:

**1. Direct COP or efficiency of the system** – Favor COP > 3 (geothermal heat pumps)

**2. EROI of the primary source** – Be wary of EROI < 7

**3. Number of transformations** – Each step erodes efficiency

**4. Uncounted externalities** – $CO_2$, pollution, resource depletion

***Geothermal (#GMI) offers the best compromise: high COP, stable and renewable source, minimum transformations, no direct emissions.***

# ANNEX A

## Energy Economics: Beyond "It's Too Expensive"

***"It's too expensive"*** is a dismissive, approximate, and often devastating response. It ignores cost dynamics, economies of scale, and technical parameters that transform an "unaffordable" solution today into tomorrow's standard.

## A.1 Technical-Economic Interdependence

A serious Business Developer must embrace all elements and constraints. The economics of an energy project depend on technical parameters that evolve with industrialization:

| Technical Parameter | Economic Impact | Evolution with Scale |
|---|---|---|
| **COP / Efficiency** | Operating cost (OPEX): energy bill | ↑ R&D and experience feedback |
| **EROI** | Macro-economic system viability | ↑ Industrial process optimization |
| **TRL (Tech maturity)** | Project risk, cost of capital, insurability | ↑ Pilot to commercial transition |
| **MRL (Mfg maturity)** | CAPEX: initial investment cost | ↓↓ Strong decrease with volume (learning curve) |
| **CRI (Commercial maturity)** | Access to financing, bankability | ↑ Investor confidence |
| **SRL (Social acceptance)** | Administrative delays, local opposition | ↑ Familiarization, successful projects |
| **Equipment lifespan** | LCOE (levelized cost of energy) | ↑ Better materials, predictive maintenance |
| **Drilling depth** | Drilling cost (30-50% of geothermal CAPEX) | ↓ Drilling innovation, standardization |

## A.2 The Learning Curve: Volume Changes Everything

Each doubling of cumulative installed capacity leads to a predictable cost reduction. This is **Wright's Law** (1936), empirically validated across all industrial technologies.

| Technology | Learning Rate | Reduction 2010→2024 | 2035 Projection |
|---|---|---|---|
| Photovoltaic (modules) | ~24% per doubling | -89% | Halving again |
| Li-ion batteries | ~18% per doubling | -85% | < $100/kWh |
| Onshore wind | ~15% per doubling | -70% | Stabilization |
| Geothermal drilling | ~12-15% estimated | -30% (low volume) | Potential -50% |
| Geothermal heat pumps | ~10-12% estimated | -40% | Growing market |
| $H_2$ electrolyzers | ~16% per doubling | -60% | Strong decline expected |

✓ **Implication:** Geothermal has not yet benefited from PV or wind deployment volumes. Its cost reduction potential is therefore **largely untapped**. Massive deployment (#GMI) would transform the sector's economics.

# A.3 Analysis Grid for the Business Developer

Before concluding on the economic viability of a project, the BD must document:

| Category | Key Questions to Document |
|---|---|
| **TECHNICAL PARAMETERS** | |
| **Performance** | Nominal COP? Seasonal COP (SCOP)? Actual efficiency in local conditions? |
| **Maturity** | Current TRL? MRL? Comparable operating references? |
| **Local resource** | Geothermal gradient? Aquifer quality? Target depth? Geological risk? |
| **System integration** | IRL with existing equipment? District heating available? |
| **ECONOMIC PARAMETERS** | |
| **CAPEX** | Current cost vs. industrial volume cost? Applicable learning curve? |
| **OPEX** | Avoided energy cost? Predictive maintenance? Equipment lifespan? |
| **LCOE / LCOH** | Levelized cost over lifespan? Comparison with fossil alternatives? |
| **Financing** | CRI achieved? Bankability? Public subsidies? Performance guarantees? |
| **Externalities** | Avoided $CO_2$ cost (€/ton)? Value of energy independence? Local jobs? |
| **TEMPORAL DIMENSION** | |
| **Project horizon** | Operating duration (30-60 years for geothermal)? Residual value? |
| **Cost evolution** | Projected fossil prices? Carbon tax? Cost of climate inaction? |
| **Tipping point** | At what volume/price does the solution become competitive without subsidies? |

# A.4 The True Cost: Integrating All Dimensions

A complete economic analysis must integrate:

1. Full lifecycle cost (CAPEX + OPEX + decommissioning)
2. Externalities ($CO_2$, pollution, health, geopolitical dependence)
3. Cost trajectory (learning curve, carbon price)
4. Systemic value (grid stability, interseasonal storage, jobs)
5. Target industrialization volume that makes the solution competitive

*"Saying 'it's too expensive' without documenting the required industrialization volume, cost trajectory, and avoided externalities,* ***is condemning a technology without trial."***

**VIABILITY = f(COP, EROI, TRL, MRL, CRI, Volume, Time, Externalities)**

*Never a single variable.*

# ANNEX B

## Technical References and Sources

## B.1 Technology Readiness Indices

### TRL – Technology Readiness Level

**Origin:** Developed by NASA in 1974 by Stan Sadin, formalized in 1989.

**Definition:** A 1-to-9 scale measuring technology maturity from basic research (TRL 1) to proven operational system (TRL 9).

**Standards:** ISO 16290:2013 – Space systems; Horizon Europe (EU) since 2014.

| TRL | Description |
|---|---|
| 1 | Basic principles observed and reported |
| 2 | Technology concept and/or application formulated |
| 3 | Analytical and experimental critical function proof of concept |
| 4 | Component validation in laboratory environment |
| 5 | Component validation in relevant environment |
| 6 | System/subsystem model demonstration in relevant environment |
| 7 | System prototype demonstration in operational environment |
| 8 | Actual system completed and qualified |
| 9 | Actual system proven in operational environment |

### Other Readiness Indices

| Index | Origin | Purpose |
|---|---|---|
| **MRL** | DoD (United States), 2000s | Manufacturing Readiness Level – Industrial production capability (1-10) |
| **CRI** | ARENA (Australia) | Commercial Readiness Index – Market maturity and adoption (1-9) |
| **SRL** | Innovation Fund Denmark / EU | Societal Readiness Level – Social acceptance, regulation (1-9) |
| **IRL** | NASA | Integration Readiness Level – Integration with existing systems |

## B.2 EROI – Energy Return On Investment

**Definition:** Ratio of energy produced to energy invested in extraction and processing.

**Formula:** *EROI = Energy produced / Energy invested*

**Origin:** Prof. Charles A.S. Hall (SUNY), foundational publication in Science (1984).

### Key Scientific References

| Author / Year | Publication |
|---|---|
| **Cleveland et al. (1984)** | "Energy and the U.S. economy", Science 225: 890-897 |
| **Murphy & Hall (2010)** | "Year in review—EROI", Annals N.Y. Acad. Sci. 1185: 102-118 |
| **Guilford et al. (2011)** | "EROI for U.S. Oil and Gas", Sustainability 3(10): 1866-1887 |
| **Raugei et al. (2012)** | "EROI of photovoltaics", Energy Policy 45: 576-582 |
| **Murphy et al. (2022)** | "EROI Review and Harmonization", Sustainability 14(12): 7098 |
| **Hall (2017)** | Energy Return on Investment (book), Springer Nature |
| **Hall & Palmer (2025)** | "Improving calculations of EROI", Nature Energy 10: 149-150 |

### EROI Methodology Levels (Mulder et al., 2010)

| Level | Description |
|---|---|
| **Point of extraction** | Raw energy at wellhead – often inflated for fossil fuels |
| **Point of use** | After refining, transport, distribution – more realistic comparison |
| **Extended societal** | Including infrastructure, maintenance, decommissioning |

**Critical threshold:** An EROI < 7 is considered insufficient to maintain a complex modern economy (Hall et al., 2009). Geothermal exceeds this with EROI 15-40.

## B.3 COP – Coefficient of Performance

**Definition:** Ratio of thermal power output to electrical power input.

**Formula:** *COP = Q (heat output in kW) / W (electrical input in kW)*

### European Measurement Standards

| Standard | Scope |
|---|---|
| **EN 14511** | Heat pumps for heating/cooling – Testing and rating (parts 1-4) |
| **EN 14825** | Part load conditions and SCOP calculation (seasonal performance) |
| **EN 15879-1** | Ground source heat pumps (brine-to-water) |
| **EN 16147** | Heat pumps for domestic hot water |
| **EN 12102** | Sound level measurement |
| **ISO 5151** | Air-to-air heat pumps (international) |

### Standardized Test Conditions

| Code | Source Temp. | Water Temp. | Application |
|---|---|---|---|
| **A7W35** | Air +7°C | Water 35°C | Air-to-water HP (standard) |
| **A2W35** | Air +2°C | Water 35°C | Air-to-water HP (mild cold) |
| **A-7W35** | Air -7°C | Water 35°C | Air-to-water HP (severe cold) |
| **B0W35** | Brine 0°C | Water 35°C | Ground source HP (standard) |
| **W10W35** | Water 10°C | Water 35°C | Water-to-water HP (aquifer) |

⚠️ **Warning:** Advertised COPs for air-source HPs are measured at +7°C. In real winter conditions (-5°C to -15°C), performance drops drastically, and defrost cycles further reduce efficiency. Geothermal HPs benefit from stable source temperatures (10-15°C) regardless of outdoor climate.

### Certification Bodies

| Certification | Description |
|---|---|
| **EHPA Quality Label** | European Heat Pump Association – Performance certification per EN 14511/14825 |
| **Eurovent Certified** | NF414 (France) – Independent laboratory testing, COP/SCOP/sound verification |
| **KEYMARK** | European quality mark for heat pumps and solar thermal |

# B.4 Geothermal Energy – Scientific References

## Geothermal Classification

| Type | Depth | Temperature | Technology |
|---|---|---|---|
| Very low enthalpy | 0-10 m | 10-15°C | Horizontal collectors, baskets |
| Low enthalpy | 10-200 m | 12-25°C | Vertical probes glycol-water |
| Medium enthalpy | 200-2000 m | 30-90°C | Doublets, direct use |
| High enthalpy | 2000-4000 m | 90-150°C | Deep doublets, ORC |
| EGS | 3000-6000 m | 150-250°C | Hydraulic stimulation |

## Key Scientific References

| Topic | References |
|---|---|
| **Paris Basin Doublets (Dogger)** | |
| French experience | BRGM – 40 years operational feedback; ADEME – Technical guides |
| **EGS (Enhanced Geothermal Systems)** | |
| Reference report | MIT (2006) "The Future of Geothermal Energy" – 372 pages |
| European pilot site | Soultz-sous-Forêts (France) – Operational since 1987 |
| EROI study | Mansure (2011) "EGS EROI", OSTI Report – EROI 9-15 |
| **Eavor-Loop™ (Closed-Loop Systems)** | |
| Independent evaluation | Beckers et al. (2022) NREL – Stanford Geothermal Workshop |
| Numerical modeling | Kelly & McDermott (2022), AIMS Geosciences 8(2): 175-212 |
| Global potential | Nature Comms. Earth Env. (2025) – 9 TWe potential (70% global electricity) |
| Commercial project | Geretsried (Germany) – First operational project, grid power Jan 2026 |

## Geothermal EROI Values

| Technology | EROI | Source |
|---|---|---|
| GMI-GSHP (Low enthalpy HP) | 20-40 | Hall et al. |
| Paris doublets (Dogger) | 15-30 | 40 yrs data |
| Soultz-sous-Forêts (EGS) | 9-15 | Mansure 2011 |
| Eavor-Loop™ (closed multilateral) | 15-25 | Estimated |

## B.5 Learning Curve – Wright's Law

**Definition:** Each doubling of cumulative capacity leads to a predictable cost reduction.

**Formula:** $C(n) = C(1) \times n^{(-b)}$ *where* $b = -\log_2(1 - \text{learning rate})$

**Origin:** Wright, T.P. (1936) "Factors Affecting the Cost of Airplanes", J. Aeronautical Sciences 3(4): 122-128

| Technology | Learning Rate | Reduction | Source |
|---|---|---|---|
| Photovoltaic (modules) | ~24% / doubling | -89% | IRENA |
| Li-ion batteries | ~18% / doubling | -85% | BNEF |
| Onshore wind | ~15% / doubling | -70% | IRENA |
| Geothermal drilling | ~12-15% (estimated) | -30% | Studies |
| Geothermal heat pumps | ~10-12% (estimated) | -40% | EHPA |
| $H_2$ electrolyzers | ~16% / doubling | -60% | IEA |

✓ **Key implication:** Geothermal has not yet benefited from PV or wind deployment volumes. Its cost reduction potential remains largely untapped. Massive deployment (#GMI) would transform the sector's economics.

## B.6 Color Codes – NF P98-332 Standard (France)

French standard for underground utility networks, used in this document for visual consistency:

| Color | Network (NF P98-332) | Document Application |
|---|---|---|
| **Red** | Electricity | Direct electric heating |
| **Yellow** | Gas, liquid hydrocarbons | Fossil fuels |
| **Violet** | District heating / cooling | Geothermal (all shades) |
| **Brown** | Sewage / drainage | Wood / Biomass |
| **Blue** | Potable water | Hot water production |
| **Green** | Telecom / Video | Hydrogen vector |
| **Orange** | Chemical products | (not used) |
| **White** | Dynamic road equipment | (not used) |

## B.7 Reference Organizations

| Organization | Domain | Country/Region |
|---|---|---|
| **BRGM** | French Geological Survey – Geothermal expertise | France |
| **ADEME** | French Agency for Ecological Transition | France |
| **EHPA** | European Heat Pump Association | Europe |
| **IEA** | International Energy Agency | International |
| **IRENA** | International Renewable Energy Agency | International |
| **NREL** | National Renewable Energy Laboratory | United States |
| **Fraunhofer ISE** | Fraunhofer Institute for Solar Energy Systems | Germany |
| **GFZ** | German Research Centre for Geosciences | Germany |
| **TNO** | Netherlands Organisation for Applied Research | Netherlands |
| **DOE** | Department of Energy – Geothermal Technologies Office | United States |

## B.8 Glossary of Acronyms

| Acronym | Full Term | Note / French |
|---|---|---|
| **AGS** | Advanced Geothermal Systems | Closed-loop, conduction-based |
| **CAPEX** | Capital Expenditure | Initial investment cost |
| **COP** | Coefficient of Performance | Heat output / Electricity input |
| **CRI** | Commercial Readiness Index | Market adoption maturity |
| **EGS** | Enhanced Geothermal Systems | Hydraulic stimulation |
| **EROI** | Energy Return On Investment | FR: TRE (Taux de Retour Énergétique) |
| **GMI** | Geothermal Mass Initiative | Hashtag: #GMI |
| **GSHP** | Ground Source Heat Pump | FR: PAC géothermique |
| **HP** | Heat Pump | FR: PAC (Pompe à Chaleur) |
| **IRL** | Integration Readiness Level | System integration maturity |
| **LCOE** | Levelized Cost of Electricity | $/MWh over lifetime |
| **LCOH** | Levelized Cost of Heat | $/GJ over lifetime |
| **MRL** | Manufacturing Readiness Level | Production capability (1-10) |
| **OPEX** | Operational Expenditure | Running costs |
| **ORC** | Organic Rankine Cycle | Low-temp electricity generation |
| **SCOP** | Seasonal COP | Annual average performance |
| **SRL** | Societal Readiness Level | Social acceptance (1-9) |
| **TRL** | Technology Readiness Level | NASA scale (1-9) |

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