Ministerie van Economische Zaken en Klimaat

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10.2.e

Directoraat-generaal Klimaat en Energie
Directie Warmte en Ondergrond

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Behandeld door
10.2.e

Datum - 2 0 DEC. 2021 -
Betreff Deelbesluit 1 op uw Wob-verzoek d.d. 26 augustus 2021

Ons kenmerk
DGKE-WO / 21275398

Bijlage(n)
3

Geachte 10.2.e,

In uw e-mail van 26 augustus 2021 heeft u met een beroep op de Wet openbaarheid van bestuur (hierna: Wob) om de volgende informatie verzocht:

U verzocht mij over de periode van 2015 tot heden in digitale vorm afschriften te sturen inzake het voornemen, de gedachtenvorming en onderzoek naar het toepassen van aardwarmte in de provincie Utrecht, inclusief het voornemen van Warmtebron Utrecht (WBU) om in of nabij de gemeente Nieuwegein aardwarmte te willen winnen en inzake het voornemen van het ministerie van EZK om een landelijke schaderegeling voor de geothermie tot stand te brengen van:

1. al het interne schriftelijke en digitale verkeer hierover (besluiten, concept-besluiten, berichten, notities, verslagen, inclusief rapporten, concept-rapporten en andere bijlagen die via de post, email, SMS, Whatsapp, Signal en andere digitale mediakanalen zijn gewisseld) van en tussen de ambtenaren en bewindslieden van het ministerie en van en met de door het ministerie ingehuurde adviseurs en adviesbureaus

2. al het schriftelijke en digitale verzonden en ontvangen verkeer hierover (via post, emails, SMS, Whatsapp, Signal en andere digitale mediakanalen) van het ministerie, van individuele ambtenaren het ministerie en van de door het ministerie ingehuurde adviseurs en adviesbureaus met:

- Warmtebron Utrecht (WBU) en
- de afzonderlijke partners binnen WBU (EBN, Eneco, ENGIE, Hogeschool Utrecht, Huisman Geo., IF Technology, Kantorenpark Rijnsweerd, TNO, UMC Utrecht, Well Engineering Partners, Universiteit van Utrecht) en
- de provincie Utrecht en
- de gemeente Nieuwegein
- Samenwerkingsverband U16 en
- Staatstoezicht op de Mijnen en
- de Mijnraad en
- Veiligheidsregio Utrecht en
- ICO Aardwarmte en
- Platform Geothermie en Geothermie Nederland (voorheen DAGO) en
- alle andere instanties en experts waarmee over dit onderwerp contact is geweest

Directoraat-generaal Klimaat en Energie
Directie Warmte en Ondergrond

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Procedure

Op 26 augustus 2021 hebben wij uw Wob verzoek ontvangen. Op 13 september heeft het ministerie met u een nader gesprek gevoerd over uw verzoek. Vervolgens heeft u op 22 september een weergave van dit gesprek aan het ministerie toegestuurd.

De ontvangst van dit Wob-verzoek is schriftelijk bevestigd bij brief van 22 september 2021, met kenmerk DGKE-WO/2105503. In deze brief is tevens de beslistermijn met vier weken verdaagd tot 21 oktober 2021.

Op 25 oktober jl. bent u per mail tussentijds geïnformeerd over het verloop van de behandeling van dit verzoek. In deze mail is aan u medegedeeld dat de behandeling van uw Wob-verzoek wordt opgesplitst in 2 deelbesluiten vanwege de omvang ervan. Deelbesluit 1 zou u – inclusief termijn voor het vragen van zienswijzen aan derden- omstreeks 30 november 2021 ontvangen. Deelbesluit 2 zou u zo spoedig mogelijk daarna ontvangen.

Hieronder zijn de twee deelbesluiten weergegeven met elk van de onderwerpen uit uw Wob-verzoek die daaronder vallen.

Deelbesluit 1

1) Alle gevoerde correspondentie m.b.t. het aanvragen en verlenen van vergunningen.

Deelbesluit 2

2) Alle overige informatie/correspondentie met betrekking op uw verzoek.

Dit besluit heeft alleen betrekking op onderdeel 1. Mijn beslissing over onderdeel 2 ontvangt u bij vaststelling van het tweede deelbesluit, welke gelijktijdig met dit deelbesluit zal worden genomen.

Wettelijk kader

Uw verzoek valt onder de reikwijdte van de Wob. Voor de relevante Wob-artikelen verwijs ik u naar bijlage 1.

Inventarisatie documenten

Op basis van uw verzoek zijn in totaal 22 documenten (waaronder bijlagen en mailstrings) aangetroffen. Deze documenten zijn opgenomen in een inventarislijst, die als bijlage 2 bij dit besluit is gevoegd. In dit besluit wordt verwezen naar de corresponderende nummers uit de inventarislijst, zodat per document duidelijk is wat is besloten.

Zienswijzen

Er zijn derde belanghebbenden bij de openbaarmaking van de documenten en deze zijn in de gelegenheid gesteld hierover hun zienswijze te geven. Zij hebben aangegeven geen bedenkingen te hebben bij de openbaarmaking van de documenten.

Besluit
Ik heb besloten (een deel van) de documenten openbaar te maken met uitzondering van de daarin vermelde persoonsgegevens. Op de inventarislijst staat bij deze documenten aangegeven dat slechts de uitzonderingsgrond uit artikel 10, tweede lid, aanhef en onder e, van de Wob (aangeduid met de afkorting 10.2.e) is toegepast.

De documenten die in de inventarislijst staan vermeld als "reeds openbaar" zijn reeds openbaar gemaakt. De Wob is niet van toepassing op reeds openbare documenten. De vindplaats van deze documenten staat aangegeven op de inventarislijst.

Ik heb besloten (een deel van) de door u gevraagde informatie niet openbaar te maken. Per document is op de inventarislijst aangegeven welke uitzonderingsgronden zijn toegepast.

Voor de motivering verwijs ik naar onderdeel Overwegingen van dit besluit.

Overwegingen
Allereerst wil ik u wijzen op het volgende. Ingevolge artikel 3, vijfde lid, van de Wob, wordt een verzoek om informatie ingewilligd met inachtneming van het bepaalde in de artikelen 10 en 11.

Het recht op openbaarmaking op grond van de Wob dient uitsluitend het publieke belang van een goede en democratische bestuursvoering. Het komt iedere burger in gelijke mate toe. Daarom kan ten aanzien van de openbaarheid geen onderscheid worden gemaakt naar gelang de persoon of de bedoeling of belangen van de verzoeker. Bij de te verrichten belangenafweging worden dan ook betrokken het algemene belang bij openbaarmaking van de gevraagde informatie en de door de weigeringsgronden te beschermen belangen, maar niet het specifieke belang van de verzoeker.

Evenmin kent de Wob een beperkte vorm van openbaarmaking. Dit betekent dat openbaarmaking van de gevraagde documenten uitsluitend aan u op grond van de Wob niet mogelijk is. Indien ik aan u de betreffende documenten verstrek, moet ik deze ook aan anderen geven indien zij daarom verzoeken. In dat licht vindt de onderstaande belangenafweging/vinden de onderstaande belangenafwegingen dan ook plaats.

Bedrijfs- en fabricagegegevens

Artikel 10, eerste lid, aanhef en onder c, van de Wob bepaalt dat het verstrekken van informatie achterwege blijft voor zover dit bedrijfs- en fabricagegegevens betreft, die door natuurlijke personen of rechtspersonen vertrouwelijk aan de overheid zijn medegedeeld. Onder bedrijfsgegevens moet blijkens bestendige jurisprudentie worden verstaan: al die gegevens waaruit wetenswaardigheden kunnen worden afgelezen of afgeleid met betrekking tot de technische bedrijfsvoering of het productieproces dan wel met betrekking tot de afzet van producten of de kring van afnemers of leveranciers. Cijfers of gegevens die de

financiële bedrijfsvoering en financiële stromen betreffen, worden eveneens als bedrijfs- en fabricagegegevens aangemerkt.

In de documenten, waarbij in de inventarislijst, in de kolom "Wob", 10.1.c staat vermeld, staan bedrijfsgegevens. Deze gegevens zijn vertrouwelijk aan mij medegedeeld. Uit deze gegevens kunnen wetenswaardigheden worden afgeleid met betrekking tot de individuele financiële bedrijfsvoering van het betrokken bedrijf. Bij verstrekking van deze informatie zou de concurrentiepositie of onafhankelijkheid van deze bedrijven kunnen worden geschaad. Ik zal deze informatie dan ook niet openbaar maken.

De eerbiediging van de persoonlijke levenssfeer
Op grond van artikel 10, tweede lid, aanhef en onder e, van de Wob blijft verstrekking van informatie achterwege voor zover het belang daarvan niet opweegt tegen het belang dat de persoonlijke levenssfeer wordt geëerbiedigd.

In de inventarislijst met "10.2.e" aangeduide documenten staan persoonsgegevens zoals namen, telefoonnummers, handtekeningen, en tot personen herleidbare functienamen. Ik ben van oordeel dat ten aanzien van deze gegevens het belang dat de persoonlijke levenssfeer wordt geëerbiedigd, zwaarder moet wegen dan het belang van openbaarheid. Daarom heb ik dientengevolge de persoonsgegevens verwijderd uit deze documenten.

Het voorkomen van onevenredige bevoordeling of benadeling
Op grond van artikel 10, tweede lid, aanhef en onder g, van de Wob blijft verstrekking van informatie achterwege voor zover het belang daarvan niet opweegt tegen het belang van het voorkomen van onevenredige bevoordeling of benadeling van bij de aangelegenheid betrokken natuurlijke personen of rechtspersonen dan wel van derden.

Openbaarmaking van (bepaalde passages uit) de documenten, waarbij in de inventarislijst, in de kolom "Wob", 10.2.g staat vermeld, zou naar mijn oordeel leiden tot mogelijke onevenredige benadeling van de organisaties waar deze informatie betrekking op heeft. Deze documenten bevatten door bedrijven verstrekte informatie. Openbaarmaking van deze informatie zou het bedrijf namelijk onevenredig benadelen dan wel concurrenten, leveranciers of afnemers onevenredig bevoordelen. Bedrijven moeten erop kunnen vertrouwen dat bedrijfsvertrouwelijke of anderszins concurrentiegevoelige informatie vertrouwelijk blijft. Het belang bij het voorkomen van onevenredig nadeel weeg ik hier zwaarder dan het algemene belang van openbaarmaking.

Directoraat-generaal Klimaat en Energie
Directie Warmte en Ondergrond

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Wijze van openbaarmaking
De documenten die met dit besluit (gedeeltelijk) openbaar worden gemaakt treft u bij dit besluit in kopie aan.

Dit besluit en de stukken die voor een ieder openbaar worden, worden geanonimiseerd op www.rijksoverheid.nl geplaatst.

Hoogachtend,

De staatssecretaris van Economische Zaken en Klimaat-Klimaat en Energie
namens deze

10.2.e

G.M. Keijzer-Baldé
Plaatsvervangend secretaris-generaal

10.2.e

De bezwaarclausule
Een belanghebbende die bezwaar heeft tegen de weigering om informatie openbaar te maken kan binnen zes weken na de dag waarop dit is bekend gemaakt een bezwaarschrift indienen. Het bezwaarschrift moet door de indiener zijn ondertekend en bevat ten minste zijn naam en adres, de dagtekening, een omschrijving van het besluit waartegen het bezwaar is gericht en de gronden waarop het bezwaar rust. Dit bezwaarschrift moet worden gericht aan: de Staatssecretaris van Economische Zaken en Klimaat, directie Wetgeving en Juridische Zaken, Postbus 20401, 2500 EK 's-Gravenhage. Dit besluit is verzonden op de in de aanhef vermelde datum.

Directoraat-generaal Klimaat en Energie
Directie Warmte en Ondergrond

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Bijlage 1 – Relevante artikelen uit de Wob

Artikel 1

In deze wet en de daarop berustende bepalingen wordt verstaan onder:

a. document: een bij een bestuursorgaan berustend schriftelijk stuk of ander materiaal dat gegevens bevat;
b. bestuurlijke aangelegenheid: een aangelegenheid die betrekking heeft op beleid van een bestuursorgaan, daaronder begrepen de voorbereiding en de uitvoering ervan;
c. intern beraad: het beraad over een bestuurlijke aangelegenheid binnen een bestuursorgaan, dan wel binnen een kring van bestuursorganen in het kader van de gezamenlijke verantwoordelijkheid voor een bestuurlijke aangelegenheid;
d. niet-ambtelijke adviescommissie: een van overheidswege ingestelde instantie, met als taak het adviseren van een of meer bestuursorganen en waarvan geen ambtenaren lid zijn, die het bestuursorgaan waaronder zij ressorteren adviseren over de onderwerpen die aan de instantie zijn voorgelegd. Ambtenaren, die secretaris of adviserend lid zijn van een adviesinstantie, worden voor de toepassing van deze bepaling niet als leden daarvan beschouwd;
e. ambtelijke of gemengd samengestelde adviescommissie: een instantie, met als taak het adviseren van één of meer bestuursorganen, die geheel of gedeeltelijk is samengesteld uit ambtenaren, tot wier functie behoort het adviseren van het bestuursorgaan waaronder zij ressorteren over de onderwerpen die aan de instantie zijn voorgelegd;
f. persoonlijke beleidsopvatting: een opvatting, voorstel, aanbeveling of conclusie van een of meer personen over een bestuurlijke aangelegenheid en de daartoe door hen aangevoerde argumenten;
g. milieu-informatie: hetgeen daaronder wordt verstaan in artikel 19.1a van de Wet milieubeheer;
h. hergebruik: het gebruik van informatie die openbaar is op grond van deze of een andere wet en die is neergelegd in documenten berustend bij een overheidsorgaan, voor andere doeleinden dan het oorspronkelijke doel binnen de publieke taak waarvoor de informatie is geproduceerd;
i. overheidsorgaan:
   1°. een orgaan van een rechtspersoon die krachtens publiekrecht is ingesteld, of
   2°. een ander persoon of college, met enig openbaar gezag bekleed.

Artikel 3

1. Een ieder kan een verzoek om informatie neergelegd in documenten over een bestuurlijke aangelegenheid richten tot een bestuursorgaan of een onder verantwoordelijkheid van een bestuursorgaan werkzame instelling, dienst of bedrijf.
2. De verzoeker vermeldt bij zijn verzoek de bestuurlijke aangelegenheid of het daarop betrekking hebbend document, waarover hij informatie wenst te ontvangen.
3. De verzoeker behoeft bij zijn verzoek geen belang te stellen.

4. Indien een verzoek te algemeen geformuleerd is, verzoekt het bestuursorgaan de verzoeker zo spoedig mogelijk om zijn verzoek te preciseren en is het hem daarbij behulpzaam.
5. Een verzoek om informatie wordt ingewilligd met inachtneming van het bepaalde in de artikelen 10 en 11.

Artikel 6

1. Het bestuursorgaan beslist op het verzoek om informatie zo spoedig mogelijk, doch uiterlijk binnen vier weken gerekend vanaf de dag na die waarop het verzoek is ontvangen.
2. Het bestuursorgaan kan de beslissing voor ten hoogste vier weken verdagen. Van de verdaging wordt voor de afloop van de eerste termijn schriftelijk gemotiveerd mededeling gedaan aan de verzoeker.
3. Onverminderd artikel 4:15 van de Algemene wet bestuursrecht wordt de termijn voor het geven van een beschikking opgeschort gerekend vanaf de dag na die waarop het bestuursorgaan de verzoeker meedeelt dat toepassing is gegeven aan artikel 4:8 van de Algemene wet bestuursrecht, tot de dag waarop door de belanghebbende of belanghebbenden een zienswijze naar voren is gebracht of de daarvoor gestelde termijn ongebruikt is verstreken.
4. Indien de opschorting, bedoeld in het derde lid, eindigt, doet het bestuursorgaan daarvan zo spoedig mogelijk mededeling aan de verzoeker, onder vermelding van de termijn binnen welke de beschikking alsnog moet worden gegeven.
5. Indien het bestuursorgaan heeft besloten informatie te verstrekken, wordt de informatie verstrekt tegelijk met de bekendmaking van het besluit, tenzij naar verwachting een belanghebbende bezwaar daar tegen heeft, in welk geval de informatie niet eerder wordt verstrekt dan twee weken nadat de beslissing is bekendgemaakt.
6. Voor zover het verzoek betrekking heeft op het verstrekken van milieu-informatie:
    a. bedraagt de uiterste beslistermijn in afwijking van het eerste lid twee weken indien het bestuursorgaan voornemens is de milieu-informatie te verstrekken terwijl naar verwachting een belanghebbende daar bezwaar tegen heeft;
    b. kan de beslissing slechts worden verdaagd op grond van het tweede lid, indien de omvang of de gecompliceerdheid van de milieu-informatie een verlenging rechtvaardigt;
    c. zijn het derde en vierde lid niet van toepassing.

Artikel 7

1. Het bestuursorgaan verstrekt de informatie met betrekking tot de documenten die de verlangde informatie bevatten door:
    a. kopie ervan te geven of de letterlijke inhoud ervan in andere vorm te verstrekken,
    b. kennisneming van de inhoud toe te staan,
    c. een uittreksel of een samenvatting van de inhoud te geven, of
    d. inlichtingen daaruit te verschaffen.
2. Het bestuursorgaan verstrekt de informatie in de door de verzoeker verzochte vorm, tenzij:

a. het verstrekken van de informatie in die vorm redelijkerwijs niet gevergd kan worden;
b. de informatie reeds in een andere, voor de verzoeker gemakkelijk toegankelijke vorm voor het publiek beschikbaar is.

3. Indien het verzoek betrekking heeft op milieu-informatie als bedoeld in artikel 19.1a, eerste lid, onder b, van de Wet milieubeheer, verstrekt het bestuursorgaan, zo nodig, en indien deze informatie voorhanden is, tevens informatie over de methoden die zijn gebruikt bij het samenstellen van eerstbedoelde informatie.

Artikel 10

1. Het verstrekken van informatie ingevolge deze wet blijft achterwege voor zover dit:
a. de eenheid van de Kroon in gevaar zou kunnen brengen;
b. de veiligheid van de Staat zou kunnen schaden;
c. bedrijfs- en fabricagegegevens betreft, die door natuurlijke personen of rechtspersonen vertrouwelijk aan de overheid zijn meegedeeld;
d. persoonsgegevens betreft als bedoeld in de artikelen 9, 10 en 87 van de Algemene verordening gegevensbescherming, tenzij de verstrekking kennelijk geen inbreuk op de persoonlijke levenssfeer maakt.

2. Het verstrekken van informatie ingevolge deze wet blijft eveneens achterwege voor zover het belang daarvan niet opweegt tegen de volgende belangen:
a. de betrekkingen van Nederland met andere staten en met internationale organisaties;
b. de economische of financiële belangen van de Staat, de andere publiekrechtelijke lichamen of de in artikel 1a, onder c en d, bedoelde bestuursorganen;
c. de opsporing en vervolging van strafbare feiten;
d. inspectie, controle en toezicht door bestuursorganen;
e. de eerbiediging van de persoonlijke levenssfeer;
f. het belang, dat de geadresseerde erbij heeft als eerste kennis te kunnen nemen van de informatie;
g. het voorkomen van onevenredige bevoordeling of benadeling van bij de aangelegenheid betrokken natuurlijke personen of rechtspersonen dan wel van derden.

3. Het tweede lid, aanhef en onder e, is niet van toepassing voorzover de betrokken persoon heeft ingestemd met openbaarmaking.

4. Het eerste lid, aanhef en onder c en d, het tweede lid, aanhef en onder e, en het zevende lid, aanhef en onder a, zijn niet van toepassing voorzover het milieu-informatie betreft die betrekking heeft op emissies in het milieu. Voorts blijft in afwijking van het eerste lid, aanhef en onder c, het verstrekken van milieu-informatie uitsluitend achterwege voorzover het belang van openbaarmaking niet opweegt tegen het daar genoemde belang.

5. Het tweede lid, aanhef en onder b, is van toepassing op het verstrekken van milieu-informatie voor zover deze handelingen betreft met een vertrouwelijk karakter.

6. Het tweede lid, aanhef en onder g, is niet van toepassing op het verstrekken van milieu-informatie.

7. Het verstrekken van milieu-informatie ingevolge deze wet blijft eveneens achterwege voorzover het belang daarvan niet opweegt tegen de volgende belangen:
    a. de bescherming van het milieu waarop deze informatie betrekking heeft;
    b. de beveiliging van bedrijven en het voorkomen van sabotage.
8. Voorzover het vierde lid, eerste volzin, niet van toepassing is, wordt bij het toepassen van het eerste, tweede en zevende lid op milieu-informatie in aanmerking genomen of deze informatie betrekking heeft op emissies in het milieu.

Bijlage 2 - Inventarislijst deelbesluit 1 (vergunningen)

Documentnr.	Datum	Tijd	Soort document	Onderwerp	Beoordeling	Wob	Afzender	Ontvanger
1	26-6-2018	10 48	E-mail	Aanvraag Opsporingsvergunning Aardwarmte Utrecht	Deels openbaar	10.2.e	ENGIE	EZK
1a			Bijlage	ENGIE Aanvraag opsporingsvergunning Utrecht	Deels openbaar	10.2.e	ENGIE	EZK
1b			Bijlage	LEAN-Projectplan-HE2017 CONFIDENTIAL	Deels openbaar	10.1.c 10.2.e 10.2.g	ENGIE	EZK
1c			Bijlage	UDG Exploration Work Program Final Draft CONF	Deels openbaar	10.2.g	ENGIE	EZK
1d			Bijlage	Geological appendix	Deels openbaar	10.2.g	ENGIE	EZK
1e			Bijlage	Uittreksel KvK ENGIE Energy Solutions B.V.	Reeds openbaar	www.kvk.nl	ENGIE	EZK
1f			Bijlage	Jaarverslag 2016 ENGIE Services Nederland N.V.	Reeds openbaar	www.kvk.nl	ENGIE	EZK
1g			Bijlage	Brochure Storengy Geothermie	Reeds openbaar	https //www.storengy.com/sites/default/files/mediateque/pdf/2020-06/Geothermal%20energy%20by%20storengy.pdf	ENGIE	EZK
1h			Bijlage	EES Zorgplan - High Level Structure 1 - bijlage VIIa pdf	Deels openbaar	10.2.e	ENGIE	EZK
1i			Bijlage	EES Zorgplan - High Level Structure 2 - bijlage VIIa word	Niet openbaar	10.2.g	ENGIE	EZK
1j			Bijlage	EES Zorgplan - High Level Structure 3 - bijlage VIIb word	Niet openbaar	10.2.g	ENGIE	EZK
1k			Bijlage	EES Zorgsysteem - High Level Structure - bijlage VIIc excel	Niet openbaar	10.2.g	ENGIE	EZK
2	4-7-2018	13 02	E-mail	Verzoek advies Sodm inzake aanvraag opsporingsvergunning Utrecht (Bijlagen behorende bij dit document zijn identiek aan de bijlagen van documentnr. 1. Om te voorkomen dat er onnodige kopieën van eenzelfde document wordt meegestuurd, zijn deze documenten verwijderd.)	Deels openbaar	10.2.e	EZK	SodM
3	4-7-2018	13 02	E-mail	Verzoek advies TNO inzake aanvraag opsporingsvergunning Utrecht (Bijlagen behorende bij dit document zijn identiek aan de bijlagen van documentnr. 1. Om te voorkomen dat er onnodige kopieën van eenzelfde document wordt meegestuurd, zijn deze documenten verwijderd.)	Deels openbaar	10.2.e	EZK	TNO
4	11-7-2018		Advies	Pre-advies Utrecht	Deels openbaar	10.2.e	Provincie Utrecht	EZK
5	9-8-2018		Publicatie	Kopie_stcrt__2018_44789__concurrerende_aanvraag_voor_een_opsp	Reeds openbaar	https //zoek.officielebekendmakingen.nl/stcrt-2018-44789.html	EZK	EZK
6	24-9-2018	11 55	E-mail	RE status geothermie in Utrecht	Deels openbaar	10.2.e	EZK	Provincie Utrecht
7	8-10-2018	13 42	E-mail	Reactie nav vooroverleg aardwarmte provincie utrecht	Deels openbaar	10.2.e	EZK	Provincie Utrecht
7a			Bijlage	Memorie van toelichting 2016	Reeds openbaar	https //zoek.officielebekendmakingen.nl/kst-34348-3.html	EZK	Provincie Utrecht
8	10-10-2018	15 45	E-mail	Adviesverzoek Provincie inzake aanvraag opsporingsvergunning aardwarmte Utrecht	Deels openbaar	10.2.e	EZK	Provincie Utrecht
9	5-12-2018	13 28	E-mail	RE_ Verzoek verlenging reactieterm. advies aanvr. opsporingsverg. aardwarmte Utr.	Deels openbaar	10.2.e	EZK	Provincie Utrecht
10	9-1-2019		Brief	Advies opsoringsvergunningen aardwarmte Haarlem Schalkwijk, Utrecht en Rotterdam Barregio	Reeds openbaar	https //www.sodm.nl/documenten/wob-verzoek/2021/11/10/wob besluit-inzake-aardwarmte-nieuwegein	SodM	EZK
10a			Bijlage	Competentie profielen SodM	Reeds openbaar	https //www.sodm.nl/documenten/wob-verzoek/2021/11/10/wob besluit-inzake-aardwarmte-nieuwegein	SodM	EZK
11	5-2-2019		Brief	Advies_van_provinvcie_Utrecht_over_opsporingsvergunningaanvraag_aardwarmte_Utrecht	Reeds openbaar	https //www.provincie-utrecht.nl/sites/default/files/2020-03/brief_gs_advies_opsporingsvergunningaanvraag_aardwarmte_utrecht.pdf	Provincie Utrecht	EZK
11a			Bijlage	Adviespunten provincie Utrecht inzake aanvraag opsporingsvergunning aardwarmte Utrecht	Reeds openbaar	https //www.provincie-utrecht.nl/sites/default/files/2020-03/brief_gs_advies_opsporingsvergunningaanvraag_aardwarmte_utrecht.pdf	Provincie Utrecht	EZK

12	25-4-2019		Brief	Geotechnische evaluatie aanvraag opsporingsvergunning Utrecht	Deels openbaar	10.2.e	TNO	EZK
12a			Bijlage	Toelichting op de evaluatie	Openbaar		TNO	EZK
12b			Bijlage	Ligging van het aangevraagde gebied	Openbaar		TNO	EZK
12c			Bijlage	(Vetrouwelijk!)- Ligging van het aangevraagde gebied met bekende olie- en gasprospects	Niet openbaar	10.1.c	TNO	EZK
13	23-5-2019		Brief	Verzoek_advies_Mijnraad_inzake_aanvraag_opsporingsvergunning_aardwarmte	Deels openbaar	10.2.e	Mijnraad	EZK
14	28-5-2019	15 58	E-mail	Dossier OV aardwarmte Utrecht	Deels openbaar	10.2.e	EZK	RVO
15	28-6-2019		Brief	Advies_vd_Mijnraad_over_de_aanvraag_opsporingsvergunning_aardwarmte_Utrecht	Reeds openbaar	https //demijnraad.nl/file/download/d7df1a77-e585-4fe7-8e75-c75d8f258cb2/15789221742019-06-28%20opsporingsvergunning%20aardwarmte%20utrecht.pdf	Mijnraad	EZK
16	29-10-2019	10 28	E-mail	Begeleidende brief en besluit opsporingsvergunning aardwarmte Utrecht	Deels openbaar	10.2.e	EZK	ENGIE
16a	29-10-2019		Bijlage	Besluit_opsporingsvergunning_aardwarmte_Utrecht	Reeds openbaar	https //www.sodm.nl/documenten/wob-verzoek/2021/11/10/wob-besluit-inzake-aardwarmte-nieuwegein	EZK	ENGIE
16b			Bijlage	Besluit_verlening_opsporingsvergunning_aardwarmte_Utrecht	Reeds openbaar	https //www.sodm.nl/documenten/wob-verzoek/2021/11/10/wob-besluit-inzake-aardwarmte-nieuwegein	EZK	ENGIE
17	13-11-2020	15 37	E-mail	2020-11-13 Reactie op uw toezegging	Deels openbaar	10.2.e	Bewoner	EZK
18	24-11-2020	18 23	E-mail	Reactie op uw vraag over de financiële toetsing ov aw Utrecht	Deels openbaar	10.2.e	EZK	Bewoner
19	14-7-2021	14 32	E-mail	RE_ overlegdatum plannen ivm vragen over verleende opsporingsvergunning aardwarmte Utrecht	Deels openbaar	10.2.e	EZK	Provincie Utrecht

Van: 10.2.e
Aan: 10.2.e
Onderwerp: FW: [UFT (User File Transfer)] New message: Aanvraag Opsporingsvergunning Aardwarmte Utrecht
Datum: dinsdag 26 juni 2018 12:37:46
Bijlagen: 20180622 ENGIE Aanvraag opsporingsvergunning Utrecht.pdf
Bijlage I - LEAN-Projectplan-HE2017 CONFIDENTIAL.pdf
Bijlage II - UDG Exploration workprogram Final draft CONFIDENTIAL excl budgets.pdf
Bijlage IV - Uittreksel KvK ENGIE Energy Solutions B.V..pdf
Bijlage V - Jaarverslag 2016 ENGIE Services Nederland N.V..pdf
Bijlage VI - Brochure Storengy Geothermie.pdf
BIJLAGE VIIa - 20180503 EES Zorgplan - High Level Structure - Beleidsverkl QHSE.pdf
BIJLAGE VIIa - 20180503 EES Zorgplan - High Level Structure.docx
BIJLAGE VIIb - 20180503 EES Zorgplan - High Level Structure - Bijlagen.docx
BIJLAGE VIIc - 20180503 EES Zorgsysteem - High Level Structure.xlsx
Bijlage VIII - Geological appendix.pdf

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aanvraag

Van: [redacted]@gdfsuez.com [mailto:[redacted]@gdfsuez.com] **Namens** 10.2.e
Verzonden: dinsdag 26 juni 2018 10:48
Aan: 10.2.e
Onderwerp: [UFT (User File Transfer)] New message: Aanvraag Opsporingsvergunning Aardwarmte Utrecht

Hello,

10.2.e sent you the following message:
Message subject: Aanvraag Opsporingsvergunning Aardwarmte Utrecht
Message sender: 10.2.e
Files: Bijlage I - LEAN-Projectplan-HE2017 CONFIDENTIAL.pdf (6.8 MB), BIJLAGE VIIa - 20180503 EES Zorgplan - High Level Structure - Beleidsverkl QHSE.pdf (67.5 KB), Bijlage VI - Brochure Storengy Geothermie.pdf (2.0 MB), BIJLAGE VIIc - 20180503 EES Zorgsysteem - High Level Structure.xlsx (524.7 KB), Bijlage II - UDG Exploration workprogram Final draft CONFIDENTIAL excl budgets.pdf (1.0 MB), BIJLAGE VIIb - 20180503 EES Zorgplan - High Level Structure - Bijlagen.docx (1.2 MB), 20180622 ENGIE Aanvraag opsporingsvergunning Utrecht.pdf (1.4 MB), Bijlage VIII - Geological appendix.pdf (6.5 MB), BIJLAGE VIIa - 20180503 EES Zorgplan - High Level Structure.docx (505.1 KB), Bijlage V - Jaarverslag 2016 ENGIE Services Nederland N.V..pdf (633.8 KB), Bijlage IV - Uittreksel KvK ENGIE Energy Solutions B.V..pdf (158.7 KB)
Message valid until: Thursday, July 26, 2018 10:48:01 AM CEST
Message access URL: https://engie.uft.mft-online.com/zephyr/DownloadToken.jsp?token=BgrIVHvVyM2itO6ODw76I3wrONIMT3qPjQ5tWu3gS0GP4USK

Comment:

Zoals besproken, nogmaals zonder wachtwoordbeveiliging.

Vriendelijke groet,
10.2.e
===

Geachte heer, mevrouw,

ENGIE heeft als operator het voortouw genomen in twee publiek-private consortia die willen investeren in geothermie en die de geschiktheid van de Utrechtse bodem voor geothermie aan moeten tonen: LEAN (Low cost Exploration And deriskiNg of geothermal plays) en GOUD (Geothermie Oost Utrecht Duurzaam).

Als deze initiatieven slagen dan wordt een groot potentieel voor geothermie ontsloten,

omdat de bovengrondse omstandigheden in Utrecht uitstekend zijn door onder andere de aanwezigheid van een groot warmtenet van Eneco (100.000 W.eq.) en van het warmtenet voor Kantorenpark Rijnsweerd en de Uithof in het Oosten van Utrecht die nu aardgasgestookt zijn.

In het kader van bovengenoemde initiatieven vindt u bijgevoegd een aanvraag voor een opsporingsvergunning voor aardwarmte in Utrecht. De aanvraag wordt gedaan door ENGIE Energy Solutions B.V. Hiermee wordt invulling gegeven aan de eisen met betrekking tot het operatorschap van een geothermisch systeem. ENGIE Energy Solutions B.V. is onderdeel van de ENGIE Group en zal ook de kennis en ervaring die binnen de ENGIE Group aanwezig is op het gebied van onder andere veiligheid, ontwerp, boren, geologie, onderhoud & beheer optimaal inzetten.

In de aanvraag hebben we alle vereiste onderdelen zo goed mogelijk uitgewerkt en toegelicht. We zijn uiteraard graag bereid om een verdere toelichting in een gesprek te geven. Mochten er naar uw mening nog zaken ontbreken, of mocht u nog vragen hebben, dan staan wij uiteraard tot uw beschikking.

Met vriendelijke groet,

10.2.e
10.2.e

10.2.e @engie.com
M +31 6 10.2.e

--
UFT

AANVRAAG OPSPORINGSVERGUNNING UTRECHT

Referentie:	20180622JBr
Versie:	1.0
Datum:	22 juni 2018

Inhoudsopgave

1 Aanvraagformulier opsporingsvergunning Mijnbouwwet

Teneinde uw aanvraag op basis van de Mijnbouwwet in behandeling te kunnen nemen, wordt u verzocht dit formulier juist en volledig in te vullen. Ondergenoemde bepalingen uit Mijnbouwwet en -regelgeving geven specifiek aan welke informatie bij de beoordeling relevant is. U wordt verzocht deze informatie – eveneens juist en zo volledig mogelijk - als onderdeel van uw aanvraag toe te voegen als bijlage(n) bij dit formulier.

Algemene gegevens	
Naam aanvrager (= (beoogd) vergunninghouder, evt. meerdere natuurlijke of rechtspersonen)	ENGIE Energy Solutions B.V.
Contactpersoon	10.2.e
Postadres	Kosterijland 20 3981 AJ BUNNIK
Telefoonnummer	06-10.2.e
Fax	Niet van toepassing
E-mail	10.2.e @engie.com
Soort vergunning	Opsporing
Soort (delf)stof	Aardwarmte
Locatie	Territoir

Teneinde door de directie Energiemarkt van het ministerie van EZ in behandeling te worden genomen, wordt u verzocht dit formulier elektronisch in te dienen bij het dienstenloket (Antwoord voor Bedrijven).

U kunt er ook voor kiezen dit formulier - ondertekend door alle aanvragers – in tweevoud per post in te dienen bij:

Ministerie van Economische Zaken

T.a.v. directeur Energiemarkt, Alp C22

Postbus 20401

2500 EK DEN HAAG

2 Inleiding

2.1 Achtergrond

Provincie en gemeente Utrecht hebben hoge ambities voor de energietransitie, waarin geothermie een belangrijke rol speelt. Helaas is het tot op heden nog niet gelukt om deze gewenste geothermie te ontwikkelen. Dit komt doordat er te weinig (betrouwbare) gegevens beschikbaar zijn over de ondergrond in de regio. Dit maakt de opbrengsten van geothermie onzeker, zelfs wanneer SDE+ zou worden toegepast.

Elders in Nederland is het mogelijk deze onzekerheid te verlagen op basis van eerdere boringen in hetzelfde gebied. Echter in Utrecht zijn deze gegevens gebrekkig voorhanden. De Utrechtse bodem is een zogenaamde 'white-spot'.

ENGIE heeft daarom als operator het voortouw genomen in twee publiek-private consortia die willen investeren in geothermie en die de geschiktheid van de Utrechtse bodem voor geothermie aan moeten tonen: LEAN (Low cost Exploration And deriskiNg of geothermal plays) en GOUD (Geothermie Oost Utrecht Duurzaam).

Als deze initiatieven slagen dan wordt een groot potentieel voor geothermie ontsloten, omdat de bovengrondse omstandigheden in Utrecht uitstekend zijn door onder andere de aanwezigheid van een groot warmtenet van Eneco (100.000 W.eq.) en van het warmtenet voor Kantorenpark Rijnsweerd en de Uithof in het Oosten van Utrecht die nu aardgasgestookt zijn.

CONSORTIUM	PARTNERS	~TOP DIEPTE	TARGET
LEAN	ebn, Huisman, Eneco, if, TNO innovation for life, Utrecht University, ENGIE	2700m	Slochteren (Rotliegend)
GOUD	Rijnstaete, Utrecht University, HU, ENGIE	5100m	Dinantien

Het target van LEAN is het Rotliegend. Op basis van beschikbaar seismologisch onderzoek en beperkte boorgegevens bestaat een indicatie dat deze aardlaag in een deel van de provincie Utrecht geschikt is voor geothermie. Om dit te bevestigen is een proefboring nodig. Voor meer informatie over het LEAN initiatief en de verschillende betrokken consortiumpartners verwijzen wij u graag naar Bijlage I. Deze bijlage bevat het projectplan van de LEAN subsidie-aanvraag ten behoeve van de Hernieuwbare Energieregeling 2018 van RVO.

Het target van GOUD is het dieper gelegen Dinantien. GOUD is dan ook 1 van de 6 overgebleven initiatieven in de Green Deal Ultradiepe geothermie (UDG). Binnen de green deal werken deze initiatieven in samenwerking met het Ministerie van Economische Zaken & Klimaat aan een uitgebreid exploratiewerkprogramma (EWP) met onder andere seismiekacquisitie om de potentie van het Dinantien voor UDG beter in beeld te brengen. Voor de inhoud van dit betreffende EWP verwijzen wij u graag naar Bijlage II.

ENGIE verwacht met deze initiatieven een bijdrage te kunnen leveren aan het nationale doel om in 2050 een CO2-arme energievoorziening te realiseren door de vervanging van fossiele brandstoffen (zoals aardgas) door duurzame energie. Daarnaast wil zij een bijdrage leveren aan de ambitie van de stad Utrecht om in 2030 energieneutraal te zijn.

2.2 ENGIE

ENGIE Energy Solutions B.V. (EES) is 100% dochter van ENGIE Services Nederland N.V. en daarmee onderdeel van de ENGIE Group. De ENGIE Group acteert wereldwijd in ongeveer 70 landen en met ongeveer 155.000 werknemers actief op het gebied van duurzame energie, energie efficiency en digitale services. EES heeft

zich de afgelopen decennia gespecialiseerd in het ontwikkelen, bouwen en exploiteren van installaties voor het leveren van duurzame warmte en koude. Op dit moment exploiteert EES ongeveer 30 WKO systemen in Nederland. Daarnaast heeft EES als doel om op vergelijkbare wijze geothermie-installaties te ontwikkelen, bouwen en exploiteren. Dat betekent dat EES van begin tot het einde betrokken is bij een project en ook daarom ook keuzes maakt die leiden tot het beste project over de gehele levensduur. EES heeft een gedegen organisatiestructuur om projecten met een hoog veiligheid- en kwaliteitsniveau te realiseren. Voor zowel LEAN als GOUD is EES dan ook de operator. Op dit moment is EES bij verschillende geothermie initiatieven betrokken en lid van Platform Geothermie en Dutch Association of Geothermal Operators (DAGO).

Voor de duurzame energieprojecten wordt de kennis en expertise van collega's van andere ENGIE onderdelen ingezet om te komen tot kwalitatief hoogstaande projecten waarbij de duurzaamheidsambities daadwerkelijk worden waargemaakt. Voor de geothermieprojecten wordt met name gebruik gemaakt van de kennis en ervaring van de collega's van Storengy.

Storengy is net als EES onderdeel van de ENGIE Group en daarmee een zusterbedrijf van EES. Storengy heeft jarenlange ervaring op onder andere het gebied van geologie, ontwerp, boortechniek en boormanagement en veilig boren van putten. De laatste jaren zet Storengy haar expertise met betrekking tot geologie, ontwerp, boorkosten, boormanagement, veiligheid ook in in geothermieprojecten. Storengy is ook lid van Association Française des Professionnels de la Géothermie (AFPG), the European Geothermal Energy Council (EGEC) en Avenia.

Naast de beschikking over een eigen exploitatieafdeling maakt EES maakt voor de realisatie, beheer & onderhoud van haar bovengrondse energie-installaties gebruik van de diensten ENGIE Services. Daarnaast maakt EES voor specifieke kennis gebruik van externe partners die naar behoefte kunnen worden ingeschakeld.

Meer informatie over EES, ENGIE Services en Storengy en de financiele draagkracht van de ENGIE Group is beschikbaar in Bijlage 1, bijlage 2 en bijlage 3. Deze bevatten respectievelijk een uittreksel van de KvK van EES, het jaarverslag van ENGIE Services en een brochure van de geothermie activiteiten van Storengy.

Ten tijde van de aanvraag van deze opsporingsvergunning was het jaarverslag van ENGIE Services voor 2017 nog niet formeel goedgekeurd door de accountant. Echter in kerncijfers is het jaar 2017 voor ENGIE Services als volgt samen te vatten.

Omzet	1.01 miljard EUR
Aantal medewerkers	5.615
Verzuimongevalfrequentie	0,92
Besparing CO_2	19,1%

Tabel 1: Kerncijfers ENGIE Services 2017

3 Aanvraag opsporingsvergunning

3.1 Doel vergunning

Doel van de vergunning is om aardwarmte op te mogen sporen in (de omgeving van) Utrecht. Het uiteindelijke doel is om de gewonnen warmte te leveren aan het bestaande warmtenet van Eneco (LEAN) en de bestaande warmtenetten van bedrijvenpark Rijnsweerd en het Science park in het Oosten van Utrecht (GOUD).

3.2 Tijdvak vergunning

Op dit moment verhouden de projecten LEAN en het project GOUD zich als volgt tot elkaar.

Figuur 1: Status LEAN en GOUD

De verwachting is dat er medio 2019 op zijn vroegst gestart kan worden met het boren van de 1e bron voor LEAN, waar dat voor GOUD op zijn vroegst in Q1 2021 kan gebeuren. Daarom wordt de opsporingsvergunning aangevraagd voor een periode van 5 jaar vanaf 1 juli 2018.

3.3 Beschrijving opsporingsgebied

Afzetgebied

In onderstaande Figuur 2 is het gebied van het bestaande warmtenet van Eneco inclusief het kantorenpark Rijnsweerd oranje gearceerd. Daarnaast zijn de bestaande warmtenetten van het kantorenpark Rijnsweerd en die van het Science Park Utrecht weergegeven middels een zwarte polygoon.

Begrenzing aan te vragen gebied

Met de kennis van nu schatten wij op (basis van weinig beschikbare informatie) in dat het Slochteren ten noordoosten van Utrecht (groene polygoon) de meeste geothermische potentie biedt. Terwijl het Dinantien ten noordwesten en noordoosten van Utrecht potentie heeft (groene arcering).

Echter, gezien de onzekerheid van de locatie van het dieper gelegen Dinantien zou ENGIE graag enig extra opsporingsgebied aanvragen voor het geval dit target gedurende de exploratie bijvoorbeeld verder naar het Zuiden zouden blijken te liggen of vanuit het Noordwesten beter benaderbaar zou zijn. ENGIE is voornemens een herevaluatie van de grootte van het opsporingsgebied te doen als deze onzekerheid aan de hand van interpretatie van seismische data kan worden verkleind.

In Figuur 2 hieronder is tevens een weergave van de belangrijkste water- en natuurgebieden met betrekking tot het opsporingsgebied weergegeven.

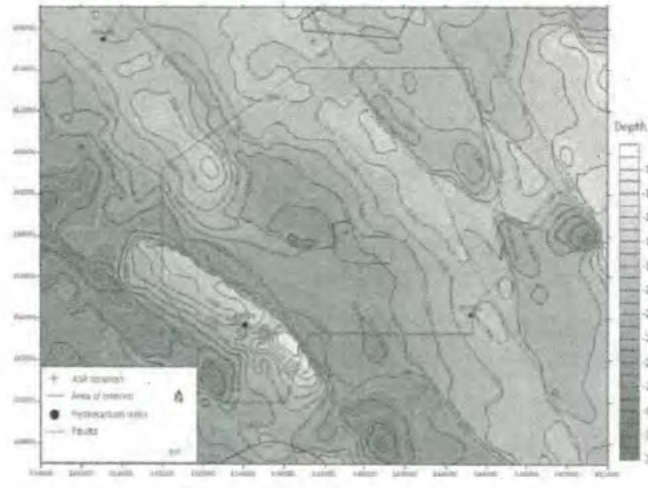
Daarnaast heeft ENGIE het gebied zoveel mogelijk proberen te beperken om het aantal stakeholders onder de opsporingsvergunning in de drukke provincie Utrecht zo veel mogelijk te beperken. ENGIE heeft er met andere woorden bewust voor gekozen om gemeentes waar zij geothermische warmte op korte termijn niet kansrijk acht niet mee te nemen in het opsporingsgebied.

ENGIE heeft er ook bewust voor gekozen het volle dieptespectrum van 500 tot 7000 meter diepte aan te vragen. De reden voor de bovengrens is dat zij laagtemperatuur aardwarmte mogelijk interessant acht als fall-back optie voor de reguliere diepe geothermie of als primaire optie voor nieuwbouwgebied in de stad. Daarnaast heeft het initiatief GOUD vanuit de green deal UDG het Dinantien als primair target, maar zou het dieper gelegen Dévoon ook een interessante target kunnen zijn.

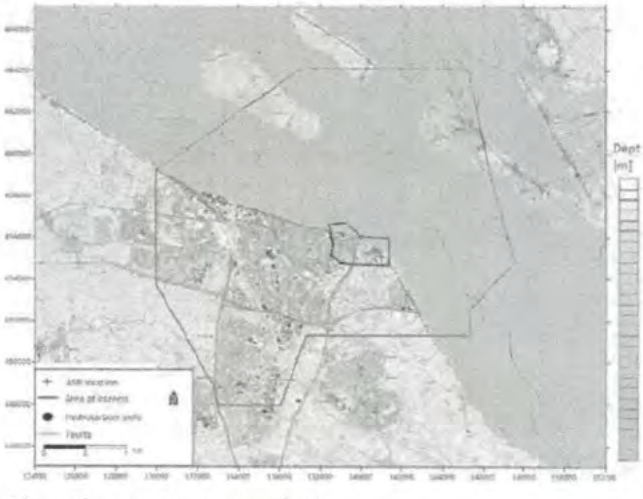
Alvorens het aanvragen van deze opsporingsvergunning heeft ENGIE in samenwerking met de Provincie Utrecht en de verschillende consortia in Q2 2018 twee stakeholderbijeenkomsten georganiseerd voor alle regiopartners van de Provincie Utrecht die onder het beoogde opsporingsgebied vallen. Dit gaat dus om verschillende gemeentes maar ook om waterschappen en drinkwaterbedrijven. De Provincie en de Gemeente Utrecht zijn beiden goed op de hoogte van zowel LEAN als GOUD maar beide consortia wilden deze betrokken stakeholders alvast een kans geven om zich te verhouden tot zowel het GOUD als het LEAN initiatief.

In Figuur 2 is het opsporingsgebied weergegeven, het gaat hierbij om het gebied in het blauwe polygoon.

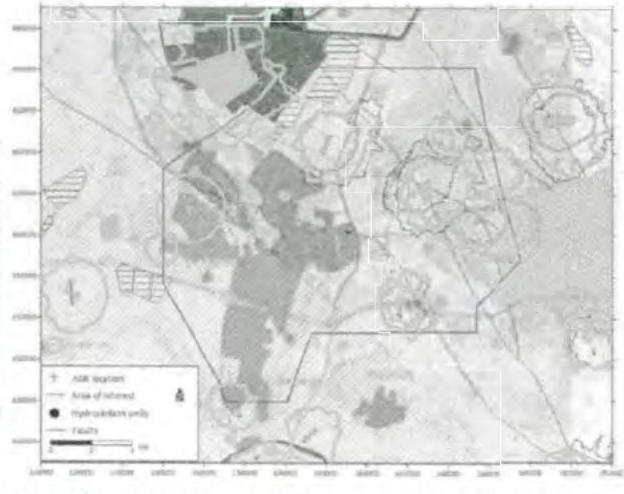
Warmtenetten Eneco (oranje) en Science Park (zwart)



Hoogste potentie Slochteren (groene polygoon)



Dinantien (groene arcering)



Waterbescherming (lichtblauw) en natuur (groen)

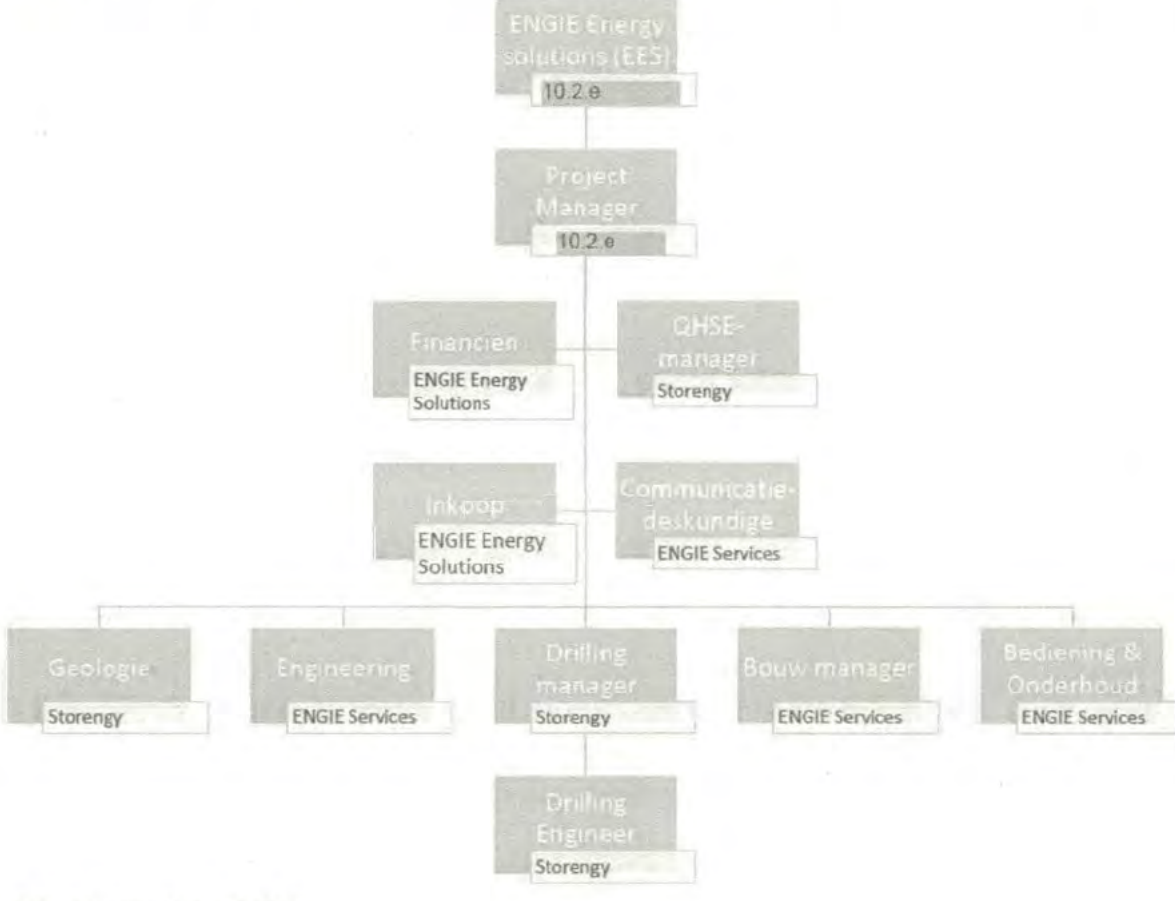
Figuur 2 Weergave opsporingsgebied

4 Organisatie

De aanvraag voor de opsporingsvergunning wordt ingediend door ENGIE Energy Solutions B.V. Voor meer informatie over EES en de hieronder beschreven expertise van verschillende bedrijven binnen de ENGIE Group, zie onderdeel 2.2.

4.1 Projectorganisatie

In onderstaande Figuur 3 is de beoogde organisatie van het geothermieproject Utrecht LEAN en Utrecht GOUD weergegeven.



Figuur 3 Projectorganisatie ENGIE

10.2.e

De directie van het project ligt bij ENGIE Energy Solutions B.V. 10.2.e is 10.2.e van ENGIE Energy Solutions B.V., zie ook KvK uittreksel in Bijlage IV.

10.2.e is 10.2.e voor geothermie projecten en zal bij belangrijke zaken en grote investeringen de beslissingen nemen. De projectdirectie is verantwoordelijk gedurende alle fases van een geothermie project. Per fase laat het zich ondersteunen door een team van experts, afhankelijk van de gevraagde competenties. Doelstelling van EES is om een goed team om zich heen te verzamelen dat samen met de projectdirectie tot de juiste besluiten komt.

10.2.e

10.2.e is 10.2.e en houdt het totaaloverzicht. Hij laat zich informeren door collega's en experts op alle vakgebieden en zorgt dat iedere partij zijn taken op een verantwoorde manier nakomt.

Voor kennis op het gebied van geologie, boortechnieken, boormanagement en andere zaken zal EES zoals aangegeven voornamelijk gebruik maken van haar zusterbedrijf Storengy.

4.2 Projectfasen

Conform het tijdschema van SodM is een geothermie project op te delen in 7 fases:

- Voorbereiding
- Verkenning
- Bouw en Aanleg
- Boren
- Constructie
- Produceren en Onderhoud
- Abandonneren

Op moment van aanvragen van een opsporingsvergunning bevinden de projecten zich in de verkenningsfase. Binnen ENGIE zijn er verschillende expertises aan de hand waarvan het project wordt ontwikkeld.

- Geologie (**Storengy**)
- Juridisch **(ENGIE Services)**
- Omgevingsmanagement & communicatie **(ENGIE Services)**
- Financien **(ENGIE Services)**

Binnen zowel het project LEAN als het project GOUD werkt ENGIE voor specifieke vakinhoudelijke expertise in partnership met andere partijen. Voor een overzicht van de expertise van verschillende partijen verwijzen wij u graag naar Bijlage I (LEAN) en Bijlage III (GOUD).

Voor volgende fases wordt ondersteuning gevraagd voor minimaal de volgende functies:

Verkenning/ontwerp fase (well design/ drilling program):

- Lead (Sr.) drilling manager (**Storengy**)
- Drilling engineer
- Engineer well test
- QHSE expert (**Storengy**)
- Omgevingsmanagement & communicatie **(ENGIE Services)**

Bouw en Aanleg, Boren, Constructie:

- Drilling manager (**Storengy**)
- Drilling supervisor (**Storengy**)
- Lead (Sr.) drilling engineer (evt. on site anders standby back office)
- Geoloog (back office)
- Evt. Engineer well test
- Engineer bouwen (**ENGIE Services)**
- Omgevingsmanagement & communicatie **(ENGIE Services)**
- QHSE expert

Tijdens de winnings fase:

- Lead (Sr.) drilling engineer (**Storengy**)
- Service Engineer (**ENGIE Services**
- Omgevingsmanagement & communicatie **(ENGIE Services)**
- QHSE expert

Aangezien nog niet bekend is welke personen ingezet worden tijdens bovengenoemde fases, is een competentie profiel opgezet, zie Tabel 2.

Functie	Omschrijving	Ervaring
Drilling manager	De drilling manager is de projectmanager boring. Hij/zij leidt het boorproces vanaf kantoor waarvandaan hij/zij de drilling supervisors op locatie aanstuurt. De drilling manager staat daarbij ook in contact met SodM.	15 jaar
Lead drilling engineer	De lead drilling engineer is projectleider tijdens de voorbereidingen van de boring. Hij/Zij overziet het put ontwerp en boor programma.	10 jaar
Communicatiemanager	De communicatiemanager is verantwoordelijk voor goede communicatie naar buren, (social) media en stakeholders van het project.	5 jaar
Drilling supervisor	De drilling supervisor leidt de boring op locatie. Hij/zij leidt en coördineert de dagelijkse gang van zaken op locatie en rapporteert aan de drilling manager.	10 jaar
Drilling engineer	De drilling engineer ondersteunt de lead drilling engineer tijdens de ontwerpfase en drilling manager en drilling supervisor tijdens de boring.	5 jaar
Geoloog, seismiciteit	De geoloog adviseert over de formaties in de ondergrond. De geoloog inventariseert en beoordeelt de mogelijkheden en risico's van de te verwachte geologische voorkomens. De geoloog maakt onderdeel uit van het welldesign en boorteam.	5 jaar
Engineer	Hij/Zij is hoofd van het ontwerpteam van de bovengrondse installaties. Hij/Zij heeft ervaring in de Nederlandse geothermie sector en is op de hoogte van de regelgeving.	10 jaar
QHSE expert	Hij/Zij heeft de juiste competenties om de QHSE onderdelen te bewaken tijdens alle werkzaamheden rondom het geothermieproject. Bij voorkeur is er ervaring opgedaan in de geothermie sector.	5 jaar

Tabel 2: Competentie matrix

In te zetten personeel of partijen worden geselecteerd op basis van bovengenoemde competenties. Daarnaast dienen ze de ENGIE HSE policy (Bijlage VI) te onderschrijven. Benodigde CV's zullen bij werkprogramma's gevoegd worden en overhandigd aan SodM.

DAGO: EES BV is als aspirant-operator lid bij vereniging DAGO.

Overheidsinstanties: EZK, Provincies, gemeentes, Rijkswaterstaat, waterschappen en brandweer zijn belangrijke stakeholders in een geothermieproject. Overheidsinstanties op enige manier betrokken bij de ontwikkeling van het geothermieproject zullen worden ingelicht en waar nodig om advies gevraagd worden. Benodigde vergunningen of meldingen zullen aangevraagd worden.

Contractors tijdens en na boorfase: Veel leden van de projectorganisatie hebben contacten met contractors. Welke contractors ingeschakeld gaan worden hangt af van betrouwbaarheid, match met andere contractors, beschikbaarheid en economische afwegingen.

4.3 Projectplanning

De globale planning van beide projecten is beschreven in Bijlage I, onderdeel 3.6 (LEAN) Bijlage II, onderdeel 2.7 (GOUD).

5 VG Zorgplan

ENGIE Energy Solutions B.V. heeft kwaliteit, veiligheid en milieu zeer hoog in het vaandel staan. Dit geldt overigens voor de gehele ENGIE organisatie. ENGIE is ISO9001 en ISO14001 gecertificeerd en in Nederland in 2016 behaalde ENGIE Services voor het vijfde jaar op rij de laagste ongeval-rating ooit. Het doel was ten opzichte van 2015 al naar beneden bijgesteld naar een injury frequency van 1,25 per miljoen gewerkte uren (2015: 1,50), maar het eindresultaat eindigde beduidend lager op 0,74 (2015: 0,93). Er vonden onder medewerkers en inleners totaal 9 ongevallen met verzuim plaats (2015: 12). Met deze resultaten is ENGIE Services toonaangevend in haar branche. ENGIE Services blijft streven naar 0 ongevallen.

Ook bij Storengy staan kwaliteit, veiligheid en milieu bovenaan de prioriteitenlijst bij alle projecten. Storengy is ook ISO9001 en ISO14001 gecertificeerd en werkt daarnaast op het gebied van HSEQ op basis van OHSAS18001.

Om in de geothermieprojecten in Utrecht te borgen dat de activiteiten in alle fasen veilig uitgevoerd worden, maakt ENGIE Energy Solutions B.V. gebruik van het VG zorgplan zoals dat in Bijlage VII is opgenomen. Dit VG-zorgsysteem is gebaseerd op de standaard van Dutch Association of Geothermal Operators (DAGO) en NTA8620 en voldoet daarmee aan de eisen die vanuit SodM gesteld worden op het gebied van veiligheid.

In dit systeem is uitgewerkt hoe de risico's geïdentificeerd en gemitigeerd worden en welke processen in gang gezet worden bij een calamiteit. De documenten zullen conform de wetgeving 6 weken voor de start van elke fase van het aardwarmteproject aan Staatstoezicht op de Mijnen (SodM) worden voorgelegd voor evaluatie.

Het VG-zorgsysteem zal ook van toepassing zijn op alle partners of onderaannemers die een rol in het project hebben/krijgen.

6 Geologische studie

Bijlage VIII bevat de geologische studie die het ondergronds potentieel van zowel LEAN als GOUD beschrijft.

Gegeven het huidige gebrek aan data is het nog niet mogelijk een gedegen seismische risico-analyse te doen. Hiervoor is zowel voor LEAN als GOUD eerst meer inzicht aan de hand van de seismische data in de omgeving Utrecht benodigd. De activiteiten met betrekking tot seismiek worden in het volgende hoofdstuk omschreven. Uiteraard is ENGIE voornemens in de verdere verkenningsfase een gedegen seismische risico-analyse op te stellen en te overleggen alvorens deze initiatieven over kunnen gaan in een volgende fase.

7 Seismiek

Voor het project LEAN is reprocessing en re-interpretatie van bestaande seismische data en passieve seismiek nodig. Het is niet de verwachting dat nieuwe seismische data dient te worden geacquireerd maar dit wordt vooralsnog niet uitgesloten. Voor meer informatie over de redenering hierachter, zie Bijlage I, Work Package 1.

Voor het project GOUD is reprocessing en re-interpretatie van bestaande seismische data ook nodig. Daarnaast dient voor het project GOUD tevens nieuw seismische data geacquireerd te worden. Voor meer informatie over de redenering hierachter, zie Bijlage II, Work Package 5.

Voor de benodigde siesmiekacquisitie zal ENGIE in overleg treden met de daartoe bevoegde autoriteiten en toezichthouders.

8 Boren, winnen, abandonneren

8.1 Boren

Voor het project LEAN is het de bedoeling bij de exploratieboring in ieder geval de volgende methodes worden gecombineerd:

- Slimhole drilling
- Managed Pressure Drilling
- Enhanced Casing Installation
- Rotary Steerable System drilling
- Open hole completion.

Het beoogde boorplan en boorontwerp voor LEAN behoeft nog wel verdere uitwerking. Voor een omschrijving van deze werkzaamheden en meer informatie over de beoogde methodes, zie Bijlage I, Work Package 1-3 en hoofdstuk 6.

Voor het project GOUD geldt dat nog meer werkzaamheden (o.a. data-acquisitie en studies) nodig zijn alvorens het mogelijk is om een boorplan of boorontwerp op te stellen. Voor een omschrijving van deze werkzaamheden, zie Bijlage II, vanaf Work Package 4.

Voor beide projecten geldt dat een uitgebreide risico analyse wordt gemaakt per fase waarbij ook de mitigerende maatregelen worden opgesteld.

8.2 Winnen

Voor zowel LEAN als GOUD geldt dat bij de productie en injectie van het water worden dezelfde veiligheidsmaatregelen in acht genomen als gebruikelijk bij productie en injectie in gas- en olievelden. Dit houdt in dat er een nauwkeurige monitoring plaats zal vinden van minimaal de volgende parameters:

- Geproduceerde en geïnjecteerde volumes
- Temperatuur aan de putmond van de geproduceerde en geïnjecteerde waterstroom
- Druk aan de putmond van de geproduceerde en geïnjecteerde waterstroom
- Annulus drukken van beide putten

Verder zal er op regelmatige basis een monster genomen worden van zowel het geproduceerde water als het geïnjecteerde water om analyses uit te voeren. Deze analyses zullen primair gericht zijn op detectie van koolwaterstoffen en van stoffen die corrosief kunnen zijn.

8.3 Abandonneren

Als LEAN en/of GOUD niet meer rendabel worden geacht zullen de putten op een veilige manier verlaten moeten worden. Het plan dat deze activiteit beschrijft ('abandonment program') zal voldoen aan dezelfde eisen waaraan productie- en injectieputten voor gas- en oliewinning moeten voldoen. Deze programma's worden altijd eerst ter beoordeling aan SodM voorgelegd alvorens met de werkzaamheden wordt aangevangen.

Bijlage I Projectplan LEAN HE 2017

Separaat document

Bijlage II UDG Exploration work program

Separaat document

Bijlage III GOUD Consortium

Het project GOUD dient een aantal verschillende en aantal gedeelde belangen van de deelnemers. Het initiatief GOUD is ontstaan binnen Kantorenpark Rijnsweerd. De Stichting Kantorenpark Rijnsweerd (SKR) verrichtte in 2013 onderzoek naar collectieve verduurzaming van de energievoorziening. Het onderzoek richtte zich in eerste instantie op WKO-systemen die niet haalbaar bleken waarna het onderzoeksveld is verbreed naar geothermie als duurzame bron.

De business case toont aan dat geothermie in ultra diepe lagen haalbaar is bij een productie van 33-55 MWth maar dat de totale energievraag van Kantorenpark Rijnsweerd te beperkt is voor een haalbare case van Geothermie. Om de energievraag te vergroten en het initiatief te versterken in de verkenningsfase is daarom samenwerking gezocht met partijen op het Utrecht Science Park (USP). Het USP-gebied omvat de eigenaren en gebruikers Universiteit van Utrecht (UU) en Universitair Medisch Centrum Utrecht (UMC U) van de bestaande warmtevoorziening en de gebruikers van warmte Hogeschool Utrecht (HU).

Vervolgens is samenwerking gezocht met ENGIE als operator en als ervaringsdeskundige.

Bijlage IV Uittreksel KvK ENGIE Energy Solutions B.V.

Separaat document

Bijlage V Jaarverslag ENGIE Services Nederland N.V.

Zie jaarverslag 2016 in een separaat document

Bijlage VI Brochure Storengy Geothermie

Separaat document

Bijlage VII VG-zorgplan ENGIE Energy Solutions B.V.

Separaat document

Bijlage VIII Geologische studie

Separaat document

LEAN:
Low cost Exploration And deriskiNg of geothermal plays:
the Rotliegend demonstrator

Projectplan Hernieuwbare Energie 2017

Table of Contents

Focus & Locatie

Het LEAN project richt zich op een SDE+ techniek: Het goedkoper maken van de productie van hernieuwbare energie (geothermische warmte, diepte >500m).
De locatie waar het project uitgevoerd wordt is Utrecht (Nederland).

0 Openbare Samenvatting

Aanleiding

Provincie en gemeente Utrecht hebben hoge ambities voor de energietransitie, waarin geothermie een belangrijke rol speelt. Helaas is het tot op heden nog niet gelukt om deze gewenste geothermie te ontwikkelen. Dit komt doordat er te weinig (betrouwbare) gegevens beschikbaar zijn over de ondergrond in de regio. Dit maakt de opbrengsten van geothermie onzeker, zelfs wanneer SDE+ zou worden toegepast.

Elders in Nederland is het mogelijk deze onzekerheid te verlagen op basis van eerdere boringen in hetzelfde gebied. Echter in Utrecht zijn deze gegevens gebrekkig voorhanden. De Utrechtse bodem is een zogenaamde 'white-spot'. ENGIE heeft daarom het voortouw genomen in een publiek-privaat consortium dat wil investeren in een demonstratieproject dat de geschiktheid van de Utrechtse bodem voor geothermie aan moet tonen: LEAN.

Als het demonstratieproject slaagt, dan wordt een groot potentieel voor geothermie bloot gelegd, omdat de bovengrondse omstandigheden in Utrecht uitstekend zijn door onder andere de aanwezigheid van een groot warmtenet van Eneco (100.000 W.eq.) dat nu nog aardgasgestookt is.

Met het project LEAN wordt gemikt op het Rotliegend op ca 2-3 km diepte. Op basis van beschikbaar seismologisch onderzoek en beperkte boorgegevens bestaat een indicatie dat deze aardlaag in een deel van de provincie Utrecht geschikt is voor geothermie. Om dit te bevestigen is een proefboring nodig.

Doel van project

In het project LEAN worden in Utrecht de volgende drie innovaties gedemonstreerd met als doel om geothermie goedkoper, veiliger en opschaalbaar te maken in zogenoemde white-spots:

1. Goedkoper boren door gebruik te maken van een innovatieve combinatie van:
    a. Slimhole drilling
    b. Managed Pressure Drilling
    c. Enhanced Casing Installation
    d. Rotary Steerable System drilling
    e. Open hole completion.
2. Innovatieve acquisitie en reprocessen van seismische data, waardoor een beperkte seismische meetcampagne nodig is, die een white-spot maximaal kan ontsluiten.
3. Portfolioaanpak, waardoor het risico van het eerste project wordt verdeeld over de vervolgprojecten. Eneco heeft de intentie getekend om de warmte van tenminste 5 vervolgprojecten af te nemen.

Deze innovaties gezamenlijk kunnen leiden tot een kostenreductie van 2 M€ per doublet. Als 25% van de toekomstige doubletten gebruik maakt van de in LEAN toegepaste technologie dan kan dat leiden tot een kostenreductie voor de SDE van 280 M€ in de periode tot 2030.
Omgevingsmanagement en communicatie is een essentieel onderdeel van het project. Dit is vernieuwend, omdat er is in Utrecht nog geen ervaring is met communiceren over boren in de diepe ondergrond.

Activiteiten

LEAN wordt uitgevoerd in 3 werkpakketten:

- WP1 PRE-DRILL EXPLORATION (M0-18).
  In WP1 wordt bestaande geologische data geanalyseerd. Om de diepte en dikte van het Rotliegend reservoir beter in te kunnen schatten is interpretatie van bestaande seismische data nodig. Vervolgens wordt een put ontwerp gemaakt, SDE beschikking aangevraagd en de businesscase voor het portfolio opgesteld. WP1 wordt afgesloten met een go/no go beslissing voor het boren van een innovatieve slimhole naar het Rotliegend.
- WP2 SLIMHOLE EXPLORATION (M18-M24).
  In WP2 wordt de eerste slimhole met open-hole completion geboord, een uitgebreid logging en coring programma en een productietest uitgevoerd. Op basis van de performance van de eerste slimhole wordt een go/no go genomen voor het boren van de tweede slimhole.
- WP3 DOUBLET DEMONSTRATION (M24-M36).
  In WP3 wordt de tweede slimhole geboord inclusief een well test en een uitbreid logging programma. Bij voldoende geschiktheid wordt het doublet productierijp gemaakt en aangesloten op het Utrechtse warmtenet. Tevens wordt de reservoir data die in beide slimholes wordt verzameld gebruikt voor een update van het herhaalpotentieel in de regio.

Resultaten

1. Demonstratie van portfolioaanpak voor de ontwikkeling van geothermie in een white-spot area in Utrecht.
2. Een rekenmodel (calculator) om de waarde van de portfolio-aanpak te demonstreren.
3. Eerste slimhole doublet aangesloten en scope voor commercieel herhaalpotentieel van minimaal 5 doubletten (totaal herhaalpotentieel is 26 doubletten).
4. Opwerking van bestaande seismiek met innovatieve aquisitie van seismiek en geavanceerde reprocessing waardoor nieuwe seismiek voor follow up doubletten niet nodig is (besparing tot ca € 0,1 M€ per doublet in portfolio).
5. Innovatieve slim hole boorontwerp & technieken, gericht op goedkoper, veilig en efficiënt boren inclusief een uitgebreid logging en coring programma, inclusief DTS/DAS (flow performance and temperature assessment). Hierdoor kan 25% kostenreductie van de boorkosten worden gerealiseerd (besparing 2 M€ per doublet).
6. Aantonen van kostenreductie en productieoptimalisatie door open-hole completion in het Rotliegendes.

De projectresultaten, zoals geologische data en rekeninstrumenten, worden publiek beschikbaar gesteld om gebruikt te kunnen worden voor de ontwikkeling van andere white-spot areas in Nederland en daarbuiten.

1 Participants and Third parties

1.1 Overview of Participants

Naam deelnemer	Type organisatie[1]	Rol in project
ENGIE	Groot bedrijf	Penvoerder, Industriepartner, operator, shareholder LEAN-SPV
EBN	Groot bedrijf	Industrie & kennispartner
Eneco	Groot bedrijf	Industriepartner, sponsor & warmteafname,
Huisman	Groot bedrijf	Industriepartner: Drilling of doublet, operator
IF Technology	Middelgroot bedrijf	Industrie & kennis partner
TNO	Onderzoeksorganisatie	Kennispartner
Universiteit Utrecht	Onderzoeksorganisatie	Kennispartner
WEP	Klein bedrijf	Industriepartner: boor management en well design
LEAN-SPV*		
Gemeente Utrecht, Provincie Utrecht**	Overheid	Sponsor, geen project partner in HE aanvraag,

The following should be noted:

- *It is foreseen to establish a LEAN Special Purpose Vehicle for the management & exploitation of the LEAN geothermal doublet. The LEAN-SPV will become a member of the consortium and a number of activities will be shifted to the LEAN-SPV by means of a contract change request. In this proposal these activities are appointed to the current consortium partners. The cost are appointed to ENGIE.
- ** The province and municipality of Utrecht are not mentioned as partner in the HE proposal and will not request funding. Both province and municipality will act as sponsor. The municipality of Utrecht will participate in the project team to be involved in the stakeholder management and communication of the project. The municipality is also the competent authority for the 'omgevingsvergunning' and the 'bestemmingsplan'.

[1] **Maak een keuze uit:** *Midden bedrijf, Klein bedrijf, Groot bedrijf, Onderzoeksorganisatie (niet-economische activiteiten), Onderzoeksorganisatie (economische activiteiten), Overheid, Overig.* Om te bepalen of een projectdeelnemer een MKB-ondernemer is, wordt uitgegaan van de MKB definitie van de Europese Commissie. Zie http://www.rvo.nl/subsidies-regelingen/subsidiespelregels/standaardformulieren/mkb-toets. Voor onderzoeksorganisaties, zie de handleiding.

1.2 Description per participant and essential sub-contractors

1.2.1 ENGIE

Introduction:
ENGIE is an international utility and service company operating in 70 countries. ENGIE operates 228 networks for urban heating and cooling in 13 countries.

- Geothermal energy is one of ENGIE's 12 key programmes to become a leader at the heart of the energy transition. Geo DH (Geothermal District Heating) projects fit well within ENGIE's future strategy:
- It provides a response to requests from existing customers in several areas in the Netherlands. The annual market potential of Geo DH in the Netherlands in 2050 is ~ € 6.3 billion due to a government focus on the transition from natural gas towards sustainable district heating;
- It can contribute to reaching ENGIE's target to increase renewable energy generation by 50%;
- It will broaden and strengthen ENGIE's portfolio of decentralized renewable energy projects;
- In the long term it can result in more integrated collaboration in the form of DBFMO (Design, Build, Finance, Maintenance and Operation) contracts for sustainable energy services;
- ENGIE can exploit its endurance, organizational, operational and financial strengths to provide for an integrated approach to local renewable heat developments from a TCO perspective.
- ENGIE is a unique player within the Dutch market given its expertise throughout the value chain. Unlike competitors aiming for part of the work we can be a one-stop-shop building on our group's competencies.

Interest of Party:
ENGIE is a unique player within the Dutch geothermal district heating market given its international expertise as an investor and operator of geothermal energy systems and potential added value throughout the value chain. ENGIE is currently present in France, Italy and Indonesia and is looking to expand its geothermal business into promising markets like the Netherlands:

- Over the past decades ENGIE Energy Solutions (EES), part of ENGIE Services NL, has realized multiple sustainable energy projects with responsibility for the entire scope of a project: from development through designing, financing and realization to operation and maintenance. ENGIE delivers sustainable heat to >1.2M m² of buildings in the residential and utility market. EES is part of ENGIE Ventures & Integrated Solutions (EVIS) B.V.
- Storengy (100% subsidiary of ENGIE) is one of the largest natural gas storage operators in the world (12,2 BCM of storage capacities). Storengy has developed a unique spectrum of in-house expertise in the design, build, operation and maintenance of underground gas storage facilities (including wells) with extensive knowledge of the regulatory requirements in Europe. The Storengy expertise in hydrogeology, geophysics, geology, geochemistry, reservoir modelling and well drilling for geothermal projects make Storengy a key player in the ENGIE group for the development of geothermal energy.

To stay a leader in the energy transition, ENGIE aims to develop a portfolio of geothermal energy projects in the Netherlands within the next decade, in line with the joint ENGIE Group expertise and strategy. Please see Annex 18 for an overview of international reference projects and our organisation structure in the Netherlands.

Importance of Party in the Consortium:
Building on its expertise in both surface and subsurface environments, ENGIE aims to develop the LEAN project from a risk-carrying TCO (Total Cost of Ownership) perspective. This enables the consortium to ensure safe, responsible, sustainable and economic decision-making.

Main task in project:
Development, design, build, financing and maintenance of the envisioned geothermal project and sustainable heat service provider.
Operator for the Dutch Mining Law and Consortium coordinator (penvoerder).

1.2.2 EBN

Introduction:
EBN (Energie Beheer Nederland) is a state participation company with the Ministry of Economic Affairs and Climate as single shareholder. EBN's mission is to realize economic and societal value from geological energy sources in the Dutch subsurface. Activities are focused across three strategic pillars. Within the first pillar 'Our Dutch Gas', EBN is a 40% participant in most oil and gas projects in the Netherlands and aims to optimize the safe and responsible use of existing and new gas fields as a means to facilitate the energy transition. In the second pillar 'Return to Nature', EBN has a leading role in re-using and decommissioning of oil and gas infrastructure. In the third pillar, 'New Energy', EBN is developing partnerships and actively pursuing sustainable energy sources and applications in the subsurface such as geothermal, energy storage and CO_2 storage.

Interest of Party:
The project will produce new data and improved understanding of the Rotliegend reservoir potential in the Utrecht region and the development of the Rotliegend geothermal play. It will also provide new subsurface data that can be used to de-risk and design safe(r) wells. The project will give insight into the application of the portfolio method for geothermal applications, in new drilling methods and the scope for cost reduction.

Importance of Party in the Consortium:
EBN brings expertise from the oil and gas sector in the subsurface projects to the consortium, varying from input on the exploration (portfolio) evaluation, target selection, well planning, data acquisition and safe and responsible execution.

Main task in project:
EBN will contribute knowledge and expertise.

1.2.3 Eneco

Introduction:
Eneco is one of the largest producers and suppliers of natural gas, electricity and heat in the Netherlands, serving more than 2 million business and residential customers. Eneco headquarters are located in Rotterdam. It also carries out energy trading and is involved in sustainable energy projects. Eneco opts for 100% sustainable and does so in an involved, clear and powerful manner. That's embedded in her mission 'everyone's sustainable energy'.

We aren't the only party that has opted for sustainability. But what sets us apart from other companies is our vision: the perspective from which we view the world around us. In our view, the energy transition is all about the shift from a centrally-organised energy system to a system where people develop their own sustainable energy arrangements; either individually or together with others. Our ambition is to reduce our energy requirements to a level that ensures that we remain within the limits of a sustainable planet. Not only for ourselves, but also for future generations.

We have chosen to only develop those assets that connect effectively and profitably to the world around us and our customers. We don't just build for ourselves, but on behalf of, or together with, our customers. With the same financial assets, we are able to realize more sustainable production (electricity and heat), contribute to embedding at the local level and to the public acceptance of sustainable projects, increase confidence in our investments and share risks with other parties.

Eneco invests structurally in sustainable assets like solar, wind farms, biomass plants and so on. This means that we have a lot experience in developing and managing such projects. We understand the project management process and have tools for implementation and evaluation. This includes project planning, resource identification, implementation, deliverables and milestones, risk assessment, stakeholder management and governance.

Interest of Party:
Eneco is currently operating the heat generation, transport and distribution in the Utrecht area. The goal of Eneco is to produce 100% sustainable heat for our customer. Therefore Eneco needs to develop new sustainable assets within the Utrecht region to reach her goals. Geothermal heat is considered as a very attractive option in terms of environmental footprint and economic benefits.

This project is an unique opportunity to address some of the most challenging questions to de-risk the application of using geothermal heat to make the district heating more sustainable.

Importance of Party in the Consortium:
With the district heating network of Eneco (see Annex 17.1), there will be enough heat demand for the pilot project and also a window of opportunity for more geothermal wells because the district heating network is one of the largest in the Netherlands, and it's expected to grow in numbers of customers. Eneco has signed a Letter of Commitment to use the heat of the LEAN project in addition to the heat of 5 follow-up projects (see Annex 17).

Main task in project:
WP1: engineering the connection between geothermal wells and district heating grid. Search for optimal location for drilling, next to low temperature district heating. Provide input for business case (BC).

WP2: update business case. Translate capacity of geothermal well and heat demand of district heating to heat production.

WP3: connect heat exchanger of geothermal well to district heating grid.

1.2.4 Gemeente Utrecht

Introduction:
With a population of more than 338,000, Utrecht is the fourth largest city in the Netherlands. The city will continue to grow in the coming years. Utrecht is located in the very heart of the Netherlands, where the country's road and rail networks intersect. Due to its central position within the country, it is an important transport hub for both rail and road transport. Utrecht is host to Utrecht University, the largest university in the Netherlands, as well as several other institutions of higher education.

The municipality of Utrecht directs policy towards maintaining Utrecht as a dynamic city. The city is active in promoting entrepreneurship and creating new businesses. One of the most important tasks of the municipality is local spatial planning for housing and business as well as for local infrastructure. Furthermore, the municipality is responsible for enforcing environmental measures through the law on environmental management and has an increasing responsibility in the area of social security, healthcare and education.

Interest of Party:
In 2015, 165 Utrecht residents worked together to develop an energy plan. The plan was largely adopted by the municipal authorities. The Municipality takes the lead in making choices regarding the utilization of the district heating network and on replacing existing gas infrastructure. The City of Utrecht aims at achieving climate neutrality by 2030 and considers the use of geothermal energy in the city's future energy supply to be crucial. By participating in the LEAN project we hope to maximise the geothermal energy potential of the region.

Importance of Party in the Consortium:
The Gemeente Utrecht is an important stakeholder in Utrecht and as such can act as a facilitator with respect with the above interests.

Main task in project:
The Gemeente Utrecht is member of the General Assembly in the project. Another role of the Gemeente will be involvement in the permitting procedure for drilling as formalized in the Dutch Mining Law. The Gemeente also contributes to communication (task 1.8, 2.6, 3.6).

The Gemeente will financially support the activities in this project through a subordinated loan.

1.2.5 Huisman

Introduction

Huisman is globally active and delivers 'step changing' technical solutions to the world's most leading companies in the markets for, offshore, oil and gas, renewable energy, recreation and civil works. The installations supplied are integrated systems and are designed and built in-house; from concept to lifetime support. Huisman's in-house designed and built LOC 400 is a fully containerized modular derrick equipped with a fully automated pipe manipulator and drill floor. This makes the Huisman LOC 400 an efficient, safe and environmentally friendly alternative to conventional drilling rigs. With the LOC 400 derrick several geothermal projects have been successfully completed in Europe.

Huisman has created the means to drastically improve drilling and equipment handling and is continuously exploring and realising new solutions to improve drilling operations. Another focus point is to further improve efficiency and reduce HSE risks by fully automating the drilling system. The land rigs are already able to trip in and out of the hole fully automatically, without the need of any people on the drill floor.

The development of new drilling solutions is done in the Joint Venture Huisman Well Technology BV which is currently owned for 75% by Huisman Equipment and 25% Well Engineering Partners. However, WEP is in the process of selling its shares to Huisman.

Interest of Party:

Huisman is investing heavily in developing solutions to lower the costs of deep and ultra-deep geothermal wells and to professionalize the industry. In this project, Huisman is able to test some innovations that should lower the costs and de-risk future projects. This demonstration is part of a multi-year roadmap in which Huisman will test and develop several new innovations.

Importance of Party in the Consortium:

- Investing in cash and knowledge.
- Huisman has more than 15 years of experience designing and building drilling equipment and has drilled approximately 35 wells in the oil & gas and geothermal sector in Europe and the US.
- Managing and executing the drilling operations.
- Supplying drilling tools and equipment.

Main task in project:

WP1 – Preparations for WP2
WP2 – Site preparations, managing and execution of the first well drilling operation
WP3 – Managing and execution of the second well drilling operation

1.2.6 IF Technology

Introduction:
With a staff of about 70 consultants and engineers, IF Technology (IF) is the largest geothermal energy consulting/engineering company in the Netherlands (and one of Europe's largest as well). IF Technology integrates all disciplines required to develop, realize and exploit geothermal resources. From shallow to ultra-deep, and from geological, geophysical and reservoir engineering to legal and financial support. IF works for many different types of clients like (local) governments that want to assess the potential of geothermal sources, heat consumers that want to change to renewable sources, energy companies/ESCo's that want to deliver geothermal heat, and geothermal operators that require specialist support during development, realization and exploitation of projects.

Interest of Party:
Improving work flows in geothermal exploration; obtaining a good position for future geothermal consulting & engineering.

Importance of Party in the Consortium:
- Permitting
- Geothermal knowledge

Main tasks in project:
- Interpretation of reprocessed seismic data; seismic attribute analysis, interpretation of existing well log data, setting up geological model, calculating geothermal reservoir potential, assistance in selecting best subsurface locations for drilling of a doublet. Improving temperature and depth prediction compared to "conventional" way in geothermal exploration.
- Assisting TNO in setting up Value of Information (VoI, see annex 13 for more information) and portfolio approach; assistance in applying the approach to the Utrecht case.
- Assistance with: exploration permit, seismic hazard analysis (level 1), test water disposal plan and permits, drawing up well trajectory, defining geological drilling risks.

1.2.7 Provincie Utrecht

Introduction:
The Province of Utrecht spans 144,915 hectares and consists of 26 municipalities with a joint population of 1,200,000. Utrecht is the oldest and smallest province in the Netherlands and is also one of the most densely populated.

The provinces of the Netherlands represent the country's middle level of government and as such work in close co-operation both with municipalities and with the State. The province of Utrecht has a tier of government comprising of elected authorities (the Provincial Council and the Provincial Executive), and employs 800 civil servants.

Our province offers a unique combination of urban living options and nature. Utrecht is a green province, but has the busiest and most intensely used road network in the Netherlands. The role of the province is to ensure accessibility and interconnectivity as well as spatial planning while maintaining our greenery.

Interest of Party:
We strive to be climate neutral by 2040 and through the Energy Agenda 2016-2019 we aim to stimulate the energy transition. Our aim is to stimulate the usage of geothermal energy in our region. By participating in the LEAN project we hope to enable the geothermal energy potential of the province. This source of energy will contribute to becoming climate neutral as well as to our aim to be healthy urban living region.

Main task in project:
The Province of Utrecht is member of the General Assembly in the project and will be supporting by cooperation of civil servants on energy transition and subsurface spatial planning in the project.

Another role of the Province will be involvement in the permitting procedure for drilling as formalized in the Dutch Mining Law.

The Province will financially support the activities in this project through a subordinated loan.

1.2.8 TNO

Introduction:
TNO is the largest fully independent Research, Development and Consultancy organization in the Netherlands with a staff of about 3,200 and a total annual turnover of about 520 M€. Its primary tasks include support and assistance of trade and industry including SME's, governments and others in technological innovation and in solving problems by rendering services and transferring knowledge and expertise. TNO provides contract research and specialist consultancy, as well as grant licenses for patents and specialist software. Also TNO tests and certifies products and services, and issues an independent evaluation of quality. TNO has clustered its variety of disciplines into 7 themes (Healthy Living, Industrial Innovation, Defence, Safety & Security, Energy, Transport and Mobility, Built Environment, Information Society).

Interest of Party:
TNO aims to strengthen the practical -yet robust- application of portfolio approaches to unlock geothermal energy in the Netherlands, through public models for performance and business case assessment including the Value of Information. Key is the development of public model instruments and improved conceptual and practical models and modelling techniques for reservoir characterization and low cost exploration. In addition, TNO aims to realise a geothermal field-lab for geothermal research. Within the LEAN project, TNO can provide access to the LEAN wells and access to geothermal well data (including DAS/DTS data and production data). This is one of the reasons that TNO is investing it's own financial resources into LEAN.

Importance of Party in the Consortium:
Provider of subsurface models, reservoir characterization concepts, exploration methods and analysis tools.

Main task in project:
Leads the development and application of portfolio analysis tools including performance assessment, business case and VoI analysis (task 1.3, 1.8, 2.5) as well as pre-drill seismic acquisition and enhanced reservoir characterization (task 1.2), as well as dissemination (task 1.10, 2.7, 3.7). TNO contributes to the well logging and coring (plan) (task 1.5, 2.4, 3.3), and communication (task 1.8, 2.6, 3.6)

1.2.9 Universiteit Utrecht

Introduction:
Utrecht University (UU) is an internationally renowned research university. The quality of research at the University is demonstrated by positive research evaluations and a high international ranking. Utrecht University hosts the largest academic institute for geosciences in the Netherlands, which also is among the larger ones in Europe. The research programme of the Department of Earth Sciences is characterised by a multi-disciplinary combination of data acquisition, advanced laboratory techniques, innovative process modelling and field-work. Research focuses on forecasting future behaviour of geo-systems and prediction of geological patterns, which are highly relevant for the basic needs of humanity: supply of resources, protection against natural hazards, and control of the environmental degradation. The UU Tectonics research group is among the world's leading groups in quantitative research of sedimentary basin (de)formation and coupling of lithosphere processes with surface processes and associated topography development.

Interest of Party:
Conceptual understanding of spatial and vertical correlations in uncertainty affecting Vol and white-spot area exploration, quantitative methods for portfolio exploration.

Importance of Party in the Consortium:
Contributor in tool development and probability models for reservoir characterization.

Main task in project:
Contributor in tool development and reservoir characterization.

1.2.10 WEP

Introduction:
Well Engineering Partners (WEP) has been involved in about all of the geothermal projects in the Netherlands from the absolute beginning. With a staff of over 30 primarily well engineers, WEP provides wells designs, handles procurement and manages the execution of the drilling projects. Furthermore, WEP provides all well related services such as subsidence studies, training or writing of company standards. Finally, WEP is actively involved in developing technical solutions for the geothermal drilling industry.

Interest of Party:
Acquiring specific and local drilling knowledge for the Utrecht area to establishing a good base for future work.

Understanding requirements and expectations of the wider proliferation of geothermal energy in The Netherlands (until now almost all activity has focused on the greenhouse sector).
Building engineering and operational experience with the combination of proposed in-house developed innovative drilling technologies:

- Slimhole drilling
- Enhanced Casing Drilling
- Managed Pressure Drilling
- Rotary Steerable System drilling
- Open hole completion

These proposed innovative drilling technologies are further detailed in Annex 11.

Importance of Party in the Consortium:
Providing geothermal drilling experience.

Main task in project:
Well design & drilling management.

1.2.11 LEAN-SPV

Interest of Party:
See other consortium partners.

Importance of Party in the Consortium & Main task in project:
To lower risks and contingencies involved in geothermal energy projects it is common to set-up a SPV (Special Purpose Vehicle), in which the assets as well as the permits and economic activities needed in the geothermal lifecycle are placed. Such legal entities (e.g. through a private company or a limited partnership) are set up to ensure the potential project rights, liabilities, gains and risk isolations can be shared amongst consortium partners through shareholding within that specific SPV.

Moreover, SPVs enable deconsolidated project-financing by partially selling the SPV shares to local investors (e.g. pension funds, banks or municipalities). This practice is commonly applied within projects with large CAPEX.

Eventual deconsolidation of the project can already be taken into account with regards to the valuation of the project amongst the consortium partners. Then, after the investment is cleared for approval (financial close) the project financing can be arranged. Project financing entails the establishment of the SPV including permits, insurances, rights, acts and articles. After this setup the project typically will be subject to a technical, legal, financial and insurability due diligence test by third parties. This is needed to ensure investors are willing to take a stake within the SPV. The costs of such due diligences should be taken into account in the business case.

Although at this stage it is clear that an SPV could be needed before financial close of the largest costs within the project (the drilling itself), parties usually formalize their cooperation through a consortium agreement first. The reason for this 'simple form' of cooperation through a consortium agreement is pragmatic since the level of complexity of the project does not yet require such complex legal structuring.

At this stage the LEAN-SPV is therefore still non-existent but is mentioned here so that the subsidizing party will not be surprised by a new legal LEAN entity within the consortium. A visualization of what such an SPV could typically entail is shown below to provide a general idea of the envisioned consortium partners and stakeholders, as well as their cooperation and interaction if the total project-scope would be fully executed.

The consortium intends to further formalize their cooperation through a consortium agreement after approval of the proposal at hand.

2 Background with objectives and results

2.1 Background

The Utrecht Province and Municipality of Utrecht have strong ambitions for the energy transition, including a potentially important role for geothermal energy. However, the development of geothermal energy has thus far been limited. This is related to the fact that the Utrecht Province is considered a 'white-spot area', a term given to areas for which limited subsurface information is available. The reason for this lack of information is due to the low density and quality of wells, combined with the fact that seismic data from past oil and gas exploration and production in the Utrecht area is relatively poor compared to other regions in the Netherlands. Consequently, geothermal energy exploration is hampered by high financial risk due to the possibility of drilling an underperforming well, as anticipated flow rates can vary one order of magnitude. This renders the potential contribution of geothermal uncertain, even when including incentives from the SDE+.

ENGIE has taken the initiative for a public-private consortium, consisting of the LEAN partners, to invest in a demonstration geothermal doublet to prove the suitability of the subsurface in the Utrecht region for geothermal energy production. If the project succeeds, a significant potential for follow up geothermal projects could be established. The geothermal doublets will feed their produced heat into a large district heating network owned by LEAN partner Eneco, with ca 38,500 heated buildings. The heat is currently delivered by gas-fired boilers, however these need to be replaced by renewables. In 2018, Eneco recently published a roadmap for renewable development of the heat network energy sources anticipating that 30MWth renewable power will be produced by geothermal doublets stemming from the success of the LEAN project.

The LEAN project aims at development of the Rotliegend reservoir. Based on existing seismic surveys and geological studies, this appears the most promising reservoir for geothermal development in white-spots. The following figure shows the white-spots of the Netherlands.

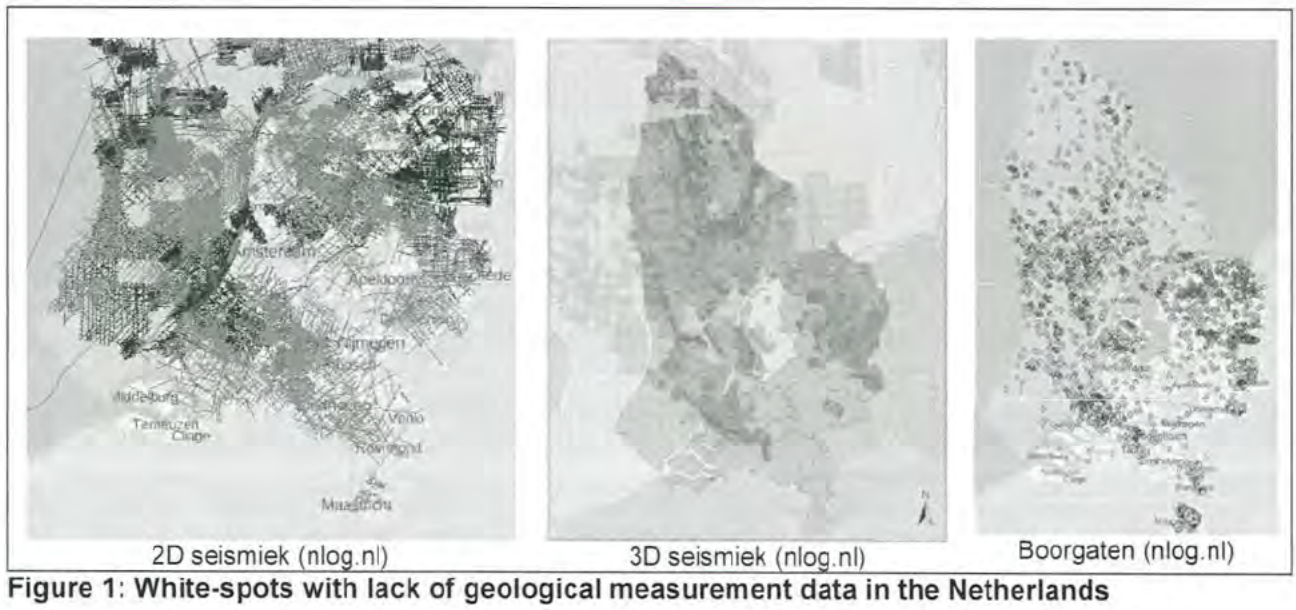


Figure 1: White-spots with lack of geological measurement data in the Netherlands

2.2 Objectives

LEAN aims to demonstrate three innovations to develop geothermal in a more cost effective way, at lower financial risk and focused towards accelerating the growth of geothermal energy in white-spot areas such as the Rotliegend in the Utrecht region:

1. Significant cost savings of at least 1 M€ on drilling and completion (see Annex 11) through a combination of:
    a. Slimhole drilling with well completion at 6' inch diameter
    b. Managed Pressure Drilling
    c. Enhanced Casing Installation
    d. Rotary Steerable System Drilling
    e. Open hole completion
2. Demonstration of an innovative seismic reprocessing method (see Annex 12) for existing seismic data and a complementary seismic campaign including a passive seismic acquisition using TNO's instruments and processing software, potentially saving costs compared to a conventional seismic campaign for mapping the subsurface. LEAN's aim is to demonstrate this step can effectively reduce pre-drill exploration costs by 0.2 M€, in particular for follow up projects in a regional white-spot area exploration strategy.
3. Quantitative portfolio approach (see annex 13) in which the prognosed NPV of the first project is taking into account the Value of Information (VoI) for the follow-up projects. To this end, the first slimhole is marked by an extensive logging and coring program and DTS/DAS[2] logging to retrieve information for subsequent projects. Eneco has committed to 5 follow up projects. LEAN aims to demonstrate that the VoI of the 5 follow-up projects contributes significantly to the business case of the first doublet, enhancing its NPV with an order of 1 M€.

The slimhole drilling, combined with open-hole completion and advanced drilling methods, reduces the costs by 25% compared to conventional borehole construction while reducing the capacity with by only a few percentage points, as expected flowrates are relatively low. The slimhole is designed larger than usual slimholes to retrieve as much information as possible from the slimhole for the portfolio of remaining doublets to be developed. The significantly lower drilling and completion costs, enhanced by cost reduction from reprocessing of vintage seismic significantly reduces the financial risk of the geothermal project, resulting in a prospective business case for the Rotliegend reservoir in the Utrecht area.

Through a quantitative portfolio exploration LEAN aims to demonstrate the capability to increase the probability of success for geothermal energy projects in the Utrecht region from a medium success rate (30%-70%) to a high success rate (>90%). The business case and VoI analysis is presented in Annex 10.

The project development approach is depicted in Figure 2 and highlights the effect of the financial benefits of the different innovations in the business case of the LEAN doublet portfolio. When all phases of the project are successfully pursued, the first doublet will be successfully developed.

Potentially also the five follow up projects will be developed. More details are given in Annex 10 on the business case and in annex 13 on the portfolio approach. Outreach and communication is considered a key element of the project development.

[2] DAS and DTS are fibre optic techniques for measurement of deformation and temperature respectively. For a detailed description see chapter 13 logging and coring plan

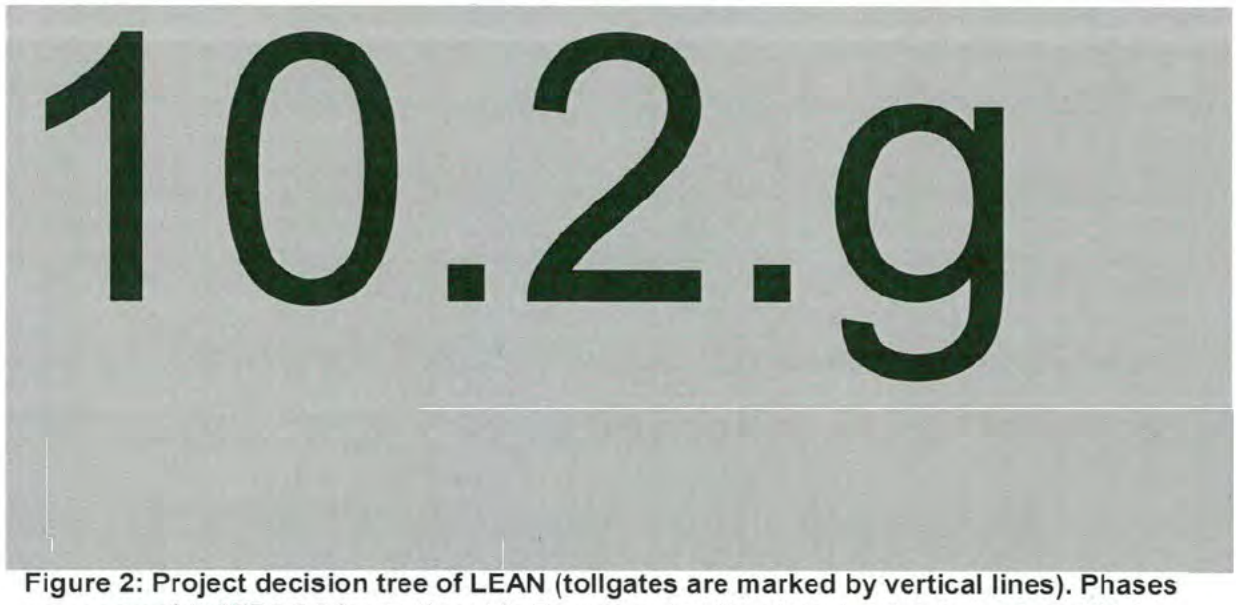


Figure 2: Project decision tree of LEAN (tollgates are marked by vertical lines). Phases correspond to WP1,2,3 in section 3.3. For more details of the business case and Vol analysis see Annex 10.

2.3 Results

1. Demonstration of a portfolio approach for the development of geothermal projects in a white-spot area in Utrecht.
2. Calculation model (calculator) to assess the Value of Information of the first doublet for the portfolio of remaining doublets to be developed.
3. First slimhole connected to the heat network of Eneco, and proof of commercially successful replicability for a minimum of 5 doublets (the total repeat potential in terms of heat demand of the network is 26 additional doublets).
4. Reprocessing of existing seismic lines, such that new acquisition of seismic lines is not necessary.
5. Innovative slimhole wellbore design & techniques aimed at affordable, save and efficient drilling and completion, including an extensive logging and coring program with permanent instalment of DAS/DTS fibre optic cables behind the casing in the top section of the well.
6. Demonstration of cost reduction through open-hole completion and open-hole performance enhancement.

The project results, including geological data, portfolio methods and performance analysis tools will be made publicly available, to be used by others for the development of similar white-spot areas in the Netherlands and abroad.

3 Project approach and workplan

3.1 Project approach

This LEAN project approach conforms to the staged de-risking approach depicted in the event tree in Figure 2. It is executed in three steps separated by go/no go decision moments:

- WP1: PRE-DRILL EXPLORATION
- WP2: SLIMHOLE EXPLORATION
- WP3: DOUBLET DEMONSTRATION

3.2 Work Breakdown Structure (WBS)

A detailed WBS of the WP is given in Annex 9, here briefly summarized:

- WP1 - PRE-DRILL EXPLORATION (M0-18). In WP1, existing geological data will be analysed. In order to improve the estimation of the Rotliegend reservoir depth and thickness, a cost-effective seismic campaign combined with passive seismic using TNO's instruments and processing software, in conjunction with reprocessing and re-interpretation of existing seismic data will be performed, and the properties analysed. Geostatistical models will be used to increase the understanding of the Rotliegend reservoir. Based on this knowledge, a portfolio of Rotliegend geothermal opportunities will be created. A detailed well plan, data acquisition and test plan will be designed for the opportunity that ranks the highest based on the exploration strategy, VoI and business case. The operator will arrange the required permits, SDE and RNES applications and communication plan for the selected opportunity. WP1 ends with a go/ no-go decision for WP2 (MS1).
- In WP2 SLIMHOLE EXPLORATION (M18-M24), the first slimhole will be drilled safely while demonstrating and evaluating the low-cost drilling methods. An extensive coring, logging and testing program will be executed. The performance of the reservoir and the implications for the portfolio will be analysed by an extensive study of the well data. Based on the evaluation of the performance of the first slimhole and a VoI analysis of the remaining portfolio, a go/no-go decision will be taken on the drilling the second well of the doublet in WP3 (MS2).
- In WP3 DOUBLET DEMONSTRATION (M24-M36), a second slimhole will be drilled (with optimizations based on learnings from WP2). If the well test is successful, the doublet will be made production-ready and connected to a heat network operated by Eneco in Utrecht. The reservoir, well and drilling data, obtained in the second slimhole, will be used to again update the VoI analysis for the entire opportunity portfolio, evaluate the actual drilling cost reduction and evaluate the expected performance of future doublets. Production is not part of the project. The project ends after a negative go/no go decision or after the drilling of the second well.

The go/no go will be influenced by *inter alia*: contracts & permits in place; drilling/seismicity risks mitigated to an acceptable level; acceptable economic risk; acceptable exploration/geological risks; acceptable political risks; the public opinion about the project; and acceptable project timing.

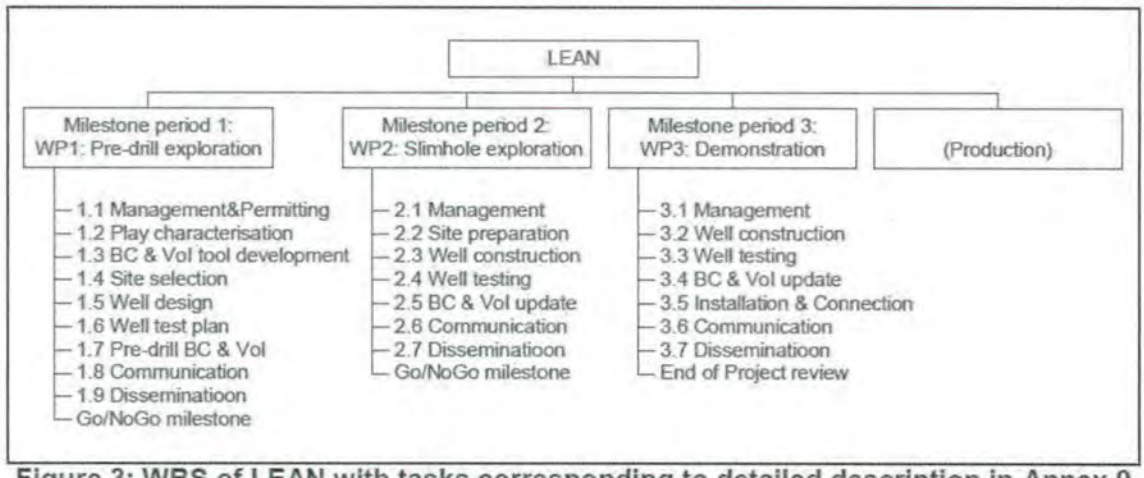


Figure 3: WBS of LEAN with tasks corresponding to detailed description in Annex 9

3.3 Work Package overview

WP of Fase	Korte beschrijving	Categorie: IO/EO/demo	Uitvoerders (met namen)	Resultaat	Geplande begin- en einddatum
1	Pre-drill exploration	Demo	ENGIE/SPV TNO Utrecht University	Portfolio of Rotliegend opportunities incl Vol and BC analysis; Slimhole & Doublet well design	M1-M18
2	Slimhole exploration of 1st well of doublet	Demo	ENGIE/SPV TNO Utrecht University	Slimhole; Extensive set of logs (Annex 11), core, drilling data, test data; Updated portfolio of Rotliegend opportunities incl Vol and BC analysis	M19-M24
3	Demonstration of 2nd well of doublet	Demo	ENGIE/SPV TNO Utrecht University	Doublet; Logs, core, drilling data, test data; Updated portfolio of Rotliegend opportunities incl Vol and BC analysis	M25-M36

3.4 Milestone overview

Mijlpalenoverzicht *(alleen in te vullen bij voorschotbetaling per mijlpaal)*:

Mijlpaal	Werkpakketnummers	Begin- en einddatum
1	WP1: Pre-drill Exploration	See Annex 9
2	WP2: Slimhole exploration	See Annex 9
3	WP3: Demonstration	See Annex 9

3.5 Risks & mitigation

The following table shows the risks and mitigation measures.

Risk	Mitigation measure
Environmental and Safety risks	These risks during drilling and operation will be covered in the permitting procedure. This relates to: seismicity; environment and safety due to uncontrolled gas or oil production; contamination of groundwater or surface water; general safety risks during drilling and operation.

Risk	Mitigation measure
Technical risk: Open hole completion collapses	A collapsed hole will require a workover operation to re-drill the reservoir section and install the more conventional sand screens.
Technical risk: Logging tools stuck in well	Most logging is scheduled for the vertical hole where the risks are the lowest. Proper running procedures according to the service providers policies and recommendations will minimise risks. Finally a fishing and wash-over service provider to be identified.
Economical risk: Drill problems lead to extra cost	Technical team on site to quickly mitigate problems.
Economic risk: Flow rate lower than expected	At go/no go milestones economical risks will be taken into account
Organizational risk: Partners leaving the Consortium	With the proposal, the Consortium Partners sign: Aanmelding deelnemer + Machtiging penvoerder At the start of the project, Consortium Partners sign a Consortium Agreement.
Schedule risk: Permitting takes (too) long	Permitting procedure will start as soon as possible At go/ no go milestones schedule risk will be taken into account
Public perception avoids permitting	Public communication and public perception will be covered in WPs

During the project, risk management (monitoring and mitigating risks) is part of the Management tasks.

3.6 Schedule

Please find the schedule in the GANTT chart below. It should be noted that every work package or milestone period ends with a go/no go decision.

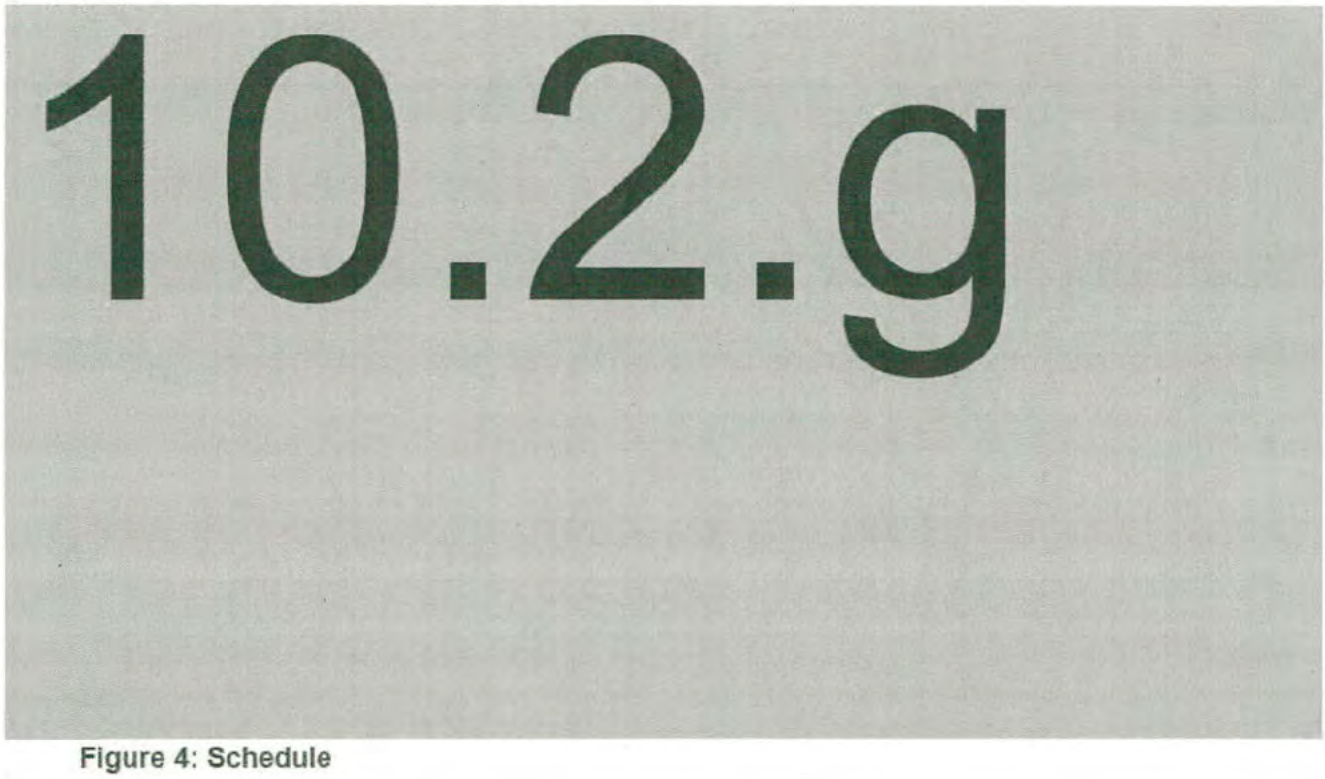


Figure 4: Schedule

4 Application in 2030 and reduction on SDE+ subsidies

4.1 Hernieuwbare energie-opties zoals genoemd in de SDE+ aanwijsregeling

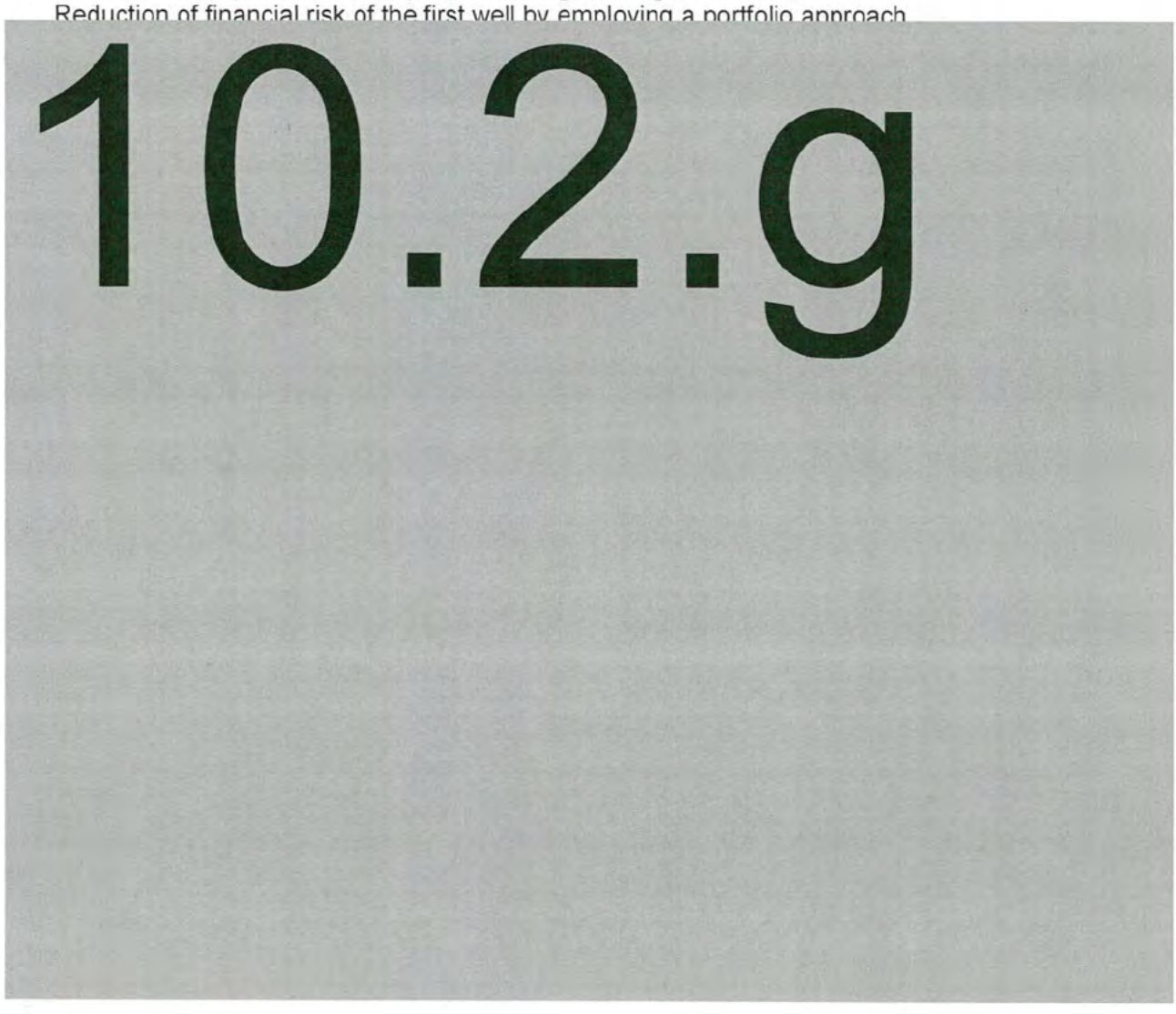
This section give the assumptions and calculations for the application of LEAN technologies and the savings on SDE+ subsidies in 2030.

- Section 4.1.1 describes the LEAN cost reductions for geothermal projects.
- Section 4.1.2 describes the SDE+ cost reduction per kWh.
- Section 4.1.3 describes the total SDE+ cost saving in 2030.
- Section 4.1.4 describes the summary table, as requested in the call text.

4.1.1 LEAN cost reductions for geothermal projects

The goal of LEAN is to demonstrate cost reductions for geothermal projects by:

- Reduction of drilling costs and risks, which can be appointed to the different drilling innovations (see Annex 11 for details):
    - Managed Pressure Drilling (MPD).
    - Enhanced Casing Installation (ECI) in combination with Rotary Steerable System (RSS).
- Reduction of exploration cost by reprocessing existing seismic data.
- Reduction of financial risk of the first well by employing a portfolio approach.



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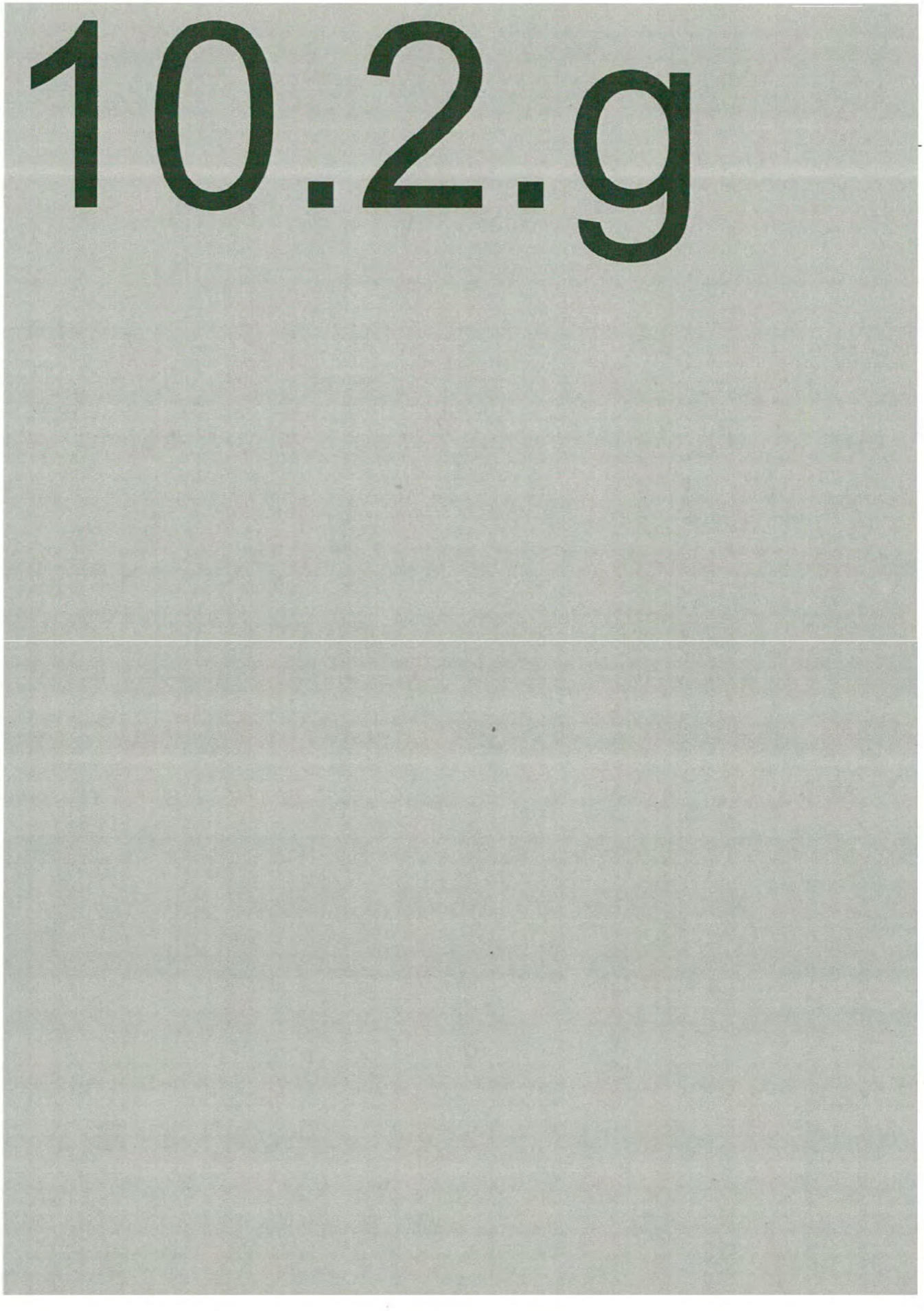

4.1.2 SDE+ cost reduction per kWh

The cost reduction per kWh can be calculated, using the file: "Rekenmodel ECN SDE Basisbedragen 2017.xls". This file is part of the proposal.

Using the conservative estimate of a cost saving of 2 M€ per geothermal project, the resulting baseline cost is **0,047 €/kWh**, which means a cost reduction of: 0,006 €/kWh (2018 baseline cost are: 0,053 €/kWh.

4.1.3 Total SDE+ cost saving in 2030

The total SDE+ cost saving can be calculated, using the file: "Rekenmodel-besparing-SDE-uitgaven-3-4-2017-tm-31-3-2018.xls". This file is part of the proposal. For this calculation, the following assumptions are used:

- TNO and EBN have calculated the potential for geothermal energy in the Netherlands based on the available geological data, suitability and heat demand. A recent (not yet published) study indicates a realistic potential of 37- 65 PJ/year (= 190-330 doublets) in 2030 in the Netherlands (see Figure 5).

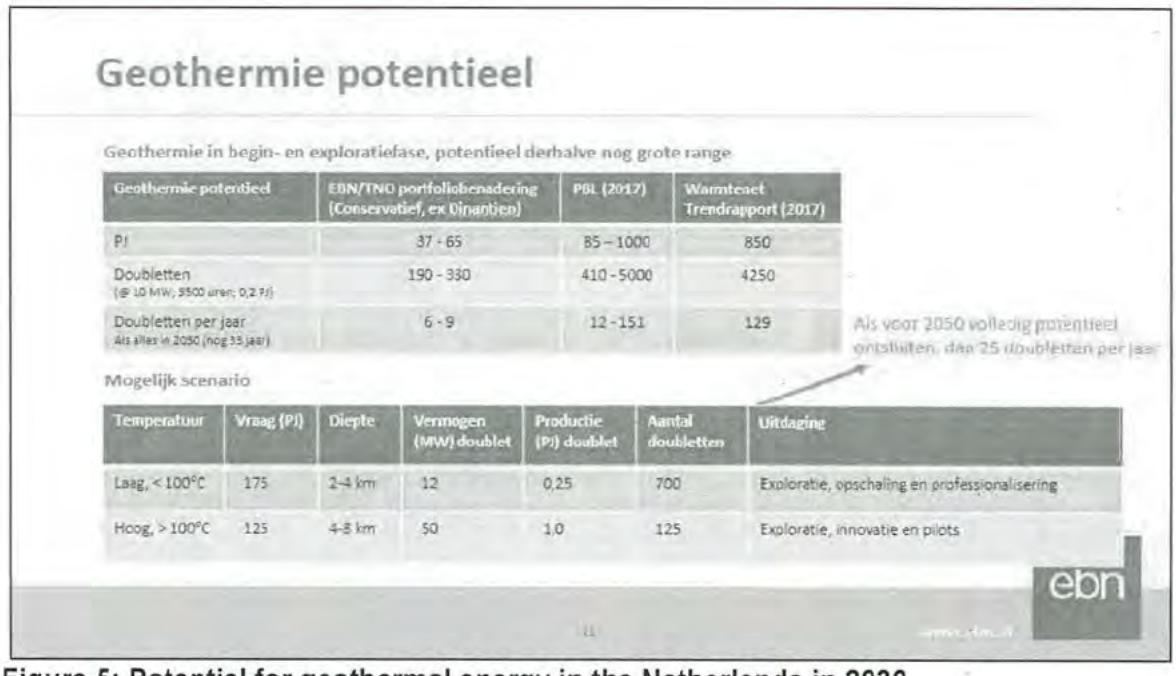

Figure 5: Potential for geothermal energy in the Netherlands in 2030

- It is expected that until 2030, at least 25% of the doublets (47) will be realized using the knowledge and technology gained by LEAN.
- The estimate of the number of doublets seems a very conservative number. Based on the heat demand in the City of Utrecht, Royal HaskoningDHV calculated[3] a total potential for 26 geothermal doublets (September 2017) for the Utrecht area only. After a successful exploration and project demonstration within LEAN, we expect at least 5 additional projects will be realized in the Utrecht area before 2025. This claim is supported by a letter of support by Eneco (see Annex 17).

The outcome of the calculation is a total SDE+ cost saving of **€ 279.180.000** till 2030.

[3] Royal HaskoningDHV, 2017. Second opinion GOUD and LEAN – Beoordeling geothermieprojecten in Utrecht. Royal HaskoningDHV, 20th October 2017 (available on request)

4.1.4 Summary table of SDE+ cost reduction

Geef eerst uw onderbouwing (tekstueel) en vat die vervolgens samen in onderstaande tabel:

Op welke specifieke SDE+ categorie heeft het project effect?	Geothermische warmte, diepte ≥ 500 m
Hoe wordt door uw project het basisbedrag verlaagd? Wat doet uw project waardoor het basisbedrag lager kan worden?	• Reduction of drilling costs and risks. • Reduction of exploration cost by reprocessing existing seismic data. • Reduction of financial risk of the first well by Portfolio approach. A conservative estimation of 2 M€ cost reduction per project (doublet) is used in the calculations.
Wat is de verwachte kostprijsverlaging? (huidige basisbedrag – verwachte nieuwe basisbedrag) *→ geef in de tekst duidelijk aan hoe u dit berekend heeft en gebruik daarbij bij het model van ECN.*	Expected SDE cost reduction is **0,006 €/kWh** (2018 SDE+ baseline cost: 0,053 €/kWh: LEAN baseline cost: **0,047 €/kWh,** see section 4.1.2)
Hoeveel daarvan komt ten goede aan de afnemers (degenen die daadwerkelijk hernieuwbare energie gaan produceren)?	100%
Waarom is het aannemelijk dat deze kostprijsverlaging bij de afnemers terecht komt?	The cost saving will lead to lower drilling costs and lower CAPEX. Geothermal operators will benefit from this.
Geef een opsomming van de aannames die u gehanteerd heeft bij de berekening van de kostprijsverlaging en de besparing op de SDE+ uitgaven. *→ Als de aannames niet duidelijk zijn, beoordeelt RVO uw onderbouwing als niet aannemelijk.*	Lowering drilling costs with 2 M€ (1 M€ per well). See section 4.1.1

Table 1: summary of SDE+ cost reduction

5 Contribution to Dutch economy

In February 2018 the Dutch Minister of Economic Affairs and Climate, Eric Wiebes, sent a policy letter[4] about geothermal energy to the House of Representatives in the Netherlands. In this letter, it was mentioned that the potential for geothermal energy can grow from the 3 PJ it is now, to 110 PJ in 2050, accounting for 14% (10% worst case, 19% best case) of the Dutch total heat demand, depending on the success of geothermal development.

According to the World Energy Council[5] around 225 PJ of geothermal energy was used for direct heat use in 2014, with China (+50%) and Europe (30%) being the largest users. Estimates of the worldwide potential of direct heat use vary from 10 (2.250 PJ) to a 100 times (22.250 PJ) the current production. The World Energy Council mentions as well that *"While estimating geothermal energy potential is difficult, the industry consensus is that growth will not be resource constrained over the next half century."*

Geothermal energy exploitation in the Netherlands is a relatively young sector, however it is developing rapidly. In 2017, there were 15 installations producing an average of 0,2 PJ of heat per installation annually. Given the physical limitations of heat transportation, geothermal energy tends to be restricted to local markets. Current installations mostly provide heat to horticultural greenhouses, and the provision of heat to the built environment is currently limited to 2 projects.

As described in section 4.1.3 it is expected that using the knowledge and technology gained by LEAN, 47 extra doublets can be developed. This brings the market potential for LEAN in the Netherlands to 47 projects or 9,4 PJ in 2030, and to 137 projects or 39,6 PJ annually in 2050 (based on a 25% market share of 110 PJ in 2050).

An overview of the three specific economical perspectives, market, strategy, finance and business case end-users can be found in Annex 16, which also match the innovations mentioned in section 6. The below table provides an overview of the sum of the economic perspectives for the Netherlands in the 5 years after the finalization of LEAN. The economic perspective of the geothermal heat market worldwide is not calculated in this table, because the scalability of geological strategies is bound to regional conditions. LEANs worldwide economical perspective can be considered larger that the Dutch economical perspective given the international presence and ambitions of the three end-users of the innovations, Huisman/WEP, TNO and ENGIE.

10.2.g

[4] Minister Wiebes Economical Affairs & Climate Beleidsbrief Geothermie (8/2/2018)
[5] https://www.worldenergy.org/data/resources/resource/geothermal/

5.1 SWOT

The following table gives an analysis of the strengths weaknesses opportunities and threats of the LEAN innovation.

Strengths: • Drill innovations (see Annex 11) reduce of drilling time, costs & risks. • Portfolio approach divides the risk of the first well over the whole portfolio of wells. Furthermore the portfolio approach quantifies the upside of the geological play • Innovative reprocessing could avoid the need for a new (expensive) seismic data acquisition, saving time and money • Consortium consisting of world class technology providers, operator, drilling company, district heating operator, a university and a R&D institute.	**Weaknesses:** • Open hole completion doesn't work in Rotliegendes. • Reprocessing is dependent on quality and accessibility of existing data.
Opportunities: • Replacing 'Groningen gas' as a source for production of (district) heating by a geothermal energy (in Utrecht already ~0.3BCM/annum) • By reducing the cost and risk, new geothermal potential in white-spot area(s) could be developed (for example in Haarlem and Amersfoort) • Innovations could be applied in other markets (e.g. oil & gas, energy storage). • Drilling innovations also suited for larger well diameters. • Political support: both the province and municipality of Utrecht endorse the LEAN project. • Play development at larger scale: commitment for 5 additional doublets / projects after 1st successful doublet.	**Threats** • Permitting takes (too) long. • Public perception avoids permitting.

Please see the section 3.5 for an overview of the risks and mitigation strategies for LEAN.

6 Innovation

The LEAN project builds on three key innovations which are described in the sub-sections below:

- 6.1 Advanced Slim hole drilling and completion
- 6.2 Innovative seismic campaign in conjunction with passive seismic and reprocessing of existing seismic
- 6.2 Portfolio approach for play development

The demonstration reference installation is considered a gas-fired boiler, which corresponds to the lowest cost non-renewable alternative to geothermal energy.

Risks related to the innovative approach have been listed in the risk matrix in section 3.

6.1 Advanced slim hole drilling and completion

LEAN integrates a number of innovations for slim hole drilling and completion of a doublet marked by relative low flow rates. These innovations are described in detail in Annex 10 and results in an expected cost saving of at least 2 M€ compared to a conventional doublet (1 M€/well). Key to 0.5 M€ per well cost savings is an innovative well design allowing to drill at smaller diameter with open-hole completion at 6' at reservoir level, which is considerably smaller than the conventional wells drilled at 7' reservoir completion. The larger diameter in conventional wells is required for sufficient room for wire wrapped screens and/or casing, which is not required in the LEAN well as the reservoir is considered sufficiently stable.

Slim hole drilling itself is not innovative, however the combination of technological innovations to manage and steer the drilling and completion process is, resulting in more safe and technically reliable drilling and completion, which results in an additional cost saving of 0.5 M€/well. The combination of key innovations related to the drilling and completion within the LEAN project comprise of:

a. Safe and reliable Slim hole drilling and completion, capable of running a full suite of logging and coring programmes.
b. Managed Pressure Drilling (MPD).
c. Enhanced Casing Installation (ECI).
d. Rotary Steerable System Drilling (ECI-RSS).
e. Open hole completion at 6' at reservoir level, suited for sufficiently high flow rates.

Section 4 and Annex 11 provide further financial and technical details respectively.

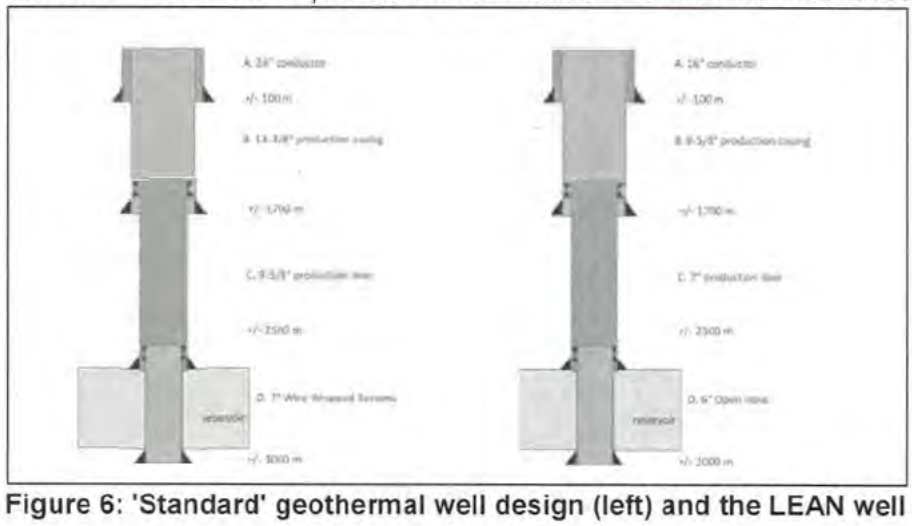

Figure 6: 'Standard' geothermal well design (left) and the LEAN well design on the right.

6.2 Innovative seismic campaign in conjunction with passive seismic and reprocessing of existing seismic

In LEAN, seismic reflection lines will be shot in conjunction with the deployment of novel passive seismic acquisition and processing using TNO's instrument pool[6] and reprocessing methods of vintage seismic data[7]. These reprocessing methods have been developed and successfully tested in the EU funded geothermal project FP7 IMAGE. The workflow includes a fast-computing algorithm that reprocesses both post- and pre-stack seismic data, which will enhance each other. The workflow is designed to provide as much information as possible on the targeted site as well as for the region, and province of Utrecht. The results of the reprocessed seismic is then tied to the new lines to passive seismic reflection tomography. The workflow saves considerable time and cost of up to 0.2 M€ per doublet, in particular when compared to shooting and interpreting new seismic.

6.3 Portfolio approach for play development

In recent years, the Netherlands has experienced a rapid development of geothermal energy, taking advantage of a wealth of knowledge from oil and gas data[8]. 15 doublets have been developed for direct heat applications in the past decade with low pre-drill risk. Few other regions in Europe have been marked by similar rapid developments, such as the Paris Basin and the Bavaria Basin. In all cases, business development appears to have been project based, in a stand-alone approach in terms of leveraging risk and revenues in an individual asset approach, i.e. the geothermal doublet system. Due to this approach, the development of geothermal energy is clustered in areas where the geothermal reservoir quality has been well proven.
In other areas the same reservoirs may be available, but the risk for a failing well is considered too high (>>10%) to take the investment decision to drill an exploration well. The proposed portfolio approach allows the development of high-risk areas (white-spot areas), through the development of multiple prospects in a collective approach targeted at a play evolution from a low (30-70%) to high probability of success (90%). In this approach, the business case is built from the trade-off between the excess financial risk of the first doublet and its Value of Information (VoI) for the successor doublets. LEAN aims to advance portfolio approaches being developed and applied by large industrial players in the oil and gas sector, and apply this approach in the geothermal energy sector for direct heat development. For the portfolio approach a number of project development and technological innovations are being developed and applied, which are critical to its success:

- *Quantitative and probabilistic methods for the estimation of Value Of Information (VoI)* - Starting from best practice from the oil and gas industry, techno-economic models will be developed for portfolio assessment in view of spatial correlation of reservoir properties, which are critical for the quality. This includes permeability, temperature, thickness, reservoir brine chemistry, and technological interdependencies associated to subsurface characteristics. To this end, a state of the art decision tree, option theory and VoI approaches[9] are modified to be used for geothermal portfolios.
- *Improved reservoir characterization based on existing oil and gas data (wells and seismic).* The geological structure (depth, thickness) and key Rotliegend reservoir characteristics, including temperature, permeability, porosity, and brine geochemistry are initially constructed from the existing mapping. The reservoir will be characterised using the interpretation of seismic, well log and core data from over 30 years of oil and gas exploration[10], in addition to a basin analysis and inclusion of models for vertical and spatial uncertainty, linked to VoI analysis. The reference model will be updated using new information from the extended coring and logging program of the first slimhole well.

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[6] Verdel et al., 2016. EGC2016, S7, Strassbourg
[7] Carpentier et al., 2016. EGC2016 S7a-4, Strassbourg
[8] Van Wees et al., 2017. Unlocking Geothermal Energy from Mature Oil and Gas Basins: a success story from the Netherlands. ICL Press.
[9] Van Wees et al., 2008, AAPG Bulletin
[10] Pluymaekers et al., 2012. Netherlands Journal of Geosciences 91-4, 621-636.

7 Knowledge dissemination and Intellectual Property

On November 29th 2017 the first regional Seminar on Geothermal Energy was held in Utrecht, on the initiative of Gemeente Utrecht and Provincie Utrecht. This seminar was aimed at organisations and individuals with professional interest in development of geothermal energy as a possible source for sustainable energy. This seminar is considered to be the starting point of a regional network of stakeholders. The results of this LEAN project will be a very interesting topic for sharing knowledge in the coming years.

The LEAN consortium will develop a communication strategy in order to inform and get the interest and support of the general public in the Utrecht area. Special attention will be paid to establishing a dialogue with residents in the direct vicinity of drilling locations.
The LEAN project approach is highly relevant for other municipalities and regions with a heat demand in the Netherlands and abroad. The Ministry of Economic Affairs and Climate has identified a number of white-spot area's (areas with limited geological data but with a demand for heat).

TNO and EBN will organize a knowledge sharing event for stakeholders in these white-spot area's including municipalities, operators of heat networks and potential geothermal operators.
The LEAN consortium aims to share the results during the 2 main conferences on Geothermal energy in the Netherlands (Delfts Aardwarmte congress & Energy conference Westland).

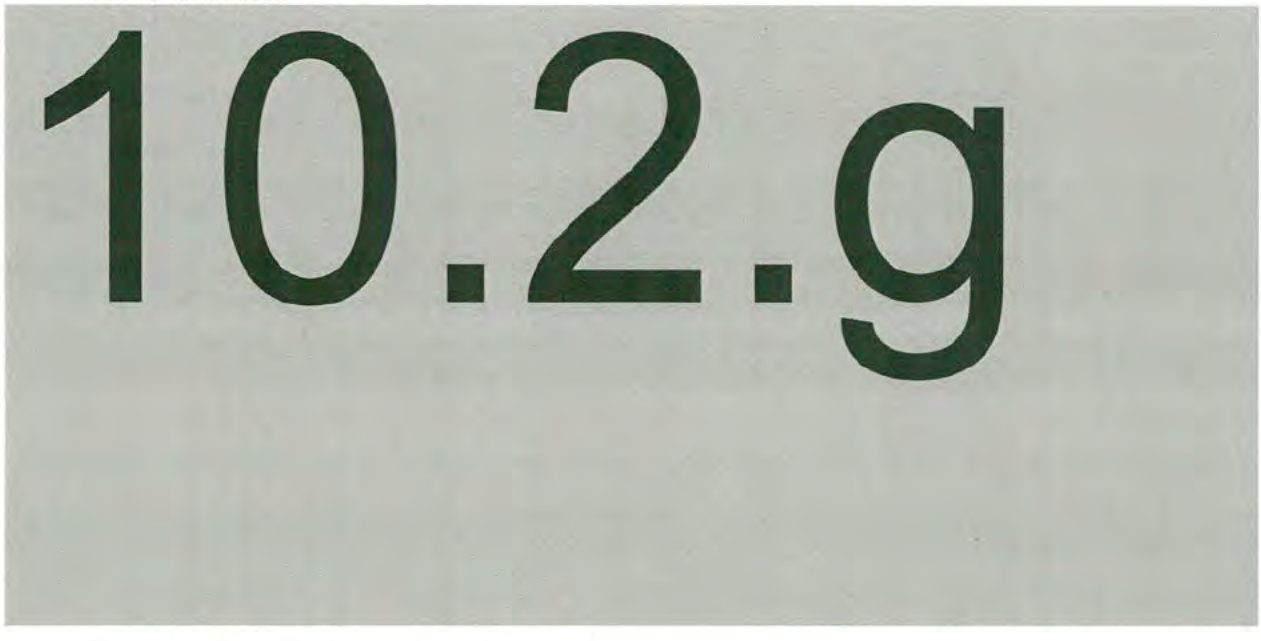
Furthermore the LEAN consortium aims to organize meetings with the Vereeniging van Nederlandse Gemeenten (VNG) and the Interprovinciaal Overleg (IPO). LEAN will organize a boothh and presentation (if accepted) at the two main geothermal conferences in Europe (Geotherm Offenburg and the European Geothermal Conference (EGC) in Strasbourg).

Intellectual Property:
The goal of the project is to de-risk the area. Therefore, it is the intention of the consortium to make all relevant project information public after the project. Knowledge already in possession of partners at start of the project, will stay IP of those partners. These starting points will be further detailed in the consortium agreement.

8 Financing of own part in project budget

The estimated cost (budget) of the of the proposal are given in a separate excel file: @LEAN-RVO-4-Begroting-v2018.02.21-confidential.xls. Detailed cost estimations of the large cost elements are given in Annex 14. A summary of the cost, including the financing of own part in the project budget is given in below tables, which show per party:

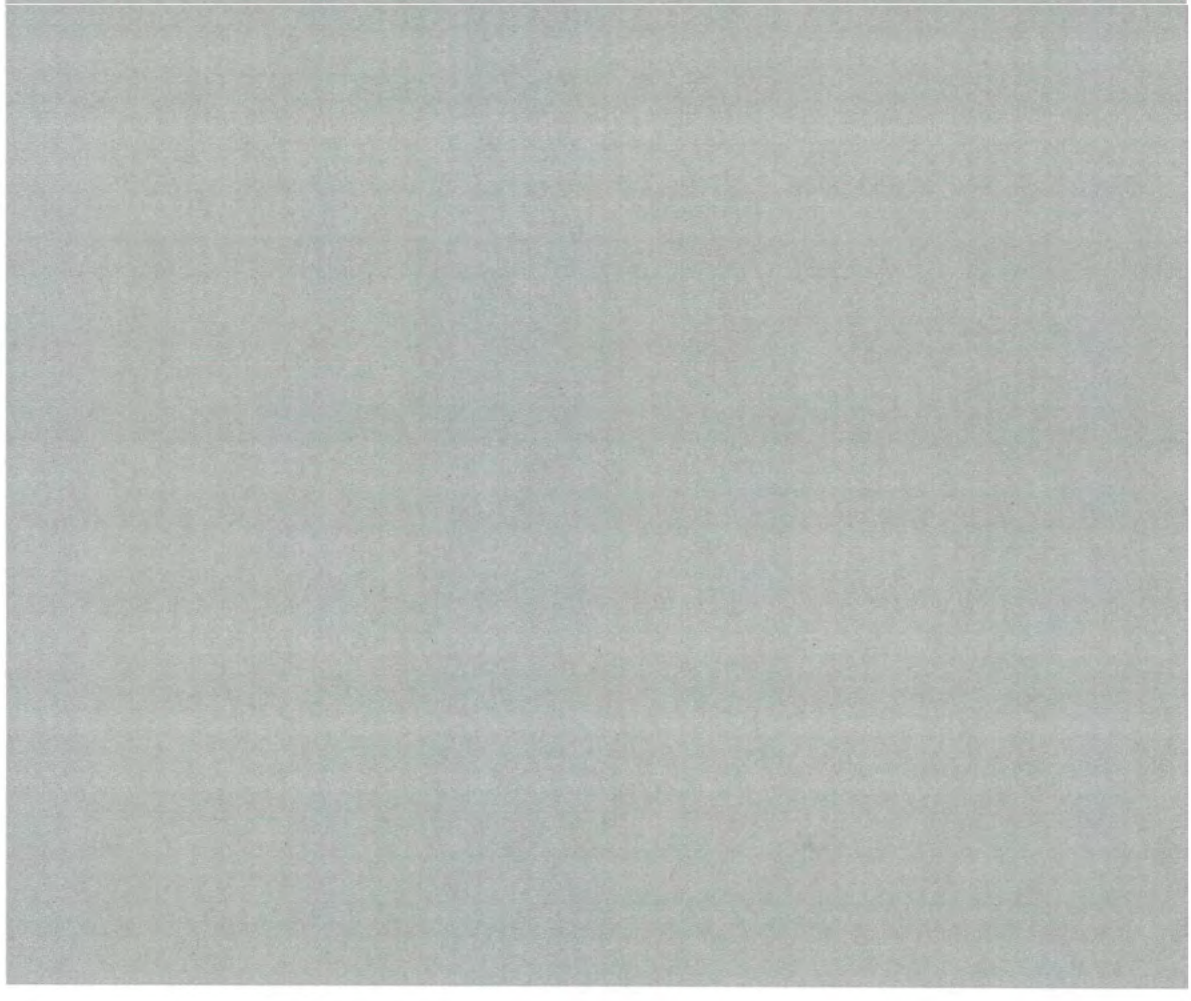
- Budget.
- Subsidy.
- In-Kind contribution (Budget minus Subsidy).
- In-Cash distribution (+ means pay; - means receive).
- Net contribution.



The following should be noted:

- All Demonstration cost are allocated to ENGIE and will later be allocated to a LEAN-SPV (see section 1.2.11).
- The In-Kind contribution of ENGIE are financed by limited In-Cash contributions of EBN, Eneco and TNO plus a subordinated loan of Gemeente Utrecht and Provincie Utrecht. The remainder is financed equally by ENGIE & Huisman (the foreseen stakeholders of the LEAN-SPV).
- TNO covers its own In-Kind cost (336 k€) + invests extra 196 k€ to obtain a geothermal field-lab.
- UU covers its own In-Kind cost.
- The table calculates the Requested Subsidy. However, since the Hernieuwbare Energie subsidy is limited to 6 M€, the In-Cash distribution covers the difference (848,350 €).
- Detailed information per Milestone Period is given in the following table.
- If the LEAN project becomes an economic success, TNO will withdraw and get back 400 k€ (In-Cash contribution + partly compensation of In-Kind contribution). The reason for this is that TNO is contributing an amount of 400 k€ to contribute to the risk coverage of the first two phases of the project.
- If the LEAN project is not an economic success, the parties will receive the remainder of their In-Cash contributions (if any).

10.2.g



9 Annex: Work package descriptions

WP1: Pre-drill exploration	
WP leader:	ENGIE
Duration	M1-M18

Objectives

The objectives of this WP are:

- Evaluation of the Rotliegend reservoir in de Utrecht area. Seismic interpretation of overburden and target level including faults using advanced (passive) seismic campaign and reprocessing of seismic data and geostatistical concepts. Enhanced reservoir characterization through well logging, coring and testing.
- Identification of optimal target locations at target depth (creating a Rotliegend project portfolio) to optimally de-risk the Rotliegend reservoir for the entire play and safely position wells.
- Evaluate the surface possibilities (feed in to heat network, surface obstructions, permits) and possibilities and preliminary cost estimates for well trajectory / design, leading to a site selection.
- Integrate all and define an optimized exploration strategy for the Rotliegend play in Utrecht region using the Vol toolset.
- Develop a business case
- To create a project portfolio and an optimized exploration strategy for the Rotliegend in the Utrecht area.

Description of work and role of partners

Task 1.1 Management and permitting (ENGIE, with support of all**)**

- Administrative issues management
- Financial issues management
- Legal issues Management
- SDE+ and RNES application
- Risk Management (see section 3.5)
- Meetings organization
- Deliverables to RVO-HE

Task 1.2 Play characterization (TNO, UU, ENGIE)

- Advanced seismic reprocessing
- seismic campaign including passive seismic
- Subsurface mapping / geological model (overburden, depth, faults) using results of seismic reprocessing
- Enhanced reservoir characterization (porosity, permeability, temperature), using advanced geostatistical models for spatial correlation of properties like poro-perm relationship
- Integrate results and create a project portfolio (subsurface focus)
- Determine geothermal power expectation curve for a slimhole doublet, and probability of success (POS).

Task 1.3 Business case and Vol tool development (TNO, ENGIE, EBN, Eneco)

- Vol tool development and business case
- Application of Vol toolkit to project portfolio (as developed in 1.2)
- Design of workflow (enhancement of DoubletCalc, business calculation sheet, Bayesian Vol tool and decision trees for portfolio of prospects), highlighting trade-off of high risk in first slimhole wells, and Vol for remainder of portfolio

- Enhanced reservoir geostatistics for POS and Vol (cf. Trumpy et al., 2016)
- Bayesian belief network based Vol tool (cf. Van Wees et al., 2008)
- Modification of DoubletCalc, reference business calculation sheet, incorporation of Vol in business case analysis

Task 1.4 Surface location selection

- Subsurface target selection, surface site selection and well path selection including embedding in heat network options
- Preliminary business case and Vol
- Permit/location/property
- Subsurface engineering options

Task 1.5: Well design (**WEP**, ENGIE, HUISMAN)

- Design of the exploration slimhole, including Managed Pressure Drilling (MPD) and Enhanced Casing Installation (ECI), to be drilled under WP2: Slimhole exploration drilling), as well as a preliminary design for the additional doublet well to be drilled in WP3: Doublet demonstration.
- Ensure a proper drilling program including all prevention and mitigation measured for all relevant risks. Both MPD and ECI cover multiple steps of the well construction process and affect the processes and materials used and each other. Hence, a good understanding of the technologies with respect to the specific objectives and regulatory body requirements (from SodM) of the project is needed from the initial concept well design
- Design and later operational lessons need to be registered accurately to ensure proper follow up in future geothermal wells.

Task 1.6: Well logging, coring and test plan (**WEP**, EBN, ENGIE, TNO)

- The most important reservoir parameter to be established is the permeability. Hence, the wireline logs that are suitable for measuring (indirectly) permeability are the most important ones. These include neutron density and NMR. Furthermore, sonic (well to seismic, time-depth relationship and conversion), gamma and laterolog (reservoir, lithology, net-to-gross) and PLT (productive zones within the reservoir) are highly desirable.
- Further, in order to better judge the relevance of the determined reservoir quality of the exploration well, it is important that not only log data is taken, but also rock samples (core) to assess the nature – whether it is primary or secondary (fracture) permeability, and what other rock properties (mineralogy, diagenetic history) play a role for the permeability.
- Apart from the 'standard' suite of logs, the acquisition of a temperature log (Distributed Temperature Sensing DTS) is envisaged. These logs, well known from oil and gas industry, are surprisingly still a novelty in the geothermal industry. Rather than temperature recordings from a single depth, a DTS records the entire temperature profile at high resolution, This yields a wealth of data that is directly related to the thermal properties of the rocks, not only the reservoir but preferably also the overlying strata. The thermal properties can therefore be estimated more accurately, and used to improve the 3D temperature model of the Netherlands, leading to a more accurate prediction of the geothermal potential.
- In order to test the well flow performance, air lift testing is planned. A well test is also a requirement for SDE+ / RNES.

Task 1.7: Pre-drill business case and Vol in Utrecht region (**TNO,** EBN, Eneco, ENGIE, TNO, UU, WEP)

- Detailed cost engineering based on well design
- Evaluation of well performance enhancement options (e.g. radials, acidizing)

- Business calculation evaluation
- Decision tree and VoI for prospect portfolio
- Preparation for go/no go exploration slimhole

Task 1.8: Communication (GU, TNO, ENGIE, PU)
- Write communication plan
- Execute communication plan

Task 1.9: Dissemination (TNO, with support of all**)**
- Within the Consortium:
- Outside the Consortium:
  - The LEAN project approach is highly relevant for other municipalities and regions with a heat demand in the Netherlands and abroad. The ministry of economic affairs has identified a number of white-spot area's (areas with limited geological data and heat demand). TNO and EBN will organize a knowledge-sharing event for stakeholders in these white-spot area's including municipalities, operators of heat networks and potential geothermal operators.
  - Furthermore, the LEAN consortium will develop a communication strategy in order to inform the general public in the Utrecht area.
  - The LEAN consortium aims to share the results during the 2 main conferences on Geothermal energy in the Netherlands (Delfts Aardwarmte congress & Energy conference Westland).
  - Furthermore, the LEAN consortium aims to organize meetings with the VNG and IPO
  - LEAN will organize a booth and presentation (if accepted) on to the two main geothermal conferences in Europe (Geotherm Offenburg and the European Geothermal Conference (EGC) in Strasbourg.

List of Deliverables	
D1.1	Management reporting (ENGIE, M18)
D1.2	Business case & VoI tools and tools report (TNO, M12)
D1.3	Pre-drill Enhanced reservoir characterization report (TNO, M12)
D1.4	Site selection report (TNO, M15)
D1.5	Well Design Report (WEP, M18)
D1.6	Well logging, and coring and Test Plan (WEP, M18)
D1.8	Pre-drill business case & VoI analysis report (TNO, M15)
D1.9	Communication plan report (GU, M12)
D1.10	Dissemination reports (TNO, M18)
List of Milestones	
MS1	go/ no go for exploration slimhole drilling and testing WP2 (ENGIE, M18)

WP2: Slimhole exploration (1st well)	
WP leader:	ENGIE
Duration	M18-M24

Objectives

The objectives of this WP are:

- Perform site preparation
- Construct a slimhole
- Well logging, coring and testing
- (Abandon slimhole in case of failure and potentially use as permanent research well)
- Incorporate slimhole data into update of reservoir characterization, and re-evaluation of business case and portfolio VoI
- Go/ no go for demonstration phase
- Communication and dissemination

Description of work and role of partners

Task 2.1: Management (**ENGIE,** with support of all)

- Administrative issues management
- Financial issues management
- Legal issues Management
- Risk Management (see section 3.5)
- Meetings organization
- Deliverables to RVO-HE.

Task 2.2: site preparation (**ENGIE**, Eneco, Huisman)

- construction and preparation of the site for drilling the exploration slimhole

Task 2.3: Well Construction (**WEP**, Huisman)

following the design of D1.4

- The top hole will be drilled with the Enhanced Casing Installation (ECI) system to ensure that the casing is set at the deepest depth possible in the relatively small hole size. The Enhanced Casing Installation installs casing while drilling and minimises the open hole time and the associated risks.
- The complete well will be drilled using the integrated and semi-automated Managed (underbalanced) Pressure Drilling (MPD), to enhance drilling speed and borehole integrity while drilling, and to prevent unsolicited infiltration of mud in the reservoir zone
- The bottom reservoir is completed open hole to preserve a maximum inflow diameter

Task 2.4: Well logging and coring, testing (**ENGIE**, EBN, ENGIE, HUISMAN, TNO, WEP)

- The well will be logged and cored and tested in 2 ways: by logging and a flow test. The flow test (as designed in D3.2). is to be executed by air lift as it will be more cost efficient. An important part of the test will be to determine the amount of sand being produced.

Task 2.5: Business case & portfolio update for slimhole information (**TNO**, UU, Eneco, ENGIE, Huisman)

- Update of thermal model based on DTS information
- Update Advanced geostatistical models based on slimhole logging and coring information
- Business calculation re-evaluation / Decision tree and VoI for prospect portfolio
- Preparation for go/no go demonstration slimhole

Task 2.6: Communication (GU, TNO, ENGIE, PU)

- Update communication plan
- execute communication plan

Task 2.7: Dissemination (TNO, with support of all)

- Within the Consortium:
- Outside the Consortium:
  - The LEAN project approach is highly relevant for other municipalities and regions with a heat demand in the Netherlands and abroad. The ministry of economic affairs has identified a number of white-spot area's (areas with limited geological data and heat demand). TNO and EBN will organize a knowledge-sharing event for stakeholders in these white-spot area's including municipalities, operators of heat networks and potential geothermal operators.
  - Furthermore, the LEAN consortium will develop a communication strategy in order to inform the general public in the Utrecht area.
  - The LEAN consortium aims to share the results during the 2 main conferences on Geothermal energy in the Netherlands (Delfts Aardwarmte congress & Energy conference Westland).
  - Furthermore, the LEAN consortium aims to organize meetings with the VNG and IPO
  - LEAN will organize a booth and presentation (if accepted) on to the two main geothermal conferences in Europe (Geotherm Offenburg and the European Geothermal Conference (EGC) in Strasbourg.

List of Deliverables	
D2.1	Management reporting (ENGIE, M124)
D2.2	Site preparation report (ENGIE, M24)
D2.3	Well Construction report (WEP, M24)
D2.4	Well Test report (WEP, M24)
D2.5	Exploration slimhole update: Enhanced reservoir characterization, Business Case & Vol report (TNO, M24)
D2.6	Updated communication plan (GU, M24)
D2.7	Dissemination reports (TNO, M24)
List of Milestones	
MS3	Go/no go demonstration phase WP3 (All, M24)

WP3: Demonstration (2nd well)	
WP leader:	ENGIE
Duration	M24-M36

Objectives

The objectives of this WP are:

- To construct a doublet (using the first slimhole)
- To test the doublet
- (To abandon the doublet in case of non-success)
- Incorporate slimhole data into update of reservoir characterization, and re-evaluation of *business case* and *portfolio VoI*
- Communication and dissemination

Description of work and role of partners

Task 3.1: Management (ENGIE)

- Administrative issues management
- Financial issues management
- Legal issues Management
- Risk Management (see section 3.5)
- Meetings organization
- General Assembly Meetings
- Deliverables

Task 3.2: Well Construction (WEP, Huisman)

- The Well Construction will be done as much as possible using the same techniques as the slimhole design although they will probably deviated.
- Following the design of D3.1
- The top-hole will be drilled with the Enhanced Casing Installation (ECI) system to ensure that the casing is set at the deepest depth possible in the relative small hole size. The Enhanced Casing Installation installs casing while drilling and minimize the open hole time and the associated risks.
- The complete well will be drilled using the integrated and semi-automated Managed (underbalanced) Pressure Drilling (MPD), to enhance drilling speed and borehole integrity while drilling, and to prevent unsolicited infiltration of mud in the reservoir zone
- The bottom reservoir is completed open hole to preserve a maximum inflow diameter

Task 3.3: Well logging and coring, testing (ENGIE, EBN, ENGIE, HUISMAN, TNO, WEP)

- The well will be logged and cored and tested in 2 ways: by logging and a flow test. The flow test (as designed in D3.2, except DTS). is to be executed by air lift as it will be more cost efficient. An important part of the test will be to determine the amount of sand this being produced

Task 3.4: Demonstration slimhole update (TNO, UU, Eneco, ENGIE, Huisman)

- Update Advanced geostatistical models based on slimhole logging and coring information
- Business calculation re-evaluation / decision tree and VoI for prospect portfolio

Task 3.5: Installation and connections (ENGIE, Eneco)

- Installation of the surface facilities for the doublet system and connection to the heat network

Task 3.6: Communication (GU, TNO, ENGIE, PU)

- update communication plan
- Execute communication plan

Task 3.7: Dissemination (TNO, ENGIE, UU)

- Within the Consortium:
- Outside the Consortium:
  - The LEAN project approach is highly relevant for other municipalities and regions with a heat demand in the Netherlands and abroad. The ministry of economic affairs has identified a number of white-spot area's (areas with limited geological data and heat demand). TNO and EBN will organize a knowledge-sharing event for stakeholders in these white-spot area's including municipalities, operators of heat networks and potential geothermal operators.
  - Furthermore, the LEAN consortium will develop a communication strategy in order to inform the general public in the Utrecht area.
  - The LEAN consortium aims to share the results during the 2 main conferences on Geothermal energy in the Netherlands (Delfts Aardwarmte congress & Energy conference Westland).
  - Furthermore, the LEAN consortium aims to organize meetings with the VNG and IPO
  - LEAN will organize a booth and presentation (if accepted) on to the two main geothermal conferences in Europe (Geotherm Offenburg and the European Geothermal Conference (EGC) in Strasbourg.

List of Deliverables	
D3.1	Management reporting (ENGIE, M36)
D3.2	Well Construction report (WEP, M27)
D3.3	Well Test report (WEP, M28)
D3.4	demonstration slimhole update: Enhanced reservoir characterization, Business Case & Vol report (TNO, M36)
D3.5	Installation and connection best practice report (ENGIE, M36)
D3.6	Updated communication plan (GU, M30)
D3.7	Dissemination reports (TNO, M36)
List of Milestones	
MS4	Final Review (ENGIE, M36)

10 Annex: Business Case

One of the main issues in developing a geothermal energy project is the lack of reliable data of subsurface characteristics. This is especially an issue in areas where there is a lack of data from exploration drillings in the past. This makes the uncertainty of geothermal potential high and such areas are called 'white-spots'.

One of these white-spots in the Netherlands is Utrecht. In Utrecht there is a gas-fired district heating in place in which geothermal could be a game-changer in greening the district heating networks of Eneco. Eneco has identified the potential of geothermal heat sources with a combined power of 30MWth.

However, given the uncertainties about the potential geothermal potential there is a lack of interest to invest in geothermal exploration even if available stimulatory measures such as RNES and SDE+ would be applied.

The business case for LEAN has been evaluated by Doubletcalc (www.nlog.nl) to assess the technical performance of the system, and these results have been fed in a discounted cashflow model (DCF) to evaluate the financial performance of the first and successor doublets, which could feed the Eneco heat network. A snapshot of the expectation curve for geothermal power of the first doublet is given in Figure 7. The input numbers for depth, thickness and temperature of the reservoir are based on thermoGIS (www.thermogis.nl) and the probability density curve of permeability is based on wells in the Utrecht province. For Doubletcalc and the CAPEX in the DCF calculations, the well technical and cost parameters are based on the innovative well design and open-hole completion proposed in LEAN (cf. Appendix 11) and coring and logging plan (cf. appendix 12).

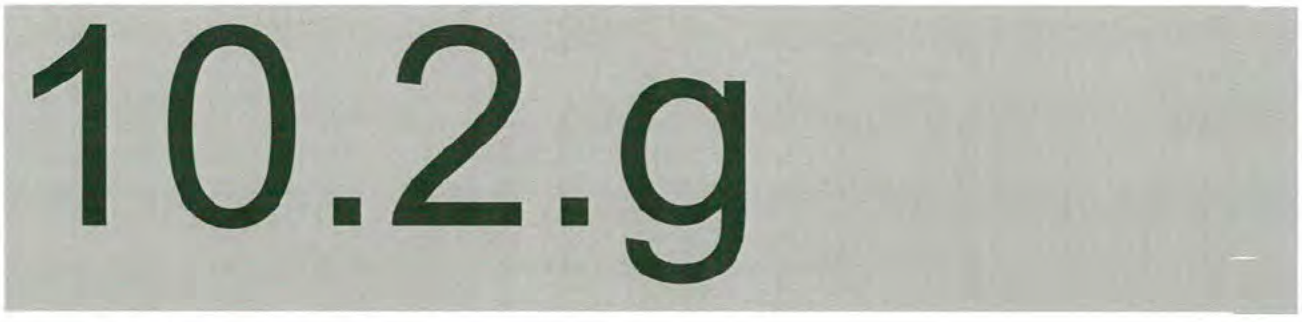
10.2.g

For other parameters we used input from experts from the partners.

The CAPEX of phase 1 includes the potential costs of including an additional seismic survey, if the reprocessing of vintage seismic would not be sufficient.

10.2.g

In phase 2, the first well will be drilled without application of RNES as the market risk would be too high. This is reflected in the very high exit costs after the second phase (end node 2 in the tree). In case the first well is successful it is assumed that the second well can be drilled with RNES, resulting in relatively low exit costs if that second well would fail (end node 3). Abandonment costs for the wells is budgeted at 325 k€ for each well. The tree represents a larger than 50% probability that the doublet will not be successful due to lower than anticipated power (P50 characteristics).



Offset of business case against business as usual

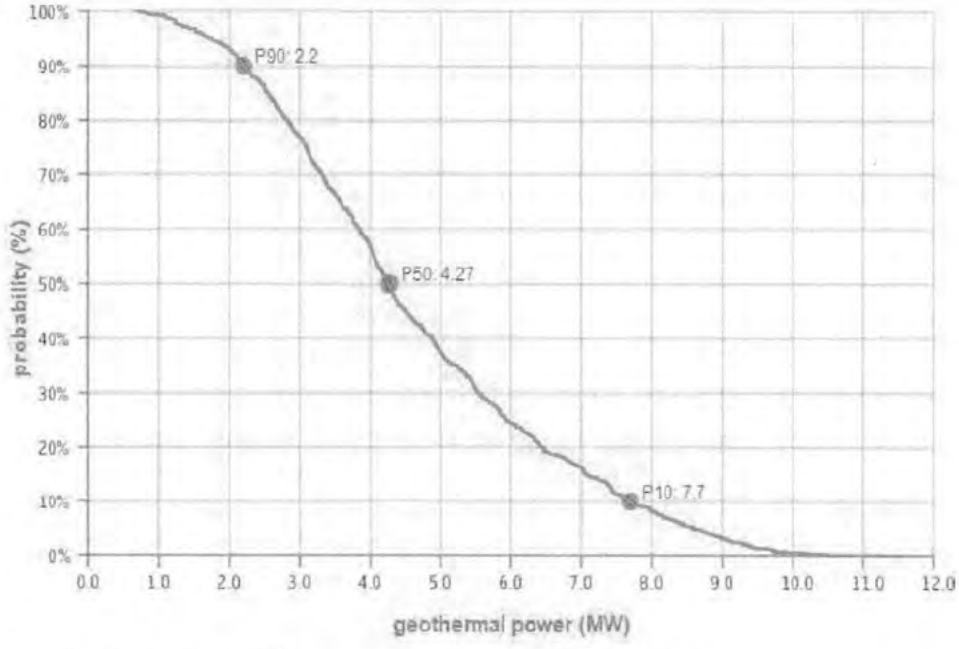
Future refinement of the business case

The business case for LEAN at this stage is a discounted cashflow model (DCF) which needs further refinement in the next phases of the project.

To further define the business case in the next stage the LEAN project requires a further specification of at least the following points of interest for the consortium:

- The contractual framework (especially the off taker contract) that has to be developed;
- More insights around the firmness of the expected production and drilling risks;
- Assumption check and sensitivity analyses as one of the first next steps in the project.
- Further remarks on the calculation of the Sellers case at the moment
- Sensitivities on the pricing used must be checked;
- Detailed information on the SDE+ decision and the application of RNES guarantee fund must be checked;
- Exact clarification of all the detailed lines in DCF calculation;

[11] Risk is defined as the expected loss in the project (= chance of losing multiplied by amount lost)



Geotechnical input

A) Aquifer properties

Property	min	median	max
aquifer permeability (mD)	20	100	300
aquifer net to gross (-)	0.9	0.95	1
aquifer gross thickness (m)	80	120	130
aquifer top at producer (m TVD)	2250.0	2500	2750.0
aquifer top at injector (m TVD)	2250.0	2500	2750.0
aquifer water salinity (ppm)	100000	120000	140000

Property	value
aquifer kh/kv ratio (-)	5
surface temperature (°C)	10
geothermal gradient (°C/m)	0.031
[mid aquifer temperature producer (°C)]	0
[initial aquifer pressure at producer (bar)]	0.0
[initial aquifer pressure at injector (bar)]	0.0

B) Doublet and pump properties

Property	value
exit temperature heat exchanger (°C)	50
distance wells at aquifer level (m)	1000
pump system efficiency (-)	0.65
production pump depth (m)	500
pump pressure difference (bar)	50

C) Well properties

calculation length subdivision (m) 50

Producer	
outer diameter producer (inch)	6.125
skin producer (-)	0
penetration angle producer (deg)	0
skin due to penetration angle p (-)	0.0

Segment	pipe segment sections p (m AH)	pipe segment depth p (m TVD)	pipe inner diameter p (inch)	pipe roughness p (milli-inch)
1	500	500	6	1.2
2	1700	1700	9.625	1.2
3	2500	2500	6	1.2

Injector	
outer diameter injector (inch)	6.125
skin injector (-)	0
penetration angle injector (deg)	45
skin due to penetration angle i (-)	-0.46

Segment	pipe segment sections i (m AH)	pipe segment depth i (m TVD)	pipe inner diameter i (inch)	pipe roughness i (milli-inch)
1	1700	1700	9.625	1.2
2	3000	2500	6	1.2
3				

Figure 7: (top) Preliminary technical evaluation of the expectation curve of expected power based on (bottom) well design and constraints of Eneco's heat network. Snapshots from DoubletCalc (default used for RNES and SDE+ applications)

10.2.g

Table 2: CAPEX assumptions of LEAN. For the first doublet decomposition is shown into financial contribution from SPV, HER, and loan and sponsoring contributions from partners

10.2.g

Table 3: OPEX and revenues/turnover parameters for P50 (top) and P20 (bottom) for the first doublet

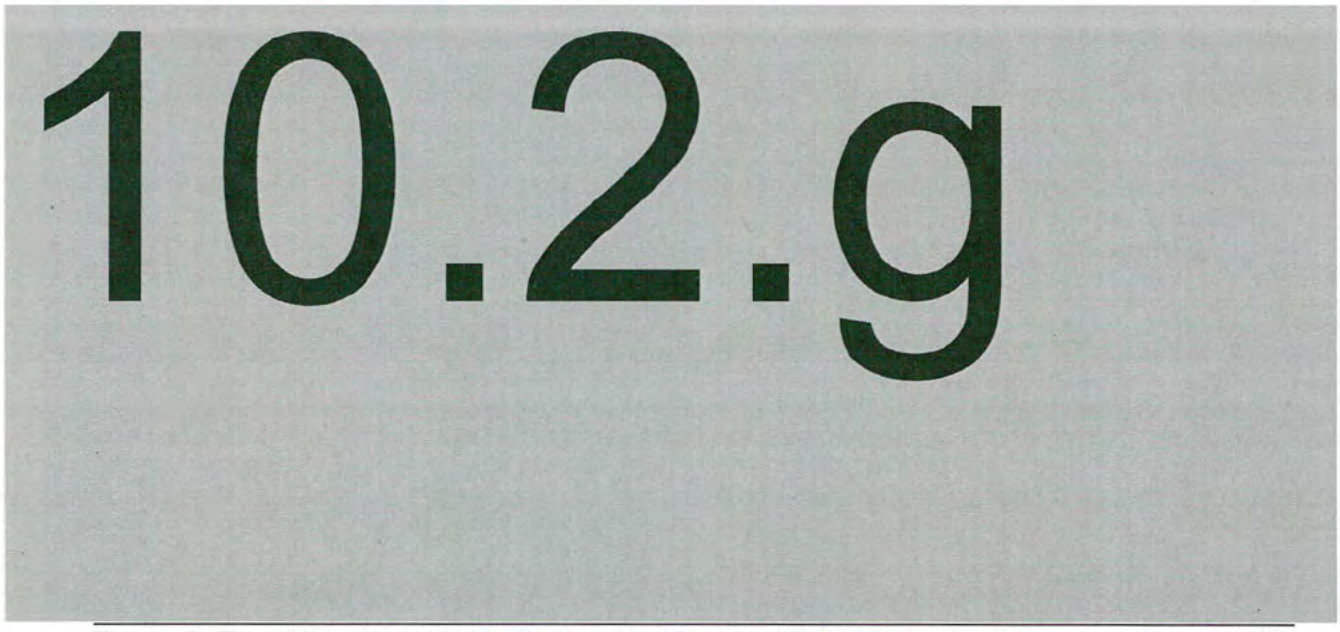


Figure 8: Event tree to evaluate the business case of LEAN. The business case is marked by positive NPV outcomes in case of demonstration of P50 or better performance (cf Figure 7). These performances have been represented in a conservative approach with the P50 and P20 characteristics for revenues (Table 3). The vertical lines correspond to four go/no go moments, the first representing the successful evaluation of the project proposal, and the following two go/no go 's at the end of the first and second phase of the LEAN project. The last go/no go decision corresponds to the evaluation of the performance of the second well.

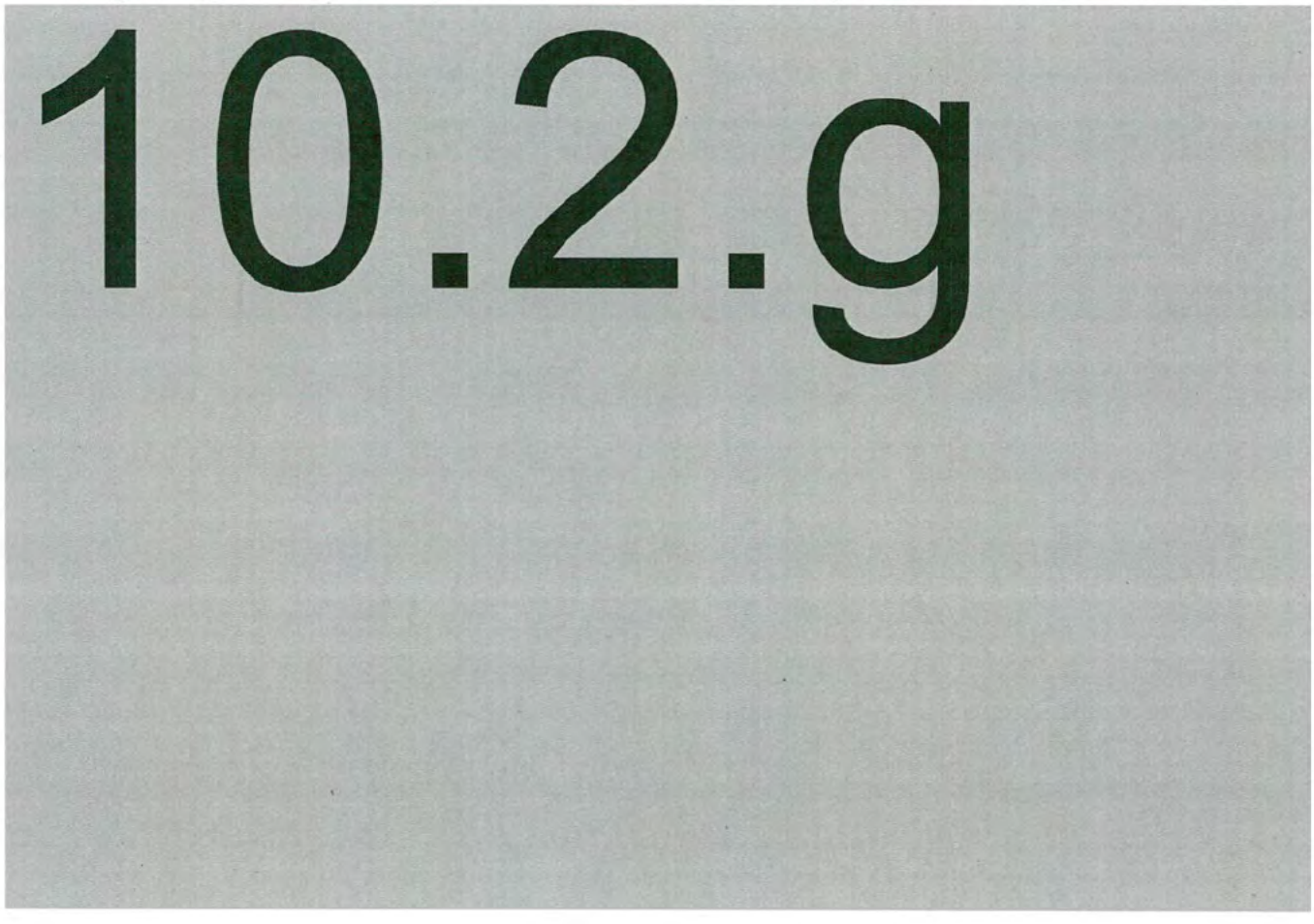


Table 2), and OPEX and revenues of the LEAN project (cf Table 3) , in timelines and phases in accordance to four go/ no go moments depicted in Figure 8.

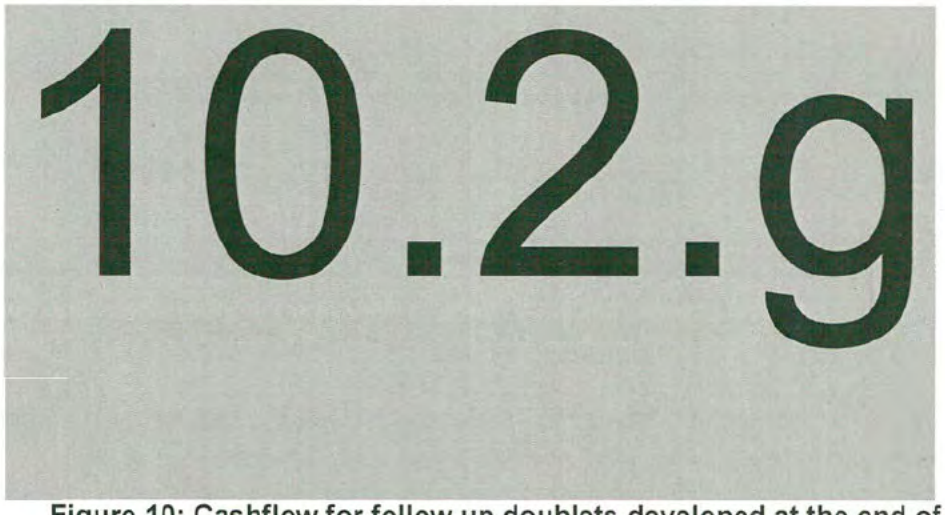


Figure 10: Cashflow for follow up doublets developed at the end of LEAN.

11 Annex: Drill innovations

Huisman Equipment and Huisman Well Technology (HWT) are working on drill innovations that de-risk the drilling operations while increasing the efficiency. The used approach is to simplify and/or increase control over the various steps in the well construction process to make it possible to integrate with the drilling rig. The drill innovations apply to various steps where typically multiple service providers are being used for but thanks to automation are now being provided by the rig which will increase efficiency with significant cost reductions as result. In this case the technology enables drilling of a smaller sized hole without increasing drilling risks.
The different drill innovations are elaborated in the following sections:

- Slim hole drilling
- Enhanced Casing Drilling
- Managed Pressure Drilling
- Rotary Steerable System
- Open hole completion

11.1 Slim hole drilling

The *slimhole*/lean well design is made one size smaller than normally done which is possible thanks to the *open-hole completion* (Figure 6). An open-hole completion is possible because it is expected that the Rotliegend formation is stable enough to handle. Slimming down the well design results in a cost saving of about 500k€ because a smaller hole is drilled resulting in less cutting to dispose and higher drilling rates and less steel for casing and cement is needed. However, a smaller well will increase the pressure induced drilling risks which account for almost 50% of all non-productive time causing events what will be mitigated by the MPD system in the deeper sections.

11.2 Managed Pressure Drilling (MPD)

Managed Pressure Drilling (MPD) is a high-tech system that is used to drill difficult wells that require special mud pressure control e.g. slim well designs. HWT is working on an integrated and (semi)-automated system including the required redundancies to allow the drilling crew with a minimum of extra staff to operate it. The two different predictive flow models that are used in combination with coordinated pump control provide an exceptional fast responding, safe and accurate MPD system. That result in higher drilling rates (>30%), more accurate influx detection but maybe most important: minimal reservoir damage.

Figure 11. MPD choke skid

The MPD system allows to drill the reservoir section at or under-balance. This means that any solids in the mud or in the reservoir are not squeezed into the reservoir and that the reservoir fluid is already moving towards the well bore. This will prevent any solids related skin effects in the well bore. The MPD system reduces the cyclic pressure loading of the mud on the formation which is especially useful in slimhole applications where the relative large pressure variations cause borehole stability problems.

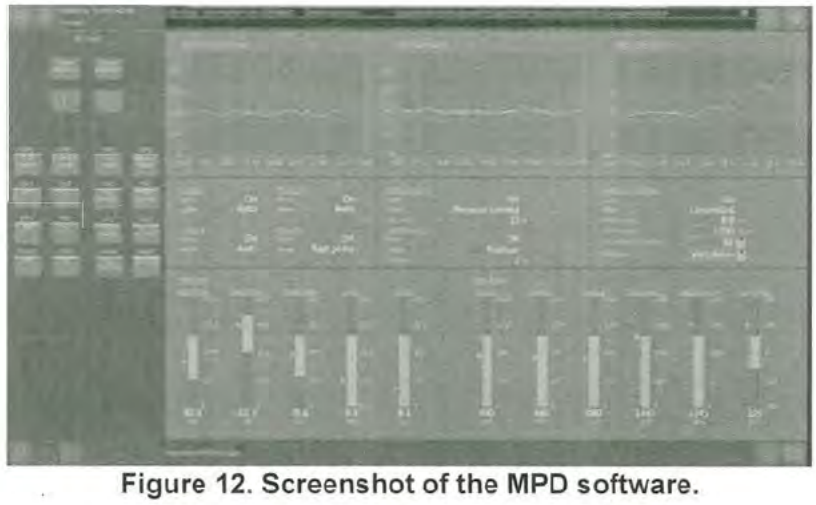


Figure 12. Screenshot of the MPD software.

MPD is used in oil and gas wells with tight pressure regimes e.g. deepwater wells It will be the future standard drilling technology as well for land drilling. MPD systems are offered by specialized service companies and typical service requires currently a number of experienced operators to install the system on the rig for each well and to manage it while drilling by verifying the various measurements vs. expected values. Typically, adjustments in drilling parameters require manual validated adjustments hence changes such as making a drilling connection are time consuming while delays are minimal with an integrated system. So, by seeing the MPD system as part of the rig instead of as a separate, both hardware as software connections can be built making the whole workflow a lot simpler.

11.3 Enhanced Casing Installation (ECI)

The *Enhanced Casing Installation (ECI)* installs casing while drilling and minimises the open hole time and the associated risks. At the required depth, the drilling assembly is being pulled out by the heavy-duty winch that is part of the Huisman rig. The for ECI required casing drive, multi-size pipe handler and winch are all part of the LOC400 and controlled by the driller. This allows a level 3 casing drilling to operate at cost level similar to conventional drilling but with a significant reduced risk and well construction time. The ECI system has already been demonstrated on a geothermal well in the Netherlands but this time the complete integrated system will be employed and combined with MPD.

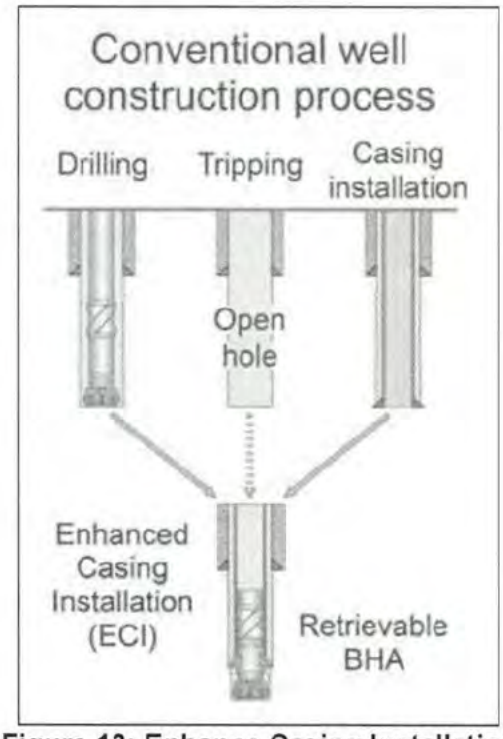


Figure 13: Enhance Casing Installation

ECI with its BHA placement inside the bottom of the casing eliminates additional holes to be drilled but mainly the risk of getting a stuck drilling assembly what makes the drilling assembly retrievable by cable. This was demonstrated with TRECIT where the assembly was retrieved with 1800 m/hrs where the rig achieved maximum 250 m/hrs. From the TRECIT project it was also concluded that costs had to be lowered by integration and the requirement of a more efficient way to install a liner which is scheduled for LEAN. The steering tool will also be used which will enable automated directional drilling with a tool requiring an absolute minimum of maintenance. No steering tool specifically for casing design exists in the drilling industry.

Figure 14. Overview of typical ECI drilling assembly components.

11.4 Rotary Steerable System (ECI-RSS)

An important and unique addition to the ECI system is a rig integrated *Rotary Steerable System* (RSS) i.e. the rig will automatically and continuously steer the full-mechanical RSS by altering top-drive speed. Although developed for deviated wells, the technology is well suited to drill vertical as well. The tool is specifically designed for ECI and is cheaper to build, to operate and to maintain when compared to conventional Rotary Steerable equipment and mud motors. Similar to all RSS tools, drilling performance is maximized.

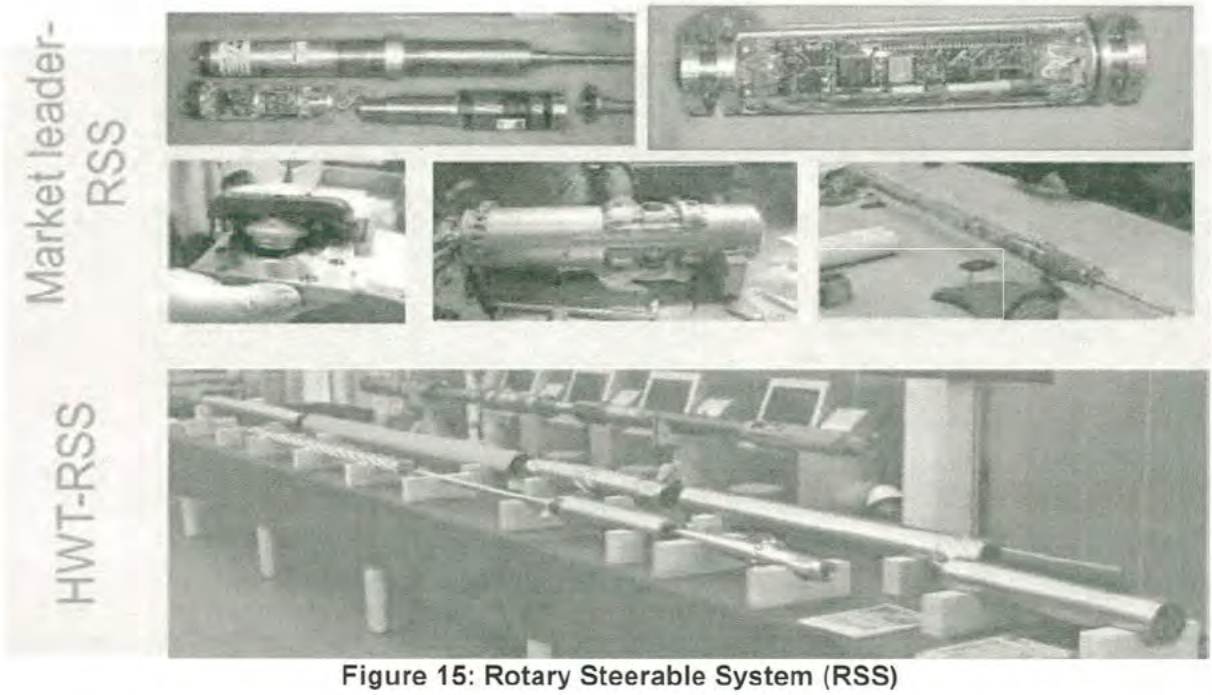


Figure 15: Rotary Steerable System (RSS)

The combination of ECI and MPD simplifies the required cementation because the casing is already installed hence the pressure can be controlled all the way to the deepest point of the well at all times. This is not the case for conventional drilling where casing installation and cementation is more complicated.

Figure 16. ECI-RSS with reamer and composite see-through joints at Huisman test locations.

11.5 Rig integration makes 1+1 to equal 3

From the relevant technologies MPD, ECI and the RSS do already commercial versions exist. However, these technologies are targeting a niche drilling market where costs are not relevant hence often expensive solutions are used or a large number of people are required to deliver the technology. The base of the HWT developments is to focus on larger volume drilling markets by simplifying and automating well construction process and create additional synergistic benefits. For example, placing the drilling BHA inside a (composite) see-through joint in the ECI system resulted in a reliable cable retrieval system with unmatched time savings as demonstrated in TRECIT.

Combining casing drives and heavy duty winches in the drilling rig and have ECI operated by the rig crew will deliver these time savings without additional cost. Using ECI enabled the construction of the simplest and most cost-efficient steering tool of the industry and combining ECI with MPD delivers numerous advantages without the regular MPD drawbacks that occur when the drill pipe is pulled out of hole prior installing casing. Combining the MPD with the rig pumps system in combination with a full-well flow model makes the technology simpler and more reliable that hopefully well control requirements can be reduced thanks to an automated MPD system. Reduced well control requirements will lead to large cost savings besides the more direct MPD cost savings such as ROP increase. So, the most important part of the demonstration will be the combination of the various technologies all controlled by the drilling rigs crew with minimal support.

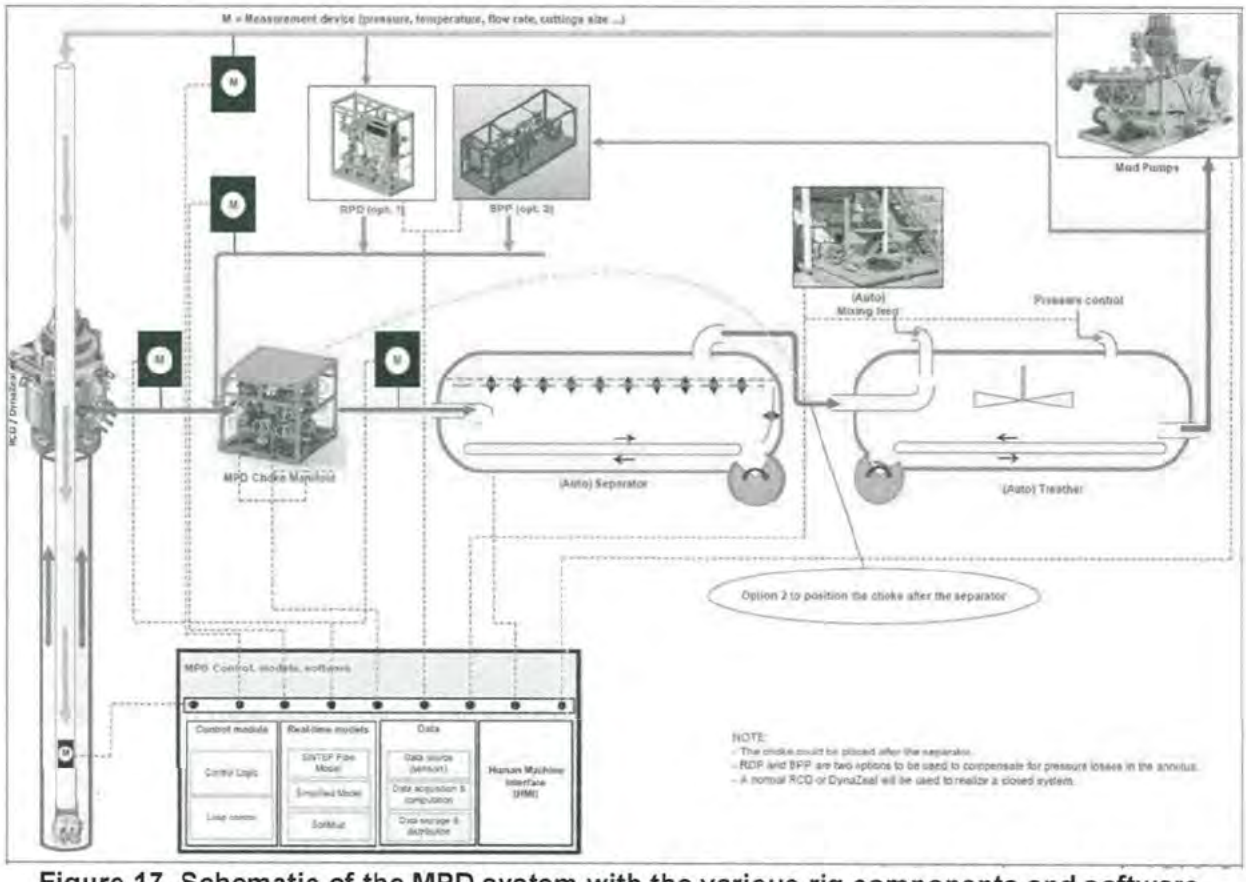


Figure 17. Schematic of the MPD system with the various rig components and software systems.

11.6 Open-hole completion

Most geothermal reservoirs in the Netherlands are producing from sandstone layers separated with claystone. To prevent the sand from being produced, in general wire wrapped screens are used from the first geothermal wells on.

For LEAN, an open-hole completion is proposed, which means that no screens are installed at reservoir depth. Because the Rotliegend reservoir consists of mechanical stable sandstone, the risk of producing sand with the water (which could damage the reservoir and the well) is very low. The advantages are that the flow is not reduced by the screens, which have the smallest diameter of the well, and that this solution is cheaper.

11.7 LEAN well design

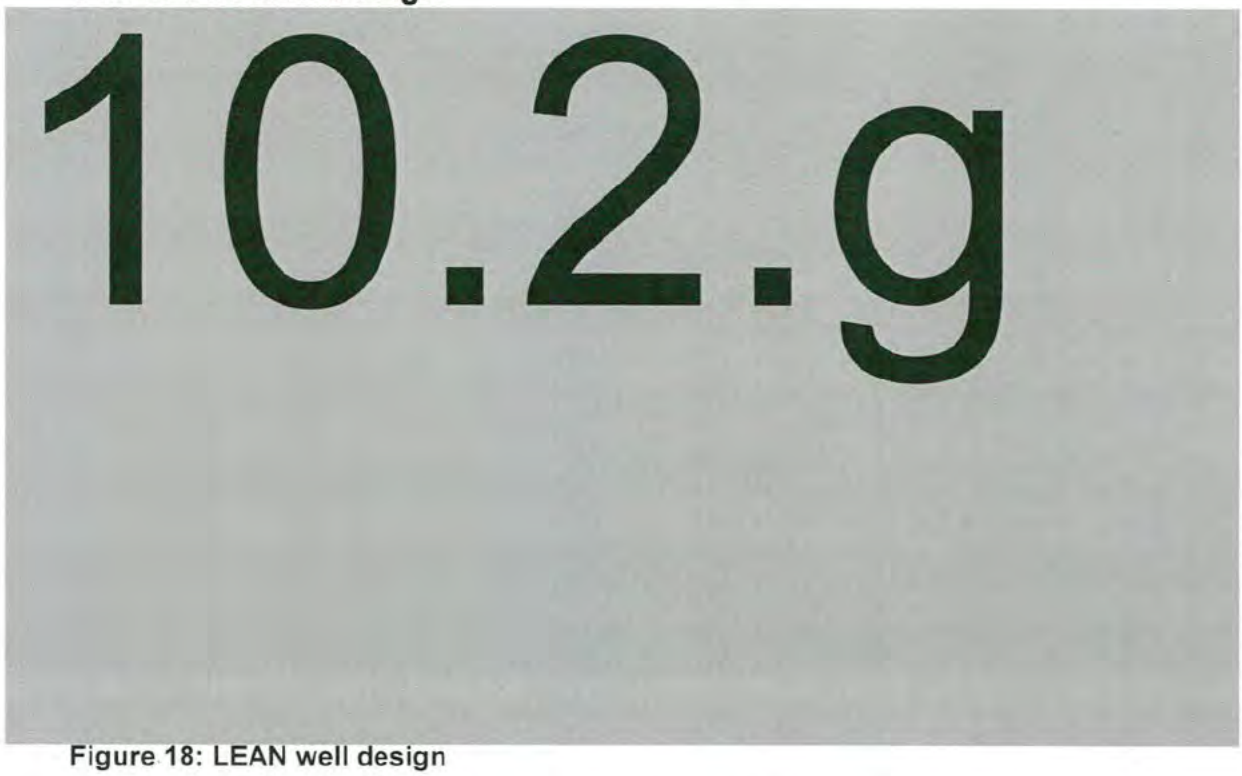


Figure 18: LEAN well design

The new technologies will be applied at different parts of the well:

- The top-hole will be drilled with the Enhanced Casing Installation (ECI) system to ensure that the casing is set at the deepest depth possible in the relative small hole size while keeping the mud program as simple as possible.
- HWT's rig integrated MPD system is used to maintain constant pressure on the reservoir and to minimize over-pressure for high drilling rates, while keeping formations stable.
- Once the desired depth is reached a heavy pill is spotted inside the casing string while the bottom hole pressure is kept constant by the MPD system. The drilling Bottom Hole Assembly (BHA) will be retrieved at the final section depth using a heavy duty winch through the heavy pill and followed by the cementation. The cable retrieving results in significant time savings and eliminates the requirement of 5" drill pipe completely. An ECI prepared rig comes with the crew and equipment needed to operate the system at a minimum of additional cost.
- Depending on project geological target requirements, HWT's Rotary Steerable System is used to maintain verticality.
- The complete well will be drilled using the integrated and semi-automated Managed Pressure Drilling (MPD), which is used to drill with lighter muds while increasing the influx detection capabilities. The lighter and cheaper muds will results in higher drilling rates and lower drilling pressure (variations) in the relative small holes while the better influx detection will make the drilling safer and allowing to extend casing setting depths. MPD allows the reservoir to be drilled with a minimum of overbalance or underbalance to produce it while drilling to prevent (skin) damage by starting to produce and test it while drilling. Producing the reservoir while drilling will result in better producing reservoirs and time-savings. The proposed rig integrated and automated system offers the service with a minimum of extra equipment or personnel. The amount of testing that can be performed depends on the reservoir properties and gas levels.

Relevant experience:

- The ECI system for 7" casing has already been demonstrated in a directional well including cable based BHA retrieval in the CAL-GT-4 well. However, a third party casing running and winch were used.
- The MPD system and the ECI-RSS is developed and tested using a test facility owned by Huisman Equipment. Drilling of directional wells in a 'real' formation besides testing in a 'cemented' casing are possible which enables reaching sufficient high TRL levels in a fast and efficient matter.

The slimhole well has the following innovations:

- The described new drilling technologies with its integrated approach enable risk reducing and cost-efficient drilling which is especially valid in slimhole drilling
- The pressure drop of the relative high flow geothermal wells has a negative and dominating effect on the COP of the geothermal system and is therefore always kept as low as possible hence diameter are kept as large as possible. A new completely different size well will provide additional insights in real production rates but also size-cost effects.
- Stimulation options will be considered for enhancing lower than anticipated flow rates. These will/may include
    - Radial jetting
    - Pressure and chemical assisted removal of skin
    - Underreaming

12 Annex: Seismic reprocessing innovation

TNO has developed multiple new innovative reprocessing methods for imaging the subsurface. The main incentive for generating these methods is the need for cost-effective processing and imaging tools that can accelerate and de-risk the realisation of geothermal projects. A development guideline for achieving sufficiently increased exploration cost-effectiveness versus reduced subsurface risk is the 80-20 rule. 80% of the maximum possible state-of-the-art reprocessing quality should be achieved at 20% of the industry standard costs. Should a 99% solution be necessary, it is always available if needed but at 100% of the maximum costs. A workflow was established that includes fast-track conventional reprocessing tools enhanced by fast-computing algorithms that together reprocess both post- and pre-stack seismic data. Included in the workflow are among others pre-stack migration, selective stacking, data (gaps) interpolation, broadband-processing, edge-preserving de-noising, de-multiple processing.

Within the EU FP7 project IMAGE project this workflow with the aforementioned methods is developed and successfully tested on real data cases. Results have shown significant improvements compared to existing reprocessing workflows that are available in the market today. Figure 19 shows one of these results from the IMAGE project. Within the Netherlands only the larger Oil and Gas companies like NAM, Shell and Neptune (former ENGIE) have the capabilities and tools to reprocess 'pre-stack' seismic data. These companies are not offering their services to other companies or markets today (this might change in the future). Thus an incentive is created to bring innovative and accessible technology to market.

Faster reprocessing at sufficient quality is only one part of the optimization of cost-effectiveness versus de-risking. If vintage seismic data can be re-used with this technique, the effort of acquiring new seismic data is also greatly reduced. Vintage data is often available free of charge and is of sufficiently high standard to be considered in subsurface de-risking of geothermal projects. Therefore using the combination of fast-track reprocessing and vintage seismic data is a double advantage over acquiring and processing new seismic data.

The technology and strategy of fast-track reprocessing vintage seismic data, developed by TNO, is based on a different approach from conventional seismic imaging approaches that are available. The vintage data and reprocessing workflow can be selected and designed tailormade such that it resolves as much information as possible on the targeted geothermal site and for the region and province of Utrecht. Ultimately the reprocessed vintage seismic lines should be tied to processed new seismic lines and passive seismic reflection and tomographic lines. The workflow saves considerable time and cost up to 0.2 M€ per doublet, in particular when compared to shooting and interpreting new seismic.

Figure 20 shows the available seismic lines around Eneco's heat distribution network (see also Annex 17.1).

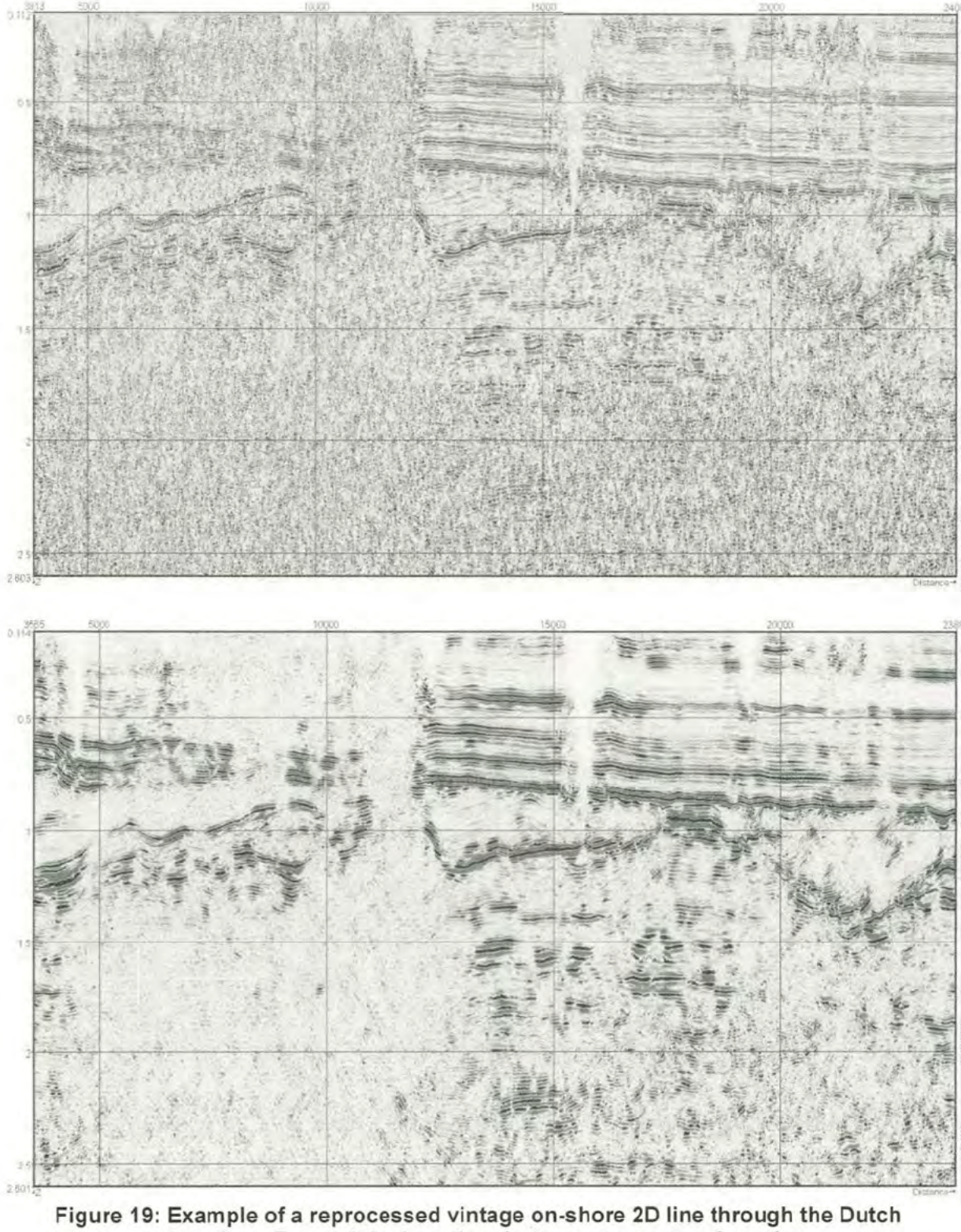


Figure 19: Example of a reprocessed vintage on-shore 2D line through the Dutch subsurface. Top: original section, bottom: reprocessed section.

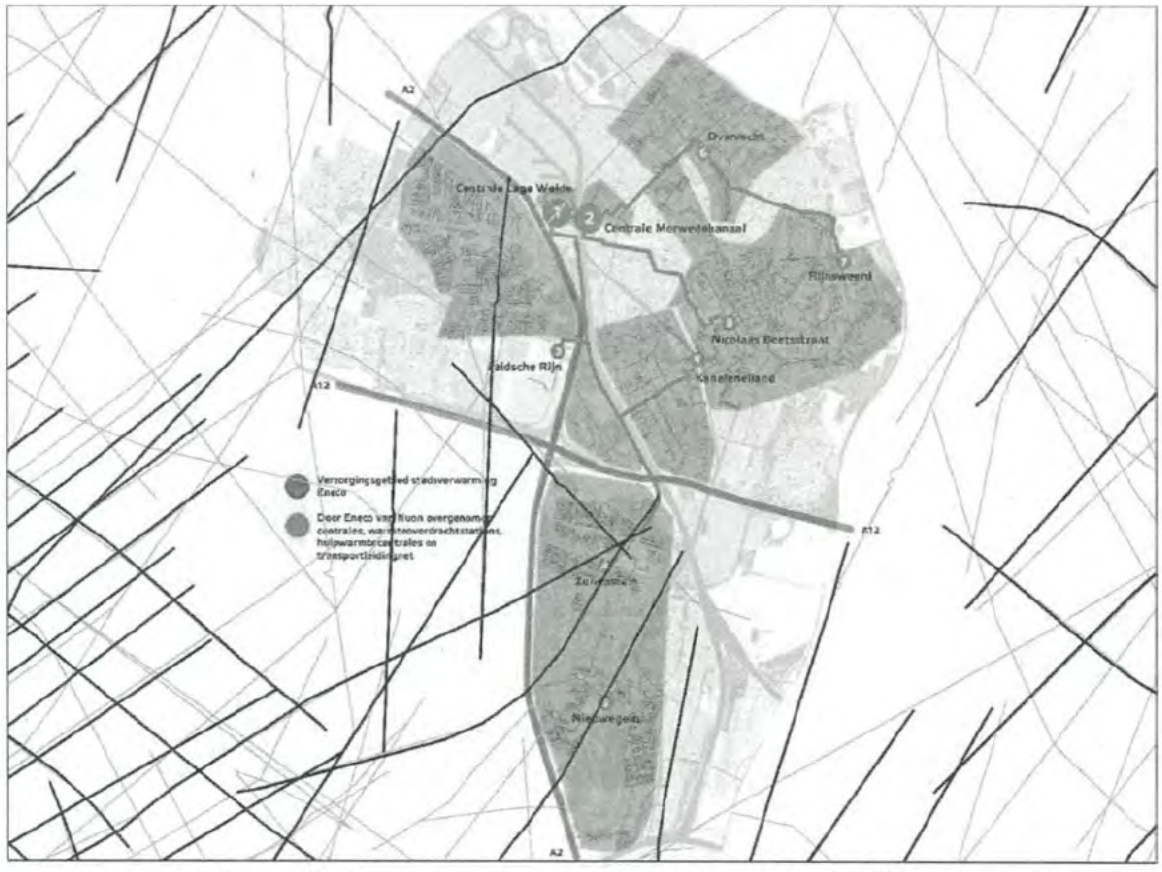


Figure 20: Seismic lines (analogue (grey) & digital (black) around Eneco's heat distribution network.

13 Annex: Play-based portfolio approach for geothermal energy

In the hydrocarbon industry the play-based portfolio approach is used to develop the subsurface and associated surface infrastructure in an optimal way. The portfolio approach implies that multiple prospects are developed in conjunction, in contrast to a stand-alone or one-off approach in which a specific operator limits its development to one or two doublets. The term play refers to the fact that in a specific region, the subsurface is marked by a certain degree of spatial homogeneity (or correlation) of key reservoir properties such as permeability.

Consequently an exploration well drilled at a particular location has a large learning effect for subsequently drilled wells in the region surrounding the first well, which shares the homogeneity in reservoir properties. Evidently, the risk for failing explorative wells for follow up doublets can be lowered compared to a stand-alone approach if the information of previous projects is used in subsequent projects. This systematically increases the probability of success for follow up projects if information is used in the right way (Figure 21).

This approach results in a safer, faster, more efficient and cheaper development of geothermal potential in the subsurface.

Geothermal play: geothermal potential in a certain region, based on the presence of specific aquifers, with spatially related geological and reservoir properties.

The play-based portfolio-approach discriminates six advantages. The most fundamental concerns the geological aspect of spatial correlation (the play approach). Additional benefits of the play based collective development approach of a portfolio of prospects includes:

1. Improvement of safe and responsible integrated project development
2. Cost reduction through synergy, increased in efficiency and scope for standardized approaches
3. Optimization between subsurface development and surface infrastructure
4. Options for structural programs for R&D and innovation
5. Financing (risk sharing and reduction of costs for financing projects)

The play-based portfolio approach for geothermal energy development is potentially a promising approach which can result in substantial reduction of risks and costs and can lead to higher revenues, and is key to enhancing the upscaling of geothermal energy as a competitive and renewable energy source for the Dutch demand in heating. It can be beneficial for geothermal development in the Netherlands and the Utrecht region in particular.

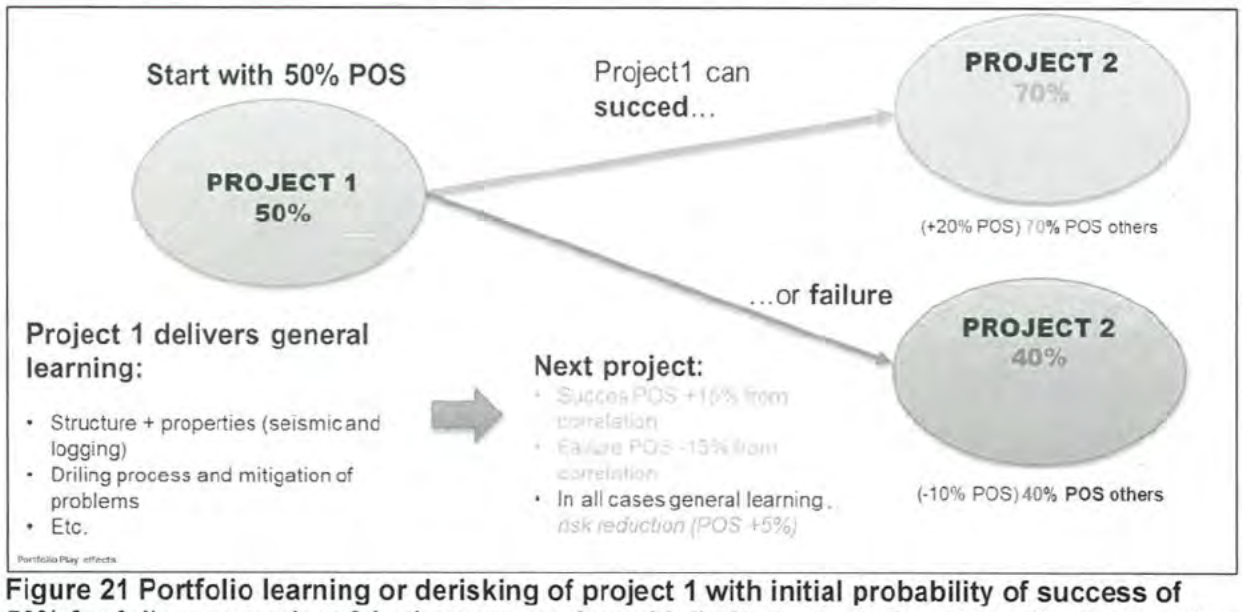


Figure 21 Portfolio learning or derisking of project 1 with initial probability of success of 50% for follow up project 2 in the same region with limited correlation strength of properties in terms of affecting Probability of success by 15%. In addition general learning contributes to a higher probability of success. The actual increase in probability of success for follow-up projects is strongly dependent on geological conditions and the distance to preceding projects. For the Utrecht region LEAN assumes the probability of success can increase to 90% for successor projects in case the first project is marked by success.

14 Annex: Detailed cost estimations

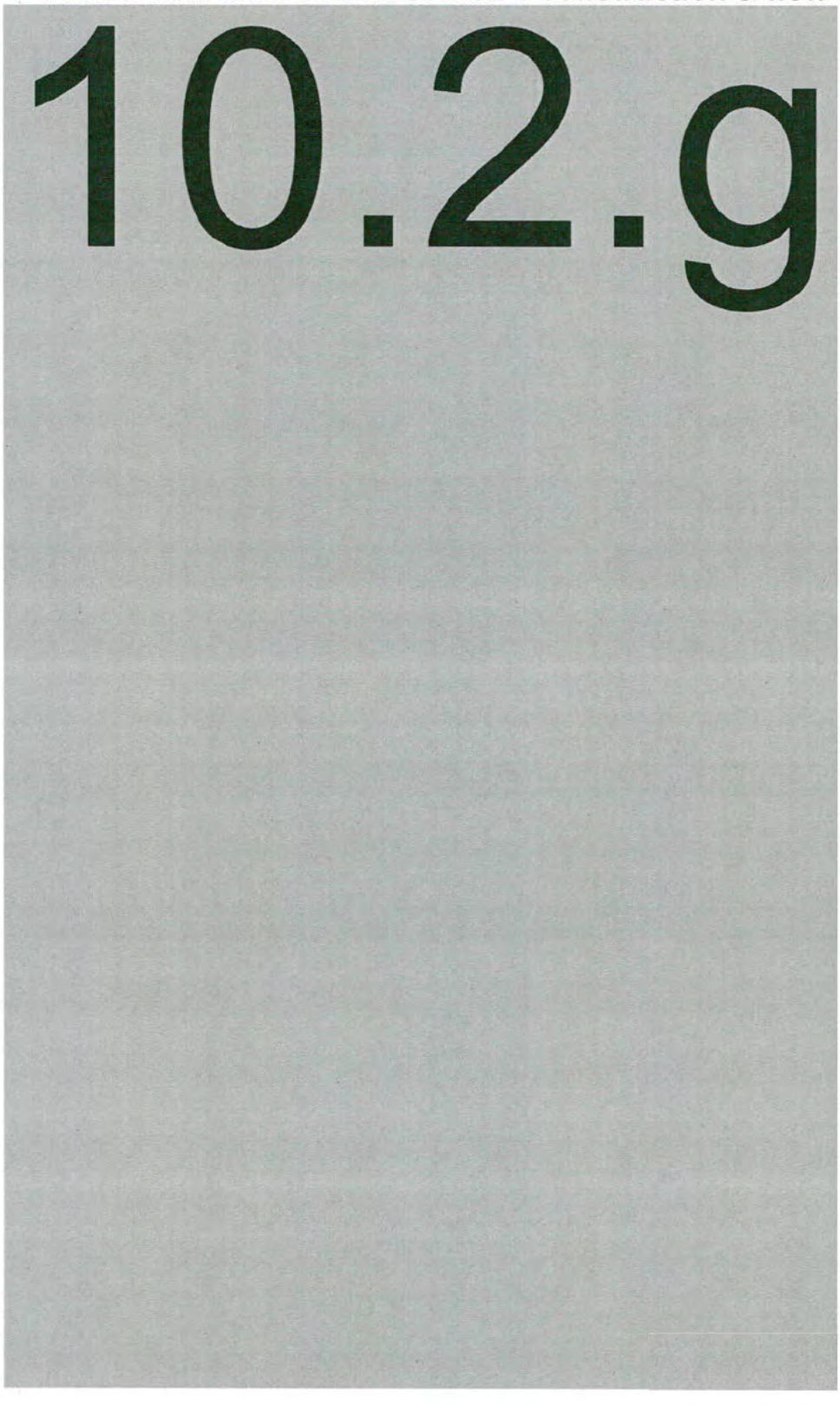
10.2.g

14.1 Annex: Cost details of Above-Surface Installation

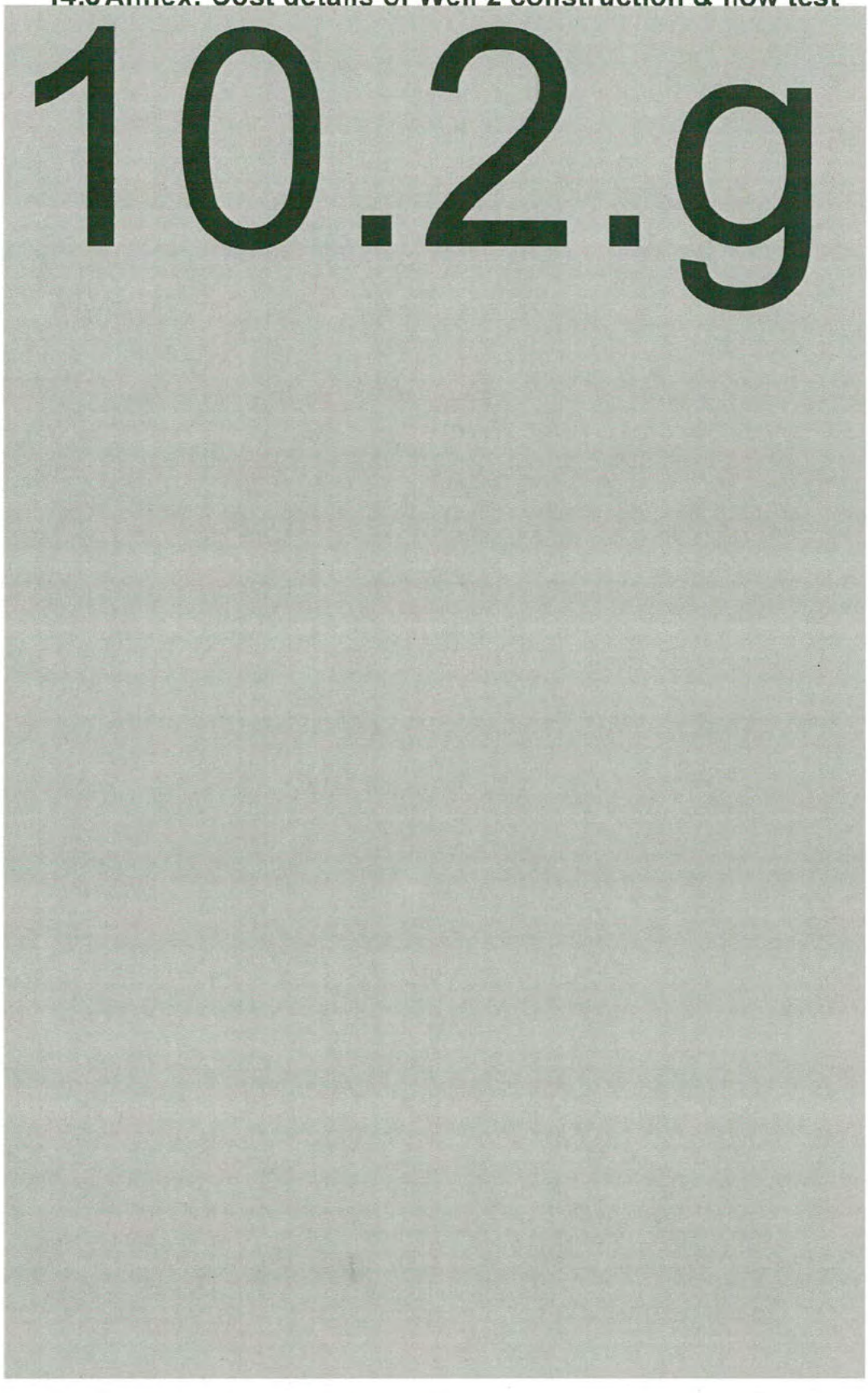
The following table gives the detailed cost estimation of Above-Surface Installation (Bovengrondse Installatie).

10.2.g

14.2 Annex: Cost details of Well 1 construction & flow test



14.3 Annex: Cost details of Well 2 construction & flow test



15 Annex: Coring & Logging plan

Well design logging:
Normally, just gamma ray and mud logs are being logged to differentiate the sandstones from the claystone's. In addition, on all geothermal wells production tests have been conducted which give immediate an accurate measurement of the specific well potential output while it cleans up the well.

Importance of data collection
During the exploration phase of an under-explored reservoir it is of utmost importance to collect as much relevant data from a new well as possible. In this phase, the value of information is largest. On the other hand, the suite of log data that needs to be collected should be balanced in order to keep the cost of the well low. Also, care should be taken when risky data collection procedures are followed, that have a high probability of causing damage to the well. This is especially important in case of a slim hole, where tools may easily get stuck, thereby increasing the risk of losing the well, or requiring expensive fishing operations to retrieve lost tools.

LWD versus wireline logging
The majority of standard logs can nowadays be recorded while drilling (Logging While Drilling or LWD). LWD has both advantages and disadvantages over (post-drill) wireline logging. The major advantage are that log information about the drilled sections is collected real-time, meaning that the drilling (speed, direction, mud weight, etc.) can be adapted real-time to the information collected, and that the formation characteristics are measured before the drilling mud invades deeply into the formation, thereby possibly changing those characteristics. No time is lost on logging after the drilling has finished. LWD is able to record the major logs like gamma ray, sonic velocity, neutron porosity, calliper, spontaneous potential and resistivity, formation testing (pressure and fluid) and sampling, nuclear magnetic resonance and image logs. Also, deviated well trajectories that can be difficult to log using wireline tools can be recorded using LWD.

On the other hand, wireline logging has some distinct advantages over LWD that make the former still the preferred option. The difference is especially in the data quality. The depth recording, which is crucial for an accurate datalogging of the reservoir, is more accurate (for LWD, the 'drillers depth' is measured by counting the number of drill pipes, thereby introducing error by stretch of the pipe. For wireline, the 'loggers depth' is measured by measuring the length of cable). Wireline tools do not suffer from the noise coming from the drill bit, which is the case for LWD. Further, wireline logging tools are small, and therefore lighter, the recording speed is higher, and there is good contact with the borehole. Last, wireline logs *can* be also be run in cased hole – but do not need to be! - , but this is usually considered a disadvantage.

Distributed Acoustic Sensing (DAS) and Distributed Temperature Sensing (DTS) are fibre optic techniques. In LEAN DAS and DTS are installed behind the casing in the top section of the well up to 1700m depth. DAS and DTS allow to detect deformation and temperature respectively at a meter scale vertical resolution and at timescales from milliseconds to years. These measurements allow to be used for diverse applications which are of relevance for geothermal exploration and reservoir exploitation. These include detection of (induced) seismicity, thermal parameters to constrain thermal models and can be used for flow test and monitoring well integrity.

The DAS/DTS cables allow the well to be used as research well in case it is sub-economic, since. the installed fibre optic cables allow permanent monitoring for (induced) seismicity, well integrity and temperature effects. Furthermore it is envisaged that if it is sub-economic, the well may be kept open for future tests of equipment, soft stimulation and complementary monitoring techniques.

The logs that need to be acquired are:

Name	Purpose	Section
Orientation	Deviation of the borehole from vertical	Full
Gamma ray	Distinguish reservoir – non reservoir (esp. sandstone – shale)	Full
Sonic	Velocity of acoustic ('seismic') waves in rocks. Used for time-depth conversion and therefore accurate depth prediction of the reservoir, and thereby temperature. From the sonic velocity, porosity can be estimated, and, from porosity, permeability, using a porosity-permeability log-linear trend	Full
Density and Neutron porosity	The combination of density and neutron porosity provides a good estimate of porosity (better than either of the two, or sonic, alone). From porosity, permeability can be derived, using a porosity-permeability log-linear trend	Reservoir section +, 200m
Caliper	Width of the borehole. The latter is determined principally by the bit diameter, but weaker and/or faulted rocks may be washed out, thereby resulting in wider borehole diameters. The log therefore provides estimates of rock integrity, and the occurrence of fractures and faults.	Full
DTS	Distributed Temperature Sensing temperature log. Fibre optic technique measures difference in rock thermal properties, and indirectly differences in permeability (possibly caused by fractures) may result in deviations of the thermal gradient	Top section
DAS	Distributed Acoustic Sensing, fibre optic technique measures strain (motion), useful for seismicity monitoring	Top section
Resistivity (Laterolog)	Measures resistivity of the rock, and thereby enables to distinguish between different rock types and fractures	Full
FMI	Image log. Formation Micro Imager provides a very detailed 3D image the borehole, distinguishing resistive and non-resistive rock layers and fractures. Non-resistive layers may be considered to contain brine, and are therefore more porous and possibly permeable.	Reservoir section +, 200m
Formation tester	Pressure isolate a part of the reservoir, reduces the pressure and determines the time required to re-establish the pressure. Needs to be evaluated if this makes sense for a brine	In reservoir
PLT	Production logging test, measures where the productive zones are in the reservoir	Reservoir section +, 200m
NMR	Measures the distribution of pore volume which is a measure of permeability	Full
Core	The most direct measurement of permeability is obtained from cores although this may only be correct for a small part of the reservoir	Reservoir section ~70m
Fluid sampler	To determine fluid content	In reservoir
Well test		

16 Annex: Contribution to Dutch economy per innovation

16.1 Seismic reprocessing innovation

16.1.1 Market specificities

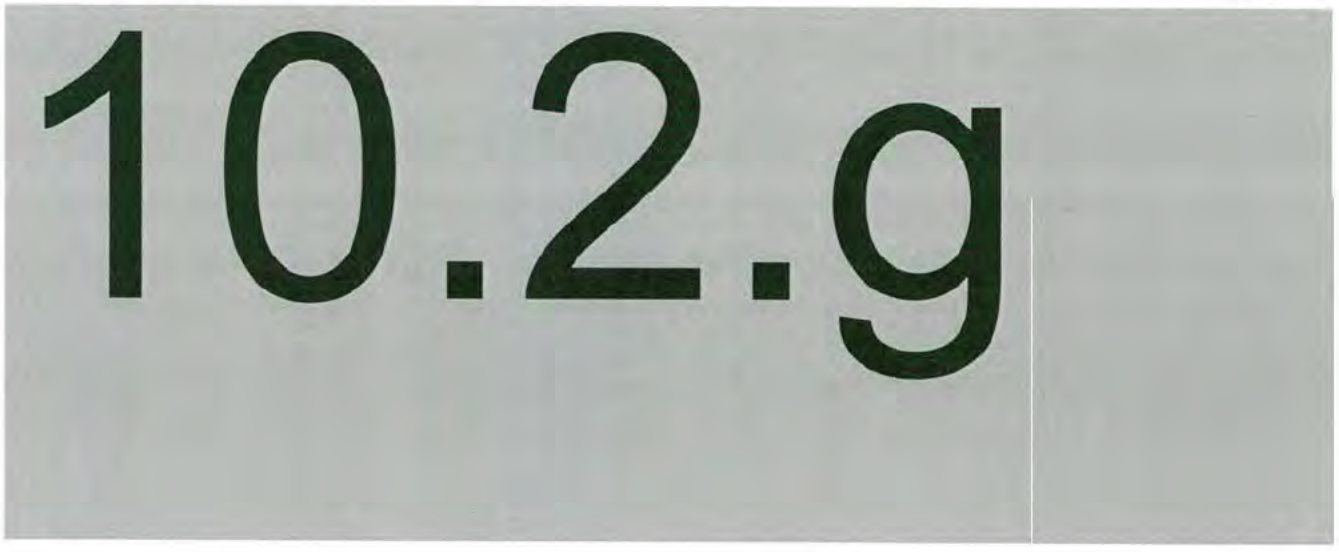
TNO has developed a new innovative reprocessing method for imaging the subsurface. Within the EU IMAGE project this method is successfully tested and demonstrated in real life conditions. Results have shown significant improvements compared to existing reprocessing tools that are available in the market today. Within the Netherlands only the larger Oil and Gas companies like NAM, Shell and Engie have the capabilities and tools to reprocess 'prestack' seismic data. These companies are not offering their services to other companies or markets today (this might change in the future). Only a limited number of Dutch consultants have the capabilities and tools to reprocess 'pre stack' seismic data. The technology developed by TNO is based on a different method than the other reprocessing tools that are available and will deliver sharper images of the sub surface at lower costs.

16.1.2 Strategic specificities

After successful demonstration of the technology within the LEAN project, the product is ready for commercial application in different markets: Geothermal energy, oil and gas industry, energy storage applications. TNO and ECN have more than 60 spin-off and start-up companies with innovative technology that was previously developed within research projects. If proven successful, TNO are committing themselves to transfer the technology into a product that will be brought to the Dutch and international markets (Geothermal, Oil & Gas, Energy storage) through a spin-out enterprise.

16.1.3 Financial specificities

The project costs within the LEAN are estimated at 160.000 euro. After successful demonstration of the technology within the LEAN project an additional investment of 80.000 euro is required to make the product ready for market introduction and establish a spin out company. TNO expect to deliver better quality at 40% lower prices compared to our competitors. Within the Dutch market we expect a growth of the geothermal market with 4- 5 doublets per year (total). Reprocessing of existing seismic data will be performed for a larger geothermal play. Results can be used by multiple geothermal doublets within the same geothermal play. Therefore we expect to assist and develop 1 new geothermal play per year in the Netherlands till 2025. The international market is much larger than the Dutch market. As a consortium we decided to present the contribution from



16.1.4 Specific Business case end-user

TNO expects to earn back our investments within 3 years after successful demonstration within the LEAN project (including the international market). The product will have a cost reduction of 40% compared our competitors. Furthermore we expect in some cases that the quality of the images of the sub surface are good enough to avoid new seismic data acquisition which is very costly. In these cases the end user will benefit with a cost saving of another 200 k€ or more (see section 4.1.1)

16.2 Drilling innovation

For clarity, the parties involved in the drilling innovations are:
- Innodrill & WEP: drilling of geothermal wells
- Huisman: building drill rigs & parent company of HWT & Innodrill
- HWT: developing and integrating in rigs of ECI, ECI-RSS and MPD

The questions below are answered primarily from Innodrills perspective unless mentioned otherwise

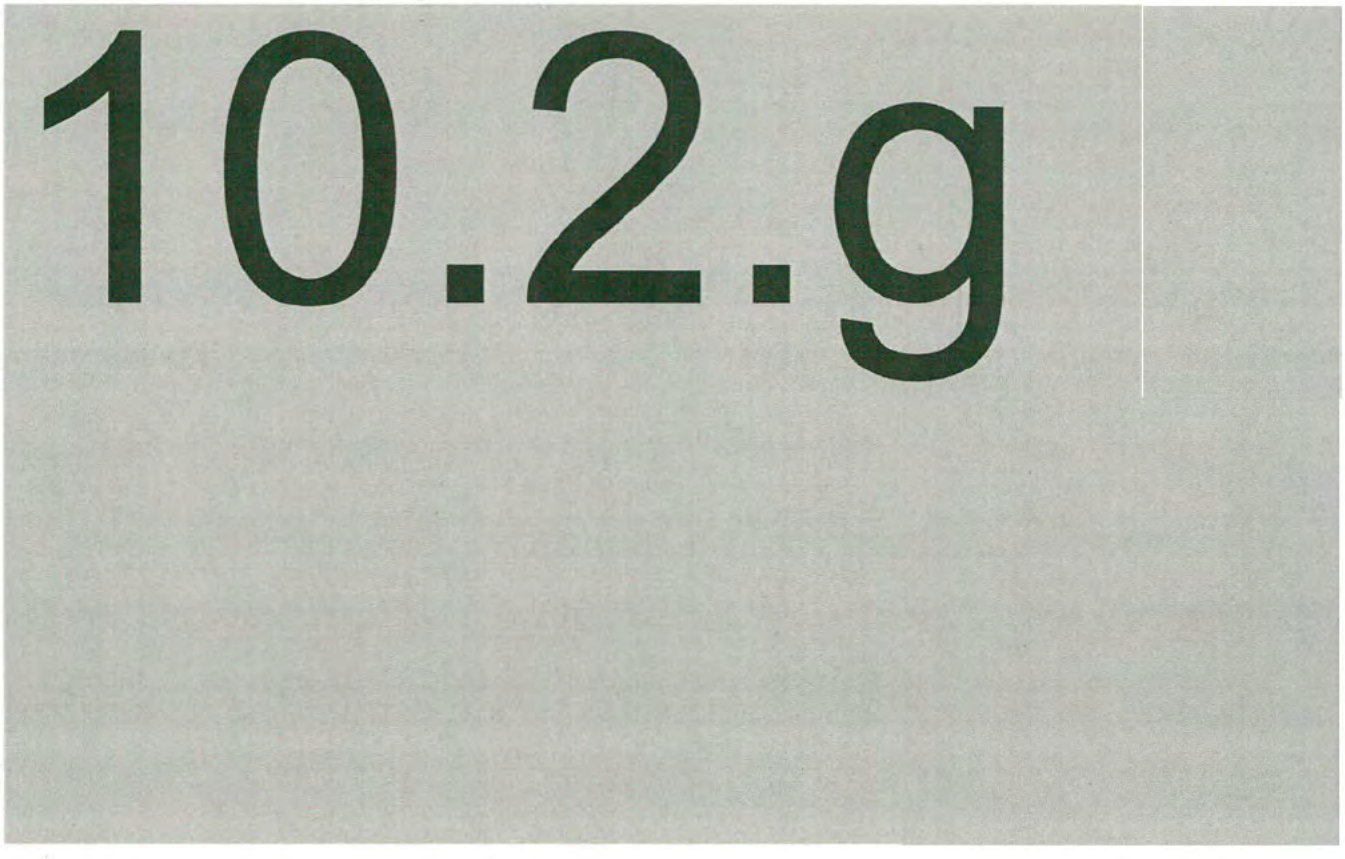
16.2.1 Market specificities

- Wie zijn de belangrijkste spelers op de markt en welke positie nemen ze in?
  - On the Dutch Drilling market 3 competing drilling contractors are active besides Innodrill. KCADeutag (1 or 2 rigs) and Drilltec (1 rig) offer dayrate based services and Daldrup/Gerf (1 rig) offers lumpsump drilling. The Innodrill competitors are all German and note that Innodrill offers both dayrate as lumpsump drilling.
- Maak een concurrentie analyse en maak een overzicht van de concurrentievoordelen.
  - KCADeutag is with over 90 rigs a well-established and major drilling contractor with a strong reputation on the oil & gas industry. Equipment and crews are good but relative standard although currently struggling a bit due to the low oil prices. KCA Deutag intends to focus themselves on the deeper geothermal drilling
  - Drilltec owns several compact single rigs of which one is active in the Netherlands. Drill rigs operate in general well. Drilltec focused on the standard geothermal wells
  - Dalldrup comes from the water drilling industry instead of oil & gas industry what causes a limit experience and drilling knowledge resulting often in delays and even SodM interventions. Their main strengths are based on their financial offerings
- De positie van de deelnemers op deze markt voor en na het project (o.a. marktaandeel).
  - The objective of the project is define a new standard of drilling in terms of safety, time and cost. The competitors don't invest in drilling efficiency and will therefore not be able to meet the new standard Innodrill will dominate the market

16.2.2 Strategic specificities

- Wat wilt u binnen nu en 5 jaar bereiken?
  - Innodrill & WEP: Minimum of 2 or 3 rigs continuous drilling with ECI and MPD in the Netherlands and beyond
  - Huisman & HWT: Sell numerous ECI&MPD integrated rigs
- De termijn tot aan de marktintroductie na afloop van het project.
  - Demonstrated manner of drilling can be continued immediately after the project
- Hoe wordt de verkoopstrategie opgezet? Die moet inzicht geven in de ontwikkeling en marketing van de in het project gebruikte technologieën / concepten / diensten nadat het project is afgerond. Hoe gaat dit project vervolg krijgen?
  - ECI and MPD technologies will be made available for other rigs However, Innodrill is bascially's Huismans 'flagstore' to demonstrate the possibilities and the advantages of the Huisman rig with the technologies integrated.
- Geef de bedrijfsontwikkeling weer in een overzicht van mijlpalen
  - 2005: Huisman builds first LOC rig
  - 2010: LOC400 rig drills The Hague Geothermal wells
  - 2016: HWT drills first time with ECI in geothermal doublet
  - 2017: Innodrill NL started and drills first doublet in NL
  - 2017: HWT trials successful ECI-RSS and MPD in a test well
  - 2018? : demonstrate ECI-RSS and MPD separately on geothermal doublet
  - 2019? : drill doublet with ECI, ECI-RSS & MPD fully integrated in rig

16.2.3 Financial specificities



16.2.4 Specific Business case end-user

- The innovations result primarily in a cost saving.
- The subsurface part of a typical doublet will be reduced with ~30% or 3M€ for a typical doublet what is the most risky part of the project.
- Safer and more efficient drilling.

16.3 Portfolio approach (Vol) innovation

16.3.1 Market specificities

Geothermal energy in the Netherlands is a relatively young sector which given its' potential is developing rapidly, including the additional growing pains. There were 15 installations in 2017 producing an average of 0,2 PJ of heat per installation annually. Given the physical limitations of heat transportation geothermal is a local market. Current installations mostly provide heat to horticultural greenhouses and the provision of heat to the built environment is currently limited to 2 projects. In most of these projects one-off operators were involved where the development and realization of the project was done by and in the backyard of the ones the heat was for.

A more recent trend is the involvement of companies like Hydreco, HVC, ECW and ENGIE which aim to operate multiple geothermal installations. In addition to these multi-operator parties EBN (a known participant in most oil and gas projects in the Netherlands) is developing geothermal partnerships.

Another recent trend to lower the risk of failure of geothermal developments and the increase the solvability for individual parties is by cross-investing of multi-project operators in projects of other operators. This practice is common in oil and gas as well and well-known by EBN. Such cross-investing of financing operators in the projects of primary technically and commercially responsible operators has a positive learning effect of an individual project for the Dutch sub-surface potential for geothermal heat. ENGIE intends to investigate if these portfolio and cross-investing practices can be applied for the Utrecht area as well as the Dutch sub-surface because ENGIE firmly believes these approaches could be a game changer in the Dutch geothermal economy.

16.3.2 Strategic specificities

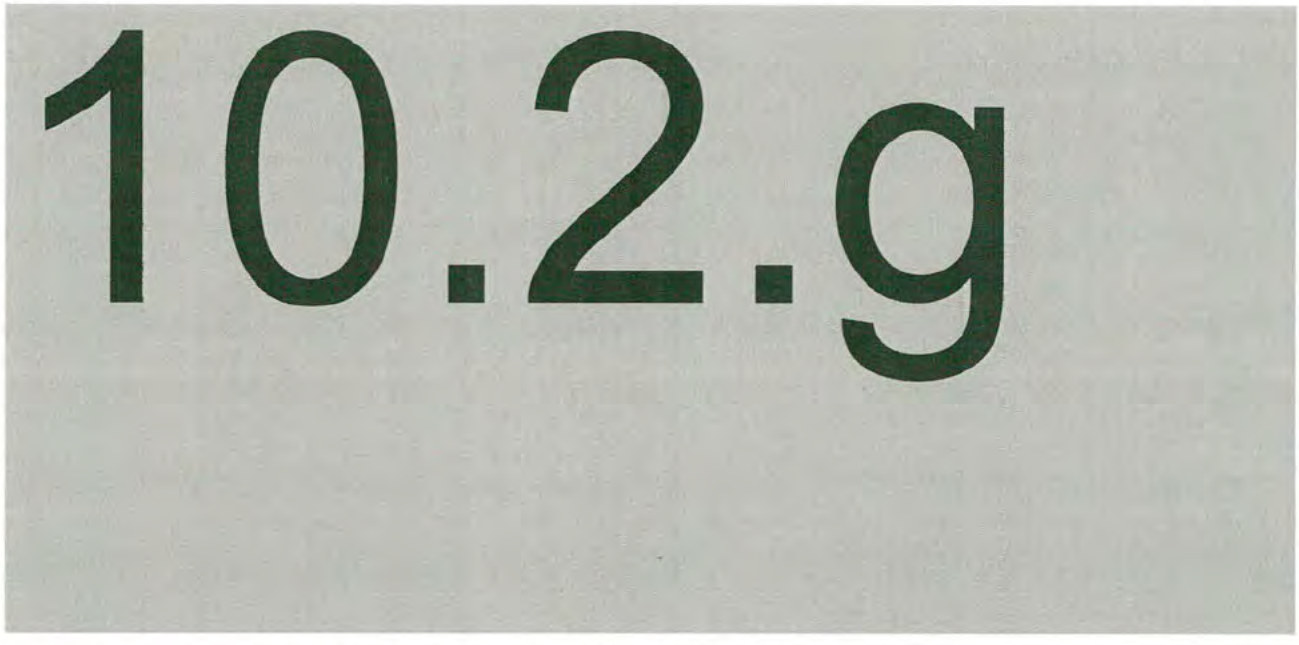
To stay a leader in the energy transition ENGIE aims to develop a portfolio of geothermal energy projects in the Netherlands and the next decade in line with the joint ENGIE Group expertise and strategy. To be specific ENGIE aims to develop 5 projects in three different plays in the coming 5 years and aims to apply the portfolio approach to be able to commercially develop and invest the disclosure of high potential white-spot areas in the Netherlands. The goal in these projects being to become an investor/operator.

After the demonstration of the portfolio approach ENGIE aims to calibrate the theory on a per-drilling basis. We therefore assume that the time-to-market for the innovation will be limited to a repetition of the activities in work package 1 in half a year to a year.

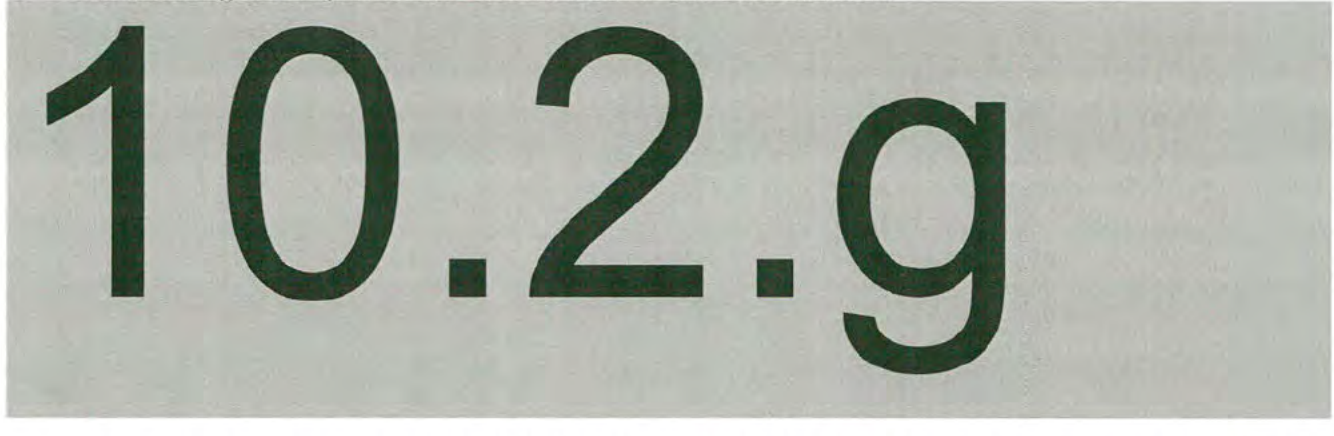
ENGIE has reached the following most relevant milestones in the past years:

- Q4 2015 – ENGIE NL and Storengy (100% ENGIE) sign a joint development agreement for the development of risk-carrying geothermal district heating solutions in the Netherlands
- Q4 2015 – involvement in the market initiative for a geothermal district heating project in Haarlem, Schalkwijk
- Q2 2016 – involvement in the GOUD Ultra deep geothermal initiative
- Q2 2017 – part of the green deal UDG ENGIE
- Q3 2017 – involved with LEAN consortium
- Q2 2018 – Exploration Working Program green deal?

The table below provides an overview of the economical perspective for the portfolio approach innovation within the Netherlands with ENGIE as an end-user.



The following assumptions have been made for these calculations:



ENGIE has the means and intends to finance this innovation and the projects themselves through risk-carrying consolidated project financing from a portfolio perspective. This innovation is needed to ensure we can do so.

The pay-back time of a geothermal project is around 5 – 15 years depending on the specificities of the project/ ENGIE hopes to earn back their investment in the portfolio approach after 7 years in which in principal the 6 Utrecht could be developed simultaneously

16.3.3 Specific Business case end-user

ENGIE is the end-user of the portfolio approach.

Much like in the oil and gas industry there is a need for portfolio-development to be able to cope with and buffer the uncertainties related to exploration and production of individual projects.

Although geological resources can be predicted relatively accurate there always remains an uncertainty that the heat resource is less than predicted. Although the probability of this event is low, it still bears a risk as it comes with a high (financial) impact [Risk=probability*impact]. The larger the portfolio of projects, the better this risk can be absorbed.

The added value of the portfolio approach therefore is that it allows to develop high risk areas (white-spot areas) through the development of multiple prospects in a collective approach targeted

at a play evolution from a low (30-70%) to high probability of success (90%). In this approach, the business case is built from the trade-off between the excess financial risk of the first doublet and its Value of Information (VoI) for the successor doublets.
The payback time of this innovation for the end-user is estimated in the previous section.

17 Annex: Eneco's heat distribution network & LoI

17.1 Eneco's heat distribution network in Utrecht

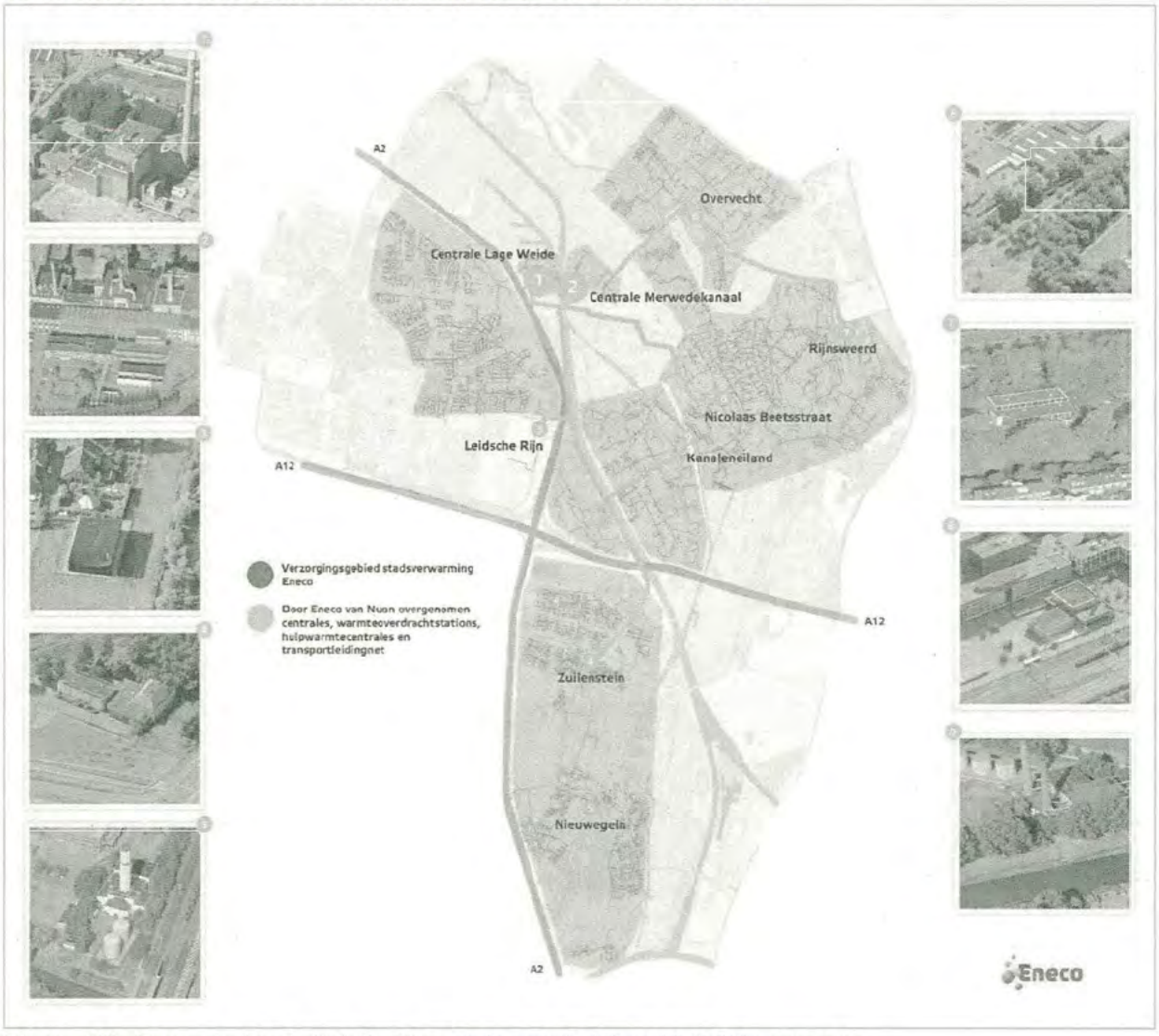


Figure 22: Eneco's heat distribution network in Utrecht & Nieuwegein

17.2 Eneco's Letter of Intent (Confidential)

Intentieverklaring Geothermie

t.b.v. de aanvraag LEAN (Low cost Exploration And derickiNg of geothermal plays)

ENGIE Ventures & Integrated Solutions B.V., statutair gevestigd te Bunnik, kantoorhoudende te (3981 AJ) Bunnik op het adres Kosterijland 20, KvKnr 68159625, de dezen rechtsgeldig vertegenwoordigd door 10.2.e 10.2.e hierna te noemen "**Producent**".

En

Eneco Warmte & Koude Leveringsbedrijf B.V., kantoorhoudende te (3068 AV) Rotterdam op het adres Marten Meesweg 5, KvKnr 24242021, de dezen rechtsgeldig vertegenwoordigd door de heer 10.2.e 10.2.e, hierna te noemen "**Afnemer**".

hierna gezamenlijk aan te duiden als **Partijen**,

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18 Annex: ENGIEs international reference projects

18.1 ENGIE: France, Arcueil

storengy

Reference factsheet
Geothermal energy

Drilling two geothermal boreholes (heating network)

Clients
ENGIE réseaux (Argéo)

France - Île-de-France
Arcueil and Gentilly

Date/timeframe
2013-2014 (6 months)

"Storengy seemed the obvious choice to perform our deep drilling due to the 'subsurface' skills it has gained by drilling hundreds of wells to date."

Olivier Racle,
ENGIE Réseaux

Client project

Establishment of a new heating network for the communes of Arcueil and Gentilly (94) powered by deep geothermal energy. (through the professionals' trade union SIPPEREC)

This project involved Storengy drilling two deep geothermal boreholes in an urban environment.

Drilling operation on site

Key figures

- **13 km of heating networks**
- **10,000 equivalent residential units supplied with heating and hot water**
- **12 MW of capacity for the geothermal power plant**
- **€32.2 million: the total cost of the project, including 25% in subsidies**
- **14,600 tonnes: the quantity of CO_2 savings each year**

Storengy's mission

- **Storengy's role:** prime contractor for drilling two deep geothermal boreholes to supply renewable energy to customers and the heating network
- **The two boreholes/geothermal energy:**
  - 1,800 metres: the depth of each borehole
  - 40°: the deviation for each borehole
  - 64°C: the temperature of the produced water
  - 320 m³/h: the maximum flow rate

Competencies involved

- Drilling, completion
- Civil engineering
- Geology and hydrogeology
- Communications
- Legal
- Purchasing

storengy.com

Storengy is an active member of various geothermal energy associations: afpg

A company of ENGIE

18.2 ENGIE: France, Bordeaux:

storengy

Reference factsheet
Geothermal energy

Subsurface partner for the planned heating network project in Bordeaux

Clients
Bordeaux Métropole

Storengy's partner
ENGIE Cofely South-West

France
Acquitaine / Bordeaux

Date/timeframe
2015 (10 months)

"We chose to work in partnership with Storengy on the (geothermal) heating network project for the Plaine Rive Droite area of Bordeaux, as it submitted an innovative technical bid on geothermal energy during the consultation phase. This renewable energy project spans tens of kilometres and will generate up to 98 GWh/year for 30,000 residents."

Jean-Christophe Allué,
Director at ENGIE Cofely South-West

Client project

This is a consortium response (with ENGIE Cofely South-West) to a call for tenders for a public service delegation contract launched by Bordeaux Métropole, which is looking to develop a new heating network project powered by renewable energy and deep geothermal energy in the greater Bordeaux area.

The project will boost exploration of geothermal energy in Bordeaux and the Aquitaine Basin and ensure its continuation for over 30 years.

Storengy's mission

- Handling the subsurface part of the project (Cofely Services in charge of the surface part): conducting a technical and economic study, devising a subsurface offering suitable for exploring and exploiting the subsurface with deep geothermal energy.
- Positioning boreholes, designing wells and drafting the related operational programmes, suitable for both exploration and exploitation.
- Investor: 1/3 of CAPEX

Key figures

- **28 km of heating networks**
- **9-18 MW of heating power and 7 MW of cooling power for the geothermal power plant**
- **€46 million gross investment**
- **18,000 tonnes of CO2 saved each year**

Competencies involved

- Business development, project
- Drilling, completion, workover
- Geology and hydrogeology
- Legal
- Permitting

Award of contract in a deliberation by the municipal council on December 16, 2016. See the website

Geological model of the site

storengy.com

Storengy is an active member of various geothermal energy associations: afpg, EGEC

A company of ENGIE

18.3 ENGIE: Italy, Castelnuovo Val di Cecina (Tuscany Region):

Press release

January 31, 2018

ENGIE, Storengy and Graziella Green Power together for the first geothermal power plant in Europe using a new and innovative technology "zero-emission"

On January 31, 2018, a Development Agreement has been signed between the Italian energy firm Graziella Green Power and the global energy player ENGIE, through its subsidiaries Storengy and ENGIE Italia, starting a cooperation to realize an innovative binary cycle geothermal plant, located in Castelnuovo Val di Cecina (Tuscany Region, Italy).

The project, whose main works are set to begin in 2019, consists in developing, building and operating a geothermal power plant of 5 MWe net capacity. It will be a zero-emission plant thanks to an innovative solution: after generating electric power, the previously extracted geothermal fluid will be reinjected in the same reservoir together with non-condensable gases (CO_2 and others), sustaining a production cycle without atmospheric emissions. When it is fully operational, the geothermal plant will reach an energy production estimated at around 40,000 MWh per year (enough to supply electricity to 14,000 families), generating also important economic benefits for the local communities. To ensure a minimal environmental impact on territory and population, the plant layout has been designed to limit its land footprint, with a low visual impact and without evaporative cooling towers.

"*Our company was seeking a big statement partner to realize innovative projects linked to geothermal power* - explains Iacopo Magrini, Chief Executive Officer of Graziella Green Power, - *and ENGIE has shown its intention to extend its commitment in this kind of renewable energy. The work that we have carried out so far, together with ENGIE's and its subsidiary Storengy's competences and knowledge, will allow to reach a new step for the future of the Italian geothermal sector.*"

Once the administrative authorizations have been obtained, civil works and drilling activities will begin on site. ENGIE will provide its industrial background for the project management and operation of power plants, and through its subsidiary Storengy, an internationally recognized expertise in subsurface knowledge, for drilling execution and geoscience activities. Graziella Green Power will support the underground exploration and drilling activities and will be an active actor on the territory for the site and project management activities.

1

"Committed to the energy transition, geothermal energy is a key component of Storengy's strategy. This partnership with Graziella Green Power is a fantastic opportunity for us to be part of a very innovative project, with our first geothermal plant in Italy." declared Cécile Prévieu, Chief Executive Officer of Storengy.

"This project is a concrete example of our vision of the 3D world, decarbonised, decentralised, digitalised - said Olivier Jacquier, Chief Executive Officer of ENGIE Italy -. *ENGIE wants to be an actor of this vision, through the development of renewable sources and energy efficiency, with the fundamental push of innovation, the main driver of all our solutions. We operate throughout the country, in Tuscany for example with the University of Florence, the Province and the University Hospital of Pisa, to help institutions and communities to manage energy and resources efficiently. The realization of this innovative geothermal power plant, in partnership with Graziella Green Power, allows us to create new jobs, to preserve the environment, to be consistent and determined with regards to our purpose: united for harmonious progress".*

With this project, the Arezzo's company reaffirms is commitment, within Graziella Holding, to develop the production of energy from renewable sources and opts now to invest in the geothermal sources naturally present in Tuscan subsurface. *"Tuscany is one of the most important geothermal pole in the world* - Gianni Gori, President of Graziella Green Power, clarifies. - *So, our project is oriented to enhance this richness with a compatible plant, without emissions and in harmony with the landscape context, which will open in Italy new frontiers for the geothermal sector, with the ambition to keep realizing in the future, other stations like the one based in Val di Cecina".*

About Graziella Green Power

Graziella Green Power SpA is today one of the largest producers of photovoltaic electricity in Italy, engaged in the development of plants in the geothermal, bioenergy and wind energy fields, with the aim of strengthening its leadership in the production of energy from sources renewable.

About ENGIE

The ENGIE Group is committed to taking on the major challenges of the energy revolution, towards a world more decarbonised, decentralised and digitalised. The Group aims to become the leader of this new energy world by focusing on three key activities for the future: low carbon generation in particular from natural gas and renewable energy, energy infrastructure and efficient solutions adapted to all its customers (individuals, businesses, territories, etc.). ENGIE is active in around 70 countries, employs 150,000 people worldwide and achieved revenues of €66.6 billion in 2016.

ENGIE in Italy offers a full range in the entire energy value chain, from supply to services, with high attention to innovative products and solutions for energy efficiency and integrated management. With over 2.800 employees in more than 50 offices throughout the country, ENGIE in Italy is the leading operator in energy services, the second in the sale of gas (wholesale market) and fifth in electricity production. ENGIE has a presence in all segments, from residential to the tertiary sector, public and private, to small and large industry. In Italy, ENGIE counts 6 wind powers, 5 photovoltaic plants and 3 biomass plants for a total of 175.8 MW. A capacity ENGIE intends to increase through acquisitions and development of new projects.

About Storengy

Storengy, a subsidiary of ENGIE, is Europe's leading operator of natural gas storage facilities. With 60 years' experience, it designs, develops and operates all types of storage facilities and provides its customers with innovative products based on its extensive experience in many different markets and their respective environments.

Storengy operates in Europe (France, Germany and the United Kingdom) and has gradually expanded its operations around the world. It owns 21 natural gas storage sites with a total capacity of 12.2 billion m³. As an active player in the energy transition, Storengy offers its technical expertise to numerous partners around the world with a view to developing geothermal projects (heat and power production) and innovative energy storage solutions.

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18.4 ENGIE: Indonesia, Muara Laboh

Press release
27 January 2017

ENGIE builds in Indonesia its first geothermal power generation plant in the world

ENGIE, as part of PT Supreme Energy Muara Laboh consortium, has reached the financial closing for phase I of the Muara Laboh geothermal project in Indonesia, the Group's first high temperature geothermal power generation plant in the world. With commissioning planned in 2019, this first phase will generate 80 MW of emission-free electricity, the equivalent of the energy consumption of around 120,000 households.

ENGIE, through its subsidiary Storengy, has all the drilling and underground expertise to manage such projects. With construction expected to commence this year in the Solok Selatan region in West Sumatra province, the project will provide employment opportunities to 1,200 people and support local businesses during the 30-month construction period.

Indonesia has around 40% of the world's geothermal reserves, estimated at 28,000 MW, making it an important resource for the country to achieve its commitments to reduce carbon emissions by 29% by 2030.

Isabelle Kocher, ENGIE Chief Executive Officer, said: "*I am proud of our teams who succeeded in confirming our expertise in such projects, from the underground exploration to the construction and operation of geothermal power plants. Those technologies are key for countries like Indonesia to provide their population with efficient low-carbon power generation sources. Our partnership in the Muara Laboh geothermal project is fully in line with ENGIE's strategy to be a leader of the energy transition in the world, notably focusing on competitive renewable energies.*"

Geothermal energy is a renewable, non-intermittent and eco-friendly source of energy that is both efficient and economical, using the heat coming from deep underground either for heat, power generation or even air-conditioning. ENGIE is a leading producer and supplier in Europe of

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geothermal energy for heating and cooling of residential and commercial facilities, using various geothermal sources.

ENGIE is part of the PT Supreme Energy Muara Laboh consortium with the Japanese trading and investment company Sumitomo Corporation and the Indonesian geothermal power developer, PT Supreme Energy.

The USD 440 Million financing agreement was signed by PT Supreme Energy Muara Laboh consortium with the Japan Bank for International Cooperation, the Asian Development Bank and a set of commercial banks under a guarantee from Nippon Export and Investment Insurance, to support clean energy development in Indonesia.

ENGIE has been present in Indonesia for over 60 years. Muara Laboh is the first renewable project of the Group in the country. ENGIE Indonesian employees are committed to contributing to the sustainable development of one of the world's fastest-growing economies, through increasing energy supply with natural gas and renewable power (geothermal, solar, biogas), as well as improving energy efficiency and providing solutions to the challenges of rapid urbanization.

About ENGIE

ENGIE develops its businesses (power, natural gas, energy services) around a model based on responsible growth to take on the major challenges of energy's transition to a low-carbon economy: access to sustainable energy, climate-change mitigation and adaptation and the rational use of resources. The Group provides individuals, cities and businesses with highly efficient and innovative solutions largely based on its expertise in four key sectors: renewable energy, energy efficiency, liquefied natural gas and digital technology. ENGIE employs 154,950 people worldwide and achieved revenues of €69.9 billion in 2015. The Group is listed on the Paris and Brussels stock exchanges (ENGI) and is represented in the main international indices: CAC 40, BEL 20, DJ Euro Stoxx 50, Euronext 100, FTSE Eurotop 100, MSCI Europe, DJSI World, DJSI Europe and Euronext Vigeo (World 120, Eurozone 120, Europe 120 and France 20).

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18.5 Organisation chart ENGIE Netherlands – EVIS – EES