Think outside the box

How creativity and innovative thinking when planning power production from geothermal resource can lead to value creation beyond expectation

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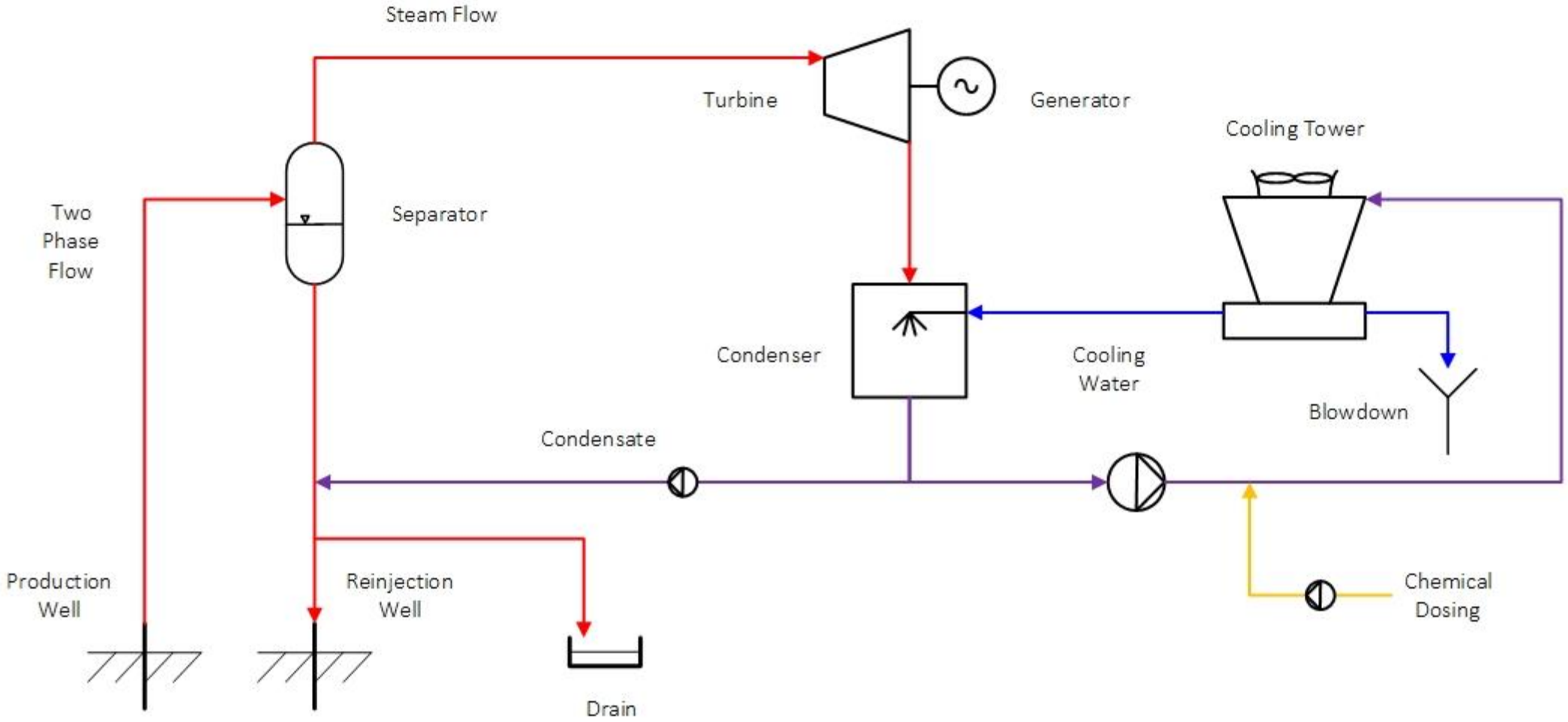
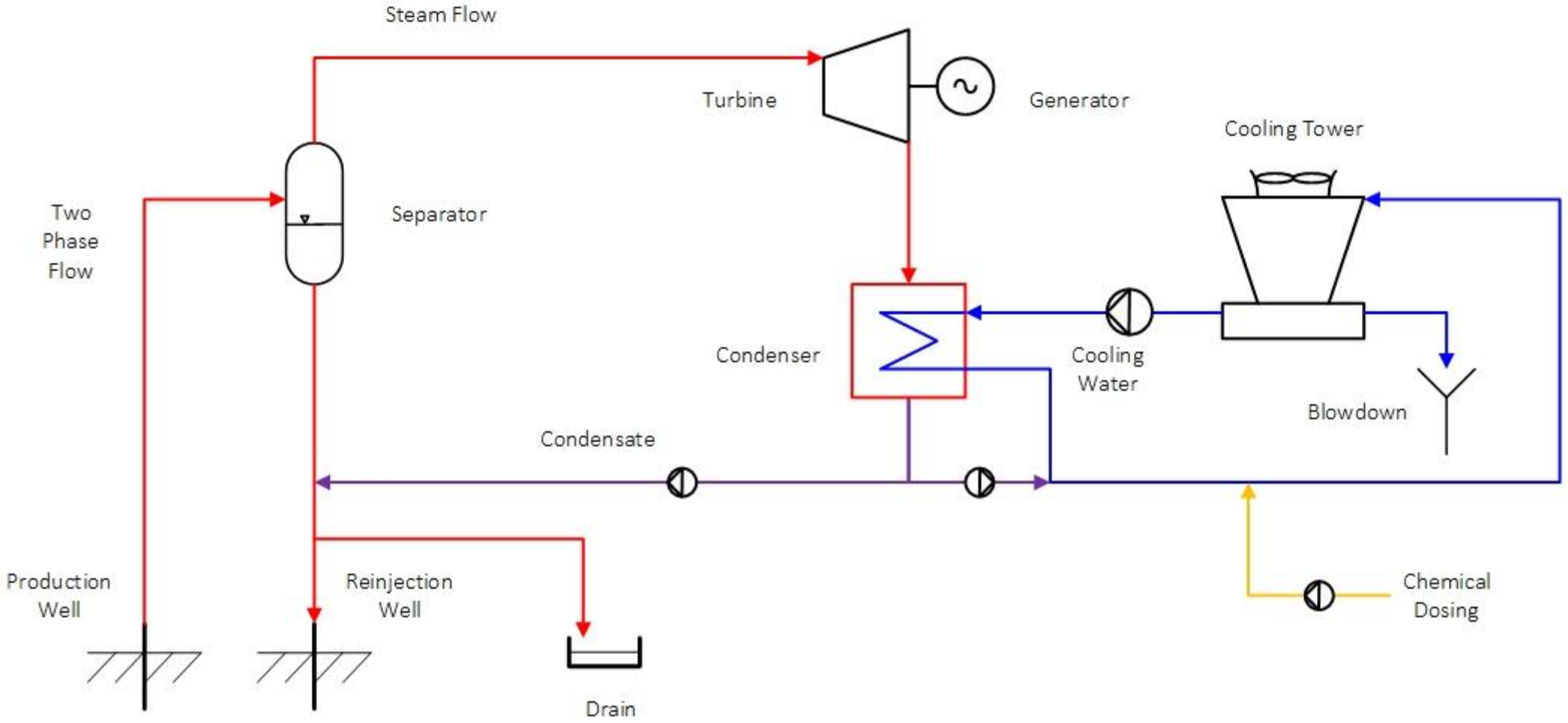
Typical components of geothermal flash plant

- Wellfield
  - Production and re-injection wells
  - Gathering pipes
  - Separators
  - Steam supply lines
- Power plant
  - Turbines
  - Generators
  - Condensers
- Wet Cooling tower

Single flash, direct condensing and wet cooling



Single flash, indirect condensing and wet cooling

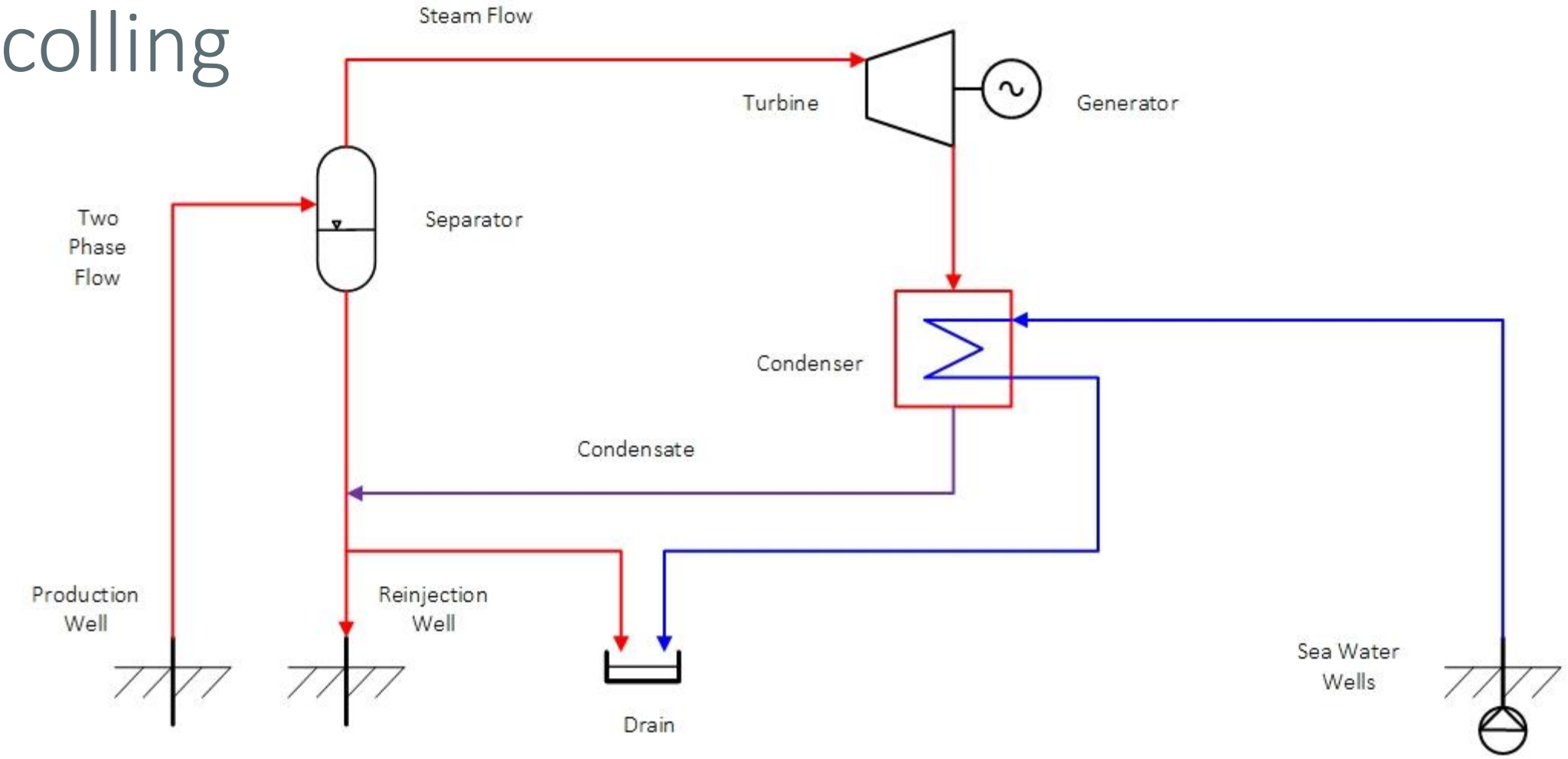


Reykjanes plant cold end design approach

- The location of the plant
  - On the tip of Reykjanes peninsula
  - Close to the sea
- Eliminate environmental impact
- Eliminate cooling towers
- Eliminate cooling tower plume
- Eliminate use of chemicals for cooling water treatment

- Use the sea for cooling!

Single flash, indirect condensing and sea water colling



Reykjanes geothermal power plant

- 100 MW geothermal single flash plant
- Separation pressure: 18 bara
- Condensing pressure: 0.1 bara.
- Shell and tube condensers
- Sea water cooled

Pros and cons

- Pros
  - Get rid of the cooling towers
  - No plume from cooling towers
  - 32°C warm clean sea...potential resource!
  - Architectural design opportunities
- Cons
  - More expensive
  - Non – standard design
  - Sea water pumping and condenser with titanium tubes
  - Plant to be moved from the steam field, closer to the sea shore

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Power streams in Reykjanes

- Steam from separators: 170 kg/s @ 210°C
  - **100 MW** of electricity, if the steam is condensed @ 45°C

- Brine from separator to re-injection and disposal: 400 kg/s @ 210 °C
  - **360 MW** of heat, if the brine is utilized to 20°C

- Sea water from condensers: 3200 kg/s @ 32°C
  - **160 MW** of heat, if warm sea is utilized to 20°C

Utilizing the 32°C clean sea water

- At design stage:
  - Usages not defined
  - Using the sea water was not a part of the initial business plan
  - Innovating thinking by Albert Albertsson and others
  - Creating a resource from waste

- After commissioning
  - Look for potential investors to harness this new resource
  - Clean warm seawater – green energy – geothermal –renewable
  - An opportunity a food producer could not resist.

Stolt sea farm

- High tech aquaculture company
- Product: Sole Senegalensis
- Utilizing 2000 l/s of 32°C
- 100 MW of heat – Direct use
- Up to 70 employees
- Many derived jobs

Stolt sea farm


Plant discharge
Seawater wells
Power plant
Stolt sea farm
Separators
Steam field
0
500 m

Conclusion

- Traditional thinking in geothermal , aiming for electricity only is outdated!
- Cascaded and multiple use is the present and future
- Geothermal licenses containing sentences like:

  “Exclusive right to use geothermal resources for the purpose of generating electric power”

  *s*hould be avoided when licensing geothermal
- Using this clean energy in a reasonable manner to enhance quality food production should be encourage through licensing
- There is no such thing as “waste”… only resources
- To think outside the box and innovative thinking never goes out of fashion.

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