Engineering for everyday world

AceEngineer

Energy Economics

Development Document

13th December 2018

13-Dec-2018	01	New Issue					VA	-	-
DATE	**REV**	**DESCRIPTION**					**ORIG**	**CHK**	**APPR**
DOCUMENT CONTROL NO		**Project**	**Type**	**Area**	**Client**	**-**	**-**	**Sequence**	**Revision**
		0026	**PY**	**-**	**-**	**-**	**-**	**0001**	**01**

Revision History:

REV	DATE	DESCRIPTION	ORIG	CHK	APPR
01	9th Dec 2014	Manual for python coding	MP	VA	VA

Change Log

REV	SECTION	CHANGE DESCRIPTION

Document Holds

Hold	DESCRIPTION
HOLD 01	

CONTENTS

1 INTRODUCTION

FDAS project objectives:
1/ Need definitions OOIG (oi in play)
Table of plays
Jilia is the poster child
Julia,
Stones
Cascade Chinook
Jack St. Malo

Need to get production data by month
Need to get

Program objectives:
Get the data first in python code program. Get plots.
List of wells in field
Develop Footprint of the wells.

Perform ROI (Return on Investment). Together with DF.

2 SUMMARY

2.1 Clients

https://youtu.be/xsAZ0jWI2dM
https://www.oedigital.com/news/488319-video-futureon-launches-new-software-for-digital-field-planning

2.2 To Do

The following things are pending in order of importance:

- Refine rig Days to assign open_hole logging/ops to Drilling instead of Completions. Suggest to refactor code as follows:
    - Add completion_start_date
    - Utilize logic to add open_hole_days prior to completion_start_date
    - Add the open_hole_days to drilling_days
    - Also prepare a rig_dict that can be displayed for users to see the logic utilized for all sub code categories (Drilling Active, Drilling Suspended.. etc.).

    - Potential miscalculations:
        - Roy "On Stones SN213 I counted 42 days (vs. 73 on app) on completion." some days from open hole operations are getting added to completion.
        - Roy "I came up with more like 56 days completion (vs. 39 on app) on Stones SN207". Some open hole days (~10) are added which is a miscalculation. How did Roy end up getting 56 which is much more?
- Rerunning error out. Somehow, check database if df is zero or not successfully inserted, error out and stop rest of process? We do not want users to tell that well data is missing for a field – very embarrassing.
- Data Refresh plan:
    - Need data refresh plan out
    - Download all files automatically
    - Import them into databases autonomously (with appropriate failures etc.)
    - Need a good summary of the data refresh that can be shown on the app screen
- Add a single Excel sheet with all the data so it makes download for end users (Roy) easier
- Directional Drilling Data with statistical summary
    - Make all 3 axes equal and add one more graph ()
    - It would be useful to be able to access the directional survey data to look at where they kicked off and what angles were used to build and drop.
        - Also max angle of the well.
        - For example on Stones 001aa they show a final departure of greater than 10,000'. I would like to get a table that shows the surveys for the well to study it in more detail.
- Casing program summary

3 DATA

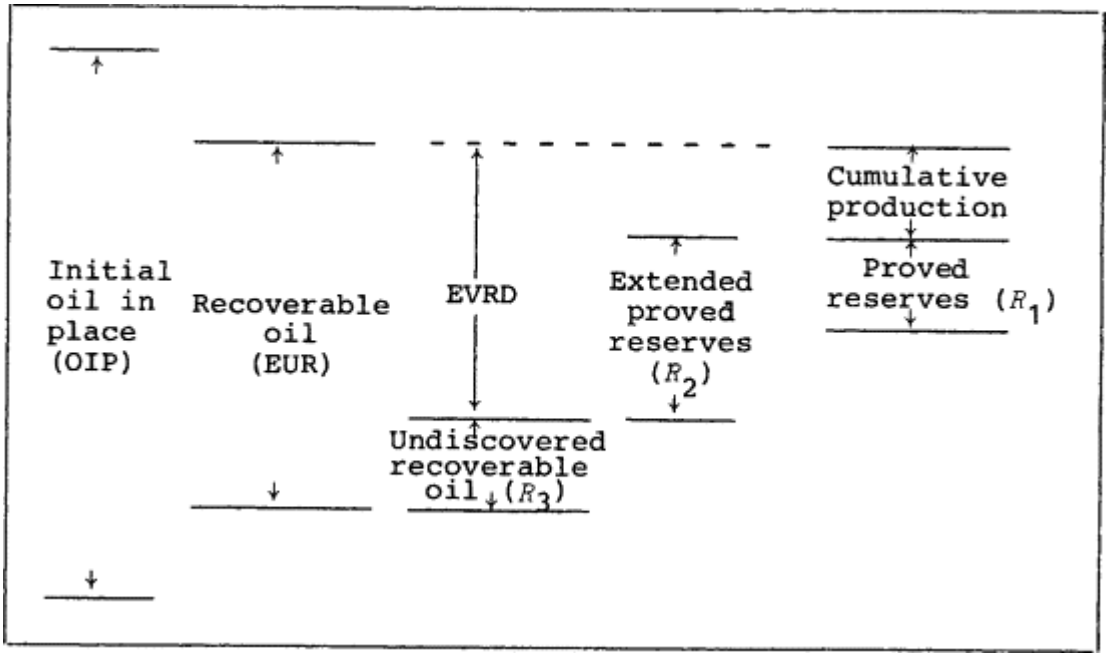
3.1 Definitions

AFD Approval for drilling

3.1.1 Reserves

OOIP Original Oil In Place, Initial Oil in Place. Also abbreviated as OIP
OIP Oil in Place or OOIP
OIIP Oil initially in place
STOIIP Stock tank oil initially in place. Volumed filled by the extracted oil
BOEM Original Oil: Original Recoverable Oil = Cumulative oil produced + SEC Oil Reserves
SEC Oil Reserves Reserves on Production + P2 (probable) Reserves. Calculated based on previous year average price

EUR Expected Ultimate Recovery (or) Recoverable Oil



Key References
https://www.investopedia.com/terms/o/oil-initially-in-place.asp
https://www.investopedia.com/terms/r/recoverabel-reserve.asp

https://petrowiki.org/Oil_in_place Detailed calculations
http://www.kgs.ku.edu/DPA/Reports/Minneola/index.html A Case Study

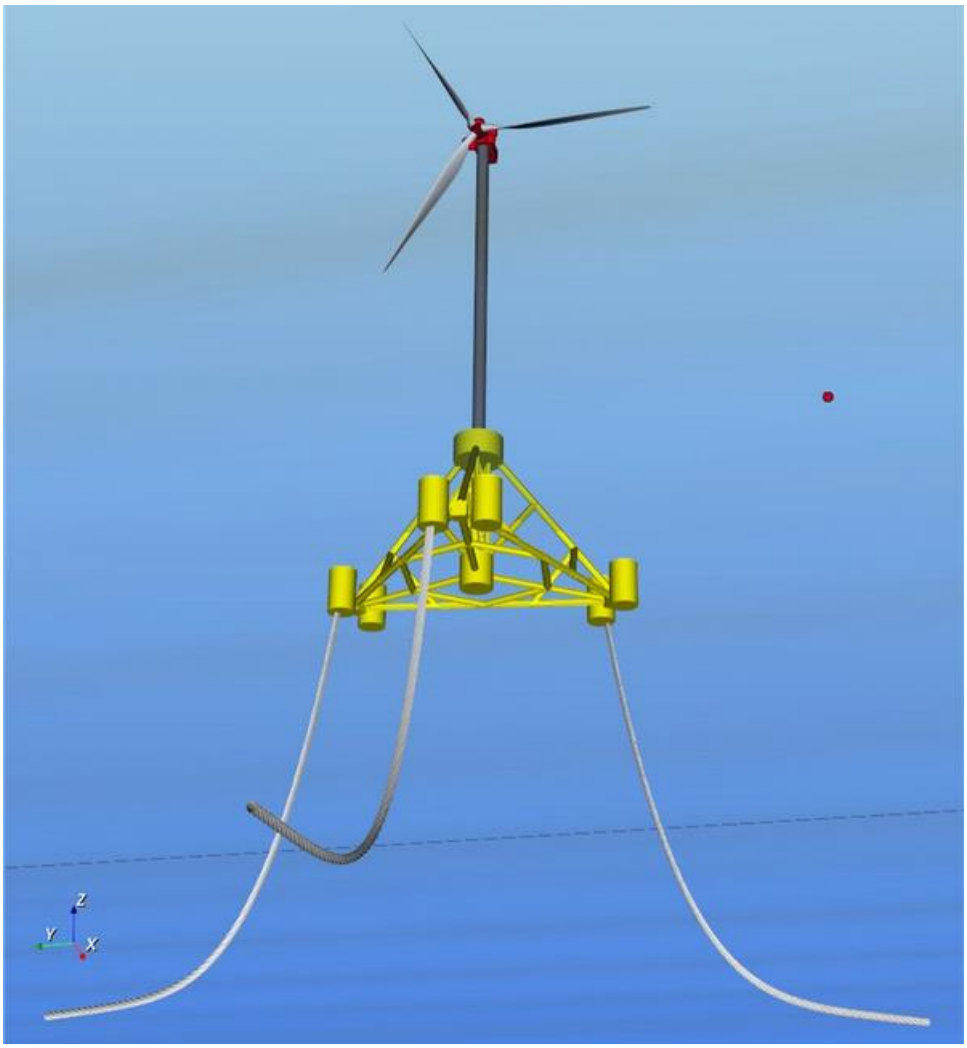
3.2 Data Source – Wind Turbines

https://www.dock90.com/windfloatatlantic/principle-power
https://www.principlepowerinc.com/en/home

https://eerscmap.usgs.gov/uswtdb/
https://eerscmap.usgs.gov/uswtdb/data/
https://eerscmap.usgs.gov/arcgis/rest/services/uswtdb/uswtdbTiled/MapServer
https://eerscmap.usgs.gov/arcgis/rest/services/uswtdb/uswtdbDyn/MapServer/0

https://www.youtube.com/watch?v=rGK6M0cn-F4
https://www.sciencebase.gov/catalog/item/57bdfd8fe4b03fd6b7df5ff9

Python notebook for location and capacity:
https://code.usgs.gov/cdi/cdi-fy20/jupyter-data-stories/-/blob/main/examples/wind_turbine/uswtdbApiMapVizExamples.ipynb



https://www.oedigital.com/news/488224-bureau-veritas-launches-digital-simulation-tool-for-floating-wind

3.3 Data Source – Energy Price

3.3.1 Crude Oil

https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M

3.3.2 Natural Gas

3.4 Data Source – US GoM

3.4.1 Summary

Description	Filename	Date	Used for Project?	Record Count	Comments
Exploration or Dev Plan Requests	ExplDevPlans.csv	Mar 2020	N		
Permanent platforms installed	PermanentPlatforms.csv	Mar 2020			
API with surface & Bottom lease info	APIList.csv	Mar 2020		54,619	
Lease and Area Block Info	LeaseAreaBlock.csv			30,563	
Approval Permit to Drill (APD)	APD.csv	Mar 2020	Y	24,667	Does not contain all development wells
Electronic APD	eAPD.csv	Mar 2020		14,892	
Approval Permit to Modify (APM)	APM.csv	Mar 2020		77,248	Contains all operations on wells
2018 Sands	2018 Atlas Update.xlsx	Mar 2020	Y		
Field Names vs. Field Nicknames; Yearly Revisions of Oil Reserves	2017 Tables xlsx Public.xlsx (2017 Hist.xlsx)				
Bore hole pressure	BHPS.csv				
Borehole with API	Borehole.csv	Mar 2020	Y		Surface & Bottom
	Borehole-by-Area-Block.pdf				
	Borehole-by-Lease.pdf				
Monthly prod data by lease number (and no. of completions)	ProdData.csv				
??	EOR.csv				
High level info only	Well-Completions-Leases.PDF				PDF Data. Should we reach out to BSEE for detailed info?
Well Test data	Well Test.PDF				conducted every 3 - 6 months. PDF Data.
eWellEORRawData	End of Operations Report				Contains how well

					is cut and closed out Etc.
eWellWARRawData	Well Activity Report				
Well Directional Survey Data	dsptsdelimit.txt				
Lease Liability for P&A (USD)	LeaseLiabilities.csv				

Table 3-1 BSEE Data References

3.4.2 Raw Data URLs

URL Link source: https://www.data.bsee.gov/Main/RawData.aspx

Description	Filename	URL
API Lookup	APIRawData.zip	https://www.data.bsee.gov/Well/Files/APIRawData.zip
Exploration or Dev Plan Requests	ExplDevPlans.csv	
Permanent platforms installed	PermanentPlatforms.csv	
API with surface & Bottom lease info	APIList.csv	
Lease and Area Block Info	LeaseAreaBlock.csv	
Approval Permit to Drill (APD)	APD.csv	Does not contain all development wells
Electronic APD	eAPD.csv	
Approval Permit to Modify (APM)	APM.csv	Contains all operations on wells
2018 Sands	2018 Atlas Update.xlsx	
Field Names vs. Field Nicknames; Yearly Revisions of Oil Reserves	2017 Tables xlsx Public.xlsx (2017 Hist.xlsx)	
Bore hole pressure	BHPS.csv	
Borehole with API	Borehole.csv	Surface & Bottom
	Borehole-by-Area-Block.pdf	
	Borehole-by-Lease.pdf	
Monthly prod data by lease number (and no. of completions)	ProdData.csv	
??	EOR.csv	
High level info only	Well-Completions-Leases.PDF	PDF Data. Should we reach out to BSEE for detailed info?
Well Test data	Well Test.PDF	conducted every 3 - 6 months. PDF Data.
eWellEORRawData	End of Operations Report	Contains how well is cut and closed out Etc.
eWellWARRawData	Well Activity Report	
Well Directional Survey Data	dsptsdelimit.txt	
Lease Liability for P&A (USD)	LeaseLiabilities.csv	

3.4.3 General

A field may have multiple leases
Each lease may have multiple wells (API)
Each well may have multiple completions. There are no completion IDs.

3.4.4 G&G Sands

2018 G&G Sands are available.

Description	Tables		
Chronozones	2018cronozones		
Play Names	2018plays		
	2018sands		
	2018xref_oper-comp		

Table 3-2 2018 G&G Sands,

Key Queries:

All Wilcox Assuming Chronozone = PLU-LL (71 records)
SELECT * FROM [master].[dbo].[2018sands]
WHERE CHRONOZONE = 'PLU-LL'

Cascade Chinook (# 3 records; 2 APIs)
SELECT * FROM [master].[dbo].[2018sands]
WHERE BOEM_FIELD in ('WR205', 'WR206', 'WR469', 'WR470')

Cascade Chinook (# 11 records; 9 APIs Including the 1997, 1998 Chinook subsea tie-ins?)
SELECT * FROM [master].[dbo].[2018sands]
WHERE BOEM_FIELD in ('WR205', 'WR206', 'WR469', 'WR470', 'MP283')

Julia (# 5 records, 2 APIs)

SELECT * FROM [master].[dbo].[2018sands]
WHERE BOEM_FIELD in ('WR627')

Stones (#5,
SELECT * FROM [master].[dbo].[2018sands]

WHERE BOEM_FIELD in ('WR508')

Field	BOEM Blocks	Setup	Run?
Kaskida	KC291, KC292	Yes	No wells plot No production, switchoff plotting
Tiber	KC102	Yes	No wells plot No production, switchoff plotting
Tigris	KC102	Yes	No wells plot No production, switchoff plotting
Shenandoah	WR051	Yes	No wells plot No production, switchoff plotting
Julia	WR627	Yes	Yes
Stones	WR508	Yes	Yes
JSM	-	-	-
Jack	WR758, WR759	Yes	Yes
St.Malo	WR678	Yes	Yes
Cascade Chinook	WR205', 'WR206', 'WR469', 'WR470'	Yes	Yes
Cascade	WR205, WR206	Yes	Yes
Chinook	WR469, WR470	Yes	Yes
Anchor	GC807	Yes	No wells plot No production, switchoff plotting
Buckskin	KC 872 (785, 828, 829, 830, 871, and 872)	Yes	Yes
Guadalupe	KC010		Yes
North Platte	GB915', 'GB916', 'GB958', 'GB959	Yes	No wells plot No production, switchoff plotting
Moccasin	KC736		No wells plot No production, switchoff plotting
Gila	KC093		No wells plot No production, switchoff plotting

Gibson	KC096		No wells plot No production, switchoff plotting
Coronado	WR098	Yes	No wells plot No production, switchoff plotting
Big Foot	WR029	Yes	Yes

Table 3-3 : Lower Tertiary Wells

3.4.5 Well API Data

Contains raw API data:
https://www.data.bsee.gov/Well/Files/APIRawData.zip

3.4.6 Production Data

Production data:

- Download year by year data in asci format from below
  - https://www.data.bsee.gov/Main/OGOR-A.aspx
- Download year by year
- Integrate into the pipelines
- Column headers for ASCII delimit format:
  - https://www.data.bsee.gov/Main/HtmlPage.aspx?page=ogorA
- Raw data is available here but some columns are missing (eg: “Days Produced” etc.)
  - https://www.data.bsee.gov/Production/Files/ProductionRawData.zip

3.4.7 Borehole

Bore hole data (Start and end)
Start and end longitude and latitude

3.4.8 Well Activity Reports

- E-submit APD
  - https://www.data.bsee.gov/Well/eWellAPD/Default.aspx
- Look by API12
- Download PDF
- May contain:
  - casing Info
  - (and additional) information as follows
  - Where to find salt top and bottom info

File	Key Columns
WAR (Well Activity Report)	
mv_war_main	SN_WAR, Start day, end day, Rig Name, SideTrack Suffix, ByPass Suffix, BOP Test : Test Date, RAM Pressure, Annular Pressure
mv_war_main_prop_remark	SN_WAR, TEXT_REMARK
mv_war_tubular_summaries_prop	SN_WAR_FK, SNWAR_CSNG_INT_FK, Casing Setting Bottom MD, Casing Setting Top MD
mv_war_tubular_summaries	SN_WAR_FK, Casing Interval Type CD, Casing hole Size, Casing Size, Casing Weight, Casing Grade, Casing Liner test pressure, Casing Shoe test Pressure, Casing Cement Volume, SN_WAR_CSNG_INTV
mv_war_boreholes_view	[API_WELL_NUMBER], [BOTM_LEASE_NUM],[WELL_SPUD_DATE], [TOTAL_DEPTH_DATE], [BOREHOLE_STAT_DT], [BH_TOTAL_MD], [WELL_BORE_TVD]
mv_war_main_prop	[SN_WAR],[WELL_NAME_SUFFIX],[WELL_ACTV_START_DT], [TOTAL_DEPTH_DATE],[WELL_ACTIVITY_CD], [WELL_ACTV_END_DT],[DRILLING_MD],[DRILLING_TVD], [DRILL_FLUID_WGT],[GEOCHEM_SMPL_COLLECTED_CD], [LITHO_SAMPLE_COLLECTED_CD],[PALEO_SAMPLE_COLLECTED_CD], [SIDEWALL_SMPL_COLLECTED_CD],[CONV_CORE_COLLECTED_CD], [VELOCITY_SURV_COLLECTED_CD]
mv_war_open_hole_tools	SN_OPEN_HOLE_FK, LOG_TOOL_TYPE_CODE
mv_war_open_hole_runs	SN_WAR_FK, BUS_ASC_NAME, OPERATIONS_COMPLETED_DATE, TOOL_LOGGING_METHOD_NAME, LOG_INTV_TOP_MD, LOG_INTV_BOTM_MD, SN_OPEN_HOLE
BOREHOLE_STATUS_CDS	[Value],[Description]
EOR (End Of Operations Report)	
mv_eor_completions	[SN_EOR_FK] ,[SN_EOR_WELL_COMP], Production Interval, [COMP_LEASE_NUMBER], [COMP_AREA_CODE], [COMP_BLOCK_NUMBER],[COMP_STATUS_CD]
mv_eor_completionsprop	[SN_EOR_FK], [SN_EOR_WELL_COMP], [COMP_LATITUDE], [COMP_LONGITUDE], [COMP_RSVR_NAME], [COMP_INTERVAL_NAME]
mv_eor_compstatcodes	Reference Table; Value, Value_Description
mv_eor_cut_casings	[SN_EOR_FK] ,[CASING_SIZE] ,[CASING_CUT_DATE] ,[CASING_CUT_METHOD_CD] ,[CASING_CUT_DEPTH] ,[CASING_CUT_MDL_IND]
mv_eor_casingcutcodes	Reference Table: Value, Abbreviation;
mv_eor_geomarkers	[SN_EOR_FK] ,[GEO_MARKER_NAME] ,[TOP_MD]
mv_eor_hcbearing_intvl_comps	[SN_EOR_WELL_COMP_FK] ,[SN_HC_BEARING_INTVL_FK]
mv_hcbearing_intervals	SN_HC_BEARING_INTVL,

	SN_EOR_FK, INTERVAL_NAME, TOP_MD, BOTTOM_MD, HYDROCARBON_TYPE_CD There can be multiple HC Bearing Intervals encountered. These can be with/without overlapping MD Range.
mv_eor_hydrobarbtypecodes	Reference Table [VALUE] ,[VALUE_DESC]
mv_eor_mainquery	[SN_EOR] ,[EOR_OPERATION_CD] ,[API_WELL_NUMBER] ,[WELL_NAME] ,[WELL_NM_ST_SFIX] ,[WELL_NM_BP_SFIX] ,[MMS_COMPANY_NUM] ,[BUS_ASC_NAME] ,[BOTM_LEASE_NUMBER] ,[BOTM_AREA_CODE] ,[BOTM_BLOCK_NUMBER] ,[SURF_LEASE_NUMBER] ,[SURF_AREA_CODE] ,[SURF_BLOCK_NUMBER] ,[BOREHOLE_STAT_CD] ,[BOREHOLE_STAT_DT] ,[OPERATIONAL_NARRATIVE] ,[SUBSEA_COMPLETION_FLAG] ,[SUBSEA_PROTECTION_FLAG] ,[SUBSEA_COMPLETION_BUOY_FLAG] ,[SUBSEA_TREE_HEIGHT_AML] ,[OBSTRUCTION_PROTECTION_FLAG] ,[OBSTRUCTION_TYPE_CD] ,[OBSTRUCTION_BUOY_FLAG] ,[OBSTRUCTION_HEIGHT_AML]
mv_eor_mainquery_prop	[SN_EOR] ,[BOTM_LONGITUDE] ,[BOTM_LATITUDE] ,[BH_TOTAL_MD] ,[WELL_BORE_TVD] ,[WELL_BP_ST_KICKOFF_MD]
mv_eor_perf_intervals	[SN_EOR_WELL_COMP_FK] ,[PERF_TOP_MD] ,[PERF_BOTM_TVD] ,[PERF_TOP_TVD] ,[PERF_BASE_MD]
Direct Measurements (not loaded into DB)	"177000002801"," 1607.00"," .000"," 180.000"," 1607.00","29.6498363"," -93.5933657","","","","","06/03/2011" "177000002801"," 1674.00"," 4.500"," 263.000"," 1673.93","29.6498353"," -93.5933739","","","","","06/03/2011" "177000002801"," 1741.00"," 5.750"," 263.000"," 1740.66","29.6498329"," -93.5933925","","","","","06/03/2011" "177000002801"," 1786.00"," 5.750"," 246.000"," 1785.44","29.6498294"," -93.593406","","","","","06/03/2011"

	https://www.data.bsee.gov/Main/HtmlPage.aspx?page=dirSurvAzimuth
DirectionalSurveyPoints	https://www.data.bsee.gov/Main/HtmlPage.aspx?page=dirSurvPoints **API_WELL_NUMBER** **INCL_ANG_DEG_VAL** **INCL_ANG_MIN_VAL** **SURVEY_POINT_MD** **WELL_N_S_CODE** **DIR_DEG_VAL** **DIR_MINS_VAL** **WELL_E_W_CODE** **SURVEY_POINT_TVD** **DELTA_X** **DELTA_Y** **SURF_LONGITUDE** **SURF_LATITUDE**

3.4.9 Data Files | Manual

The following files are imported manually and they work

File	Key Changes
eWellEORRawData \mv_eor_mainquery.txt	Replace "\U" with "/U". Unicode escape error.
mv_war_main.txt	Deleted "\" by replacing with empty character
mv_war_main_prop_remark.txt	Replaced "\" with "/"
Mv_bhpsurvey.txt	Replaced "\" with "/"?

3.5 Data Sources – NPD

https://www.worldoil.com/news/2017/4/4/npd-reports-6-000-wells-on-the-norwegian-shelf
https://www.npd.no/en/about-us/information-services/available-data/

https://factpages.npd.no/en/field/tableview/production/saleable/monthly
https://factpages.npd.no/en/wellbore/statistics/entryyear

https://factpages.npd.no/en/wellbore
https://factpages.npd.no/en/wellbore/pageview/development/all/6612

https://factpages.npd.no/en/field/tableview/resources
https://factpages.npd.no/en/field/tableview/inplacevolumes

Geological data sharing on shallow water wellbores
https://www.offshore-mag.com/geosciences/article/14174903/norwegian-petroleum-directorate-makes-available-offshore-shallow-wellbores-for-stratigraphy-studies?utm_source=OFF+Daily&utm_medium=email&utm_campaign=CPS200428056&o_eid=2327J8748301C3W&rdx.ident%5Bpull%5D=omeda%7C2327J8748301C3W&oly_enc_id=2327J8748301C3W

3.6 Data Sources –US States

3.6.1 Colorado

Currently providing from Colorado, US:

- Production Data
- Formation Tops

https://github.com/Rocks-n-Code/COGCCpy

3.6.2 Texas

https://github.com/vamseeachanta/TXRRC_data_harvest

Installation

```
$ pip install COGCCpy
```

Production Example

```
from COGCCpy import production

apis = ['05-013-40002','0501305023']
prod = production(apis)

#Preview production data
prod.df.head()
```

Formation Tops Example

```
from COGCCpy import formation_tops

apis = ['0501306049','05-013-06457']
tops = formation_tops(apis)

#Preview formation tops
tops.df.head()
```

3.7 Data Sources – UK

https://www.ogauthority.co.uk/data-centre/
https://data-ogauthority.opendata.arcgis.com/

3.8 Metocean

https://blogs.dnvgl.com/energy/tropical-storm-isaias-what-did-it-mean-for-the-ny-bight
https://oswbuoysny.resourcepanorama.dnvgl.com/download/f67d14ad-07ab-4652-16d2-08d71f257da1?_ga=2.158735098.1714304250.1604593589-818200915.1600785057

3.8.1 Wind

https://oswbuoysny.resourcepanorama.dnvgl.com/?_ga=2.154589816.1714304250.1604593589-818200915.1600785057

3.8.2 Geoscience Data

https://github.com/yohanesnuwara/open-geoscience-repository

4 THEORY – OIL AND GAS

4.1 Go-by Architectures

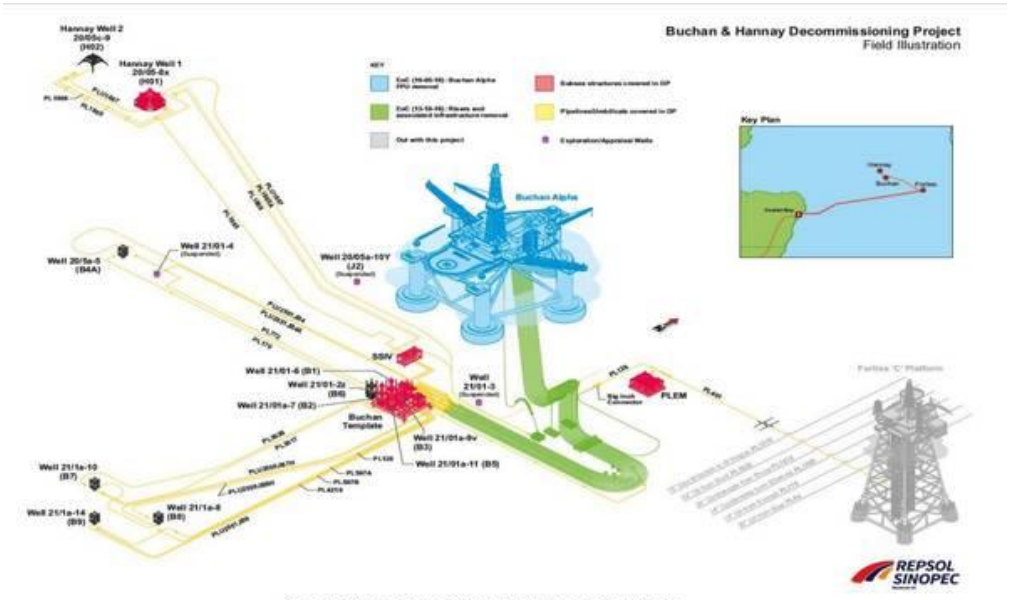
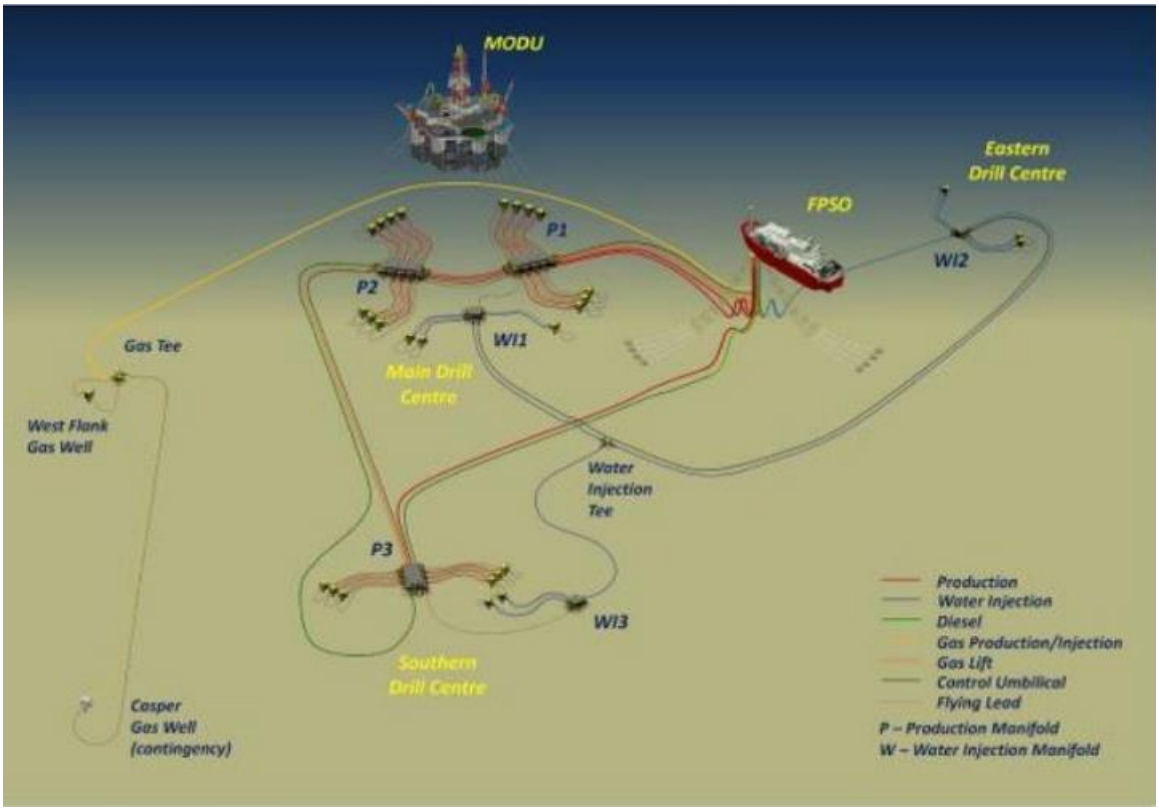
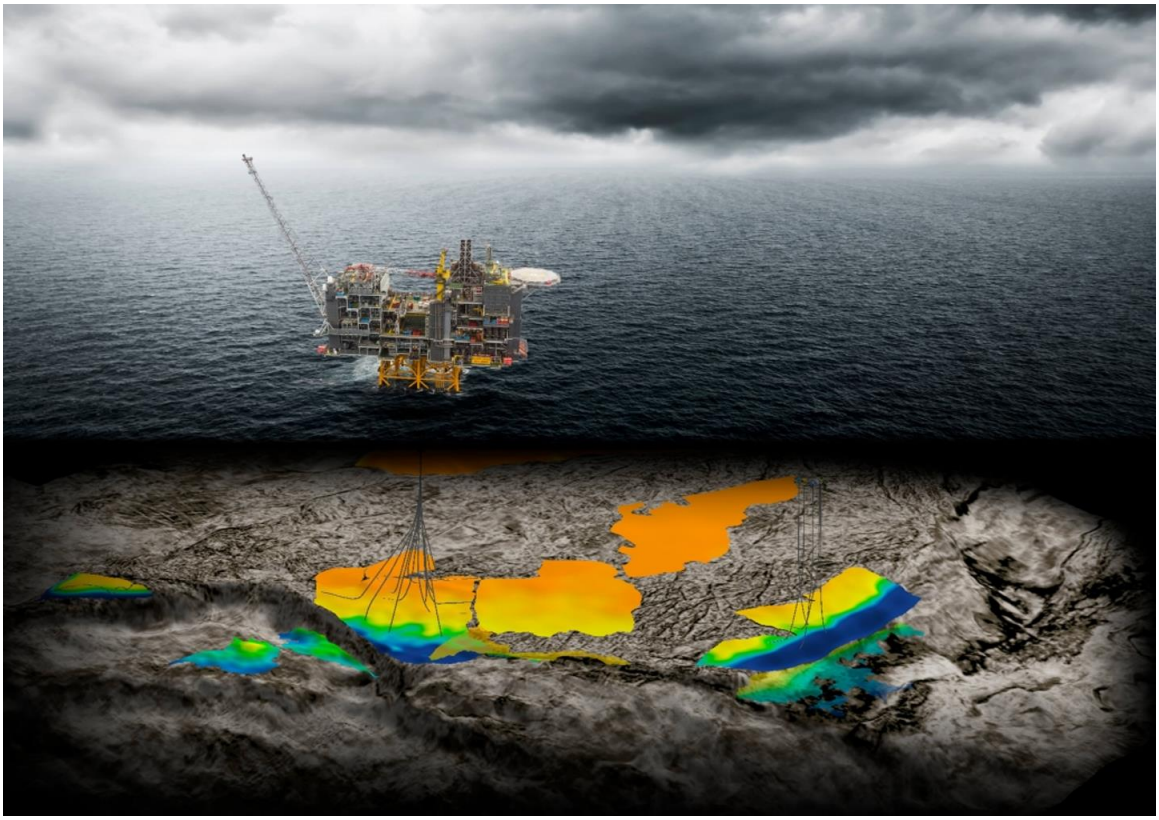


Figure 1-1: Representative schematic of the Buchan and Hannay fields

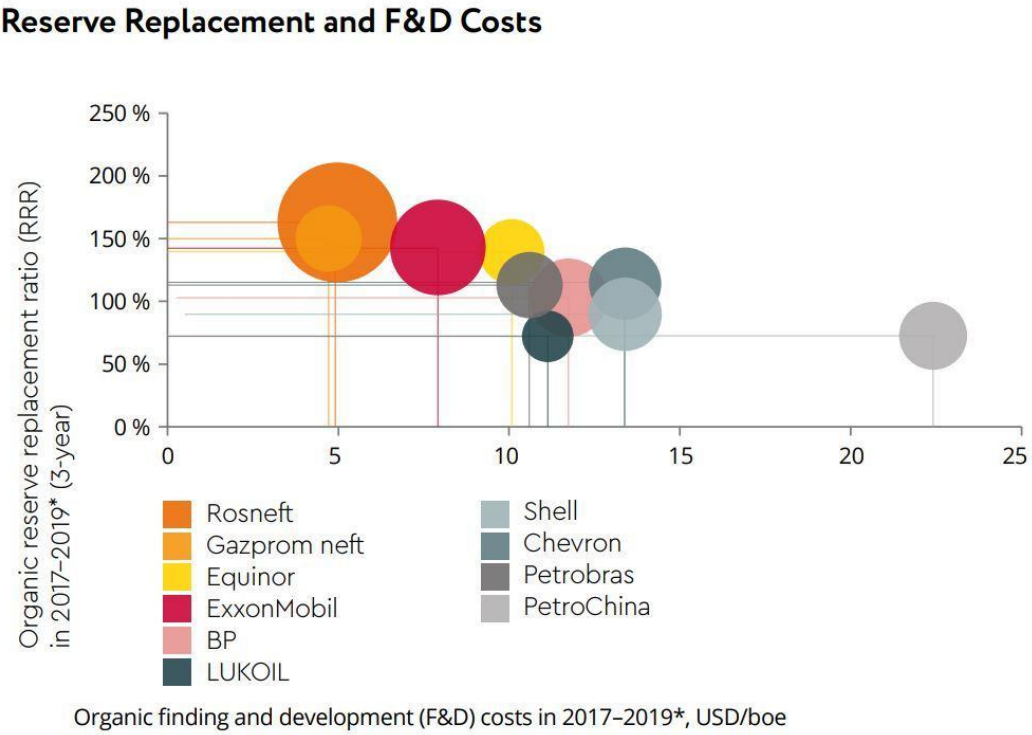

MODU
Eastern Drill Centre
FPSO
P1
P2
WI2
WI1
Gas Tee
Main Drill Centre
West Flank Gas Well
Water Injection Tee
P3
WI3
Southern Drill Centre
Casper Gas Well (contingency)
Production
Water Injection
Diesel
Gas Production/Injection
Gas Lift
Control Umbilical
Flying Lead
P – Production Manifold
W – Water Injection Manifold


Production barge
Floating hose from production barge to shuttle tanker
Shuttle tanker
Wellhead platform (WHP)
Production flowlines
KRISENERGY



4.2 Oil Reserves

Oil reserves are estimated annually and are dependent on the oil price in the previous year. See reserves definitions, section 3.1.1 for more appropriate definition.



4.3 Development

4.3.1 Royalty

4.3.2 Overriding Royalty Interest, ORRI

ORRIs are created out of the working interest in a property and do not affect mineral owners. An overriding royalty interest (ORRI) is often kept or assigned to a geologist, landman, brokerage, or any entity that was able to reserve an interest in the properties.

https://mercercapital.com/energyvaluationinsights/how-to-value-overriding-royalty-interests/
https://www.mineralweb.com/library/oil-and-gas-terms/overriding-royalty-interest-orri-definition/
https://mineralrightspodcast.com/mrp-43-overriding-royalty-interests/

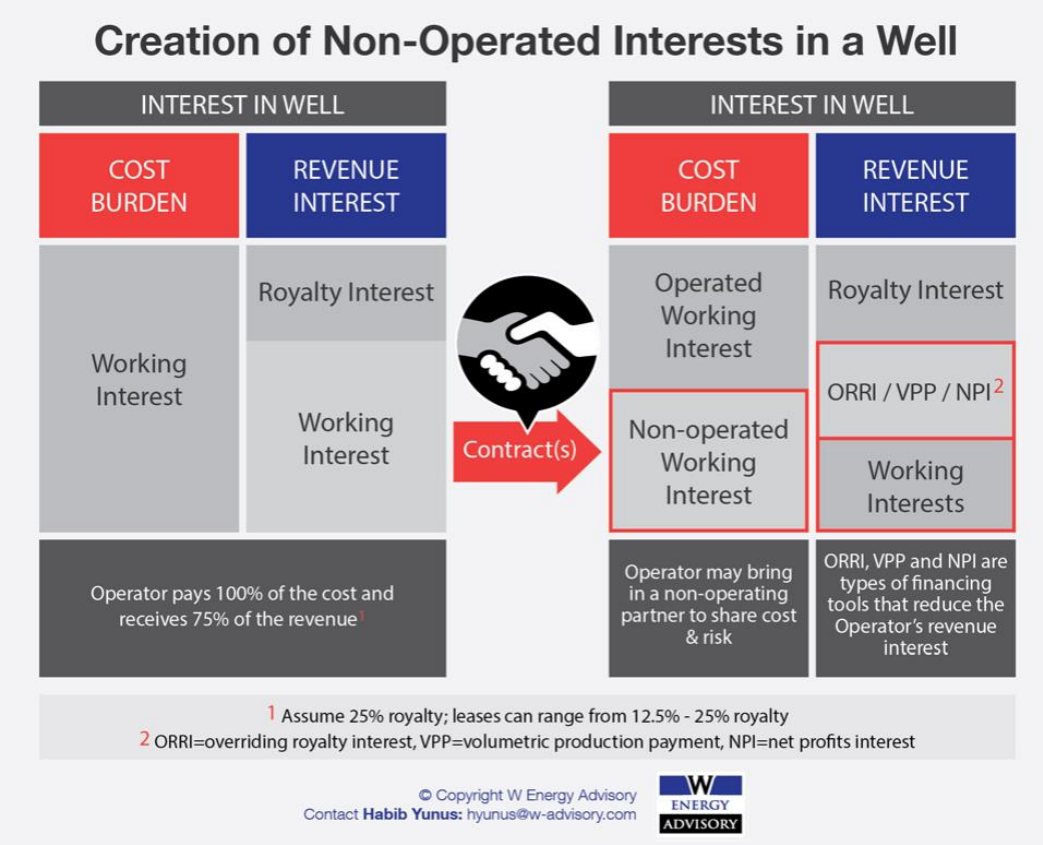
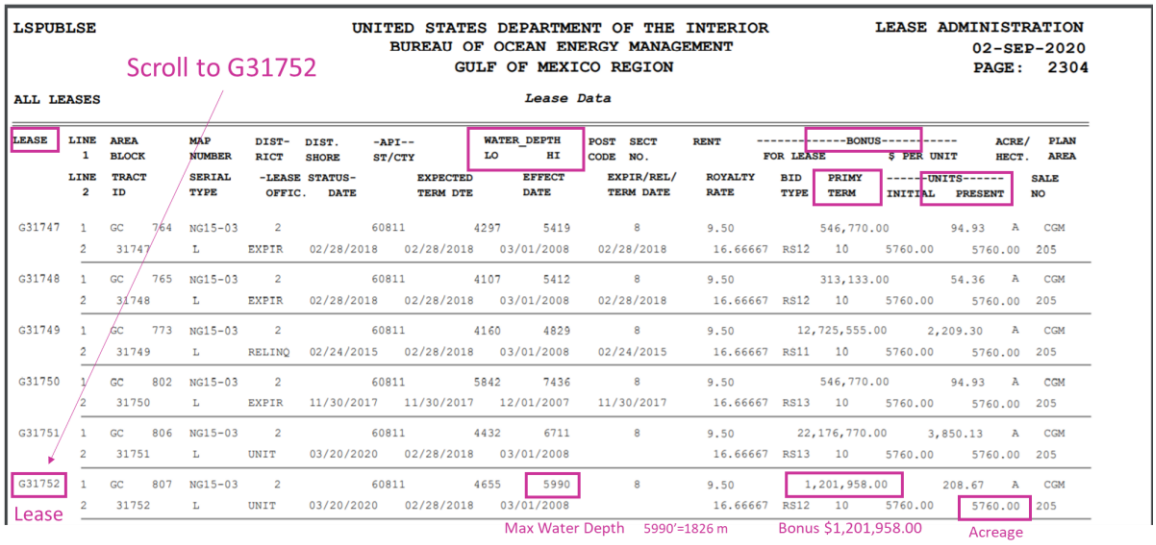


Figure 4-1 Non-Operating Interests in O&G

4.3.3 Lease

See "Using BOEM Data Center to Find Costs.pptx" for getting further information.

This will open https://www.data.boem.gov/leasing/files/1221.pdf



LSPUBLSE — UNITED STATES DEPARTMENT OF THE INTERIOR — BUREAU OF OCEAN ENERGY MANAGEMENT — GULF OF MEXICO REGION — LEASE ADMINISTRATION — 02-SEP-2020 — PAGE: 2304

ALL LEASES — *Lease Data*

Scroll to G31752

LEASE	LINE	AREA	BLOCK	MAP NUMBER	DIST-RICT	DIST. SHORE	-API-- ST/CTY	WATER_DEPTH LO	WATER_DEPTH HI	POST CODE	SECT NO.	RENT	BONUS FOR LEASE	BONUS $ PER UNIT	ACRE/ HECT.	PLAN AREA
	LINE 2	TRACT ID	SERIAL TYPE	-LEASE STATUS- OFFIC.	DATE	EXPECTED TERM DTE	EFFECT DATE	EXPIR/REL/ TERM DATE	ROYALTY RATE	BID TYPE	PRIMY TERM	UNITS INITIAL	UNITS PRESENT		SALE NO	
G31747	1	GC	764	NG15-03	2		60811	4297	5419	8	9.50		546,770.00	94.93	A	CGM
	2	31747	L	EXPIR	02/28/2018	02/28/2018	03/01/2008	02/28/2018	16.66667	RS12	10	5760.00	5760.00		205	
G31748	1	GC	765	NG15-03	2		60811	4107	5412	8	9.50		313,133.00	54.36	A	CGM
	2	31748	L	EXPIR	02/28/2018	02/28/2018	03/01/2008	02/28/2018	16.66667	RS12	10	5760.00	5760.00		205	
G31749	1	GC	773	NG15-03	2		60811	4160	4829	8	9.50		12,725,555.00	2,209.30	A	CGM
	2	31749	L	RELINQ	02/24/2015	02/28/2018	03/01/2008	02/24/2015	16.66667	RS11	10	5760.00	5760.00		205	
G31750	1	GC	802	NG15-03	2		60811	5842	7436	8	9.50		546,770.00	94.93	A	CGM
	2	31750	L	EXPIR	11/30/2017	11/30/2017	12/01/2007	11/30/2017	16.66667	RS13	10	5760.00	5760.00		205	
G31751	1	GC	806	NG15-03	2		60811	4432	6711	8	9.50		22,176,770.00	3,850.13	A	CGM
	2	31751	L	UNIT	03/20/2020	02/28/2018	03/01/2008				16.66667	RS13	10	5760.00	5760.00	205
G31752	1	GC	807	NG15-03	2		60811	4655	5990	8	9.50		1,201,958.00	208.67	A	CGM
	2	31752	L	UNIT	03/20/2020	02/28/2018	03/01/2008				16.66667	RS12	10	5760.00	5760.00	205

Lease — Max Water Depth 5990'=1826 m — Bonus $1,201,958.00 — Acreage

4.4 Well

4.4.1 Well Reviews

https://prowellplan.com/news/35-11-24-5-min-well-review
https://prowellplan.com/data-driven-workflow/dugong-exploration-well-5-min-review

4.4.2 Well Data

It would be good to have an accompanying table that shows surface and bottom hole x-y, and well depth.

~~Well Name~~
~~Operator~~
~~Water Depth~~
Drive Size
Drive Depth
~~Start Date (Spud Date)~~
~~TD Date (Total Depth Date)~~
~~Drill days~~
Complete days (How?)
~~Surface location~~
Kick Off Point (KOP)
~~Final Total Vertical Depth~~
~~Final Total Measured Depth (BH Total MD (feet))~~

Plug back depth (Add to Well data – Which df?)
~~Bottom hole location~~
~~Number of sidetracks~~
Casing program (~~all strings including shoe test~~, ~~weight, grade~~, connections, burst, collapse, pore pressure, ~~liner top~~)
Mud weights in different hole sections
Mud weight at TD
Formation tops
Perforation intervals
~~Tree height above mudline (Add to Well data)~~

Distinguishing between Exploration and Development Wells. Typically the timelines will be pretty distinct and demarcated. The exploration wells are way earlier and there will be a minimum of 2-3 year gap and longer timeline wells.

Make it clickable with the ability clear for users to use
Producers
Non-producers

A journey inside a wellbore
https://www.linkedin.com/feed/update/urn:li:activity:6657902297445732355/

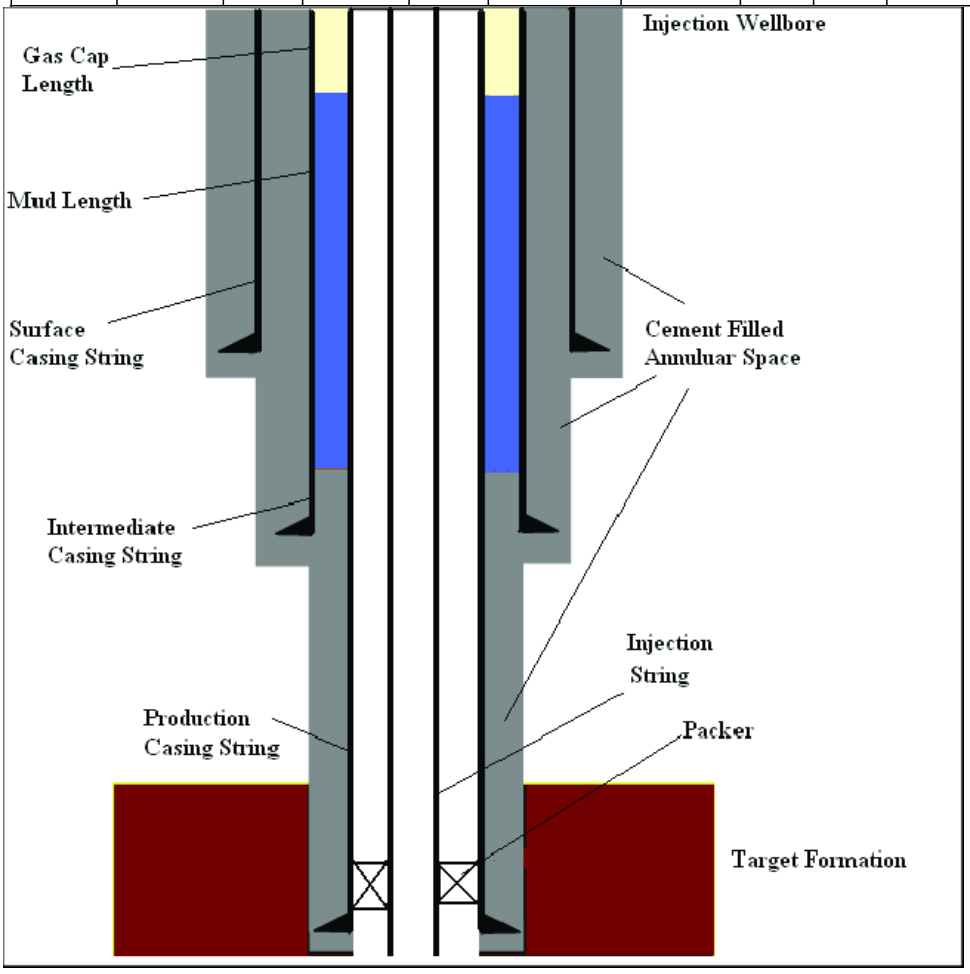
https://www.linkedin.com/pulse/geological-mapping-coordinate-conversion-python-dicman-alfred/?trackingId=Zj3TYGUrTbqu08SEoKhQ1g%3D%3D

4.4.3 Casing Program

Get the program.
Display data per well

- Consolidate data to remove duplicates:
  - marginal clean up done
  - Clean up can be improved based on historical data of well activity and when records started appearing in well activity. Preliminary analysis shows this is also difficult to do.
- Column comparison of casing data (To be developed)
- Pictorial comparison of casing data (To be developed)

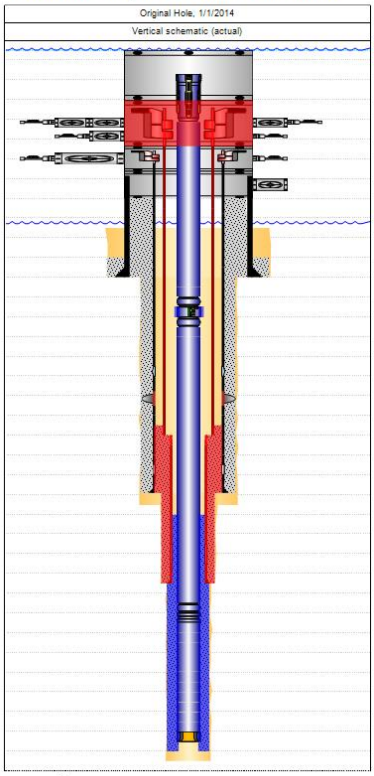
12. CASING/LINER/TUBING RECORD									
TUBULAR TYPE	HOLE SIZE (IN)	SIZE (IN)	WEIGHT (#/FEET)	GRADE	TEST PRESSURE (psi)	SHOE TEST (EMW)	SETTING DEPTH (MD)		CEMENT QUANTITY (Cubic Feet)
							LOW	HIGH	
C	12.25	10	73.9	Q-125HC	2800	0	0	15953	1199
C	12.25	10.05	73.9	JFE-15CR-125HC	2800	0	0	15953	1199
C	12.25	10.75	85.3	Q-125HC	2800	0	0	15953	1199
C	14.875	13.625	88.2	Q125	2550	15	0	24500	842
L	21	17.875	93.5	HCN-80	1800	13.4	9227	12528	2900
L	21	18	94	X-80	1800	13.4	9227	12528	2900
C	28	22	224.3	X-80		0	0	10206	10000



Well Barrier

WellView

Well Name: Sample 44 - Wellhead and Barriers



Description	Start Date	End Date
Production	1/1/2014	

Well Barrier Types

Barrier Number	Type	Subtype
P1	Primary	

Well Barrier Links

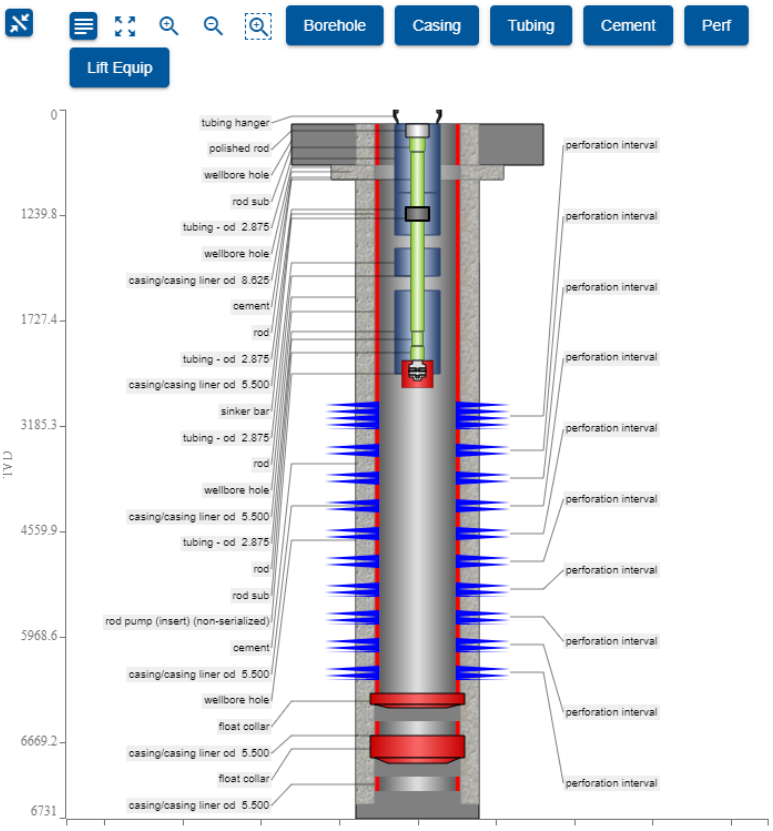
Item #	Link String	Associated Items
P1-1	4 1/2" TUBING CEMENT, Casing, 1/7/2008 00:00	1, 14,015.7-17,821.5ftKB
P1-2	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, DHSV
P1-3	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Flow coupling
P1-4	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-5	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-6	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-7	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Flow coupling
P1-8	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, 3.75"QN nipple
P1-9	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-10	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-11	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-12	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-13	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-14	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-15	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-16	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Pup Jt
P1-17	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-18	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Collar
P1-19	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Tubing
P1-20	4 1/2" Completion set at 17,804.9ftKB on 1/6/2008 12:30	4 1/2in, Wireline Guide

Barrier Number	Type	Subtype
S1	Secondary	

Well Barrier Links

Item #	Link String	Associated Items
S1-1	9 5/8" x 7", 15,913.0ftKB	Hanger, 9 5/8in
S1-2	9 5/8" x 7", 15,913.0ftKB	Pup Joint, 9 5/8in
S1-3	9 5/8" x 7", 15,913.0ftKB	Cross Over, 9 5/8in
S1-4	9 5/8" x 7", 15,913.0ftKB	Casing, 9 5/8in
S1-5	9 5/8" x 7", 15,913.0ftKB	Casing reducer, 7in
S1-6	9 5/8" x 7", 15,913.0ftKB	Casing, 7in
S1-7	9 5/8" x 7", 15,913.0ftKB	Baker locked joint, 7in
S1-8	9 5/8" x 7", 15,913.0ftKB	Float Collar, 7in
S1-9	9 5/8" x 7", 15,913.0ftKB	Baker locked joint, 7in
S1-10	9 5/8" x 7", 15,913.0ftKB	Float Shoe, 7in
S1-11	Compact Wellhead, CAMERON on 11/15/2007 00:00	9 5/8" Casing Bowl, 9 5/8"
S1-12	9 5/8" x 7" Casing cement, Casing, 11/27/2007 21:30	1, 4,389.8-15,913.0ftKB

www.peloton.com Page 1/1 Report Printed: 5/9/2017


Borehole
Casing
Tubing
Cement
Perf
Lift Equip
0
1239.8
1727.4
3185.3
4559.9
5968.6
6669.2
6731
TVD
tubing hanger
polished rod
wellbore hole
rod sub
tubing - od 2.875
wellbore hole
casing/casing liner od 8.625
cement
rod
tubing - od 2.875
casing/casing liner od 5.500
sinker bar
tubing - od 2.875
rod
wellbore hole
casing/casing liner od 5.500
tubing - od 2.875
rod
rod sub
rod pump (insert) (non-serialized)
cement
casing/casing liner od 5.500
wellbore hole
float collar
casing/casing liner od 5.500
float collar
casing/casing liner od 5.500
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval
perforation interval


Casing Setting Depth
Liner, Tieback
Open hole
Casing
0
2000
4000
6000
8000
10000
12000
25 0 -25

4.4.4 Well Completion Data

Top Perf TVD:
Bottom Perf TVD:
Top Perf MD:
Bottom Perf MD:
Plug Back TD:
Plug Back MD:
Anchor Depth TVD:
Anchor Depth MD:

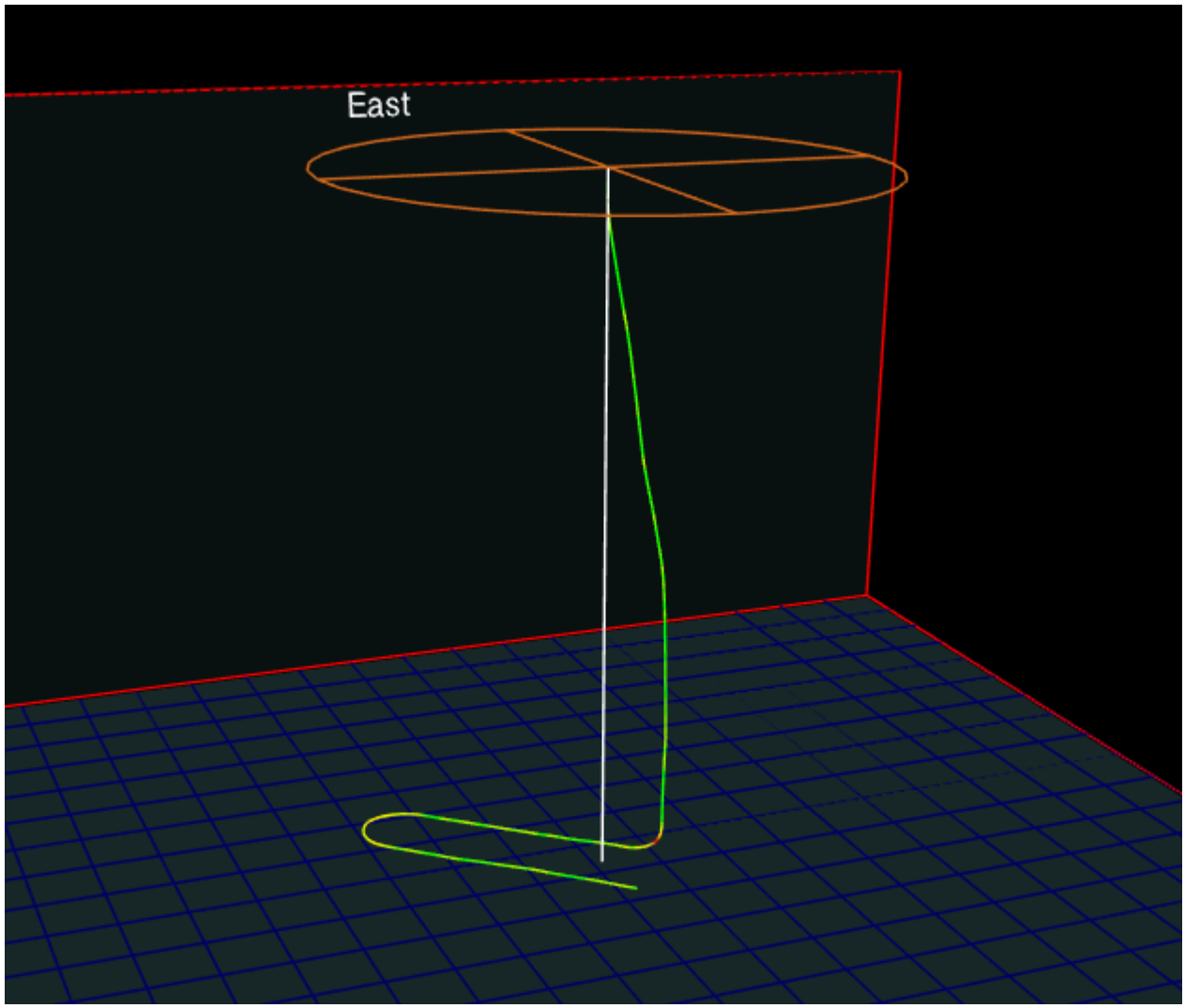
4.4.5 Well Operations

Well Activity Summary record for well

Well Activity Notes (Direct query by ID or similar):
Arrange into several sections in webpage

4.4.6 Well Path

https://github.com/microsoft/seismic-deeplearning



3D shape using survey data.

http://www.drillingformulas.com/minimum-curvature-method/
https://www.drillingformulas.com/tag/directional-drilling-calculations/

Python Package
https://pypi.org/project/well-profile/
https://github.com/pro-well-plan/well_profile
https://pwp-opensource.herokuapp.com/

Well Bore uncertainty

https://github.com/jonnymaserati/welleng

4.5 Reservoir

Is there completion info on the wells in the database?
Top of reservoir,
pay interval,
type of completion etc? That would help documenting the resource.

It would be great to have a one or two page summary of the well location, number of days drilling and completion, casing program, formation tops, mud weights etc. and maybe another multi-page report that has the operations summary listed from start to finish if possible.

4.5.1 Well Log

https://github.com/Oslandia/QGeoloGIS

I thought I would share some useful #python libraries that I have come across for working with well log and petrophysical data. I would highly recommend checking them out.

lasio: https://lnkd.in/dvJnQS8
A Python package that reads and writes LAS files. Loaded LAS files can be easily converted to pandas dataframes to carry out machine learning.

dlisio: https://lnkd.in/didSQ3H
A DLIS tool for reading and working with DLIS files currently being developed by Equinor.

lascheck: https://lnkd.in/dqyQWWf
A library used for checking if LAS files conform to LAS standards set by the Canadian Well Logging Society

petropy: https://lnkd.in/dX4Re7D
A library for working with petrophysical data. Library contains tools for loading LAS files, viewing logs on a number of different plots and creating electrofacies through clustering.

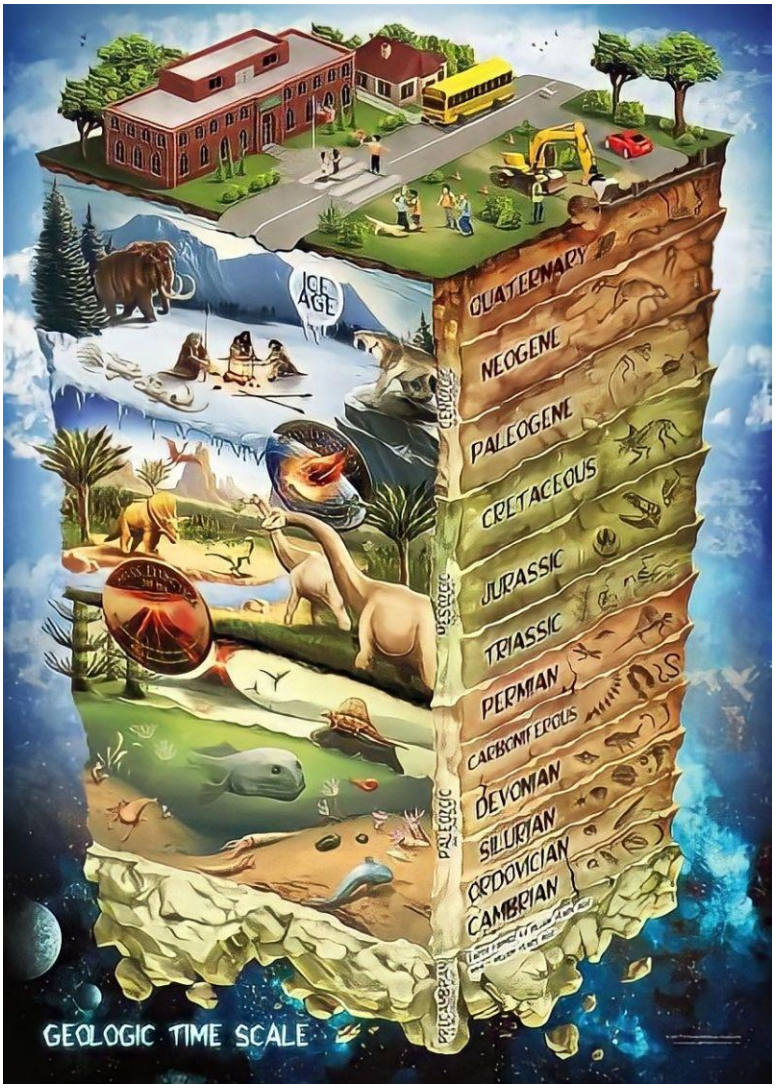
striplog: https://lnkd.in/daKH2kV
Tools for working with lithology and stratigraphical data.

welly: https://lnkd.in/d2gCqMV
A library containing tools for working, processing and analysing well logs.

4.5.2 Formation Tops

Picks, Markers, formations, interpretations: How is it distinguished. Zones?
Defined md.
Formations tie-in with siesmic data (survey data) against volume/trace

How are they marked? Geophysics can mark them on discretion
Who names them? Geophysics names them on discretion
Are they related to Zeological eras?
Standardization and interpretation
https://dug.com/dug-insight-well-correlation/
https://www.slb.com/resource-library/case-study/dr3/ecoflex-offshore-norway-cs



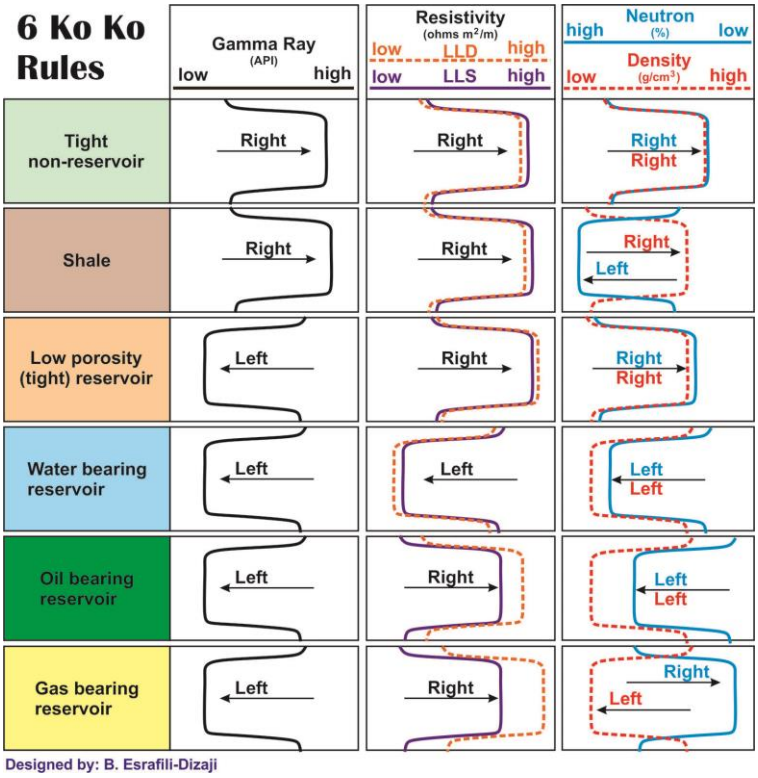
4.5.3 Salt Top

https://geology.com/stories/13/salt-domes/

4.6 Production

4.6.1 Compressibility (Z-factor)

https://github.com/f0nzie/zFactor



4.7 Decline Curve Analysis

https://github.com/chatosolutions/R_Notebooks_Oil_-_Gas_examples/tree/main/Decline%20Curve%20Analysis

https://github.com/chatosolutions/PTA_shinyapp
https://github.com/yohanesnuwara

https://towardsdatascience.com/loading-well-log-data-from-dlis-using-python-9d48df9a23e2
https://github.com/scuervo91/WellTesting.jl

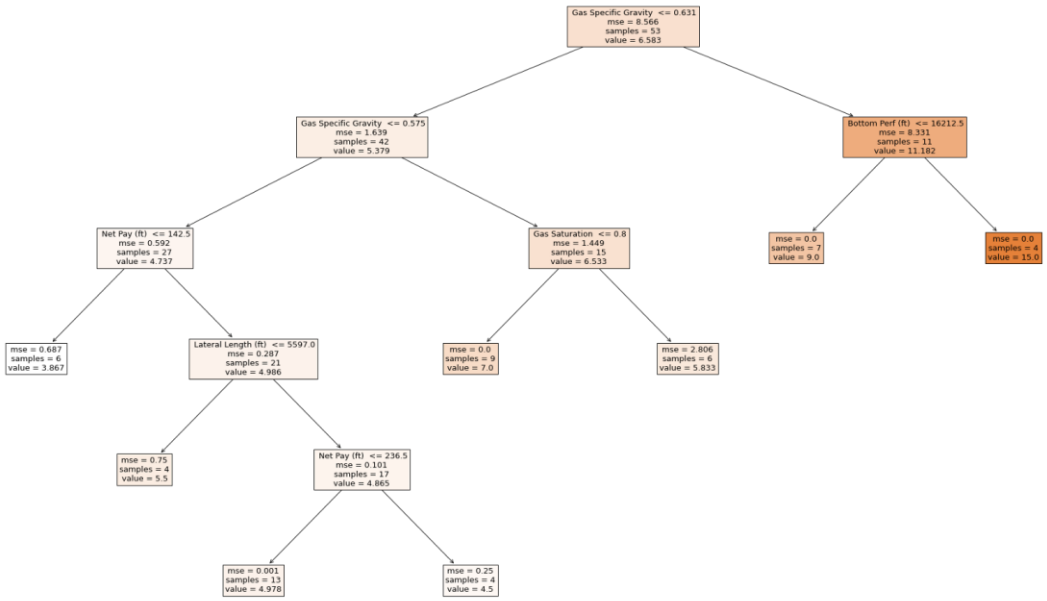
4.8 Reservoir Simulation Analysis

https://github.com/chatosolutions/R_Notebooks_Oil_-_Gas_examples/tree/main/Reservoir%20Simulation

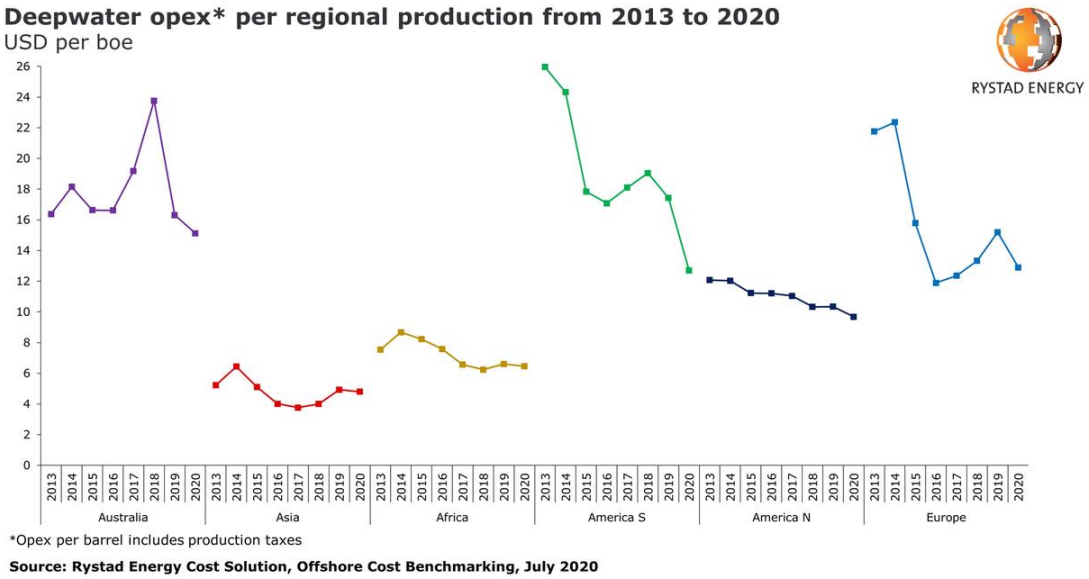
4.9 Completion - Perforations

https://github.com/yohanesnuwara/volve-machine-learning
https://medium.com/analytics-vidhya/machine-learning-for-prediction-in-hydraulic-fracturing-43de92b0e10a
https://github.com/yohanesnuwara

https://github.com/vinomarkus/Monograph-20-Examples



4.9.1 Operational Expenditure (OpEx)



https://oilprice.com/Energy/Crude-Oil/Where-Will-Gulf-Of-Mexico-Oil-Production-Go-From-Here.html

4.10 Decommission

If end of well report exists. Then this well is decommissioned.

5 THEORY – WIND

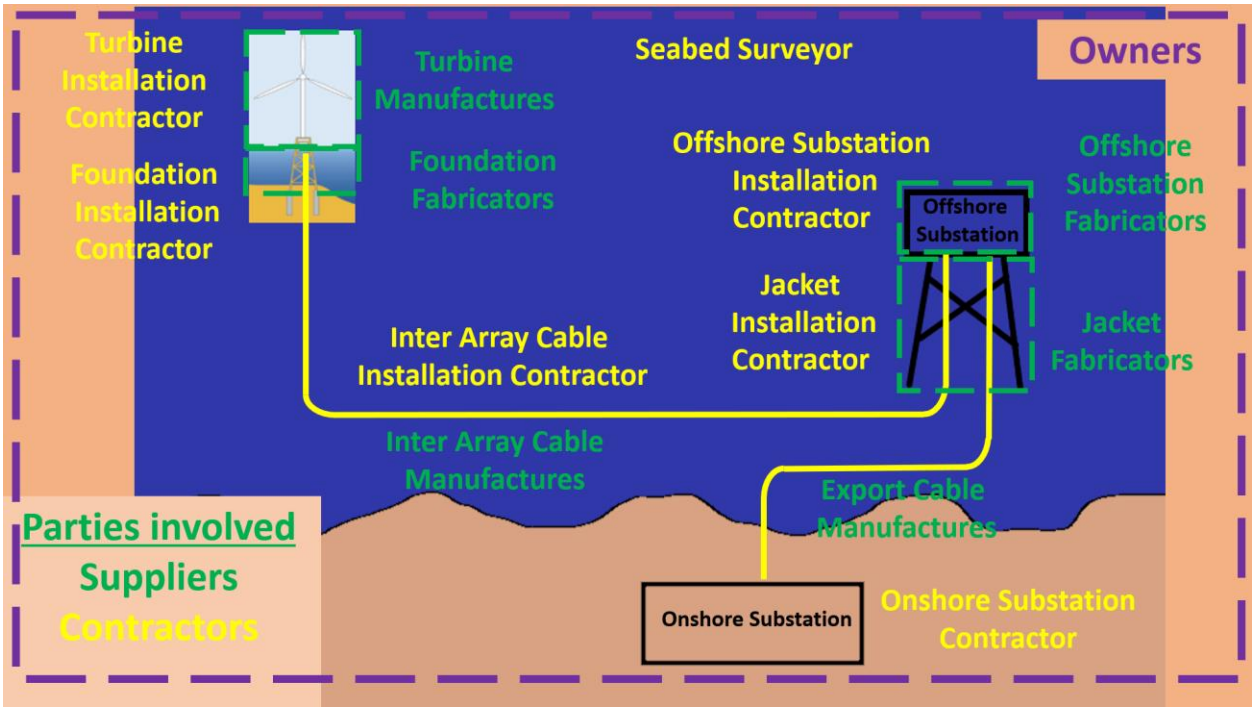
5.1 Technical Challenges

- Stability of the floater while being towed to the production site to minimize LCOE
  - Damping using a damping pool
  - Use of heave plate and ballast
  - Light floater weight, Long span and distributed buoyancy while towing
- Optimization of energy production
- Maintenance of the blade swept area perpendicular to the wind direction to mitigation of fatigue

- Control
  - Control is the ability to adjust one or several parameters of an operating system to put this system in a more efficient position. This is used in the production phase.
  - Control tunes the torque, nacelle and the blade. It shuts down the system in order to keep the system safe from excessive wind.

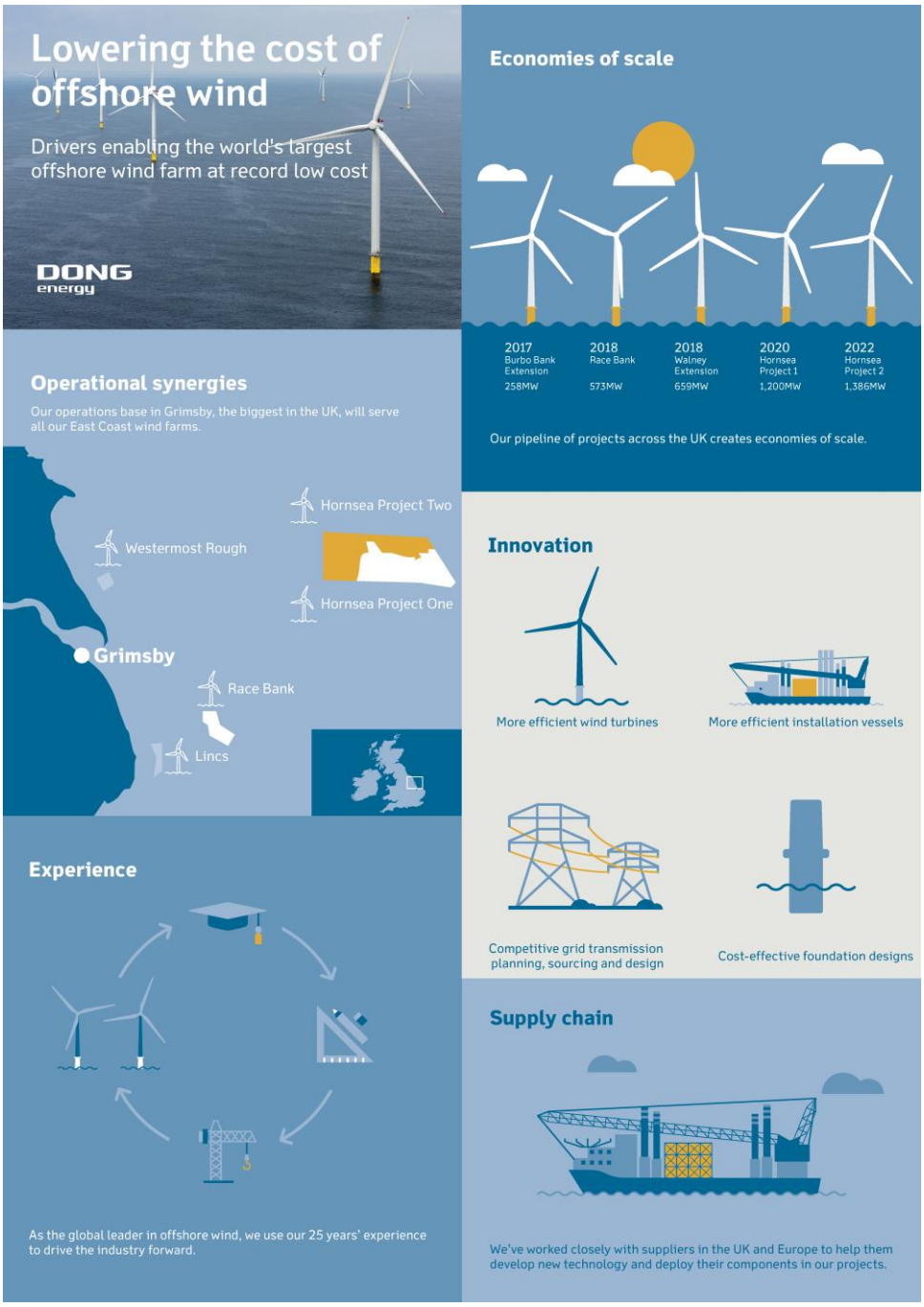
References:
FWOT Freddo Technical Information

5.2 Asset Summary



https://www-euronews-com.cdn.ampproject.org/c/s/www.euronews.com/amp/2020/11/27/what-are-offshore-renewables-and-how-do-they-work

5.3 Cost Drivers



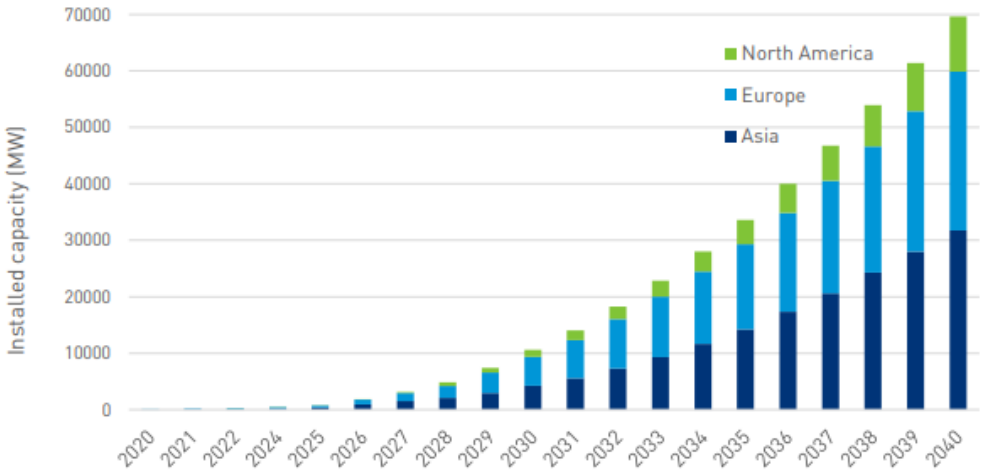
Can bigger turbines help with higher power

https://blogs.dnvgl.com/energy/should-the-trend-of-larger-turbines-continue-offshore-an-analysis-of-the-new-york-bight-floating-lidar

5.4 Fixed Bottom vs. Floating Economics

Economics of fixed bottom versus floating turbines. It is estimated that the cost of electricity from a demonstration project, such as WindFloat Atlantic, is three times greater than the cost will be when the projects of the near future are operational. Industrialized construction and installation processes, in addition to numerous economies of scale, will lead to an increasingly profitable and efficient method of harnessing natural energy. It will become still more profitable when technological advances allow even larger and higher-capacity wind turbines, probably by 2030, allowing an equivalent amount of power to be generated by fewer wind turbines and floaters, meaning less capital investment and lower installation costs. By this time, the cost of electricity from fixed-bottom and floating turbines will most likely be comparable.

Figure 2: Global floating wind deployment



References:
https://acteon.com/blog/what-is-driving-floating-offshore-wind

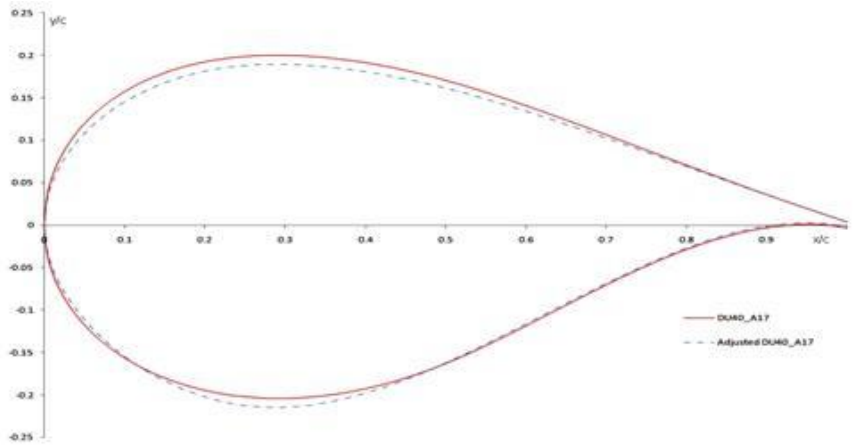
5.5 Exploration

5.6 Development

Load out of wind turbines
https://www.linkedin.com/posts/orsted_the-perfect-puzzle-loading-out-an-offshore-activity-6714130642201821184-eCd6/

5.7 Turbines

Turbine profile:
https://wind.nrel.gov/forum/wind/viewtopic.php?p=9944



Radius (m)	BlFract (-)	PitchAxis (-)	AeroRef (-)
1.50	0.00000	0.50000	0.50000
1.70	0.00325	0.50000	0.50000
2.70	0.01951	0.49951	0.49902
3.70	0.03577	0.49510	0.49020
4.70	0.05203	0.48284	0.46569
5.70	0.06829	0.47059	0.44118
6.70	0.08455	0.45833	0.41667
7.70	0.10081	0.44608	0.39216
8.70	0.11707	0.43382	0.36765
9.70	0.13335	0.42156	0.34311
10.70	0.14959	0.40931	0.31863
11.70	0.16585	0.39706	0.29412
12.70	0.18211	0.38481	0.26962
13.70	0.19837	0.37500	0.25000
14.70	0.21465	0.37500	0.25000
15.70	0.23089	0.37500	0.25000
16.70	0.24715	0.37500	0.25000
17.70	0.26341	0.37500	0.25000
19.70	0.29595	0.37500	0.25000
21.70	0.32846	0.37500	0.25000
23.70	0.36098	0.37500	0.25000
25.70	0.39350	0.37500	0.25000
27.70	0.42602	0.37500	0.25000
29.70	0.45855	0.37500	0.25000
31.70	0.49106	0.37500	0.25000
33.70	0.52358	0.37500	0.25000
35.70	0.55610	0.37500	0.25000

37.70	0.58862	0.37500	0.25000
39.70	0.62115	0.37500	0.25000
41.70	0.65366	0.37500	0.25000
43.70	0.68618	0.37500	0.25000
45.70	0.71870	0.37500	0.25000
47.70	0.75122	0.37500	0.25000
49.70	0.78376	0.37500	0.25000
51.70	0.81626	0.37500	0.25000
53.70	0.84878	0.37500	0.25000
55.70	0.88130	0.37500	0.25000
56.70	0.89756	0.37500	0.25000
57.70	0.91382	0.37500	0.25000
58.70	0.93008	0.37500	0.25000
59.20	0.93821	0.37500	0.25000
59.70	0.94636	0.37500	0.25000
60.20	0.95447	0.37500	0.25000
60.70	0.96260	0.37500	0.25000
61.20	0.97073	0.37500	0.25000
61.70	0.97886	0.37500	0.25000
62.20	0.98699	0.37500	0.25000
62.70	0.99512	0.37500	0.25000
63.00 1.00000 0.37500 0.25000			

5.8 Technical Codes

Firm knowledge of ABS FOWTI/FPI/MODU, BV ROU, DNV OS and/or API RP2A

5.9 Mega Fields

5.9.1 Japan

Yurihonjo and Noshiro, two areas offshore the northern Japanese prefecture of Akita, as promotional zones for offshore wind, each representing an area for bottom-fixed offshore wind farms of approximately 400 MW and 700 MW respectively.

5.9.2 UK

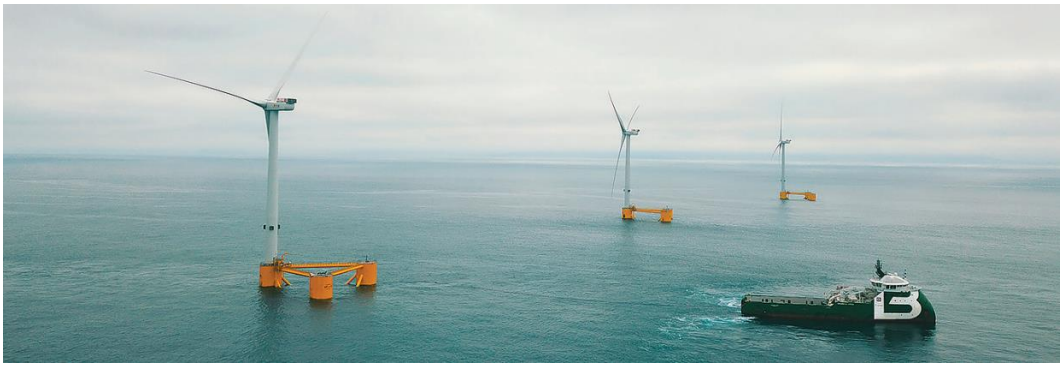
5.9.3 Europe

The powerful WindFloat Atlantic project consists of three 8.4 MW Vestas wind turbines, the largest installed to date on floating platforms. The towers are 100 meters (m) tall and the diameter of the rotor assemblies is 164 m

The wind farms will comprise not three or five floating wind turbines, but probably eight to ten (Erebus Wales project with Total in the UK) to 25 units (two French projects to be

commissioned between 2025 and 2030) and then an even larger scale (the Scotwind leasing round, for instance, with projects be commissioned between 2025 and 2030 in Scotland).

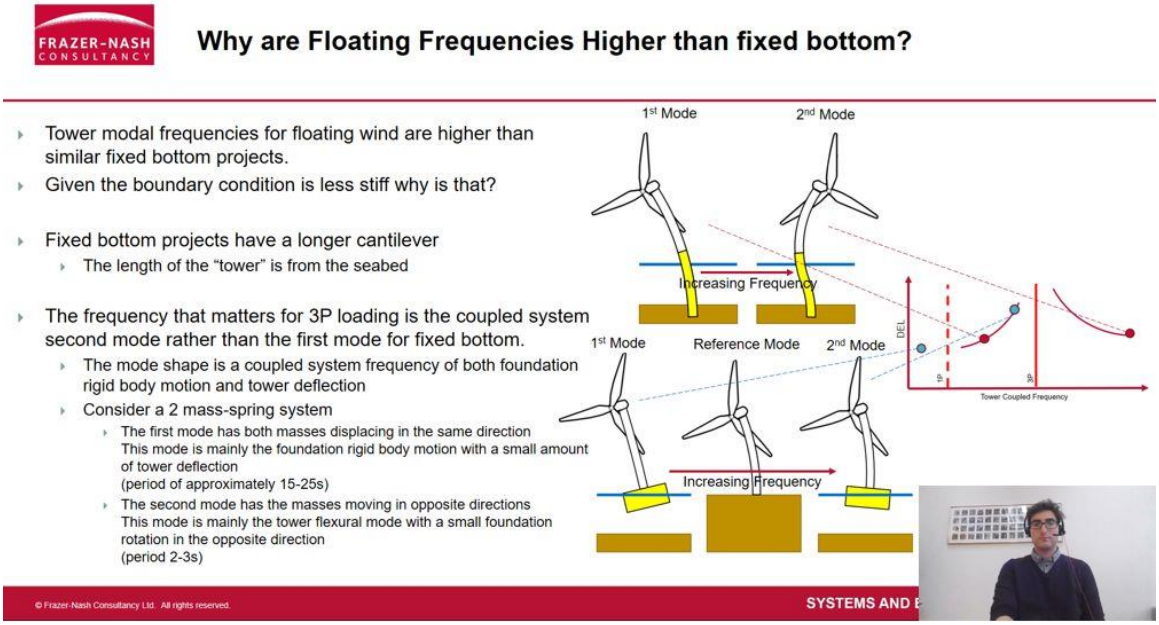
The WindFloat Atlantic site has a water depth of 85 to 100 metres and an average wind speed of 7.8 metres per second (m/s). Although this wind resource is not as high as Hywind Scotland (10.31 m/s) or Kincardine (9.93 m/s) the challenging met-ocean conditions will be key to validating the commercial-scale design.



References:
The rise of floating offshore wind energy , World Oil Aug 2020
https://www.dock90.com/windfloatatlantic/
Floating Wind JIP Phase II Summary Report

5.9.4 USA

5.10 Analysis - Dynamic



5.11 Analysis - OpenFast

How to prepare a github package so other users can install.
https://github.com/blueOceanSustainableSolutions/pyTST

https://pypi.org/project/fowt-force-gen/
https://raf-openfast.readthedocs.io/en/docs-turbsim/source/this_doc.html
https://raf-openfast.readthedocs.io/en/docs-turbsim/source/install/index.html

michaelcdevin@outlook.com

https://pypi.org/project/wombat/
https://github.com/WISDEM/WOMBAT/blob/main/examples/dinwoodie_validation.ipynb
https://github.com/WISDEM/WOMBAT/blob/main/examples/iea_26_validation.ipynb

https://pypi.org/project/ANYstructure/
https://github.com/audunarn/ANYstructure

5.12 Analysis - CP

Case study:

https://acteon.com/case-studies/retrobuoys-installed-on-german-offshore-windfarm-to-replace-failing-anodes/

An offshore wind farm in Germany, comprising 80 tripod structures in water depths of 30-40m, was protected by an impressed current cathodic protection system (ICCP) using close mounted anodes. On 33 tripod structures, the existing anodes were beginning to deteriorate and the levels of cathodic protection current was falling and failing to adequately protect the structures submerged steel surfaces.

Deepwater, an Acteon company, carried out an initial estimate of the cathodic protection (CP) current that would be required to provide adequate levels of CP to the tripod for an extended period and this was found to be approximately 280 A, as a mean current requirement. A system providing approximately 400 A would be required to aid final current (i.e. loss of calcareous deposits after a storm event) and extra contingency. Deepwater recommended a modified version of the RetroBuoy ICCP anode sled.

One of the key design criteria was that the system had to be installed in a short period of time with all components deployed from the installation vessel with no special heavy lift equipment. As a solution, the design incorporated the following:

The power supply unit was modular so it could be easily handled onto the turbine and taken to the location and assembled. The concrete stabilisation mattresses were assembled quayside with local labour and concrete. The subsea cable for the RetroBuoy Juniors was spooled onto a single deployment reel in finished lengths and the cable protection system was supplied in kit form for assembly on the deck of the vessel.

Up to four complete retrofit ICCP retrofit systems were taken to the field on the installation vessel at a time. Specially designed installation and deployment equipment was used to speed up the installation process including a mattress deployment frame. All subsea equipment was designed to be installed by ROV without the need for diver involvement. The power supply unit, junction boxes and topside cabling was installed by teams on the tower whilst teams on the vessel simultaneously prepared the subsea equipment. The subsea cable protection clamp was located on the turbine and secured by ROV.

The complete system was custom designed for the application and had to be installed without diver intervention. In addition, there was a very narrow installation window due to weather conditions. Deepwater met these challenges and, with cooperation from the operator and other subcontractors, achieved the target of reinstating specified levels of cathodic protection to the wind turbine subsea structures.

Offshore Floating Wind – Animation

Off-Shore Wind Turbines: When Aerodynamics meets Hydrodynamics
Before building offshore structures, scaled models are created to study experimentally the hydrodynamic behavior of the system.

The hydrodynamic experiments are very important to analyze the off-shore wind turbine motions
These tests are very expensive, mostly if multiple designs analyzed

In most cases, the blades are not represented, which can alter the results.
Scale effects are present leading sometimes to deviation from full scale.

Thanks to CFD analysis, a full scaled numerical model can regroup hydrodynamic and aerodynamic effects with time and cost saving.

- The wind turbine is submitted to waves, using the VOF Waves model and the DFBI model for the heave motion.

- A sliding mesh for blades rotation using superposing motion,

- The use of AMR is done for the free surface refinement in the whole domain, the overset interface and the high vorticity locations due to the blade's rotation.

We can characterize how the wind turbine behaves in regular or irregular waves and how the air flow acts behind the blades.

PS : Many Thanks to Doris Engineering for providing experimental data !

https://www.linkedin.com/posts/karimloueslati_eurocfd-cfd-simcenter-ugcPost-6726793987983765504-N6SR/

Installation
Fixed Offshore Platform Installation
https://www.linkedin.com/posts/fidar-animation_animation-offshore-offshoreenergy-ugcPost-6728271272251269120-0JqC/

6 DECOMMISSIONING - THEORY

Decommissioning of oil and gas assets has been on the riser. The various options and current status

https://www.rigzone.com/news/offshore_oils_105b_hangover_compounds_industry_woes-5-jun-2020-162312-article

The typical activities are:

- Well P&A
- Platform and Structure Removal
- Pipeline and power cable decommissioning
- Platform transportation and disposal
- Site clearance

6.1 Well P&A

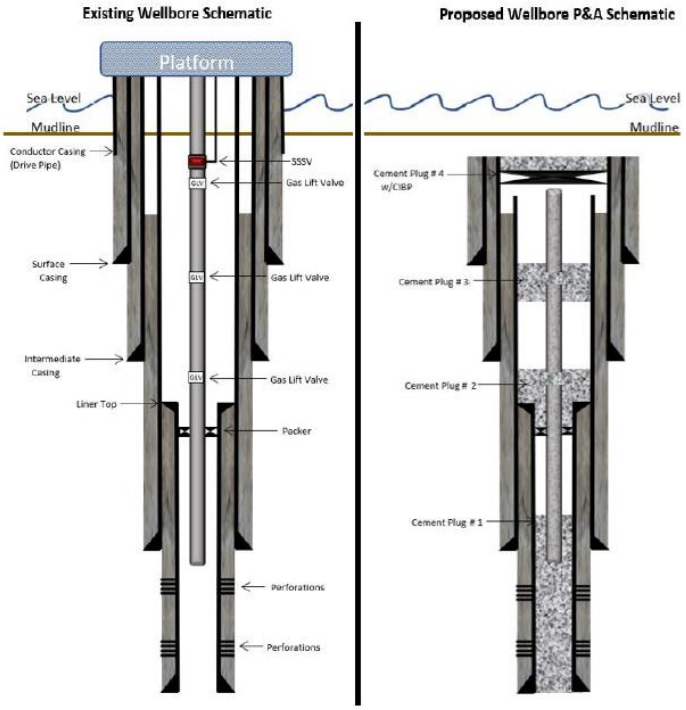


Figure 7.2 Typical Wellbore Configuration (Existing and P&A Schematics)

6.2 Codes

6.3 Assets - Offshore

Red Hawk

Independence Hub

6.3.1 Platforms

6.3.2 Subsea installations

will be removed to shore for either re-use, disposal or recycling.

Buried and stable pipelines will be left in situ. Surface laid pipelines will be removed to shore for re-use, disposal or recycling.

As for the subsea installations, the plan is to remove them and bring them for recycling onshore.

Where piles exist, these will be cut to -3m below the seabed.

Trenched and buried lines will be decommissioned in situ, with remediation of any exposed sections. Lines to be decommissioned in situ if trenched and buried for most of their lengths and will not affect other users of the sea

Surface laid lines will be recovered and returned to shore. This will help prevent future interaction with fishing gear

6.3.3 Wells

Cut casings

What depth can they be removed?

When a well is permanently abandoned by law they have to cut of the conductor 15' below mudline and there are at least 3 to 5 cement plugs down in the casing. That said, I doubt any of these wells have been permanently abandoned at this point and so they just have the cement plugs and a TA cap that locks on the high pressure housing. Most all the wells at this point would be re-enterable by the FrPS.

Is it true that the "15ft below mudline" target for clearing wellheads is code/practice because, in many deep ocean locations, it is very difficult to establish just where the mudline is? Sometimes, local drop cores which are needed to establish bending restraint characteristics of the "soil" for wellhead and mooring pile strength/fatigue characteristics show a range of results over a relatively small area.

Condition	What to do
Zones in open hole	Cement plug(s) set from at least 100 feet below the bottom to 100 feet above the top of oil, gas, and fresh-water zones to isolate fluids in the strata.
Open hole below casing	Alternative actions: • A cement plug, set by the displacement method, at least 100 feet above and below deepest casing shoe. • A cement retainer with effective back-pressure control set 50 to 100 feet above the casing shoe, and a cement plug that extends at least 100 feet below the casing shoe and at least 50 feet above the retainer. • A bridge plug set 50 feet to 100 feet above the shoe with 50 feet of cement on top of the bridge plug, for expected or known lost circulation conditions
A perforated zone that is currently open and not previously squeezed or isolated	Alternative actions: • A method to squeeze cement to all perforations. • A cement plug set by the displacement method, at least 100 feet above to 100 feet below the perforated interval, or down to a casing plug, whichever is less. • If the perforated zones are isolated from the hole below, you may use any of the 5 plugs specified in bullets points below instead of those specified in the two previous bullet points. ○ A cement retainer with effective back-pressure control set 50 to 100 feet above the top of the perforated interval, and a cement plug that extends at least 100 feet below the bottom of the perforated interval with at least 50 feet of cement above the retainer. ○ A casing bridge plug set 50 to 100 feet above the top of the perforated interval and at least 50 feet of cement on top of the bridge plug. ○ A cement plug at least 200 feet in length, set by the displacement method, with the bottom of the plug no more than 100 feet above the perforated interval. ○ A through-tubing basket plug set no more than 100 feet above the perforated interval with at least 50 feet of cement on top of the basket plug. ○ A tubing plug set no more than 100 feet above the perforated interval topped with a sufficient volume of cement so it extends at least 100 feet above the uppermost packer in the wellbore and at least 300 feet of cement in the casing annulus immediately above the packer.
A casing stub where the stub end is within the casing	Alternative actions: • A cement plug set at least 100 feet above and below the stub end. • A cement retainer or bridge plug set at least 50 to 100 feet above the stub end with at least 50 feet of cement on top of the retainer or bridge plug. • A cement plug at least 200 feet long with the bottom of the plug set no more than 100 feet above the stub end.
A casing stub where the stub end is below the casing	A plug as specified in the open hole sections above, as applicable.
An annular space that communicates with open hole and extends to the mud line	A cement plug at least 200 feet long set in the annular space. For a well completed above the ocean surface, you must pressure test each casing annulus to verify isolation.
A subsea well with unsealed annulus	A cutter to sever the casing, and you must set a stub plug as specified in the casing stub sections above.
A well with casing	A cement surface plug at least 150 feet long set in the smallest casing that extends to the mud line with the top of the plug no more than 150 feet below the mud line.
Fluid left in the hole	A fluid in the intervals between the plugs that is dense enough to exert a hydrostatic pressure greater than the formation pressures in the intervals.
Permafrost areas	• A fluid to be left in the hole that has a freezing point below the temperature of the permafrost, and a treatment to inhibit corrosion. • Cement plugs designed to set before freezing and have a low heat of hydration.

6.4 Assets – Onshore

6.5 References

https://offsnet.com/north-sea/requirements-for-plug-and-abandonment-of-oil-and-gas-wells-legislation-and-job-design/

https://www.law.cornell.edu/cfr/text/30/250.1715

Interact BSEE reports

7 RESULTS

7.1 Report Layout

The field lifecycle results consists of the following key information:

- Geology Markers (Salt, Hydrocarbons and Formation MDs)
- Well Data
  - Exploration Wells. Order by Well name
  - Development Wells. Order by Well name
- Well Location
  - Well Location
  - Default show only developments?
  - Categories
    - Exploratory
    - Development – Non Producers
    - Development - Producers
- Well drilling data
  - Number of days drilled
  - TD date
  - Etc.
- Well Tubular data
  - Display entire table by ordering by Well Name.
  - Figure out grouping strategy later.
- Well completion data
  - Completion properties and summary (location, names etc)
  - hydrocarbon_bearing_interval for wells
  - Top and Bottom Perforation depths
- Well production data
- Field production data

    - Add individual well total production to date
- Well Open Hole Operations (Future)
- Well BOP Tests (Future)
- Well Activity Report Notes
    - Well name, start date, end date, comments
- Decommission
    - cut_casings for Decommision (Future)

Only first section not collapsed
Rest of sections collapsed

7.2 Detailed Well Layout

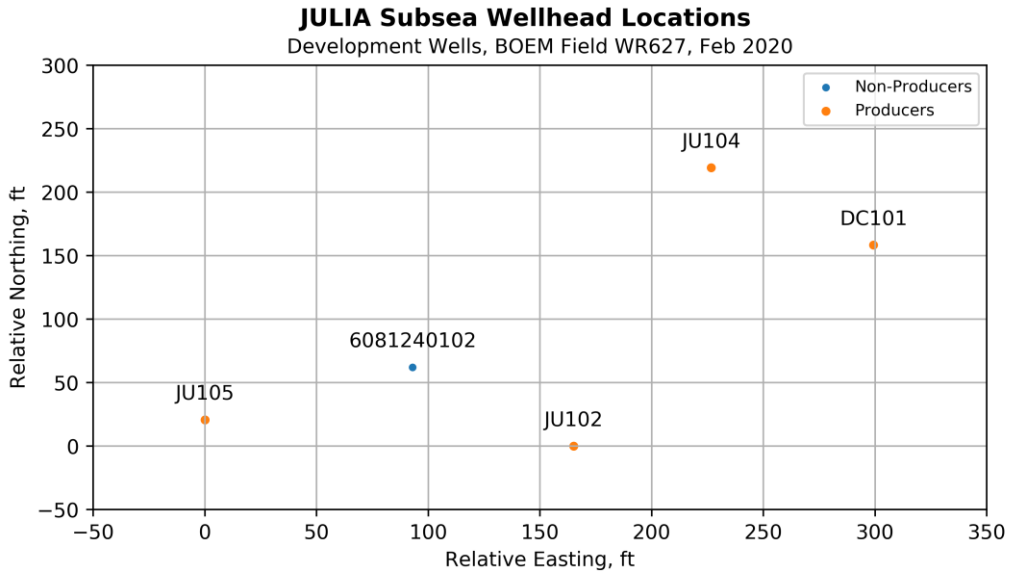
7.2.1 Subsea Layout:

Wellhead Locations

[1] Producing

Non-Producing
Max wellhead distance (producing)
Max wellhead distance (All)

Make location X, Y Garaph equal spacing gridlines.
Also make it interactive chart.
Possibly add GIS chart which is interactive?



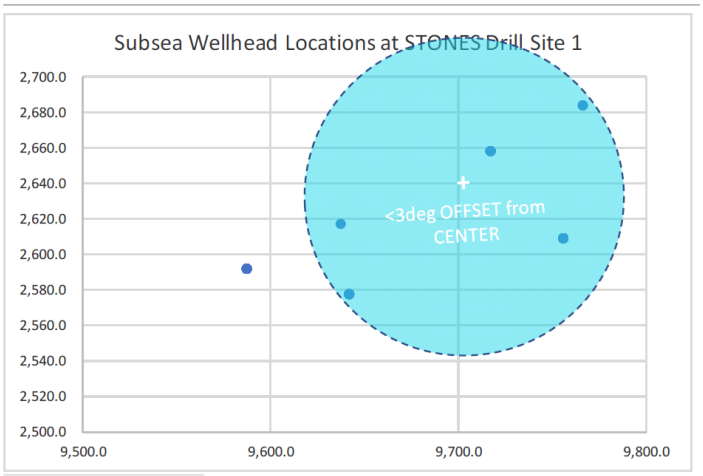


Figure 7-1 Subsea Wellhead Locations, Stones Drill Site 1

Figure 7-2 Subsea Wellhead Locations, Julia

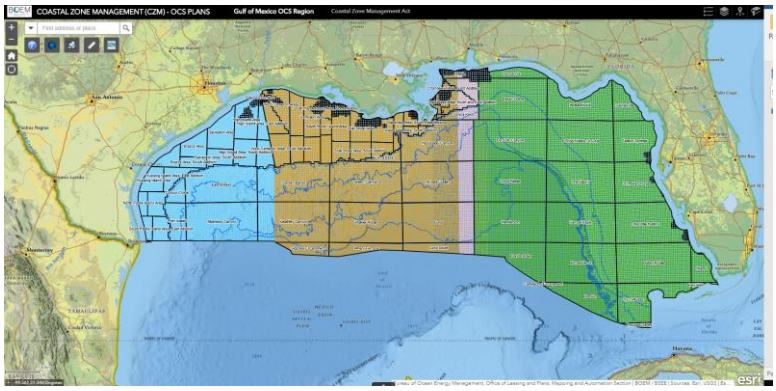
Wellhead and WellBore End

Also, the bottom holes are not very far apart with the max departure being about 2,250'.

Bottom holes are not that far apart? They are not reaching out very far with their directional work.

Map References
https://www.boem.gov/oil-gas-energy/mapping-and-data
https://www.boem.gov/oil-gas-energy/mapping-and-data/gomr-geographic-information-system-gis-data-and-maps
https://bobson.maps.arcgis.com/apps/webappviewer/index.html?id=d076142fda2d46b69f2d6727705fcbb2

consider:

- National Geographic Style Map
- Zoom to certain boundaries
- 

7.3 Detailed Resource Summary

Table summarizing the following:

- Water depth
- Well Summary (For all wells)
    - surface and bottom hole x-y
    - well depth.
    - Completion info
        - Top of reservoir,
        - pay interval,
        - type of completion

7.4 Detailed Casing Info

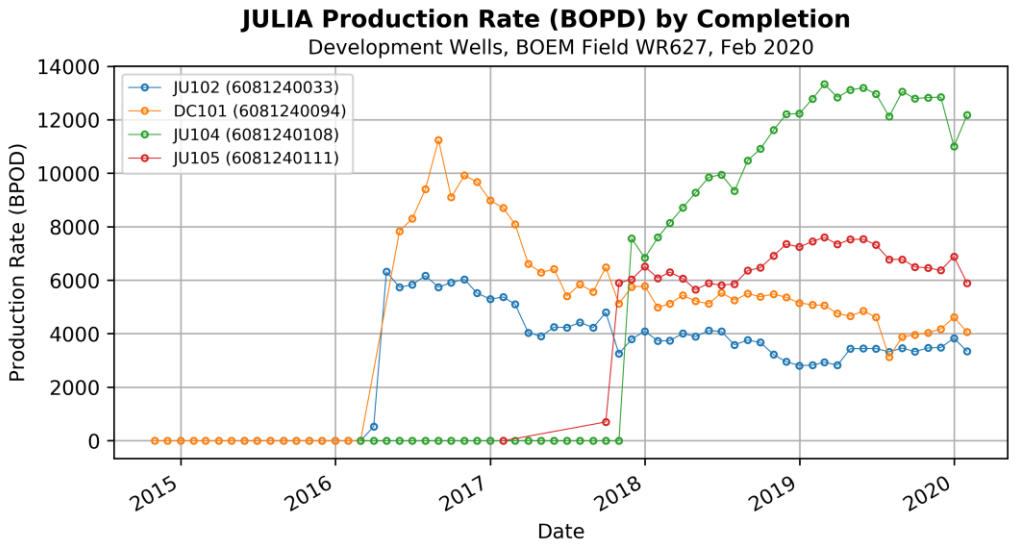
Is there casing info on each of the wells? Size and setting depths?

7.5 Detailed Well Program Summary

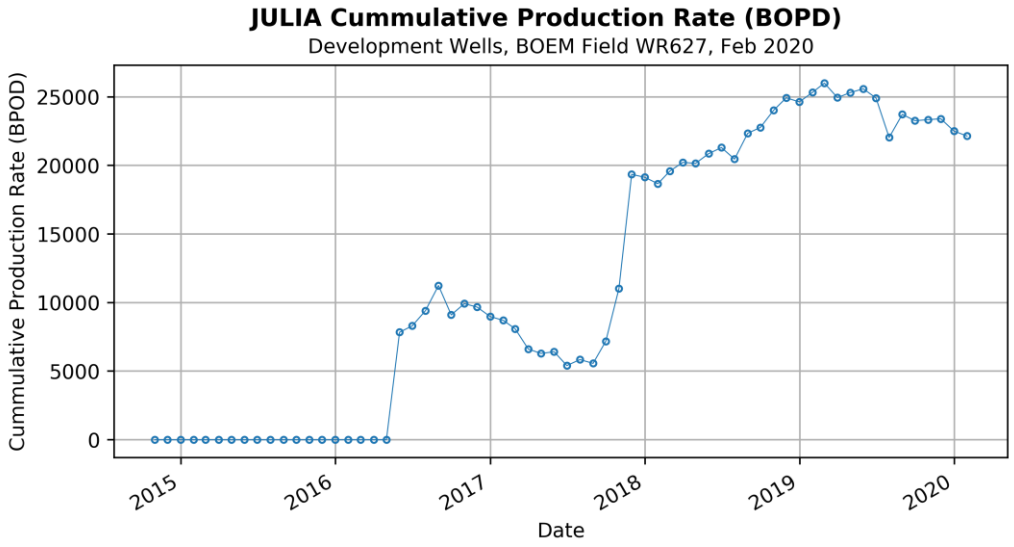
it would be great to have a one or two page summary of the well location, number of days drilling and completion, casing program, formation tops, mud weights etc. and maybe another multi-page report that has the operations summary listed from start to finish if possible.

7.6 Detailed Production Output

7.6.1 Individual well production



7.6.2 Field Cumulative Production



7.7 Detailed Data Output

Save data as dataframes.

7.8 Summary Field Development

Project Economics, Field exploration, etc

General Improvements:
Make each tab into individual template (Vijay's recommendation?)
Fix csv download.
Make tabs into individual templates;
Add other data tab for .xlsx download

https://www.data.boem.gov/Main/HtmlPage.aspx?page=estimated2018

UI design
Select the application (

digitaltwinfeed.com\BSEEDataInterfaceTool.html

- Select a Field;
- Refresh on selecting a field?

Add sub tabs to browse through the data for particular field

Tab Name	Data Description
Field Data	Field Well Data Well Locations Well Location Statistics Wellhead and Bottom Locations
Production Data	
Well Data	User to select well to display all other data: Location Drilling Information Hydrocarbon bearing interval Completion Casing info Open Hole Activities Well activity summary Well activity remarks Show sidetrack information only for relevant wells (Pending in next revision) Also need to show individual sidetrack days of operation etc. and keep the query ready. Add Mud Weight vs. MD Chart
Reserves	Not most important per Roy. Chuck may find this information somewhat valuable information (i.e. for investors and other high level information parties)

;

~~Move field reserves section down in priority (Made this last tab)~~

Field name
BOEM block

Display all data by well name. Integrate the data so the latest bore is shown

Latlong should be pushed down. Visually can not assess it quickly. Arrange them logically
Add Spud date to well data (missing now)
Add completion status to Main well Data

Perforations (Arrange data as follows)

- perf top MD
- perf bot MD
- Perf Footage
- Perf TVD
- Perf TVD
- Perf Vertical Span

Casing program: Refer to spreadsheet

Clean up chart with wellhead and Bottom TD. Utilize transperancy and size to get maximum impact (FUTURE)

Sidetrack Details (for wells only with sidetracks to see the division of operations) (FUTURE)

Expand Completion stub code single, dual, P, etc. (FUTURE)

Completion location may be wrong: verify or ditch the data completely. Bottom MD is sufficient. (FUTURE)

Hydrocarbon interval. Remove duplicates (FUTURE Utilize SQL?)

Also, ability to download any or all data. Client side calls for majority. Ability to save data for user to see further information. Have a button to select a well and look at the data. (FUTURE).

7.9 Summary Project Economics

https://www.feasta.org/2018/09/20/end-of-the-oilocene-the-roar-of-the-oil-fizzle-dragon-king/

7.10 Deal Making

People are used to PV10, PV20 talk - but few are aware just how much leeway or manipulation can go into a “reserves database” to give you PV.

Forecast differences of course ex giant b factors and low Dmins that can be thrown on shale wells but what about cost? And the common failure to tie to LOS/LOE?

This week I’ve seen:
- Database has gas revenue - lease uses all gas and sales are $0
- Use of last 12 month averages for LLS premium - which dropped significantly
- Use of average last 12 month premiums/diffs vs reading marketing contracts
- Averaging out real costs ex annual SUA and SWD
- Pulling all workover costs (not accounting for maintenance with regular well failure)
- Taking costs when production is high and calling it all variable or $/bbl which can get arbitrarily low as well bbls drop - no base minimum costs (ex pumper, electricity, SWD, base chemicals)
- COPAs expense excluded in database
- COPAs expense doesn’t match JOA
- Dropping rental compressors 6-12 months in but no tie to how physical production will continue
- And of course no P&A consideration

You can put whatever you want into a forecast database... Better take a closer look at reality!

7.11 References

Utilize Python BaseMap Package

Utilize Cartopy
https://stackoverflow.com/questions/tagged/cartopy

https://ocefpaf.github.io/python4oceanographers/blog/2013/12/16/utm/

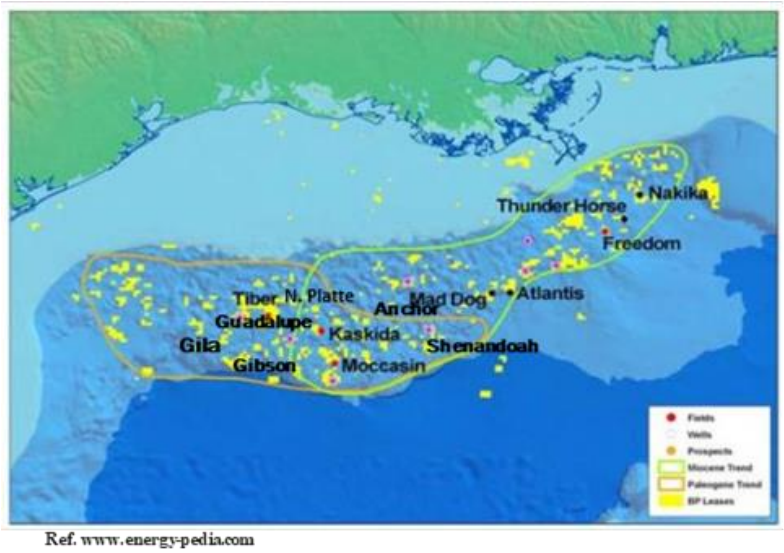
https://stackoverflow.com/questions/6778288/lat-lon-to-utm-to-lat-lon-is-extremely-flawed-how-come

https://stackoverflow.com/questions/40374441/python-basemap-module-impossible-to-import/43234894

https://gis.stackexchange.com/questions/333607/converting-lat-long-to-xy-in-arcgis-api-for-python
https://gis.stackexchange.com/questions/290761/easting-and-northing-conversion-into-lat-and-long-gives-wrong-information-python
https://www.latlong.net/lat-long-utm.html (WGS84 standard,

8 PROJECT DELIVERY

8.1 Overview



Ref. www.energy-pedia.com

Wilcox Onshore vs. Offshore

http://archives.datapages.com/data/gcags/data/064/064001/685_gcags640685.htm
https://pubs.geoscienceworld.org/aapgbull/article-abstract/103/3/745/568851/Insights-into-deep-onshore-Gulf-of-Mexico-Wilcox?redirectedFrom=fulltext
https://www.corelab.com/irs/studies/louisiana-wilcox

https://www.researchgate.net/publication/331452262_Insights_into_deep_onshore_Gulf_of_Mexico_Wilcox_sandstone_pore_networks_and_reservoir_quality_through_the_integration_of_petrographic_porosity_and_permeability_and_mercury_injection_capillary_pressur
https://www.hartenergy.com/exclusives/venerable-wilcox-wait-it-13519

8.2 Notebook

https://smartbear.com/learn/api-design/what-are-microservices/ Microservices
https://opensource.com/resources/what-are-microservices

8.3 Digital Twin Feed

9 REFERENCES

No.	Description	Comment
[2]	Reservoir Engineering for Geologists, Fekete	
[3]		
[4]		
[5]		
[6]		
[7]		

APPENDIX 1.0 – WORK SCOPE

1.1 Draft Scope, Chuck White, 18th March 2020

Vamsee, with the current price collapse even more MODU's will be set aside… so, FDAS should be able to someone/corp/investor group who'd see the current situation (and what it will do to all the "assets" in the WILCOX) as a real opportunity to invest. I have not finished updating the attached slideshow, but it's something we can discuss tomorrow. Let me know when you can schedule to chat with me.

To do the study we should carefully organize the following data on the WILCOX discoveries listed below:

- Original Oil in Place (per oil companies' estimates/press releases – not what BSEE reports as OOIP)
- Exploration/Appraisal wells drilled before project sanction (find project sanction date?)

- Cost of appraisal/testing program prior to sanction
- CAPEX (PUBLIC DATA?)
    - Number and Cost of wells/completions budgeted (and actually spent if we can find it)
    - Cost of facilities… subsea systems/SURF and platform
- Seabed Location of all production wells drilled (plotted 2D with distances between wells and well clusters) (Provide Data to Chuck)
- Discovery Date (see attached database)
- Date production started (ditto)
- Remaining reserves (ditto)
- Production history for each well and each field (see Roy's db's and my variants thereof)
- OPEX… if we can find it (like the MODU costs at STONES)… Roy's sprdshts include a factor of OPEX $/bbl… we can use if it's all we got
- More???

With the following discoveries (even those currently producing) leaving billions of barrels of Oil in Place (OIP), there should be opportunities for real bargain hunting this year and next:

- **Anchor**… sanctioned at $6.7b in Dec'19
    - Pretty sure nobody believes CVX can deliver on time/budget based on past performance (ref. Big Foot multi-billion $ overrun and writedown last year)
    - Pretty sure the budget excludes the $750 commitment to the 20k MODU
    - We might expect to see a project postponement (cancellation?) announcement this year
- **Cascade-Chinook**… "given" to Murphy by Petrobras at <<$1B after Petrobras spent over $4B on appraisal/dev… Murphy recently contacted us to help them figure out how to develop a prospect that is only a few miles away… according to my friend who used to work for P'bras (now Murphy), P'bras there was >2B bbls OIP in the 2 fields
    - BOEM 2018 data cites 20M bbls produced with ~7M reserves remaining (<<1% recovery rate)
- **Jack St. Malo (JSM)**… producing from a relatively small part of the reservoirs… total $14B spending plan includes billions for water injection… and many subsea wells. The subsea injection project was recently sanctioned… BUT, it's effectiveness is suspect.
- **Julia**… XOM declared 6B bbls in place when it was sanctioned in 2013 for a $4bn 6-well Phase 1 subsea tieback system (to JSM)… but XOM gave up after drilling 4 producers when the 3rd well turned out to be a $200M duster.
    - BOEM 2018 data indicates initial reserves at ~68M bbls (just over 1% recovery rate???)
    - Erik Oswald, XOM VP Americas, confirmed to me (and the audience at the Norwegian Energy Day) that XOM had given up on Julia because "it's complicated"!
    - Being "complicated" is exactly why an Operator needs Frontier's ultra-deepwater dry tree solution.
- **Kaskida**… well over $1B spent on exploration/appraisal and BP could not figure out how to make a subsea field development work.
    - Several billion bbls OIP… no way to make it pay???
    - My partner, Roy, was a key team leader on BP's Kaskida & 20k subsea systems for several years before he got pulled into putting together the subsea production system for Macondo (to take the captured production)
- **Shenandoah**… $2bn spent on exploration/appraisal on this huge, complex reservoir… LLOG acquired from last remaining "owner" Anadarko for "pennies"… and, has been doing FEED work to sanction a

small 2-well subsea tieback development… but, they may need CVX's 20k MODU to complete those wells… and, may not reach sanction in this pricing situation

- **Stones**… Shell announced 2B OIP when it sanctioned up to $4B for 6-well Phase 1 to produce 50kbopd to FPSO in 9,250ft WD… so far, field is averaging <25kbopd… and Shell is spending ~$1M/day to keep a MODU on the field full time.
- **Tigris, Tiber, Guadalupe, & Gibson… all abandoned!**
- more?

Seems like this year and Frontier's technology yields a great opportunity to:

- Buy a field for pennies (for example, Julia in ~7,000ft WD)
- Buy a semisub MODU
- Convert it ala FDAS technology
- Start producing by the end of 2022… at a very low cost/bbl and with a dramatic increase in reserves recovery.

I would not be surprised if the collapse in exploration, big project dev, and onshore drilling that is happening now will cause a big drop in global capacity to produce oil, causing oil prices to rebound over $80 in 2022-25… so, those who can lock in an ultra-deep bargain or two now should be well rewarded over the rest of the decade.

1.2 BOEM Contact, Oil Reserves, P2 etc.

My contact at BOEM says that they do not actually track OOIP the way that the oil companies do. "Original Oil" is simply the sum of "Cum. Oil" produced plus "Oil Reserves". Oil Reserves = SEC reporting number, which includes Reserves on Production + P2 (probable) Reserves… and that number depends on what is recoverable based on the past year's average price.

So, both "Cum. Oil" and "Oil Reserves" change every year… and, thus, their sum (= "Original Oil") is not constant as OOIP should be.

Case in point: JULIA field… BOEM's "Original Oil" = 59.6M bbls versus the 6B bbls XOM put in the press when Julia was sanctioned.

Of course, every time the geologists get new seismic data or reinterpret old seismic, the company's internal OOIP number can/does change – even though what was actually in the ground at the start never changes.

So, when we cite a value for OOIP, we should just cite the source.

Email Chain:

Yes Chuck. But to further qualify, Original Oil is what we used to call Original Recoverable Oil. OOIP, as you stated, is listed in the database under OIP.

Eric

From: chuck.white@frontierdeepwater.com <chuck.white@frontierdeepwater.com>
Sent: Monday, March 02, 2020 9:53 AM
To: Kazanis, Eric EK <Eric.Kazanis@boem.gov>
Cc: Cross, Kellie <Kellie.Cross@boem.gov>; Burgess, Grant <Grant.Burgess@boem.gov>; roy.shilling@frontierdeepwater.com; vamsee.achanta@frontierdeepwater.com; 'Ellen Coopersmith' <ellencoopersmith@decisionframeworks.com>; jeremy@decisionframeworks.com
Subject: [EXTERNAL] RE: BOEM link to Reserves and OOIP data

Eric, thanks mucho for the clarifications.
It odes appear that BOEM's definition of "original oil in place" is much more limited than what reservoir engineers would track as OOIP.

This "Original oil is oil reserves + cum production" is definitely a subset of what is in the rock(s).

I believe there is alignment between BOEM and SEC reserves… "*Reserves* in this report are proved plus probable (2P) reserves estimates. This is based on the classifications recommended in *Petroleum Resource Management System* (2007) which account for the range of uncertainty associated with reserve/resource estimation. For example, a 1P estimate would include only proved reserves, while a 3P estimate would incorporate proved, probable, and possible reserves. "

It is clear that financial pressure due to low oil prices can significantly decrease the "reserves" and, thus, OOIP (or OIP) that is reported in the BOEM database… while true OOIP should only change when the geologists and reservoir engineers agree on a reassessment based on evolving technical data/understanding of the reservoir itself.

Cheers,
Chuck
iPhone +1.832.745.6348

From: Kazanis, Eric EK <Eric.Kazanis@boem.gov>
Sent: Friday, February 28, 2020 2:27 PM
To: chuck.white@frontierdeepwater.com
Cc: Cross, Kellie <Kellie.Cross@boem.gov>
Subject: FW: [EXTERNAL] RE: link to Reserves and OOIP data

From: chuck.white@frontierdeepwater.com <chuck.white@frontierdeepwater.com>
Sent: Thursday, February 20, 2020 5:13 PM
To: Kazanis, Eric EK <Eric.Kazanis@boem.gov>
Cc: Burgess, Grant <Grant.Burgess@boem.gov>; roy.shilling@frontierdeepwater.com; 'Vamsee Achanta' <vamsee.achanta@frontierdeepwater.com>; 'Ellen Coopersmith' <ellencoopersmith@decisionframeworks.com>; jeremy@decisionframeworks.com
Subject: [EXTERNAL] RE: link to Reserves and OOIP data

Eric, I was able to access what must be the file you intended. I'm attaching an abridged version that focuses on the WILCOX sands/fields because I have some specific questions. I redacted over 11,000 rows from the database.

1. According to the press and articles by the Operators, all of the following fields are supposed to be Lower Tertiary WILCOX discoveries. Why does this database show them to be Cenozoic instead of Lower Tertiary?
    a. Cascade
    b. Chinook
    c. Jack
    d. Julia
    e. St. Malo
    f. Stones

    You are correct, these are all Lower Tertiary discoveries. This initial level of chronozone organization/range is broad (Cenozoic Mississippi Fan Fold Belt Play PLU-LL), and was more geographically based; however BOEM does recognize and capture the specific ages of these sands at a proprietary level. We plan on upgrading this classification in the future.

2. The data indicates that reserves for these WILCOX fields average to be 74% of OOIP… how is such a high recovery of OOIP possible in such a complex, multi-zone play?
    a. Typically, recovered reserves end up being less than 50% OOIP… recovery over 40% is considered fantastic.

Original oil is oil reserves + cum production. Original oil in place has the heading OIP.

3. What are the definitions of the column headings, esp.

Cum oil is cumulative oil production, FDYear is field discovery year

There is no way that companies would spend billions of dollars to recover the paltry reserves shown in this table.

- ExxonMobil/Statoil(Equinor) sanctioned $4B to develop Julia Phase 1 (6 subsea wells)… with only ~52 Mbbls reserves at the field, they're announced plans would have them spending ~$77/bbl up front to get production paying back over a 40yr life. Such economics cannot justify investment.

We only publish and release Reserves. We do not release Contingent Resource estimates. Here is an explanation of our classification methods:

Classification of Resources and Reserves

The BOEM resource classification framework is shown in **Figure 2**. Definitions for each resource class are presented in **Appendix A**. At the point in time a discovery is made, the identified accumulation of hydrocarbons is classified as a Contingent Resource, since a development project has not yet been identified. When the lessee makes a formal commitment to develop and produce the accumulation, it is classified as a Reserves Justified for Development. During the period when infrastructure is being constructed and installed, the accumulation is classified as Undeveloped Reserves. After the equipment is in place the accumulation is classified as Developed Non-Producing Reserves, and when production of the accumulation has begun, the status becomes Developed Producing Reserves. If an accumulation goes off production, for a year or more, for any reason, the classification changes back to Developed Non-Producing. *Reserves* in this report are proved plus probable (2P) reserves estimates. This is based on the classifications recommended in *Petroleum Resource Management System* (2007) which account for the range of uncertainty associated with reserve/resource estimation. For example, a 1P estimate would include only proved reserves, while a 3P estimate would incorporate proved, probable, and possible reserves. The reserves must be discovered, recoverable, commercial and remaining. *Reserves*, starting with the 2011 report, now include *Reserves Justified for Development.* All hydrocarbons produced and sold are included in the Cumulative Production category. Should a project be abandoned, at any phase of development, any estimates of remaining hydrocarbon volumes could be re-classified to Contingent Resources.

So the reserves and OOIP being reported into BOEM's database must be some kind of limited subset of what oil companies use to justify development. For example,

- Chevron has publicly announced as much as 500 Mbbls recoverable from Jack St. Malo complex vs. ~240Mbbls shown;
- Shell has announced ~8 Bboe in place at the STONES field versus ~70 Mboe shown as "Original BOE" in the BOEM database.

Yes, as stated in the previous response, we don't release Contingent Resources.

I hope y'all can clarify!

Chuck

iPhone +1.832.745.6348

From: Kazanis, Eric EK <Eric.Kazanis@boem.gov>
Sent: Wednesday, February 19, 2020 10:41
To: chuck.white@frontierdeepwater.com
Cc: Burgess, Grant <Grant.Burgess@boem.gov>
Subject: RE: [EXTERNAL] link to Reserves and OOIP data

Chuck,
Here's the link I we talked about. https://www.data.boem.gov/ Got to the G & G Studies tab and download the 2018 Sands zip file. Then open the 2018 Atlas Update file (access or excel). Then you will see some columns with field name, another with sand and another with play.
You can sort by sand name. Many Wilcox sands are called Wilcox XX. But, you can also sort by play name too, and maybe get some more data points.
Eric

From: chuck.white@frontierdeepwater.com <chuck.white@frontierdeepwater.com>
Sent: Wednesday, February 19, 2020 8:24 AM
To: Kazanis, Eric EK <Eric.Kazanis@boem.gov>
Subject: [EXTERNAL] link to Reserves and OOIP data

Eric, as we discussed, please send me a link(s) to the page(s) in BOEM's database where I'll be able to find reserves and original oil in place info for the various Wilcox discoveries/fields.

Along the lines or our discussion, you and your colleagues may appreciate reading a pre-print of an article we produced for WORLD OIL. Now, we are preparing a study that focuses on what can be done to increase performance of existing/producing fields in ways that will dramatically increase value and ultimate recovery from the Wilcox.

Best wishes,
Chuck
Charles N. White, *LP SDP*
EVP, Frontier Deepwater Appraisal Solutions LLC
CEng (Marine), Fellow IMarEST & SNAME
iPhone +1.832.745.6348

1.3 Julia Discussion

Oh yeah… I did get a Julia Excel file from you back in January, but I threw it away because all the data in the Table 1 sheet appeared to be for Cascade Chinook. Now I understand that

you just left the Cascade Chinook column and row headings put inserted Julia data. If you don't mind fixing the Table 1 worksheet, it would be much better if we had a properly labeled set of data.

I can work with this for now (see attached with my adds)… still, having clean spreadsheet will be important when/if we start working with Decision Frameworks… and, it will confirm to me/them that we are actually using the right data.

What shocks me about this is that they have only put 3 wells onstream 3yrs after start-up! I think I remember Lars(?) saying that Julia was a serious disappointment… do you???

Anyway, a few questions about the file/info therein:

- The first well is labeled "DC101" in your tables… do you think XOM filed/got permit to drill when the field had a different "name"… "DC-something"?
  - Is it possible to look up Permit to Drill under that well name?
- Do you think that JU103 was drilled… but, abandoned… because it looked so bad when they got to TD?
  - Is it possible to find/see a P&A document that would have been filed with BSEE or BOEM?
- They have not completed a well since Nov 2017… seems they've given up on Julia???
  - XOM nursed the well up over 13kbopd 15months after its first oil.
  - Hard to believe they can't justify doing any thing on the other wells… or,
  - Drill a new well… when that one has done so well.

A few comments:

- XOM/Equinor must be totally confused about how to get any more out of that field after having invested at least ~$3B (of the announced $4B budget).
- Assuming a net average of $45/bbl (after covering OPEX & payments to JStM partners), **the field has paid back less than $1B since start up**. **Net avg oil price I have been using is $55 - $12 – 18.25% royalty. $12/bbl is a reasonable subsea operating cost that has been used by multiple operators.**
- They produced only 4Mbbls in 2017, but well JU104 added ~50% more to cumulative 2018 production.
- If they could add another well like JU104, I am sure they'd drill it.
- The wells they've put onstream have good up time… but, somehow I doubt they still plan to get 40yrs of life out of Julia! **None of the subsea fields will have equipment reliability that will last 10 years I believe – they will need to maintain and replace as necessary.**

Seems like Julia might just be another WILCOX disaster "poster child". **They need dry trees, simpler completions, downhole pumping, and regular maintenance. They need to be able to sidetrack and redrill the "CUBE" inexpensively to maximize reserve recovery.**

APPENDIX 2.0 – RESERVES CALCULATIONS

$$Initial\ oil\ in\ place\ O_i = \frac{A \times d \times 7758 \times \phi \times (1 - S_w)}{B_i}$$

$$Oil\ in\ place\ at\ abandonment\ O_a = \frac{A \times d \times 7758 \times \phi \times (1 - S_w - S_g)}{B_a}$$

$$Oil\ reserve\ O_r = O_i - O_a$$

$$Recovery\ factor = \frac{O_r}{O_i}$$

2.1 Key References

APPENDIX 3.0 – BSEE DATA

3.1 Well Data

3.2 Data Definitions

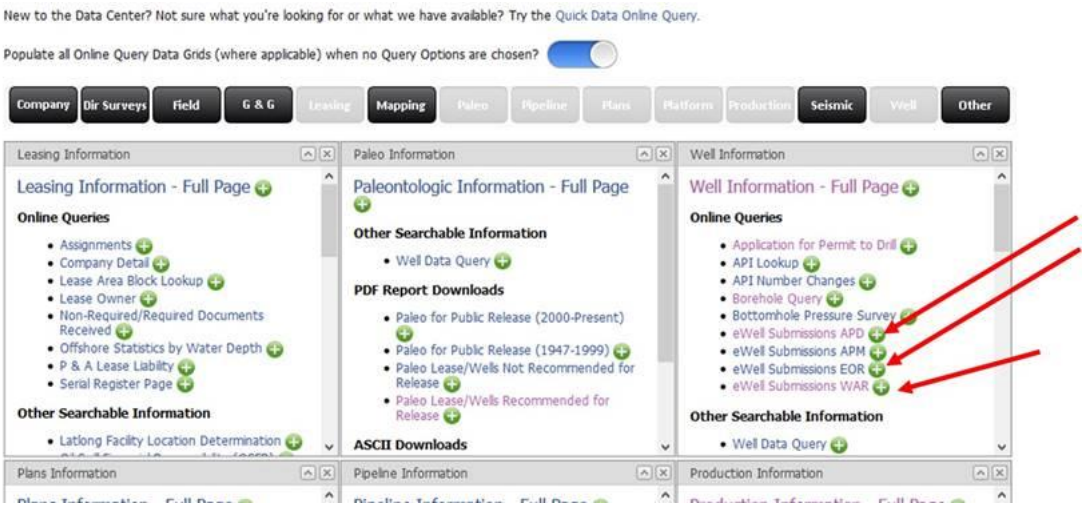
3.2.1 Borehole Data

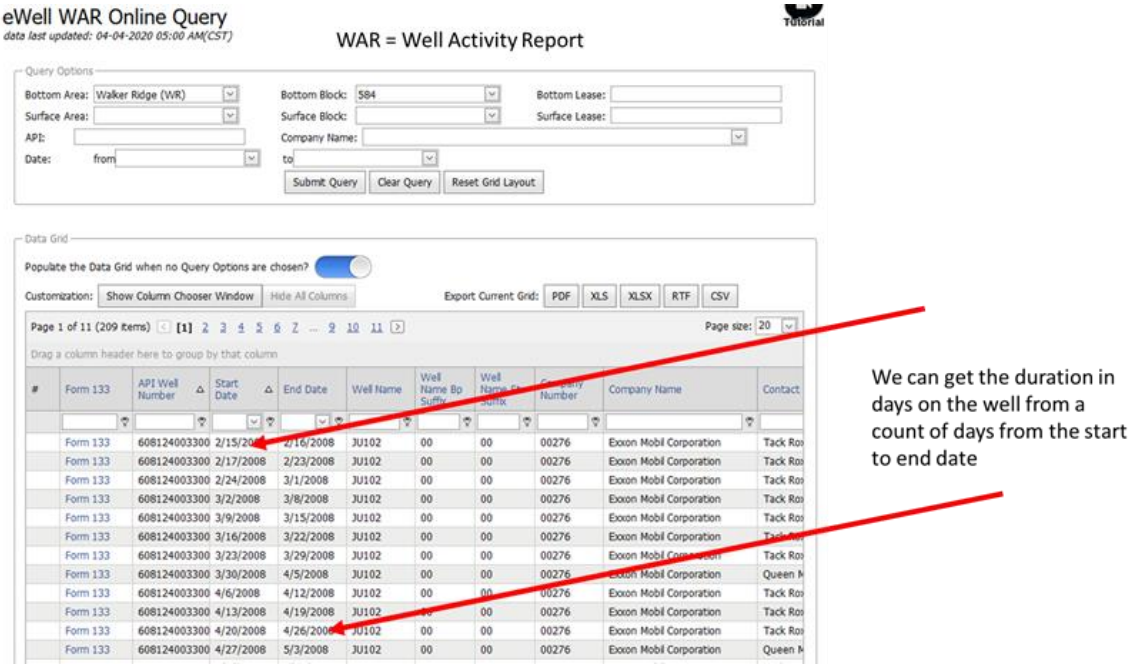
API Well Number			Values	API10 or API14
Well Name				
Type Code			E, R, C, D	Indicates the final classification of a borehole denoting the purpose of the drilling.
Status Code				Indicates the conditions relating to a borehole.

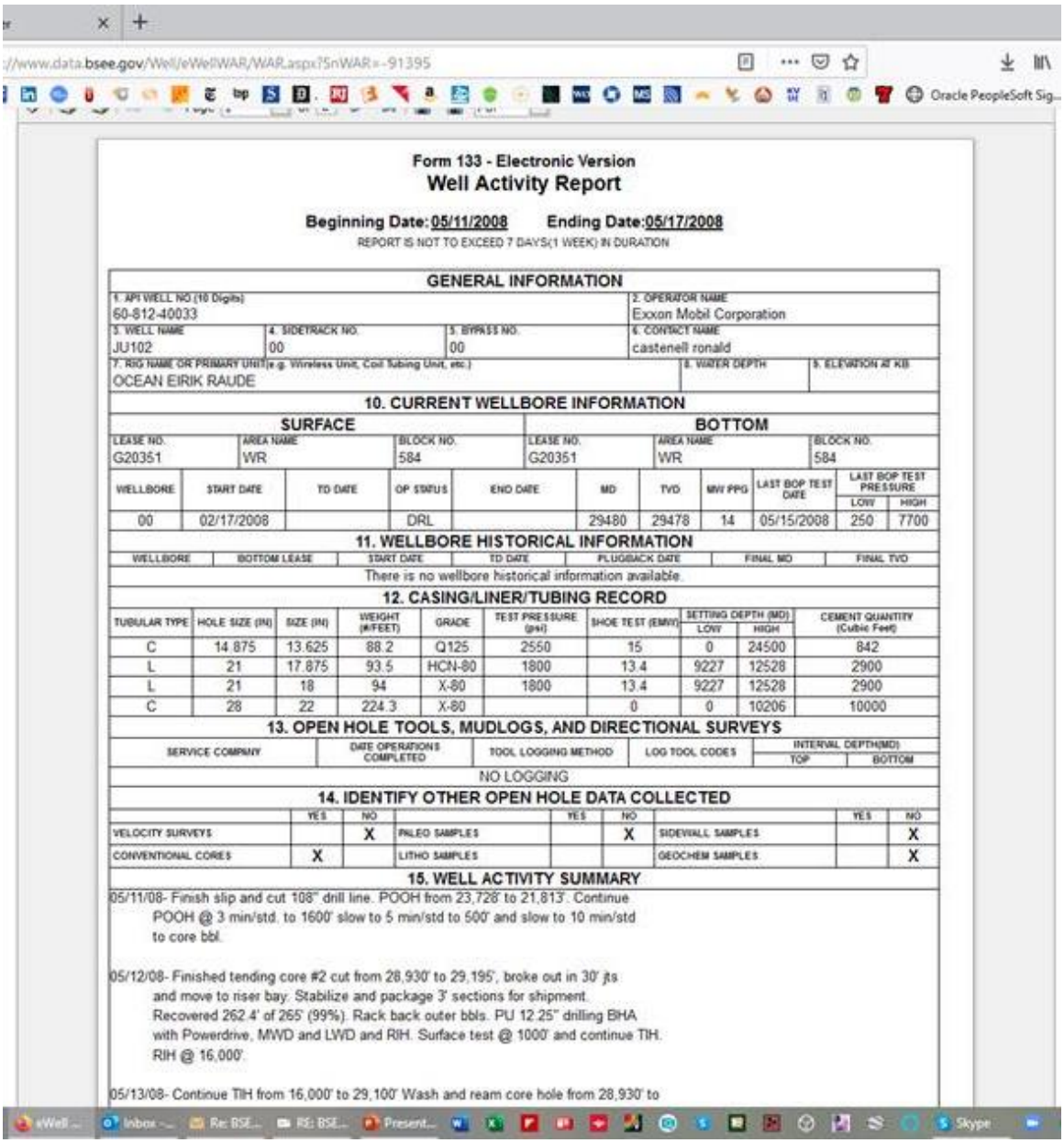
Bore Hole Status Codes

Minimum Value	Maximum Value	Value Description	
	Domain Name: BOREHOLE_STAT_CDS		
	APD		APPLICATION FOR PERMIT TO DRILL
	AST		APPROVED SIDETRACK
	CNL		BOREHOLE IS CANCELLED. THE REQUEST TO DRILL THE WELL IS CANCELLED AFTER THE APD OR SUNDRY HAS BEEN APPROVED. THE STATUS DATE IS THE DATE THE BOREHOLE WAS CANCELLED.
	COM		BOREHOLE COMPLETED
	CT		CORE TEST WELL
	DRL		DRILLING ACTIVE
	DSI		DRILLING SUSPENDED
	PA		PERMANENTLY ABANDONED
	ST		BOREHOLE SIDETRACKED
	TA		TEMPORARILY ABANDONED
	VCW		VOLUME CHAMBER WELL

3.2.2 Driller's (Roy) Mark up


New to the Data Center? Not sure what you're looking for or what we have available? Try the Quick Data Online Query.
Populate all Online Query Data Grids (where applicable) when no Query Options are chosen?
Company
Dir Surveys
Field
G & G
Leasing
Mapping
Paleo
Pipeline
Plans
Platform
Production
Seismic
Well
Other
Leasing Information
Leasing Information - Full Page
Online Queries
Assignments
Company Detail
Lease Area Block Lookup
Lease Owner
Non-Required/Required Documents Received
Offshore Statistics by Water Depth
P & A Lease Liability
Serial Register Page
Other Searchable Information
Latlong Facility Location Determination
Paleo Information
Paleontologic Information - Full Page
Other Searchable Information
Well Data Query
PDF Report Downloads
Paleo for Public Release (2000-Present)
Paleo for Public Release (1947-1999)
Paleo Lease/Wells Not Recommended for Release
Paleo Lease/Wells Recommended for Release
ASCII Downloads
Well Information
Well Information - Full Page
Online Queries
Application for Permit to Drill
API Lookup
API Number Changes
Borehole Pressure Survey
eWell Submissions APD
eWell Submissions APM
eWell Submissions EOR
eWell Submissions WAR
Other Searchable Information
Well Data Query
Plans Information
Pipeline Information
Production Information


eWell WAR Online Query
data last updated: 04-04-2020 05:00 AM(CST)
WAR = Well Activity Report
Tutorial
Query Options
Bottom Area: Walker Ridge (WR)
Bottom Block: 584
Bottom Lease:
Surface Area:
Surface Block:
Surface Lease:
API:
Company Name:
Date: from
to
Submit Query
Clear Query
Reset Grid Layout
Data Grid
Populate the Data Grid when no Query Options are chosen?
Customization: Show Column Chooser Window Hide All Columns
Export Current Grid: PDF XLS XLSX RTF CSV
Page 1 of 11 (209 items) [1] 2 3 4 5 6 7 ... 9 10 11
Page size: 20
Drag a column header here to group by that column
Form 133 API Well Number Start Date End Date Well Name Well Name Bp Suffix Well Name Ex Suffix Company Number Company Name Contact
Form 133 608124003300 2/15/2008 2/16/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 2/17/2008 2/23/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 2/24/2008 3/1/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 3/2/2008 3/8/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 3/9/2008 3/15/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 3/16/2008 3/22/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 3/23/2008 3/29/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 3/30/2008 4/5/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 4/6/2008 4/12/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 4/13/2008 4/19/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 4/20/2008 4/26/2008 JU102 00 00 00276 Exxon Mobil Corporation
Form 133 608124003300 4/27/2008 5/3/2008 JU102 00 00 00276 Exxon Mobil Corporation
We can get the duration in days on the well from a count of days from the start to end date



Form 133 - Electronic Version

Well Activity Report

Beginning Date: 05/11/2008 **Ending Date:** 05/17/2008

REPORT IS NOT TO EXCEED 7 DAYS(1 WEEK) IN DURATION

GENERAL INFORMATION

1. API WELL NO (10 Digits)			2. OPERATOR NAME
60-812-40033			Exxon Mobil Corporation
3. WELL NAME	4. SIDETRACK NO.	5. BYPASS NO.	6. CONTRACT NAME
JU102	00	00	castenell ronald
7. RIG NAME OR PRIMARY UNIT (e.g. Wireless Unit, Coil Tubing Unit, etc.)		8. WATER DEPTH	9. ELEVATION AT KB
OCEAN EIRIK RAUDE			

10. CURRENT WELLBORE INFORMATION

SURFACE			BOTTOM		
LEASE NO.	AREA NAME	BLOCK NO.	LEASE NO.	AREA NAME	BLOCK NO.
G20351	WR	584	G20351	WR	584

WELLBORE	START DATE	TD DATE	OP STATUS	END DATE	MD	TVD	MW PPG	LAST BOP TEST DATE	LAST BOP TEST PRESSURE	
									LOW	HIGH
00	02/17/2008		DRL		29480	29478	14	05/15/2008	250	7700

11. WELLBORE HISTORICAL INFORMATION

WELLBORE	BOTTOM LEASE	START DATE	TD DATE	PLUGBACK DATE	FINAL MD	FINAL TVD
There is no wellbore historical information available.						

12. CASING/LINER/TUBING RECORD

TUBULAR TYPE	HOLE SIZE (IN)	SIZE (IN)	WEIGHT (#/FEET)	GRADE	TEST PRESSURE (psi)	SHOE TEST (EMW)	SETTING DEPTH (MD) LOW	SETTING DEPTH (MD) HIGH	CEMENT QUANTITY (Cubic Feet)
C	14.875	13.625	88.2	Q125	2550	15	0	24500	842
L	21	17.875	93.5	HCN-80	1800	13.4	9227	12528	2900
L	21	18	94	X-80	1800	13.4	9227	12528	2900
C	28	22	224.3	X-80		0	0	10206	10000

13. OPEN HOLE TOOLS, MUDLOGS, AND DIRECTIONAL SURVEYS

SERVICE COMPANY	DATE OPERATIONS COMPLETED	TOOL LOGGING METHOD	LOG TOOL CODES	INTERVAL DEPTH(MD) TOP	INTERVAL DEPTH(MD) BOTTOM
NO LOGGING					

14. IDENTIFY OTHER OPEN HOLE DATA COLLECTED

	YES	NO		YES	NO		YES	NO
VELOCITY SURVEYS		X	PALEO SAMPLES		X	SIDEWALL SAMPLES		X
CONVENTIONAL CORES	X		LITHO SAMPLES			GEOCHEM SAMPLES		X

15. WELL ACTIVITY SUMMARY

05/11/08- Finish slip and cut 108" drill line. POOH from 23,728' to 21,813'. Continue POOH @ 3 min/std. to 1600' slow to 5 min/std to 500' and slow to 10 min/std to core bbl.

05/12/08- Finished tending core #2 cut from 28,930' to 29,195', broke out in 30' jts and move to riser bay. Stabilize and package 3' sections for shipment. Recovered 262.4' of 265' (99%). Rack back outer bbls. PU 12.25" drilling BHA with Powerdrive, MWD and LWD and RIH. Surface test @ 1000' and continue TIH. RIH @ 16,000'.

05/13/08- Continue TIH from 16,000' to 29,100' Wash and ream core hole from 28,930' to

Form 133 - Electronic Version
Well Activity Report

Beginning Date: 03/27/2016 **Ending Date:** 04/02/2016
REPORT IS NOT TO EXCEED 7 DAYS(1 WEEK) IN DURATION

GENERAL INFORMATION

1. API WELL NO.(10 Digits)			2. OPERATOR NAME
60-812-40033			Exxon Mobil Corporation
3. WELL NAME	4. SIDETRACK NO.	5. BYPASS NO.	6. CONTACT NAME
JU102	01	00	Tack Roxanne
7. RIG NAME OR PRIMARY UNIT(e.g. Wireless Unit, Coil Tubing Unit, etc.)			8. WATER DEPTH / 9. ELEVATION AT KB

10. CURRENT WELLBORE INFORMATION

SURFACE			BOTTOM		
LEASE NO.	AREA NAME	BLOCK NO.	LEASE NO.	AREA NAME	BLOCK NO.
G20351	WR	584	G20351	WR	584

WELLBORE	START DATE	TD DATE	OP STATUS	END DATE	MD	TVD	MW PPG	LAST BOP TEST DATE	LAST BOP TEST PRESSURE LOW	LAST BOP TEST PRESSURE HIGH
01	01/20/2015	02/26/2015	COM		30483	30453	14.5	03/12/2016	250	8100

11. WELLBORE HISTORICAL INFORMATION

WELLBORE	BOTTOM LEASE	START DATE	TD DATE	PLUGBACK DATE	FINAL MD	FINAL TVD
00	G20351	02/17/2008	05/23/2008	01/20/2015	30955	30951

12. CASING/LINER/TUBING RECORD

TUBULAR TYPE	HOLE SIZE (IN)	SIZE (IN)	WEIGHT (#/FEET)	GRADE	TEST PRESSURE (psi)	SHOE TEST (EMW)	SETTING DEPTH (MD) LOW	SETTING DEPTH (MD) HIGH	CEMENT QUANTITY (Cubic Feet)
C	12.25	10	73.9	Q-125HC	2800	0	0	15953	1199
C	12.25	10.05	73.9	JFE-15CR-125HC	2800	0	0	15953	1199
C	12.25	10.75	85.3	Q-125HC	2800	0	0	15953	1199
C	14.875	13.625	88.2	Q125	2550	15	0	24500	842
L	21	17.875	93.5	HCN-80	1800	13.4	9227	12528	2900
L	21	18	94	X-80	1800	13.4	9227	12528	2900
C	28	22	224.3	X-80		0	0	10206	10800

13. OPEN HOLE TOOLS, MUDLOGS, AND DIRECTIONAL SURVEYS

SERVICE COMPANY	DATE OPERATIONS COMPLETED	TOOL LOGGING METHOD	LOG TOOL CODES	INTERVAL DEPTH(MD) TOP	INTERVAL DEPTH(MD) BOTTOM
NO LOGGING					

14. IDENTIFY OTHER OPEN HOLE DATA COLLECTED

	YES	NO		YES	NO		YES	NO
VELOCITY SURVEYS			PALEO SAMPLES			SIDEWALL SAMPLES		
CONVENTIONAL CORES			LITHO SAMPLES			GEOCHEM SAMPLES		

15. WELL ACTIVITY SUMMARY

03/27/16: Install 4-1/2" x 7" VBR in middle pipe ram. Perform ROV intervention testing on middle pipe ram. Continue with Blue MUX cable termination. Begin BOP stump testing.

03/28/16: Perform BOP stump test, troubleshoot unsuccessful pressure test, replace

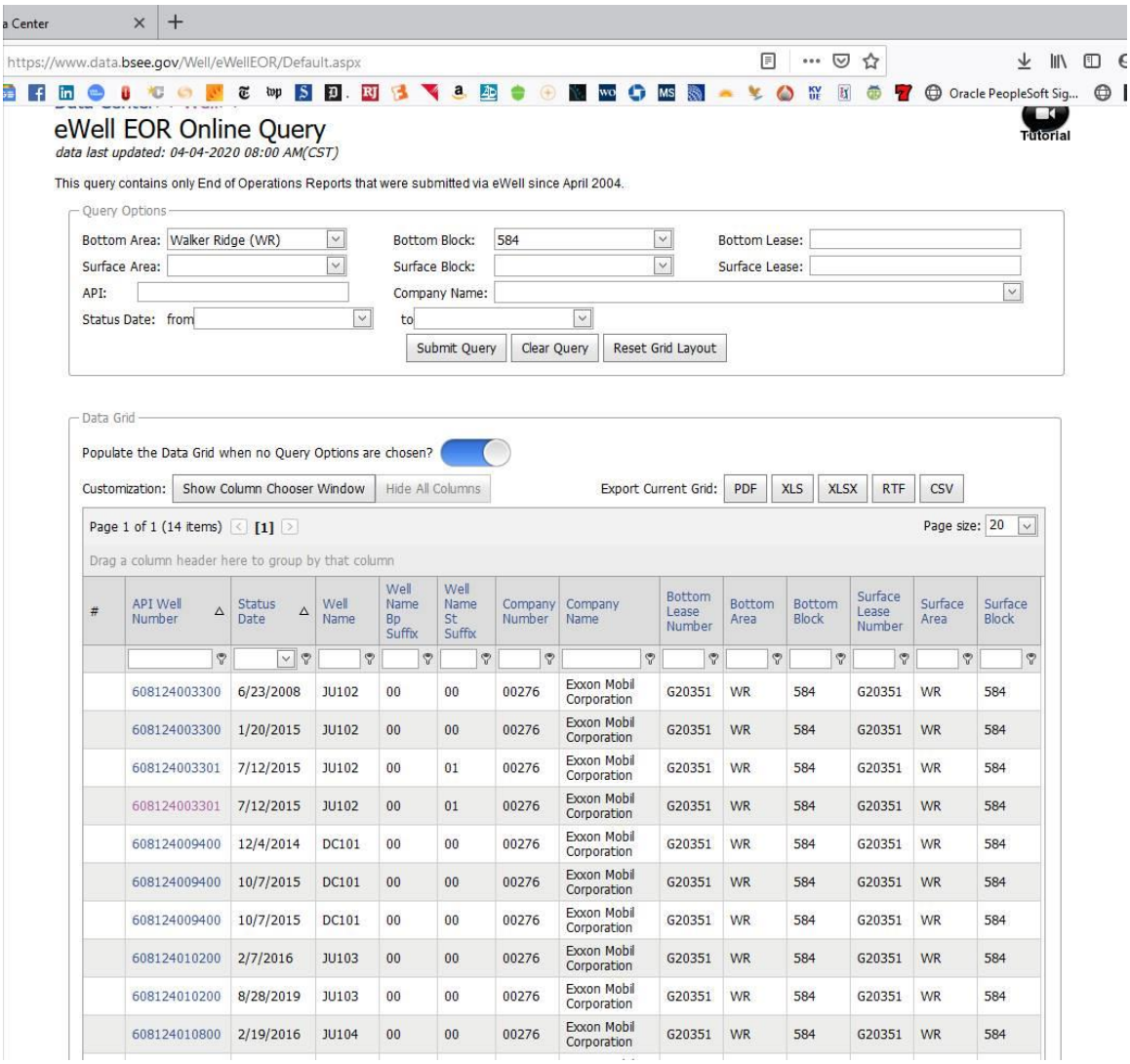
Completion Mode

Plug Back Depth

Max Mud Weight

Casing Program

Operations Summary



https://www.data.bsee.gov/Well/eWellEOR/Default.aspx

eWell EOR Online Query

data last updated: 04-04-2020 08:00 AM(CST)

Tutorial

This query contains only End of Operations Reports that were submitted via eWell since April 2004.

Query Options

Bottom Area: Walker Ridge (WR) | Bottom Block: 584 | Bottom Lease:
Surface Area: | Surface Block: | Surface Lease:
API: | Company Name:
Status Date: from | to

Submit Query | Clear Query | Reset Grid Layout

Data Grid

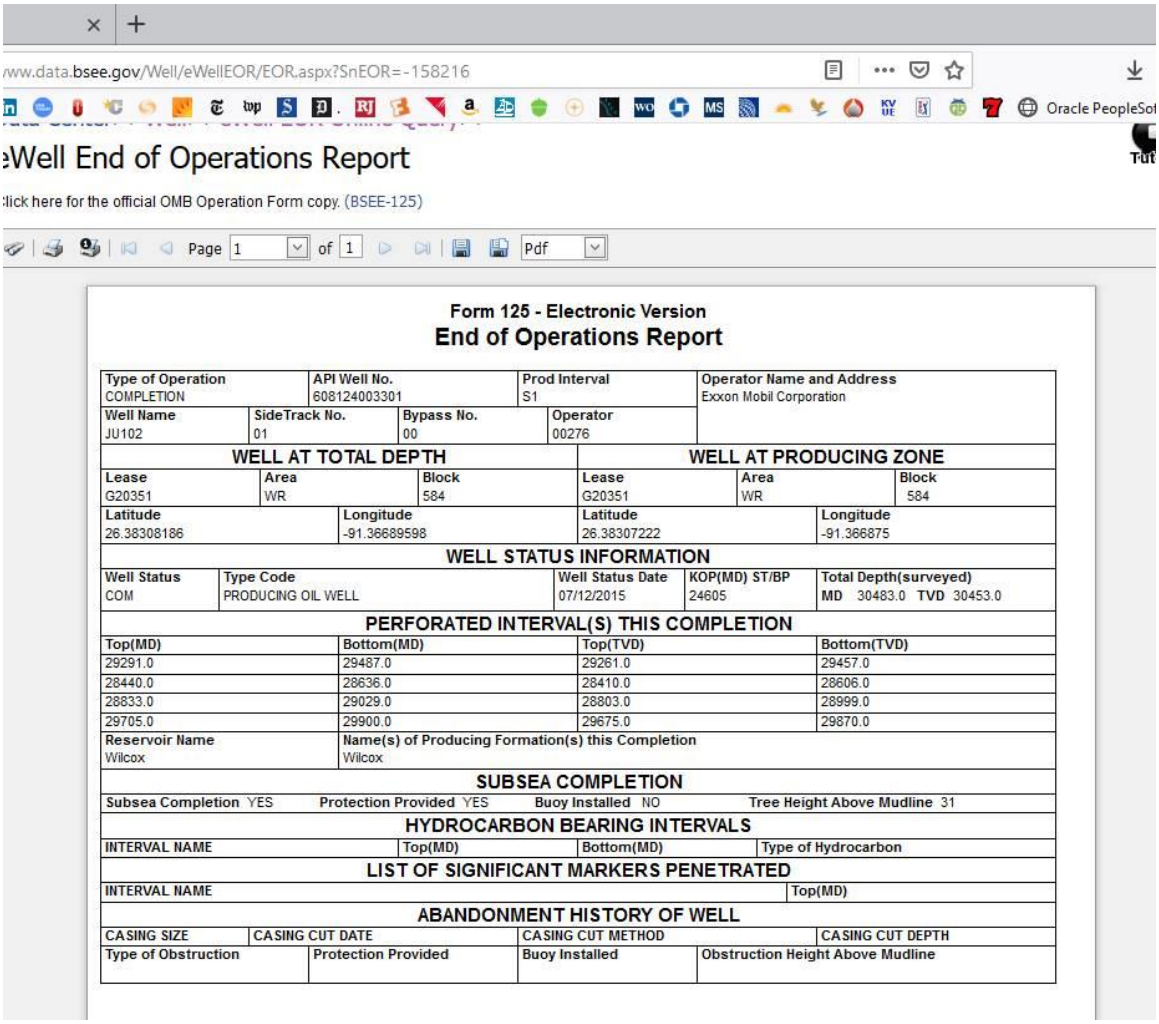
Populate the Data Grid when no Query Options are chosen?

Customization: Show Column Chooser Window | Hide All Columns | Export Current Grid: PDF | XLS | XLSX | RTF | CSV

Page 1 of 1 (14 items) [1] Page size: 20

Drag a column header here to group by that column

#	API Well Number	Status Date	Well Name	Well Name Bp Suffix	Well Name St Suffix	Company Number	Company Name	Bottom Lease Number	Bottom Area	Bottom Block	Surface Lease Number	Surface Area	Surface Block
	608124003300	6/23/2008	JU102	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124003300	1/20/2015	JU102	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124003301	7/12/2015	JU102	00	01	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124003301	7/12/2015	JU102	00	01	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124009400	12/4/2014	DC101	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124009400	10/7/2015	DC101	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124009400	10/7/2015	DC101	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124010200	2/7/2016	JU103	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124010200	8/28/2019	JU103	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584
	608124010800	2/19/2016	JU104	00	00	00276	Exxon Mobil Corporation	G20351	WR	584	G20351	WR	584



www.data.bsee.gov/Well/eWellEOR/EOR.aspx?SnEOR=-158216

eWell End of Operations Report

lick here for the official OMB Operation Form copy. (BSEE-125)

Page 1 of 1 Pdf

Form 125 - Electronic Version

End of Operations Report

Type of Operation	API Well No.	Prod Interval	Operator Name and Address
COMPLETION	608124003301	S1	Exxon Mobil Corporation

Well Name	SideTrack No.	Bypass No.	Operator
JU102	01	00	00276

WELL AT TOTAL DEPTH			WELL AT PRODUCING ZONE		
Lease	Area	Block	Lease	Area	Block
G20351	WR	584	G20351	WR	584
Latitude	**Longitude**		**Latitude**	**Longitude**	
26.38308186	-91.36689598		26.38307222	-91.366875	

WELL STATUS INFORMATION

Well Status	Type Code	Well Status Date	KOP(MD) ST/BP	Total Depth(surveyed)
COM	PRODUCING OIL WELL	07/12/2015	24605	MD 30483.0 TVD 30453.0

PERFORATED INTERVAL(S) THIS COMPLETION

Top(MD)	Bottom(MD)	Top(TVD)	Bottom(TVD)
29291.0	29487.0	29261.0	29457.0
28440.0	28636.0	28410.0	28606.0
28833.0	29029.0	28803.0	28999.0
29705.0	29900.0	29675.0	29870.0

Reservoir Name	Name(s) of Producing Formation(s) this Completion
Wilcox	Wilcox

SUBSEA COMPLETION

Subsea Completion	Protection Provided	Buoy Installed	Tree Height Above Mudline
YES	YES	NO	31

HYDROCARBON BEARING INTERVALS

INTERVAL NAME	Top(MD)	Bottom(MD)	Type of Hydrocarbon

LIST OF SIGNIFICANT MARKERS PENETRATED

INTERVAL NAME	Top(MD)

ABANDONMENT HISTORY OF WELL

CASING SIZE	CASING CUT DATE	CASING CUT METHOD	CASING CUT DEPTH

Type of Obstruction	Protection Provided	Buoy Installed	Obstruction Height Above Mudline

Form 123A/123S - Electronic Version

Revised Application for Permit to Drill a New Well

Lease G20351 **Area/Block** WR 584 **Well Name** JU104 **ST** 00 **BP** 00 **Well Type** D
Permit ID -17386 **Operator** 00276 Exxon Mobil Corporation

General Well Information

API Well Number	608124010800			**Kickoff Point**	
Date of Request	07/12/2016	**Approval Date**	07/15/2016	**Req Spud Date**	02/09/2016
Water Depth(ft.)	7148	**Drive Size(in.)**	36	**Mineral Code**	H
RKB Elevation(ft.)	84	**Drive Depth(ft.)**	279	**Subsea BOP**	Y

Proposed Well Location

SURFACE

LEASE(OCS)	G20351	**Area/Block**	WR 584		**State Lease(if applicable)**		
Entered NAD 27 Data		**Calculated NAD 27 Departures**			**Calculated NAD 27 X-Y Coordinates**		
Lon:	-91.36614333	**W**	5090		2175169.983814		
Lat:	26.38442694	**N**	6033		9577167.039267		
Plan Information							
Control ID	N 9699	**Lease**	G20351	**Area**	WR	**Block** 584	**Well Name** DC1-3

BOTTOM

LEASE(OCS)	G20351				**Area/Block**	WR 584	
Entered NAD 27 Data		**Calculated NAD 27 Departures**			**Calculated NAD 27 X-Y Coordinates**		
Lon:	-91.35898639	**W**	7382		2177461.592707		
Lat:	26.39549306	**N**	1981		9581218.526509		
Plan Information							
Control ID	N 9699	**Lease**	G20351	**Area**	WR	**Block** 584	**Well Name** DC1-3

Rig Information

RIG SPECIFICATIONS		**ANCHORS** N	
Rig Name	MAERSK VIKING		
Type	DRILLSHIP	**ID Number**	50410
Function	D	**Constructed Year**	2014
Shipyard	SINGAPORE	**Refurbished Year**	
RATED DEPTHS			
Water Depth	12000	**Drill Depth**	40000
CERTIFICATES			
ABS	02/23/2019	**Coast Guard**	06/02/2017
SAFE WELDING AREA			
Approval Date	06/18/2014	**District**	GOMR Houma District
Remarks			

Geologic Information

H2S Designation Absent	**H2S TVD**

Geologic Markers

Name	Top MD
Top of Salt	12222
Base of Salt	23546
Middle Miocene	24814
Langhian	25486
Burdigalian	26159
Oligocene	27260
Lower Oligocene	27766
Eocene	28533
Top Wilcox	28759

Permit Attachments
There are no attachments available.

Well Design Information

Interval Number	1			Type C		Name C		
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth(ft) MD	Depth(ft) TVD	Pore Pressure
1	28	218	X60	2810	950	8372	8372	8.6

GENERAL INFORMATION		PREVENTER INFORMATION		TEST INFORMATION	
Hole Size(in)	32	Type	GSW	Annular Test(psi)	0
Mud Weight(ppg)	0	Size(in)	18.75	BOP/Diverter Test(psi)	0
Mud Type Code	GSW	Wellhead Rating(psi)	15000	Mud Test Weight(ppg)	0
Fracture Gradient(ppg)	0	Annular Rating(psi)	10000	Casing/Liner Test(psi)	0
Liner Top Depth(ft)	0	BOP Rating(psi)	15000	Formation Test(ppg)	0
Cement Volume(cu ft)	2019				

Interval Number	2			Type C		Name S		
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth(ft) MD	Depth(ft) TVD	Pore Pressure
1	22	224.5	X-80	6360	3870	10420	10420	8.6

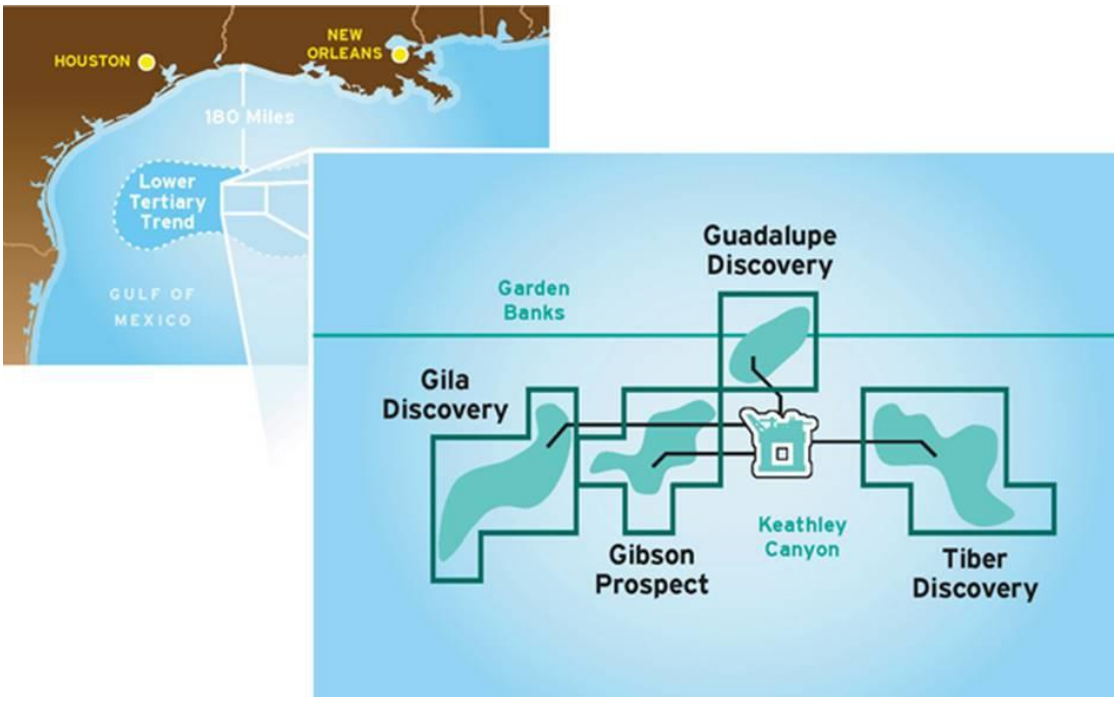
GENERAL INFORMATION		PREVENTER INFORMATION		TEST INFORMATION	
Hole Size(in)	28	Type	SBM	Annular Test(psi)	4000
Mud Weight(ppg)	8.6	Size(in)	18.75	BOP/Diverter Test(psi)	5000
Mud Type Code	SBM	Wellhead Rating(psi)	15000	Mud Test Weight(ppg)	8.6
Fracture Gradient(ppg)	11	Annular Rating(psi)	10000	Casing/Liner Test(psi)	3000
Liner Top Depth(ft)	0	BOP Rating(psi)	15000	Formation Test(ppg)	11
Cement Volume(cu ft)	4971				

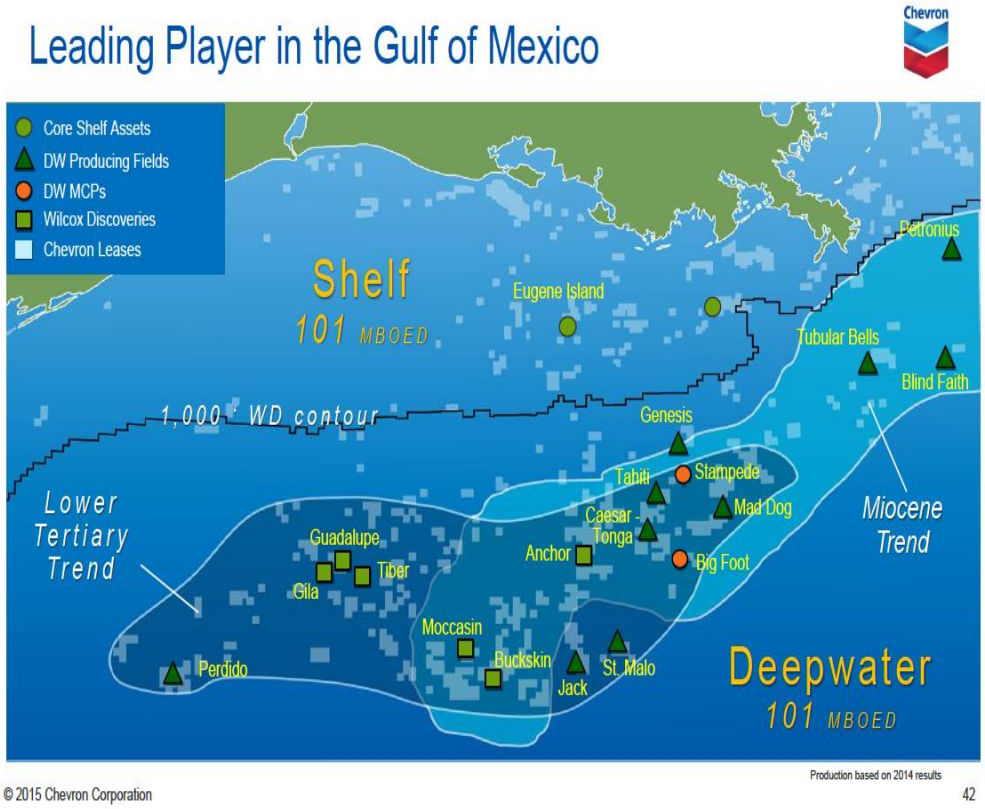
Interval Number	3			Type L		Name S		
Section Number	Casing Size (in)	Casing Weight (lb/ft)	Casing Grade	Burst Rating (psi)	Collapse Rating (psi)	Depth(ft) MD	Depth(ft) TVD	Pore Pressure
1	17.875	93.5	Q-125	6469	1090	14067	14067	9.9

GENERAL INFORMATION		PREVENTER INFORMATION		TEST INFORMATION	
Hole Size(in)	21	Type	SBM	Annular Test(psi)	4000
Mud Weight(ppg)	12	Size(in)	18.75	BOP/Diverter Test(psi)	5500
Mud Type Code	SBM	Wellhead Rating(psi)	15000	Mud Test Weight(ppg)	12
Fracture Gradient(ppg)	12.8	Annular Rating(psi)	10000	Casing/Liner Test(psi)	2500
Liner Top Depth(ft)	9913	BOP Rating(psi)	15000	Formation Test(ppg)	12.8

3.2.3 FDAS Fields of Interest

Kaskida
Tiber
Tiger
Shenandoah
Julia
Stones
JSM
Cascade Chinook
Anchor
Buckskin
Guadalupe
North Platte
Moccasin
Gila
Gibson
Coronado
Big Foot


HOUSTON
NEW ORLEANS
180 Miles
Lower Tertiary Trend
GULF OF MEXICO
Guadalupe Discovery
Garden Banks
Gila Discovery
Keathley Canyon
Gibson Prospect
Tiber Discovery


Leading Player in the Gulf of Mexico
Chevron
Core Shelf Assets
DW Producing Fields
DW MCPs
Wilcox Discoveries
Chevron Leases
Shelf
101 MBOED
Eugene Island
1,000' WD contour
Petronius
Tubular Bells
Blind Faith
Genesis
Tahiti
Stampede
Mad Dog
Caesar - Tonga
Anchor
Big Foot
Miocene Trend
Lower Tertiary Trend
Guadalupe
Tiber
Gila
Moccasin
Buckskin
Jack
St. Malo
Perdido
Deepwater
101 MBOED
Production based on 2014 results
© 2015 Chevron Corporation
42

3.2.4 Well Data | BSEE Response

We have additional questions concerning the WR 584 data that you are interested.

Typically - for releasable well data --beyond the online query you referenced - we would refer individuals to our BSEE Data Center "Disc Media Store" where individuals may create an account - from which they can select/purchase a wide range of well data and reports (predominately PDF format for EOR and WAR) - and create custom CD, DVD or BluRay output .

That link can be found here
https://www.data.bsee.gov/Other/DiscMediaStore/Default.aspx

You can browse the index without an account -- but require a login account to purchase the CD/DVD/Blu Ray output and have it shipped to you
https://www.data.bsee.gov/Other/DiscMediaStore/Login.aspx

> Log In - BSEE Data Center
> This is a United States Government computer system, maintained by the Department of the Interior, to provide Official Unclassified U.S. Government information only.
> www.data.bsee.gov

ALTERNATIVELY: The Raw tabular ASCII data from which the EOR and WAR online reports are created -- can be accessed here
https://www.data.bsee.gov/Main/RawData.aspx

> Raw Data
> Files listed in the table below represent the raw data used to support the associated Online Query. Due to the complex runtime programming and relationships involved in the online queries we do not provide support for the downloadable raw data.
> www.data.bsee.gov

https://www.data.bsee.gov/Well/Files/eWellEORRawData.zip
https://www.data.bsee.gov/Well/Files/eWellWARRawData.zip

These links indicate the column definitions for each RawData Set
https://www.data.bsee.gov/Well/eWellEOR/Default.aspx

eWell EOR Online Query - BSEE Data Center

Data Center >> Well >> eWell EOR Online Query data last updated: 04-03-2020 04:00 PM(CST) This query contains only End of Operations Reports that were submitted via eWell since April 2004.
www.data.bsee.gov

https://www.data.bsee.gov/Well/eWellWAR/Default.aspx

Please feel free to contact TDM@bsee.gov with additional questions - should this not meet you need.

United States Department of the Interior
Bureau of Safety and Environmental Enforcement
Gulf of Mexico Region
Office of Technical Data Management
New Orleans, Louisiana

3.2.5 Contacts

Eric.Kazanis@boem.gov

Possible Highers up of Eric:
Grant.Burgess@boem.gov
Kellie.Cross@boem.gov

3.2.6 Roy, Chuck Conversation Notes (1st revision of app)

This will also allow us to easily calculate the difference between final bhl's for example JUL05 and JUL06 as Chuck notes below. I see from your table the BHL for JUL05 is 2500' from the SHL. If that is the same or greater for the JUL06 sidetrack, the BHL locations could be more than a mile apart so the 42.2 ft has no real bearing on the reservoir assessment. This is called a drill center in the D&C world.

In this case, the drill center is a "keeping wellheads close to the manifold" issue so that short tieback jumpers can be used.

As Roy has noted previously, the reach of the deviating wellbores can cover a whole block since the reservoir is so deep!

Yes it would be interesting to expose the emperor who has no clothes. If we were to do a study of subsea developments with 5 wells per drill center, what we would see is these guys are drilling directional wells to some extent. If we were to look at 5 well templates I wonder what the deviations would be to cover the reservoir for subsea development? My guess is that 5 well drill centers are excessive! But if we step out twice as much as they do now with established directional drilling technology, 5 wells is probably covers a tremendous area for re-drills and sidetracks. These guys have not integrated the whole problem. Choosing 42' well center locations on a manifold is stupid to keep jumper costs down. Insignificant except to the subsea engineers.

3.3 Data Refresh Methodology (from 2019 to 2021)

API Well List

Production Data:
https://www.data.bsee.gov/Production/Files/ogora2020delimit.zip
https://www.data.bsee.gov/Production/Files/ogoradelimit.zip

APPENDIX 4.0 - PYTHON DEVELOPER/DATA SCIENCE IN O&G

Title: Python Developer (USD 83/hour)
Length: 6 month contract with likely extension
Location: Houston, TX
Description: - 5+ years experience using Python
- Experience working connecting Python with relational databases (Oracle/Sql Server)
- Experience working in environments running multiple versions of Python (2.x and 3.x)
- Experience using Python on a big data environment is a big plus (Spark, Hadoop, Mongo DB)
- Experience using Python with real-time data is a big plus

Interview Format:

- Technical Round (30 mins)
    - Interviewer: Software Developer / Internal Consultant-Business Intelligence & Data Management
    - Python experience focus
- Business functional Round (30 mins)
    - Business function focus
    - Interviewers:
        - IT Manager, Data Management and Analytics
        - Business owner
- Why candidates are rejected?
    - Too much ETL experience. Not sufficient data science experience
    - Too quiet that one may not communicate/sell ideas through to other team members

APPENDIX 5.0 - PRACTISE MATERIALS

- Kaggle for practicing ML
- StackOverflow for questions on pandas
- planetpython.org
- dataskeptic.com, more on machine learning
    - https://dataskeptic.com
- hacker rank, codility, codechef - data structure puzzles, upto intermediate
- MySQL http://sqlzoo.net
- Stats, ML - Khan Academy
- Coursera Andrew Ng Course ML

5.1 Interview Preparation

5.1.1 Sample Interview 1

https://www.youtube.com/watch?v=0HmAEWPfMnM
produce histogram
do fizba?
anagram solver
basic data structure question - intermediate level
hash table, linked list, arrays, Big O notation,
past project- problem, metrics for success, assumptions, data preprocessing, modeling, classification, validation test, training split, how the model works
if its text, TF-IDF, how does cross product occur, bayes, grading decent, hyper parameter select, regression, vector machines
hacker rank, codility, codechef - data structure puzzles
binary search, prefix sum
How to approach a data problem - how much data do we have, time series, sample data, plotting histogram, time of day, # of posts, design experiments, split testing

5.1.2 Sample Interview 2

https://www.youtube.com/watch?v=ccCblUZFM0w
take home ML task
whiteboard code task - data structures / algo
whiteboard sql
bayes therem probability questions
how to evaluate ML models
glassdoor data scientist interview questions
basics of NLP

5.1.3 Sample Interview 3

1\ If you have a data set of 1000 columns and 1M rows and you know it is a classification problem what would you do with it?

Now if I tell you this is cancer detection data, then what will you do with the data?

If that same data was about cancer progression instead, then how will you look at this data?

How is the cancer increasing, can you predict something?

I said use some regression model with error factor to predict cancer progression. If somebody else uses a decision tree then which one will be more reliable? Why?

Decision tree is more reliable as there may be events that happen which will eliminate/confirm the possibility of outcomes.
While regression model is a crude factor analysis coming out with only 1 number and an associated probability of positiveness.

2\ Business Problem - Lets say I have a restaurant and I deliver orders within a 5 mile radius
and in the last 6 months I have not been able to make deliveries on time and having to give customers discounts

How can this problem be solved? What information do you need to solve this problem?

3\ which graphing package will you use to plot which kind of data?
when will you use pandas to plot data? For what data is it more efficient?
what kind of data is matplotlib not good at plotting

Pandas for time series
Matplotlib for all other data

4\ difference between: tuple, list and series?

Note : This language is Python specific. Things may be different in other programming languages
Tuple: Heterogenous data structures. Tuples are not imutable. The length of tuple is fixed.
List: : Are homogenous sequences. List can be a collection of tuples. Length of list is not fixed. Lists are mutable.

Series: Series will have a name and values. Series is a data structure for a single column of a DataFrame.
DataFrame : DataFrame is stored in memory as a collection of series.

"Series vs. DataFrame" is analogous to "List vs. Matrices"

5\ If I give you log data and core data for a reservoir, and you don't have legacy software such as landmark,
can you make the reservoir layers? How?

Reservoir data is of pre-defined format (https://en.wikipedia.org/wiki/SEG_Y) and is part of standardized committee development. There are open source programs (python, java etc.) which can tap into or write own program to get the required data.
http://segymat.sourceforge.net/segypy/

6\ Lets say there is a building with 100 stories and I drop a ball from each story and the bounce back height is noted
Can you tell me which storey I should drop the ball for it to bounce back to height X? How?

Examine if a trend exists. If trend is not monotonic, then go to do specific study.
If yes, do Simple interpolation function?

7\ what parameters can be tweaked in random forest model to improve prediction?

8\ what transformations and actions can you perform on RDDs in Spark?

Resilient distributed Dataset (RDD). This is a lazy process. Nothing of real value is done on the data.

- Count data.
- If a word is present or absent? Etc.

9\ Have you done spark caching?

Cacheing is done when the RDD branches out or RDD is to be used multiple times in a loop.

10\ Which cluser manager did you use with Spark? Yarn? Cassandra?

Clusters work with master and Slave (workers) concepts. Scheduling and processing will happen.
The type of manager will depend on the application and will hep in scheduling and allocations.
API's supported.

11\ Difference between 2 types of join in SQL?

12\ How will you reduce shuffling in spark? What things can you use?
Shuffling is memory intensive and can cause problems. However it is necessary if single node operations are to be performed shuffling is necessary to reduce the memory pressure.

https://blog.cloudera.com/blog/2015/05/working-with-apache-spark-or-how-i-learned-to-stop-worrying-and-love-the-shuffle/

APPENDIX 6.0– DRILLING DATA

https://seekingalpha-com.cdn.ampproject.org/c/s/seekingalpha.com/amp/article/4077386-shale-oil-self-driving-drilling-rigs-will-arrive-sooner-self-driving-cars Shale Oil Automation Revolution

https://www.klietech.com/single-post/2017/05/31/Data-Analytics-Done-Right-in-Oil-and-Gas Data analytics for O&G

https://www.linkedin.com/pulse/exploring-drilling-data-from-volve-dataset-witsml-r-alfonso-r-reyes

https://www.energistics.org/pds-releases-open-source-witsml-technologies-to-improve-drilling-workflows-and-data-exchange/
Server and Studio

https://www.energistics.org/witsml-developers-users/

https://www.energistics.org/prodml-developers-users/

https://www.energistics.org/portfolio/resqml-data-standards/

https://witsml.pds.technology/docs/downloads/ (PDS Technology; Desktop application, Source code etc.)

References:

https://sparkcognition.com/2017/05/automating-drilling-machine-learning/?utm_medium=social&utm_campaign=Oilandgas&utm_source=linkedin&lipi=urn%3Ali%3Apage%3Ad_flagship3_feed%3B0fbL6NhqS%2BaTgU8I1%2FiToQ%3D%3D

https://www.linkedin.com/pulse/17-more-must-know-data-science-interview-questions-3-gregory Data Science

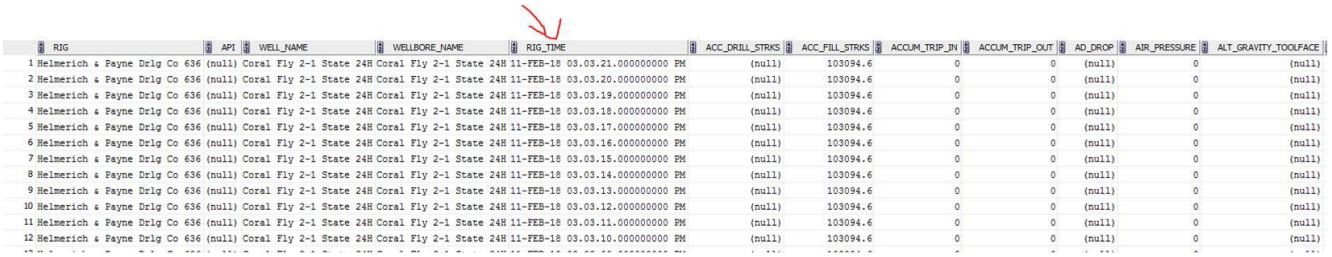
https://info.drillinginfo.com/machine-learning-in-oil-and-gas/

https://www.linkedin.com/pulse/raw-thoughts-og-drilling-digitalization-sebastien-riviere Raw Thoughts on O&G Drilling Automation

http://insights.energentgroup.com/rig-counts Rig Count Analytics. Good idea for display.

6.1 Drilling Systems Automation

Drilling Systems Automation Report
http://dsaroadmap.org/drilling-systems-automation/dsa-r-report/



	RIG	API	WELL_NAME	WELLBORE_NAME	RIG_TIME	ACC_DRILL_STRKS	ACC_FILL_STRKS	ACCUM_TRIP_IN	ACCUM_TRIP_OUT	AD_DROP	AIR_PRESSURE	ALT_GRAVITY_TOOLFACE
1	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.21.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
2	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.20.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
3	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.19.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
4	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.18.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
5	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.17.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
6	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.16.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
7	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.15.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
8	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.14.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
9	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.13.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
10	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.12.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
11	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.11.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)
12	Helmerich & Payne Drlg Co 636	(null)	Coral Fly 2-1 State 24H	Coral Fly 2-1 State 24H	11-FEB-18 03.03.10.000000000 PM	(null)	103094.6	0	0	(null)	0	(null)

Some data Code examples are given below. They are essentially accessed by the database.

```
select count(*)
FROM drilling_witsml_data
WHERE WELL_ID = '30-015-44510'

select count(*)
FROM drilling_witsml_data_dotnet
where well_id='30-015-44510'

select *
from drilling_witsml_data_dotnet
where well_name in ('Coral Fly 2-1 State 24H')
order by rig_time desc
```

6.2 Sample Postings

Machine Learning & Drilling Dynamics Modeling Specialist

Triad Resources _7 reviews -Houston, TX 77067
JOB TITLE: Machine Learning & Drilling Dynamics Modeling Specialist

LOCATION: Houston, TX

POSITION TYPE: Direct Hire

POSITION NUMBER: 8026

CONNECT WITH TRIAD RECRUITER: (713) 523-6003

COMPANY PROFILE

Our client owns and operates the world's largest land-based drilling rig fleet and is a leading provider of offshore drilling rigs in the United States and multiple international markets. Our client also provides directional drilling services, performance tools and innovative technologies throughout the world’s most significant oil and gas

markets. The company is engaged in leveraging their advanced drilling automation capabilities, and their highly skilled workforce continues to set new standards for operational excellence and transform the industry.

RESPONSIBILITIES

- Work with a team investigating new techniques to optimize and create new and novel ways to drill a well
- Work on new Algorithms and methods for optimizing drilling processes
- Work in a technically challenging environment with an excellent track record of creating new intellectual property through patents and trade secrets
- Research and develop new Algorithms and methods for optimizing the drilling processes by using machine learning techniques
- Design, validate and implement controls Algorithms to manage Electrical and Mechanical stability of surface and Downhole Drilling equipment
- Analyze and recommend approaches to handling dynamics of the electromechanical systems and their interactions with the Drilling string, BHA and Surface equipment
- Conduct Empirical statistical analysis / modeling on relevant data used in drilling controls
- Collaborate with the Engineering team to implement proposed strategies and Algorithms in our technology system
- Develop large scale machine learning Algorithms for pattern recognition using Bayesian and non-linear systems

REQUIRED SKILLS

- MS degree in Engineering, Science or related field, or equivalent practical experience
- 5 years of experience in Designing and Implementing Controls systems and Dynamic modeling
- 5 years of experience with Machine learning and construction of Algorithms and programming background (C, Python, MATLAB or LabVIEW)
- Well organized and self-paced
- Ability to interact with Engineers and field operational staff to gather information required for analysis
- Effective time management
- Experience with dynamic system analysis, feedback control systems (PID Control, MFA)
- Experience with modeling / statistical software such as Simulink, R, MATLAB Machine Learning Toolbox
- Familiar with microcontrollers, PLC, sensor technology, signal conditioning, filtering (SW and HW)
- Familiarity with basic machine learning Algorithms (e.g., linear regression, classification, neural networks) and the math needed to discuss them (linear algebra, probability / statistics)

- While this position is primarily based in a professional office environment, travel to yards and rigs is essential and required

25% travel is expected

DESIRED SKILLS

- PhD in Engineering, Science or related field, or equivalent practical experience

ABOUT TRIAD

Triad Resources specializes in direct hire staffing, managed contract services, and comprehensive training solutions. As a company committed to the highest level of integrity, honesty and quality in service, we are unique in two important ways: First, we always operate with the utmost discretion and never submit your resume without discussing the opportunity and client with you. Second, we are committed to helping you find a position that matches not only your skills and experience, but your personal and professional goals as well. Utilizing our network of premier global and progressive companies, we are able to offer you exciting opportunities that keep your best interests at heart. We look forward to working with you.

Completions

APPENDIX 7.0 –RESERVOIR DATA

https://www.linkedin.com/posts/tatyana-plaksina-27984b3a_petroleum-dataanalytics-programming-activity-6616059711118815232-u2mF

7.1 Typical Job Descriptions

7.1.1 W.D. Von Gonten Labs (GE Ventures):

Skills Data Science Python NumPy, Scipy, PyBrain,
5+ years of hands on experience in developing Analytical solutions using Python. Must have experience in using various Python libraries such as Pandas, NumPy, Scipy, PyBrain, etc. Any experience with MATLAB and COMSOL would be a plus.
Requires Data science experience
- Candidate must have 2+ year of hands on experience in developing solutions using big data technologies such as Hadoop and Cassandra
- Candidate must have 2+ year of hands on experience in developing Cloud based solutions on AWS

Technologies: Hadoop Cassandra Matlab Spark AWS Azure

Position: Tech Lead and Software Engineer

From Another Recruiter:
Model large data sets (multi terabytes) on Hadoop, Cassandra
Work with data science engineer to convert MATLAB models to highly scalable Apache Spark programs
Optimize data and code for high performance parallel computing on AWS/Azure

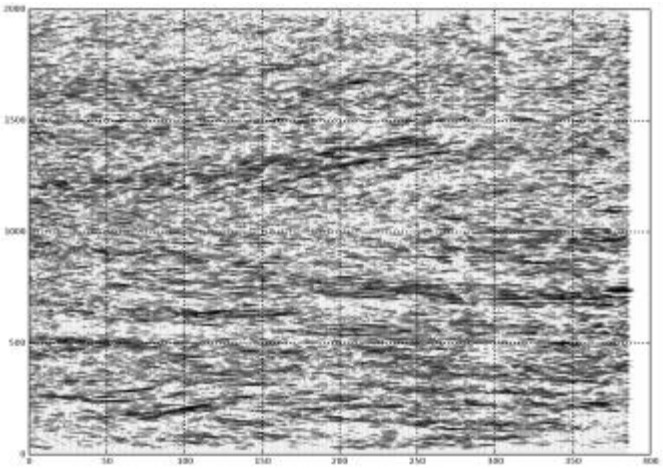
7.1.2 Reservoir Engineer

Geologist Skills:
Engage in the exploration, development, acquisition, and production of oil and natural gas reserves in several domestic basins including the Permian, GOM (Onshore) and Rockies.
A geologist trained with a knowledge of geophysics would be ideal.
- Conventional gas asset experience required.
- Experience interpreting and integrating diverse vintages of 2D/3D/4D seismic with well log analysis
- Ability to identify sweet spots and prospects using seismic amplitude anomalies, AVO responses and geological concepts in conventional plays
- Strong geomodeling, stratigraphy, well planning and geological operations experience
- Experience in prospect identification, seismic interpretation, synthetic well ties, velocity modeling, seismic amplitude and attribute analysis, quantitative seismic evaluation, and crucial interdisciplinary integration between geology and geophysics will be desired.

7.2 Technical

Reservoir Data Wiggle Plot (Using Matplotlib)

```
segypy.wiggle(Data,SH)
```



Sample Data:
https://walrus.wr.usgs.gov/namss/survey/s-5-09-sc_c/

http://segymat.sourceforge.net/segypy/

For well logs
https://www.linkedin.com/feed/update/urn:li:activity:6507949258430349312/

7.3 Downhole Pressure Calculations

https://github.com/f0nzie/vlp-bottomhole-algorithm
https://github.com/f0nzie/vlp-bottomhole-algorithm/blob/master/README.md

https://www.linkedin.com/feed/update/urn:li:activity:6507468845987528704/ Volvo dataset analysis.

7.4 History Matching

https://www.linkedin.com/pulse/fabrication-artificial-intelligence-agent-reservoir-history-reyes

7.5 SEG Y

The **SEG Y** file format is one of several standards developed by the Society of Exploration Geophysicists (SEG) for storing geophysical data.

7.5.1 Structure of SEG Y FILE

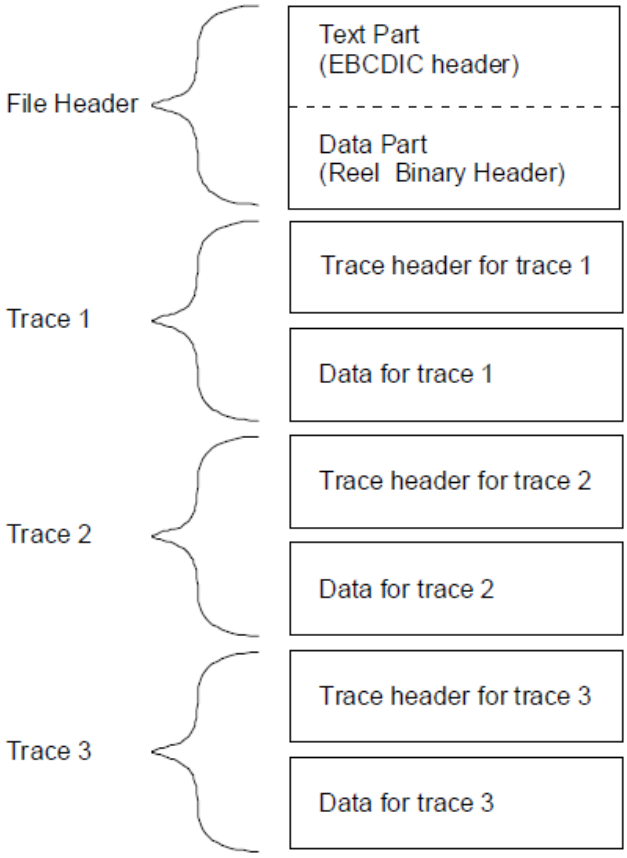


Figure 1. Structure of a SEG-Y file.

7.5.2 Header Format

Textual file header can be encoded as EBCDIC OR ASCII characters.

7.5.3 SEG Y File Versions

	Versions
SEG Y FILE	seg_y_rev0
	seg_y_rev1
	seg_y_rev2

7.5.4 References

http://seg.org/Portals/0/SEG/News%20and%20Resources/Technical%20Standards/seg_y_rev0.pdf

https://www.seg.org/Portals/0/SEG/News%20and%20Resources/Technical%20Standards/seg_y_rev1.pdf/

http://seg.org/Portals/0/SEG/News%20and%20Resources/Technical%20Standards/seg_y_rev2_0-mar2017.pdf

https://pubs.usgs.gov/of/2001/of01-326/HTML/FILEFORM.HTM

https://www.crewes.org/ForOurSponsors/ResearchReports/2000/2000-29.pdf

http://www.epmag.com/industry-moves-closer-automated-real-time-production-optimization-1584966 Real-time Production Optimization

https://www.spe.org/en/twa/twa-article-detail/?art=3007 Cluster Spacing Optimization

7.5.5 SEG Y File Package Summary

Module	**Description/Usage**	Software	License	Working	Error
segpy	Read and Write SEG Y files	Python	LGPL (Open Source)	In progress	Syntax Error
Segyio	Read and Write SEG Y files	C, Python	LGPL		
Segy-py	Read SEG Y files	Python	Custom		
Segy-MAT	Read and Write SEG Y files	MATLAB	LGPL		
Obspy	Read and Write SEG Y files	Python	LGPL		
Gsegy view	Display SEG Y files	Fortran, C	GPL		

7.5.6 SEGPY

The segpy module is used in python for storing and accessing the seismic data. The module helps to read SEG Y files and in writing complex seismic data.

7.5.7 Installation

The following syntax is used for installing segpy module in python by running as admin or through command prompt by giving the directory of the file.

"pip install segpy"

Or
"pip install C:\Python\segpy-2.0.0a2-py2.py3-none-any.whl"

7.5.8 SEGPY

https://github.com/sixty-north/segpy/commit/abedd838b3d7a8ce81b2a380c964917975d8d953
https://pypi.python.org/pypi/segpy
https://github.com/sixty-north/segpy/tree/master/examples

7.5.9 SEGYIO

Segyio is used for interaction with SEG Y formatted seismic data, with language bindings for Python, Mat lab and a low-level C interface with few assumptions; easy to bind to other languages.

7.5.10 SEGYIO

https://pypi.python.org/pypi/SegyIO/1.0.9b8
http://gsegyview.sourceforge.net/

7.5.11 SEGY-PY

SegyPY includes M-files to read and write SEG-Y files from Python, implemented using the syntax of the SEG-Y format, commonly used for storing seismic data.

7.5.12 SEGY-PY

http://segymat.sourceforge.net/segypy/
https://walrus.wr.usgs.gov/namss/survey/s-5-09-sc_c/

7.5.13 SEGYMAT

SegyMAT is a set of m-files that allows mat lab programs to easily read and write segy data, and a Mat lab GUI to read and write SEG-Y files, and edit the SEG-Y headers.

7.5.14 SEGY-MAT

http://segymat.sf.net/
http://segymat.sourceforge.net/segypy/
https://in.mathworks.com/matlabcentral/fileexchange/30585-large-data-in-matlab--a-seismic-data-processing-case-study

7.5.15 OBSPY

Obspy is an open-source project dedicated to provide a python framework for processing seismological data. The obspy.io.segy package contains methods in order to read and write files in the SEG Y(rev.1) format.

Technical

- Time is handled using UTCDateTime class
  - Universal Time Coordinated.
  - Typical format is YYYYMMDD-HH:MM:SS (whole seconds) or YYYYMMDD-HH:MM:SS.sss*
- Accessing meatadata and waveform data of a trace
  - Print(tr.stats) for metadata
  - Print(tr.data) for waveform data
- Waveform plotting
  - Simple plot
  - Customized plot
- Signal processing - Obspy.filter
  - Bandpass
  - Bandstop
  - Lowpass
  - Highpass
  - Etc
- Instrument correction - Obspy.signal
  - Poles
  - Zeros
  - Gain
  - Sensitivity
- Working with Data centers and webportals

7.5.16 OBSPY

https://github.com/obspy/obspy
https://www.seg.org/Portals/0/SEG/News%20and%20Resources/Technical%20Standards/seg_y_rev1.pdf
https://docs.obspy.org/master/genindex.html
https://docs.obspy.org/master/contents.html

https://nbviewer.jupyter.org/github/obspy/docs/blob/master/workshops/2015-08-03_iris/02_ObsPy_Introduction.ipynb

7.5.17 Example 1 – Read Siesmic File

7.6 GSEGY

GSEGY View is a viewer for seismic data in SEG-Y format.

7.6.1 GSEGY VIEW

http://gsegyview.soft112.com/
http://gsegyview.sourceforge.net/

7.7 Summary for packages.

Module	Description	Working	Comments	Errors
Segpy		In Progress		
Segyio				
Segy-py				Can not load big files as it takes into memory
Segy-MAT				
Gsegy view				
Obspy		In progress		Obspy reads file on disk. Can read large files.
Load Save	TBU			

https://docs.obspy.org/master/packages/obspy.io.segy.html

https://agilescientific.com/blog/2016/9/21/x-lines-of-python-read-and-write-seg-y

7.8 References

7.8.1 Packages Information

http://ahay.org/wikilocal/docs/vienna2016/B07.pdf

https://www.linkedin.com/pulse/data-science-petroleum-production-engineering-alfonso-r-reyes/

https://f0nzie.github.io/rODE/articles/Muskat-MBal.html?lipi=urn%3Ali%3Apage%3Ad_flagship3_pulse_read%3BvrMvyXMRT4u2zqE%2BdnTnRw%3D%3D

https://www.linkedin.com/pulse/building-your-petroleum-engineering-library-r-muskats-reyes/

7.9 Volvo Dataset

7.9.1 Overview

https://www.discovervolve.com/2020/04/02/__trashed/#Geoscience_OW_Archive_content

Direct download

You can use Azure Storage Explorer (available for both Windows and Linux) to look at the files inside these zip files without actually downloading them. In this way, you can select for download only the files you find interesting. There are SEGY files in both depth and time domain, with different offsets, contained in the Volve data set. (edited)
LikeLike Yogendra Narayan Pandey's commentReply
5 Likes5 Likes on Yogendra Narayan Pandey's comment · 6 Replies6 Replies on Yogendra Narayan Pandey's comment
Load previous repliesLoad previous replies on Yogendra Narayan Pandey's comment
17hOpen options for Yogendra Narayan Pandey's comment

Yogendra Narayan Pandey

Yogendra Narayan Pandey **2nd degree connection2nd**Founder at PRABUDDHA | AI and Data Science

Alfonso R. Reyes 1. Login to **data.equinor.com** with your credentials. 2. Navigate to Volve Data Village. 3. In the Data Links section, locate the shared access signature URI to the data set. Use this URI to create a connection in the Azure Storage explorer. You should be able to browse entire Volve data set in the Azure Storage Explorer now.

https://www.software.slb.com/products/eclipse

https://www.equinor.com/en/how-and-why/digitalisation-in-our-dna/volve-field-data-village-download.html
https://www.equinor.com/en/news/2019-06-12-sleipner-co2-storage-data.html

https://www.linkedin.com/pulse/volve-history-matching-using-machine-learning-nigel-goodwin/?trackingId=

7.10 Northern Lights

https://www.equinor.com/en/news/20201019-sharing-data-northern-lights.html

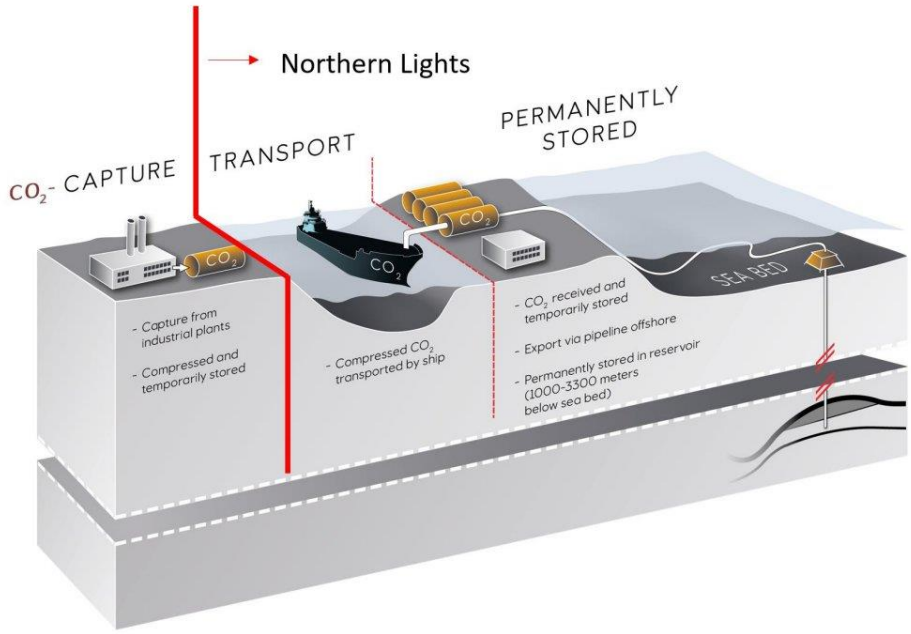
AlBahrani, Hussain , Papamichos, Euripides , and Nobuo Morita. "Building an Integrated Drilling Geomechanics Model Using a Machine-Learning-Assisted Poro-Elasto-Plastic Finite Element Method." SPE J. 26 (2021): 1893–1913. doi: https://doi.org/10.2118/205497-PA

Sinha, Utkarsh , Dindoruk, Birol , and Mohamed Soliman. "Prediction of CO2 Minimum Miscibility Pressure Using an Augmented Machine-Learning-Based Model." SPE J. 26 (2021): 1666–1678. doi: https://doi.org/10.2118/200326-PA

Li, Boxiao , Billiter, Travis C., and Timothy Tokar. "Rescaling Method for Improved Machine-Learning Decline Curve Analysis for Unconventional Reservoirs." SPE J. 26 (2021): 1759–1772. doi: https://doi.org/10.2118/205349-PA

Abbas, Mohammed A., and Watheq J. Al-Mudhafar. "Lithofacies Classification of Carbonate Reservoirs Using Advanced Machine Learning: A Case Study from a Southern Iraqi Oil Field." Paper presented at the Offshore Technology Conference, Virtual and Houston, Texas, August 2021. doi: https://doi.org/10.4043/31114-MS

Okon, Edet Ita, and Dulu Appah. "Application of Machine Learning Techniques in Reservoir Characterization." Paper presented at the SPE Nigeria Annual International Conference and Exhibition, Lagos, Nigeria, August 2021. doi: https://doi.org/10.2118/208248-MS



APPENDIX 8.0 - SUBMARINE CABLES

Interactive Submarine Cable Chart
https://www.submarinecablemap.com/

APPENDIX 9.0- NOAA DATA

https://www.kaggle.com/noaa/noaa-icoads NOAA Dataset

https://pypi.org/project/meteorology/

APPENDIX 10.0 – GOM DATA

Gulf of Mexico information. Implement in Digital Twin Feed when time is appropriate.

10.1 Drilling Activity

https://www.bsee.gov/stats-facts/ocs-regions/gulf-of-mexico/deepwater_activity#Reports

Run Weekly jobs to save and keep data :
https://www.bsee.gov/sites/bsee.gov/files/weeklyreport/current_deepwater_activity_010720.pdf

10.2 Offshore Rig Values

https://www.bassoe.no/rigvalues/

10.3 Qualified Fields

10.3.1 Deepwater

https://www.data.bsee.gov/Other/DataTables/DeepQualFields.aspx

10.4 Production

10.4.1 Oil and Gas

https://www.data.bsee.gov/Production/ProductionData/Summary.aspx

10.4.2 Platforms

Complexes, bubbles, Fixed, TLP, Spar, SEMI, Others
10 year forecast
Using public data to make O&G more economic

10.4.3 Well Data

https://www.data.bsee.gov/homepg/data_center/other/webstore/master.asp
https://www.data.bsee.gov/homepg/data_center/well/well.asp
https://www.data.bsee.gov/homepg/data_center/other/tables/deeptbl2.asp
https://www.data.boem.gov/homepg/data_center/production/production.asp

10.4.4 Architecture and Assets

See SubseaIQ database dump to start working on asset diagrams (start with cartoons).

Add enhanced 3D effect to it as we get more data reinforced.
Add costing to the subsea architectures
This becomes a project feasibility and architecture planning tool for O&G industry. However, driven by engineering fundamentals.

10.4.5 Map

https://eos.org/project-updates/a-1-4-billion-pixel-map-of-the-gulf-of-mexico-seafloor 1.4B Pixel data

10.5 EIA

Trade data
https://www.eia.gov/todayinenergy/detail.php?id=39672

https://www.eia.gov/naturalgas/data.php#pipelines

https://www.eia.gov/petroleum/data.php#movements

https://github.com/kailashahirwar/cheatsheets-ai/tree/master/PDFs AI
https://medium.com/google-cloud/a-tensorflow-glossary-cheat-sheet-382583b22932 TensorFlow
https://stackoverflow.com/questions/18169587/get-the-index-of-point-which-create-convexhull Index of a convexhull

Ocado Warehousing Platform
https://www.youtube.com/watch?v=XJqsdprXF5c
https://www.cambridgeconsultants.com/case-studies/ocado-smart-platform

https://cloud.google.com/customers/ocado/ https://en.wikipedia.org/wiki/Bees_algorithm
https://en.wikipedia.org/wiki/Travelling_salesman_problem

A good ML Model is : Two Class Boosted Decision Tree

APPENDIX 11.0 - OIL WELL PRODUCTION AND WELL TEST PERFORMANCE

An example case of Monte Carlo simulation for oil well production performance

OpenServer is an API tool bundled with the oil industry standard Petroleum Experts IPM software suite (MBAL, PROSPER, GAP etc.) which allows the input and output of the software to be controlled using Visual Basic and Excel. The tool allows expansion of the base IPM suite for whatever purpose may be needed. I have used OpenServer/VBA/Excel tools in the past for Monte Carlo simulation, model history matching, fluid allocation and STOIIP analysis to name just a few.
One limitation of OpenServer is that it is linked to the VBA environment. As well as slow read/write interaction with Excel, VBA has a limited library for external functions. Python, by contrast, is simpler and quicker than Excel for results management and analysis, and is more flexible given the large amount of external libraries available. Of particular interest for Reservoir Engineers are the data science modules which are being increasingly utilised across the industry. One use case for the functions presented here could be for the basis of a hybrid data model combining field data with the physics of material balance, nodal analysis and PVT. Another use for the functions could be for real time matching of field data from live SQL databases to alert engineers of changes to well conditions.
I have written a guide to working with OpenServer and Python as I have not seen this written up elsewhere. I will go through the Python implementation and show an example use of Monte Carlo simulation for oil well production performance.

9.2 OpenServer Functions

9.2.1 Modules Required

```
# Import modules for OpenServer functions
import win32com.client
import sys
import time
```

The main module that is required is "win32com.client". We will use this to create a reference to the OpenServer ActiveX object.

9.2.2 Functions

```
class OpenServer():
    "Class for holding ActiveX reference. Allows license disconnection"
    def __init__(self):
        self.status = "Disconnected"
        self.OSReference = None

    def Connect(self):
        self.OSReference = win32com.client.Dispatch("PX32.OpenServer.1")
        self.status = "Connected"
        print("OpenServer connected")

    def Disconnect(self):
        self.OSReference = None
        self.status = "Disconnected"
```

```
        print("OpenServer disconnected")
```

OpenServer uses an ActiveX object called "PX32.OpenServer.1" to interact with the IPM suite. When the PX32.OpenServer.1 object is loaded into memory it also checks out an OpenServer license. I created an OpenServer class in Python to hold the ActiveX reference, to allow the reference to be passed between functions, to ensure multiple licenses are not checked out and to ensure the object is correctly unloaded (and the license is closed) when the script stops running.
The functions below are translations of the standard VBA OpenServer functions into Python. If you have worked with OpenServer before the functions will be familiar, the main difference being that the "OpenServe" object is passed to each function for the reasons outlined above. The main consideration here was that upon failure the error strings are printed to the console using sys.exit and that the OpenServer license is closed.

```
def GetAppName(sv):
    # function for returning app name from tag string
    pos = sv.find(".")
    if pos < 2:
        sys.exit("GetAppName: Badly formed tag string")
    app_name = sv[:pos]
    if app_name.lower() not in ["prosper", "mbal", "gap", "pvt", "resolve",
                                "reveal"]:
        sys.exit("GetAppName: Unrecognised application name in tag string")
    return app_name


def DoCmd(OpenServe, cmd):
    # perform a command and check for errors
    lerr = OpenServe.OSReference.DoCommand(cmd)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("DoCmd: " + err)


def DoSet(OpenServe, sv, val):
    # set a value and check for errors
    lerr = OpenServe.OSReference.SetValue(sv, val)
    app_name = GetAppName(sv)
    lerr = OpenServe.OSReference.GetLastError(app_name)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("DoSet: " + err)

def DoGet(OpenServe, gv):
    # get a value and check for errors
    get_value = OpenServe.OSReference.GetValue(gv)
    app_name = GetAppName(gv)
    lerr = OpenServe.OSReference.GetLastError(app_name)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
```

```
        sys.exit("DoGet: " + err)
    return get_value


def DoSlowCmd(OpenServe, cmd):
    # perform a command then wait for command to exit and check for errors
    step = 0.001
    app_name = GetAppName(cmd)
    lerr = OpenServe.OSReference.DoCommandAsync(cmd)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("DoSlowCmd: " + err)
    while OpenServe.OSReference.IsBusy(app_name) > 0:
        if step < 2:
            step = step*2
        time.sleep(step)
    lerr = OpenServe.OSReference.GetLastError(app_name)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("DoSlowCmd: " + err)


def DoGAPFunc(OpenServe, gv):
    DoSlowCmd(gv)
    DoGAPFunc = DoGet(OpenServe, "GAP.LASTCMDRET")
    lerr = OpenServe.OSReference.GetLastError("GAP")
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("DoGAPFunc: " + err)
    return DoGAPFunc


def OSOpenFile(OpenServe, theModel, appname):
    DoSlowCmd(OpenServe, appname + '.OPENFILE ("' + theModel + '")')
    lerr = OpenServe.OSReference.GetLastError(appname)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("OSOpenFile: " + err)


def OSSaveFile(OpenServe, theModel, appname):
    DoSlowCmd(OpenServe, appname + '.SAVEFILE ("' + theModel + '")')
    lerr = OpenServe.OSReference.GetLastError(appname)
    if lerr > 0:
        err = OpenServe.OSReference.GetErrorDescription(lerr)
        OpenServe.Disconnect()
        sys.exit("OSSaveFile: " + err)
```

9.3 Example Case: Monte Carlo Simulation for Well Test Performance

In this example scenario we have been asked to estimate the well test oil production rates for an appraisal well to help with well test design. This well is the second to be drilled on the field following a successful discovery well. The team have some expectation of reservoir properties but due to the uncertain environment there are a range of possible outcomes. Four key uncertainties have been identified: reservoir permeability, net pay thickness, completion skin damage and reservoir pressure.
All data is synthetic and has been created for this example.

Input	Base	Low	High	Distribution
Permeability (mD)	300	50	550	Truncated normal
Net pay (m)	10	5	15	Uniform
Skin damage	5	0	10	Uniform
Pressure (psia)	3000	2750	3250	Triangular

9.3.1 Modules

```
# Import modules for plotting and handling data
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
import numpy as np
import os
from tqdm import tqdm

# Import input distributions as required
from scipy.stats import truncnorm
from scipy.stats import triang
from scipy.stats import uniform
```

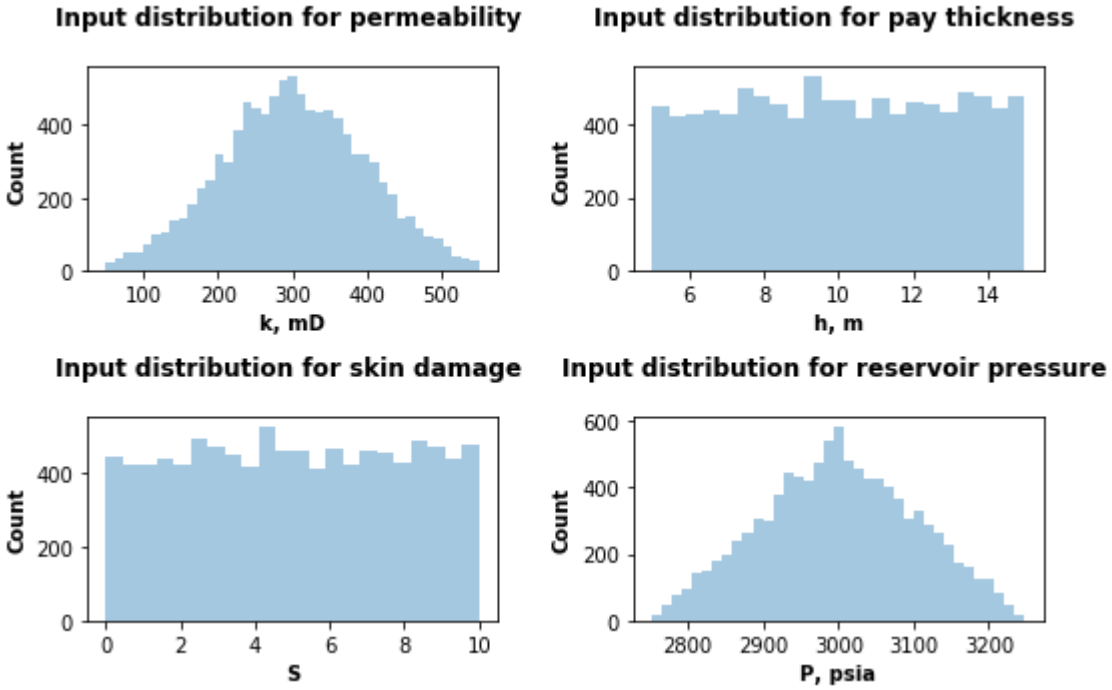
As well as "matplotlib", "pandas", "seaborn" and "numpy" which are standard libraries for managing datasets and plotting, "os" is used to get the model directory, "tdqm" shows a simple progress bar for the simulation loop and the input distributions use the "scipy.stats" module.

9.3.2 Inputs

The code below builds each of the input distributions and plots the results using a seaborn distplot. The "n_trials" parameter defines the number of trials to run in the Monte Carlo simulation and defining the seed number allows each of the input distributions to be reproduced at a later date. Running the script without controlling the seed number for the random number generators would give a slightly different output distribution each time.

```
# Define a random number seed for reproducible results

seed = 123456
n_trials = 10000
```

```
# Set up plot grid for inputs

fig, axs = plt.subplots(2,2, figsize=[8,5])


# Permeability input will be normally distributed, truncated to the range 50 mD -
550 mD
#                                                                          See
https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.truncnorm.html

a, b = (50 - 300) / 100, (550 - 300) / 100
perm_dist = truncnorm.rvs(a, b, loc = 300, scale = 100, size = n_trials,
random_state = seed)
ax = sns.distplot(perm_dist, kde = False, ax=axs[0,0])
axs[0,0].set_title("Input distribution for permeability \n", fontweight = 'bold')
ax.set_ylabel("Count", fontweight = 'bold')
ax.set_xlabel("k, mD", fontweight = 'bold')


# Net pay thickness will be uniformly distributed
# See https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.uniform.html

pay_dist = uniform.rvs(loc = 5, scale = 10, size = n_trials, random_state = seed)
ax = sns.distplot(pay_dist, kde = False, ax=axs[0,1])
axs[0,1].set_title("Input distribution for pay thickness \n", fontweight = 'bold')
ax.set_ylabel("Count", fontweight = 'bold')
ax.set_xlabel("h, m", fontweight = 'bold')


# Skin will be uniformly distributed

skin_dist = uniform.rvs(loc = 0, scale = 10, size = n_trials, random_state = seed)
ax = sns.distplot(skin_dist, kde = False, ax=axs[1,0])
axs[1,0].set_title("Input distribution for skin damage \n", fontweight = 'bold')
ax.set_ylabel("Count", fontweight = 'bold')
ax.set_xlabel("S", fontweight = 'bold')


# Reservoir pressure will be use the triangular distribution
# See https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.triang.html

pres_dist = triang.rvs(c = 0.5, loc = 2750, scale = 500, size = n_trials,
random_state = seed)
ax = sns.distplot(pres_dist, kde = False, ax=axs[1,1])
axs[1,1].set_title("Input distribution for reservoir pressure \n", fontweight =
'bold')
ax.set_ylabel("Count", fontweight = 'bold')
ax.set_xlabel("P, psia", fontweight = 'bold')


plt.tight_layout()
plt.show()
```



We will then use a pandas dataframe to hold all of the inputs and the oil rate output.

```
# Create a dataframe to hold inputs and results
#                         See                         https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.html

df_well_MC = pd.DataFrame({
        'perm' : perm_dist,
        'pay' : pay_dist,
        'skin' : skin_dist,
        'pres' : pres_dist
         })
```

9.3.3 Base Case Calculation

Now that we have all of the inputs defined we can run the base case calculation and ensure that all of the OpenServer functions are working as intended. The following code opens the Prosper model which is stored in the same folder as the Python script ("cwd"), runs the base case and returns the oil rate. The code is wrapped in a "try....finally" statement. This ensures that should the script run into errors, the OpenServer license disconnects correctly.

```
try:
    # Initialises an 'OpenServer' class

    petex = OpenServer()

    # Creates ActiveX reference and holds a license

    petex.Connect()

    # Perform functions
```

```
    cwd = os.getcwd()
    OSOpenFile(petex, cwd + r'\Example_Well.Out', 'PROSPER')
    DoCmd(petex, 'PROSPER.ANL.SYS.CALC')
    OPR = DoGet(petex, 'PROSPER.OUT.SYS.Results[0].Sol.OilRate')
    OPR = round(float(OPR),0)
    print("""
            Base case oil rate: %s stb/d
          """ % OPR)

finally:
    # Required to close the license otherwise remains checked out

    petex.Disconnect()
```

```
Base case oil rate: 8147.0 stb/d
```

9.3.4 Full Monte Carlo Simulation

Now that we know that the OpenServer functions are working correctly, we will create a function called "calc_OPR" to hold all of the required code in one place.

```
# Custom function for performing PROSPER calculation

def calc_OPR(OpenServe, k, h, S, P):
    DoSet(OpenServe, "PROSPER.SIN.IPR.Single.ResPerm", k)
    DoSet(OpenServe, "PROSPER.SIN.IPR.Single.Thickness", h)
    DoSet(OpenServe, "PROSPER.SIN.IPR.Single.Skin", S)
    DoSet(OpenServe, "PROSPER.SIN.IPR.Single.Pres", P)
    DoCmd(OpenServe, "PROSPER.ANL.SYS.CALC")
    OPR = DoGet(OpenServe, "PROSPER.OUT.SYS.Results[0].Sol.OilRate")
    OPR = round(float(OPR),0)

    return OPR
```

The Monte Carlo simulation loop can be run using one line of code under "Perform functions" below. This line runs through each row in the dataframe, passes each of the inputs to the "calc_OPR" function and fills a new column called "OPR" with the output. The "for" loop is wrapped in the "tdqm" function which creates a useful progress bar in the console window to update the user with the progress. Again, the code is wrapped in a "try....finally" statement.

```
try:
    # Initialises an 'OpenServer' class

    petex = OpenServer()

    # Creates ActiveX reference and holds a license

    petex.Connect()

    # Perform functions
```

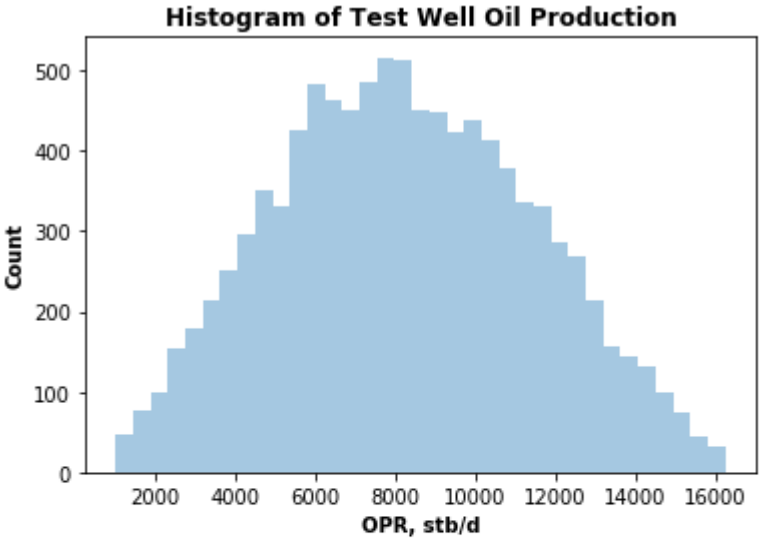
```
    df_well_MC.loc[:,'OPR'] = [calc_OPR(petex, row[0], row[1], row[2], row[3]) for
row in tqdm(df_well_MC[['perm', 'pay', 'skin', 'pres']].values)]
```

```
11%|          | 1075/10000 [00:31<04:36, 32.26it/s]
```

```
finally:
    # Required to close the license otherwise remains checked out

    petex.Disconnect()
```

Finally, we can plot the oil rate output distribution and define the P90, P50 and P10 expected range for well test performance.

```
# Post-processing results
ax = sns.distplot(df_well_MC.loc[:,'OPR'], kde = False)
plt.title("Histogram of Test Well Oil Production", fontweight = 'bold')
ax.set_ylabel("Count", fontweight = 'bold')
ax.set_xlabel("OPR, stb/d", fontweight = 'bold')
plt.show()

percentiles = np.percentile(df_well_MC.loc[:, 'OPR'], [10, 50, 90])
print("""
  --------------------------------
   Distribution of oil production
  --------------------------------
    P90: %s stb/d
    P50: %s stb/d
    P10: %s stb/d
  --------------------------------

     """ %(percentiles[0], percentiles[1], percentiles[2]))
```




```
---------------------------------
 Distribution of oil production
---------------------------------
  P90: 4049.0 stb/d
  P50: 8149.0 stb/d
  P10: 12593.0 stb/d
---------------------------------
```

9.4 Speed Comparison

I ran the above example using Python and VBA for a speed comparison. The time taken for Excel / VBA to run was dependent on the method used to read the inputs and write the outputs. Reading and writing line by line as an Excel range took 1h 12min to run the 10,000 cases. Completing the same loop within a VBA array (i.e. outside Excel ranges) took 294 seconds. This highlights the slowest aspect of running code in VBA: the interaction with Excel. The Python loop took 269 seconds to run showing a 10% improvement over the quicker VBA script. For large or complex projects where it is not possible or desirable to work within VBA arrays, the time saving from moving to Python from Excel could be significant.

Script	Time Taken (10,000 cases)
VBA (Excel ranges)	1h 12 min
VBA (internal arrays)	4 min 54 sec
Python	4 min 29 sec

I hope you find the functions useful!

11.1 Production Optimization, Open Server

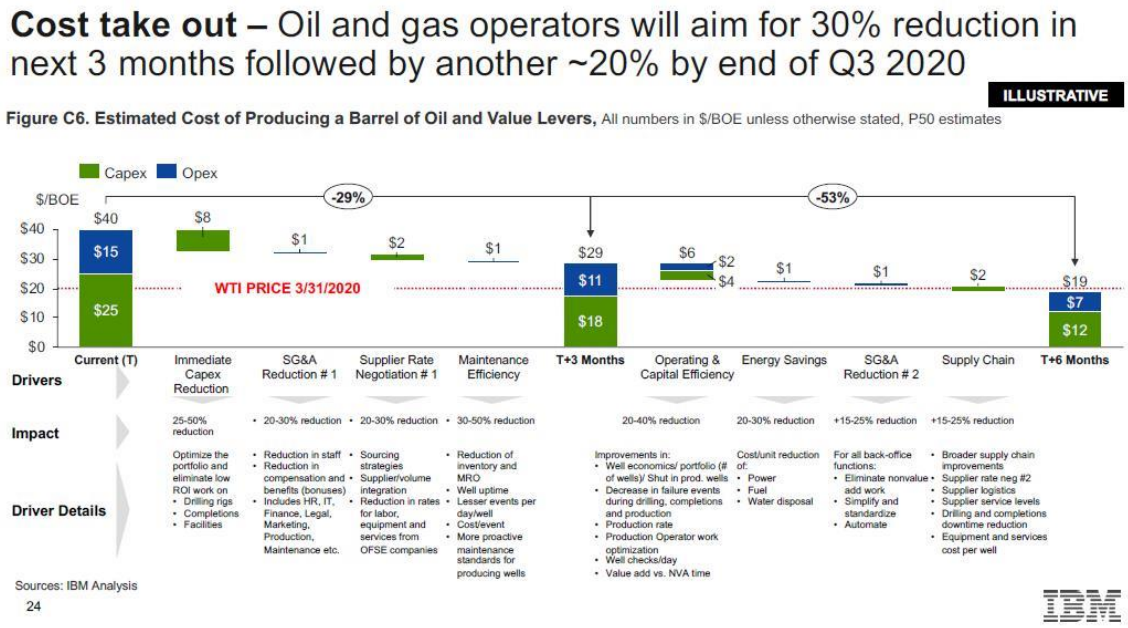
Example code to find number of steps for GAP model prediction
https://f0nzie.github.io/rOpenserver/articles/gap-hello_world.html

rOpenServer, A package to connect R with PeTex applications, Prosper, GAP and MBAL to perform automated tasks, create datasets for statistical analysis and advanced control of solvers and solutions.
https://github.com/f0nzie/rOpenserver?files=1

APPENDIX 12.0 – GLOBAL ECONOMICS

12.1 Covid-19

12.1.1 O&G Cost Reduction and Optimization



12.1.2 Stock Performance

12.1.3

APPENDIX 13.0 - ENGERY FUNDAMENTALS

13.1 Oil Price

Jeanine Wai	+1 212 526 3557	Jeanine.Wai@barclays.com	BCI, US	Completed: 21-Apr-20, 0
William Thompson	+1 212 526 8641	william.s.thompson@barclays.com	BCI, US	Released: 21-Apr-20, 0
Kane Chen	+1 212 526 6180	kane.chen@barclays.com	BCI, US	

E&P Topic Du Jour

Addressing Confusion on Negative Oil Prices; the Hidden Cost of Super Contango

On Monday, the May WTI futures contract fell over 100%, trading at an unprecedented negative $38/bbl ahead of its Tuesday expiration that will force holders to take physical delivery. While this clearly signals concerns about limited Cushing oil storage capacity, it is curious to see the June WTI still trading at a positive ~$21/bbl. Either the market expects producers to shut in enough production to alleviate the Cushing storage situation or there are outside influences, such as oil ETFs that continue to rollout into the front month contracts since they can't take physical delivery. If the answer is that Cushing storage is simply full, we struggle to see how producers can shut in enough production, particularly given the complexities around midstream and leasehold obligations, to mitigate the June WTI from also selling off sharply ahead of its expiration next month.

Where we think there is a lot of confusion is what this will mean to E&P price realizations and cash flows. In addition to the fact that many Permian E&Ps

have now contracted much of their volumes to Gulf Coast and international indexes (Brent, LLS, MEH), which have held up well relative to WTI, we'd also note that:

- **A few days of negative prices will not have much influence on average prices.** Assuming the current WTI future strip stays where it is, the May WTI contract turning negative for potentially two days before expiration will have very limited impact on E&P price realizations since oil price contracts are generally based on monthly averages. It's our understanding that the general pricing mechanism for the industry comprises the average daily settlement price (calendar monthly average or "CMA") for the front month contracts during the delivery month. Said another way, April pricing is set by May and June contracts. Since the trade month for the front contract expires ~2/3rd into the calendar month, the May contract would make up ~2/3rd of April's price average and June would make up the balance. CDEV, CPE, CXO, DVN, FANG, NBL, OAS, CDEV, WPX, and XEC have disclosed or confirmed that their pricing uses monthly averages, and we assume the bulk of our remaining coverage is structured similarly.

- **The bigger issue is the steepness in the oil contango, leading to elevated CMA roll adjustments.** Contracted oil pricing formulas also generally include "CMA rolls" adjustments that adjust for the timing differences between the CMA delivery month and the delivery months of the future contracts used to calculate the CMA (e.g., the CMA average for April delivery is an average of future prices for delivery in May and June). The CMA roll thus mitigates the impact that contango and backwardation in the oil price curve would have on contracted pricing. Given the current super contango of the WTI curve, we calculate this month's roll at a wide ($8/bbl) or an $8/bbl deduct from the realized price, which would be the largest

adjustment dating back to at least 1983. Some E&Ps have roll swaps that offer protection against the super contango, including:

- NBL: 90 MBO/d of May-June WTI Roll Swaps at ($2.63)/bbl, 78 BO/d of July-Sept at ($2.28)/bbl, and 64 MBO/d Oct-Dec at ($2.19)/bbl.
- EOG: 10 MBO/d of May-June NYMEX Roll Swaps at +$0.70/bbl and 110 MBO/d of July-Dec NYMEX Roll Swaps at ($1.29)/bbl.
- DVN: 50 MBO/d for Q1-Q4'20 of NYMEX Roll Swaps at $0.36/bbl
- MRO: 44 MBO/d of Q2'20 NYMEX Roll Swaps at ($1.62)/bbl
- FANG: 20 MBO/d of Q2-Q4'20 WTI Roll Swaps at +$0.44/bbl
- WPX: 8.4 MBO/d of 2020 WTI Roll Swaps at +$0.57/bbl
- CPE: 25 MBO/d of May-Sept. 2020 WTI NYMEX Roll Swaps at ($1.67)/bbl

Source: CME Group & Barclays Research.

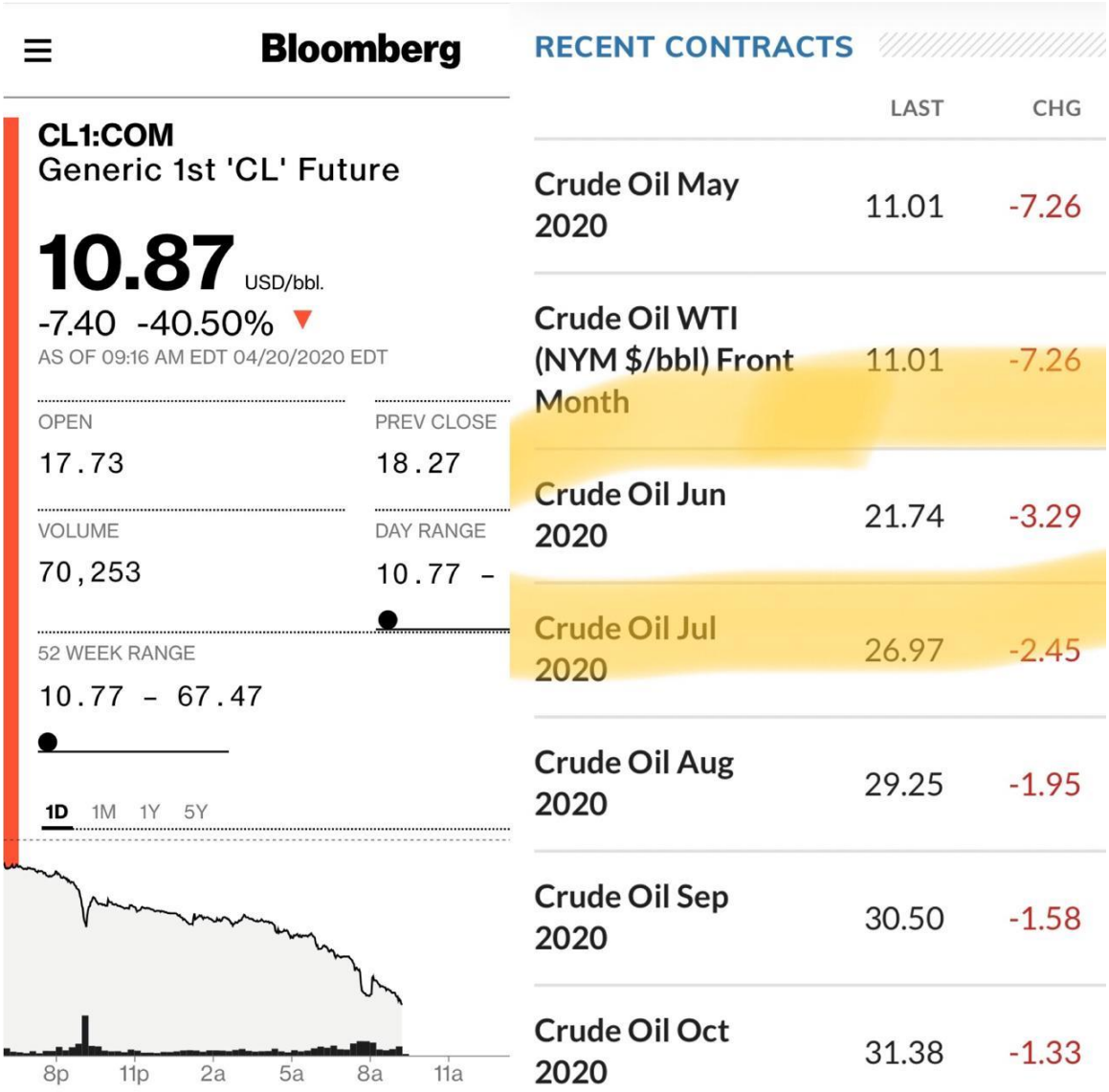
The good news is we are in "super contango", "record contango" etc.

For normal people just means this months contracts are trading lower than next months (see comment at end).

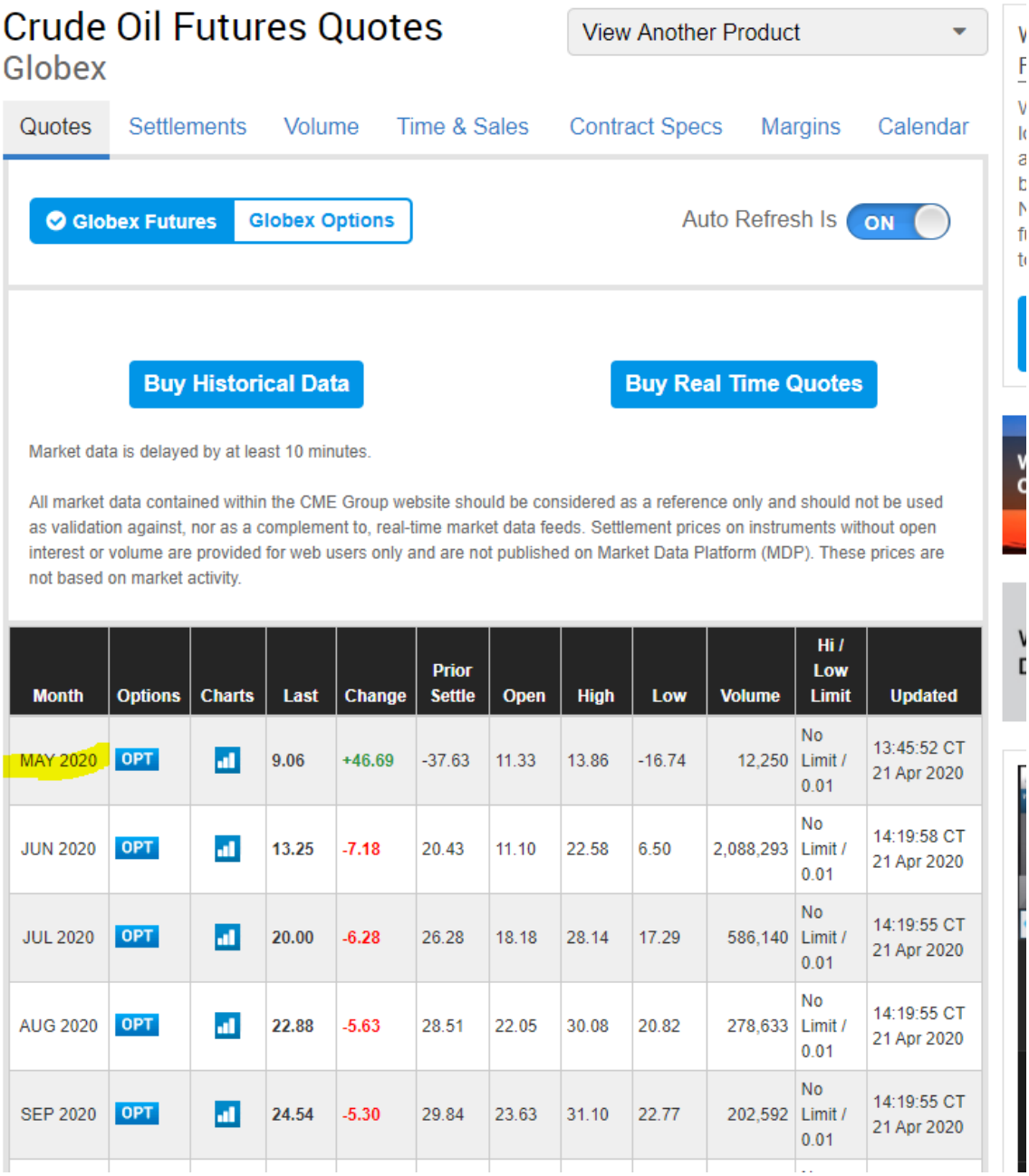
May contract rolls tonight - June contract is up at $22/bbl.

Bad news is:
- we're settling May at $10/bbl apparently
- storage, global demand, and speculative frenzy issues are not ending tomorrow morning (I think June will slide too at some point)
- for most US oil operators $10 or $22 or even $30 all still mean you're in a dire situation.

- Contango futures curve goes up with prices higher next month next year etc than today - considered "normal" although this big of a one month jump, Backwardation futures curves go down with prices higher today then next month next year etc - considered abnormal and showing pessimistic market expectations - "abnormal" in oil and bonds but oil has been in backwardation a while now.



CL is the product - it always rolls in month batches corresponding to the future promised delivery month but it "always" collapses to current spot price close to the close and the next month opens at that price. This time there was no spot market so to speak driving into a "pay you to take it" situation. Yesterday the May went way negative and the June was ~$22/bbl hence the "super contango", "record contango"... Today they are merging towards a "standard market" bridge over in the $12/13/bbl range. Concern now is that June will slide as well as it nears it's close in a month.



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Month	Options	Charts	Last	Change	Prior Settle	Open	High	Low	Volume	Hi / Low Limit	Updated
MAY 2020	OPT		9.06	+46.69	-37.63	11.33	13.86	-16.74	12,250	No Limit / 0.01	13:45:52 CT 21 Apr 2020
JUN 2020	OPT		13.25	-7.18	20.43	11.10	22.58	6.50	2,088,293	No Limit / 0.01	14:19:58 CT 21 Apr 2020
JUL 2020	OPT		20.00	-6.28	26.28	18.18	28.14	17.29	586,140	No Limit / 0.01	14:19:55 CT 21 Apr 2020
AUG 2020	OPT		22.88	-5.63	28.51	22.05	30.08	20.82	278,633	No Limit / 0.01	14:19:55 CT 21 Apr 2020
SEP 2020	OPT		24.54	-5.30	29.84	23.63	31.10	22.77	202,592	No Limit / 0.01	14:19:55 CT 21 Apr 2020

The long answer or the short answer? Hahaha. Short answer is that "oil less than zero" is an oil futures contract specifically one that expires at the end of the trading today and corresponds to May production deliveries. The base contract has physical (vs financial) settlement so you can trade and speculate all you want but the last man standing tonight is required to take physical delivery of that contract - or barrels of crude. The trader in NYC isn't going to be storing it in his parents swimming pool so a large group of folks with no physical storage had to dump contracts that expire today. In very short terms -

you had the oh shit moment and paid someone to take the physical delivery. As a general comment and to Angus's point - physical storage in the US is about full and offtakers are driving a hard bargain. Plain and Phillips 66 for example are crude oil purchasers (actually send the truck to the oil field and pick up the oil out of the tanks) - they post what they will buy your oil for if you are a producer. Right now you basically pay them to come get it. That part is even more exceptional than the futures issue - where a bunch of traders, hedgers, speculators, etc have to dump contracts they can't physically settle.

Phillips 66 Crude Oil Prices for Apr-2020

in dollars ($)

Bulletin Number	Effective Dates	WT Inter	NM Inter	WT Sour	NM Sour	TX Pan All Fields	OK Pan All Fields	Central OK Swt	W Central TX Inter	NTX Inter	LLS Onshore	Central MT
Gravity Adjustment		A	A	B	H	A	A	C	C	C	A	G
2020-063	4/1/2020	16.93	16.93	14.12	16.49	16.43	16.43	16.73	16.93	16.93	15.68	14.02
2020-064	4/2/2020	21.94	21.94	19.13	21.50	21.44	21.44	21.74	21.94	21.94	20.69	19.03
2020-065	4/3/2020	24.96	24.96	22.15	24.52	24.46	24.46	24.76	24.96	24.96	23.71	22.05
	4/4/2020	24.96	24.96	22.15	24.52	24.46	24.46	24.76	24.96	24.96	23.71	22.05
	4/5/2020	24.96	24.96	22.15	24.52	24.46	24.46	24.76	24.96	24.96	23.71	22.05
2020-066	4/6/2020	22.70	22.70	19.89	22.26	22.20	22.20	22.50	22.70	22.70	21.45	19.79
2020-067	4/7/2020	20.25	20.25	17.44	19.81	19.75	19.75	20.05	20.25	20.25	19.00	17.34
2020-068	4/8/2020	21.71	21.71	18.90	21.27	21.21	21.21	21.51	21.71	21.71	20.46	18.80
2020-069	4/9/2020	19.38	19.38	16.57	18.94	18.88	18.88	19.18	19.38	19.38	18.13	16.47
	4/10/2020	19.38	19.38	16.57	18.94	18.88	18.88	19.18	19.38	19.38	18.13	16.47
	4/11/2020	19.38	19.38	16.57	18.94	18.88	18.88	19.18	19.38	19.38	18.13	16.47
	4/12/2020	19.38	19.38	16.57	18.94	18.88	18.88	19.18	19.38	19.38	18.13	16.47
2020-070	4/13/2020	19.03	19.03	16.22	18.59	18.53	18.53	18.83	19.03	19.03	17.78	16.12
2020-071	4/14/2020	16.73	16.73	13.92	16.29	16.23	16.23	16.53	16.73	16.73	15.48	13.82
2020-072	4/15/2020	16.49	16.49	13.68	16.05	15.99	15.99	16.29	16.49	16.49	15.24	13.58
2020-073	4/16/2020	16.49	16.49	13.68	16.05	15.99	15.99	16.29	16.49	16.49	15.24	13.58
2020-074	4/17/2020	14.89	14.89	12.08	14.45	14.39	14.39	14.69	14.89	14.89	13.64	11.98
	4/18/2020	14.89	14.89	12.08	14.45	14.39	14.39	14.69	14.89	14.89	13.64	11.98
	4/19/2020	14.89	14.89	12.08	14.45	14.39	14.39	14.69	14.89	14.89	13.64	11.98
2020-075	4/20/2020	-41.01	-41.01	-43.82	-41.45	-41.51	-41.51	-41.21	-41.01	-41.01	-42.26	-43.92

https://www.valoranalytics.com/2020/04/22/valor-view-wti-futures-go-negative-on-4-20-a-deep-dive/

Company Production example

Volumes 05/14/2020 thru 05/20/2020 (9 a.m.)	Current Week				Prior Week	Comments
	Gross BOPD	Gross MMCFD	Gross NGLs BPD	Net BOE/d	Var Net BOE/d	
Holstein	18,285	8.1	1,421	18,445	590	**Return to production after downtime due to a pipeline valve closure on SS332 and BGC issues. A9 well came online.**
Constitution	299	0.4	45	358	-462	
Ticonderoga	962	0.3	39	526	30	
Caesar Tonga	50,621	40.8	5,061	20,004	-2,530	**Curtailments due to 3A MPFM validation and FGC #2 overhaul.**
Constellation	12,234	8.1	1,009	4,314	-465	
Heidelberg	8,924	1.7	228	3,626	-118	
GREEN CANYON TOTAL	**91,325**	**59**	**7,804**	**47,273**	**-2,955**	
Marco Polo	0	0.0	0	0	0	
K2	22,276	7.0	1,088	9,489	-1,551	**562-2 shut in by regulatory directive due to FIVA failure.**
FOLDBELT TOTAL	**22,277**	**7**	**1,088**	**9,490**	**-1,551**	
Lucius	42,655	38.9	3,499	23,781	-48	
Nansen	0	0.0	0	0	0	**Facility shut in waiting on hose replacement.**
Boomvang	0	0.1	5	6	-1	**Shut in due to blistering on glycol hoses.**
Gunnison	91	1.8	45	222	-165	
WEST GOM TOTAL	**42,746**	**40.8**	**3,548**	**24,009**	**-214**	
Horn Mountain	36,365	12.6	2,590	36,328	1,504	**Return to production after downtime due to well testing and TSE issues on 5/12.**
Marlin	15,646	14.0	1,440	16,990	207	
EAST GOM TOTAL	**52,011**	**26.6**	**4,030**	**53,319**	**1,711**	
Blind Faith	11,563	6.5	389	3,259	-197	
Baldpate	653	1.3	113	431	431	
Power Play	69	0.1	10	45	45	
Conger	20,191	61.8	5,232	7,442	-1,620	**Downtime due to issues with MCC switch gear at Shell Enchilada 5/15.**
Northwestern	0	0.0	0	0	0	
Diana Hoover	3,147	0.7	0	953	235	
Pt. Arguello	0	0.0	0	0	0	
Tahiti (ORRI)				2,699	0	

OBO TOTAL	35,623	70	5,744	14,829	-1,106	
DW Americas Total	243,981	204	22,215	148,919	-4,115	

APPENDIX 14.0 - POSTGRESQL APPLICATION QUERIES

14.1 Remove bad output data from db

```
DELETE FROM bsee.output_tubular_summary WHERE "Field NickName" = 'block_placeholder';
DELETE FROM bsee.output_tubular_summary WHERE "Field NickName" = 'block_placeholder';
DELETE FROM bsee.output_completions WHERE "Field NickName" = 'block_placeholder';
DELETE FROM bsee.output_field_summary WHERE "Field NickName" = 'block_placeholder';
DELETE FROM bsee.output_data_api12 WHERE "Field Name" = 'block_placeholder';
DELETE FROM bsee.output_data_well WHERE "Field Name" = 'block_placeholder';
```