

SMU Conference: Geothermal Energy Utilization Associated with Oil and Gas
Development, June 13-15, 2011

*"Dinosaur and Ant Are Friends - O&G and
Geothermal Can Join Forces"*

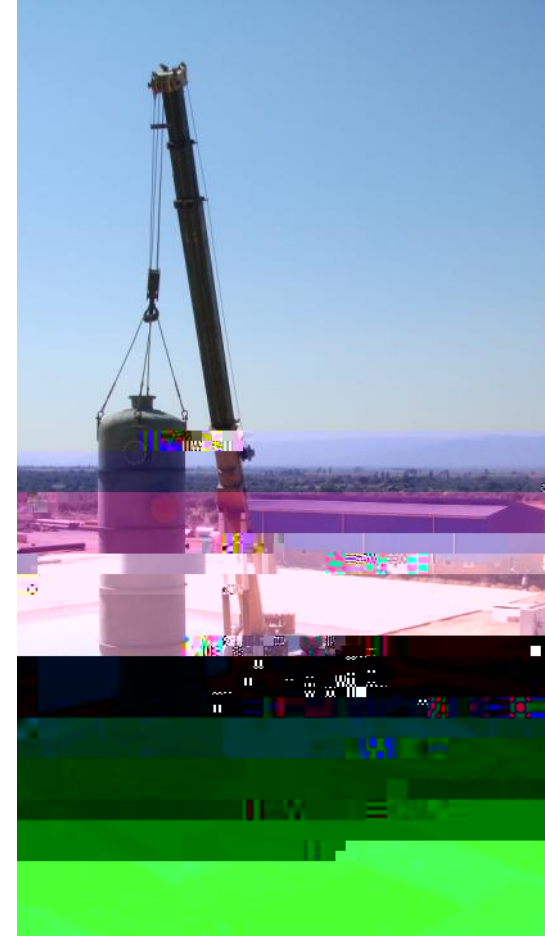
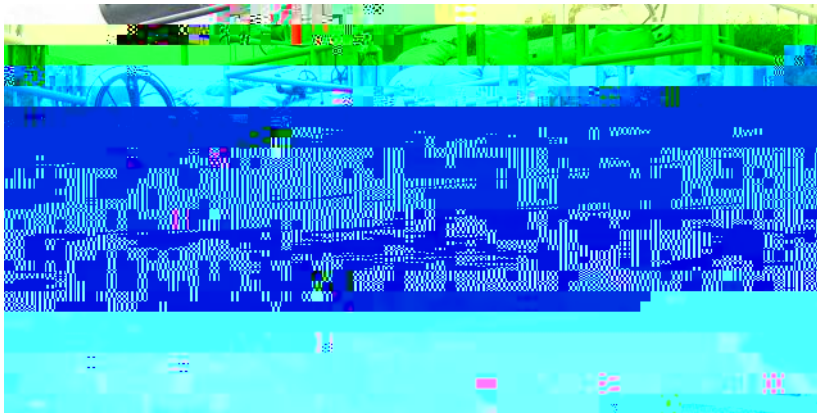


Intro to this presentation!

There's a strong family resemblance between O&G projects

O&G and geothermal are friends?

Well, yes. Sure, O&G is a huge industry, and geothermal is small by comparison. But our two industries function in the same world of geological risk, and we have a similar accountability for what happens at the wellhead.



We stole it fair and square!

Much of the key technology of geothermal resource identification and production were borrowed from our oil and gas cousins. We in the geothermal world have been

O&G and Geo: practical similarities!

Betting on production of stuff nobody can see

Reliance on crusty, highly knowledgeable old-timers who are usually not presentable to bankers

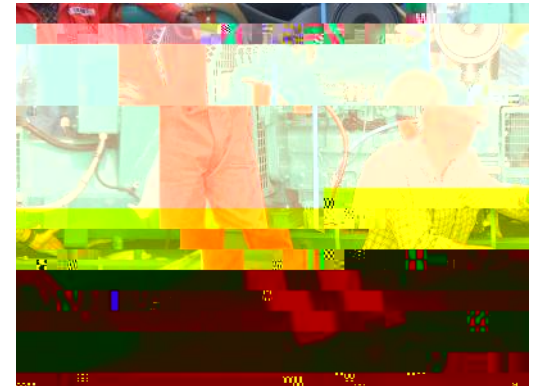
Funny smells

Weird stuff building up in the pipes

Chemical-process-intensive content of technology

Risk and depletion issues for production and financing

Similar community concerns re: environmental impacts



Specific Areas of Congruence

Obvious Resource Congruencies

Risk: both industries bet on
resources nobody can see

Exploration techniques

Drilling and well completion
techniques

Resource management

Congruency in export strength

Congruency: Multiple cash streams

O&G is used to breaking down its production into various resource streams. Similarly, geothermal can deliver:

- Electricity

- Process and district heat

- Bottom-end minerals recovery (zinc, lithium, sulfur)

A Quick Look at Technical Aspects of Co-Production

Co-Production: familiar stuff

Mechanical interconnection, separation, brine handling systems = no-brainer

Cooling system selection = thought-provoking, climate- and water-dependent

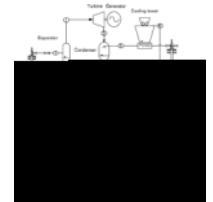
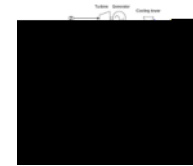
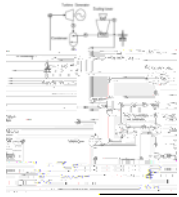
Cycle selection (flash, binary) = sometimes thought-provoking, most likely flash

T-G and B.O.P. design = sometimes thought-provoking

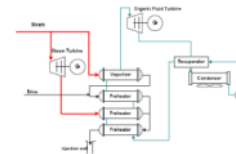
Electrical interconnection systems = sometimes thought-provoking

Dizzying Array of Cycle Choices

Customization is often worth it
Bigger is better, unless it isn't
Consider O&M



Combine standardization with flexibility
No such thing as waste



(Mlcak, 2002)
(Swandaru and Palsson, 2010)
(Kaplan, 2007)

The dynamic binary marketplace

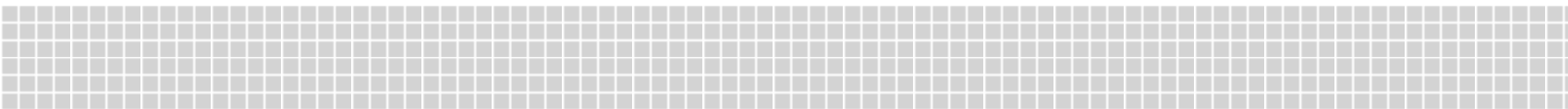
Package wrap or equipment supply

Big or small

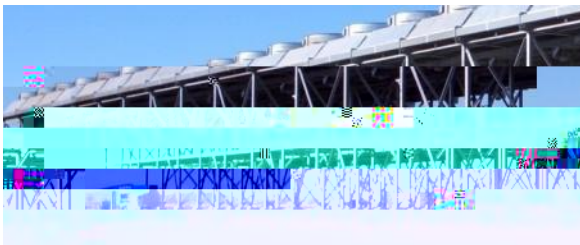
High or low temperature



Binary solutions applicable to geothermal, co-production, industrial heat recovery, etc.



Heat rejection: very important



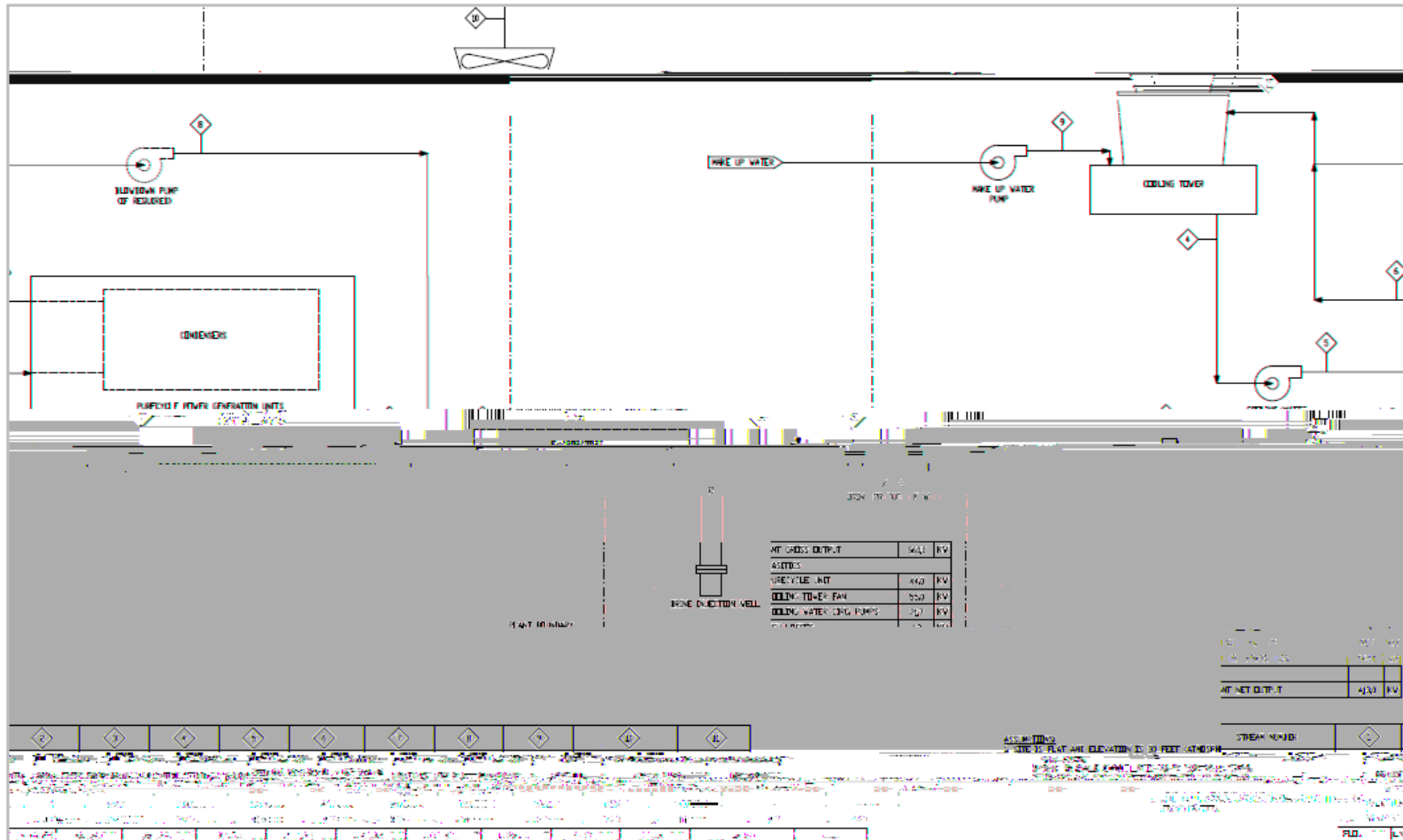
Selection of the optimal cooling system is crucial to getting the most out of the unit, since a co-production turbine-generator machine needs to take efficient advantage of a fairly narrow temperature difference between the resource and the environment.

Geothermal plant engineers pay an obsessive amount of attention to cooling system design.

Where to connect!

Commercial Considerations

An example PFD/heat balance



Indicative costs & project approaches

Cost

Indicative Cost for 560 kW gross: \$3,900/kW (1-2 wells)

Indicative Cost for 2.5 MW gross: \$3,000/kW (5-10 wells)

Approach

EPC – full wrap with 15% markup or more due to small scale

Design/Bid/Build with self or local financing

Summary!

In many ways, O&G people are on familiar ground when it comes to geothermal co-production.

The O&G and geothermal industries have potentially lavish export and domestic application possibilities.

Equipment economics will improve with wider and more applications!

Ant dinosaur! Open invitation to share forces and insights for heat recovery/co-production and geopressure opportunities!

Thank you for your attention!

Any questions?

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