



Overview of Geothermal Power Plant Discharge and Its Utilization

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April 8th 2014



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Overview

- Scope of Discharge
 - Wastewater
 - Exhaust
- Current Utilization
 - Wastewater
 - Exhaust

Note: All figures in the slides from 2011



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Wastewater

- **Seperation water**
 - Geothermal fluid (at seperation pressure) after steam seperation
 - Temperature 80-210°C, varies between power plants
 - High concentration of dissolved solids (nutrients and heavy metals)
 - Main chemicals: SiO₂, Na, Cl, CO₂, K, H₂S, SO₄, Al, F, Fe, Ca, Mg, B
 - Trace elements: As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sr, Zn
 - Disposal can cause both cemical and thermal pollution
- **Condensate**
 - Condensed steam from a condenser
 - Temperature 35-55°C, varies between power plants
 - Low concentration of dissolved solids
 - Low pH-value
 - Disposal can cause both cemical and thermal pollution
- **Cooling water**
 - Heated fresh water or brine
 - Temperature 35-55°C, varies between power plants
 - Disposal can cause thermal pollution





Disposal methods

- Surface disposal – Land
 - Ponds or lagoons
 - Drainage wells (svelgholur). Depth: 10-60 m
- Surface disposal – Sea
- Re-injection – Shallow wells
 - Depth: 400-800 m
 - Not connected to the upper groundwater or geothermal system
- Re-injection – Deep wells
 - Depth: > 800 m
 - Connected to the geothermal system





Discharge 2011 - Wastewater

	Seperation water [Mt/y]	Condensate [Mt/y]	Cooling water [Mt/y]	Total [Mt/y]
Re-injection				
Deep wells	17,4	4,64	0	22,05
Shallow wells	4,08	3,75	0	7,83
Sum	21,48	8,4	0	28,88
Surface disposal				
Land	12,30*	3,15*	28,55	44,00
Sea	11,90	3,97	110,38	126,25
Drainage wells	1,89	4,35	0	6,24
Sum	26,09	11,47	138,93	176,49
Total	47,57	19,86	138,93	206,37

*Disposal to the Blue Lagoon and Myvatn Nature Baths included.

Mt/y = Million tonnes/year



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Discharge 2011 - Seperation water

	Bjarnarflag [Mt/y]	Krafla [Mt/y]	Svartsengi [Mt/y]	Reykjanes [Mt/y]	Nesjavellir [Mt/y]	Hellisheiði [Mt/y]	Total [Mt/y]
Re-injection							
Deep wells	0	2,53	3,1	1,85	0	9,92	17,4
Shallow wells	0	0	1,13	0	2,95	0	4,08
Sum	0	2,53	4,23	1,85	2,95	9,92	21,48
Surface disposal							
Land	2,26	1,48	3,29	0	4,76	0,51	12,3
Sea	0	0	0	11,9	0	0	11,9
Drainage wells	0	0	1,89	0	0	0	1,89
Sum	2,26	1,48	5,18	11,9	4,76	0,51	26,09
Total	2,26	4,01	9,41	13,75	7,71	10,43	47,57

Mt/y = Million tonnes/year



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Discharge 2011 - Condensate

	Bjarnarflag [Mt/y]	Krafla [Mt/y]	Svartsengi [Mt/y]	Reykjanes [Mt/y]	Nesjavellir [Mt/y]	Hellisheiði [Mt/y]	Total [Mt/y]
Re-injection							
Deep wells	0	0	2,06	0,62	0	1,96	4,64
Shallow wells	0	0	0,31	0	3,44	0	3,75
Sum	0	0	2,38	0,62	3,44	1,96	8,4
Surface disposal							
Land	0	2,05	1,1	0	0	0	3,15
Sea	0	0	0	3,97	0	0	3,97
Drainage wells	0	0	0	0	2,05	2,3	4,35
Sum	0	2,05	1,1	3,97	2,05	2,3	11,47
Total	0	2,05	3,48	4,58	5,49	4,26	19,86

Mt/y = Million tonnes/year



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Discharge 2011- Cooling water

	Bjarnarflag [Mt/y]	Krafla [Mt/y]	Svartsengi [Mt/y]	Reykjanes [Mt/y]	Nesjavellir [Mt/y]	Hellisheiði [Mt/y]	Total [Mt/y]
Surface disposal							
Land	0	0	0	0	28,55	0	28,55
Sea	0	0	0	110,38	0	0	110,38
Total	0	0	0	110,38	28,55	0	138,93

Mt/y = Million tonnes/year



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Exhaust

- Major gases in geothermal fluids
 - CO_2 , H_2S , N_2 , H_2 , Ar, CH_4
- Non condensable gases
 - Greenhouse (CO_2 , CH_4)
 - Toxic (H_2S)
- Concentration depends on:
 - Temperature
 - Composition of fluid
 - Geological settings





Exhaust 2011 – Non Condensed Gases

	CO ₂ (t/y)	CH ₄ (t/y)	H ₂ S (t/y)	Total (t/y)
Bjarnarflag	1.269	17	1.524	2.810
Krafla	39.295	12	5.012	44.319
Svartsengi	61.153	5	1.128	62.286
Reykjanes	22.114	2	819	22.935
Nesjavellir	14.800	47	9.414	24.261
Hellisheiði	39.479	57	16.110	55.646
Samtals	178.110	140	34.007	212.257

t/y = tonnes/year



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Current Utilization

- **Wastewater**

- Injection into the geothermal system for improved and more sustainable utilization of the resource – OR, LV, HS Orka.
 - Krafla, Svartsengi, Reykjanes and Hellisheiði
- Hot water production – OR, HS Orka
 - Svartsengi, Nesjavellir and Hellisheiði
- Geothermal baths/spas – Blue lagoon and Myvatn nature baths
 - Svartsengi and Bjarnarflag
- Silica and mineral salt production (for skin care products) – Blue Lagoon
 - Svartsengi
- Fish farming – Stolt Seafarm
 - Reykjanes





Current Utilization

- **Exhaust**
 - Methanol production – Carbon Recycling
 - Svartsengi
 - Microalgae Production (for skin care products) – Blue lagoon
 - Svartsengi





Thank you



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