



National Rural Electric
Cooperative Association

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Potential for Geothermal Technologies in Heat Recovery

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Typical Waste Heat Sources

- Utility Industries
- Heavy Industries: Steel, Aluminum, Copper, Cement, Pulp & Paper, and Glass
- Refinery and Petrochemical Plants
- Incinerators/Gasification/Combustors
- Gas Compression/Pipelines

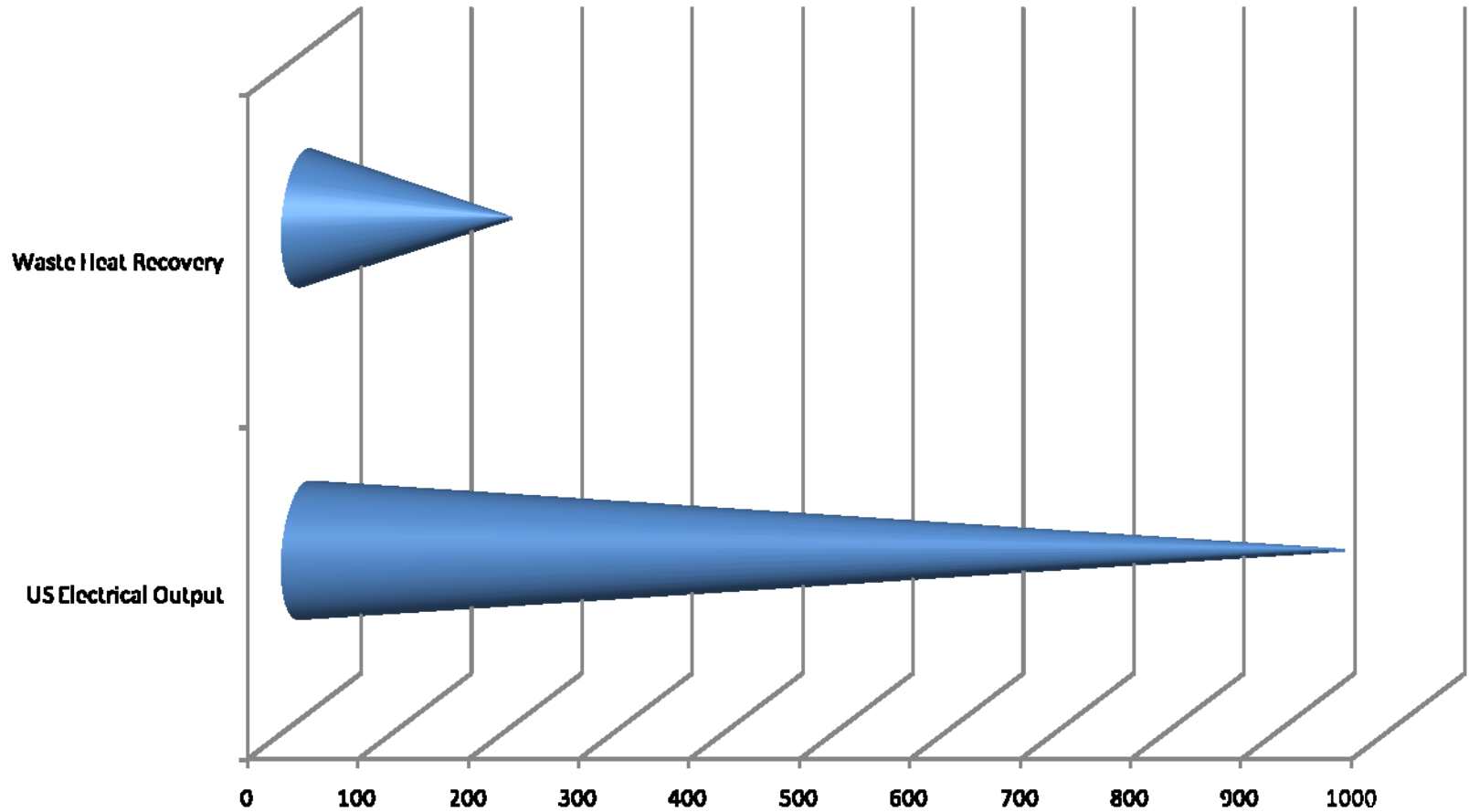


Unit Ops Generating Waste Heat

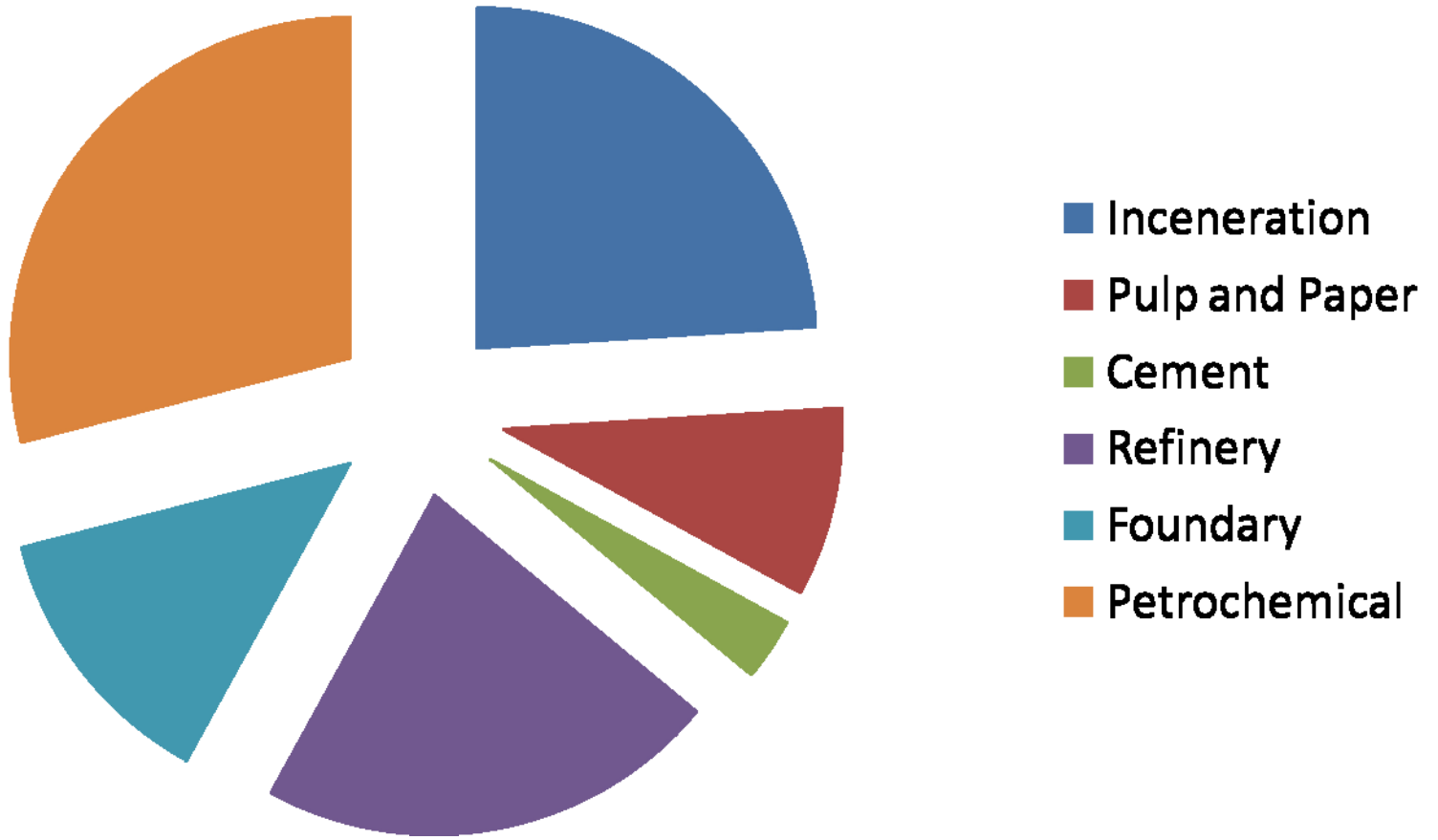
- Boilers, heaters and furnaces (gas, diesel, coal, nuclear, refuse, petroleum, and coke)
- Gas turbine exhaust
- Steam turbine exhaust
- IC engine exhaust



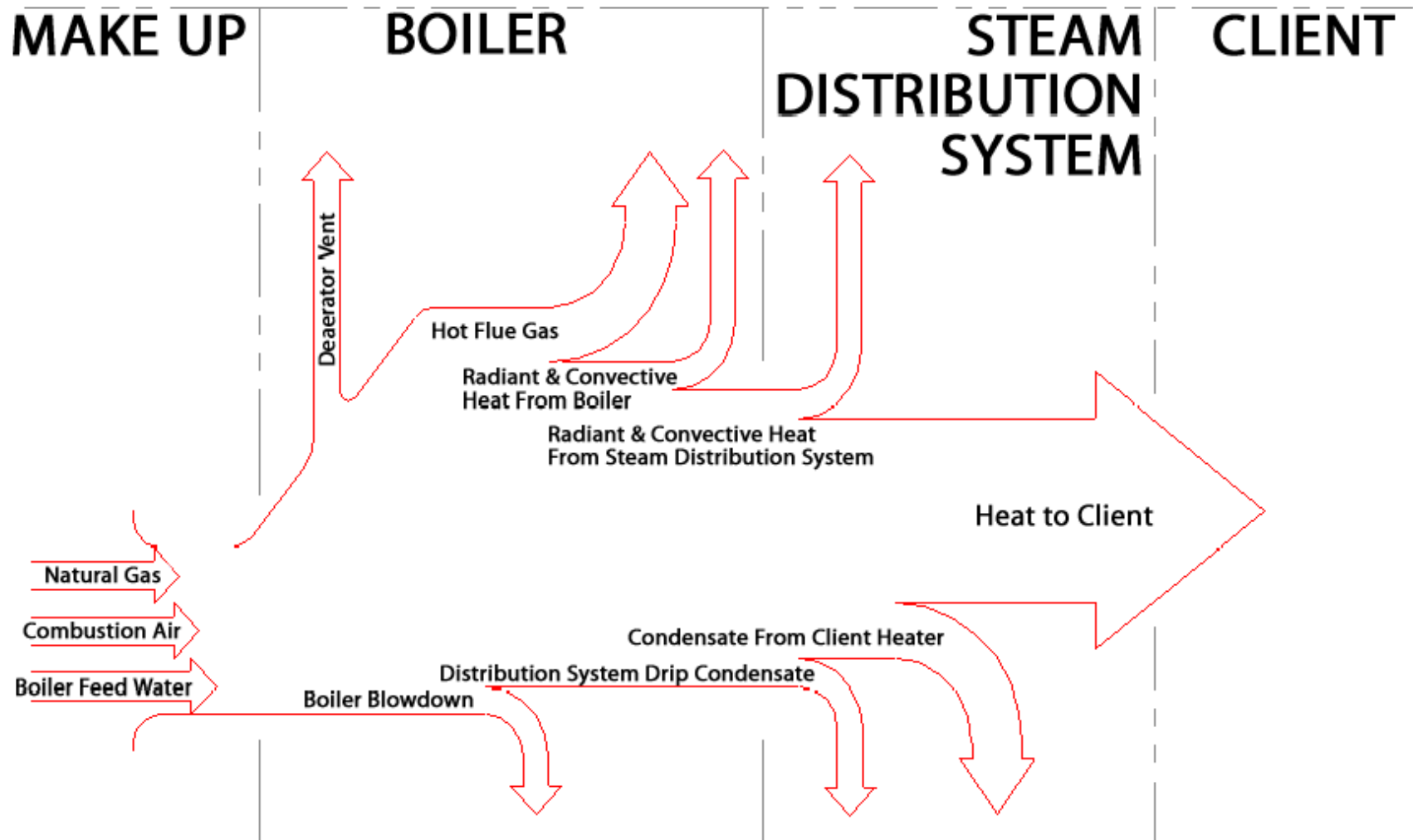
Potential (GW)



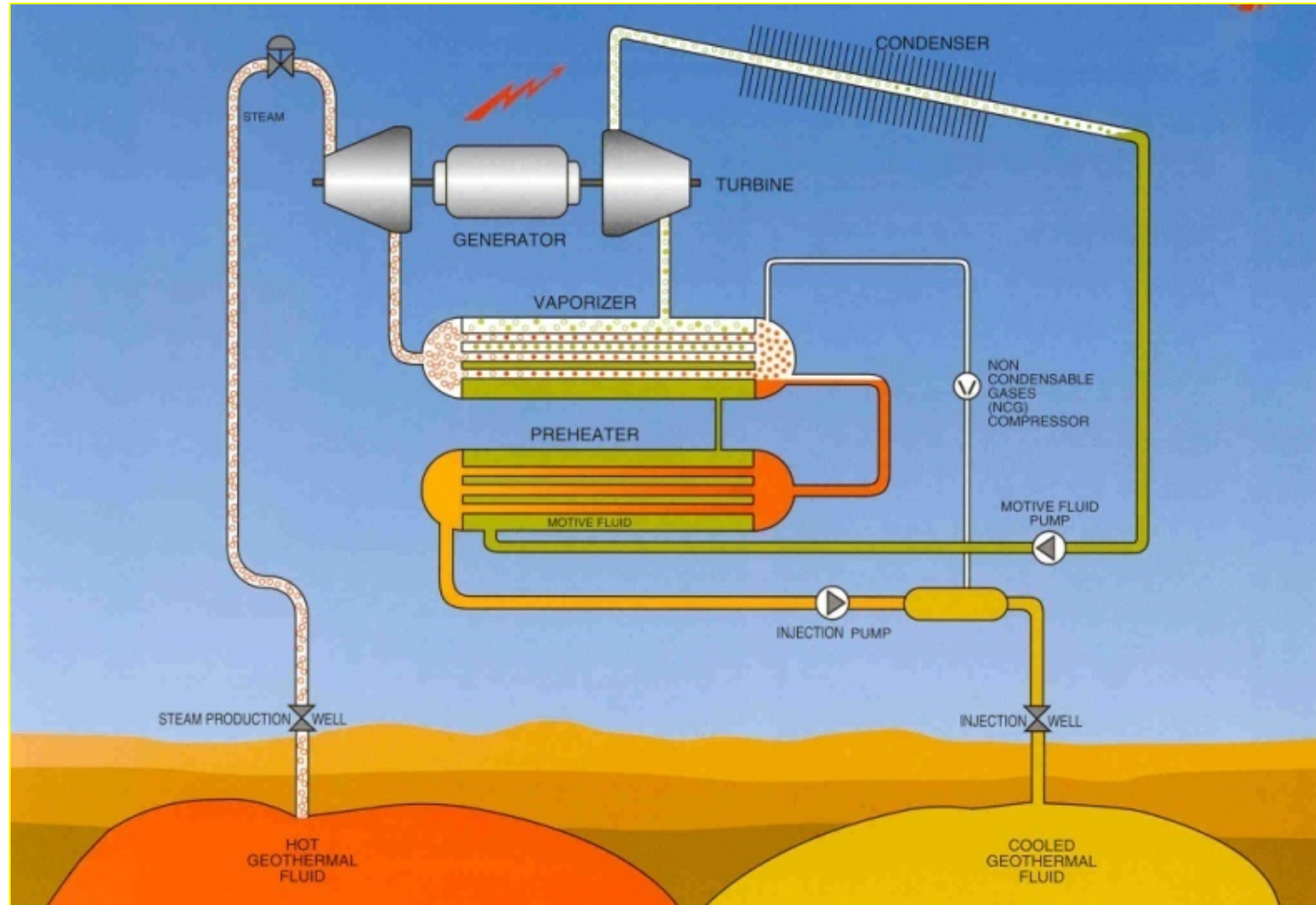
Potential by Industry



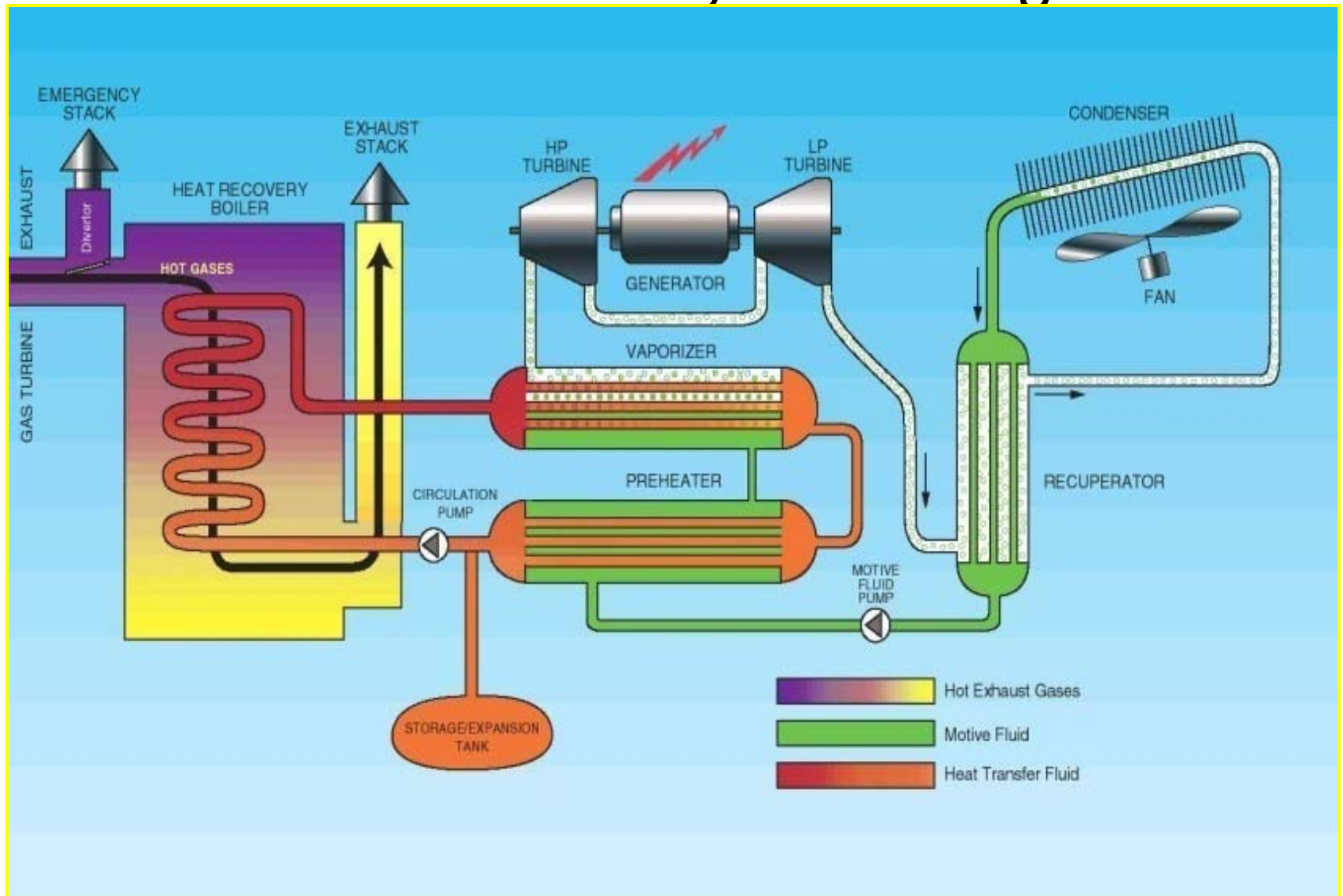
Typical Steam System Heat Flow



Geothermal Combined Cycle Flow Diagram using Organic Rankine Cycle Technology



ORC Heat Recovery Flow Diagram



Cost Comparison (\$/kW)

	<u>Conv Geo</u>	<u>ORC Heat Rec</u>
Resource assessment (1)	\$ 400	\$ 200
Well field development	1000	-0-
Power plant & transmission	2000	2000
Other costs(2)	<u>600</u>	<u>600</u>
		4000
2800		
TOTAL COST FOR 10 MW PROJECT	\$ 40 MM	\$ 28 MM

(1) Includes exploration costs

(2) commitment, consulting, development, contingency, legal & accounting fees, interest during construction, and operating reserve

Annualized Capital Costs (CC)

for Organic Rankine Heat Recovery Projects

Capital Costs \$2800/kW

@ 0.2 Annual Factor, $CC = 71 \text{ \$/mWh}$

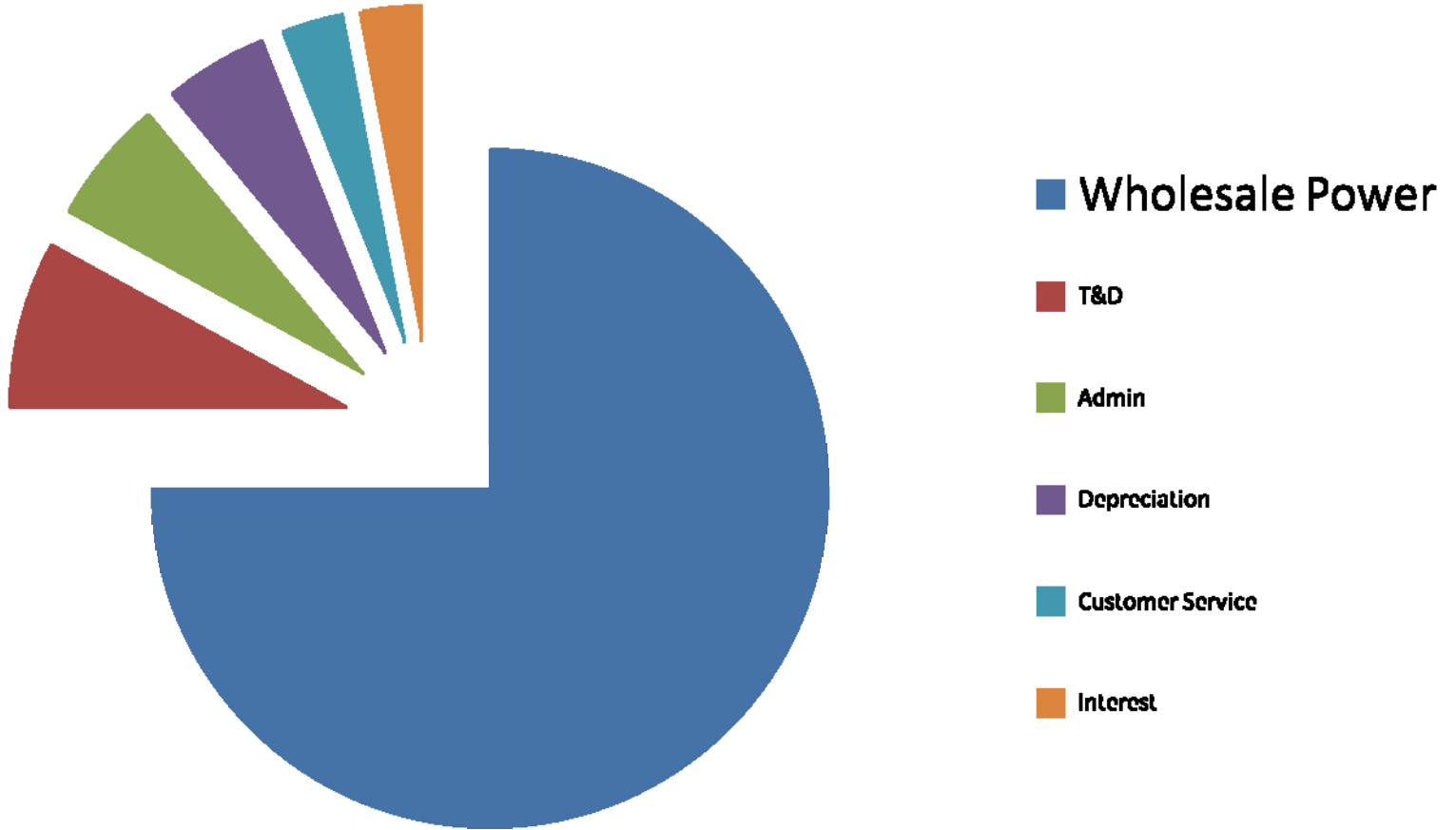
@ 0.15 Annual Factor, $CC = 53 \text{ \$/mWh}$

@ 0.10 Annual Factor, $CC = 36 \text{ \$/mWh}$

O&M costs $\sim 15 \text{ \$/mWh}$ Fuel Cost = 0

Typical Utility Costs of Doing Business

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In Summary

Waste heat recovery applications using geothermal technologies are available with less risk, because the heat sources can be easily quantified and accessed without drilling

The major barrier to widespread deployment is the lack of awareness of the technology and its economic and environmental

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