PwrCor

Green Power From Heat

Introduction to PwrCor, Inc.

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What Is PwrCor

We are working to (1) improve the economics of energy production and (2) reduce carbon output globally by converting the world's vast quantities of wasted heat into clean power.

We use an entirely novel application of thermodynamics, exploiting known and proven principles to generate mechanical or electrical power.

PwrCor's technology

1. Extracts heat from the environment or existing process operations, reducing waste heat
2. Produces mechanical power from that free heat 24x7, which can be used to generate electricity
3. Directly reduces ongoing combustion of hydrocarbons and resulting harmful emissions.

And we can do this

- at very low cost, and
- with greater output for any volume of input than other existing technologies.

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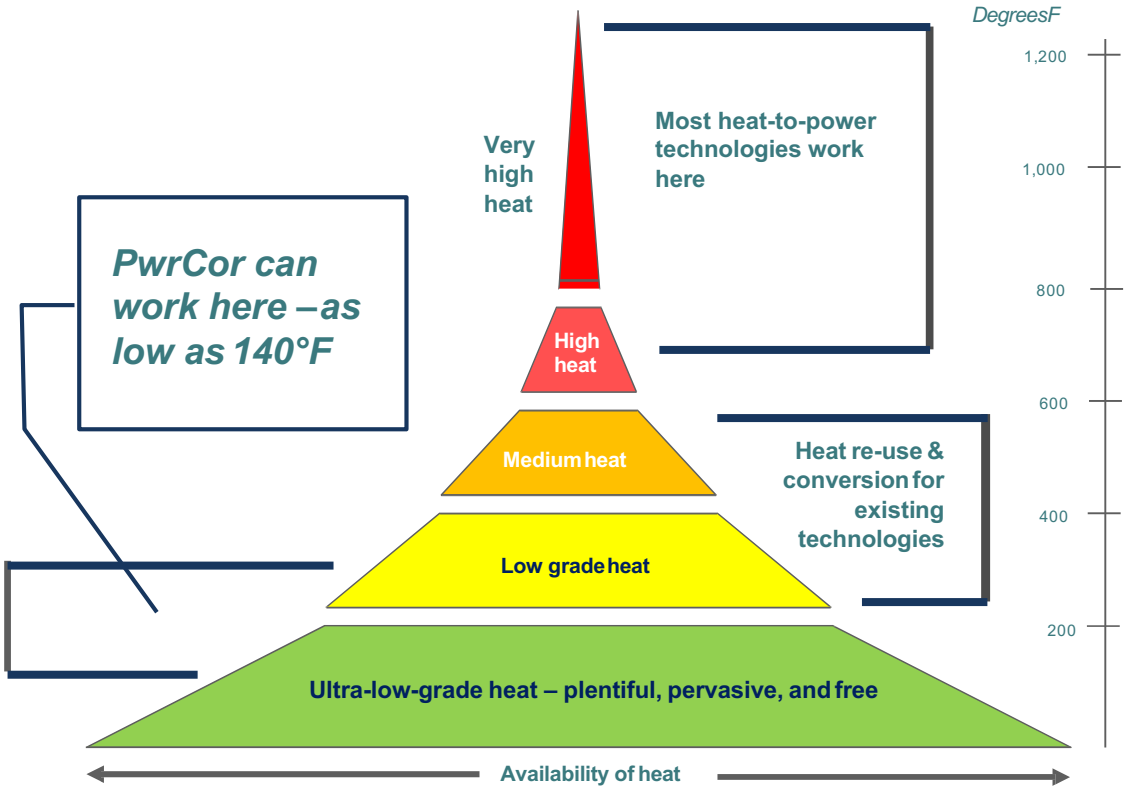
Harnessing Waste Heat

PwrCor's proprietary technology allows for the harnessing of ultra-low-grade (ULG) waste heat into usable energy at temperatures as low as 140ºF.



Each 20°F temperature band below 170°F increases the size of the addressable market by an estimated 75%.

This heat is being wasted only because to date there has been no technology that can harness it economically.

Now,
PwrCor can deliver that technology.

It has been demonstrated to efficiently convert ULG heat into power.

The ability to generate power at these relative low temperatures makes this technology ideal for industries producing waste heat as a by-product.

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PwrCor Proprietary Technology

Simple Mechanical Concept. Novel heat-engine technology, similar in purpose and somewhat similar in function as an Organic Rankine Cycle (ORC) engine, generates power by exploiting the properties of CO_2 as a working fluid.

How is it better? The PwrCor cycle does *not* undergo energy-robbing phase changes (i.e.: liquid to gas state and back) as does the Organic Rankine Cycle (ORC) driven systems, which undergoes *two* phase changes per cycle.

Significant increase in power output at equivalent flowrate and temperature for both heating & cooling:

Comparing the PwrCor engine to typical ORC systems -

- Seeing 1.5x - 3x the power output while operating in the 140 - 400°F (60 - 200°C), source heat temperatures range.
- CO_2 is stable & does not undergo thermal decomposition at higher temperatures, as does ORC.
- CAPEX: PwrCor sCO_2 engine – $1900-$4000 / kW ORC engine – $2300-$8900 / kW

On Effectiveness vs Efficiency* -

Given a 1000 kW thermal flow available:

- The ORC cycle extracts 100 kW as thermal input and outputs 20 kW of work. The thermal efficiency is 20%.
- The PwrCor cycle extracts 500 kW *from the same flow* and outputs 100 kW of work. This also has a 20% thermal efficiency, but it is clear which is better.

*For illustrative purposes

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PwrCor R&D & Applications Engineering

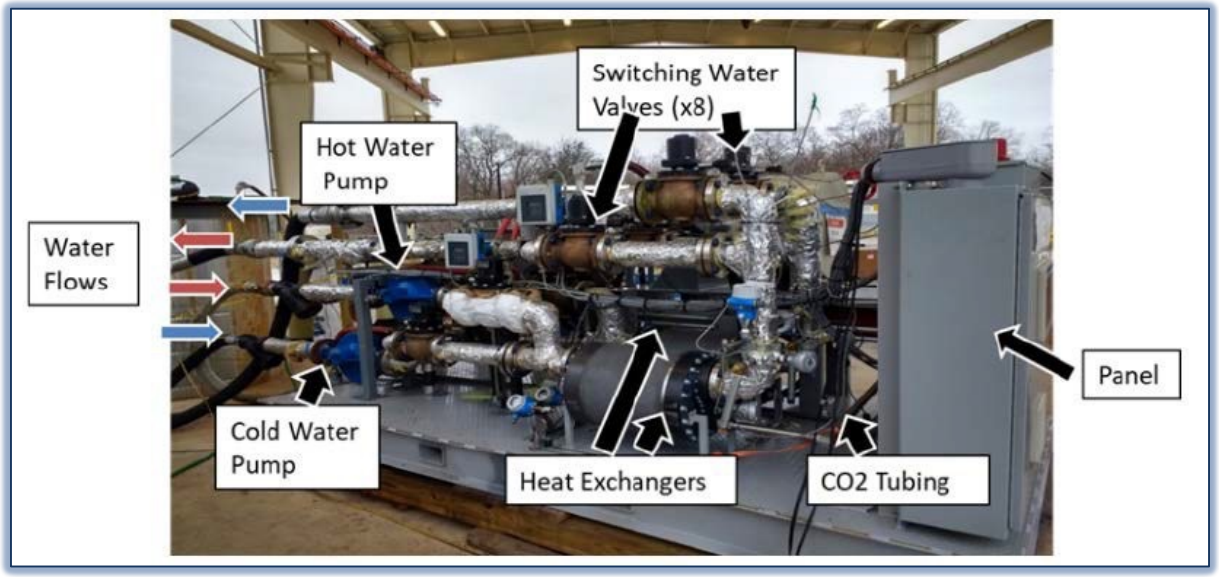
PwrCor engages the prominent Southwest Research Institute (SwRI) for R&D and applications engineering.

The SwRI engineers and scientists are recognized as experts and leaders in working with and developing Supercritical CO2 power cycles, and has world-class research & testing capabilities.

SwRI has validated PwrCor's technology, done extensive testing using their sophisticated testing facility, and assisted in PwrCor's technology development.

From the beginnings of this technology – initially used to power rigs on shallow stripper wells – to today, as we engineer our Fourth Generation systems (current TRL 6), we have found SwRI to be an excellent partner.

PwrCor's technology portfolio is protected by an on-going patent program with patents granted and patent work pending.



PwrCor Second Generation Unit Demonstrated at SwRI Test Facility and on a Geothermal Hot Spring

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What PwrCor Can Do For Geothermal

- **Provide a more effective heat-to-power surface technology for new planned development**
  - Greater power output from the same source heat resource as ORC
  - Capex / MW is less
  - Projected maintenance costs and LCOE is low

- **Utilize resources that cannot now be used economically**
  - Add immediate value to existing operations with a PwrCor Bottoming Cycle
  - Enable the development of currently marginal low-temperature geothermal resources
  - Revisit abandoned wells, making them economically productive

- **Heat needed for a desired output may now be found at shallower depths**
  - Reduced drilling costs
  - More opportunities for development

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Sample Opportunities in Low-Grade Heat Conversion

Immediate and longer-term opportunities involving geothermal heat:

Geothermal energy alone has the potential to provide for all the electricity needed annually in the U.S. if it was able to be accessed and harnessed.

Immediate: Current US and Global Geothermal Operations – Bottoming Cycle:

- Commissioned study with Southern Methodist University's (SMU) Geothermal Laboratory

  Results - Discharged geothermal fluid, destined to return downhole, typically has sufficient heat for PwrCor. PwrCor can simply intercept that return flow and create a "bottoming cycle".

Estimated potential: 6+GW

Potential: Low-Temperature Geothermal:

- The number of known and projected low-temperature geothermal locations targeted for binary plant (ORC) development far exceed the number of existing plants. PwrCor technology can be deployed to generate substantially more electrical power at a lower cost per kw than existing binary technologies.

Potential: "Dry" or Abandoned Geothermal Wells:

- Wells drilled and determined to not have sufficient thermal energy to run economically using existing binary (ORC) technologies may be suitable for PwrCor operation, similarly; existing binary plants abandoned due to degradation of the geothermal resource may be made viable with PwrCor.

This can be an opportunity to convert a sunk cost into a productive asset.

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Sample Opportunities in Low-Grade Heat Conversion

Renewable opportunities to develop sustainable oil & gas field operations:

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Existing Active Wells:

- Heat from co-produced fluids on existing wells can be utilized to produce on-site power.
- The electricity generation potential is substantial

In the U.S. alone –

Studies place co-produced water during oil and gas production at 15-25 billion bbl per year

One such study, titled-

"*An Estimate of the Near-Term Electricity-Generation Potential of Coproduced Water From Active Oil and Gas Wells*" was based on co-produced fluid data from 500,000 wells (out of 2.5M existing) and concluded :

Of the 15 billion bbl per year of co-produced water accounted for:

69% is less than 257°F (125°C)

48% is less than 176°F (80°C) – deemed "too cool" for ORC and not evaluated

Estimated ORC power potential – 625 MW

Estimated PwrCor power potential - 1,579 MW -- ***2.5x greater than ORC****

**Includes potential from water temperatures between 150 -176°F (66-80°C)*

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Abandoned Wells:

Approximately 40% of developing a geothermal power plant is drilling costs. Repurposing these wells can make a non-productive liability into an asset.

Total Count of U.S. Abandoned Oil & Gas Wells in 2019 – 3,441,000

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PwrCor Economics

Superior conversion efficiency drives better system economics and shorter payback periods

- Prevailing U.S. grid-based power costs and the existing tax credit framework translate to a projected payback period for commercial PwrCor systems of ***under 2 years***

- In addition, accelerated R&D and manufacturing initiatives are expected to cut production costs in half at least twice in the first four years as PwrCor moves along the technology development curve – we see a clear path to a significantly low cost of production such that customer costs should be well below $2,000/kW. Sub-$1,000/kW pricing is achievable at commercial production scale.

- The PwrCor heat engine has the potential to produce power at a Levelized Cost of Energy (LCOE) under $0.04 at the demand site – competitive with Solar or Wind plus Battery systems, as systems are built mostly from standard components and are projected to require minimal servicing
  - Adjusting for power savings from reduced cooling demand (where applicable) can drive the LCOE closer to zero

As regulations push toward a carbon neutral economy, PwrCor technology is uniquely positioned to provide a sustainable solution that is economical and reliable

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PwrCor Value

To recap –

- PwrCor has engineered a proprietary, novel heat engine, using known thermodynamic principles, that
  - ✓ Extracts more energy from heat than other technologies like ORC
    - PwrCor can produce more power from a given heat flow than ORC can
    - Alternatively, PwrCor can produce the same amount of power from a smaller heat flow
  - ✓ Can effectively utilize lower-temperature heat than these other ORC technologies
  - ✓ Promises lower capital costs and far better economics

- Southwest Research Institute has done most of PwrCor's R&D and Applications Engineering and has considerable expertise in this field of thermodynamics

- PwrCor has gained great interest for its solutions in a wide range of industrial applications
  - ✓ Two pilots in the works

- Seeking geothermal pilot and partnering opportunities with industry leaders having the foresight to embrace disruptive technology and the resources to help accelerate its commercialization.

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