Wellhead power plants

Elín Hallgrímsdóttir
Yngvi Guðmundsson
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Installed and predicted future power generation

Geothermal power generation, updated report 2015, Bertani
Small 0-15 MW plants from 1980-2016

Reference list from manufacturer, single flash.
Wellhead power plants

**Purpose**

**Permanent plants**
- Long term utilization
- Optimally utilize the resource

**Temporary plants**
- Early generation
- Standard plants
- Information gathering
Wellhead power plants

Temporary
• Pros
  – Early generation
  – Continuous well testing
  – Small units, standard
• Cons
  – Grid connection
  – Decline
  – Relocation
  – Distributed operation

Permanent
• Pros
  – “Early” generation
  – Continuous well testing
  – Small units, customized
• Cons
  – Grid connection
  – Make-up drilling/decline
  – Distributed operation
  – Spare parts
Feasibility

- Cost
  - Well cost
  - Re-injection
  - Equipment
  - Grid connection
  - Capacity factor
  - Relocation (for temporary)
  - Make up wells (for permanent)
- Feed-in tariff
- Depreciation period
- Well characteristics
Technology

• Backpressure
  – Topping plants, temporary plants
  – Lowest capital cost
  – Lowest efficiency

• Condensing
  – Permanent plants
  – Higher capital cost
  – Higher efficiency

• Binary
  – Bottoming plants, permanent plants
  – Highest capital cost
  – Higher efficiency
Environmental impact

- Gas emissions
- Noise
- Grid connections
Efficiency comparison, single flash

![Graph showing steam rate vs. turbine inlet pressure for 5 MW wellhead and large centralized plant.](graph.png)
Pressure selection
## Comparison

### Conventional

**Pros**
- High efficiency
- Geothermal fluid mixing
- Simpler operations

**Cons**
- Single operating condition in the steam supply system
- Long lead times for large scale equipment
- Cross-country piping

### Wellhead power plants

**Pros**
- Early generation
- Reservoir production response information
- Simple construction
- Relocation option

**Cons**
- Distributed operation
- Make-up wells
- Grid Connection
- Reinjection
Cost comparison

• Single flash condensing plant cost – excl. Wells
  – (50 MW, 6-16 bara, 1-2% NCG)
  – Large scale: 1,8 – 2,5 MUSD/MW
  – Well head: 1,75 – 2,4 MUSD/MW
  – ........ Mostly the same or even cheaper!

• When wells are included, Large scale become cheaper because of higher efficiency
Conclusion

- Selection between one or the other does not seem obvious
- Well head power plants along side large scale plant most likely scenario for field development
- Combining the best of both by using a combination of both
- Temporary well head for early generation
- Permanent well head for “off design” wells and surplus steam
- Well head plant can be the key to project feasibility with early generation
Thank you