

# Geothermal Data Management System

Egill Juliusson  
Chief Reservoir Engineer  
Landsvirkjun – National Power Company of Iceland



## What's Next?

SIS Global Forum 2017

**September 13–15**

Le Palais des Congrès de Paris

**Schlumberger**

## Agenda

- About Landsvirkjun
- Project Aim
- Solution Overview
- Next Steps
- Q&A Session

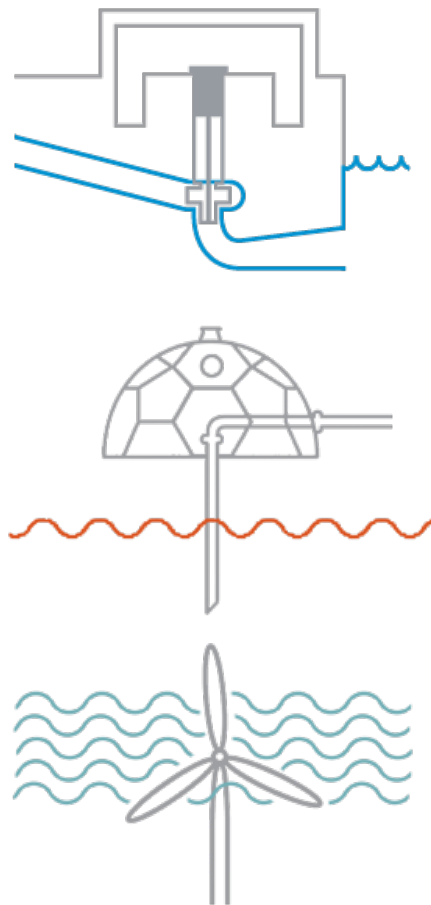


## About Landsvirkjun

### Mission:

«Landsvirkjun's role is to maximise the potential yield and value of the natural resources it has been entrusted with, in a sustainable, responsible and efficient manner.»

- Hydro and Geothermal and Wind Power generation
- Hydro production, 1953 MW in 14 stations
- Geothermal production, 63 MW in 2 stations
- Third Geothermal Plant under construction
- Geothermal wells similar to O&G → Steam
- +130 wells, declining output → 1 new every 1-2 years
- Total worth of LVs geothermal wells on the order of 100s of MUSD
- LV focus both on plant construction and operation
- All employees and most consultants and contractors based in Iceland



## Project Aim

Information system for wide range of data in geothermal operations

# Challenges

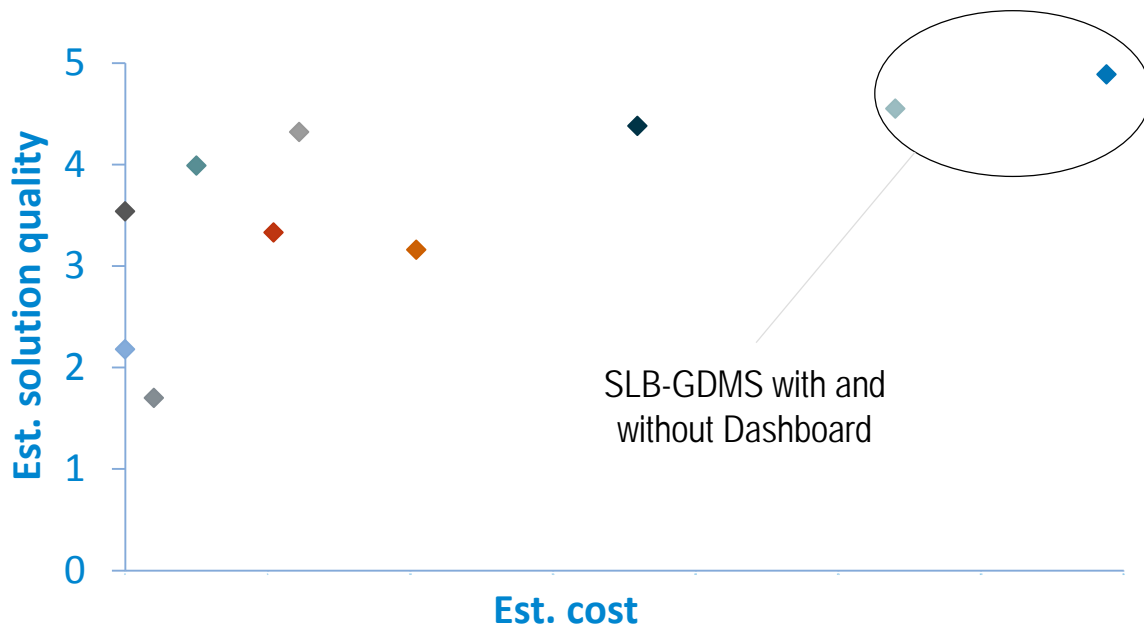
- Geothermal research and operations data stored in various places
  - Petrel, Power plant SCADA system, Share Point, various files and databases (MySQL, Oracle, PostGRES, SQLite, Excel)
- Key information systems outdated
- A good information system fulfills the requirements of the field operators, the power plant development team and the R&D division.
- Need to facilitate cooperation (both in-house and outside)
- A thorough requirements analysis for a new information system carried out

## Requirements Analysis

Schlumberger Solution scored highest in quality and cost, both with and without Avocet Dashboard

Schlumberger chosen with aim to develop a long-term relationship with a dedicated partner

- Data Integration and Validation
- Well established solution
- Field capture to analysis workflow
- Standardization
- Ties to geothermal industry
- Tools to incorporate own analysis and plug-ins



## Solution Scope

System and data integration from field data collection to geospatial analysis

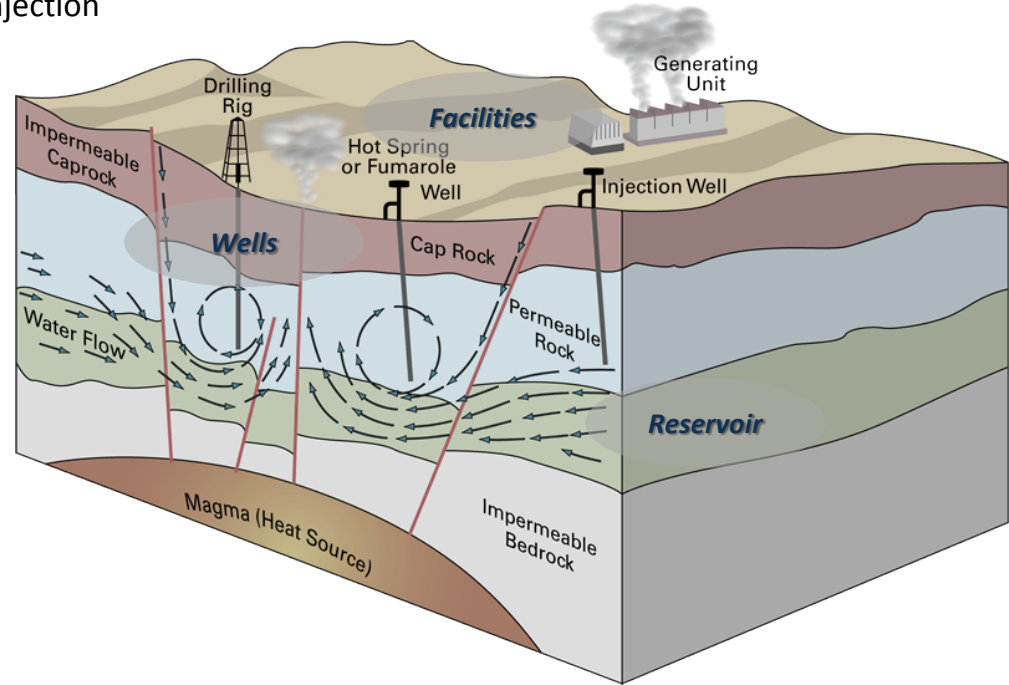
Well Production and Injection

Well Logs

Well Configurations

Chemical Analysis

Facility measurements



Steam Tables Link

Well Output Calculations

Geochemical Calculations

Power Plant Performance

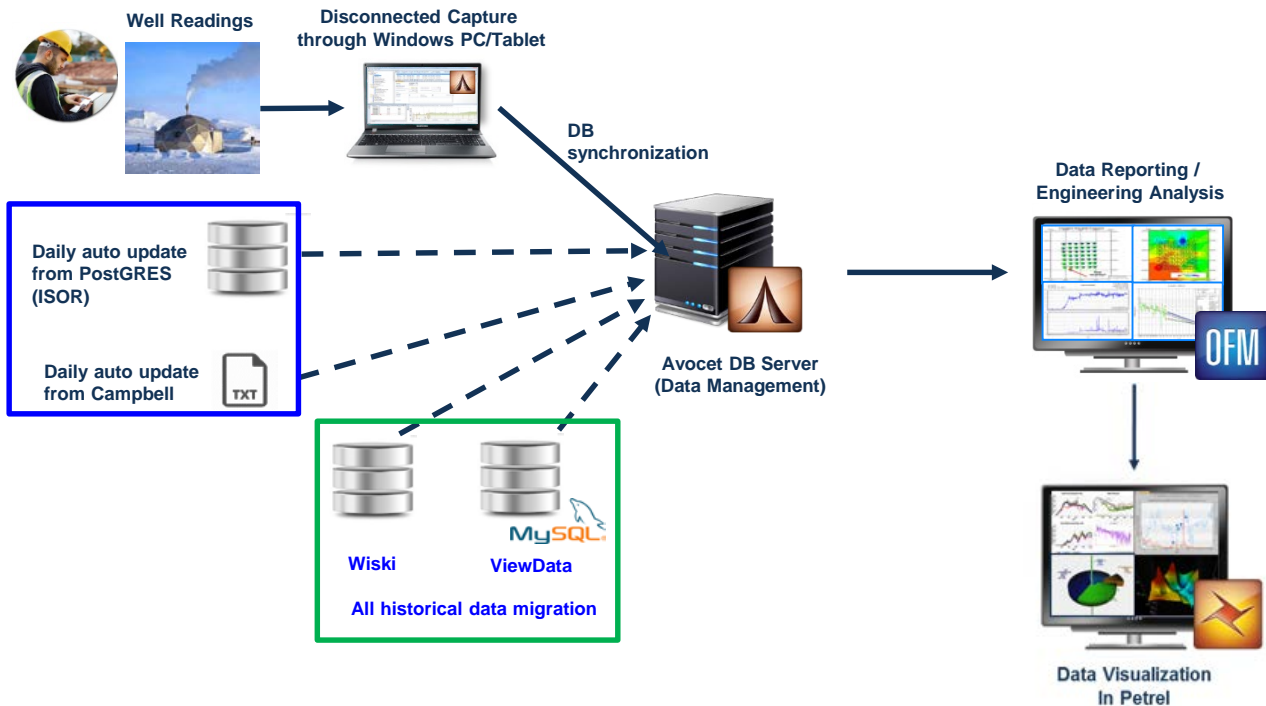
Horner Analysis

Image Source: British Geological Survey

## Proposed Solution Architecture

System and data integration from field data collection to geospatial analysis

# Solution Architecture







## Project Scope

Data from legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Create common item hierarchy and nomenclature

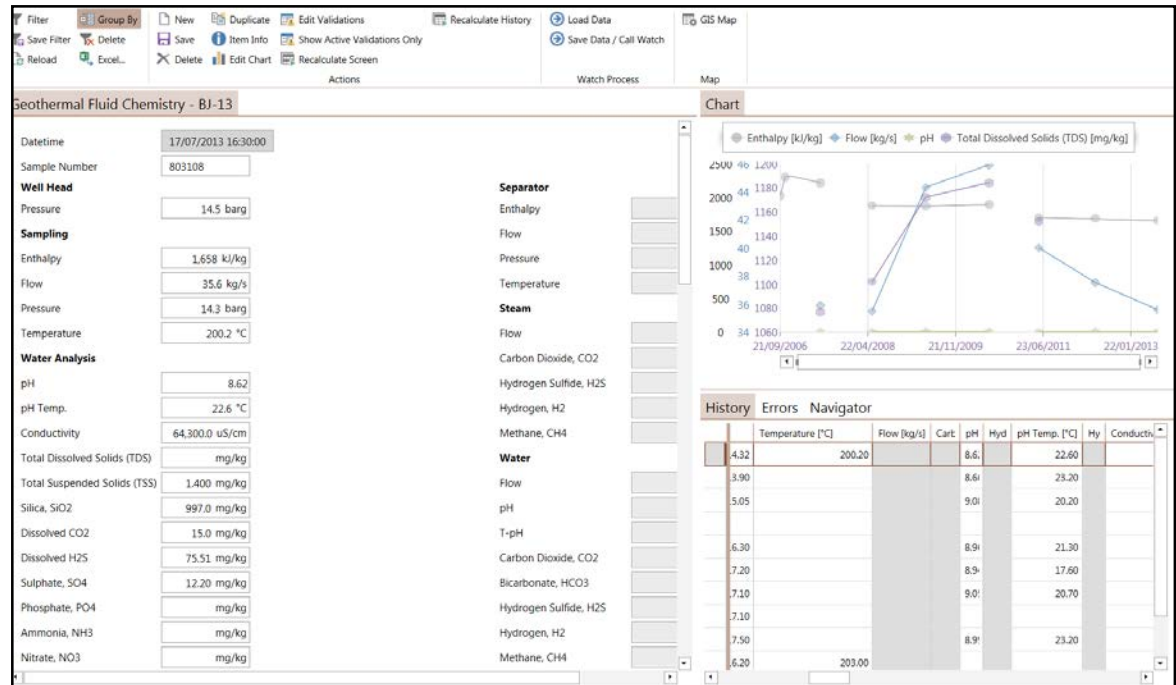
# Integration of Data from legacy systems

Chemical Analysis

Sampling Data

Water, Steam and Gas Analysis

Data Verification, Operator Remarks, etc.



## Project Scope

Data from legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Create common item hierarchy and nomenclature

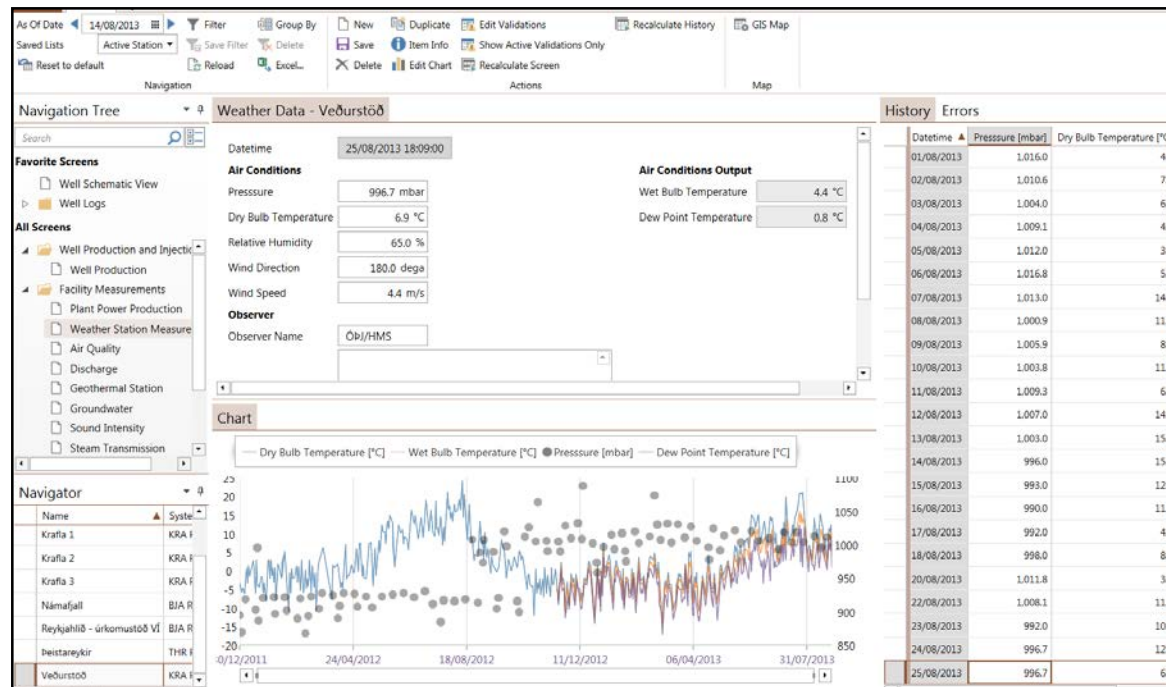
# Integration of Data from legacy systems

Facility Measurements

Power Plant Production Parameters

Weather Conditions, Air Quality, Sound Intensity

Steam Transmission, Fluid Discharge, Groundwater Level, etc



## Project Scope

Data from legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Create common item hierarchy and nomenclature

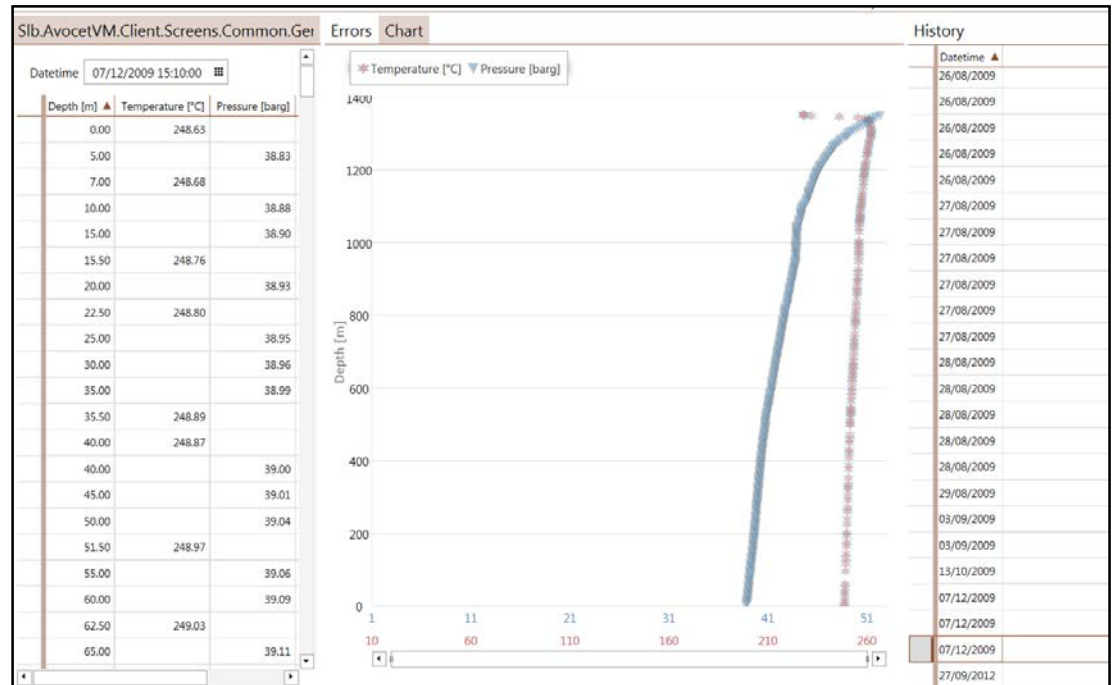
# Integration of Data from legacy systems

Well Logs

Pressure, Temperature, Flow Rate (PTS)

Gamma, Neutron, Resistivity, Spontaneous Potential

Caliper, Cement Bond (CBL)



## Project Scope

Data from legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Create common item hierarchy and nomenclature

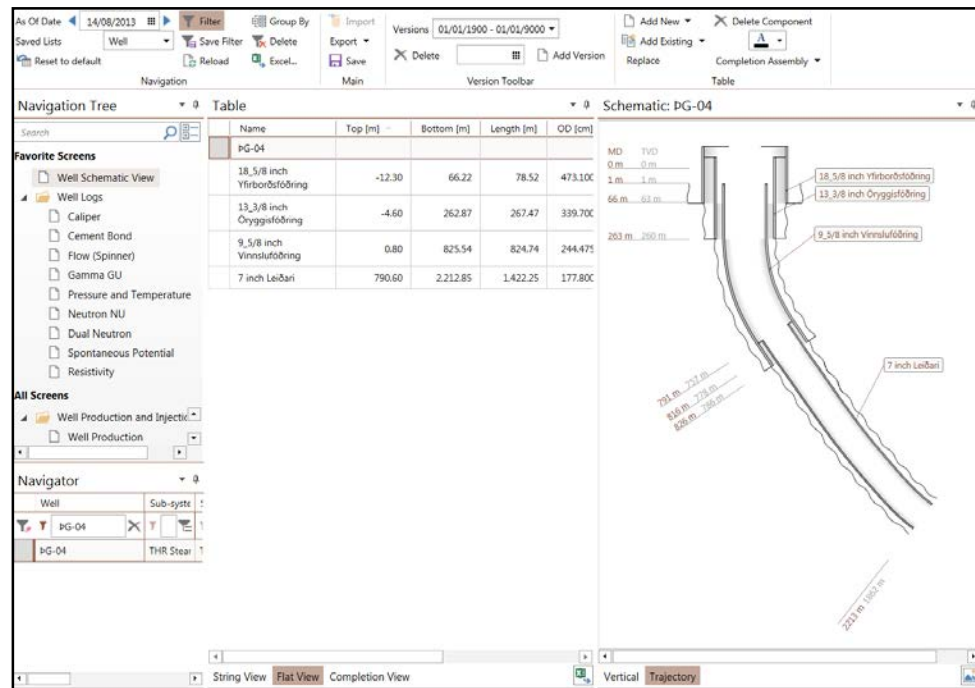
# Integration of Data from legacy systems

Well Configuration

Trajectory

Casings

Schematics



# Key calculations in Avocet and OFM

## Project Scope

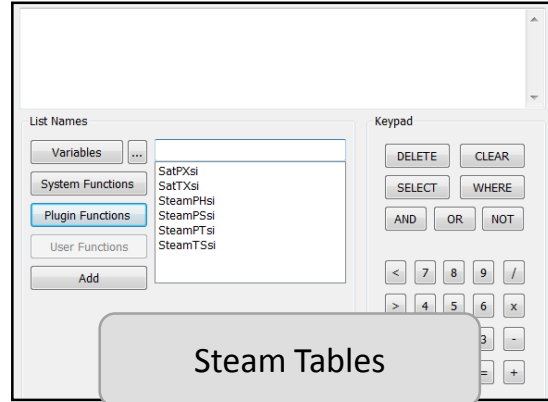
Data from legacy data systems into Avocet

Build key calculations into Avocet and OFM

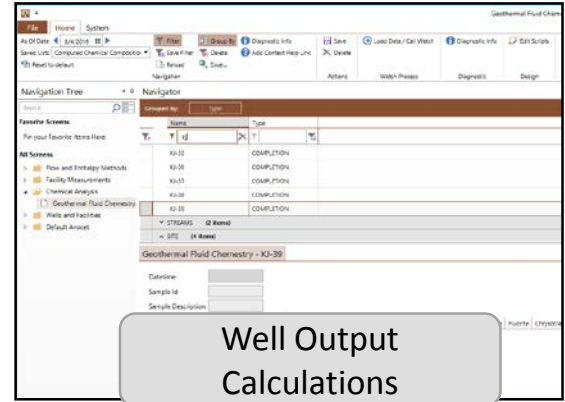
Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

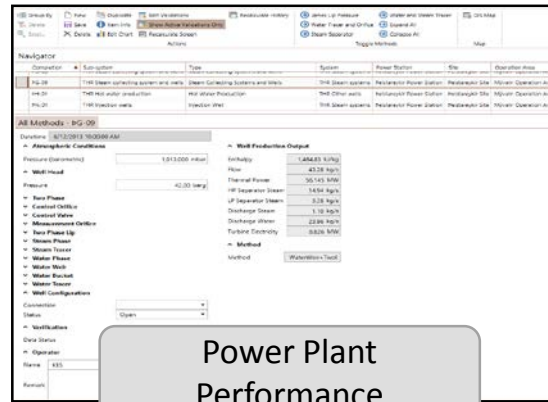
Create common item hierarchy and nomenclature



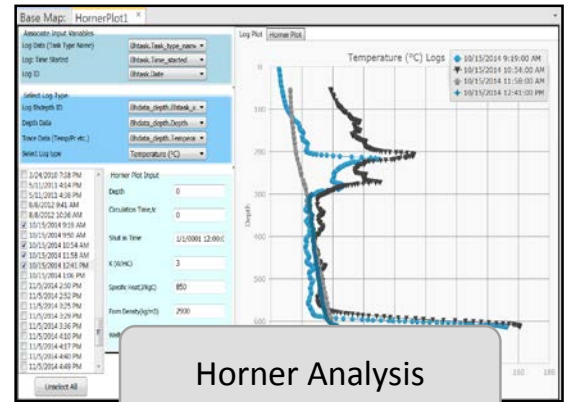
**Steam Tables**



**Well Output Calculations**



**Power Plant Performance**



**Horner Analysis**

# Link OFM to Avocet to setup preliminary analysis

## Project Scope

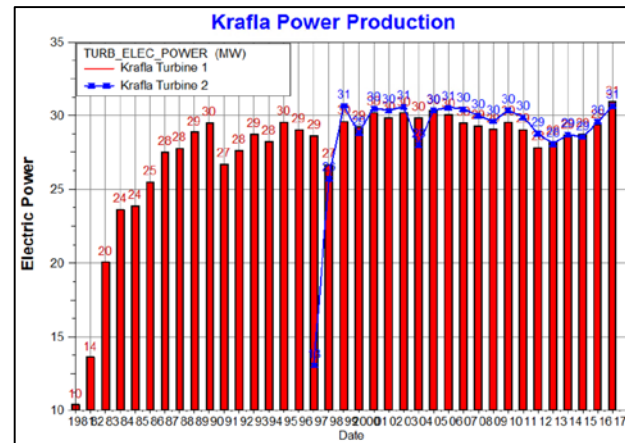
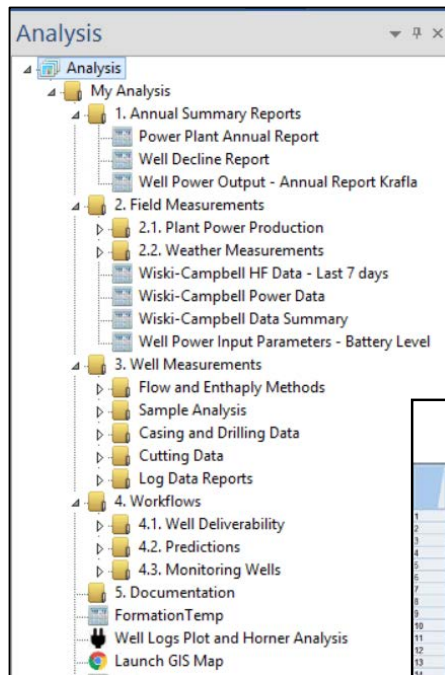
Data from three legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

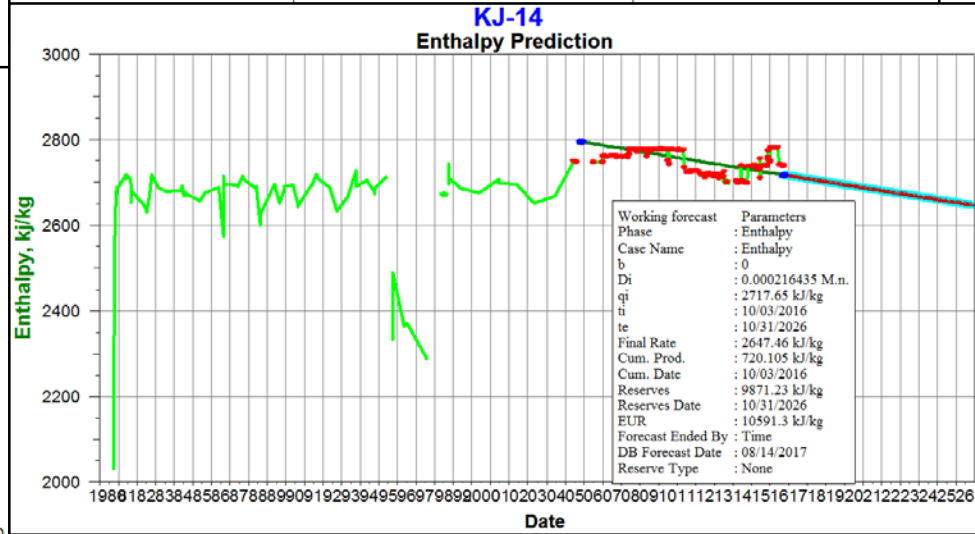
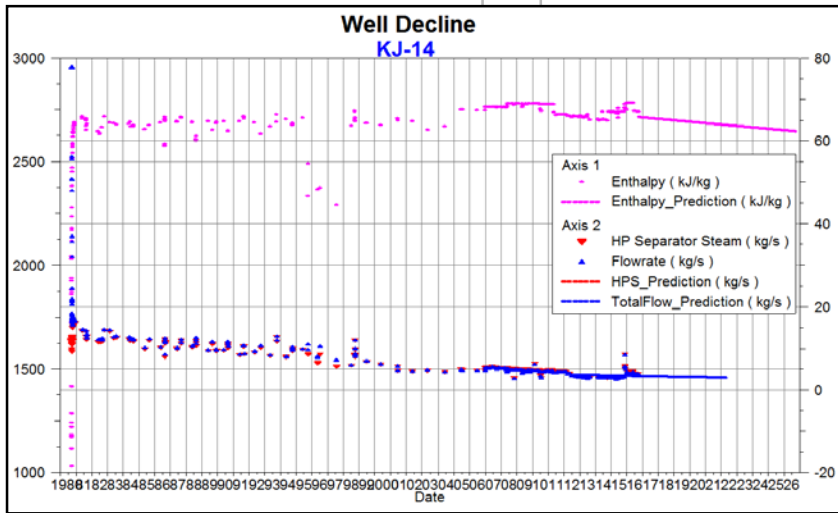
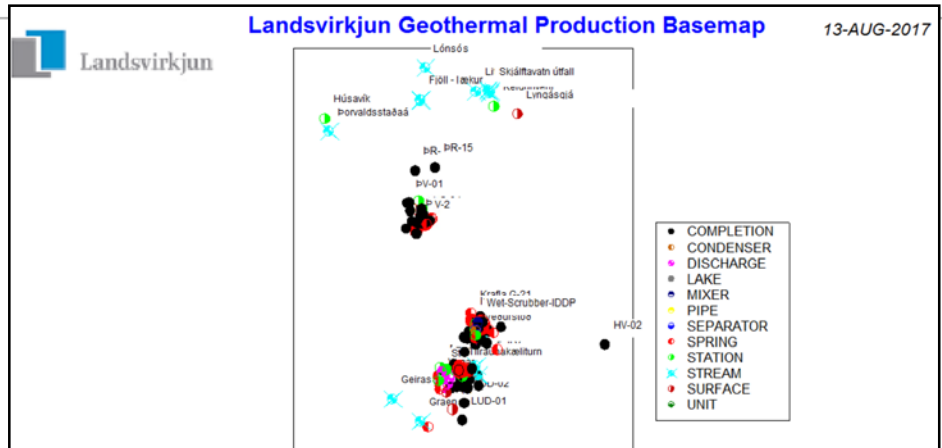
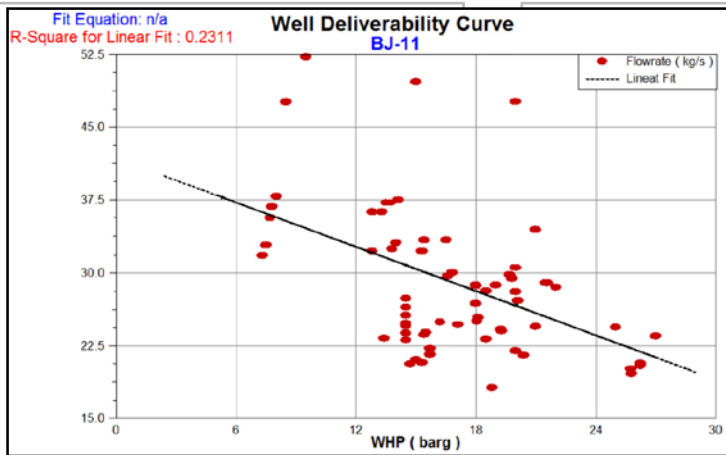
Create common item hierarchy and nomenclature



**Power Station Annual Report**  
**Krafla Turbine 1**

Note: Please select Krafla Turbine 1 or Krafla Turbine 2 under the completions or under item\_type 'Unit' from the navigation

Year	Turbine Electric Power MW	Turbine HP Pressure barg	Turbine LP Steam Rate kg/s	Turbine LP Steam Pressure barg	Turbine LP Steam Rate kg/s	Power Production Tj	Turbine Thermal Efficiency %	Turbine Mechanical Efficiency %	Condenser Pressure mmHg(C)	Condenser Temperature Deg. C
1 1981	10.37	6.09	32.58	0.66	0.33				95.29	30.22
2 1982	13.61	6.76	36.71	0.80	4.27	0.43	12.53	57.28	110.98	28.65
3 1983	20.06	7.23	46.83	0.89	6.04	0.63	14.40	63.27	98.04	30.84
4 1984	23.64	6.98	52.70	0.99	10.41	0.75	14.26	65.66	90.59	36.94
5 1985	23.87	6.88	53.15	0.95	7.80	0.75	15.88	63.38	80.91	33.86
6 1986	25.50	6.40	55.77	0.95	8.03	0.80	15.58	66.72	81.06	37.52
7 1987	27.53	6.56	58.68	0.99	7.23	0.87	16.23	69.42	64.01	38.32
8 1988	27.79	6.74	51.68	1.17	8.09	0.88	18.09	75.88	65.52	37.73
9 1989	28.87	6.83	47.95	1.06	13.86	0.91	18.52	79.00	87.66	38.91
10 1990	29.53	7.16	50.24	1.09	12.56	0.93	18.56	78.92	87.71	39.77
11 1991	26.71	7.34	52.34	1.16	10.51	0.84	17.31	72.32	82.43	38.26
12 1992	27.82	7.22	51.13	1.08	12.14	0.87	16.87	71.27	84.52	37.82
13 1993	28.73	7.28	54.06	1.04	12.47	0.91	16.17	65.49	77.66	38.51
14 1994	28.24	7.29	50.43	1.06	10.44	0.89	18.00	74.18	76.04	38.13
15 1995	29.56	7.26	47.35	1.06	10.05	0.93	19.85	81.24	73.07	38.25
16 1996	29.04	7.26	46.97	1.05	8.96	0.92	20.11	83.72	81.34	39.14
17 1997	28.66	7.27	45.51	1.40	12.95	0.90	19.32	81.04	82.71	39.26
18 1998	26.68	7.34	45.05	1.26	11.35	0.84	18.31	75.65	85.30	39.03
19 1999	29.61	7.32	48.71	1.25	11.15	0.93	19.39	83.97	99.16	41.54
20 2000	29.24	7.31	58.36	1.65	14.86	0.92	16.75	70.40	90.38	41.87
21 2001	30.23	7.45	62.68	1.22	15.96	0.95	15.56	64.16	52.82	42.89



## Project Scope

Data from three legacy data systems into Avocet

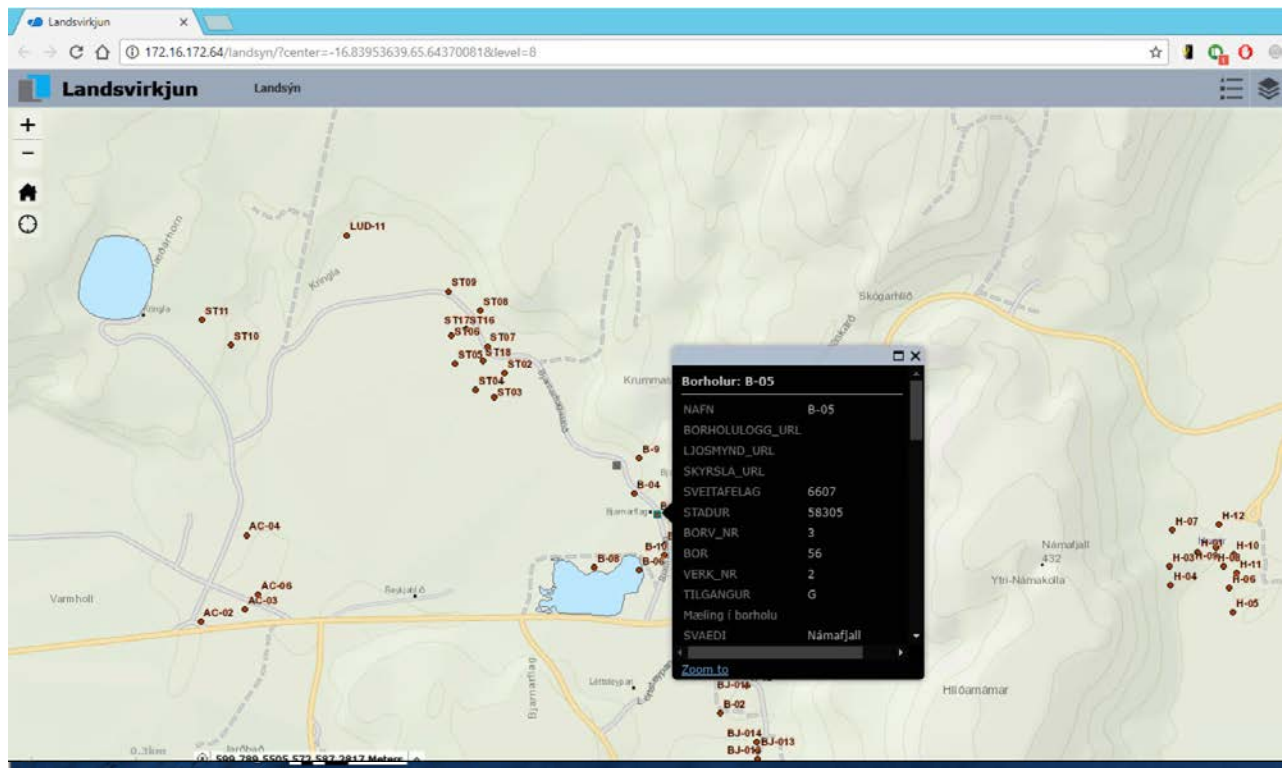
Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Create common item hierarchy and nomenclature

## GIS from OFM and Avocet





## Project Scope

Data from three legacy data systems into Avocet

Build key calculations into Avocet and OFM

Link OFM to Avocet and set up preliminary analysis

GIS from OFM and Avocet

Common item hierarchy and nomenclature

# Common Item Hierarchy and Nomenclature

**All Screens**

- ▲ 📁 Well Production and Injection
  - 📄 Well Production
- ▶ 📁 Facility Measurements
- ▶ 📁 Chemical Analysis
- ▲ 📁 Wells and Facilities
  - 📄 Bore
  - 📄 Completion
  - 📄 Condenser
  - 📄 Cooling Tower
  - 📄 Discharge
  - 📄 Lake
  - 📄 Mixer
  - 📄 Pipeline
  - 📄 Separator
  - 📄 Spring
  - 📄 Station
  - 📄 Streams
  - 📄 Sub-system
  - 📄 Surface
  - 📄 Unit
  - 📄 Well

**Organization Viewer**

Start Datetime	End Datetime	Operation Area			
01/01/1900	01/01/9000	Myvatn Operation Area			
Start Datetime	End Datetime	Site			
01/01/1900	01/01/9000	Bjarnarflog Site			
01/01/1900	01/01/9000	Krafla Site			
Start Datetime	End Datetime	Power Station			
01/01/1900	01/01/9000	Krafla Power Station			
Start Datetime	End Datetime	System			
01/01/1900	01/01/9000	KRA Other wells			
Start Datetime	End Datetime	Sub-system			
01/01/1900	01/01/9000	KRA Cold water production			
Start Datetime	End Datetime	Well	Function	Product	Active
01/01/1900	01/01/9000	AE-01		Water	<input checked="" type="checkbox"/>
01/01/1900	01/01/9000	AE-02		Water	<input checked="" type="checkbox"/>
Start Datetime	End Datetime	Sub-system			
01/01/1900	01/01/9000	KRA Drainage well			
01/01/1900	01/01/9000	KRA General research			
Start Datetime	End Datetime	System			
01/01/1900	01/01/9000	KRA R&D data system			
Start Datetime	End Datetime	Sub-system			
01/01/1900	01/01/9000	KRA Measuring stations			
01/01/1900	01/01/9000	KRA Sampling point			
01/01/1900	01/01/9000	KRA Weather Stations			
Start Datetime	End Datetime	System			
01/01/1900	01/01/9000	KRA Steam systems			
Start Datetime	End Datetime	Sub-system			
01/01/1900	01/01/9000	KRA Injection wells			
01/01/1900	01/01/9000	KRA Steam collecting system and wells			

## Future Work

- Start capturing manual field data through Avocet web
- Define views for partner collaboration
- Connect OFM to other data sources
- Standardized reporting to field operations
- Extended functionality for geothermal applications
- Design Dashboard for KPI monitoring

Q&A

Thank you!