



## D1.4 Validation site selected

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## DOCUMENT INFO

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### Document History

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## EXECUTIVE SUMMARY

The most interesting well to test the Optidrill concept is Aardwarmte Koekoekspolder KKP in IJsselmuide, the Netherlands. The reservoir is Rotliegend sandstone. The new well runs in a field of three existing well documented wells where two are active geothermal wells and one abandoned gas well. From all wells core samples are available. The validation activity equipment will be used to drill into ground at user sites and to perform well completions. These activities will be monitored by the owners and their support partners. An iteration of equipment modification is likely to be made at the mid-point of each demonstration run if it is deemed beneficial.

Once the demonstrations are well established and have generated sufficient data, the results will be evaluated and formed into benefits statements and costed options to be communicated to the industry and other stakeholders.

Due to the nature of drilling and well completion activities multiple validation sites will be selected. Timing of all the other developments and testing will be critical, as well as a fail-safe procedure, in case the system does exhibit issues in a commercial environment. Testing results from IEG's full-scale test rig will give operators the confidence in testing OPTIDRILL testing at their production site.

Other projects are planned further in the future. If for what reason the KKP site will not be suitable, a campaign has to start to convince another party. Recent lessons learned in the Geothermica CAGE and Hipe project should help to increase the quality of the results.

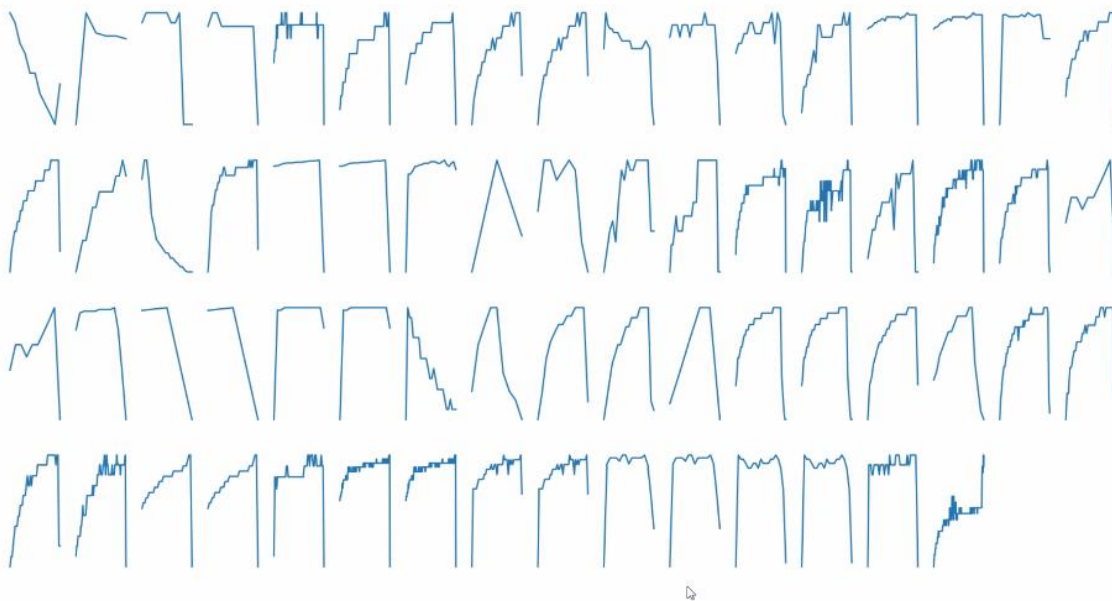
## 1. Objectives

The purpose of this task is to choose a validation site where we will drill a section of the well with OPTIDRILL. A very crucial and important part of the OPTIDRILL project is to build and test prototypes, both in lab environments as well as realistic and industrially relevant environments.

Partner RDS has drilled 2000 wells in the last 15 years and there are always some well drilling going on. We will select one of them as the validation site for Field testing and validation of OPTIDRILL drilling advisory system for ROP, lithology, drilling problems, well completion & well enhancement will be performed. If no suitable wells can be found, then we will validate at OPTIDRILL at field-scale test stand at IEG in the same principle as the conduction of testing of prototypes, system tests, and initial validations of system parts e.g. sensor housing, connectivity, and compatibility testing, using IEG's full-scale test rig.

## 2. Lessons learned

The objective of the project is to optimize the drilling and stimulation process with the deployment of artificial intelligence. The EU project Cage and the Dutch research project Hipe resulted in some lessons learned. The day reports show some information but the corresponding detailed data do deliver far more information which cannot be found in the day report. In countless conversation on the rig floor and deep understanding of the different processes the real issues comes on the table. As can be seen in the adjacent graph this are all time laps of approx. one minute. Some corresponds to what is now believed to be successful others to less successful and finally some do not contribute at all to any form off progress.



Lesson learned show that a standard day report and a detailed file with some TByte of data is not enough. Hopefully a clear understanding of the key factors of successful and not successful drilling operations is clear before the data acquisition starts. During the job information should be continuously be exchanged to enrich the day report to generate maximum results. For the stimulation part of the Optidrill project this is covered by RDE. The other drilling part should have a similar approach.

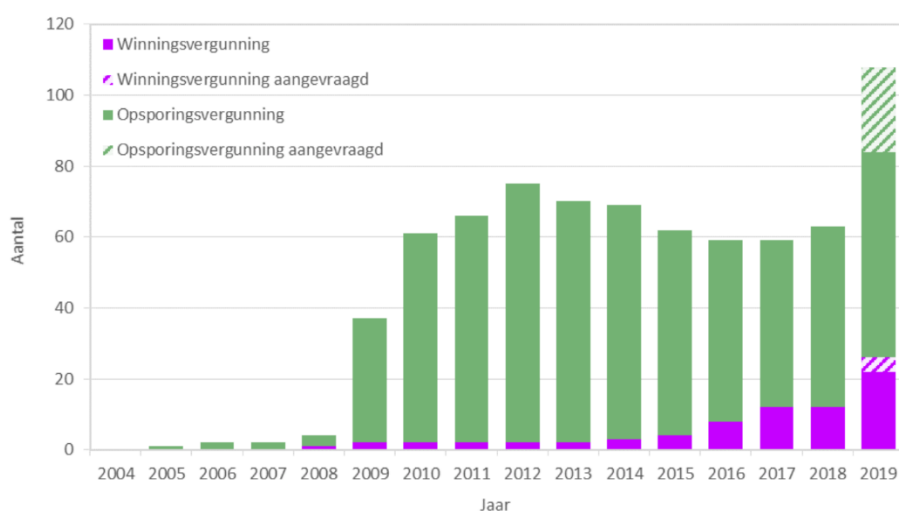
A second lessons is 1000 % testing of the hardware before the operations starts. The conditions are hard and the collected amount of data is all most beyond human dimensions. Hardware gets heated up and data overflow or simple mechanical damage is something which is not unlikely to happen. For the stimulation part the hardware is been tested for over a year in several projects and has been increased in quality from a poor day report to 150 variables each three seconds with a AI interface generating the first results on the operator screen within seconds.

For the candidate selection this means that the operator should be willing to have us around the site day and night.

### 3. Potential candidates

Last year alone, 25 geothermal doublets were installed in the Netherlands of which 22 are in active operation. Another 90 projects are in the development phase. An overview of such development and project names can be seen in the following figures below indicating an increase in the rate of development in such systems. The KPP site which has been chosen as the main candidate has been annotated in the list.

In 2019 zijn 4 nieuwe aanvragen voor een winningsvergunning voor aardwarmte ingediend, waarmee er totaal 4 winningsvergunningen in aanvraag zijn. Er zijn in 2019 10 winningsvergunningen voor aardwarmte verleend. Op 1 januari 2020 zijn 22 winningsvergunningen voor aardwarmte van kracht (Figuur 5.1). Wijzigingen met betrekking tot vergunningen voor opsporing en winning van aardwarmte gedurende 2019 staan vermeld in tabellen in Hoofdstuk 8. Onderstaande grafiek geeft het verloop van de aardwarmte vergunningen weer waarbij voor statusdatum 1 januari 2020 ook het aantal aangevraagde vergunningen in 2019 is weergegeven.



Tabel 5.2 Aardwarmteproductiesystemen.

	Naam productie-installatie	Putten	Vergunning aardwarmte	Operationeel in 2019
1	Californië Geothermie	CAL-GT-1,2&3	Californië IV	Nee, in mei '18 stilgelegd
2	De Lier Geothermie	LIR-GT-1&2	De Lier	Ja
3	Honselersdijk Geothermie	HON-GT-1&2	Honselersdijk	Ja
4	Installatie Berkel en Rodenrijs	VDB-GT-3&4	Bleiswijk-1b	Ja
5	Installatie Bleiswijk	VDB-GT-1&2	Bleiswijk	Ja
6	Koekoekspolder Geothermie	KKP-GT-1&2	Kampen	Ja
7	Mijnwater energiecentrale Heerlen	HLH-G-1&2	Heerlen	Ja, WKO
8	Pijnacker-Nootdorp Geothermie	PNA-GT-5&6	Pijnacker-Nootdorp-4	Ja
9	Pijnacker-Nootdorp Zuid Geothermie	PNA-GT-3&5	Pijnacker-Nootdorp-5	Ja
10	-	HAG-GT-1&2	Den Haag	Tijdelijk ingesloten
11	Heemskerk Geothermie	HEK-GT-1&2	Heemskerk	Ja
12	MDM-GT-02 /MDM-GT-05	MDM-GT-2&5	Middenmeer I	Ja
13	MDM-GT-04 /MDM-GT-03	MDM-GT-3&4	Middenmeer II	Ja
14	Vierpolders	BRI-GT-1&2	Vierpolders	Ja
15	Californië Lipzig Gielen	CAL-GT-4&5	Californië V	Nee, in aug '18 stilgelegd
16	Poeldijk	PLD-GT-1&2	Honselersdijk-2	Ja

#### 4. KKP site as candidate

KKP has planned to drill a third geothermal well in Q1 of 2022. The operator has signed a contract to give access to the drilling rig for data acquisition during the stimulation job to RDE. The subsurface is well described in the two existing wells KKP GT-01 and KKP GT-02 and the oil well of KAM-01 which is less than 2 km north east from the new well site. The new well site is a few hundred meters north east from the well site at 1947 meter (t) depth.





## 4.1 Site details

The technical details of the two main sub-locations of the KKP site which has been located and chosen as an initial candidate are shown in the figures below. The details of each site also can be found at the provided URL's of each figure and are publically available.

## 4.2 Data KKP-GT-01 Active Geothermal producer (2258 meter)

Basisgegevens boorgat	
Naam :	KOEKOEKSPOLDER-GT-02
Code :	KKP-GT-02
Coördinaten (x, y in UTM31, ED50 formaat)	699905 , 5829856
Lat/Long (°)	52.58083974 , 5.95045108
Aangeleverde coördinaten	193092 , 510425 (RD)
Diepte in meter t.o.v. :	Rotary Table
Einddiepte (m) :	2205
Verticale positie van Rotary Table :	-0.05 meter t.o.v. NAP
Vorm boortraject :	Gedevieerd
Deviatie in de x-richting :	-730.6
Deviatie in de y-richting :	465.4
Werkelijke diepte (TVD) in m :	1923.678
Opdrachtgever :	Aardwarmtecluster 1 KKP BV
Begindatum	27-jul-2011
Einddatum	10-sep-2011
Naam platform/mijnbouwwerk :	Wirth B12
Boorfirma :	Daldrup en Sohne AG
Type boring :	Ontwikkeling aardwarmtewinning
Resultaat van de boring :	Water
Status :	Producing/Injecting
Veld(veldcode) :	Koekoekspolder Geothermie (KKP-GT)

### Documenten met boorgatmetingen

CMR Log - CMR - PEX - LEHQT(2072-2203)(01 Sep 2011)  
 Density and Porosity Log - CMR - PEX - LEHQT(2072-2203)(01 Sep 2011)  
 Final Litholog(100-2202)(31 Aug 2011)  
 Litholog - Technical Log - 1:1000(100-2205)(03 Sep 2011) # 1  
 Litholog - Technical Log - 1:1000(100-2205)(03 Sep 2011) # 2  
 Techniklog - Technical Log - 1:1000(100-2205)(29 Aug 2011)

### Documenten met profielgegevens van het boorgat

Appendix A\_Deviation of proposed wells(01 Jan 2010)  
 End of Well Report - Injection Well(10 Sep 2011)  
 KKP-GT\_01\_en\_KKP-GT-02\_Laagbeproeving(17 Feb 2014)

### Documenten met testresultaat boorgat

Clean Up - Prod Test Form KKP-GT-01 en KKP-GT-02(16 Mar 2012)  
 Formation Strength Test (FST)(28 Aug 2011) # 1  
 Formation Strength Test (FST)(28 Aug 2011) # 2  
 Injector Well Test(07 Sep 2011)  
 Producer Well Test(18 Jul 2011)  
 Puttest Injectieput Koekoekspolder(28 Sep 2011)  
 Toelichting Injectiedrukken Koekoekspolder(12 Jun 2012) # 1  
 Toelichting Injectiedrukken Koekoekspolder(12 Jun 2012) # 2  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 1  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 10  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 11  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 12  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 13  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 14  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 15  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 16  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 17  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 18  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 19  
 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 2

<https://www.nlog.nl/nlog/requestData/nlogp/allBor/metaData.jsp?tableName=BorLocation&id=803909123>

## 4.3 DATA KKP-GT-02c Active Geothermal injectro 1923 meter depth

Basisgegevens boorgat	
Naam :	KOEKOEKSPOLDER-GT-02
Code :	KKP-GT-02
Coördinaten (x, y in UTM31, ED50 formaat)	699905 , 5829856
Lat/Long (°)	52.58083974 , 5.95045108
Aangeleverde coördinaten	193092 , 510425 (RD)
Diepte in meter t.o.v. :	Rotary Table
Einddiepte (m) :	2205
Verticale positie van Rotary Table :	-0.05 meter t.o.v. NAP
Vorm boortraject :	Gedevieerd
Deviatie in de x-richting :	-730.6
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Werkelijke diepte (TVD) in m :	1923.678
Opdrachtgever :	Aardwarmtecluster 1 KKP BV
Begindatum	27-jul-2011
Einddatum	10-sep-2011
Naam platform/mijnbouwwerk :	Wirth B12
Boorfirma :	Daldrup en Sohne AG
Type boring :	Ontwikkeling aardwarmtewinning
Resultaat van de boring :	Water
Status :	Producing/Injecting
Veld(veldcode) :	Koekoekspolder Geothermie (KKP-GT)

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 Well Test Data - Week 41 tm 52 en Week 1 tm 46 - Serial Number: 104 tm 161(17 Nov 2013) # 2

<https://www.nlog.nl/nlog/requestData/nlogp/allBor/metaData.jsp?tableName=BorLocation&id=872287025>

#### 4.4 DATA KAM-01 Abandonend gas well

Basisgegevens boorgat	
Vaam :	KAMPEN-01-SIDETRACK1
Code :	KAM-01-S1
Coördinaten (x, y in UTM31, ED50 formaat)	Zie moederboorgat
Lat/Long (°)	Zie moederboorgat
Diepte in meter t.o.v. :	Kelly Bushing
Einddiepte (m) :	2154.5
verticale positie van Kelly Bushing :	5 meter t.o.v. NAP
Vorm boortraject :	Vertikaal
Deviatie in de x-richting :	0
Deviatie in de y-richting :	0
Werkelijke diepte (TVD) in m :	2154.5
Opdrachtgever :	Signal
Begindatum	22-sep-1969
Einddatum	10-okt-1969
Type boring :	Exploratie koolwaterstof
Resultaat van de boring :	Gas shows
Status :	Abandoned

<https://www.nlog.nl/nlog/requestData/nlogp/allBor/metaData.jsp?tableName=BorLocation&id=872287025>

## 5. Alternative candidates

Geothermal operators are in general very reluctant to share data. By law, data should be made public which results in a huge database of data. It will help if based on the public data the model could compare the cost of the realized operation with the predicted cost of operation. The model can then be validated at KKP. If results are according to expectations, new drillings can have the same approach, resulting in a new standard.

In case additional investment is needed, additional local funding can be requested. Again, some results should justify the new proposal.