

pForecast User Manual

Software as a service solution to digitalize, simplify, and standardize how production forecasts are generated and utilized.



www.pForecast.com

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Overview

[Powersim Software](#) is a Norwegian company based in Bergen. Powersim Software provides a family of business tools tailored to forecast and analyze complex dynamic problems. pForecast, which has been developed for predicting oil and gas production, is one of these tools. pForecast is an uncertainty-centric software that digitalizes, simplifies, and standardizes how production forecasts are generated and utilized. pForecast performs a full lifetime simulation of the production and injection forecast, including historical data, in keeping with the industry's ever-increasing need for agility.

This manual covers the essential steps to get started with the pForecast software. For users seeking specialized support, please reach out to us at:

Email: pForecast@powersim.no

Phone: +47 55 60 65 00

Introduction

pForecast is a SaaS solution with a user-friendly and interactive interface, offering a simple and consistent methodology for production forecasting. It performs deterministic and stochastic analyses and generates unbiased production forecasts considering the involved uncertainties for the entire field. pForecast consolidates the forecasting and acts as a common framework across assets.

pForecast, which uses Monte Carlo simulations at its core, improves analysis quality as uncertainties are an integral part of the forecasting, not added as a deviation on a deterministic run. The software applies to both short and long-term forecasting.

pForecast's hierarchical structures consist of three levels: asset, forecast, and scenario. This manual shows how to configure each level and generate a comprehensive production forecast. A short description of each chapter is given in Table 1.

Table 1: Structure of the pForecast user manual.

Chapter	Description
1	Accessing pForecast
2	Asset Configuration
3	Forecast Configuration
4	Scenario Configuration
5	Running the Simulation
6	Corporate Analysis
7	Incremental Profiles
8	Corner Cases
9	Glossary

1. Accessing pForecast

pForecast is accessible through the web browser. The users need to request access to pForecast via their company IT support. The Company Administrator can assign different roles at the corporate level as well as create new assets for the company and assign roles at the asset level.

1.1. Asset

You will at least need to define one asset that mirrors the structure in your organization model. Several users can use and add forecasts and scenarios for the same asset, depending on the settings of access rights in the next sub chapter.

Figure 1.1 shows how to create new assets for the company.

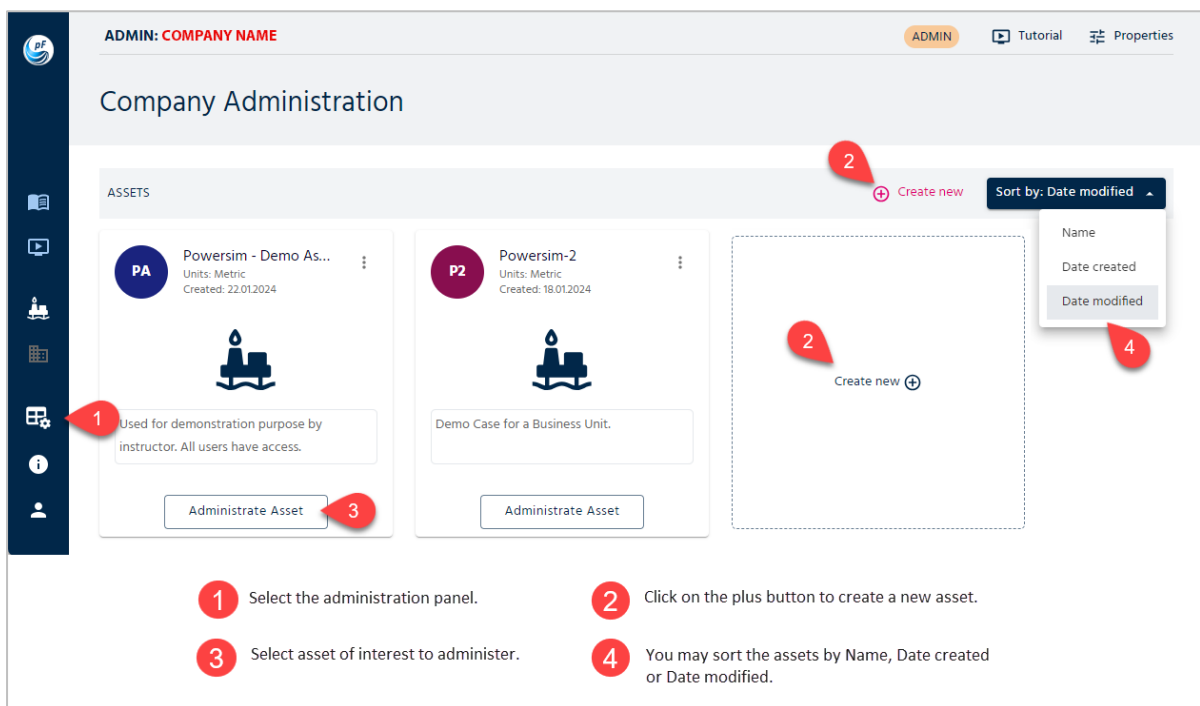


Figure 1.1: Creating the assets.

1.2. Asset roles

Once the asset is created, the Company Administrator can assign user roles for each asset. After selecting the asset, choose the Asset Roles tab and you will see the page shown in Figure 1.2, where you can assign the roles.

For each role, there are associated access rights:

1. Administrator: Allowed to administrate an asset, e.g., assign users to roles, and set up connectivity properties for assets
2. Contributor: Allowed to work with forecasts
3. Editor: Allowed to work with forecasts and flag forecasts for review
4. QC: Quality Controller is allowed to work with forecasts, flag forecasts for review, and approve/reject forecasts
5. Subscriber: Allowed to view forecasts

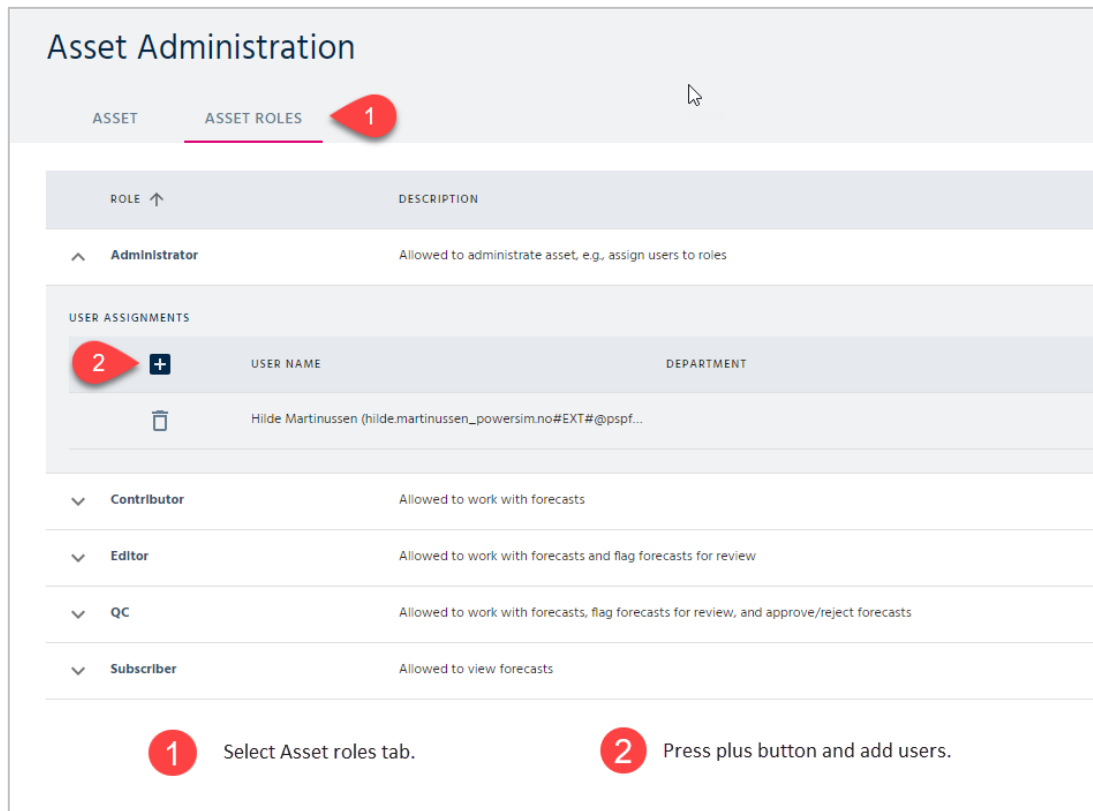


Figure 1.2: Defining users' roles.

1.3. Connectivity

pForecast can be configured to allow for scheduled imports of data from other systems/databases. If so, you will find a Connectivity tab under Asset Administration where you can control how input data will be imported into pForecast. Currently only historical production data is supported in this context.

As an administrator you can control how often and for which facilities historical production data should be uploaded to pForecast.

Connectivity must be established through your IT department. pForecast currently supports only one bespoke/tailored connectivity solution where connectivity settings can be fully controlled. This is a solution for Equinor's Production Data Mart (PDM), allowing import of historical production data as described in chapter 1.3.1. pForecast also supports connections to Aker BP's Cognite Data Fusion (CDF) for import of historical production data. As of yet, for this solution connectivity settings cannot be user controlled, historical production data imports are scheduled to happen every night for all assets.

For a full-fledged connectivity solution, we have:

- The import is handled automatically, i.e., the communication between pForecast and the database happens in a scheduled background process.
- Imports can be scheduled on monthly, weekly, or daily basis. In all cases the import uses a time of day given as Coordinated Universal Time (UTC). This is a standard used to set all time zones around the world. So, for instance, Norway is in the time zone UTC plus one, meaning that we are one hour ahead of the reading on a UTC clock (except during daylight savings, when we are two hours ahead).
- You may also import data instantly, by selecting the "Import now" option.

Figure 1.3 shows all the elements you may define to set up a daily schedule for importing historical data.

Asset Administration

ASSET ASSET ROLES **CONNECTIVITY**

Historical production data import Active

Import every Day(s) at UTC 19:55

Update history for last Day(s) Week(s) Month(s)

Limit import to the following facilities

FPSO Vela

Vela B facility

Production Data Mart (PDM) & import

PDM well type *

- 1 Move the slider to activate the import of historical production data.
- 2 For import by day, you may select between 1, 2, 3 or 4 days.
- 3 Define a UTC time for import using the clock icon or type directly in the field.
- 4 Set how far back in time you want to import historical data.
- 5 Use the slider to include data or not for the current month.
- 6 If you want to import only for specific facilities, select which one(s).
- 7 Save/update your connectivity settings.

Figure 1.3 Daily import of historical data.

If you choose a daily interval of 2-4, please note that the selected day interval is realigned to the beginning of each month, possibly resulting in a smaller (reduced) interval in the transition between two months.

When you select to only import data for specific facilities, the switch called “Limit import to the following facilities” is automatically toggled on. You cannot toggle it on manually. You can however toggle it off if there are checked facilities in the list, effectively unchecking all facilities, meaning that you choose to import historical data for all facilities.

In fig 1.4 the options to schedule a weekly import of historical data is shown. The settings which are equal to the daily settings explained in Figure 1.3 are not included.

Historical production data import Active

Import every Week(s) at Saturday UTC hh:mm

Update history for last months current month

Limit import to the following facilities

FPSO Vela

Vela B facility

Production Data Mart (PDM) & import

PDM well type *

- 1 For weekly import, you may only choose 1 week. For more frequent imports, see daily import.
- 2 Select which day of the week to import data on.

Figure 1.4 Weekly import of historical data.

If historical data are updated only once a month, you may utilize the monthly import choice as illustrated in Figure 1.5. You may only select one day within the month. To import more frequently, see weekly or daily import described above.

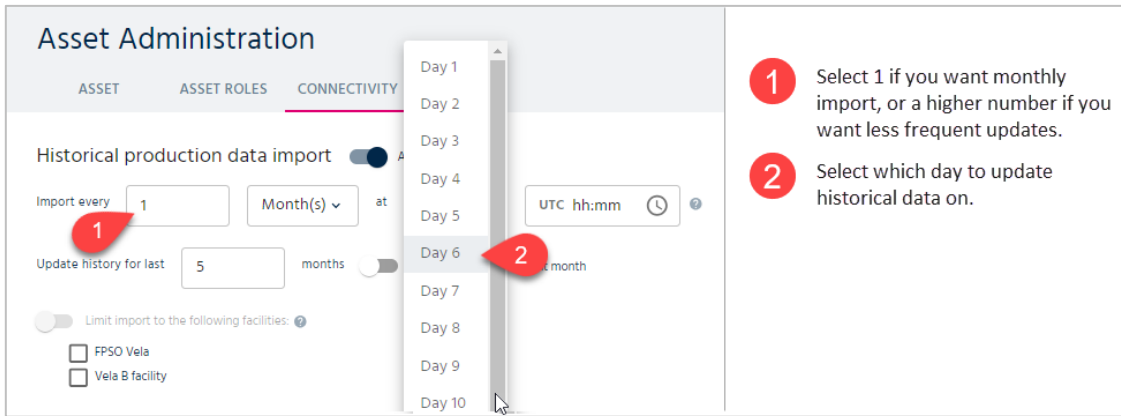


Figure 1.5 Import of monthly historical data.

1.3.1. Configuration using PDM

If pForecast is set up to import historical production data using the bespoke Production Data Mart (PDM) solution for Equinor, there are a couple of user-configurable properties in addition to the generic ones described above.

You may choose how to map well types in PDM to entities in pForecast:

- Wellbore, one well and one wellbore in pForecast for each wellbore in PDM.
- Completion, one well and one wellbore in pForecast for each completion in PDM.

You may also select a geographical area for the asset. Setting this PDM area property will limit access to this asset and its historical production history to users who have access to the corresponding area in PDM.

Note: Once the property is specified, it cannot be changed or reset, i.e., the dropdown will be read only. If Figure 1.6 you can see an example of these two settings.

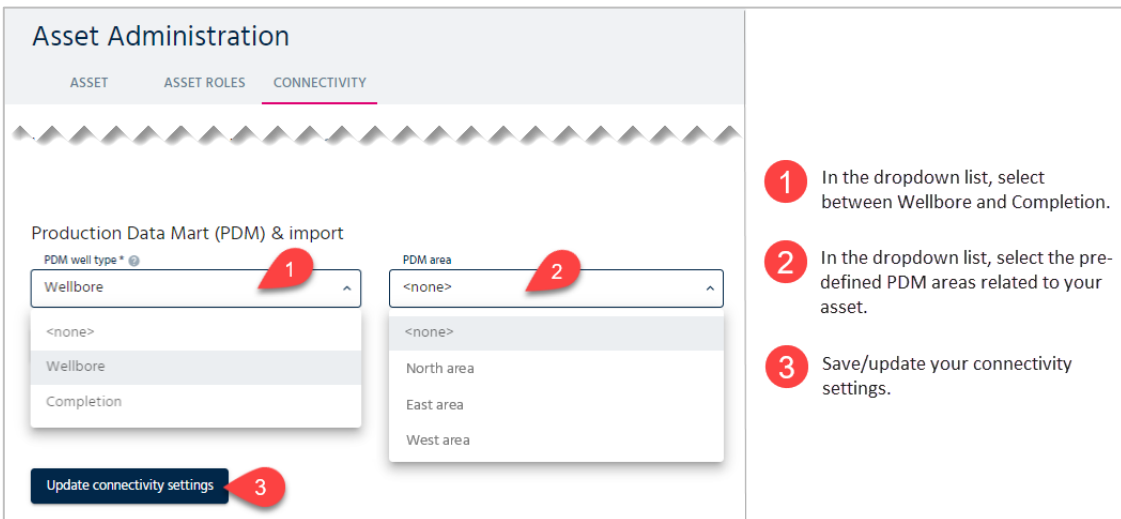


Figure 1.6 Import using the PDM connection/connectivity.

2. Asset Configuration

An asset or a business unit in the pForecast context is a group of fields that share data. When a user is given access to an asset, the user can be given read-only or read-and-edit access. The access provided applies to the entire asset. The first time the users start pForecast, they need to select the asset they are working on. The left-hand side navigation bar has a button called “Select asset.” You can choose or switch between different assets you have access to by clicking on this button. See Figure 2.1.

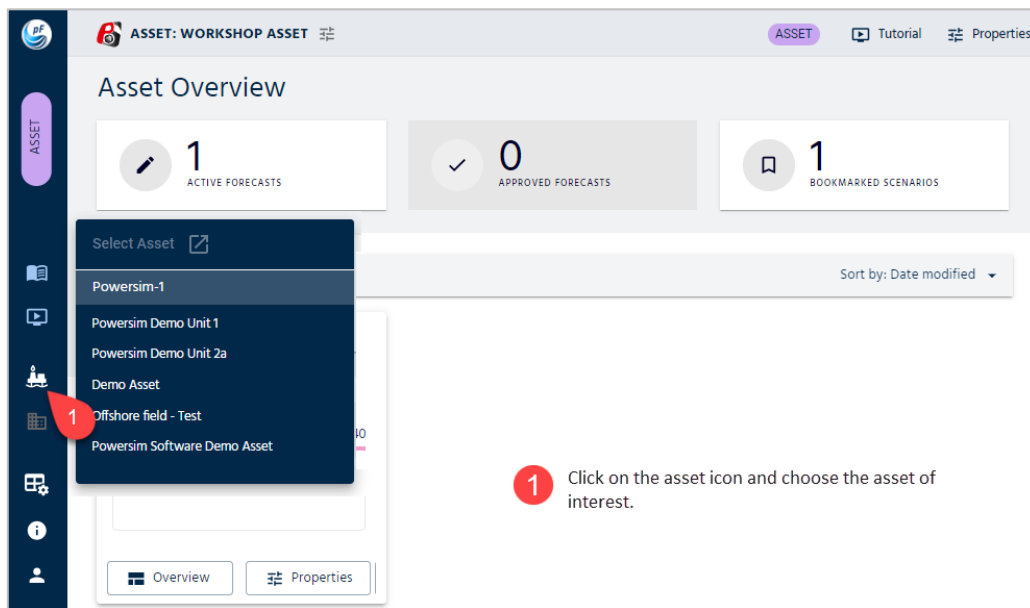


Figure 2.1: Asset selection.

When the asset of interest is selected, the user is presented with the following screen (Figure 2.2), where it is possible to configure the asset by pushing the properties button in the top-right corner.

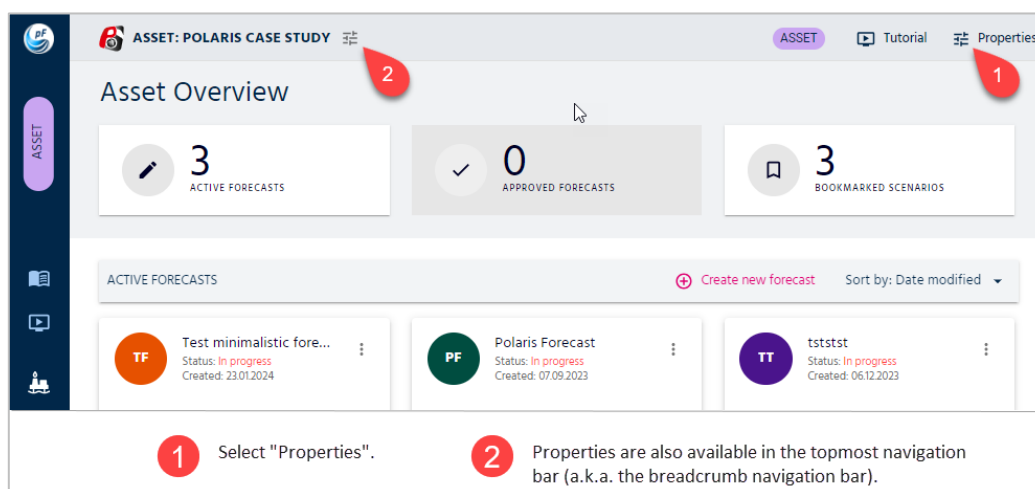


Figure 2.2: Asset configuration.

Asset configuration is for setting up static input that does not usually change or require frequent updating. There are five main areas to choose from: Facility, Field, Reporting Schemes, Ownership Groups, and Gas Lift Curve Sets. For the first three areas, there are additional parameters that can be set, as detailed in the following structure:

Facility:

- Clusters
- Wells
- Fuel and Flare

Field:

- PVT
- Voidage
- RNB
- Sales Conversion

Reporting Schemes:

- Tags
- Reporting Groups

In the following sections, you will find an explanation of how to configure these parameters.

2.1. Facility

The user can select an existing facility or create a new one by pressing the “Create new” card. When a facility is selected, it is possible to edit or delete it. It is worth noting that if the facility is deleted, all associated data is deleted. Figure 2.3 depicts how to make a new facility.

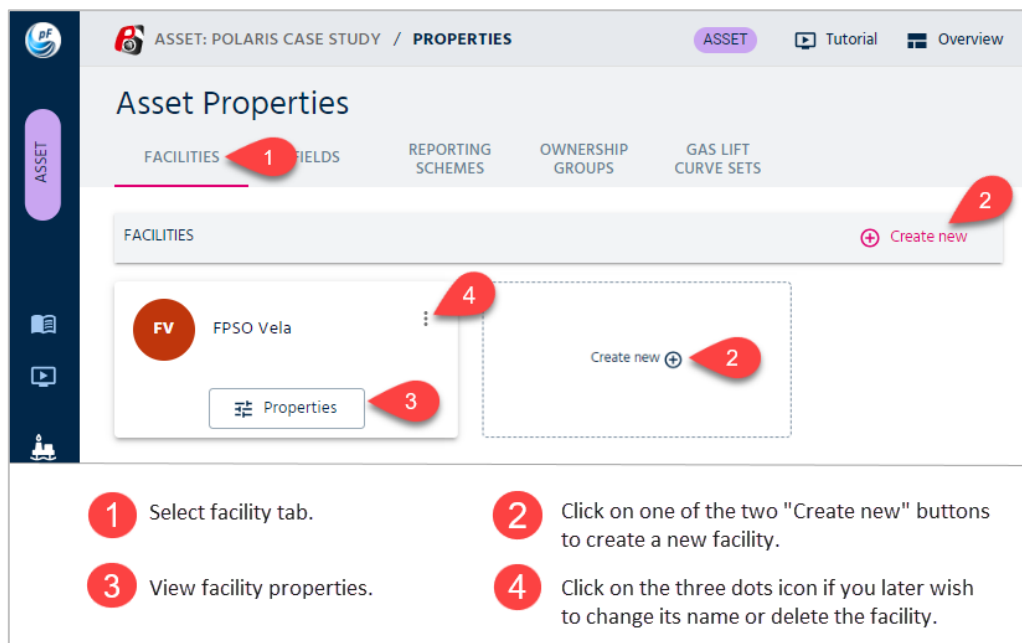


Figure 2.3: Facility configuration.

In the oil and gas industry, it is common to find multiple production facilities within a single asset. This practice serves several purposes, driven by the following factors:

- Large field size: Some oil and gas fields are characterized by their significant size and abundant reserves. To efficiently extract and process the hydrocarbons from such fields, it becomes necessary to establish multiple production facilities. These facilities encompass drilling platforms, processing plants, storage tanks, and other crucial infrastructure elements. By distributing the production capacity across various facilities, operators can optimize the extraction process and ensure that the asset reaches its full potential.
- Geographic dispersion: In certain instances, an oil and gas asset comprises multiple fields that are spread across a vast geographic area. Each field may possess distinct characteristics, such as varying reservoir pressures or different types of hydrocarbons. To address these unique requirements and maximize operational efficiency, multiple facilities are strategically deployed. This approach enables operators to tailor production and processing operations according to the specific needs of each field, minimizing logistical challenges and enhancing overall performance.
- Expansion and tie-in fields: Oil and gas assets often undergo development in stages. Initially, a production facility is designed and constructed to handle the output from primary fields. However, as new fields are discovered or tie-in fields are integrated into the asset following the initial development, the existing facility's capacity may prove insufficient. Consequently, additional facilities are built, or existing ones are expanded to accommodate the increased production volume. This adaptive approach allows for seamless integration of new fields into the asset's infrastructure.

Within the pForecast software, users have the capability to simulate the segregation of phases within a single facility, exporting specific portions of production while redirecting the remaining volumes to another facility. Additionally, the system allows for the modeling of dependencies in facility uptimes, which arise when multiple facilities share power units or processing plants.

Figure 2.4 shows how, under the Facility Properties, you can set up a two-level hierarchical structure for a multi-facility asset, in order to model separation of phases at child facilities as well as dependencies on PE and shutdowns in the hierarchy.

Facility Properties

FACILITY CLUSTERS WELLS FUEL & FLARE

General

Facility name *
FPSO Vela

Unique identifier 1

Hierarchy 2

Parent facility 2
<none>

Parent cluster 3
<none>

Save changes 4

1 Optionally provide an identifier that is globally unique across domains and systems.

2 Select a facility that is to be the parent of this (child) facility.

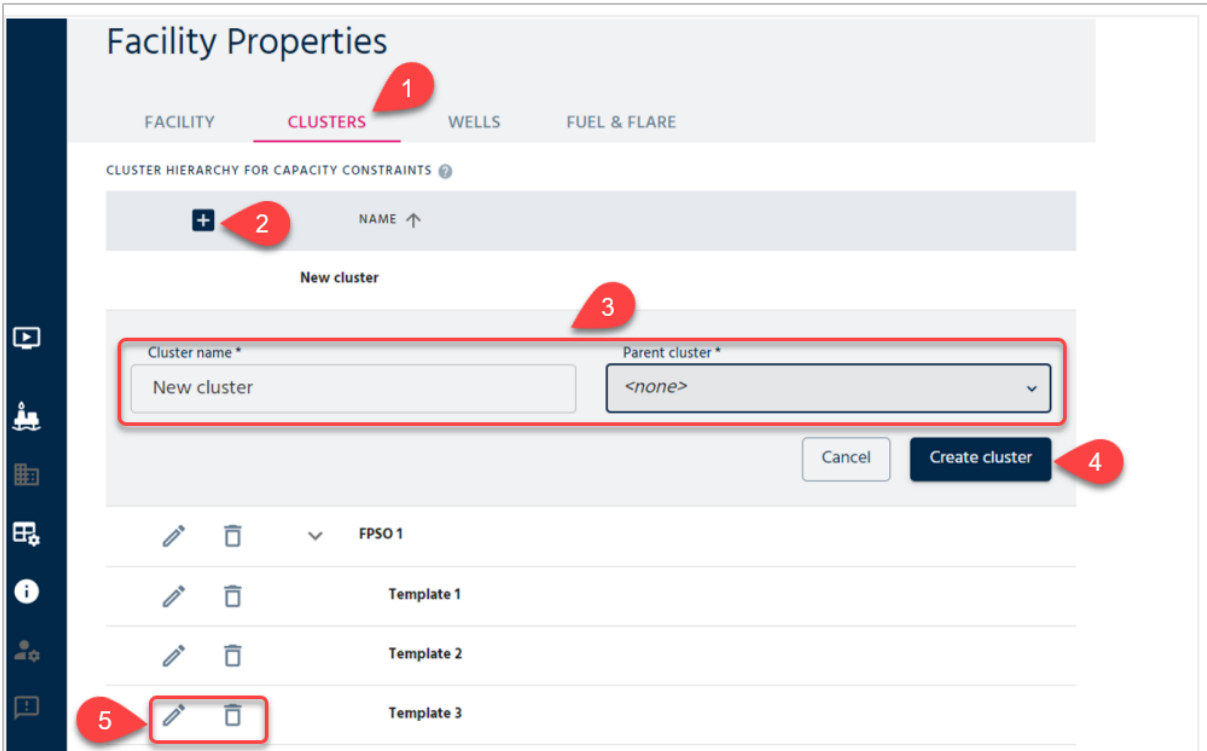
3 Select a cluster in the parent facility to which to attach the child facility's top-level clusters.

4 Press "Save changes"

Figure 2.4 Setting up a hierarchical structure for a multi-facility asset.

2.1.1. Clusters

Clusters are used to group wells and to constrain the production and injection to the capacity of that group. Clusters can be routed to other clusters; there can be up to four levels of clusters in a facility. Later, when configuring forecasts, you can attach constraints to the clusters defined here. When the "Clusters" tab is selected, it is possible to create, edit, and delete clusters. When the plus icon is clicked, the cluster dialog box appears. It is possible to give the cluster a name. The name must be unique. It is also possible to specify an existing parent cluster. If no parent is specified, the cluster will be a top-level cluster. Figure 2.5 shows how clusters can be created and structured.

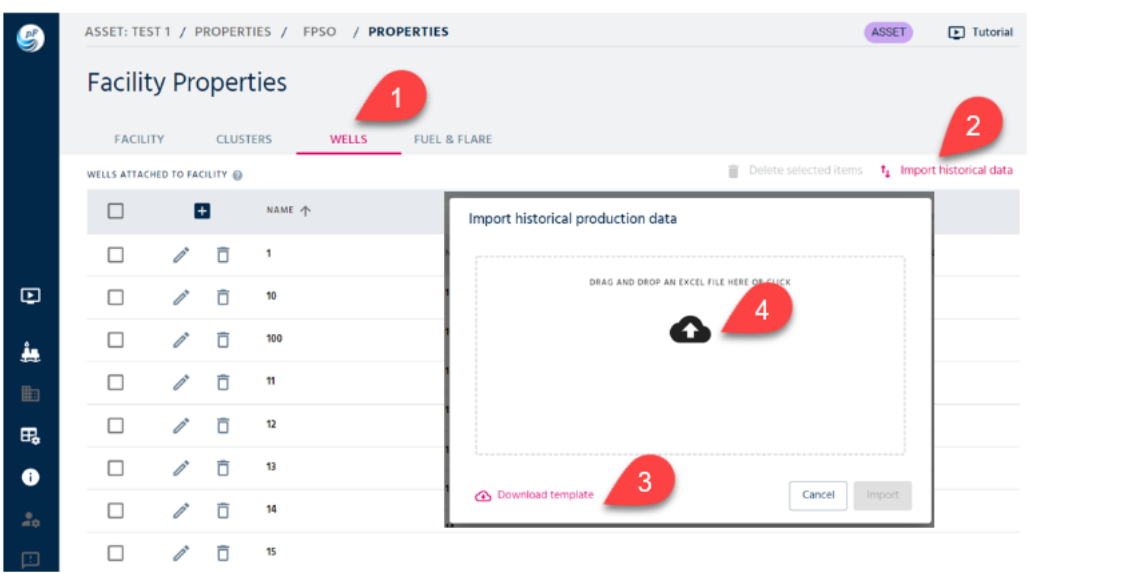


- 1 Select the "Clusters" tab.
- 2 Click on the plus icon to create a new cluster.
- 3 Enter the cluster's name and parent cluster.
- 4 Press "Create cluster" to save.
- 5 Press the pen icon to edit clusters and the trash icon to delete.

Figure 2.5: Cluster configuration.

2.1.2. Wells

The most crucial feature of wells in the pForecast software is to hold the production history. pForecast has two notions of a well. Firstly, it is a physical well, as detailed here; secondly, it is a forecast well that connects to the physical well. The forecast well connects to a wellbore of a given physical well, and each well must have at least one wellbore to get the historical production over to the forecast. Wells can be created, edited, and deleted. Figure 2.6 depicts how historical production and injection data can be uploaded from Excel. Figure 2.7 shows the Excel template for uploading historical production per well.



The screenshot shows the 'Facility Properties' page in the pForecast software. The 'WELLS' tab is selected, indicated by a red callout '1'. The 'Import historical data' button is highlighted with a red callout '2'. A dialog box titled 'Import historical production data' is open, showing a dashed box for file upload with a red callout '4' pointing to the upload icon. A 'Download template' link is highlighted with a red callout '3'. Below the screenshot, four numbered steps describe the process:

- 1 Select the "Wells" tab.
- 2 Press "Import historical data".
- 3 Download the Excel template and populate with historical production data.
- 4 Drag and drop populated Excel file to upload.

Figure 2.6: Wells configuration and uploading of historical data from Excel.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
WellName	AllocationYear	AllocationMonth	OnStreamDays	Oil	Gas	Water	GasInjection	WaterInjection	GasLift	AverageWellheadPressure	AverageChokeOpening		
1	2004	1	31	0.00	0	500							
2	2004	2	28	0.00	0	510							
3	2004	3	31	0.00	0	520.2							
4	2004	4	30	0.00	0	530.604							
5	2004	5	31	0.00	0	541.2161							
6	2004	6	30	0.00	0	552.0404							
7	2004	7	31	0.00	0	563.0812							
8	2004	8	31	0.00	0	574.3428							
9	2004	9	30	0.00	0	585.8297							
10	2004	10	31	0.00	0	597.5463							
11	2004	11	30	0.00	0	609.4972							
12	2004	12	31	0.00	0	621.6872							
13	2005	1	31	0.00	0	500							
14	2005	2	28	0.00	0	510							
15	2005	3	31	400.65	52084.1412	520.2							
16	2005	4	30	400.65	52084.1412	530.604							
17	2005	5	31	400.65	52084.1412	541.2161							
18	2005	6	30	400.65	52084.1412	552.0404							
19	2005	7	31	400.65	52084.1412	563.0812							
20	2005	8	31	400.65	52084.1412	574.3428							
21	2005	9	30	400.65	52084.1412	585.8297							
22	2005	10	31	400.65	52084.1412	597.5463							
23	2005	11	30	400.65	52084.1412	609.4972							
24	2005	12	31	400.65	52084.1412	621.6872							

1 Well name.
 2 Allocation Year/Month.
 3 On Stream Days.
 4 Production of different fluids and injected gas and water; and consumed gas lift.
 5 Fields are not in use.

Figure 2.7: Excel template for uploading historical production per well.

Historical production data can also be imported from Cognite Data Fusion (CDF). Once the connection is set up, pForecast will collect updated historical data from CDF daily.

Figure 2.8 shows how to configure for import of historical production data from CDF.

After importing production data through either Excel sheets or CDF, for quality control, you can open the “History details” menu for each well and observe the production and injection profiles for different fluids (see Figure 2.9).

The screenshot shows a software interface with a top navigation bar containing 'FACILITY', 'CLUSTERS', 'WELLS', and 'FUEL & FLARE'. The 'WELLS' tab is active. Below the navigation bar, there is a section 'WELLS ATTACHED TO FACILITY' with a 'Delete selected items' button and an 'Import historical data' button. A table header is visible with columns for 'NAME', 'START DATE', and 'END DATE'. A plus icon is located in the table header. Below the table, there is a 'New well' section with a 'General' tab. The 'General' section contains a 'Well name' input field, a 'Time horizon' section with 'Start date' and 'End date' fields, a 'Wellbores' section with a plus icon and a table header, a 'Connections to CDF time series' dropdown menu, and a 'History details' dropdown menu. At the bottom right, there are 'Cancel' and 'Create well' buttons.

- 1 Select the "Wells" tab.
- 2 Press plus icon to create a new well.
- 3 Enter the well's name.
- 4 Open the "Connections to CDF time series" section and select the relevant time series.
- 5 Click "Create well" to save.

Figure 2.8: Import historical production data from CDF.

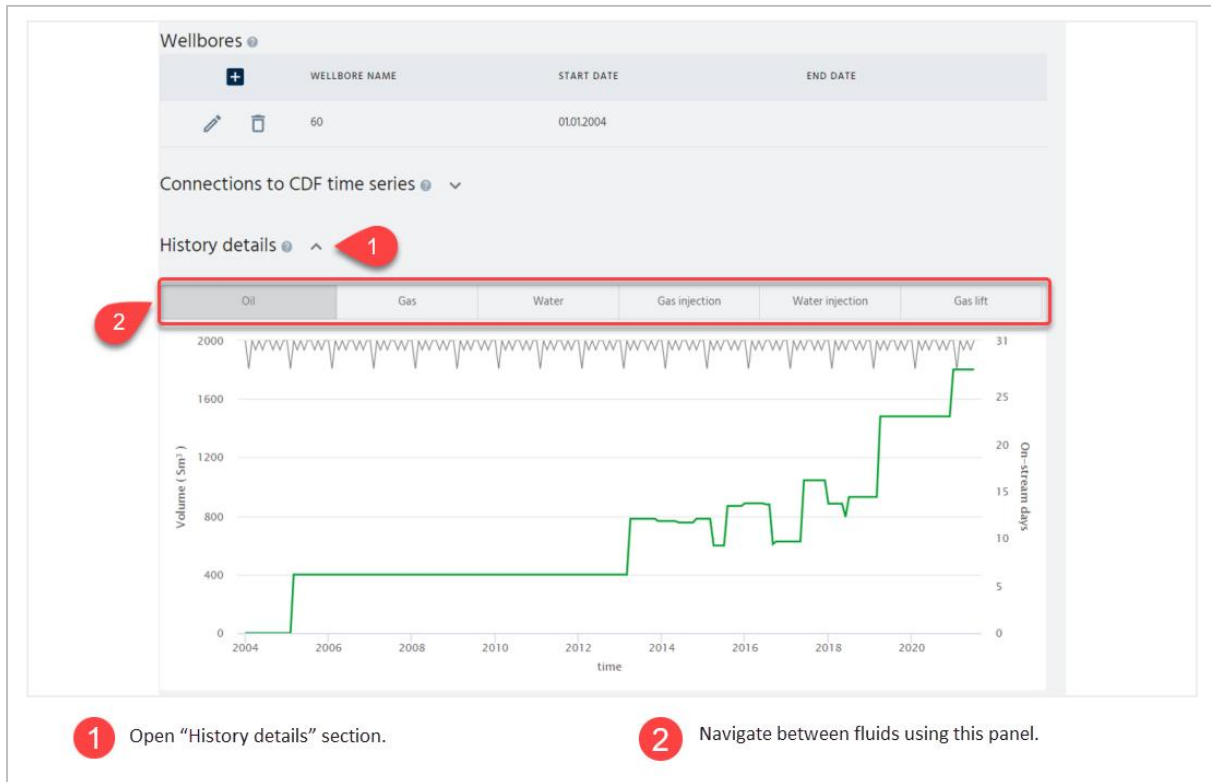


Figure 2.9: Quality control of imported historical data per well.

2.1.3. Fuel and Flare

Both fuel and flare are calculated at the facility level as linear functions of produced and injected volumes. The fuel and flare calculated per facility are distributed to the contributing wells for sales calculations based on one of the following methods:

- a. Liquid volume (use as the default)
- b. Gas volume
- c. Oil volume
- d. Sum of produced oil, gas in oil equivalents and water
- e. Sum of produced oil, gas in oil equivalents, produced water, injected gas in oil equivalents, and injected water

The below formula will be used to distribute the fuel based on the liquid volume method:

$$V_{\text{fuel from well } i} = V_{\text{total fuel for facility}} \cdot \frac{V_{\text{liquid from well } i}}{V_{\text{total liquid facility}}}$$

The other methods follow this pattern.

In pForecast, fuel and flare input data can be imported through an Excel file or edited manually using the embedded table. See Figure 2.10 for more details.

The screenshot shows the 'Facility Properties' interface with the 'FUEL & FLARE' tab selected. A modal window titled 'Import fuel & flare parameters' is open, showing a 'DRAG AND DROP AN EXCEL FILE HERE OR CLICK' area with an upload icon. Red callout numbers 1-5 point to the 'FUEL & FLARE' tab, the 'Import fuel & flare parameters' button, the 'Download template' link, the upload icon, and the 'YEAR/MONTH' dropdown menu respectively.

- 1 Select Fuel & Flare.
- 2 Press "Import fuel & flare parameters".
- 3 Download the Excel template and populate with fuel and flare parameters.
- 4 Drag and drop populated Excel file to upload.
- 5 Fuel and flare input can also be added by using the table in the user interface.

Figure 2.10: Uploading fuel and flare input data.

Figure 2.11 shows the available Excel template in pForecast for uploading fuel and flare input data.

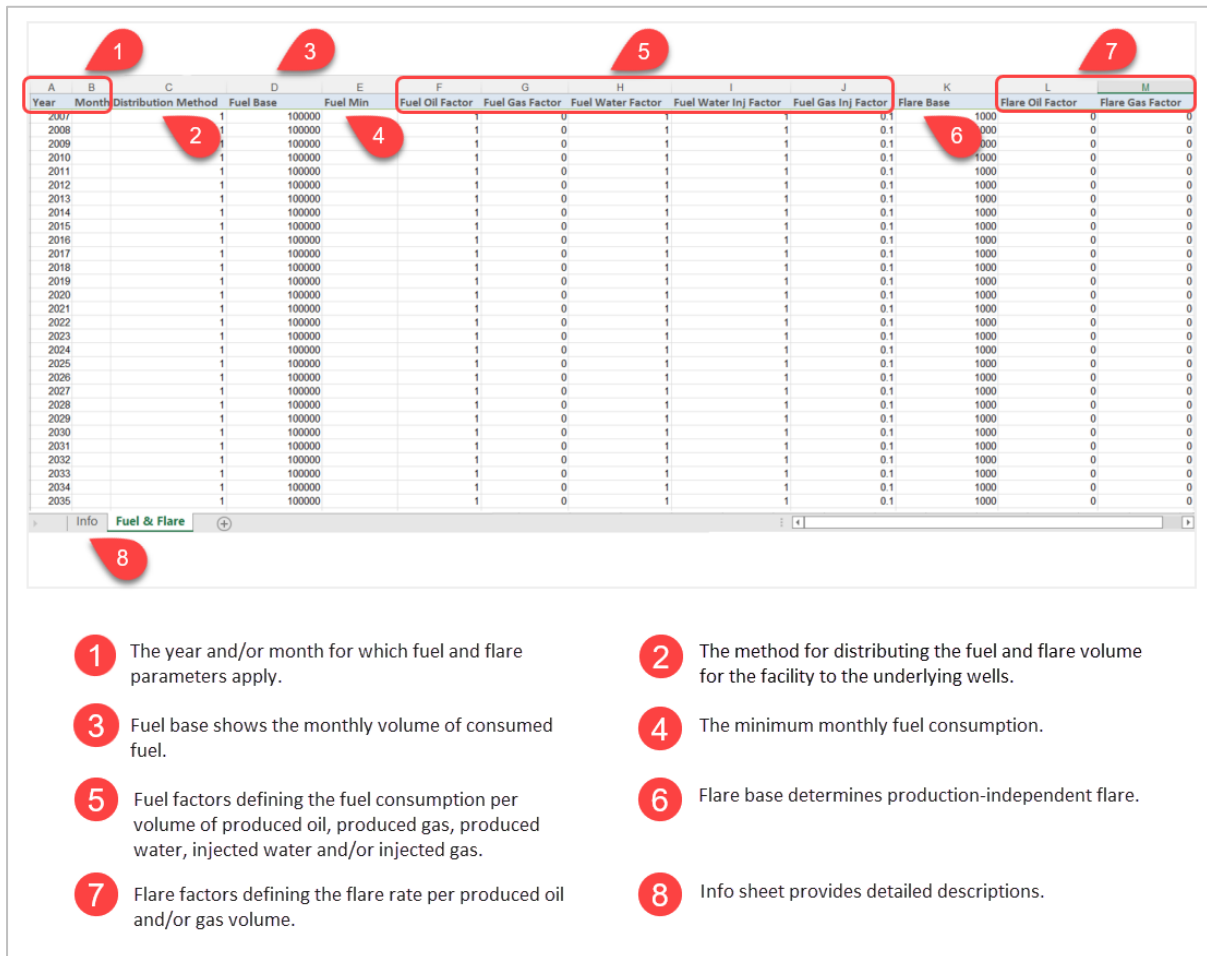
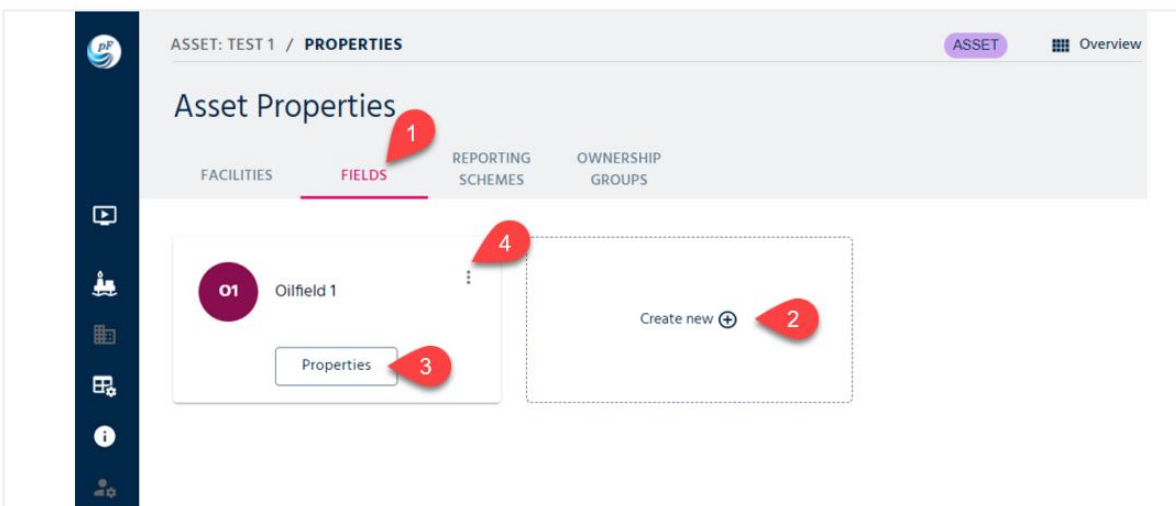


Figure 2.11: Excel template for uploading fuel and flare input data.

2.2. Fields

The user can select an existing field or create a new one on the asset level by pressing the create card. You can define as many fields as needed. When a field is selected, it is possible to edit or delete it. If one of the fields is deleted, all associated data is deleted. Figure 2.12 illustrates how to create a new field.



ASSET: TEST 1 / PROPERTIES

ASSET Overview

Asset Properties

FACILITIES FIELDS REPORTING SCHEMES OWNERSHIP GROUPS

01 Oilfield 1

Properties

Create new +

- 1 Under asset properties select the "Field" tab.
- 2 Create a new field.
- 3 View field properties.
- 4 Click on the three dots icon if you later wish to delete the field.

Figure 2.12: Creating a new field on the asset level.

2.2.1. PVT

Voidage groups use PVT properties. Constant PVT properties are assumed to be sufficiently accurate to model injection to achieve a reasonable voidage replacement. PVT properties can be edited by selecting the PVT Properties tab. PVT properties can be created, edited, and deleted. When the plus icon is pressed, PVT properties can be set, and the following parameters are entered: formation volume factors for oil and gas and solution gas oil ratio. The formation volume factor for water is assumed to be unity. Figure 2.13 indicates how to apply PVT properties.

The screenshot shows the 'Field Properties' interface for 'ASSET: TEST 1 / OILFIELD 1 / PROPERTIES'. The 'PVT' tab is selected. Below the tabs, there is a 'PVT PROPERTIES' section with a '+ ' icon to create a new property set. The 'New PVT Properties' form is open, showing the 'General' section. The 'PVT properties name' field contains 'New PVT Properties'. The 'Formation volume factors and solution gas oil ratio' section has three input fields: 'Bo (Rm³/Sm³)' with the value 1.12, 'Bg (Rm³/Sm³)' with the value 0, and 'Rs (Sm³g/Sm³o)' with the value 130. A 'Create PVT properties' button is visible at the bottom right.

- 1 Select "PVT" tab.
- 2 Click the "+" icon to create a new PVT property set.
- 3 Write a suitable name for the PVT property set.
- 4 Insert the relevant PVT data.
- 5 Press "Create PVT properties" to save your work.

Figure 2.13: Applying PVT properties for voidage calculations.

2.2.2. Voidage

Voidage groups are used to model required injection volumes. The groups are created here and used later when a scenario is built. When the voidage tab is selected, it is possible to create a new one and edit or delete the selected voidage group. In the field properties, the following page appears when the “Voidage” tab is pressed. A unique name must be entered, and a set of PVT properties, defined in the previous step, must be selected. By applying the target voidage factor as a fraction, pForecast will steer the injection rates to reach the target voidage factor. See Figure 2.14 for more details.

ASSET: TEST 1 / PROPERTIES / OILFIELD 1 / PROPERTIES

Field Properties

FIELD PVT **VOIDAGE** RNB SALES CONVERSION

VOIDAGE GROUPS Delete selected items

NAME VOIDAGE FACTOR

New voidage group

General

Voidage group name *

Voidage

PVT properties * Voidage factor *

Maximum voidage reservoir volume deficit (Rm³) *

Export schedule

Constrained by gas export requirements

START MONTH EXPORT REQUIREMENTS... FUEL (SM³/DAY) FLARE (SM³/DAY) EXTERNAL GAS (SM³/D...)

- 1 Select the “Voidage” tab.
- 2 Press the “+” icon to create a new voidage group.
- 3 Give the voidage group a proper name.
- 4 Select the PVT properties you previously defined.
- 5 In case of insufficient injection, you can define how large a deficit to accept.
- 6 Turn this toggle on, if it is desired to calculate the injection based on production & gas export.
- 7 Apply the target voidage factor.
- 8 Click “Create voidage group” to save.

Figure 2.14: Defining the voidage group.

2.2.3. RNB

A structure of RNB profiles and projects can be defined for a field. These profiles and projects are used to aid in reporting data to the Revised National Budget (RNB) in Norway each autumn, 15 October. An RNB profile is a set of profiles given to the authorities. The Norwegian Petroleum Directorate (NPD) allows up to 15 profiles with annual reports on recoverable resources in classes 0 to 5. Projects in resource classes 6 and 7, which are reported separately in the RNB reports, are to be placed in profile 0. The reader is referred to the [NPD website](#) for more information about resource classification. Each profile should be given a unique name and a profile number.

When the RNB Profiles tab is selected, it is possible to create a new RNB profile or to edit or delete the selected profile. See Figure 2.15 for more details.

The screenshot shows the 'Field Properties' interface for 'ASSET: TEST 1 / PROPERTIES / OILFIELD 1 / PROPERTIES'. The 'RNB' tab is selected, indicated by a red callout 1. Below the tabs, there is a table for 'RNB PROFILES & PROJECTS' with columns for NAME, PROFILE NUMBER, and PROJECT STATUS. A red callout 2 points to a '+' icon for creating a new profile. Below the table is a 'New RNB profile' form with fields for 'RNB profile name *' (callout 3), 'Profile number *' (callout 5), 'Project status *' (callout 6), 'Tag *' (callout 4), and 'Report group *' (callout 7). A 'Create RNB profile' button (callout 8) is at the bottom right. A 'Update RNB reporting scheme' button is also visible at the top right of the table area.

- 1 Select the "RNB" tab.
- 2 Press the "+" icon to create a new RNB profile.
- 3 Provide a suitable name.
- 4 Tag forecast wells, belonging to this profile either manually or automatically, by pressing the "Update RNB reporting scheme" button at the top of the page.
- 5 Select the profile number.
- 6 Select a project status from the ones given in NPD's guidelines.
- 7 This property gives the group for reporting production of this profile. It can be set manually or by pressing the "Update RNB reporting scheme" button at the top of the page.
- 8 Click "Create RNB profile" to save.

Figure 2.15: RNB profiles and projects.

2.2.4. Sales Conversion

For a field, the user can define yearly or monthly entries, each containing various parameters related to conversion from production to sales figures. If a set of parameters is provided for both a month and the year of that month, the month data will be used in calculations. In the

case that there is no provided entry for a month, the defaults for the various parameters will be used. See Figure 2.16 for more details.

The screenshot shows the 'SALES CONVERSION' tab in a software interface. The interface includes a sidebar with 'ASSET' and various icons. The main area has a header with 'FIELD', 'PVT', 'VOIDAGE', 'RNB', and 'SALES CONVERSION'. Below the header is a table with columns for 'YEAR/MONTH', 'GA...', 'OI...', 'RIC...', 'DR...', 'OI...', 'GA...', 'NG...', 'NG...', 'NG...', 'GA...'. A 'New year/month' section contains a 'Year/month*' field with '2022' entered. Below this is a large form with two columns of input fields. A red box highlights the parameter input fields, and numbered callouts (1-6) provide instructions on how to use the interface.

- 1 In the Field properties, select the "Sales Conversion" tab.
- 2 Download the Excel file and populate with sales parameters.
- 3 Alternatively, click the "+" icon to create a new table entry with sales conversion parameters.
- 4 Provide a yearly or monthly entry.
- 5 Provide sales conversion factors. Where no factors are entered, default values are used.
- 6 Click "Create sales conversion parameters" to save.

Figure 2.16: Sales conversion factors-

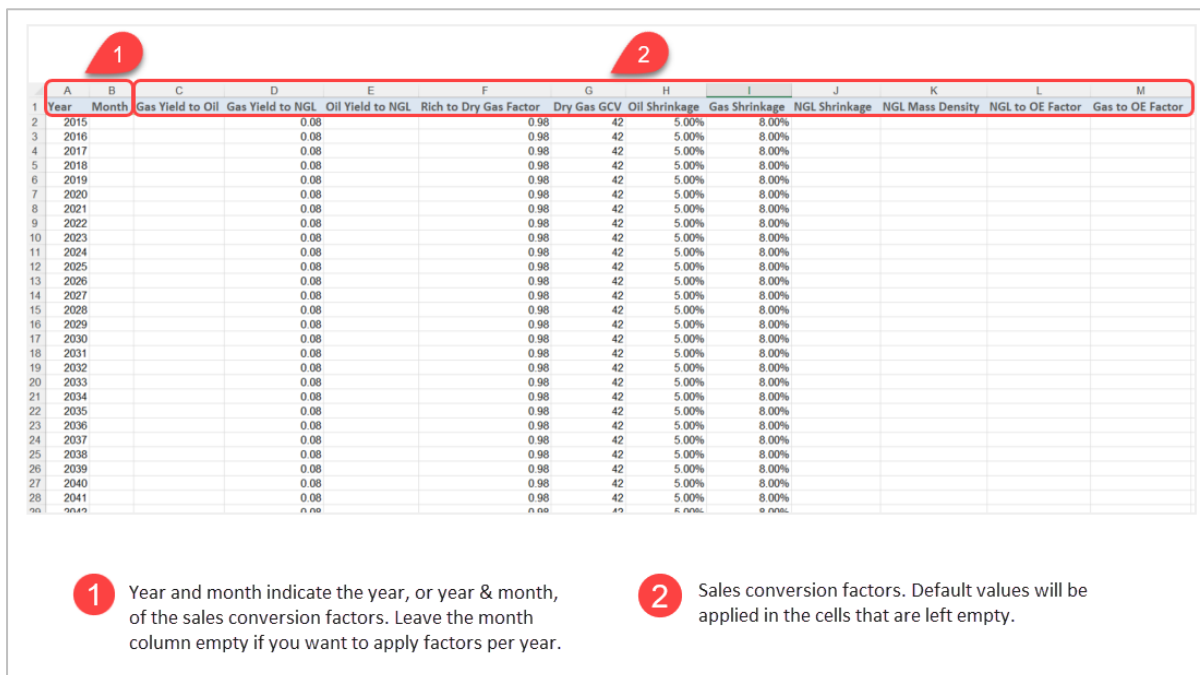


Figure 2.17: Excel template for uploading sales conversion parameters.

2.3. Reporting Schemes

A reporting scheme is used to define how the simulation results are aggregated and output. pForecast calculates the production rates per well, and reporting schemes enable the users to define what groups of wells they wish to output production rates for. It is possible to define multiple reporting schemes.

Each forecast well is assigned one 'tag' that describes a property of the well. In fact, a well can only be assigned one tag per reporting scheme. The tags must therefore be disjoint, meaning the properties do not overlap. Examples of properties used to define tags are which reservoir the well produces from, which production license it belongs to, if the well is a producer or injector, and so on and so forth.

On the other hand, tags are collected into one or more report groups. The report groups will be used to output results containing the sum of production from all wells assigned tags belonging to the report group. To sum up, the steps for configuring a reporting scheme in pForecast software are:

1. Create a new reporting scheme.
2. Define the tags that will be assigned to the wells.
3. Define the report groups that will be output in the results and assign well tags to the report group.
4. Assign tags to the specific wells in the forecast. This step is performed in the forecast configuration.

In pForecast, reporting schemes can be defined either by populating the provided Excel file and uploading it or by creating them manually. Figure 2.18 demonstrates the process of creating a new reporting scheme, Figure 2.19 showcases the creation of tags, and Figure 2.20 explains the creation of report groups. On the other hand, Figure 2.21 demonstrates the method of importing an Excel file to accomplish the same task.

ASSET: TEST 1 / PROPERTIES

ASSET Tutorial Overview

Asset Properties

FACILITIES FIELDS **REPORTING SCHEMES** OWNERSHIP GROUPS GAS LIFT CURVE SETS

AL Asset Layout Properties

FL Field Layout Properties

PS Project status Properties

RB RNB Properties

VE Voidage Properties

WS Well status Properties

WS Wells Properties

Create new ⊕

Import ↓

- 1 Press the Reporting Schemes tab.
- 2 Here a new reporting scheme can be created.
- 3 Press the report scheme properties and define well tags and reports group.
- 4 Click the three dots if you wish to delete the scheme.

Figure 2.18: Creating a new reporting scheme.

ASSET: TEST 1 / PROPERTIES / WELL STATUS / PROPERTIES ASSET Tutorial

Reporting Scheme Properties

REPORTING SCHEME **TAGS** REPORT GROUPS

TAGS

+	NAME ↑	DESCRIPTION
✖	Existing	Existing wells
✎	New	New wells

- In the Reporting Scheme properties, select the "Tags" tab.
- Click the "+" icon to create a new well tag.
- Enter a name and description for the tag.
- Save your work.

Figure 2.19: Creating tags.

ASSET: TEST 1 / PROPERTIES / WELL STATUS / PROPERTIES ASSET Tutorial

Reporting Scheme Properties

REPORTING SCHEME TAGS **REPORT GROUPS**

REPORT GROUPS

+	NAME ↑	DESCRIPTION
^	All wells	

INCLUDED TAGS

+	TAG NAME	TAG DESCRIPTION
✎	Existing	Existing wells
✎	New	New wells

- In the Reporting Scheme properties, select the "Report Groups" tab.
- Click the "+" icon to create a new report group..
- Write a name and description for the report group.
- Click the "+" icon to add well tags to the report group.

Figure 2.20: Creating report groups.

The screenshot shows the 'Asset Properties' interface with the 'REPORTING SCHEMES' tab selected. A dialog box titled 'Import reporting schemes, tags & report groups' is open, showing options to clear existing items and a 'Download template' button. Red callouts 1-5 are placed over the interface to indicate the steps for importing an Excel file.

- 1 Press the Reporting Schemes tab.
- 2 Click "import".
- 3 Choose whether to clear all unreferenced existing reporting items or not.
- 4 Download the template and populate.
- 5 Upload the populated Excel file.

Figure 2.21: Creating report groups by importing an Excel file.

2.4. Ownership Groups

For an asset, the user can define a set of ownership groups consisting of ownership shares for sales oil, gas, and natural gas liquid (NGL).

A forecast well, defined under forecast properties, can subsequently connect to an ownership group. The various ownership shares are used when calculating net sales values. In other words, wells are tagged to ownership groups to characterize the company's ownership share of the produced volumes. It is also possible to define a default ownership group; in that case, all wells that have not been specifically tagged to an ownership group will be assigned to this group. Suppose there is no default ownership group for the asset, and a well is not assigned to a specific ownership group. In that case, pForecast will assume 100% ownership share as the default value when generating net sales profiles. In that case, the net sales and the gross sales are equal. Figure 2.22 shows how to create an ownership group step by step.

ASSET: TEST 1 / PROPERTIES

ASSET Overview

Asset Properties

FACILITIES FIELDS REPORTING SCHEMES **OWNERSHIP GROUPS**

OWNERSHIP GROUPS Delete selected items

	+	NAME ↑	DEFAULT	SHARE SALES OIL	SHARE SALES GAS	SHARE NGL
--	---	--------	---------	-----------------	-----------------	-----------

New ownership group

General

Ownership group name *

Oilfield 1 Default ownership group

Ownership shares

Share sales oil (%) *	Share sales gas (%) *	Share NGL (%) *
100	100	100

Cancel Create ownership group

- 1 Under Asset Properties select the "Ownership Groups" tab.
- 2 Click the "+" icon to create a new ownership group.
- 3 Provide a suitable name.
- 4 Insert the ownership share per sales fluid.
- 5 You may define a default ownership group.
- 6 Save your work.

Figure 2.22: Creating ownership groups.

2.5. Gas Lift Curve Sets

For an asset, the user can define gas lift curve sets, consisting of curves that give the relationship between the fraction of gas lift potential and the fraction of production potential for given water cuts. A production profile, which is defined under Forecast Properties, can subsequently connect to a gas lift curve set. The gas lift curves are used in connection with constraint calculations involving gas lift. Figure 2.23 shows how to specify gas lift curves.

1 Under Asset Properties select "Gas Lift Curve Sets".

2 Click the "+" icon to create a new gas lift curve set.

3 Provide a suitable name and description.

4 Specify three different percentage values for water cuts.

5 In the table, enter the fraction of gas lift potential and fraction of production potential or drag the corresponding curve points.

6 Here you can get previews of interpolated curves for two user-specified water cut values.

7 Save your work.

Curve #1 WCT (%)			Curve #2 WCT (%)			Curve #3 WCT (%)		
PT	FRACTION GAS LIFT (%)	FRACTION PRODUCTION (%)	PT	FRACTION GAS LIFT (%)	FRACTION PRODUCTION (%)	PT	FRACTION GAS LIFT (%)	FRACTION PRODUCTION (%)
#1	0	0	#1	0	0	#1	0	0
#2	0	75	#2	0	30	#2	0	0
#3	1	90	#3	3	70	#3	68	25
#4	5	99	#4	10	90	#4	95	50
#5	100	100	#5	100	100	#5	100	100

Figure 2.23: Generating gas lift curves.

3. Forecast Configuration

Forecast configuration provides future projections for three main input data domains: subsurface, facility operations, and drilling. The following sections give details on creating a forecast and configuring previously mentioned input data.

3.1. Create a Forecast

The first step is to create a new forecast. It is worth mentioning that if the user selects to duplicate a forecast, the original one is kept, and changes in the duplicated forecast are not reflected in the original. It is also possible to edit or delete the selected forecast. See Figure 3.1 and Figure 3.2 for more details.

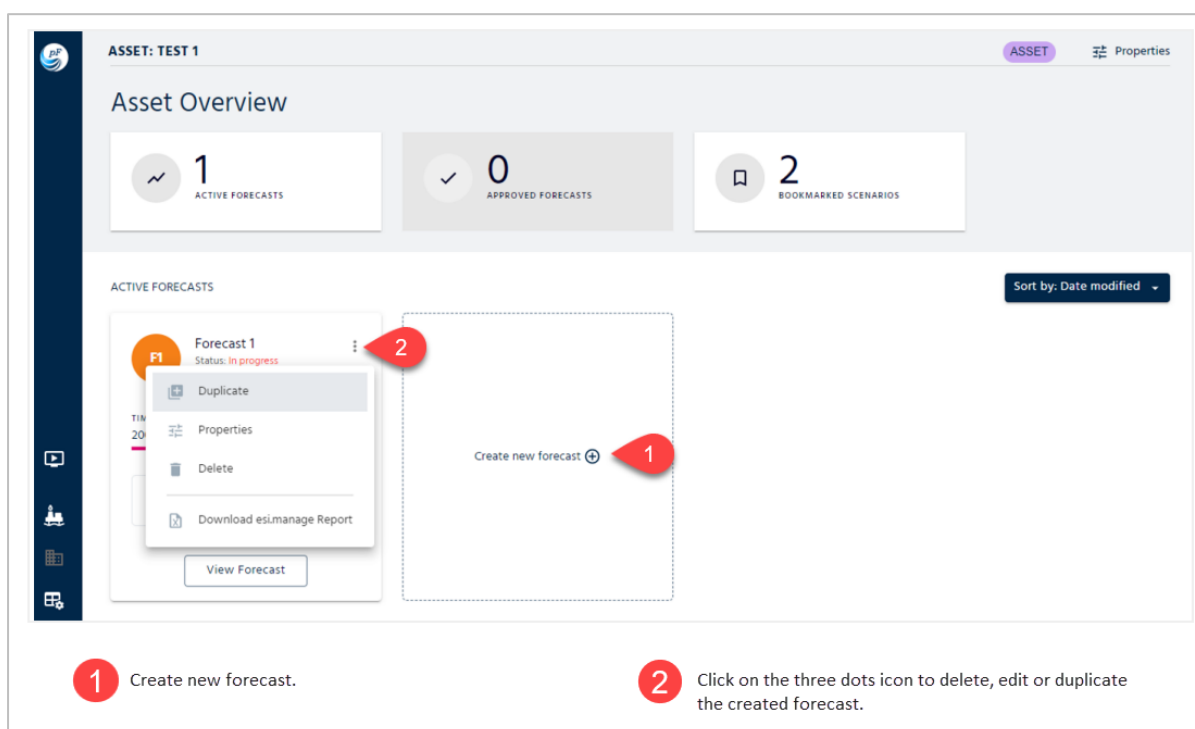


Figure 3.1: Creating a new forecast (part 1).

After creating a new forecast, the following page will be shown, in which the user can provide high-level forecast properties and time ranges:

ASSET: TEST 1 / CREATE NEW FORECAST ASSET Overview

New Forecast

Provide a name and possibly a longer description text for the new forecast and then determine the forecast's time range. In the comments section, you may enter other information about the new forecast.

General **Time range**

Forecast name * Purpose * Other

Must be specified.

Description

First visible year * 1980

Last visible year * 2040

Forecast start month * January 2022

Forecast years with monthly data * 6

Miscellaneous

Comments

Create forecast

- 1 Give the forecast a suitable name and description.
- 2 Set the first and last visible year.
- 3 Define the start month and year for the forecast.
- 4 Specify the number of years for which forecast result detailed per month will be presented.
- 5 Provide free-text comments about the forecast.
- 6 Click "Create forecast" to save.

Figure 3.2: Creating a new forecast (part 2).

After making a new forecast, the user can easily access all properties (see Figure 3.3).

The production potential for the well is imported from an Excel file, and for the first time, a new profile will be created and appear in the list. When production potential is uploaded for a profile that already exists, the new data will overwrite the old data.

After importing, a list of the production profiles is shown. A unique name for each production profile is shown together with the type of production profile. It is also specified whether the profile is generic or not. Different forecast wells can reuse a generic production potential profile. The list also shows how many times the production potential profile is used by forecast wells, noted by use count. The dates for the creation and last modification of the production potential profile are also shown.

Figure 3.4 and Figure 3.5 display how to upload and configure well production potentials.

Forecast Properties

FORECAST PRODUCTION POTENTIAL FORECAST WELLS DRILLING CAPACITY SEPARATION PRODUCTION EFFICIENCY PRODUCTION CORRELATION INTERVENTION JOBS

PRODUCTION POTENTIAL PROFILES

	NAME	TYPE	GENERIC	#	CREATED	MODIFIED
<input type="checkbox"/>	A1	Stream day rate vs month				2023
<input type="checkbox"/>	A2	Stream day rate vs month				2023
<input type="checkbox"/>	A3	Stream day rate vs month				2023
<input type="checkbox"/>	A4	Stream day rate vs month				2023
<input type="checkbox"/>	B1	Stream day rate vs month				2023
<input type="checkbox"/>	B2	Stream day rate vs month				2023
<input type="checkbox"/>	B3	Stream day rate vs month				2022
<input type="checkbox"/>	B4	Stream day rate vs month				2022
<input type="checkbox"/>	C1	Stream day rate vs month				2022

Import production potential profiles

FIELD* Mars

CREATE/LINK FORECAST WELLS FOR All profiles Non-generic profiles only No profiles

WELLBORES Automatically link forecast wells to wellbores with same name

Drag and drop an Excel file here or click to upload

- 1 Under Forecast Properties, select the Production Potential tab.
- 2 Click "Import profiles".
- 3 Select the relevant field.
- 4 Choose the degree of automatic creation/linking of forecast wells and populate with production potentials.
- 5 Choose if there should be an automatic connection between wellbores and forecast wells with same names.
- 6 Download Excel template and populate.
- 7 Upload the populated Excel file.

Figure 3.4: Uploading well production potentials.

After uploading the well potentials, click the pen icon to enter the menu for potential configuration. More details are shown in Figure 3.5.

General

Profile name * 1
 Description Added by auto load
 Field * Oilfield 1
 Type Profile type * Stream day rate vs delta month
 Primary phase * Oil
 Oil input type * Rate
 Gas input type * Rate
 Water input type * Rate

Miscellaneous

Volume-based profile 2
 Average PE when volume-based (%) 98 3
 Default gas lift rate (Sm³/day) 6
 Minimum liquid rate (Sm³/day) 4
 Production uncertainty Distribution Triangular (P10, P90)
 Use profile reference values as <none>
 Treat negative values as zero 5

Cut-off

At volume (Sm³)
 At rate (Sm³/day)
 On date dd.mm.yyyy
 At drilling start of well <none>

Capacity limitation priorities

Default GOR (Sm³/Sm³)
 Default water cut (%)
 Priority group * Normal
 Priority switch date dd.mm.yyyy
 New priority group Normal

Potential details

Chart: input Table: input Chart: output
 Oil Gas Water Gas lift

Sm³/stream day
 months relative to start

Cancel Update profile 8

- 1 Select the distribution type for the potential and how to handle the reference value with respect to distributions.
- 2 Activate the volume-based profile toggle if you want the volume from the well potential to be preserved when production is delayed due to shut-ins, PE, and so on.
- 3 Enter an average PE to have the correct relationship between time and produced volume.
- 4 Define a minimum liquid production rate per stream day.
- 5 Here you can define default GOR and water cut and choose the priority group to use in connection with capacity calculations.
- 6 Define criteria for permanent well cut off based on produced volume, production rate, given date or when drilling of a new well starts.
- 7 Navigate between chart and table view, and between different fluids.
- 8 Save your work.

Figure 3.5: Configuration of well production potentials.

3.2.1.1. Distribution types in pForecast

pForecast supports several types of distributions. For all of them, up to three parameters are used when generating samples from the distribution. A low value, a high value, and a mid/deterministic value (the value used in a deterministic analysis).

Triangular (P10, P90) - The Triangular distribution is a continuous probability distribution with lower limit, upper limit and mode. There are two variants of the Triangular distribution in pForecast. In this variant, the three defining parameters are calculated from the provided low/P10 value (10% probability of non-exceedance), the provided high/P90 value (90% probability of non-exceedance), and the mid value that is used either as a most likely value (mode) or an expected value.

Normal - The Normal (or Gaussian) distribution is a continuous probability distribution given by a mean (expected value) and a standard deviation. In pForecast, these two parameters are calculated from a provided low value (10% probability of non-exceedance), and a provided high value (90% probability of non-exceedance). The mean is the average of the low and high value, while the standard deviation is the difference between high and low multiplied with 0.39. Note that for this distribution the provided mid value is not used; it should however not deviate too much from the calculated mean.

Pert - The Pert distribution is a continuous probability distribution defined by a minimum value, a most likely value and a maximum value. It is a smoother shape alternative to the Triangular distribution. In pForecast, the provided low value and high values give the minimum and maximum values directly, while the mid value is either the most likely value or an expected value that is used to derive the most likely value.

Log normal - A Log normal distribution is a continuous probability distribution of a random variable whose logarithm is normally distributed. Like the Normal distribution, it is defined by a mean and a standard deviation. In pForecast, these two parameters are calculated from a provided low value (10% probability of non-exceedance), and a provided high value (90% probability of non-exceedance). The mean is 0.5 multiplied with the natural logarithm of the product between the low and high value, while the standard deviation is 0.39 multiplied with the natural logarithm of the quotient of the high value and the low value. Note that for this distribution the provided mid value is not used; it should however not deviate too much from the calculated mean.

Uniform - A Uniform distribution is a continuous probability distribution that defines an arbitrary outcome that lies between certain bounds. In pForecast, these bounds are defined by subtracting one eighth of the difference between the provided high (90% probability of non-exceedance) value and the low (10% probability of non-exceedance) value from the lower value and adding one eighth to the high value. Note that for this distribution the provided mid value is not used; it should however not deviate too much from the average of the high and low values.

Triangular (P0, P100) - The Triangular distribution is a continuous probability distribution with lower limit, upper limit and mode. There are two variants of the Triangular distribution in pForecast. In this variant, the three defining parameters are given by the provided low/P0 value (the actual lower limit), the provided high/P100 value (the actual upper limit), and the mid value that is used either as a most likely value (mode) or an expected value.

3.2.1.2. Fraction Resources

The fraction resources profile type (Fractions vs delta month) is very similar to the delta monthly profile type. The values you provide per month represent the proportion of the resource volume. Typically, the sum of all your fraction monthly values should add up to one. If this condition is met, the entire resource volume will be produced during the specified relative months.

Example: let's say you have a resource of one million Sm^3 . Normally it would take 400 months to produce this resource, however, for the sake of simplicity, let's assume that the total production time is five months. In that case, the five production fractions could be: [0.3, 0.3,

0.2, 0.1, 0.1]. That will give a production volume per month of [300.000, 300.000, 200.000, 100.000, 100.000]. So far, this is quite straightforward. This input could also work fine if we change our resource to 900.000 Sm³. In that case we would get another scale on our production, only by changing the resource value: [270.000, 270.000, 180.000, 90.000, 90.000]. In many cases you want to do this, because the shape of your profile remains the same for many resource volumes. pForecast requires input about how much the resources will decrease over time. This is given in a separate Excel sheet containing resource values versus time. This could for example mean that if the well starts producing in 2027 the resource will be one million Sm³, but if it starts producing in 2035, the resource will be 900.000 Sm³. By giving this in the “VsTime” Excel sheet, pForecast will interpolate the resource volumes in the years between. The same monthly fraction values will be used regardless of the resource volume which is dependent on the production start time.

3.2.2. Forecast Wells

The user can create, edit, and delete forecast wells by selecting the “Forecast well” tab. A list of forecast wells is presented. It is worth mentioning that when the production potential for a well is uploaded for the first time, a new forecast well will automatically be created and appear under the tab “Forecast Well.” The list shows the name, whether this well is already in operation (or whether it is a drilling target), and the facility the forecast well belongs to. It is also shown how many times the forecast well is used in scenarios and the dates for the creation and last modification of the forecast well.

After clicking on the “Forecast well” tab, the user should click the pen icon to enter the menu to configure the forecast well. A unique name for the well should be given. The well should be linked to a facility. The production efficiency of the well typically depends on which facility the well is connected to. The default set is used if the well is not connected to any facility. Users can specify production efficiency forecasts for all facilities and the default set. It is also possible to override the production efficiency for a particular well by choosing a specific production efficiency forecast for the well. A forecast well that is in operation is typically linked to a wellbore. The production history is taken from the given wellbore. No history is included if the well is not linked to any wellbore. The forecast well can also be linked to a cluster. A cluster is a group of wells that share the same capacity, and this capacity limit may constrain the well. Another option is to link a well to a voidage group. The voidage groups are used for calculating injection requirements. No producing wells are influenced by this, but injection can be reduced according to voidage requirements. The well can also be linked to an uncertainty group. It is also possible to assign the well a tag per reporting scheme. See Figure 3.6 for more details.

Forecast Properties

WELLS IN OPERATION & DRILLING TARGETS

NAME	TYPE	IN OP.	FACILITY	#	CR	MODIFIED
A1						

Created: 29.05.2021 02:44 (Erik Norrud Pollen). Modified: 26.04.2022 15:12 (Shirin Safarzadeh)

General

Forecast well name * A1

Well type: Producer Is in operation

Facility: FPSO Archimedes

Wellbore: A1

Cluster: Template Alpha

Reservoir simulation well: <none>

Voidage group: <none>

Uncertainty group: <none>

Field: <none>

Ownership group: Main fields (Darcy and Arps)

PE forecast: PE 4 wells only Clu... Use PE exclusively

Tagging

Project status: C0

Well status: Existing

Field Layout: Alpha

Business Plan Project Name: Darcy

Wells: A1

RNB: <not used>

Production

Production profile: A1

Buttons: Cancel, Update well

- Assign well to its production facility.
- Connect to historic production profile.
- Assign well to its Cluster.
- Assign well to ownership group.
- Import properties (including tagging) of forecast wells from Excel.
- Connect to the well's forecasted production profile.
- Assign a well-specific production efficiency.
- Assign the well to a defined voidage group.
- Assign the well to a defined Uncertainty group to correlate its production to other wells.
- Save your work.

Figure 3.6: Configuration of forecast wells.

3.2.2.1. Injectors Wells

Under the “Forecast well” tab, injector wells can also be created, and provided a target rate schedule for injectors.

The user must supply a start year and a start month for the injection control. The user then provides a mode for the injector. The mode can be one of the following:

- Water injection
- Gas injection
- Water Alternating Gas (WAG) injection.

Priority is given to all wells within the same cluster. If an injection constraint is exceeded, the higher priority wells are kept on injection. The target rate for water and gas are entered. If the well does not belong to a voidage group, the well is kept on the target rate if injection constraints permit it. If the well belongs to a voidage group, the target rate may be reduced to match the production level of the voidage group. If the injection mode is selected to be WAG, then the user must supply WAG duration in months. If the well injects gas, the gas formation volume factor for the injection gas (B_g) should be entered. Figure 3.7 shows more details about injector well configuration.

Forecast Properties

FORECAST **FORECAST WELLS** DRILLING PRODUCTION PROFILES PRODUCTION EFFICIENCY CAPACITY UNCERTAINTY RIG AVAILABILITY RESERVOIR SIMULATIONS

WELLS IN OPERATION & DRILLING TARGETS Delete selected items Import injection schedules Switch to property view

	+	NAME ↑	TYPE	IN OPERATION	FACILITY	USE COUNT	CREATED	MODIFIED
New forecast well								

General

Forecast well name * New forecast well Well type Injector Is in operation

Facility <none> Wellbore <none> Cluster <none>

Reservoir simulation well <none> Voidage group <none> Uncertainty group <none>

Field <none> Ownership group <default> PE forecast <none> Use PE exclusively

Tagging

Project status <not used> Well status <not used> Wells <not used> RNB <not used>

Injection schedule

+	START	MODE	PRIORITY	WATER RATE (SM ³ /D...	GAS RATE (SM ³ /DAY)	WAG DURATION (MO)	BG (RM ³ /SM ³)
---	-------	------	----------	-----------------------------------	---------------------------------	-------------------	--

Cancel Create well

- Select the "Forecast Wells" tab.
- Press the plus icon to create a new well.
- Set the well type to "Injector".
- Provide a suitable name.
- Configure the forecast well as described previously.
- Add an injection schedule using the table, or upload data using the Excel template.
- Click "Create well" to save.

Figure 3.7: Creating injector wells.

Figure 3.8 shows the available Excel template in pForecast for uploading injection schedules.

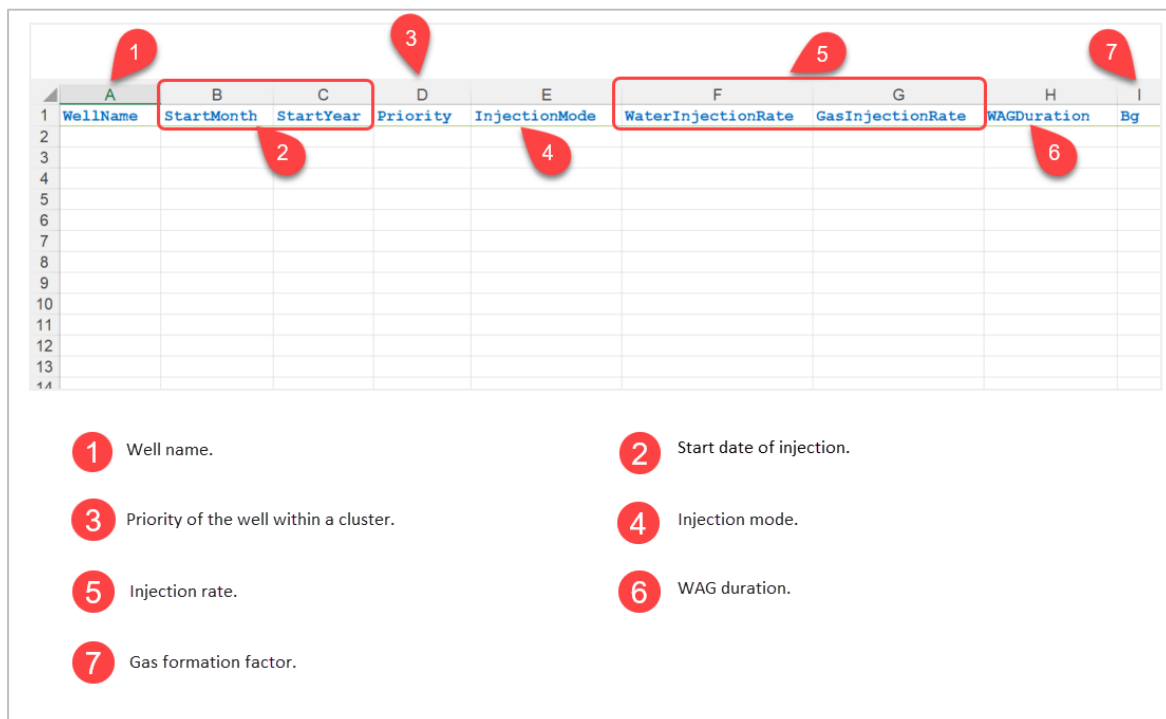


Figure 3.8: Injection schedules template.

3.2.3. Production Correlation

The well can also be linked to an uncertainty group. An uncertainty group is used to correlate the production of a collection of wells in stochastic analyses. In fact, the group's correlation factor is used to define the strength of the wells' interdependency. It is also possible to have negative dependencies (correlations). For instance, for a group of two wells, a negative correlation would mean a relationship in which one well's production increases as the other's decreases and vice versa. Figure 3.9 shows the steps toward making an uncertainty group.

ASSET: DEMO ASSET / 2Q NEWTON ASSET / PROPERTIES

FORECAST Tutorial Overview

Forecast Properties

FORECAST PRODUCTION POTENTIAL FORECAST WELLS DRILLING CAPACITY PRODUCTION EFFICIENCY PRODUCTION CORRELATION BOOST RESERVOIR SIMULATIONS

UNCERTAINTY GROUPS Delete selected items

NAME ↑	CORRELATION FACTOR	USE COUNT	CREATED	MODIFIED
New uncertainty group				
Dalton reservoir characterist...	0.50	4	31.05.2021	31.05.2021

- Under Forecast Properties, select the “Production Correlation” tab.
- Click the plus icon to create a new uncertainty group.
- Provide a suitable name for the uncertainty group.
- Select a correlation factor between -1 and 1.
- Click “Create uncertainty group” to save.

Figure 3.9: Creating uncertainty group.

After creating an uncertainty group, the user can assign production wells to the uncertainty groups under the “Forecast well” tab. The created uncertainty group will now be an option in the dropdown menu (see step 9 in Figure 3.6).

3.3. Facility Operations Input and Configuration

3.3.1. Production Efficiency

Normally, the uptime for the production facilities is close to 100%. In pForecast, in addition to most likely values for Production Efficiencies (PE), it is possible to provide upside and downside cases. Users can create, edit, and delete PE forecasts by selecting the “Production Efficiency” tab under the forecast menu. A list of PE forecasts is presented. The list shows the name and the facility the PE forecast belongs to. It is also shown how many times the PE forecast is used in scenarios (use count) and the dates for the creation and last modification of the PE forecast. Figure 3.10 illustrates how to upload the PE forecast from an Excel file.

PE uncertainty Boost

Distribution type: Triangular (P10, P90) | Use PE values as: Most likely | Boost factor schedule: <none>

PE values

Chart Table

YEARLY VALUES

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
PE				95	95	95	95	95	95	95						
PE Low				87	87	87	87	87	87	87						
PE High				99	99	99	99	99	99	99						

MONTHLY VALUES

	08.2021	09.2021	10.2021	11.2021	12.2021	01.2022	02.2022	03.2022	04.2022	05.2022	06.2022	07.2021
PE	95	96	95	95	95	95	95	95	95	95	95	95
PE Low	87	87	87	87	87	87	87	87	87	87	87	87
PE High	99	99	99	99	99	99	99	99	99	99	99	99

Buttons: Cancel, Update PE forecast

- Provide mid, low and high estimates of PE values.
- Select distribution type and boost factor schedule.
- Navigate between chart and table format.
- Save your work.

Figure 3.12: Providing PE values in tabular format.

If you have previously set up a two-level hierarchical structure for a multi-facility asset at the asset level, you can control dependencies on PE (Production Efficiency) within the hierarchical facility structure. These dependencies are established for PE forecasts of child facilities in the two-level hierarchy. A correlation factor determines how the PE values of a child facility are related to the PE values of the parent facility. It is important to note that negative dependencies (correlations) are allowed. This implies a relationship in which one facility's PE increases as the other facility's PE decreases, and vice versa. Furthermore, you can specify that the PE values of the child facility will never exceed those of the parent facility under any circumstances. See Figure 3.13.

PE uncertainty

Distribution type: Triangular (P10, P90)

Use PE values as: Most likely

PE & hierarchy

Correlation with parent facility PE: 0

PE upper limited by parent facility:

PE values

Chart | Table

YEARLY VALUES

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
PE	97	97	95	95																				
PE Low	95	95	93	93																				
PE High	98	98	97	98																				

MONTHLY VALUES

	09.2022	10.2022	11.2022	12.2022	01.2023	02.2023	03.2023	04.2023	05.2023	06.2023	07.2023	08.2023	09.2023	10.2023	11.2023	12.2023	01.2024	02.2024	03.2024	04.2024				
PE																								
PE Low																								
PE High																								

Cancel | Update PE forecast

- Determine the correlation factor with parent facility PE.
- To ensure that the PE values of the child facility never exceed those of the parent facility, toggle this option on.
- Save your work.

Figure 3.13: Controlling the dependencies on PE in a hierarchical facility structure.

3.3.2. Boost Factors

Boost factors model boost production after a long shut-in of a field. After such a stop, many fields experience significant changes in water cut, gas-oil ratio, or well potential until the production stabilizes after a period of production. In order to model this, it is possible to specify a monthly boost factor in a boost factor schedule and connect this schedule to the PE forecast. Each phase rate is then multiplied by the boost factor for that phase for the year and month specified. Users can create, edit, and delete boost factors by selecting the “Boost” tab. A list of boost factor schedules is presented. The list shows the name of the boost factor. It is also shown how many times the boost factor schedule is used in scenarios and the dates for the creation and last modification of the boost factor schedule. The boost factor schedule dialog box appears when the plus icon is clicked. A unique name for the boost factor schedule should be entered. It is then possible to add, edit or delete individual boost factors from the list in the dialog box. When a new boost factor is entered, the user must supply the year and month for the boost and the boost factors for oil, gas, and water. See Figure 3.14 for more details.

1 In the forecast properties, select the Boost tab.

2 Press the plus icon.

3 Provide a suitable name.

4 Specify the year, month and phase factors and save.

5 Click "Create boost factor schedule" to save.

6 Here you may edit, delete, or copy the selected boost factor schedule.

Figure 3.14: Boost factor schedule.

3.3.3. Planned Shutdowns

In addition to PE values, planned shutdowns can also be considered. For instance, in case of scheduled shutdowns due to facility maintenance, turnarounds (TAR) can be defined, and it is possible to assign uncertainties both to the start date and the duration of these scheduled shut-ins.

In pForecast planned shutdowns can be defined either by populating the provided Excel file and uploading it, see Figure 3.15, or by manually defining the schedule, see Figure 3.16.

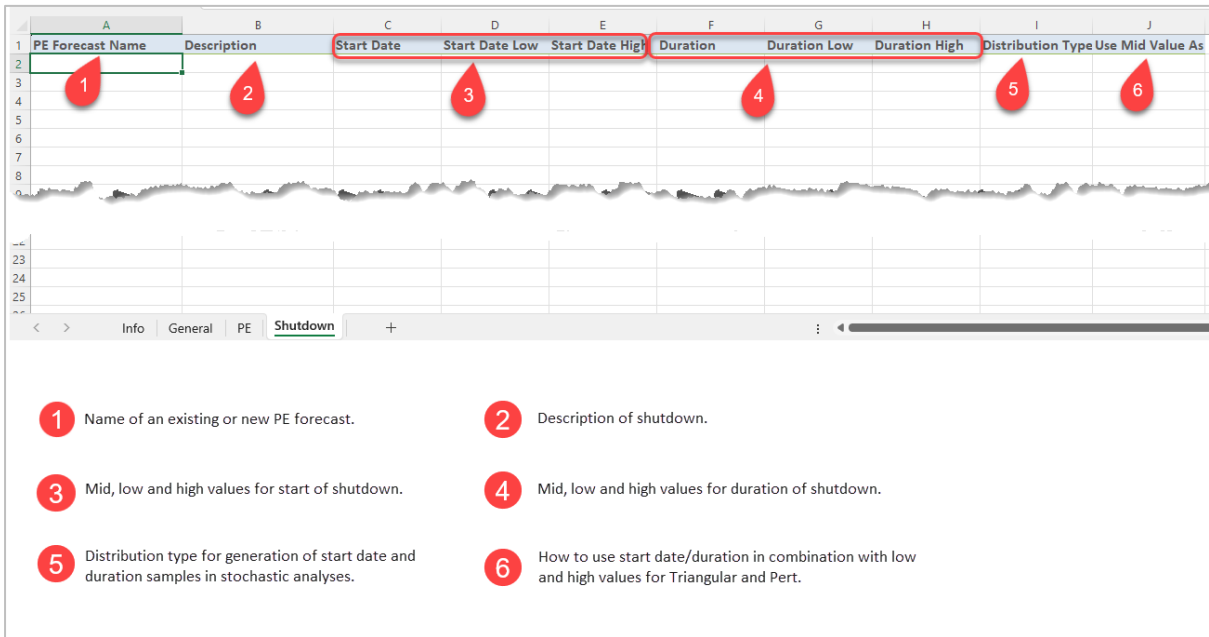


Figure 3.15: Planned shutdowns schedule template.

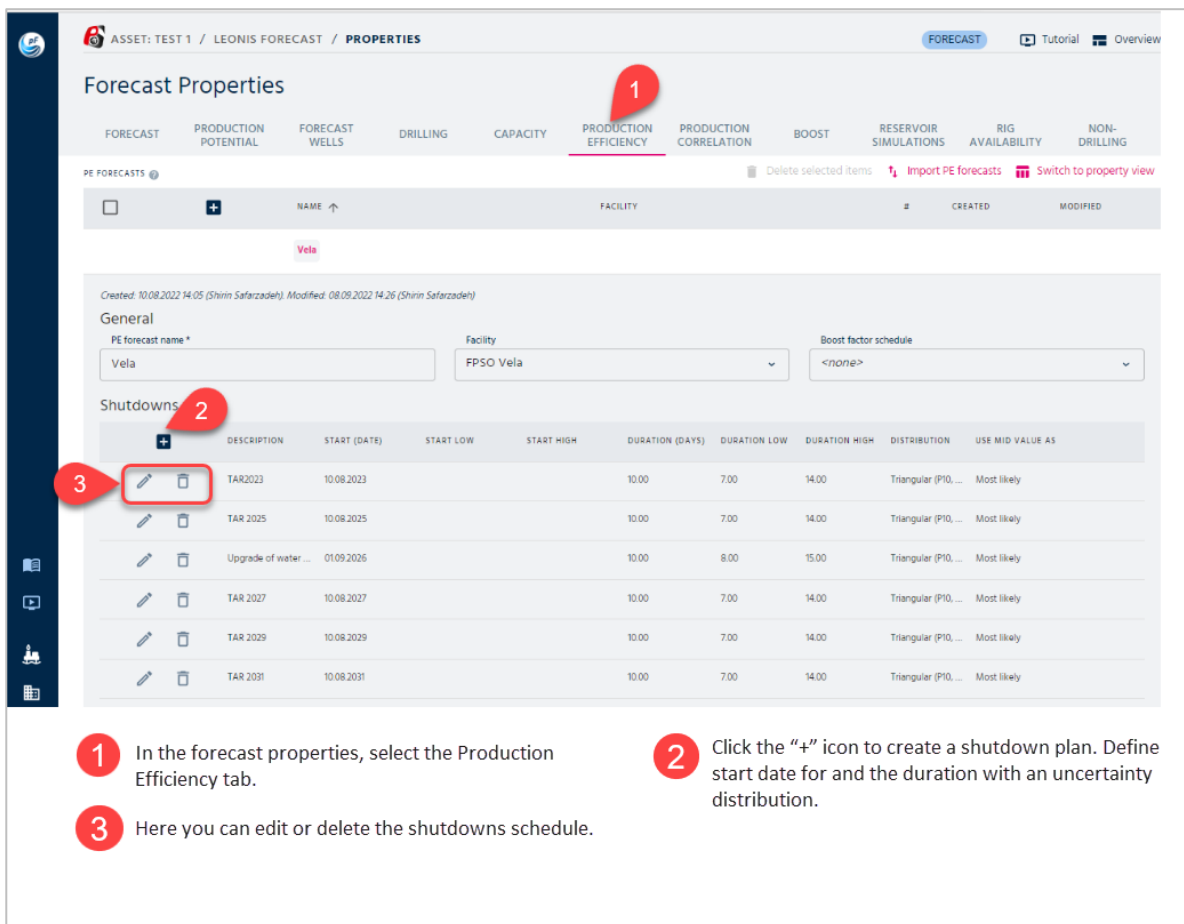


Figure 3.16: Defining planned shutdowns manually.

In a two-level facility hierarchy, a child facility's PE forecast can incorporate shutdowns from the parent facility's PE forecasts. When inheritance is enabled, you will observe potential shutdowns from the parent PE forecasts mixed with the shutdowns specific to this PE forecast. For each inheritable shutdown, you have the option to choose whether to inherit it or not. If there are multiple PE forecasts for the parent facility, the inherited shutdown descriptions will include the respective PE forecast names as prefixes.

It's important to note that inheriting a shutdown from a parent PE forecast does not activate the shutdown in a scenario unless that specific PE forecast is also included for the parent facility. In other words, you can opt to inherit shutdowns from multiple PE forecasts, and the final decision regarding activation depends on the inclusion of the respective PE forecast for the parent facility. See Figure 3.17.

General

PE forecast name *
New PE forecast

Facility: Jacob - Child facility

Boost factor schedule: <None>

Enable inheritance of shutdowns

+	DESCRIPTION	INHERIT	START (DATE)	START LOW	START HIGH	DURATION (DAYS)	DURATION LOW	DURATION HIGH	DISTRIBUTION	USE MID VALUE AS
	TAR 1		04.07.2023			10.00	7.00	14.00	Triangular (P10, ...	Most likely
	TAR2023	From parent	Yes	10.08.2023		10.00	7.00	14.00	Triangular (P10, ...	Most likely
	TAR 2025	From parent	Yes	10.08.2025		10.00	7.00	14.00	Triangular (P10, ...	Most likely
	Upgrade of water capacity	From parent	No	01.09.2026		10.00	8.00	15.00	Triangular (P10, ...	Most likely
	TAR 2027	From parent	No	10.08.2027		10.00	7.00	14.00	Triangular (P10, ...	Most likely
	TAR 2029	From parent	No	10.08.2029		10.00	7.00	14.00	Triangular (P10, ...	Most likely
	TAR 2031	From parent	No	10.08.2031		10.00	7.00	14.00	Triangular (P10, ...	Most likely

1 Select the child facility.

2 Enable this toggle to show potential shutdowns from parent PE forecasts alongside this PE forecast's shutdowns.

3 Choose whether to inherit each of the potential shutdowns or not.

Figure 3.17: Inheriting planned shutdowns from parent facility.

3.3.4. Capacity Constraints

Users can add constraints by selecting the “Capacity” tab under the forecast properties section. It is also possible to copy, edit or delete selected constraints. When the plus icon is selected, the user can create a new capacity constraint. The user must enter a name and indicate from when the constraint is valid. A constraint is valid from this point in time and onwards until a new constraint is entered. Maximum values for oil, gas, water, and liquid production are entered along with maximum values for the injection of water and gas. Regularity factors for the injection can also be entered. Figure 3.18 shows more details.

Forecast Properties

FORECAST | PRODUCTION POTENTIAL | FORECAST WELLS | DRILLING | **CAPACITY** | PRODUCTION EFFICIENCY | PRODUCTION CORRELATION | BOOST | RESERVOIR SIMULATIONS

CAPACITY CONSTRAINTS

General

Constraint name * Cluster *

Uncertainties No Yes

Valid from *

Production constraints

Oil (Sm³/stream day) Gas (Sm³/stream day) Water (Sm³/stream day) Liquid (Sm³/stream day)

Injection constraints

Gas injection (Sm³/stream day) Water injection (Sm³/stream day) Gas lift constraint

Injection regularity

Gas Water

Cancel Create constraint

Constraint after upgrade - Improved fac... FPSO Vela Sep 2026 2 08.09.2022 9.09.2022

- 1 In the forecast properties, select the Capacity tab.
- 2 Click the "+" icon to create a new set of capacity constraints.
- 3 Provide a suitable name.
- 4 Indicate the cluster that the set of constraints applies to.
- 5 Specify the month and year the set of constraints is valid from.
- 6 Provide values for production constraints in stream day rates.
- 7 Provide values for injection constraints in stream day rates.
- 8 Choose whether to include uncertainty or not.
- 9 Add values for injection regularity.
- 10 Click "Create constraint" to save.
- 11 Later, you may edit, delete, or copy the constraint.

Figure 3.18: Adding capacity constraints.

3.3.5. Separation

In a forecast, users can define separation forecasts, which provide monthly estimates for the phases' separation before routing to the next level of the cluster hierarchy. These forecasts help users understand how the phases progress and are distributed within the hierarchy, aiding in planning and decision-making. Figure 3.19 shows how to create a separation forecast.

Forecast Properties

FORECAST PRODUCTION POTENTIAL FORECAST WELLS DRILLING CAPACITY **SEPARATION** PRODUCTION EFFICIENCY PRODUCTION CORRELATION INTERVENTION JOBS INTERVENTION >

SEPARATION FORECASTS Delete selected items Import separation Switch to property view

NAME ↑ CHILD FACILITY OIL GAS WATER # CREATE MODIFIED

Heimdal

Created: 28.06.2023 13:09 (Shirin Safarzadeh), Modified: 28.06.2023 13:15 (Shirin Safarzadeh)

General

Separation forecast name * Child facility *

Heimdal Jacob

Defaults

Default oil separation (%) Default gas separation (%) Default water separation (%)

75 60

Profile Chart **Table**

	09.2022	10.2022	11.2022	12.2022	01.2023	02.2023	03.2023	04.2023	05.2023	06.2023	07.2023	08.2023	09.2023	10.2023	11.2023	12.20
Oil separation (%)					50	55	60	60	65	65	70	70	70	70		
Gas separation (%)					4	2	3	5	4	5	1					
Water separation (%)					40	50										

Update separation forecast

- In the Forecast Properties, select the Separation tab.
- Click the plus icon to create a new separation forecast.
- Provide a suitable name for the separation forecast.
- Choose the relevant child facility.
- Provide separation input data either manually or by importing an Excel file.
- Press "Create separation forecast"

Figure 3.19: Creating a separation forecast.

3.4. Drilling Input and Configuration

3.4.1. Drilling Schedules

For a forecast, the user can define a set of wells in operation and drilling targets (wells to be drilled). The two types are both referred to as forecast wells. It is worth mentioning that a forecast well is not to be confused with a physical well defined under the asset level. The latter is used to hold the production history, and an in-operation forecast well typically connects to a wellbore of a physical well in order to get the historical production over to the forecast. Figure 3.20 shows how to create the undrilled wells.

The screenshot displays the 'FORECAST WELLS' interface. At the top, there is a navigation bar with tabs: FORECAST, FORECAST WELLS (highlighted), DRILLING, PRODUCTION PROFILES, PRODUCTION EFFICIENCY, CAPACITY, UNCERTAINTY, RIG AVAILABILITY, RESERVOIR SIMULATIONS, BOOST, and NON-DRILLIN. Below the navigation bar is a table header with columns: NAME, TYPE, IN OPERATION, FACILITY, USE COUNT, CREATED, and MODIFIED. A table titled 'WELLS IN OPERATION & DRILLING TARGETS' is visible, with a '+' icon in the top left corner. Below the table is a 'New forecast well' form. The form is divided into several sections: 'General' (Forecast well name, Well type, Facility, Wellbore, Reservoir simulation well, Voidage group, Field, Ownership group, Uncertainty group, PE forecast, Use PE exclusively), 'Tagging' (Project status, Well status, Wells, RNB), 'Production' (Production profile), and 'Drilling' (Drilling time, Hookup time, Distribution type, Use drilling time as, Low drilling time, High drilling time). At the bottom right of the form are 'Cancel' and 'Create well' buttons. Red callout boxes with numbers 1 through 6 are overlaid on the interface to indicate the steps for creating a well.

- 1 Select the Forecast Wells tab.
- 2 Click the "+" icon to create a new forecast well.
- 3 Set the "Is in operation" toggle to off.
- 4 Configure the forecast well as described previously.
- 5 Insert drilling time (in days) with uncertainty, and the hookup time.
- 6 Click "Create well" to save.

Figure 3.20: Creating a well to be drilled.

The next step is to set up drilling schedules. The list under the "Drilling" tab shows the name of the drilling schedule and which facility it belongs to. It is also shown how many times the drilling schedule is used in scenarios and the dates for the creation and last modification of the drilling schedule. A drilling schedule can be created, and the selected drilling schedule can be copied, edited, or deleted. A unique name should be entered for each drilling schedule. A description can also be given. The drilling schedule can be linked to a facility. If it is linked to a given facility, only wells from that facility can be included in the drilling schedule. The start date of the drilling schedule must be provided. In addition, the user can specify a rig availability schedule. A rig availability schedule is a forecast of how much time the rig is used for drilling. This factor is given as a yearly efficiency factor. Non-drilling periods can also be specified. These are planned periods when the rig is not drilling. These periods are provided with a fixed start date and duration, including uncertainties. Finally, the sequence of wells on the drilling schedule is shown in a list. Wells can be added or removed from the list. A selected well can be easily moved up or down in the sequence. Figure 3.21 shows how to create a drilling schedule.

ASSET: DEMO ASSET / TEST / PROPERTIES

FORECAST PRODUCTION POTENTIAL FORECAST WELLS **DRILLING** CAPACITY SEPARATION PRODUCTION EFFICIENCY PRODUCTION CORRELATION INTERVENTION INT >

DRILLING SCHEDULES Delete selected items Import drilling Switch to property view

DRILLING SCHEDULES

NAME ↑	FACILITY	USE COUNT	CREATED	MODIFIED
Alliance Drilling		2	30.05.2021	04.11.2021

General

Drilling schedule name *

Description

Facility *

Drilling

Start date *

Drilling time scaling factor

Rig availability forecast

Non-drilling schedule

Sequence

ORDER	NAME	TYPE	FACILITY
-------	------	------	----------

- Under Forecast Properties, select the "Drilling" tab.
- Click the "+" icon to create a new drilling schedule.
- Provide a suitable name and description.
- Set the start date for the drilling schedule.
- Enter rig availability and non-drilling schedule.
- Specify the relevant facility.
- Click the "+" icon to add wells to the drilling schedule.
- Save your work.
- Here you may edit, delete, or copy the selected schedule.
- It is also possible to import drilling schedule through Excel file.

Figure 3.21: Creating a drilling schedule.

3.4.2. Rig Availability Configuration

Normally, the rig cannot be utilized for drilling the entire time it is in operation. Maintenance on the rig itself and other activities on the platform may prevent drilling operations. These activities are either planned or unplanned. In pForecast, unplanned periods without drilling are entered as rig availability. While planned work can be entered as non-drilling periods with fixed start times and uncertain duration. Let us first look at unplanned periods. A rig availability factor is an expression of how much a drilling rig is used for drilling wells. The rig availability is entered as a percentage on an annual basis and influences the drilling schedule performance. Selecting the "Rig Availability" tab presents a list of rig availabilities. The list shows the name and the facility the rig availability belongs to. It is also shown how many times the rig availability is used in scenarios (use count) and the dates for the creation and last modification of the rig availability. Rig availability can be created, and the selected rig availability can be copied, edited, or deleted. The rig availability form appears when the plus icon is clicked. A unique name should be entered, and a facility to link to. The rig availability for each year is entered in the table as a percentage. If no rig availability is given, pForecast assumes it to be 100%. See Figure 3.22 for more details.

ASSET: TEST 1 / LEONIS FORECAST / PROPERTIES

FORECAST Tutorial Overview

Forecast Properties

FORECAST WELLS DRILLING CAPACITY PRODUCTION EFFICIENCY PRODUCTION CORRELATION BOOST RESERVOIR SIMULATIONS **RIG AVAILABILITY** NON-DRILLING

RIG AVAILABILITY FORECASTS Delete selected items

+ NAME ↑ FACILITY # CREATED MODIFIED

New rig availability

General

Rig availability forecast name* Facility*

New rig availability

Yearly availability (%)

DECADE	#0	#1	#2	#3	#4	#5	#6	#7	#8	#9
2010-2019										
2020-2029										
2030-2039										

Cancel Create rig availability forecast

Polaris Rig availability FPSO Vela 0 10.08.2022 10.08.2022

1 In the forecast properties, select the Rig Availability tab.

2 Click the "+" icon to create a new rig availability plan.

3 Provide a suitable name.

4 Select the facility the rig availability belongs to.

5 Enter the rig availability as percentage per year.

6 Save your work.

7 Here you may edit, delete or copy the selected schedule.

Figure 3.22: Rig availability configuration.

3.4.3. Non-Drilling Configuration

On the other hand, planned periods when no drilling takes place are modeled as non-drilling periods in the pForecast software. Typical examples are plant maintenance stops, major rig upgrades, or when the license owner has decided not to drill wells for an extended period. A non-drilling period is assumed to have a fixed start point in time. The stop duration is given alongside low and high estimates for the duration. The user can create, edit, and delete the non-drilling schedule by selecting the "Non-drilling" tab. A list of non-drilling schedules is presented. The list shows the name of the schedule. It also shows how many times the schedule is used in scenarios and the dates for the creation and last modification. The non-drilling schedule form appears when the plus icon is clicked. The user should enter a unique name, description, fixed start date, and duration. The duration is entered together with low and high estimates. If the distribution type is set on triangular, the value of the duration can be assumed either as expected or as the most likely value. See Figure 3.23 for more details.

1 In the forecast properties, select the Non-Drilling tab.

2 Click the "+" icon to create a new non-drilling schedule.

3 Provide a suitable name.

4 Provide a description, start date and duration with uncertainty.

5 Click "Create non-drilling schedule" to save.

6 Here you may edit, delete or copy the selected schedule.

Figure 3.23: Non-drilling schedule configuration.

3.5. Intervention Input and Configuration

A well intervention is an operation that is performed on the well during its operational lifetime. The objective for performing a well intervention is to perform maintenance on installed equipment, improve the well performance, improve the well integrity, or acquire data about the well or near-well area.

After it has been determined when the intervention job initiates and how long it lasts, we want to model the production increase. A production increment is added to the well's initial production potential. The model accounts for uncertainty related to both the base production and the increment. These are assumed to be independent draws. For reference, typical impacts of successful interventions are one or more of the following events:

- Higher oil rates
- Lower water rates or reduced water-cut
- Higher or lower gas rates
- No change (maintenance)

The impact of well interventions can be significant for a field or an asset and should therefore be reflected in its production forecast. It is common for oil companies to perform a significant number of well interventions.

An intervention operation impacts the well's production:

- a) The well's production is temporarily shut in during the operation.
- b) The well's performance can be improved as a result of the operation.

This is illustrated in the Figure 3.24 below, showing the concept of well intervention for one selected well in the deterministic model with a positive increment after the shut-in.

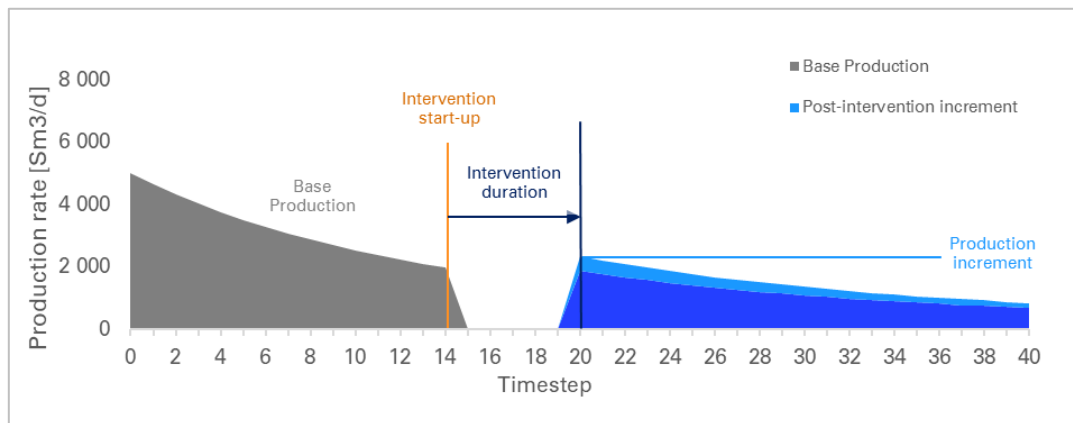


Figure 3.24 Intervention operation with production increment.

As the figure illustrates, the well has an initial base production potential. The well is shut-in temporarily for the intervention operation. When the well starts producing again, it continues producing its initial base production potential, plus an incremental production potential. The key uncertainties are related to timing of the production shut-in and the size of the incremental production potential.

The timing of the production shut-in is primarily decided by the well intervention schedule, which is described in further detail in Chapter 3.5.2. The key uncertainty driver for the timing of production shut-ins is the duration of the intervention and schedule dependencies. Figure 3.25 illustrates how the stochastic model includes uncertainty on both timing and the size of the production increment.

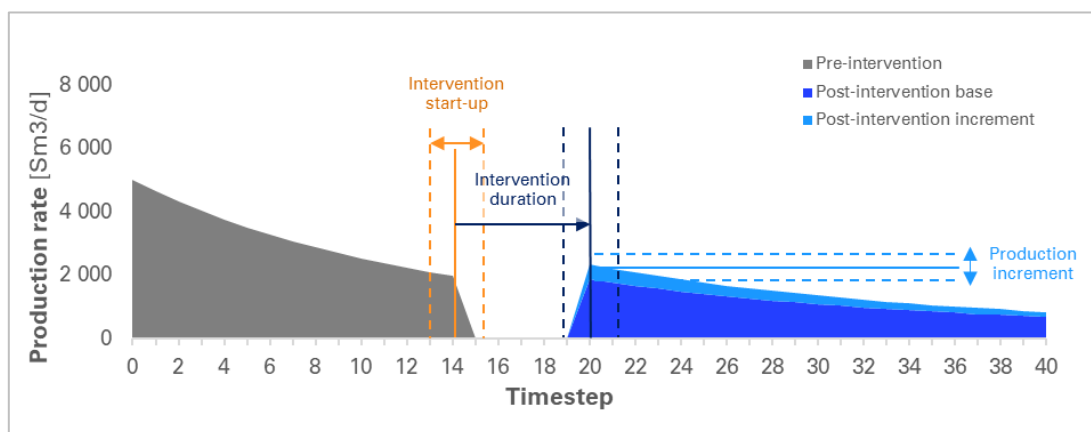


Figure 3.25 Intervention operation including uncertainties.

The improvement in the well's production potential following an intervention operation is represented as an incremental production profile. The well's resulting production potential thereby includes both its initial base production potential and an incremental production potential. Both types of production potential are prone to uncertainty and the incremental potential can be both positive and negative values. See illustrations in Figure 3.25.

Similarly, if an intervention is performed on an injection well, the resulting injection profile should consist of an initial base injection and an incremental injection.

If no incremental production or injection are provided, the increment can be assumed to be zero and the resulting profile equals the initial base profile. This is, for instance, applicable for maintenance interventions.

Running a stochastic analysis with 30 runs, Figure 3.26 shows the realizations for a selected well. Each individual run is created from a random draw according to the uncertainty settings for the intervention job on the well. Bear in mind that the result may also be affected by uncertainties applied to the previous wells in the schedule.

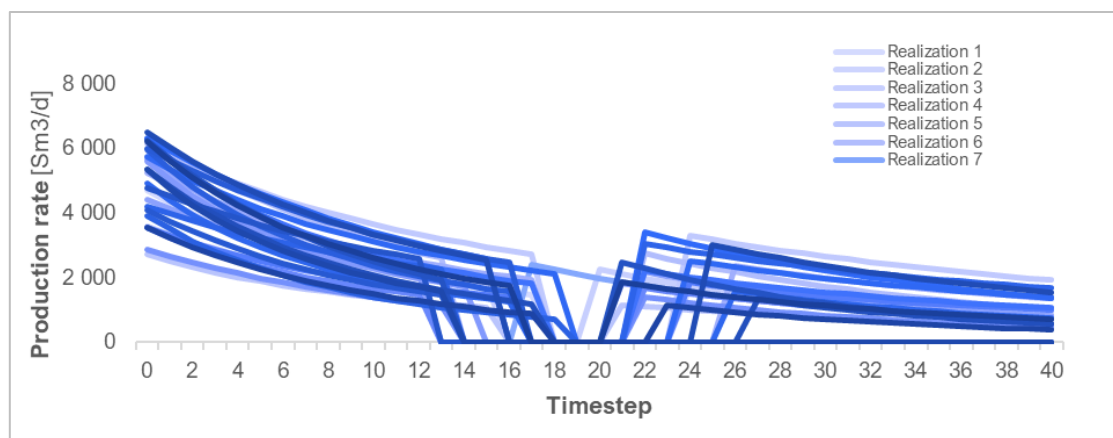


Figure 3.26 Intervention operation uncertainties with 30 runs.

In pForecast’s result viewer, stochastic results are presented with percentiles as depicted in Figure 3.27 below. In this figure we have shown a selection with three percentiles. In chapter 5.3.3. more choices are available for viewing stochastic results from intervention operations.

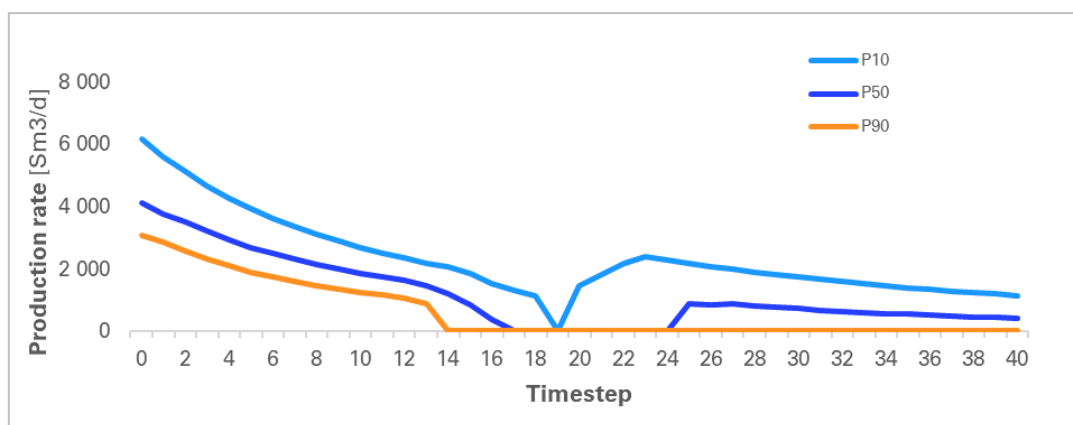


Figure 3.27 Intervention operation with percentile results.

You can effectively do quality assurance on the impact of intervention campaigns by running scenarios with and without interventions and then compare the results. (Chapter 5.1.3).

In addition to the wells being intervened, nearby wells, or offset wells, may be temporarily shut in during the operation. These shut-ins are also reflected in pForecast’s production forecasts.

3.5.1. Intervention Jobs

The intervention functionality in pForecast adds an opportunity to control timing of well interventions, including schedule dependencies between wells, intervention job durations and temporary shut-in of wells.

The following assumptions are made for the intervention scheduling functionality in pForecast:

- An intervention crew follows a schedule.
- One well is intervened at a time, per crew.
- The duration of an intervention job is uncertain.
- Once a well intervention job is completed, another job initiates.
- There can be multiple intervention crews working in parallel on the same asset.

For reference, the duration of a typical well intervention ranges from between 3 to 60 days. Figure 3.28 shows how to define one intervention job. The duration of an intervention job is a property of the intervention job and independent of when in the intervention schedule it occurs.

A forecast well can have multiple interventions in its forecast period, but it is not common practice. pForecast offers an opportunity to test different intervention schedules quickly, i.e., you can define multiple schedules on the forecast level and then include various combinations of these in different scenarios of the forecast.

During execution of a well intervention, the intervened well's production (or injection) is shut in. For some jobs, the well is shut in in advance of the operation (pre-job shut-in). Production/injection starts up again after the intervention is completed, plus a "hook-up time" or "time to restart production" (post-job shut-in).

Forecast Properties

SEPARATION | PRODUCTION EFFICIENCY | PRODUCTION CORRELATION | **INTERVENTION JOBS** | INTERVENTION | BOOST | RESERVOIR SIMULATIONS | RIG AVAILABILITY | NON-DRILLING

INTERVENTION JOBS

Intervention job name * Intervened well

Durations

Job duration (days) * Low duration (days) High duration (days)

Pre-job shut-in (days) Post-job shut-in (days)

Duration distribution type Use duration as

Offset wells shut in during intervention

Cancel **Create intervention job**

- Under Forecast Properties, select the "Intervention Jobs" tab.
- Click the "+" icon to create a new intervention job.
- Provide a suitable name and description.
- Select the intervened well.
- Define duration for the job, and optionally include low and high values as well as any pre- or post-job shut-ins.
- If low and high values are specified, select a distribution type.
- Once non-optional settings are specified, you may save your work.
- Additional settings will be explained with new figures.

Figure 3.28 Defining an intervention job.

During execution of certain intervention jobs, production may be shut in on one or more nearby wells too, so called offset wells. The offset wells are not impacted by pre-job shut-ins and post-job shut-ins. The input for offset wells are illustrated in Figure 3.29

General

Intervention job name *
Spring24 Gamma Ursae Subsea upgrade

Intervened well ①
C1

Durations

Job duration (days) * ②: 25
Low duration (days) ②: 15
High duration (days) ②: 32
Duration distribution type ②: Triangular (P10, P90)
Use duration as ②: Expected

Pre-job shut-in (days) ②: 1
Post-job shut-in (days) ②: 2

Offset wells shut in during intervention

NAME	TYPE	FACILITY
E2 ③	Producer	FPSO Vela
E1	Producer	FPSO Vela

① For the intervention job on well C1, you may add one or more offset wells to be shut in together with C1.
② Select an additional well to be shut in during the intervention job. The type of well and any associated facility will be shown.
③ Make sure to save the selected offset well.

Figure 3.29 Including offset wells for an intervention job.

Each offset well has a set of properties that you may view and edit once you have added it to your intervention job's list. Please note that if you change any values in the dialog window that appears, this will impact the characteristics for this well for all scenarios in this forecast.

E1

Created: 07.09.2023 12:40 (Hilde Martinussen); Modified: 07.09.2023 12:42 (Hilde Martinussen)

General

Forecast well name *
E1

Well type
Producer

Is in operation

Facility
FPSO Vela

Wellbore
<none>

Cluster
<none>

Reservoir simulation well
<none>

Voidage group
<none>

Uncertainty group
<none>

Field
<none>

Ownership group
<default>

Well-specific PE forecast
<none>

Use PE exclusively

Tagging

Project status
C2F

Well status
New

Field Layout
Templa...

Voidage
<not us...>

Wells
E1

Asset Layout
<not us...>

Well Status & Project
<not us...>

Production

Production profile
E1

Drilling

Drilling time (days) *
35

Hookup time (days) *
15

Low drilling time
29

High drilling time
45

Distribution type *
Triangul...

Use drilling time as
Most lik...

Cancel Update well

Figure 3.30 Properties of an offset well.

For a job that is an intervention on a producer well, a production increment profile can be specified in order to model the incremental effect of the intervention on the production.

This profile is added to the base production profile for the well, starting from the production restart date given by the job end date and possibly a post-job shut-in.

pForecast supports two types of production increment profiles:

- Stream day rate vs delta month – Incremental potentials and gas lift rates given for a range of months relative to production restart.
- Decline curve – Incremental potentials given as an Arps formula decline curve with production restart as initial time.

Both types of increment profiles can be specified with uncertainty, i.e. with up to three values (low, mid/deterministic, and high) per parameter to be combined with a provided distribution type to create samples for the profile when performing a stochastic analysis.

3.5.1.1. Stream day rate vs delta month

You can see the details of a “Stream day rate vs delta month” increment profile in either chart or table form. The window opens by default showing the profile details as a chart. This is illustrated in Figure 3.31.

If the input data ranges over many months, it is most convenient to add input for the intervention profile through importing the data, something which is described in chapter 3.5.3.

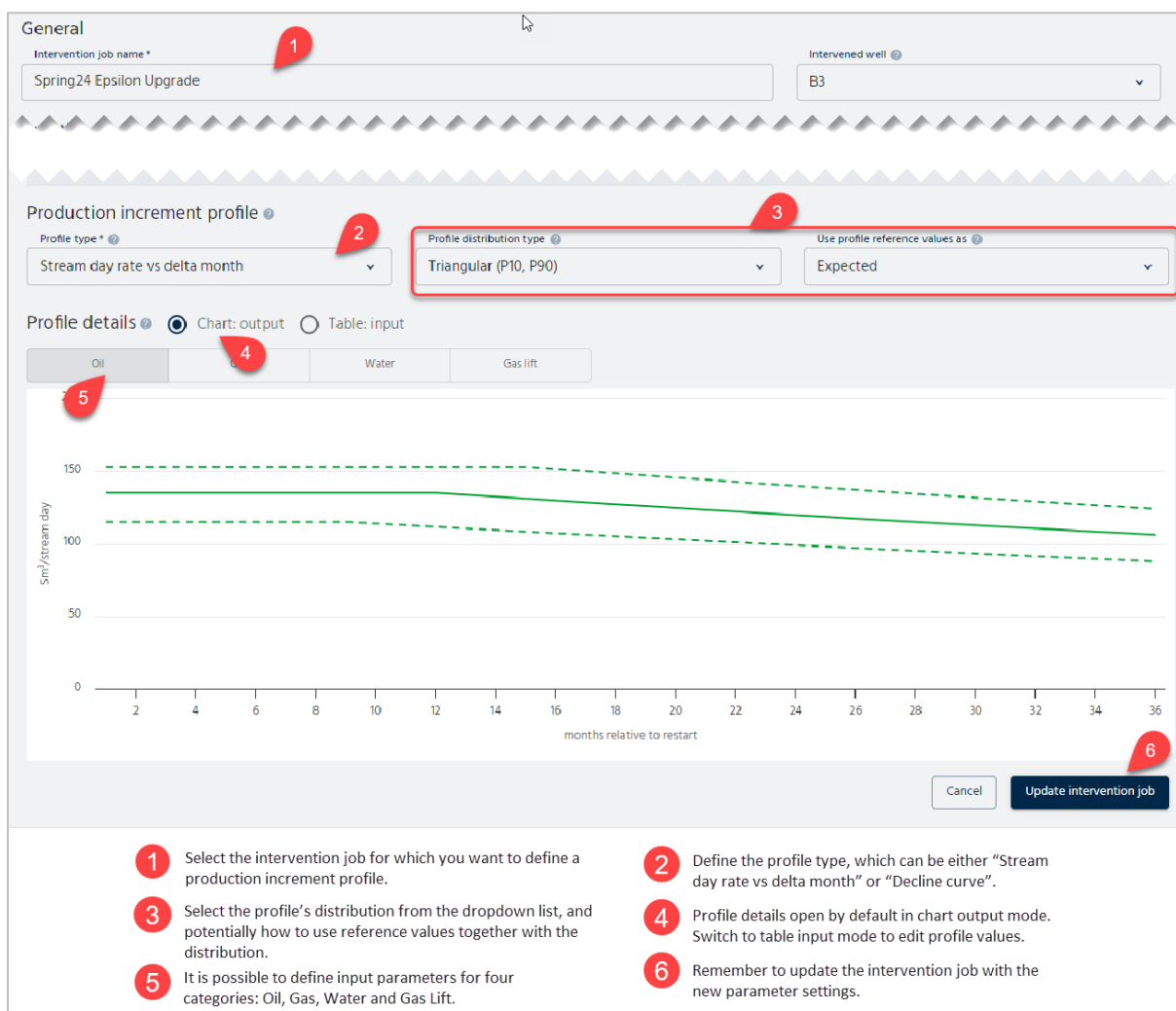


Figure 3.31 Parameters for the profile details “Stream day rate vs delta month”.

3.5.1.2. Decline curve

You can see the details of a decline curve increment profile in either chart or table form. The window opens by default showing the profile details as a chart. This is illustrated in Figure 3.32.

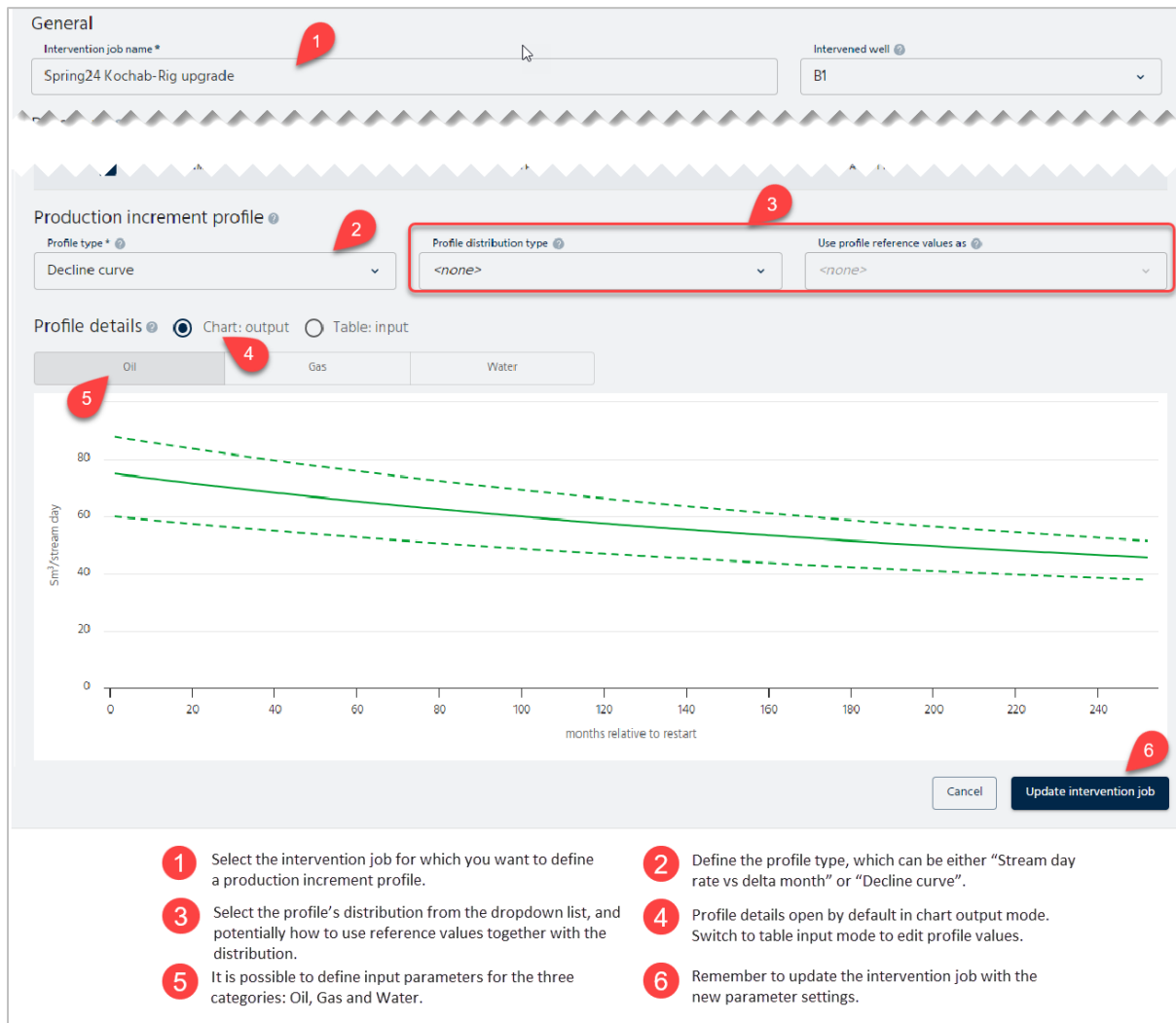


Figure 3.32 Parameters for the profile details for "Decline curve".

Decline curve increment profiles are given by Arps formula. In the table input, you may add values for the following parameters:

- Initial rate, initial (nominal) decline and hyperbolic exponent (B factor) for the oil phase given by three values, one low value, one mid/deterministic value and one high value.
- For the gas phase, it is GOR times oil rate.
- And for the water phase, it is liquid minus oil rate.

For a decline curve you may check the resulting curves visually before submitting them, by switching to the chart output view. The table input is illustrated in Figure 3.33.

Profile details Chart: output Table: input

	VALUE
Initial rate low	Sm ³ /stream day
Initial rate *	Sm ³ /stream day
Initial rate high	Sm ³ /stream day
Initial decline low	fraction 1/year
Initial decline *	fraction 1/year
Initial decline high	fraction 1/year
B factor low	unitless
B factor *	unitless
B factor high	unitless
Liquid rate	Sm ³ /stream day
Gas-oil-ratio (GOR)	Sm ³ /Sm ³

Decline profiles in pForecast are given by the Arps formula:

$$q_t = q_i (1 + bD_f)^{-1/b}$$

- q_t = Rate at time t
- q_i = Initial rate
- D_f = Initial (nominal) decline
- b = Hyperbolic exponent (degree of curvature, B factor)

In the table to the left, you can edit the set of parameters (initial rate, initial decline and B factor) of three different decline curves corresponding to a high, a mid/deterministic and a low case for the oil phase. The gas phase is GOR times oil rate, while the water phase is liquid rate minus oil rate.

Note that you can check the resulting curves visually before submitting by switching to the chart output view.

- Select table input mode to define the parameters of the decline curve increment profile.
- The Arps formula is used by pForecast to calculate a decline curve profile.
- Enter the parameters for oil phase, potentially with high and low cases, and provide GOR and liquid rate to determine the gas and water phases
- Remember to update the intervention job with the new parameter settings.

Figure 3.33 Table input for decline curve increment profiles.

There can also be slots in the intervention schedule that are not related to work on a producing or injecting well, so-called non-intervention activities. Examples of these are moving of crews and interventions on non-producing wells, e.g. plug and abandonment, rigging equipment and maintenance campaigns. Such slots will be defined as a job that is not connected to any well. An example of a non-intervention activity can be found in Figure 3.34.

PRODUCTION EFFICIENCY PRODUCTION CORRELATION **INTERVENTION JOBS** INTERVENTION BOOST RESERVOIR SIMULATIONS RIG AVAILABILITY NON-DRILLING

INTERVENTION JOBS

<input type="checkbox"/>	<input type="button" value="+"/> NAME ↑	INTERVENED WELL	DURATION	#	CREATED	MODIFIED
New intervention job						
<div> <p>General</p> <p>Intervention job name * <input type="text" value="Spring24 Lambda Minoris - move crew"/> Intervened well <input type="text" value="<none>"/></p> <p>Durations</p> <p>Job duration (days) * <input type="text" value="4"/> Low duration (days) <input type="text" value="3"/> High duration (days) <input type="text" value="6"/></p> <p>Duration distribution type <input type="text" value="Normal"/> Use duration as <input type="text" value="<none>"/></p> <p style="text-align: right;"><input type="button" value="Cancel"/> <input type="button" value="Create intervention job"/></p> </div>						
<input type="checkbox"/>	<input type="button" value="edit"/> <input type="button" value="trash"/> <input type="button" value="add"/>	Spring24 Delta Ursae	C2	22 days	1	07.12.2023
<input type="checkbox"/>	<input type="button" value="edit"/> <input type="button" value="trash"/> <input type="button" value="add"/>	Spring24 Epsilon Upgrade	B3	10 days	0	18.12.2023
<input type="checkbox"/>	<input type="button" value="edit"/> <input type="button" value="trash"/> <input type="button" value="add"/>	Spring24 Eta Ursae	B2	15 days	1	07.12.2023

- Give the non-intervention job a name.
- Leave the intervened well at "<none>", which indicates that this is a non-intervention job.
- For non-intervention jobs, these five parameters are the only ones that need to be defined.
- Save the non-intervention job.

Figure 3.34 Non-intervention activity added as part of an intervention project.

To view all the defined input parameters in a more compact way, you may switch to property view mode using the button just above the list of defined intervention jobs. This view is illustrated in Figure 3.35.

Forecast Properties

PRODUCTION EFFICIENCY | PRODUCTION CORRELATION | **INTERVENTION JOBS** | INTERVENTION | BOOST | RESERVOIR SIMULATIONS | RIG AVAILABILITY | NON-DRILLING

SELECT A PROPERTY: <All> 1 Switch to full view

INTERVENTION JOB	INTERVENED WELL	JOB DURATION (DA...)	LOW DURATION (DA...)	HIGH DURATION (D...)	DURATION DISTRIB... DURATION DISTRIB...	USE DURATION AS	PRE-JOB SHUT-IN ...	POST-JOB SHUT-IN...
Spring24 Delt...	C2	22	19	27	Triangular (P10, P...	Expected	2	1
Spring24 Epsl...	B3	10	9	11	Normal	<none>	0	0
Spring24 Eta ...	B2	15	9	21	Normal	Expected	1	1
Spring24 Gam...	C1	25	15	32	Triangular (P10, P...	Expected	1	2
Spring24 Koch...	B1	13	10	16	Triangular (P10, P...	Expected	2	3
Spring24 Min...	C3	22	18	25	Triangular (P10, P...	Expected	1	2

1 Switch between property view and full view. 2 Select which property to look at in detail, here "All" is selected.

3 List of all intervention jobs defined.

Figure 3.35 Intervention jobs shown in property view mode.

For the following three parameters you can view and control the selections in a detailed radio-button-based view:

- Intervened well
- Duration distribution
- Use duration as

We have selected the "Intervened well" property in the example shown in Figure 3.36, and this gives us an easy overview of which intervened well is connected to which job. The view also allows you to change a connection if it turns out to be incorrect. For the intervention job in question, simply click on the radio button corresponding to the new well.

SELECT A PROPERTY Intervened well Switch to full view

INTERVENTION JOB	CURRENT VALUE	B1	B2	B3	B4	C1	C2	C3
Spring24 Delt...	C2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Spring24 Epsll...	B3	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Eta U...	B2	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Gam...	C1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Koch...	B1	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Mino...	C3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

1 Select a property to view details for, here "Intervened well" is chosen.

2 Click the radio button for a well in the header to quickly set the well as intervened well for all intervention jobs.

3 See which well each intervention job is currently connected to.

4 Assume that all jobs are properly connected to intervened wells. If not, click another well's radio button to connect to this well.

Figure 3.36 Connections between intervention jobs and intervened wells.

In the same way you may see an overview of 'Duration distribution', as shown in Figure 3.37 and 'Use duration as', as shown in Figure 3.38.

SELECT A PROPERTY Duration distribution Switch to full view

INTERVENTION JOB	CURRENT VALUE	<NONE>	TRIANGULAR (P10, P90)	NORMAL	PERT	LOG NORMAL	UNIFORM	TRIANGULAR (P0, P100)
Spring24 Delt...	Triangular (P10, P90)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Epsll...	Normal	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Eta U...	Normal	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Gam...	Triangular (P10, P90)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Koch...	Triangular (P10, P90)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Lam...	Normal	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1 Select a property to view details for, here "Duration distribution" is chosen.

2 Click the radio button for a distribution in the header to quickly set the distribution for all intervention jobs.

3 See which type of distribution each intervention job is currently set up with.

4 Click another distribution's radio button to change the setting for the selected intervention job.

Figure 3.37 Setup of "Duration distribution" property for each intervention job.

SELECT A PROPERTY Use duration as 1 Switch to full view

INTERVENTION JOB	CURRENT VALUE	<input type="radio"/> <NONE>	<input type="radio"/> EXPECTED	<input type="radio"/> MOST LIKELY
Spring24 Delta Ursae	Expected	<input type="radio"/>	<input checked="" type="radio"/> 3	<input type="radio"/> 4
Spring24 Epsilon Upgrade	<none>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spring24 Eta Ursae	Expected	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Spring24 Garkha Ursae Sube...	Expected	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Spring24 Kochab-Rlg upgrade	Expected	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Spring24 Lambda Minoris - 1s...	<none>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

1 Select a property to view details for, here "Use duration as" is chosen.

2 Click the radio button for a distribution reference value type in the header to quickly set the type for all intervention jobs

3 See which type of duration each intervention job is currently set up with.

4 Click another distribution reference value type's radio button to change the setting for the selected intervention job.

Figure 3.38 Setup of "Use duration as" property for each intervention job.

The set of intervention jobs for a forecast may be imported through pre-made Excel templates, see chapter 3.5.3. This is particularly useful in cases with extensive job lists.

3.5.2. Intervention Schedules

The well intervention schedule reflects the timing of the actual intervention operations. In addition to shutting in the well for the operation, a well may be shut in some time in advance of the operation (pre-job shut-in) and remain shut in for some time after the operation (post-job shut-in).

There may be uncertainty in the start date of an intervention job; this is related to the job being part of a schedule. For the end date we have uncertainty related to the schedule but also to the duration of the job. We may also add idle slots (non-intervention jobs) in the schedule, modeling for example moving of crews and other operations taking time but not being an intervention job per se.

The background and assumptions for modeling schedule dependencies and temporary production shut-ins in pForecast is as follows:

An intervention job is always executed within a schedule. The time it takes to perform an intervention job is prone to uncertainty. The timing of a particular intervention job is dependent on all the intervention jobs performed/lined up earlier in the schedule.

Typically, the timing uncertainty is largest for well intervention jobs late in the schedule.

For the production forecast, the timing of an intervention tells us when a well is not in production and when we can expect additional production after the intervention.

The well's production may be stopped days in advance of an intervention job to allow the pressure around the well to stabilize prior to any operations. Similarly, the well's production may be shut in some time after the intervention job due to slowness in restarting flow or additional work needed to reconnect the well to the flowline.

To define an intervention schedule, there must be at least one intervention job defined. Figure 3.39 illustrates how you get started with defining an intervention schedule, when setting it up through the dashboard's user interface.

Forecast Properties

PRODUCTION EFFICIENCY | PRODUCTION CORRELATION | INTERVENTION JOBS | **INTERVENTION** | BOOST | RESERVOIR SIMULATIONS | RIG AVAILABILITY | NON-DRILLING

INTERVENTION SCHEDULES + Delete selected items ↑↓ Import intervention 🏠 Switch to property view

	+	NAME ↑	START D...	#	CREATED	MODIFIED
		Spring24 Upgrade				

Created: 07.12.2023 13:01 (Hilde Martinussen); Modified: 07.12.2023 14:16 (Hilde Martinussen)

General

Intervention schedule name *
 2

Description

Intervention

Start date * ?
 3

Sequence + 4

	+	ORDER	JOB NAME	INTERVENED WELL	DURATION
<input type="text"/>	<input type="text"/>	↑ ↓ 5	Spring24 Kochab-Rig upgrade	B1	13.00
<input type="text"/>	<input type="text"/>	↑ ↓	Spring24 Gamma Ursae Subsea up...	C1	25.00
<input type="text"/>	<input type="text"/>	↑ ↓	Spring24 Delta Ursae	C2	22.00
<input type="text"/>	<input type="text"/>	↑ ↓	Spring24 Eta Ursae	B2	15.00

6

- 1 Click the plus symbol to add a new intervention schedule to your forecast.
- 2 Give your schedule a name and description.
- 3 Set the starting date for the first intervention job for this schedule.
- 4 Click the plus icon/symbol to add a new intervention job to the current schedule
- 5 Re-arrange the sequence of intervention jobs.
- 6 Update your intervention schedule with the latest changes.

Figure 3.39 Creating a new intervention schedule.

When working with interventions it is often useful to create a copy/clone of an already defined schedule. You can for example use this to analyze an alternative sequence of jobs or to see the impact of adding or subtracting maintenance items. Figure 3.40 illustrates how to create a copy/clone.

Forecast Properties

[PRODUCTION EFFICIENCY](#)
[PRODUCTION CORRELATION](#)
[INTERVENTION JOBS](#)
[INTERVENTION](#)
[BOOST](#)
[RESERVOIR SIMULATIONS](#)
[RIG AVAILABILITY](#)
[NON-DRILLING](#)

INTERVENTION SCHEDULES Delete selected items Import intervention Switch to property view

	+	NAME ↑	START D...	#	CREATED	MODIFIED		
<input type="checkbox"/>				Spring24 Upgrade	16.04.2024	1	07.12.2023	07.12.2023
<input type="checkbox"/>				Spring24 Upgrade schedule	15.04.2024	0	19.12.2023	19.12.2023
		Spring24 Upgrade schedule Clone						

Created: 19.12.2023 16:39 (Hilde Martinussen); Modified: 19.12.2023 16:39 (Hilde Martinussen)

General

Intervention schedule name* 3

Description

Intervention

Start date* 15.04.2024

Sequence

	+	ORDER	JOB NAME	INTERVENED WELL	DURATION
		^	Spring24 Epsilon Upgrade	B3	10.00
		^	Spring24 Lambda Minoris - 2nd cre...		4.00
		^	Spring24 Delta Ursae	C2	22.00
		^	Spring24 Lambda Minoris - 1st. cre...		4.00

- Use the add copy icon to create a copy of a ready-made intervention schedule.
- The suggestion for the name of the new schedule is the origin's name suffixed with Clone.
- Give the intervention schedule a name if you don't want to go with the suggestion.
- Remove an intervention job from the schedule using the bin icon.

Figure 3.40 Creating a copy of an intervention schedule.

For a quality assurance check or a last-minute update to the schedule, you can access each individual job of the schedule from the schedule directly. This is illustrated in the dialog window in Figure 3.41. It is possible to update any of the properties that are presented in the view, but please note that changes will be reflected in **all instances** of this intervention job, also in other schedules where it is included.

The screenshot shows the 'Forecast Properties' interface for 'ASSET: POLARIS CASE STUDY / POLARIS FOR...'. The main section is 'Forecast Properties' with tabs for 'PRODUCTION EFFICIENCY', 'PRODUCTION CORRELATION', and 'INTERVENTION JOBS'. Under 'INTERVENTION SCHEDULES', there are several 'Spring24 Upgrade' entries. A red callout '1' points to a pencil icon next to one of these entries. To the right, a modal window titled 'SPRING24 EPSILON UPGRADE' is open. It shows the 'General' tab with various fields. A red callout '2' points to the 'Intervention job name' field, which contains 'Spring24 Epsilon Upgrade'. Other fields include 'Intervened well' (B3), 'Job duration (days)' (10), 'Low duration (days)' (9), 'High duration (days)' (11), 'Duration distribution type' (Normal), 'Use duration as' (<none>), 'Pre-job shut-in (days)' (0), and 'Post-job shut-in (days)' (0). Below these are sections for 'Offset wells shut in during intervention' and 'Production increment profile'. At the bottom of the modal, there are radio buttons for 'Chart: output' (selected) and 'Table: input', and buttons for 'Oil', 'Gas', 'Water', and 'Gas lift'.

1 Get access to the properties of an intervention job in the scheduled sequence by clicking on the pencil icon.

2 Edit any of the available fields to correct values. Please note that these changes will be reflected in other schedules containing the job!

Figure 3.41 Last-minute changes to jobs of a schedule.

The setup of intervention schedules and their contained jobs can be imported using pre-made Excel templates, see chapter 3.5.3.

3.5.3. Import Intervention

You may also import a list of both intervention schedules and intervention jobs using an Excel workbook template. Download the template as described in Figure 3.42. When using the template, you will work with the same parameters that are described as part of the user interface, see chapter 3.5.1 and chapter 3.5.2. All the parameters are listed on the Excel sheet named Info, which also lists what type of information to input for each parameter on each of the different worksheets.

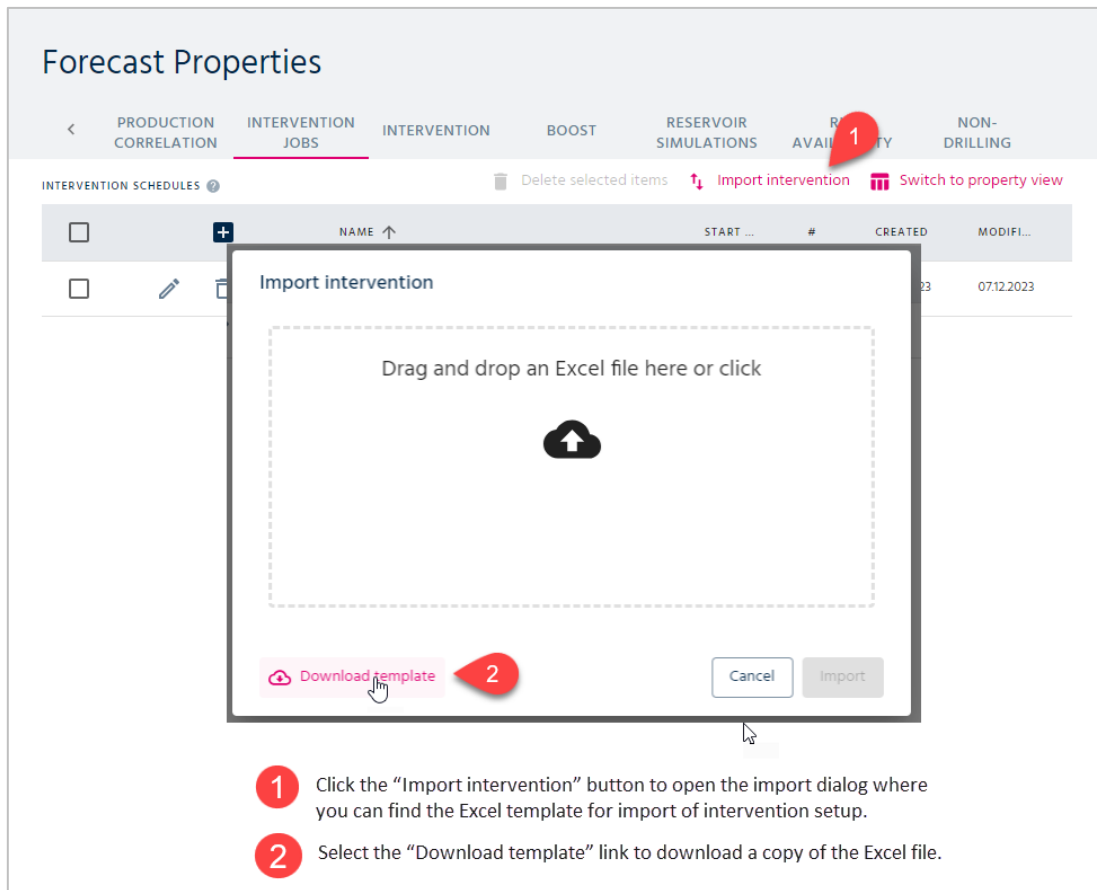


Figure 3.42 Find the Excel workbook template to import intervention setup.

On the Intervention Jobs worksheet, you may add a list of intervention jobs to import into pForecast. You need to supply the information as described in Figure 3.43. Our example illustrates three different intervention jobs, the first uses a Triangular distribution to describe the uncertainty of the duration of the job. The second one uses a Normal distribution. The last job is a non-intervention job, therefore no intervened well is connected to this job.

1	Intervention Job Name	Duration	Duration Low	Duration High	Distribution Type	Use Duration Value As	Pre-job Shut-in	Post-job Shut-in	Intervened Well	Facility
2	Spring24 Zeta upgrade	16	12	19	Triangular (P10, P90)	Expected	1	2	C10	
3	Spring24 Zeta Ursae upgrade	14	12.5	16	Normal	Most likely	1	1	E3	Vela
4	Spring24 Lambda crew move	2	1	3						
5										
6										
7										

- 1 Write a name for the intervention job (must be unique within the forecast).
- 2 Define the duration of the intervention job, and optionally include low and high values for stochastic analyses.
- 3 Select distribution type for uncertainty in duration, and how to use the deterministic duration value with the low and high values.
- 4 Optionally define how many days the intervened well is to be shut in before and after the intervention.
- 5 Define which well to intervene, non-intervention job, leave empty. Facility name is included to distinguish among wells in the rare case that we have the same well name in two or more facilities, typically this column can be left unused.
- 6 Remember to save and close the Excel file before importing it into pForecast.

Figure 3.43 Excel input data on the Intervention Jobs sheet.

To import the data from Excel, follow the instructions shown in Figure 3.44. The data will be validated upon import, and in our example from above, we can see that there are two

problems with the input data. pForecast offers sensible error messages that easily allow you to identify the problem at hand and rectify the problem.

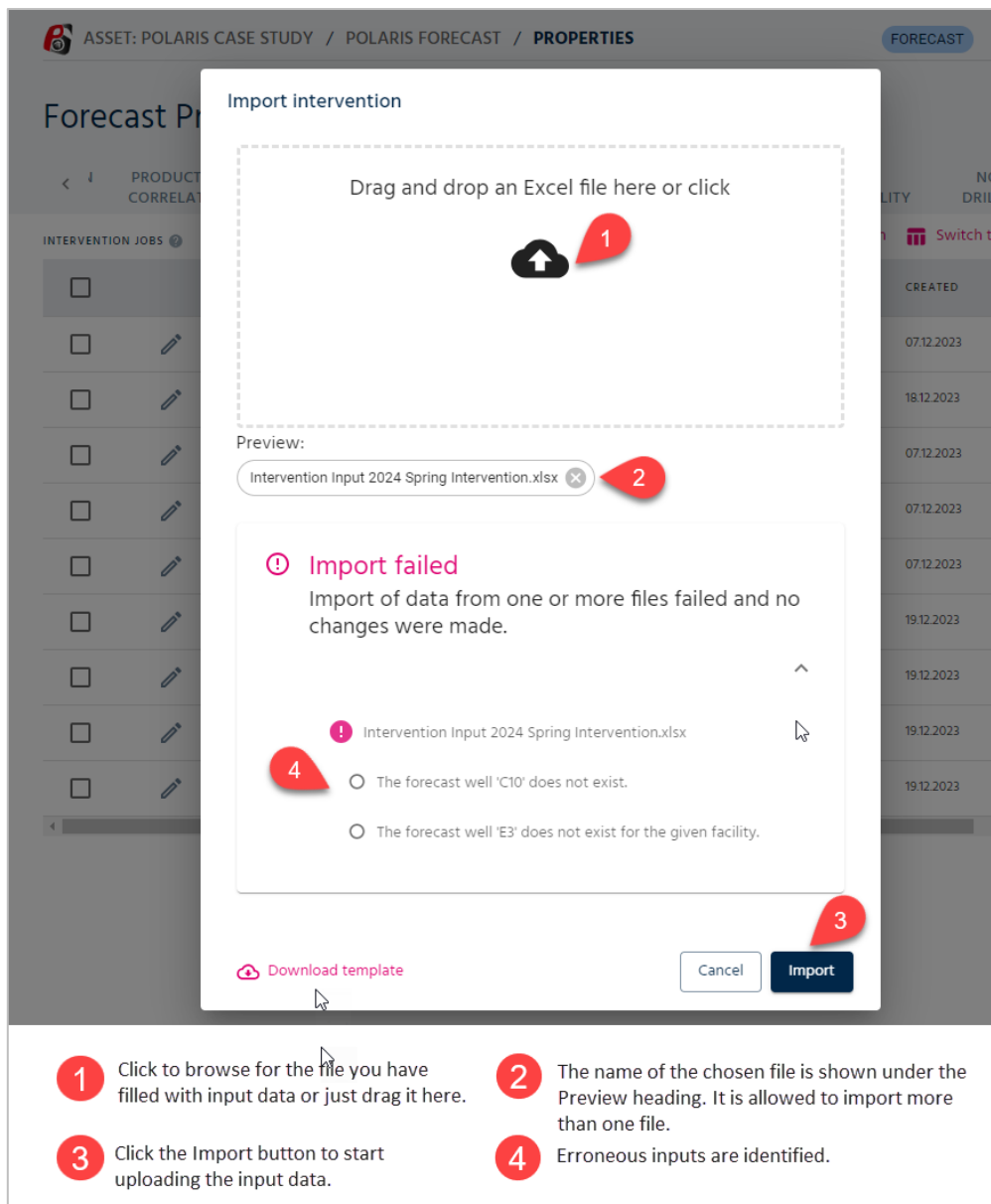


Figure 3.44 Validation of imported intervention data.

In our example the well mentioned for our first intervention job should have been well “C4”, while the correct facility notation for the second job was “FPSO Vela” instead of “Vela” only. If you now try to import again, you will receive feedback that the file is successfully imported. This is illustrated in Figure 3.45. A list of which input data was added is also presented.

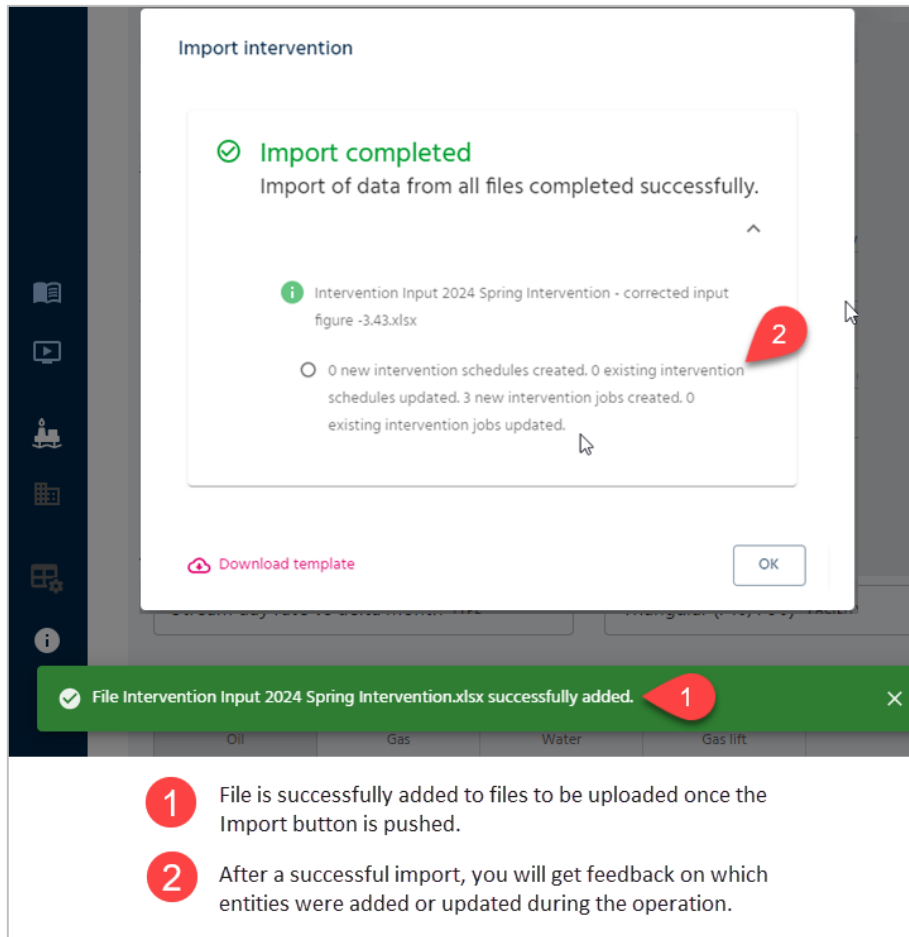


Figure 3.45 Successful import of intervention jobs.

On the Intervention Schedules worksheet, you may add a list of intervention schedules that can be imported into pForecast in one operation. You need to supply the information as described in Figure 3.46. Our example includes one intervention schedule, and we always need to specify which intervention job should be the first to be executed in the schedule. We have listed this new intervention job on the previous tab of intervention jobs, and the import of the schedule will then give us the familiar complete message, illustrated in Figure 3.47.

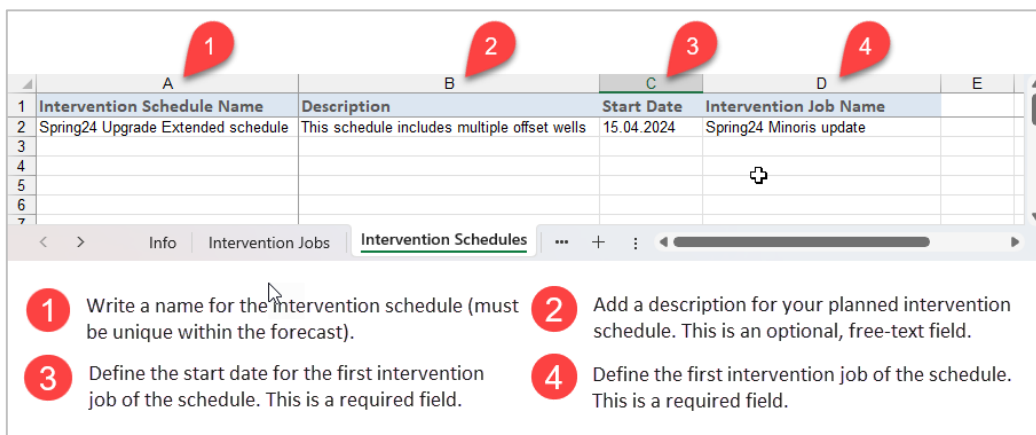


Figure 3.46 Input data for intervention schedules.

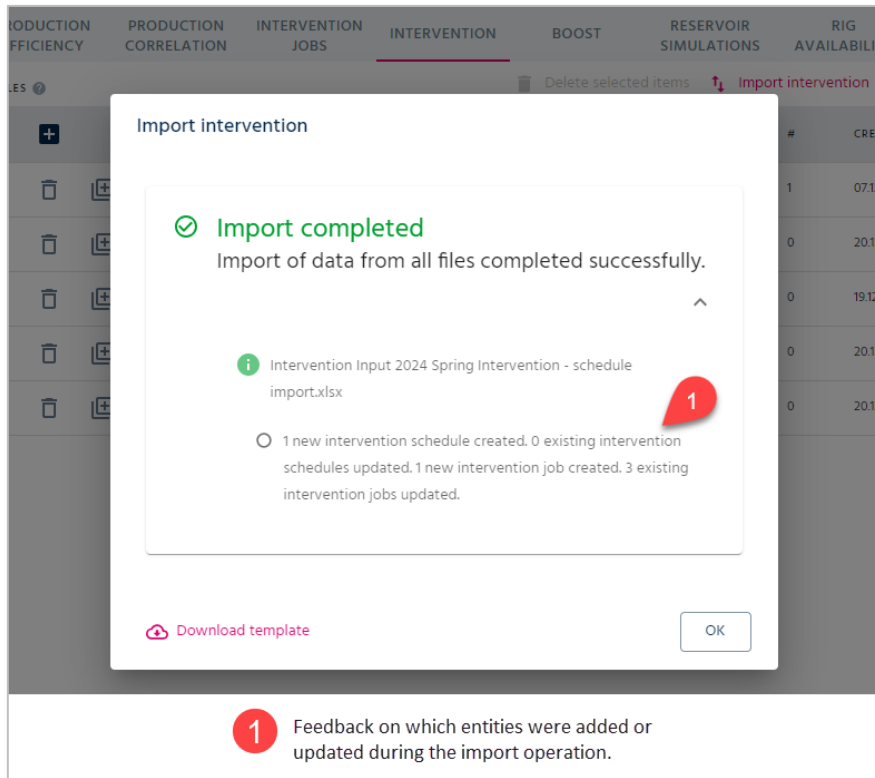


Figure 3.47 Successful import of intervention schedules.

Also on the Intervention Schedules worksheet, you may import monthly data for a production increment profile of type “Stream day rate vs delta month”. Since this profile type typically contains data for many months, Excel import is the most convenient way of adding data for such production increments. See Figure 3.46.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Intervention Job Name	Distribution Type	Use Reference Value As	Month Number	Oil Potential	Gas Potential	Water Potential	Gas Lift	Oil Potential Low	Gas Potential Low	Water Potential Low	Gas Lift Low	Oil Potential High	Gas Potential High
1	Spring24 Epsilon Upgrade	Triangular (P10, P90)	Expected	1	135	5750	423	0	115	5233	395	0	153	6542.8
2				2	135	5808	427	0	115	5285	399	0	153	6615
3				3	135	5866	432	0	115	5338	403	0	153	6688
4				4	135	5924	436	0	115	5392	407	0	153	6761
5				5	135	5983	440	0	115	5445	411	0	153	6835
6				6	135	6043	445	0	115	5500	415	0	153	6911
7				7	135	6104	449	0	115	5555	419	0	153	6987
8				8	135	6165	454	0	115	5610	423	0	153	7064
9				9	135	6226	458	0	115	5667	428	0	153	7141
10				10	135	6288	463	0	115	5725	433	0	153	7219
32				32	110	5916	576	0	91	4921	538	0	129	7521
33				33	109	5857	582	0	90	4882	543	0	128	7453
34				34	108	5798	587	0	89	4843	549	0	126	7386
35				35	107	5740	593	0	89	4804	554	0	125	7320
36				36	106	5683	599	0	88	4765	560	0	124	7254

- 1 Find the worksheet named “Delta Monthly” to input data for “Stream day rates vs. delta month”.
- 3 Select profile distribution type from the dropdown list, and “Use Reference Value As” per selected profile type.
- 5 Define the increment in oil potential, gas potential, water potential and gas lift for a given relative month.

- 2 Write a name for the intervention job for which this increment profile is defined. This is one of the jobs from the “Intervention Jobs” worksheet.
- 4 Define an increment production profile for the months following production restart, for as long as there is an effect of the intervention.
- 6 If you have selected to work with uncertainty for the increment, provide high and low values for the three phases and gas lift.

Figure 3.48 Input data for “Stream day rate vs delta month” data.

4. Scenario Configuration

Scenario configuration is the last level of the pForecast hierarchical structure. A scenario is essentially a consumer of existing data and can also be seen as a version of a forecast. At this stage, it is possible to run different scenarios of the forecast and visualize, analyze, and compare results.

4.1. Create a Scenario

In order to create a scenario, the user should select an active forecast. After selecting the forecast, you will see the following overview page, shown in Figure 4.1, where you can create a new scenario. After clicking the “Create the new scenario” button, the page in Figure 4.2 will be shown, allowing high-level scenario configuration.

ASSET: TEST 1 / FORECAST 1

FORECAST Properties

Forecast Overview

Flag for review

DESCRIPTION

TIME RANGE: 2004 2050
01.08.2021

STATUS: IN PROGRESS

SCENARIOS

Sort by: Date modified

Scenario 2/ with drilli...
Created: 04.11.2021
By: Shirin Safarzadeh

Scenario 1/ no drilling
Created: 04.10.2021
By: Shirin Safarzadeh

Create new scenario

1

2

1 From the Forecast Overview, click “Create new scenario”

2 It is possible to sort created scenarios based on date or name.

Figure 4.1: Creating a scenario (part 1).

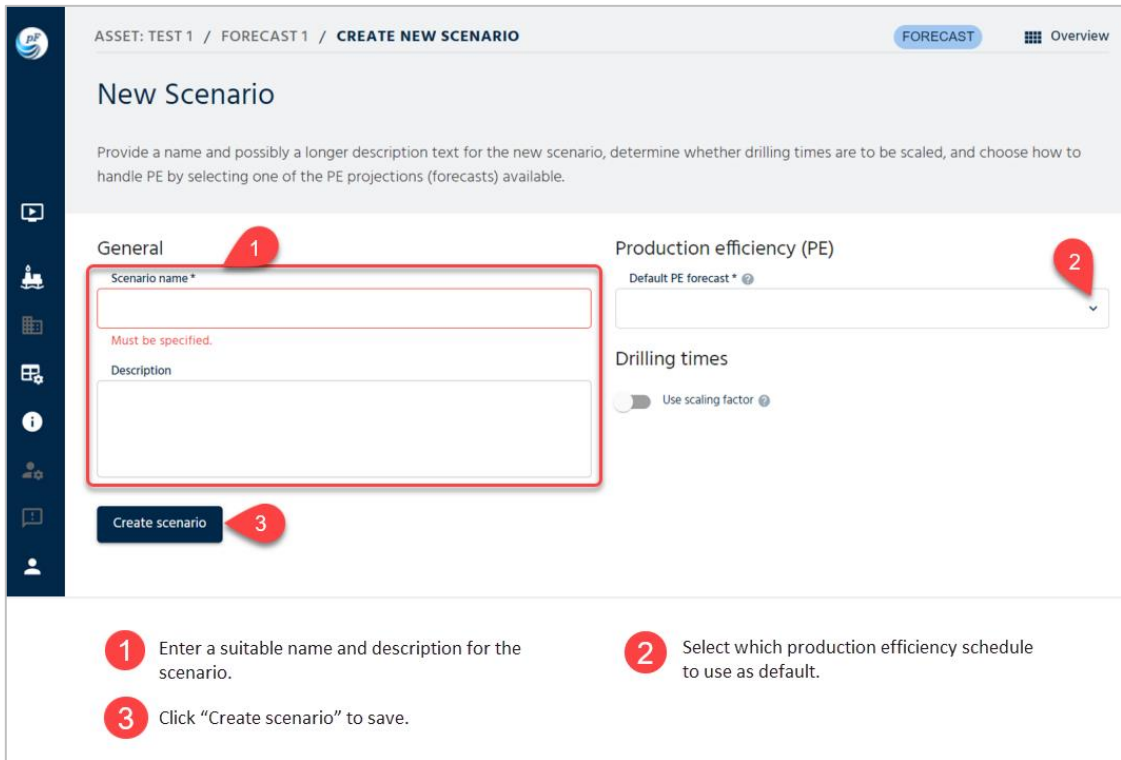


Figure 4.2: Creating a scenario (part 2).

4.2. Scenario Properties

After making a new scenario, the user can easily access all scenario properties as illustrated in Figure 4.3, and start the configuration process.

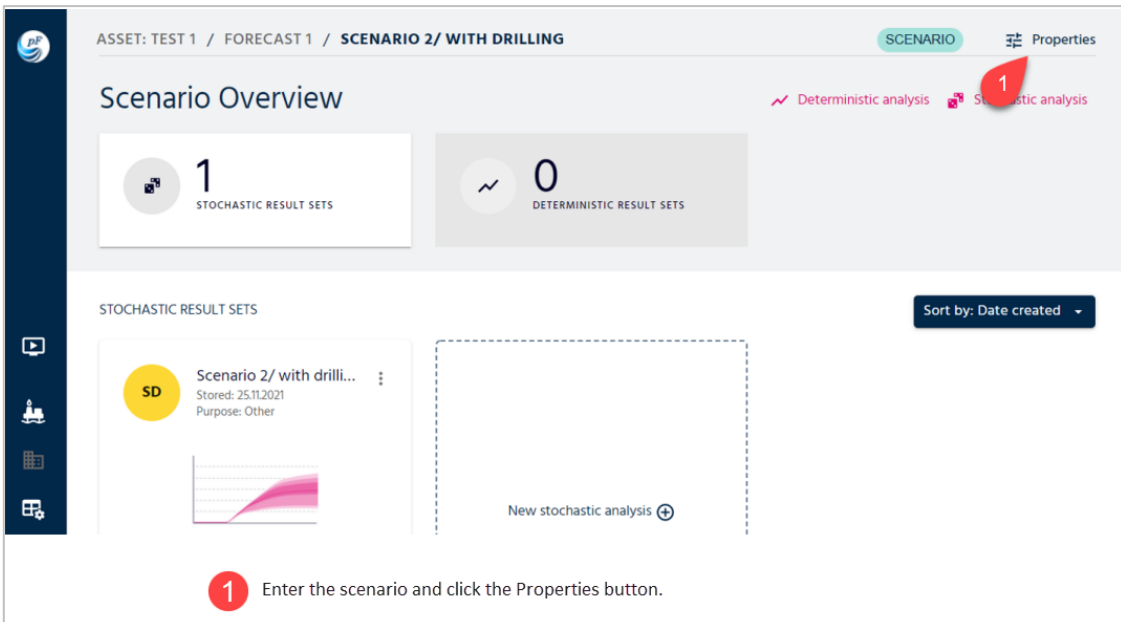


Figure 4.3: Access to the scenario properties.

4.2.1. Scenario

Under Scenario Properties, when the “Scenario” tab is selected, a list of attributes for the current scenario is shown. You can choose to set both default production efficiency (PE) and define dependencies also called correlations. A PE forecast gives monthly and annual estimates of the production efficiency as well as potential shutdowns. The PE forecast selected here (typically a PE forecast not linked to a facility) will be used for all facilities that are configured to use the default PE forecast rather than a specific one. See Figure 4.5 for more details.

If the “Use scaling factor” switch is switched on, all drilling times will be multiplied with the factor, a number between zero and 1, given in the involved drilling schedules.

Specify the dependency, correlation, between various events/characteristics within a simulation run as a factor between zero, fully independent, and on, fully dependent. These factors are only used when running stochastic analyses.

The screenshot displays the 'Scenario Properties' interface for 'POLARIS BASE SCENARIO'. The 'SCENARIO' tab is active. The interface is divided into several sections:

- General:** Includes a 'Scenario name *' field (callout 1) containing 'Polaris Base scenario' and a 'Description' text area.
- Production efficiency (PE):** Includes a 'Default PE forecast *' dropdown menu (callout 2) set to '<100%>'. Below it is a 'Use scaling factor' toggle switch (callout 3) which is currently turned off.
- Dependencies (Correlations):** This section (callout 4) contains five sliders for different parameters, each ranging from 0.0 (independent) to 1.0 (dependent):
 - Drilling times: slider at 0.0
 - Non-drilling period durations: slider at 0.0
 - Shutdown durations: slider at 0.0
 - Production efficiency over time: slider at 0.0
 - Production over time: slider at 1.0 (callout 5)

At the bottom, five numbered callouts provide instructions:

- 1 Provide a name for the current scenario.
- 2 Select the default PE forecast, i.e. the PE forecast that will be used for facilities configured in the scenario to use the default rather than a specific PE forecast.
- 3 Switch on if you want all drilling times to be multiplied with the specified factor (a number between 0 and 1) of the involved drilling schedules.
- 4 Specify how various events/characteristics within a simulation are correlated.
- 5 Use the slider or write a value between 0 and 1 in the edit field.

Figure 4.4 Define default PE and dependencies/correlations for scenarios.

4.2.2. Wells in operation

Under the scenario properties, when the “Wells in operation” tab is selected, a list of existing wells in the current forecast is shown. You can choose to include or exclude the wells in the current scenario. See Figure 4.5: Activation of wells in operation, a.k.a. existing wells. Figure 4.5 for more details.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / **PROPERTIES** SCENARIO Tutorial Overview

Scenario Properties

Deterministic analysis Stochastic analysis

SCENARIO **WELLS IN OPERATION** DRILLING CAPACITY SEPARATION PRODUCTION EFFICIENCY INTERVENTION REPORTING

WELLS IN OPERATION – CHOOSE WHICH TO INCLUDE IN SCENARIO Include selected Exclude selected

NAME ↑	INCLUDED	TYPE	FIELD	ACTIONS
<input type="checkbox"/> A1	<input checked="" type="checkbox"/>	Producer	Draco	<input type="checkbox"/> <input type="checkbox"/>
<input type="checkbox"/> A2	<input checked="" type="checkbox"/>	Producer	Draco	<input type="checkbox"/> <input type="checkbox"/>
<input type="checkbox"/> A3	<input checked="" type="checkbox"/>	Producer	Draco	<input type="checkbox"/> <input type="checkbox"/>
<input type="checkbox"/> A4	<input checked="" type="checkbox"/>	Producer	Draco	<input type="checkbox"/> <input type="checkbox"/>

- 1 In the scenario properties, press the “Wells in Operation” tab.
- 2 Indicate the wells that you want to include in your forecast using the toggle.
- 3 Here you can view and manage details per well.

Figure 4.5: Activation of wells in operation, a.k.a. existing wells.

4.2.3. Drilling

The next step is about wells to be drilled. When the “Drilling” tab is selected, you can activate previously defined drilling schedules. It is worth mentioning that if a drilling schedule is activated, all forecast wells belonging to that drilling schedule will be automatically included in the scenario. Figure 4.6 gives more details.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / **PROPERTIES** SCENARIO Tutorial

Scenario Properties

SCENARIO WELLS IN OPERATION **DRILLING** CAPACITY SEPARATION PRODUCTION EFFICIENCY INTERVENTION REPORTING

DRILLING SCHEDULES – CHOOSE WHICH TO INCLUDE IN SCENARIO Include selected Exclude selected

<input type="checkbox"/>	NAME ↑	INCLUD...	DESCRIPTION	FACILITY	START D...	ACTIONS
<input type="checkbox"/>	Drilling schedule 1	<input checked="" type="checkbox"/>		FPSO	03.12.2024	
<input type="checkbox"/>	Drilling schedule 2	<input type="checkbox"/>		FPSO	09.08.2033	

- In the scenario properties, select the “Drilling” tab.
- Indicate the drilling schedules that you want to include in your forecast using the toggle.
- Here you can view and manage details of the drilling schedule.

Figure 4.6: Activation of wells to be drilled.

4.2.4. Capacity

As previously mentioned, see section 3.3.4, a set of capacity constraints can be defined for a forecast. A constraint is given with maximum rates for production/injection as well as regularity factors for injection and is valid from a given point in time and onwards until a new constraint is activated. Each constraint is connected to a cluster in the hierarchical capacity cluster structure. Use the toggles under the “Included” column to determine which of these constraints to include in the current scenario. See Figure 4.7 for more details.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / **PROPERTIES** SCENARIO Tutorial

Scenario Properties

SCENARIO WELLS IN OPERATION DRILLING **CAPACITY** SEPARATION PRODUCTION EFFICIENCY INTERVENTION REPORTING

CAPACITY CONSTRAINTS – CHOOSE WHICH TO INCLUDE IN SCENARIO Include selected Exclude selected

	NAME ↑	INCLUDED	VALID FRO...	ACTIONS
	FPSO 1			
<input type="checkbox"/>	Separator 1	<input checked="" type="checkbox"/>	01.11.2021	

- In the scenario properties, select the “Capacity” tab.
- Navigate to the cluster where you want to activate the constraint for.
- Indicate the sets of constraints that you want to use in your simulation.
- Here you can view and manage details of capacity constraint.

Figure 4.7: Activation of constraints.

4.2.5. Separation



For a forecast, you can define a set of separation forecasts, each of them giving monthly estimates for separation of phases prior to routing the next level of the cluster hierarchy. Use the dropdowns of the separation forecast column to determine which separation forecast to use for each involved child facility in the current scenario. See more details in Figure 4.8.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS W/INTERVENTION BA... / **PROPERTIES** SCENARIO

Scenario Properties ✓ Deterministic analysis

SCENARIO WELLS IN OPERATION DRILLING CAPACITY **SEPARATION** PRODUCTION EFFICIENCY INTERVENTION REPORTING

CHILD FACILITIES - CHOOSE SEPARATION FORECASTS FOR SCENARIO

CHILD FACILITY	SEPARATION FORECAST	ACTIONS
Vela B facility	Vela B separation forecast	 

<no separation>
Vela B separation forecast

- 1 In the Scenario Properties, select the "Separation" tab.
- 2 All defined child facilities will be listed here.
- 3 In the drop-down list, select the separation forecast to be used with your facility.
- 4 Here you can view and manage details of the separation forecast.

Figure 4.8 Add separation for your facility.

4.2.6. Production Efficiency

The user can select the scenario's active production efficiencies by selecting the "Production efficiency" tab under the scenario properties. The user is asked to provide a PE forecast for each facility. Different facilities may use the same PE forecast if appropriate. Each of the facilities in the model is shown in the list, and the PE forecast is chosen from the drop-down menu. See Figure 4.9 for more details.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / **PROPERTIES** SCENARIO Tutorial

Scenario Properties

✓ Deterministic analysis Stochastic

SCENARIO WELLS IN OPERATION DRILLING CAPACITY SEPARATION **PRODUCTION EFFICIENCY** INTERVENTION REPORTING

FACILITIES – CHOOSE PE FORECASTS FOR SCENARIO

FACILITY	PE FORECAST	ACTIONS
Default	PE	📄
FPSO	PE	📄 ➡

- In the Scenario Properties, select the “Production Efficiency” tab.
- Assign a Production Efficiency schedule to your facilities using the dropdown.
- Here you can view and manage details of the selected PE forecast.

Figure 4.9: Activation of PE forecasts.

4.2.7. Intervention

To take intervention projects/campaigns into account for a forecast, you must first define both intervention jobs and one or more containing intervention schedules for the forecast. This is described earlier in chapter 3.5.

In the Intervention tab for Scenario Properties, you are presented with a cockpit to include one or more intervention-related campaigns. You may use the toggles in the Included column to determine which of the listed interventions schedules should be included in the current scenario. In this way it is easy to evaluate two alternative schedules by switching the corresponding schedule on and off in two separate scenarios.

In our example shown in Figure 4.10 Activate Intervention schedules, we have multiple schedules to implement an upcoming intervention project for an upgrade during the spring of 2024. Each schedule has a slightly different setup, and we will run different scenarios to compare the outcome of each schedule. Note that a specific intervention job can only be present once in a scenario. This means that in our case where the alternative schedules contain some of the same jobs, only one of the alternative schedules can be active in a scenario. In general, as long as there are no common intervention jobs, it is allowed with multiple active schedules in the same scenario.

ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / PROPERTIES SCENARIO Tutorial Overview

Intervention schedules inclusion successfully updated

Scenario Properties

Deterministic analysis Stochastic analysis

SCENARIO WELLS IN OPERATION DRILLING CAPACITY SEPARATION PRODUCTION EFFICIENCY INTERVENTION REPORTING

INTERVENTION SCHEDULES – CHOOSE WHICH TO INCLUDE IN SCENARIO

Include selected Exclude selected

<input type="checkbox"/>	NAME ↑	INCLUDED	DESCRIPTION	START DATE	ACTIONS
<input type="checkbox"/>	Spring24 Upgrade	<input type="checkbox"/>	Planned upgrade of subsea rigs and injection wells	16.04.2024	
<input type="checkbox"/>	Spring24 Upgrade Extended schedule	<input type="checkbox"/>	This schedule includes multiple offset wells	15.04.2024	
<input type="checkbox"/>	Spring24 Upgrade schedule	<input checked="" type="checkbox"/>	Schedule second alternative on how to upgrade during ...	15.04.2024	
<input type="checkbox"/>	Spring24 Upgrade schedule 3rd alt	<input type="checkbox"/>	Third alternative on upgrade during spring break, exclu...	15.04.2024	
<input type="checkbox"/>	Spring24 Upgrade schedule 4th alt	<input type="checkbox"/>	Third alternative on upgrade during spring break, includ...	15.04.2024	

- Click the "Intervention" tab to select the intervention schedules you would like to include in the scenario.
- Include the intervention schedule of choice using the switch/toggle.
- A notification will appear to inform that inclusion was successful.
- You may view the list of intervention jobs associated with this intervention schedule using the details button/icon.

Figure 4.10 Activate Intervention schedules for scenarios.

When you open the details of an intervention schedule, a pop-up window will appear as illustrated in Figure 4.11. The sequence (the execution order) of jobs in the intervention schedule is shown as a list.

SPRING24 UPGRADE SCHEDULE

Created: 19.12.2023 16:39 (Hilde Martinussen); Modified: 19.12.2023 16:39 (Hilde Martinussen)

General

Intervention schedule name *
Spring24 Upgrade schedule

Description
Schedule second alternative on how to upgrade during spring break.

Intervention

Start date *
15.04.2024

Sequence

ORDER	JOB NAME	INTERVENED WELL	DURATION
^ v	Spring24 Epsilon Upgrade	B3	10.00
^ v	Spring24 Lambda Minoris ...		4.00
^ v	Spring24 Delta Ursae	C2	22.00
^ v	Spring24 Kochab-Rig upgr...	B1	13.00

Cancel

1 View all the intervention jobs contained in this schedule.

Figure 4.11 View sequence of an intervention schedule.

4.2.8. Reporting

As mentioned earlier, see chapter 2.3, a set of reporting schemes can be defined for an asset. In order to configure reporting for a given scenario, the user should select the “Reporting” tab under the scenario properties. You can choose which of these schemes to consider for the reports of the current scenario. In order to add, edit or delete group schemes, you should go to the asset level and perform any necessary changes there. Figure 4.12 gives more details.

The screenshot shows the 'Scenario Properties' interface. At the top, there is a breadcrumb trail: 'ASSET: POLARIS CASE STUDY / POLARIS FORECAST / POLARIS BASE SCENARIO / PROPERTIES SCENARIO'. Below this, the 'Scenario Properties' title is displayed. On the right, there are two analysis options: 'Deterministic analysis' (checked) and 'Stochastic analysis'. A navigation bar contains tabs for 'WELLS IN OPERATION', 'DRILLING', 'CAPACITY', 'SEPARATION', 'PRODUCTION EFFICIENCY', 'INTERVENTION', and 'REPORTING'. The 'REPORTING' tab is selected and highlighted with a red circle labeled '1'. Below the navigation bar, the section is titled 'REPORTING SCHEMES - CHOOSE WHICH TO INCLUDE IN SCENARIO'. There are two radio buttons for 'Include selected' and 'Exclude selected'. A table lists the reporting schemes with their inclusion status:

NAME ↑	INCLUDED
<input type="checkbox"/> Asset Layout	<input type="checkbox"/>
<input type="checkbox"/> Field Layout	<input type="checkbox"/>
<input type="checkbox"/> Intervention Upgrade project	<input checked="" type="checkbox"/>
<input type="checkbox"/> Project status	<input type="checkbox"/>
<input type="checkbox"/> Voidage	<input type="checkbox"/>
<input type="checkbox"/> Well Status & Project	<input type="checkbox"/>
<input type="checkbox"/> Well status	<input checked="" type="checkbox"/>
<input type="checkbox"/> Wells	<input type="checkbox"/>

A red box labeled '2' highlights the 'INCLUDED' column, specifically the toggle switches for 'Intervention Upgrade project' and 'Well status'. At the bottom of the interface, there are two numbered instructions:

- 1 Under Scenario Properties, select the "Reporting" tab.
- 2 Indicate the reporting schemes that you wish to use for viewing simulation results.

Figure 4.12: Activation of reporting schemes.

5. Running the Simulation

pForecast can be run in two different modes, deterministic and stochastic. In the deterministic mode, it is possible to review the reference case without considering any uncertainties. In the stochastic mode, the Monte Carlo approach is used to perform uncertainty analyses.

5.1. Running a deterministic simulation

Running a scenario in deterministic mode allows performing an analysis of a reference case without considering uncertainties. Figure 5.1 shows how to enter the deterministic analysis mode, and Figure 5.2 shows how to start running a deterministic scenario.

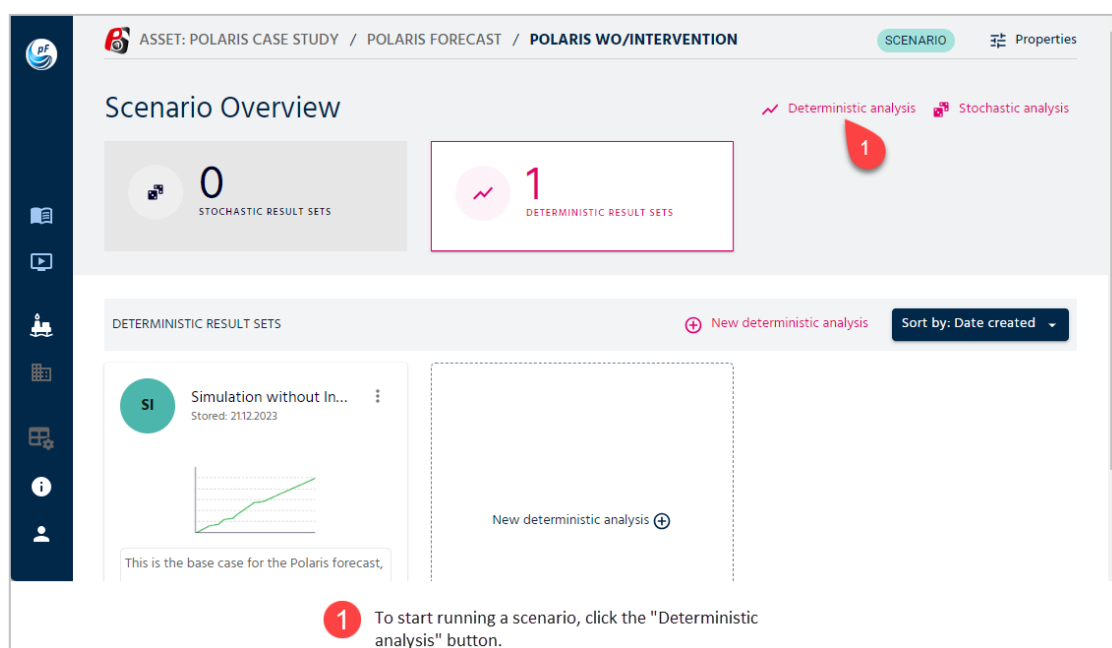


Figure 5.1 Running a deterministic simulation (part one).

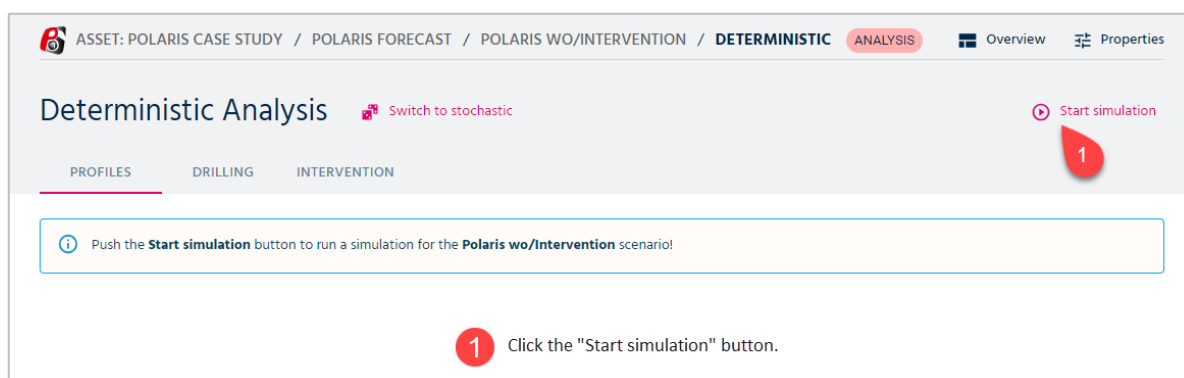


Figure 5.2 Running a deterministic simulation (part two).

When the simulation is complete, the user is presented directly with the production profile results.

5.1.1. Profiles

In pForecast, the user can choose between different report groups for viewing results. It is possible to present both calendar day rate, volume and accumulated volume, as well as production efficiency (PE). Figure 5.3 shows how to navigate the result viewer under the “Profiles” tab.

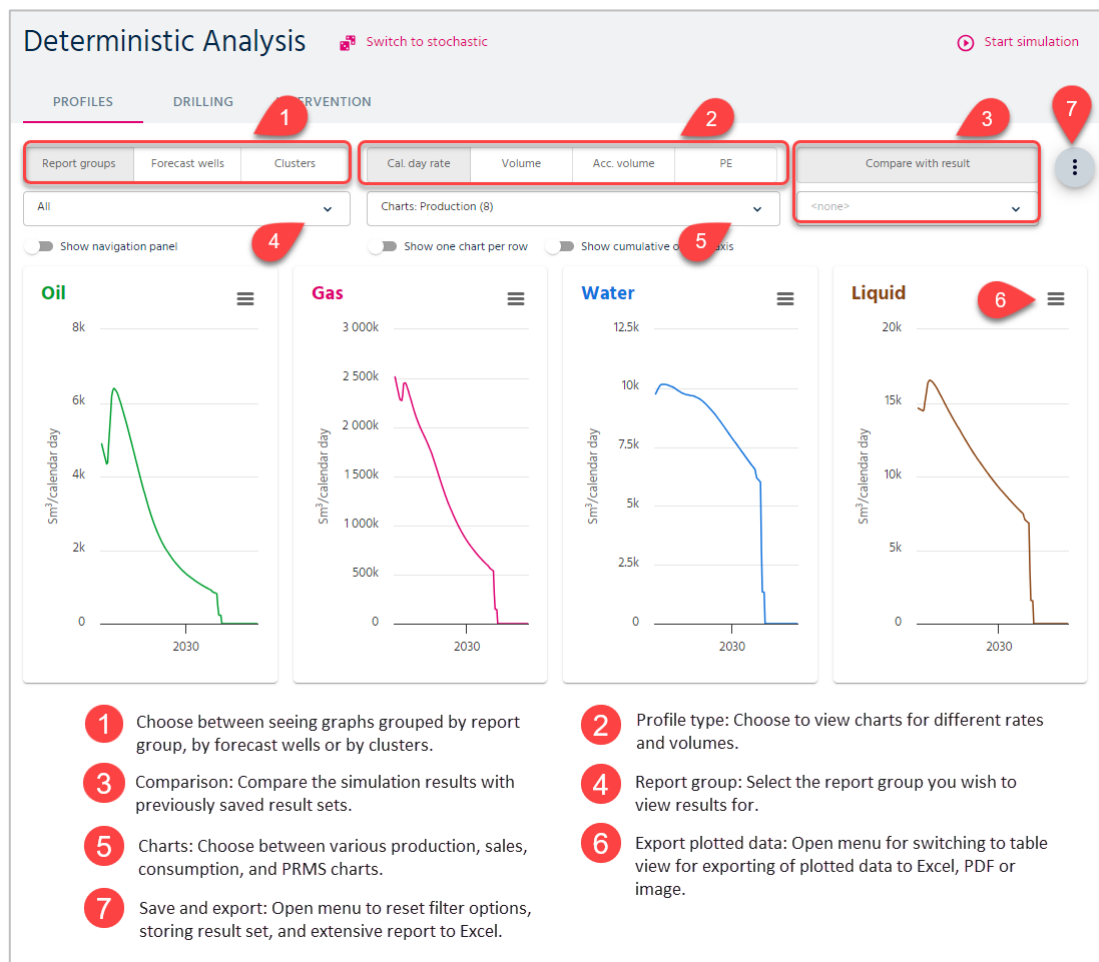


Figure 5.3: The pForecast result viewer for a deterministic analysis.

In addition to charts for the three basic phases (oil, gas, and water), you can also select other charts like GOR (gas oil ratio) and WCT (water cut) and injection. Figure 5.4 shows the selection of available charts in the pForecast result viewer for deterministic analyses.

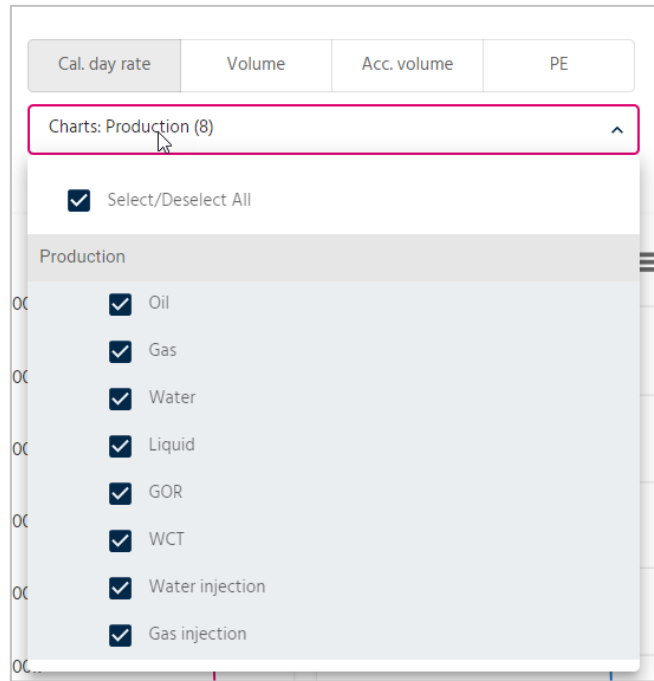


Figure 5.4: Available charts for deterministic analysis in pForecast.

5.1.2. Drilling

For Exploration and Production (E&P) companies, it is essential to consider the time related to drilling, the time before a well is put into production. To meet this need, pForecast considers the drilling programs involved, automatically generates resulting Gantt charts for drilling schedules and shows how drilling targets propagate. You can view the expected drilling schedules by selecting the Drilling tab under Deterministic Analysis. If there is more than one drilling schedule, you select between them by using the schedule dropdown list. Start of drilling, end of drilling, and start of production are visualized for each well. Figure 5.5 provides more details.

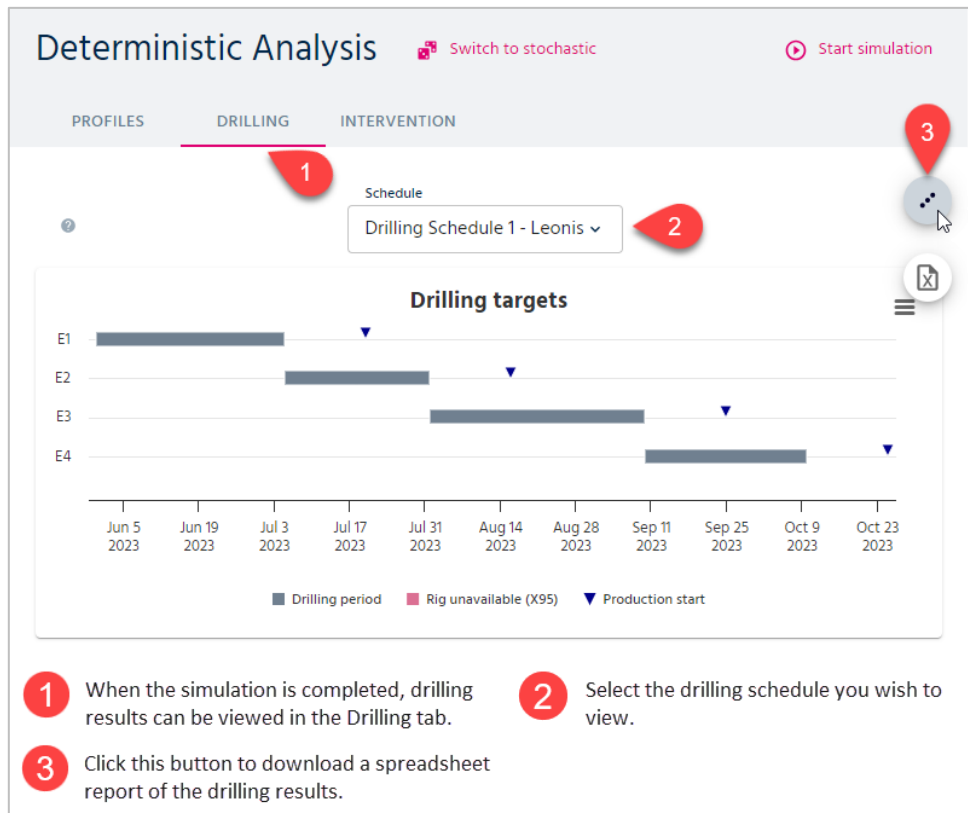


Figure 5.5: Gantt charts for drilling schedules in a deterministic analysis.

5.1.3. Intervention

You can see the expected intervention schedules by selecting the Intervention tab under Deterministic Analysis.

In Figure 5.6, you will see intervention activities for interventions on producers or injectors indicated with dark blue lines. Non-intervention activities (crew movements, etc.) are shown using slanted blue lines.

Diamonds and triangles indicate production shut-in for intervention jobs, starting at the diamond icon and ending at the triangle icon.

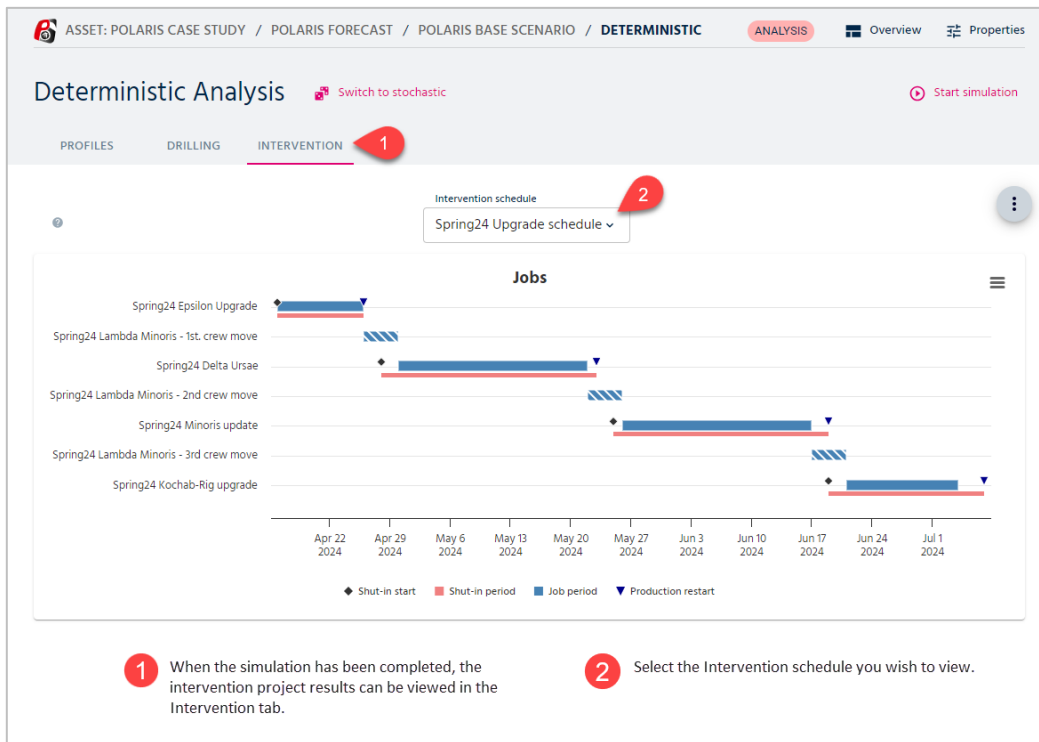


Figure 5.6 Gantt charts for intervention schedules in a deterministic analysis.

5.2. Deterministic result sets

If you save a result set for your simulation, you can find these data in the Scenario Overview window as shown in Figure 5.7.

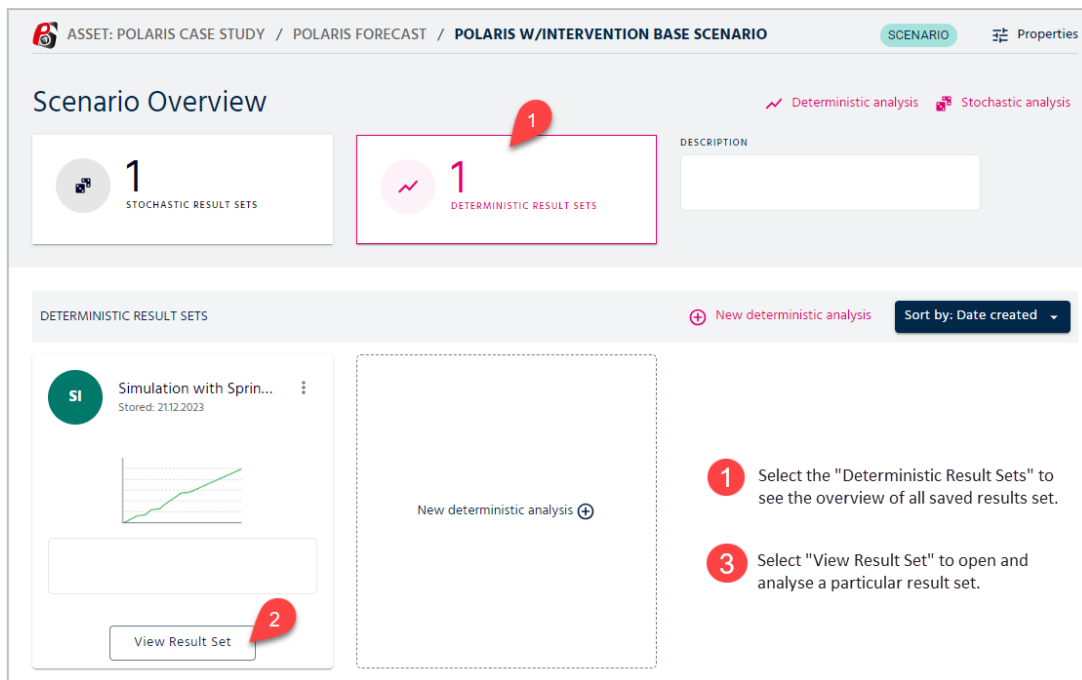


Figure 5.7 Saved result sets for a deterministic analysis of a scenario.

When you open this result set, you may analyze the data for each well, on a yearly or monthly basis. It is possible to zoom in to study details of a graph by using the slider underneath the graph. This is illustrated in Figure 5.8.

Saving results sets are very useful, because you may compare one result set towards another simulation as described in chapter 0, shown in Figure 5.3 point 3.

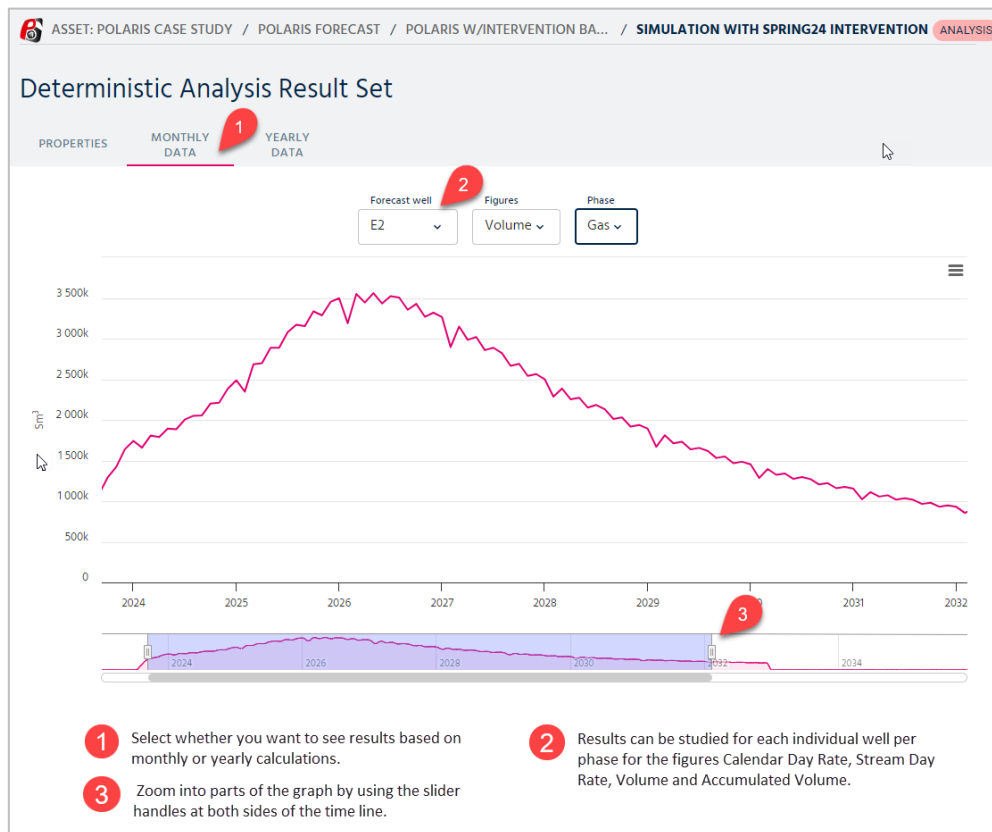


Figure 5.8 Result set for a deterministic analysis.

5.3. Running a stochastic simulation

In pForecast there is also a second mode, the stochastic mode, where a Monte Carlo approach is used to perform an uncertainty analysis. Figure 5.9 and Figure 5.10 show how to run a stochastic simulation.

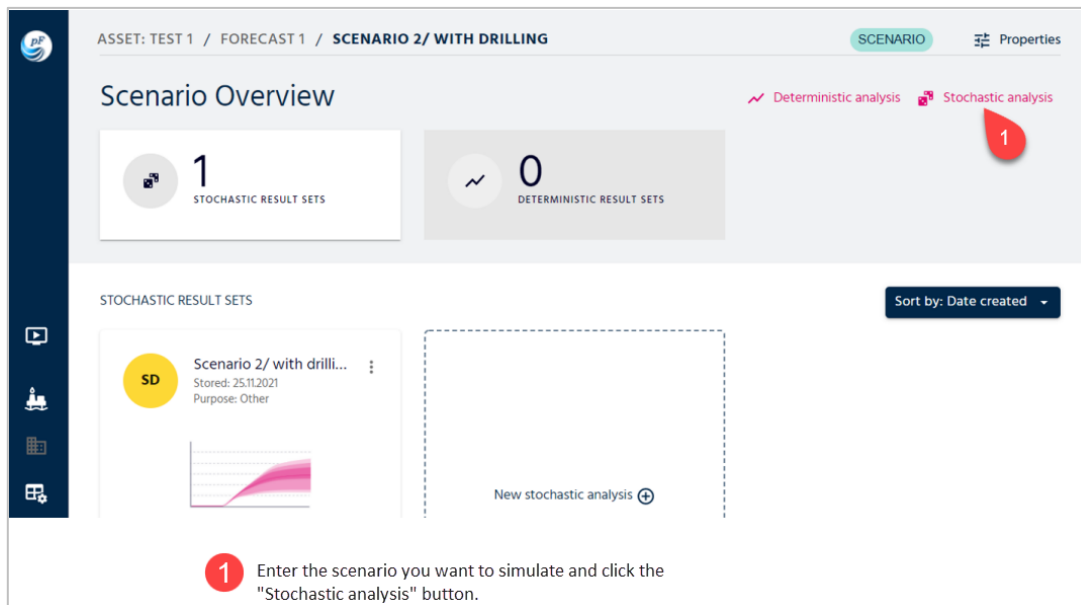


Figure 5.9: Running a stochastic simulation (part one).

After clicking the “Stochastic analysis” button, you will see the following page (Figure 5.10), where you can adjust the number of runs and start the simulation. The user can run between 10 to 2000 simulations and derive production profiles for different scenarios. It is recommended to run at least 200 runs for reporting purposes.

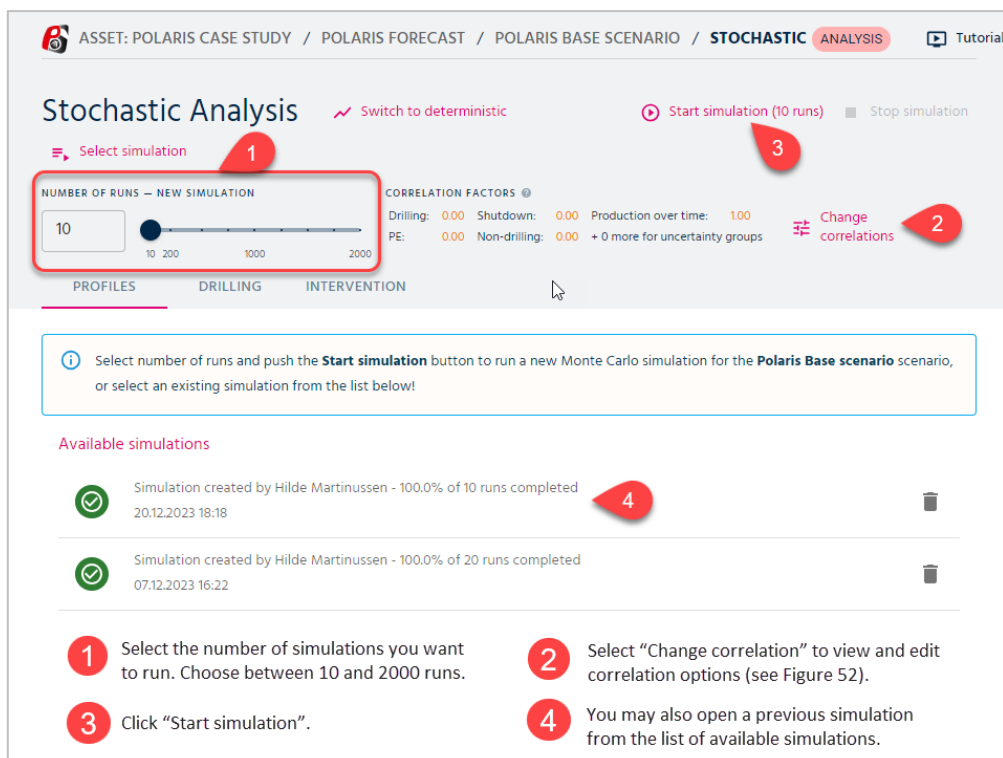


Figure 5.10: Running a stochastic simulation (part two).

Before running the stochastic simulation, the user can specify how a series of events/characteristics in the simulation relate to each other. Figure 5.11 shows how to set up the dependencies within a simulation run as a factor between zero (fully independent) and

one (entirely dependent). For uncertainty groups, it is also possible to set correlation factors between minus one and zero to model negative dependencies.

The screenshot shows the 'CORRELATIONS' panel in the software interface. It features several sliders and input fields for setting dependencies between variables. The 'Production over time' slider is set to 1. The 'Uncertainty group dependencies' section is highlighted with a red box, showing a slider for 'Production within group: Oilfield 1' set to 0. A legend at the bottom of the panel provides a numbered key for each option.

Number	Description
1	Correlate drilling times between wells within each drilling schedule.
2	Correlate the duration of temporary shutdowns for each facility.
3	Correlate production potential over time.
4	Set correlation factor between wells in uncertainty groups.
5	Correlate the duration of temporary non-drilling periods for each drilling schedule.
6	Correlate the Production Efficiency (PE) in time for each facility.
7	Click "Change correlations" to save.

Figure 5.11: Description of correlation options.

When the simulation is complete, you are presented with production profile results showing a reference case as well as uncertainty estimates.

5.3.1. Profiles

In the result viewer for a stochastic analysis, you can choose between yearly or monthly plot granularity. Results are shown by report groups. It is possible to present both stream day rates, assuming 100 percent uptime, and calendar day rates accounting for planned and unplanned downtime. Figure 5.12 shows how to navigate the result viewer under the Profiles tab of Stochastic Analysis.

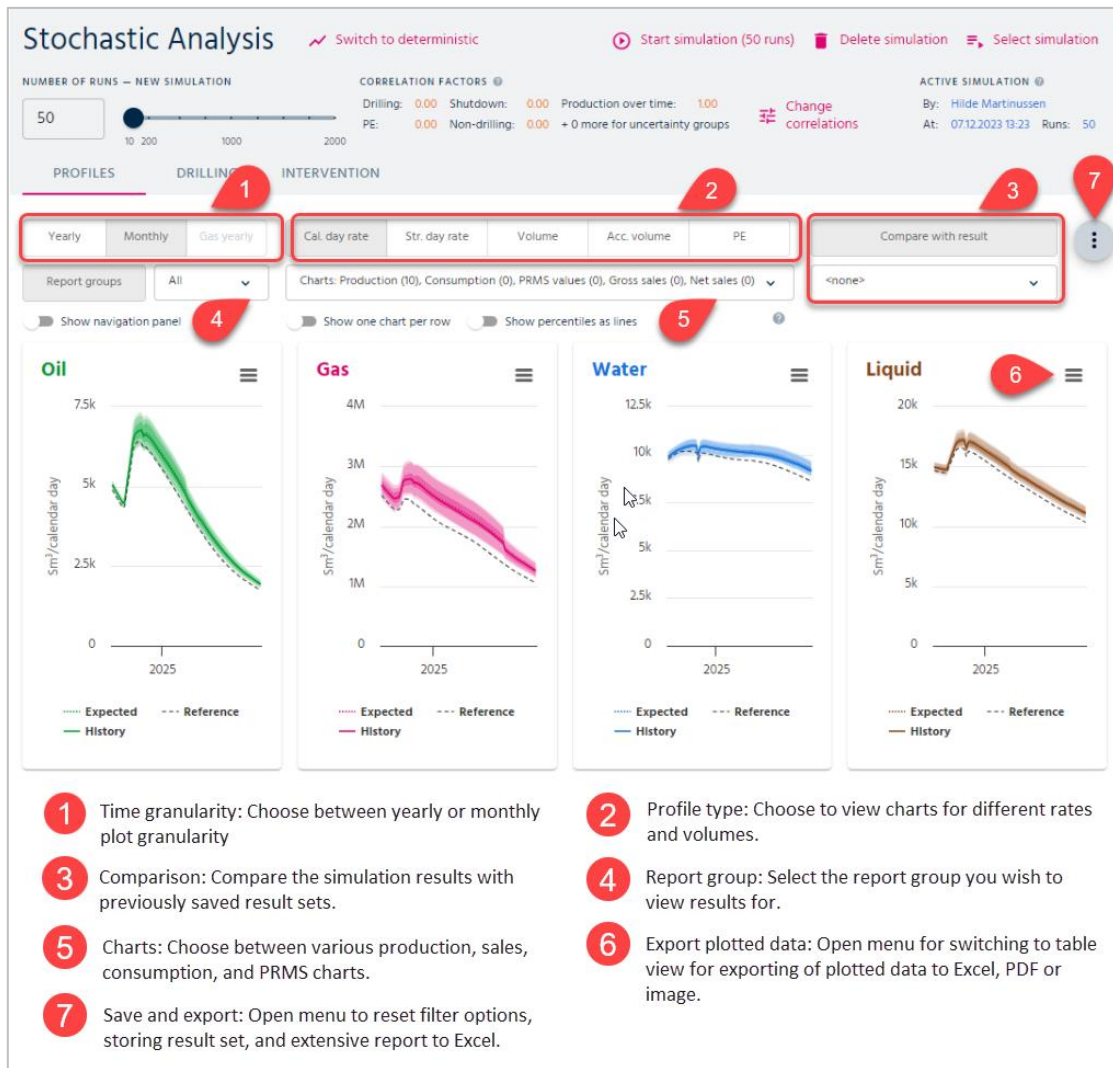


Figure 5.12: pForecast result viewer for a stochastic analysis.

In addition to production profiles, the user can easily generate other profiles, i.e., injection, fuel, and flare, as well as gross and net sales. Figure 5.13 shows an overview of available profiles in the pForecast software.

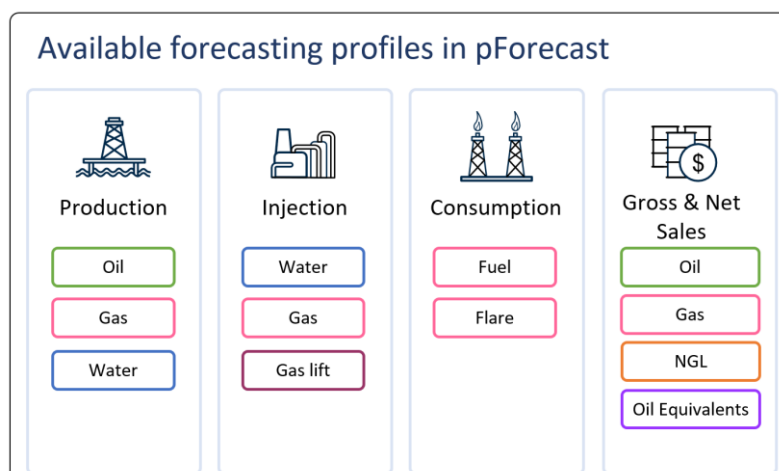


Figure 5.13 Available profiles in pForecast.

5.3.2. Drilling

For Exploration and Production (E&P) companies, it is essential to take into account the uncertainties related to drilling. To meet this need, pForecast considers uncertainties involved in drilling programs, automatically generates Gantt charts for drilling schedules and shows how uncertainty propagates over drilling targets. You can view the expected drilling schedules by selecting the “Drilling” tab under Stochastic Analysis. If there is more than one drilling schedule, you can select one of them by using the schedule dropdown list. The early start of drilling, expected start of drilling, expected end of drilling, expected start of production, and the late end of drilling are visualized for each well.

Figure 5.14 provides more details.

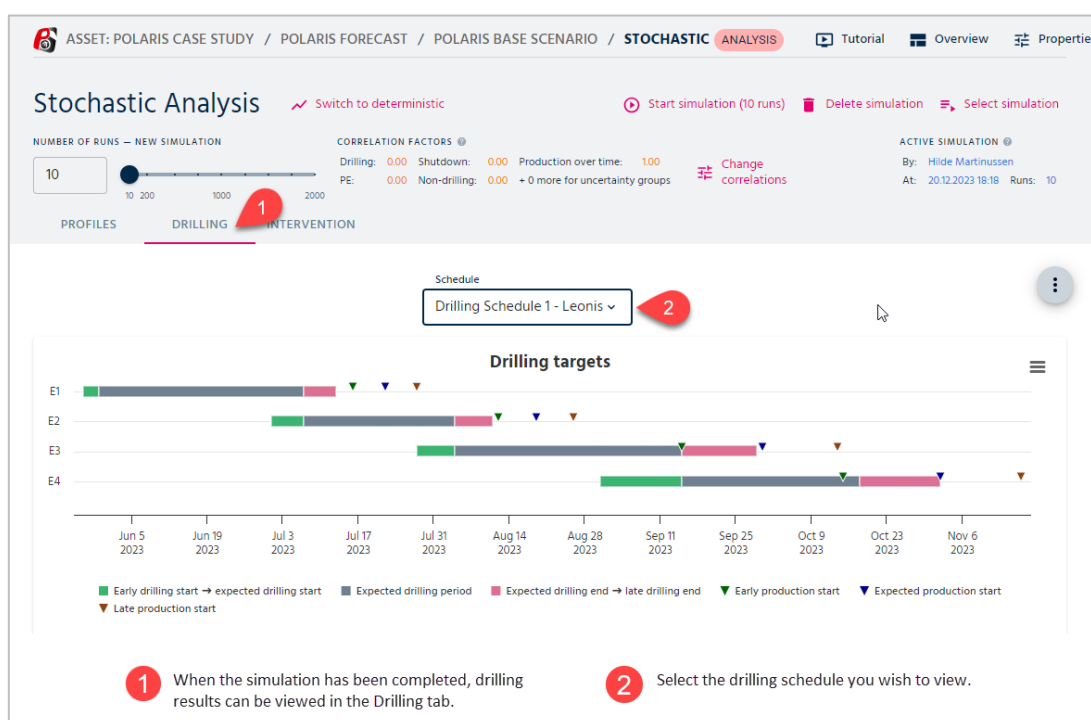


Figure 5.14: Gantt charts for drilling schedules in a stochastic analysis.

5.3.3. Intervention

You can see the expected intervention schedules by selecting the Intervention tab under Stochastic Analysis.

In Figure 5.15, you will see intervention activities for interventions on producers or injectors indicated with blue lines with three different shades (representing uncertainty estimates). Non-intervention activities (crew movements, etc.) are shown using slanted blue lines with the same three shades.

Diamonds and triangles indicate production shut-in for intervention jobs, starting at the diamond icon and ending at the triangle icon. The colors of the diamond and triangle icons indicate different uncertainty estimates for shut-in start and end.

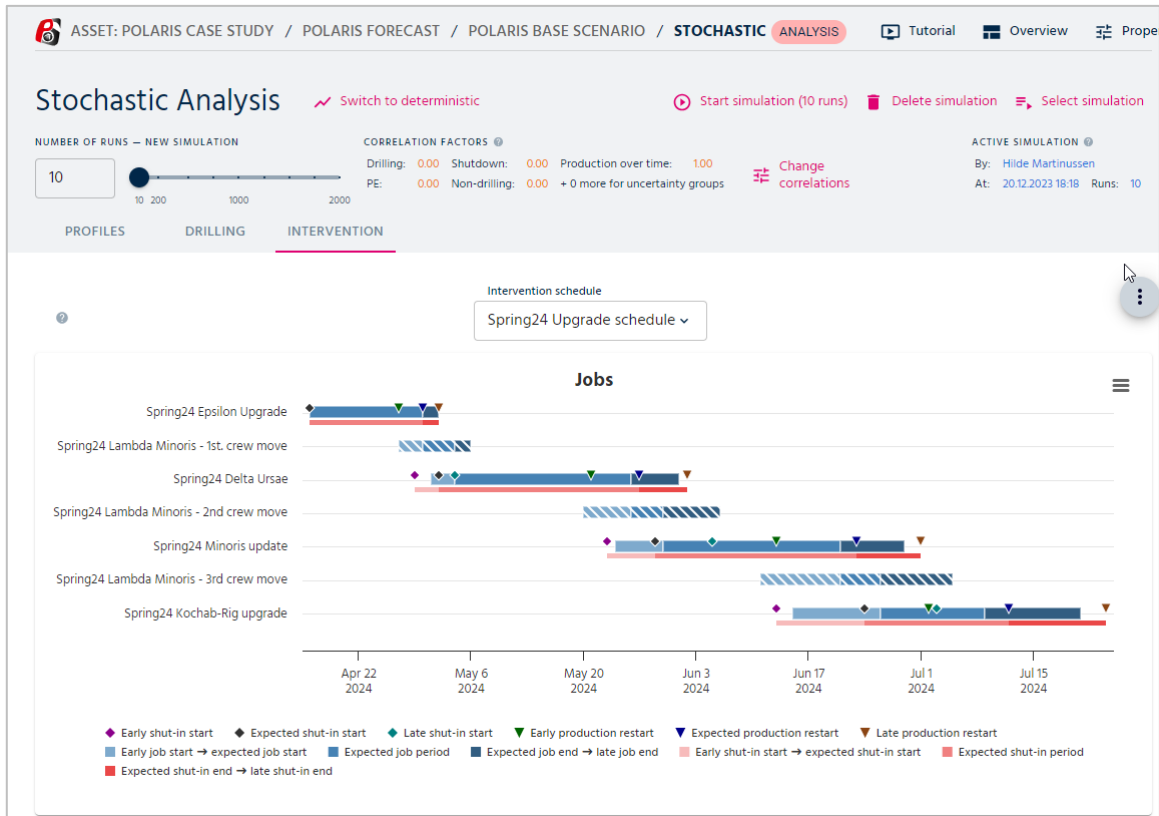


Figure 5.15 Gantt charts for intervention schedules in a stochastic analysis.

5.4. Stochastic result sets

If you save a result set of a stochastic analysis, you can find these data in the Scenario Overview window as shown in Figure 5.16.

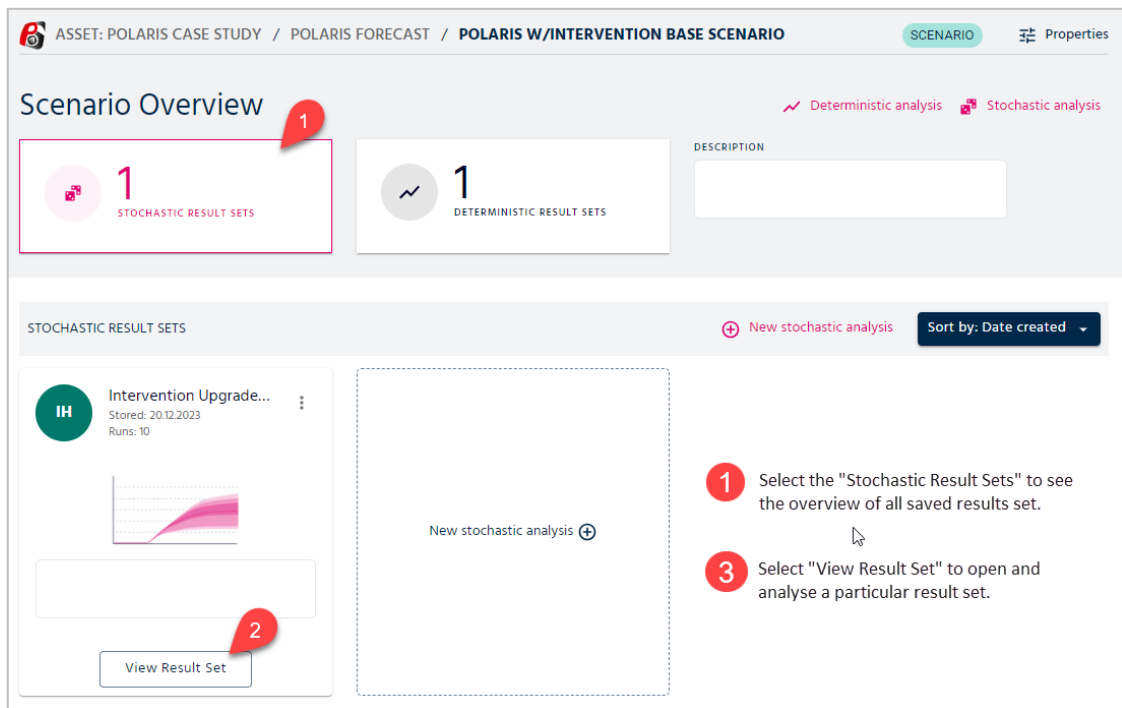


Figure 5.16 Saved result sets for a stochastic analysis.

When you open a saved result set, you will find the same information and same tabs as described in sections 5.3.1 - 5.3.3.

A great feature of pForecast is the possibility to compare one result set with another. This is illustrated in Figure 5.17. The graph shows one result set without an intervention, the other result set includes a suggested intervention and allows you to compare the benefits or drawbacks of your planned/scheduled intervention.

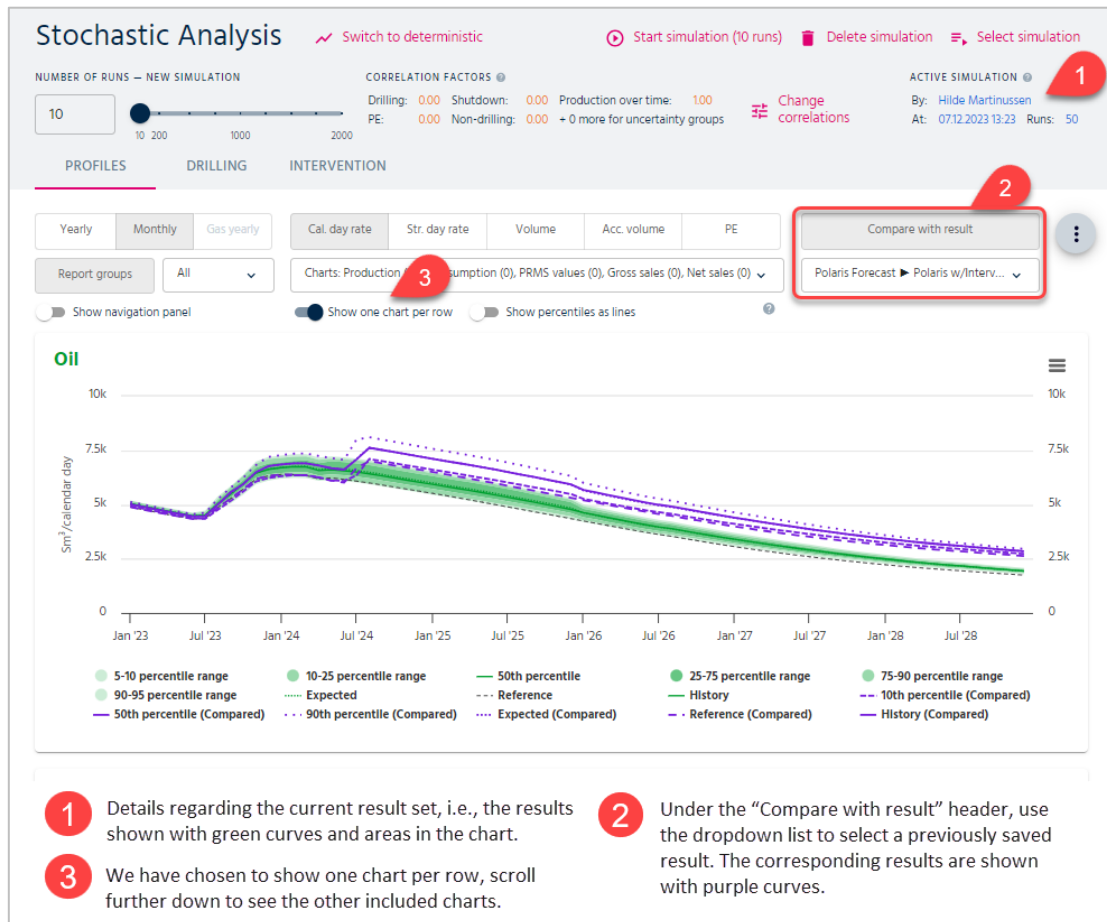


Figure 5.17 Comparing result sets.

6. Corporate Analysis

In most cases, companies own multiple assets, and it is desired to see the cumulation of values for all or a few of these assets. The pForecast software can support corporate roll-up analyses, which are cumulations of values for a selected set of assets. The users can create as many roll-ups as they wish for corporate-wide analyses and reports. Figure 6.1 through Figure 6.6 illustrate how to create a new roll-up.

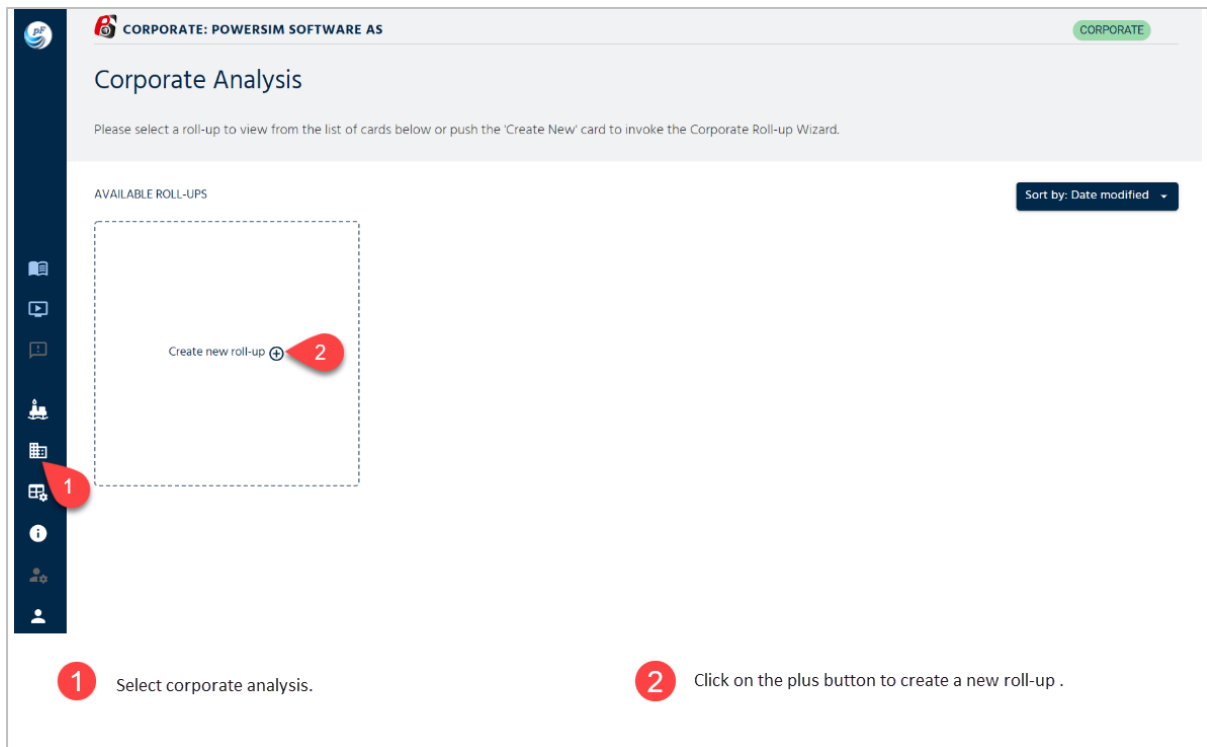


Figure 6.1: Creating a new corporate roll-up (part 1).

When creating a new roll-up, the following wizard page will be shown, in which the user can provide a name and description. It is also possible to insert the number of runs. The user can select a number between 100 and 10000. An automatic number will be used if this box is left empty. The automatic number is determined by selecting the larger value between 1000 and the number with the highest occurrence in the input (result sets). See Figure 6.2 for more details. Since corporate roll-ups consist of more than one asset, you will be asked to select the assets of interest in the next step. See Figure 6.3.

Create Corporate Roll-up

In order to create a corporate roll-up you need to provide additional information in the steps below.

1 Intro — 2 Assets — 3 Result sets — 4 Report groups — 5 Misc Optional

INFO
A corporate roll-up is a cumulation of values for a selected set of assets. You can create as many roll-ups as you like.

GENERAL

Name 1

Number of runs 3
<automatic>

Description 2

INSTRUCTIONS
Provide a name and possibly a description for the corporate roll-up. Specify the number of runs (combinations) used when generating the roll-up result set from the involved assets' stochastic result sets. Leave empty to use an automatic number.

Push the Next button to go on to the next step of the wizard. In later steps, you can use the Back button to take you one step back.

Cancel Back **Next** Create 4

1 Provide a suitable name.

2 Give the roll-up a suitable description.

3 Here you can specify the number of runs.

4 Click "Next".

Figure 6.2: Creating a new corporate roll-up (part 2).

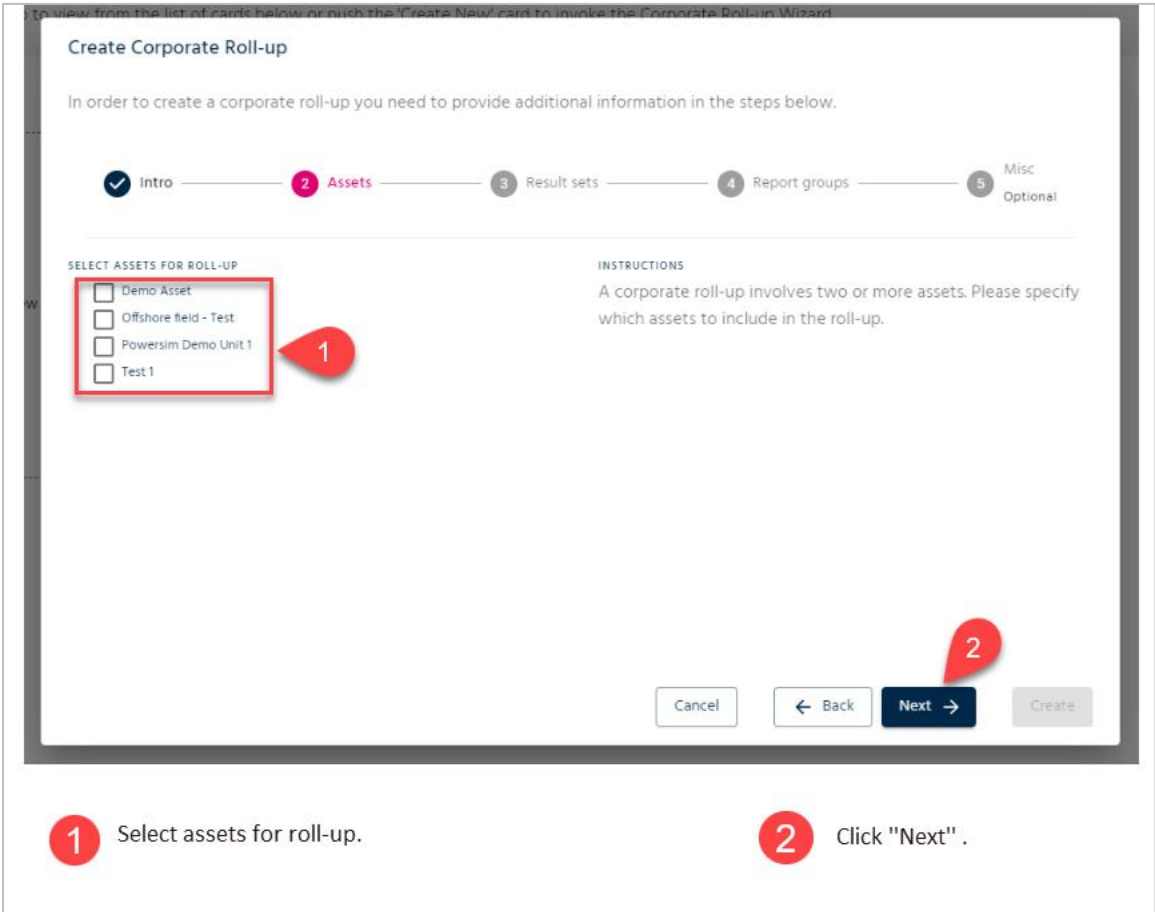


Figure 6.3: Creating a new corporate roll-up (part 3).

In the next step, for each of the assets selected in the previous step, a stochastic result set that is to produce the results for the asset during corporate roll-up should be specified. Figure 6.4 gives more details.

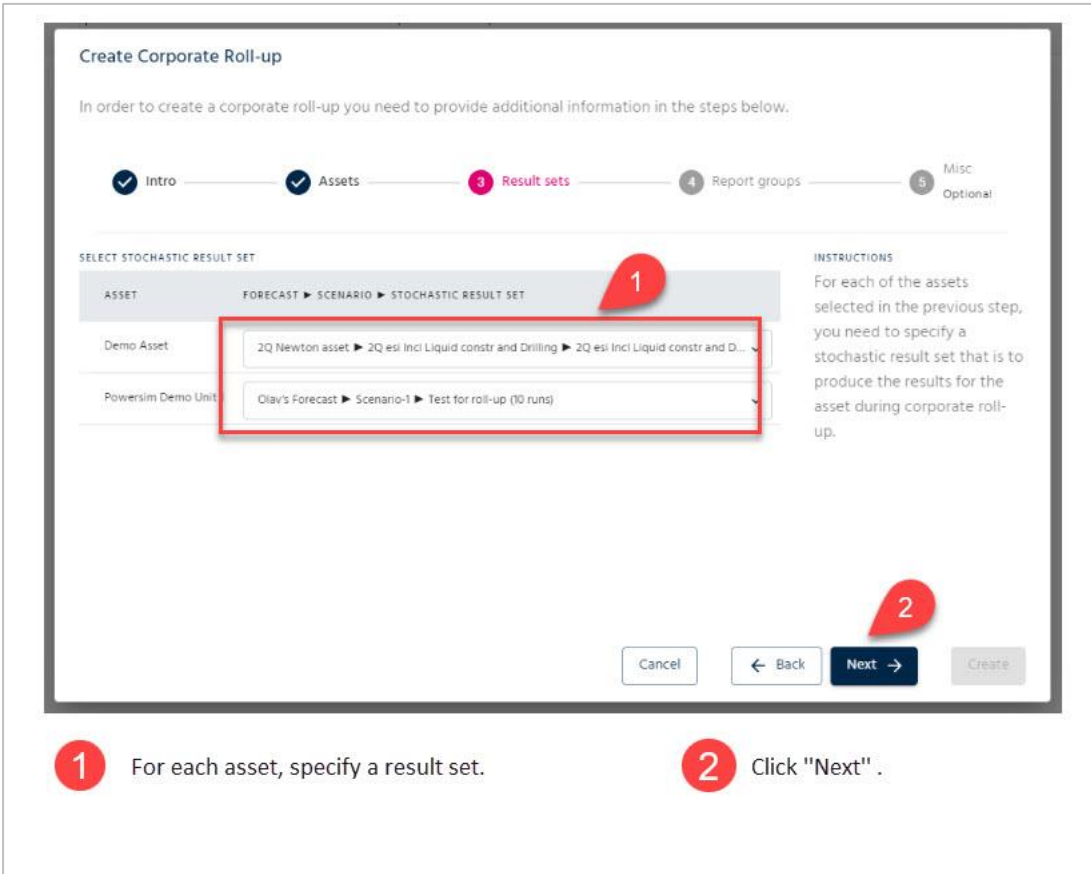


Figure 6.4: Creating a new corporate roll-up (part 4).

Now for each of the assets and result sets selected in the previous step, you need to specify which report groups from the result set that are to represent all wells, existing wells, and new wells of the asset during a roll-up. See Figure 6.5.

Create Corporate Roll-up

In order to create a corporate roll-up you need to provide additional information in the steps below.

Intro — Assets — Result sets — **4 Report groups** — 5 Misc Optional

SELECT REPORT GROUPS

ASSET ▶ RESULT SET	ALL	EXISTING	NEW
Demo Asset ▶ 2Q esl Incl Ligu...	All	Existing	New
Powersim Demo Unit 1 ▶ Test ...	All	Existing	<none>

INSTRUCTIONS
For each of the assets & result sets selected in the previous step, you need to specify which report groups from the result set that are to represent all wells, existing wells and new wells of the asset during roll-up.
The latter two report groups are optional.

Cancel ← Back **Next →** Create

1 For each asset/result set, specify the relevant report groups.

2 Click "Next".

Figure 6.5: Creating a new corporate roll-up (part 5).

In the last step and after having provided the necessary information for the roll-up, you can specify if you want to view the roll-up once the wizard closes. Figure 6.6 shows how to do so.

Create Corporate Roll-up

In order to create a corporate roll-up you need to provide additional information in the steps below.

Intro — Assets — Result sets — Report groups — **5 Misc**
Optional

WHEN WIZARD CLOSES
 View roll-up

INSTRUCTIONS
All necessary information for the roll-up about to be created has been collected. Please specify what is to happen once the wizard closes.

Cancel ← Back Next → **Create**

1 Turn the toggle on if you wish to view the roll-up when the wizard closes.

2 Click "Create".

Figure 6.6: Creating a new corporate roll-up (part 6).

7. Incremental Profiles

Introducing new fields, new wells, or performing facility upgrades and maintenance affect the production of already producing fields. To support project investment decisions, incremental profile analysis can be performed to quantify the net production of the entire project.

Incremental profiles are based on two scenarios, a base case, and a new case, within the same forecast. In fact, the total production of the incremental profile is the difference between the base case and the new case. Figure 7.1 through Figure 7.6 illustrate how to create incremental profiles analyses.

The screenshot displays the 'Forecast Overview' interface for 'ASSET: POLARIS CASE STUDY / POLARIS FORECAST'. The interface is divided into several sections:

- Forecast Overview Summary:** Shows '2 SCENARIOS' and '1 INCREMENTAL PROFILES ANALYSES'. It includes a 'DESCRIPTION' field, a 'TIME RANGE' from 2015 to 2035 (with a start date of 01.01.2023), and a 'STATUS' of 'IN PROGRESS'. A 'Flag for review' button is also present.
- SCENARIOS:** A list of scenarios including 'Polaris Scenario wo/l...' (PW) and 'Polaris w/Interventio...' (PS), both created by Hilde Martinussen on 07.09.2023. A 'Create new scenario' button and a 'Sort by: Date modified' dropdown are visible.
- INCREMENTAL PROFILES ANALYSES:** A list of analyses including 'New analysis' (NA) created and modified on 06.12.2023. A 'Create new incremental profiles analysis' button and a 'Sort by: Date modified' dropdown are visible.

Red callout boxes with the number '1' highlight the 'Create new incremental profiles analysis' button in the 'INCREMENTAL PROFILES ANALYSES' section and the 'plus' button in the 'New analysis' card. A text box next to the 'plus' button reads: 'Evaluate an additional profile on the ... field into the ... fields.' Below this is a 'View Analysis' button.

1 Under forecast overview click on the plus button to create a new incremental profile analysis.

Figure 7.1: Creating a new incremental profiles analysis.

When clicking the 'Create new incremental profiles analysis' card, the following wizard page will be shown, in which the user can provide a name, description, and the number of runs for the Monte Carlo simulation behind the analysis. The user can select a number between 10 and 2000. See Figure 7.2 for more details.

Please note that if you select 50 as the number of runs, this means that your Incremental Profiles Analysis will run both scenarios 50 times, that is 100 runs all together.

Also, please note that in this type of analysis, the two stochastic simulations are run with the same draw of random values for mutual entities, which makes them mathematically viable to compare with each other. This is one of pForecast's greatest strengths.

Create Incremental Profiles Analysis

In order to create a incremental profiles analysis you need to provide additional information in the steps below.

1 Intro — 2 Scenarios — 3 Increment report group — 4 QC report groups Optional — 5 Misc Optional

INFO

To support project investment decisions, an incremental profiles analysis can be performed to quantify the net production to the entire project resulting from the incremental project.

GENERAL

1 Name

Description

2

NUMBER OF RUN 50 **3**

10 200 1000 2000

INSTRUCTIONS

In addition to name and description for the analysis, specify the number of runs for the Monte Carlo simulations behind the analysis.

Push the Next button to go on to the next step of the wizard. In later steps, you can use the Back button to take you one step back.

Cancel ← Back **Next →** Create **4**

1 Provide a suitable name for your incremental profile analysis.

2 Provide a suitable description.

3 Specify the number of runs.

4 Click "Next".

Figure 7.2: Apply a name and decide number of runs.

Since an incremental profiles analysis consists of two scenarios, in the next step, you need to select both a base and new case (see Figure 7.3). Note that the new case scenario typically include an incremental project.

Create Incremental Profiles Analysis

In order to create a incremental profiles analysis you need to provide additional information in the steps below.

✓ Intro — 2 Scenarios — 3 Increment report group — 4 QC report groups Optional — 5 Misc Optional

SELECT BASE CASE SCENARIO 1

Polaris Scenario wo/Intervention

Polaris w/Intervention Base scenario

SELECT NEW CASE SCENARIO 2

Polaris Scenario wo/Intervention

Polaris w/Intervention Base scenario

INSTRUCTIONS

An incremental profiles analysis involves two scenarios from the same forecast. Please specify a scenario for both the base case and the new case (the one including the incremental project).

Note that if you started the wizard from the card of a base case scenario, you only need to specify the new case scenario.

Cancel Back **Next** → Create

1 Select base case scenario.

2 Select new case scenario.

3 Click "Next".

Figure 7.3: Selecting scenarios for incremental profile analysis.

Next, you are required to select the report group which constitutes the basis for the increment calculations. This is normally a report group that represents the total project. In the incremental profiles analysis result viewer, the selected report group will result in three available report groups:

1. Report group for the base case gross value.
2. Report group for the new case gross value.
3. Report group for the increment value.

Figure 7.4 illustrates how to perform this step.

Create Incremental Profiles Analysis

In order to create a incremental profiles analysis you need to provide additional information in the steps below.

✓ Intro — ✓ Scenarios — **3 Increment report group** — 4 QC report groups Optional — 5 Misc Optional

SELECT REPORT GROUP FOR INCREMENT **1**

Well status ► Existing

REPORT GROUP NAMES IN ANALYSIS RESULT **2**

Base case gross value
Gross (base case)

New case gross value
Gross (new case)

Increment (net value)

Increment

INSTRUCTIONS

In this step, you decide which report group that is the basis for the calculation of the increment. This is typically a report group representing the total project (whole asset).

In the incremental profiles analysis result viewer, the selected group will result in three available report groups: one for the base case gross value, one for the new case gross value, and one for the project increment (the net value). You can change the suggested names for these report groups, if you like.

Cancel ← Back **Next →** **Create** **3**

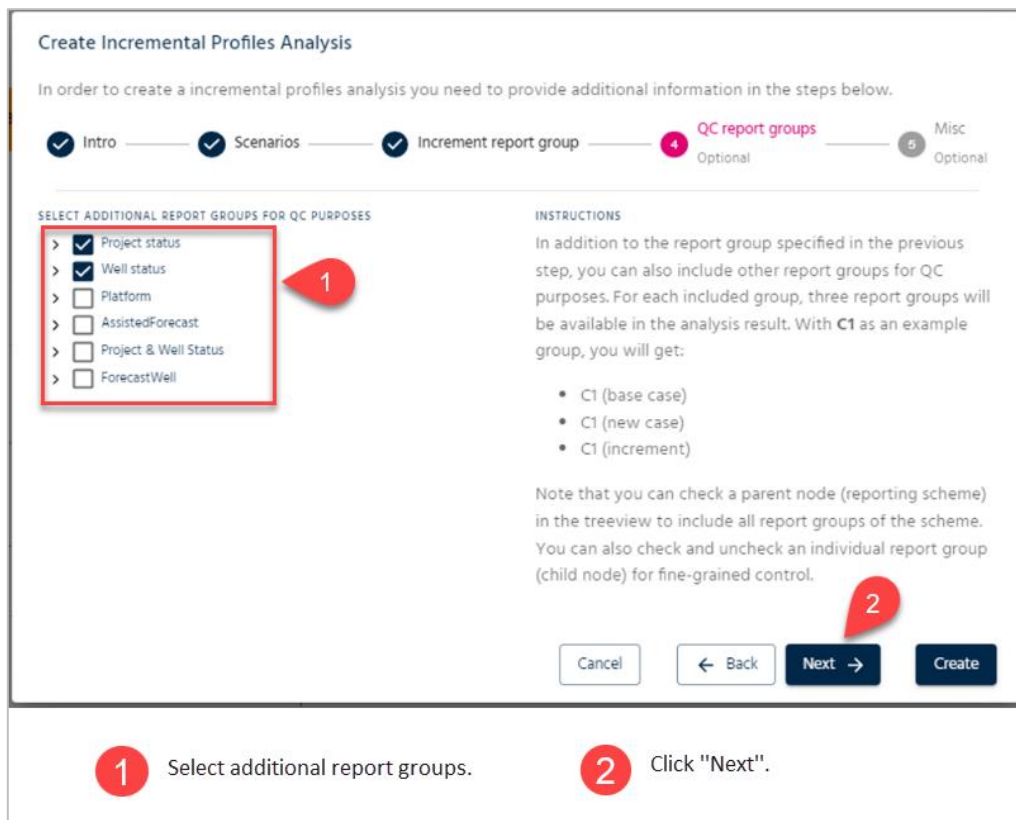
1 Select report group for increment calculations.

2 Provide report group names in analysis result.

3 Click "Next".

Figure 7.4: Selecting a report group for incremental profiles analysis.

In addition to the report group that you have already specified, you can also include other report groups for quality check purposes. Like with the previous step, for each selected group, three report groups will be available, base, new, and increment. Figure 7.5 shows how to select additional report groups.



Create Incremental Profiles Analysis

In order to create a incremental profiles analysis you need to provide additional information in the steps below.

Intro — Scenarios — Increment report group — **QC report groups** — Misc

Optional — Optional

SELECT ADDITIONAL REPORT GROUPS FOR QC PURPOSES

- Project status
- Well status
- Platform
- AssistedForecast
- Project & Well Status
- ForecastWell

INSTRUCTIONS

In addition to the report group specified in the previous step, you can also include other report groups for QC purposes. For each included group, three report groups will be available in the analysis result. With C1 as an example group, you will get:

- C1 (base case)
- C1 (new case)
- C1 (increment)

Note that you can check a parent node (reporting scheme) in the treeview to include all report groups of the scheme. You can also check and uncheck an individual report group (child node) for fine-grained control.

Cancel ← Back **Next →** Create

1 Select additional report groups. **2** Click "Next".

Figure 7.5: Selecting additional report groups for incremental profiles analysis.

After collecting all the necessary data for the analysis of the incremental profiles, you can decide whether you want to view the incremental profiles analysis once the wizard closes. See Figure 7.6.

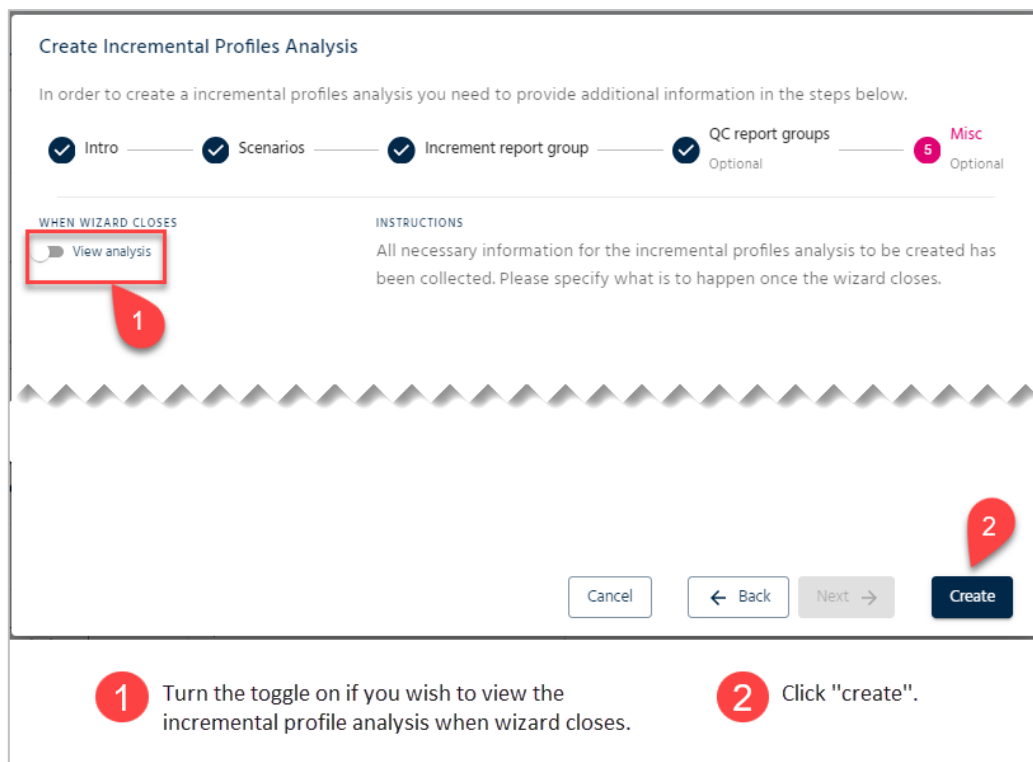


Figure 7.6: Creating a new incremental profiles analysis.

After running the incremental analysis, you will be able to see the results in the Result Viewer. You can view the base case scenario, the new case scenario, and most importantly the resulting increment.

Figure 7.7 shows accumulated volume for the increment for oil, gas, water and liquid respectively.

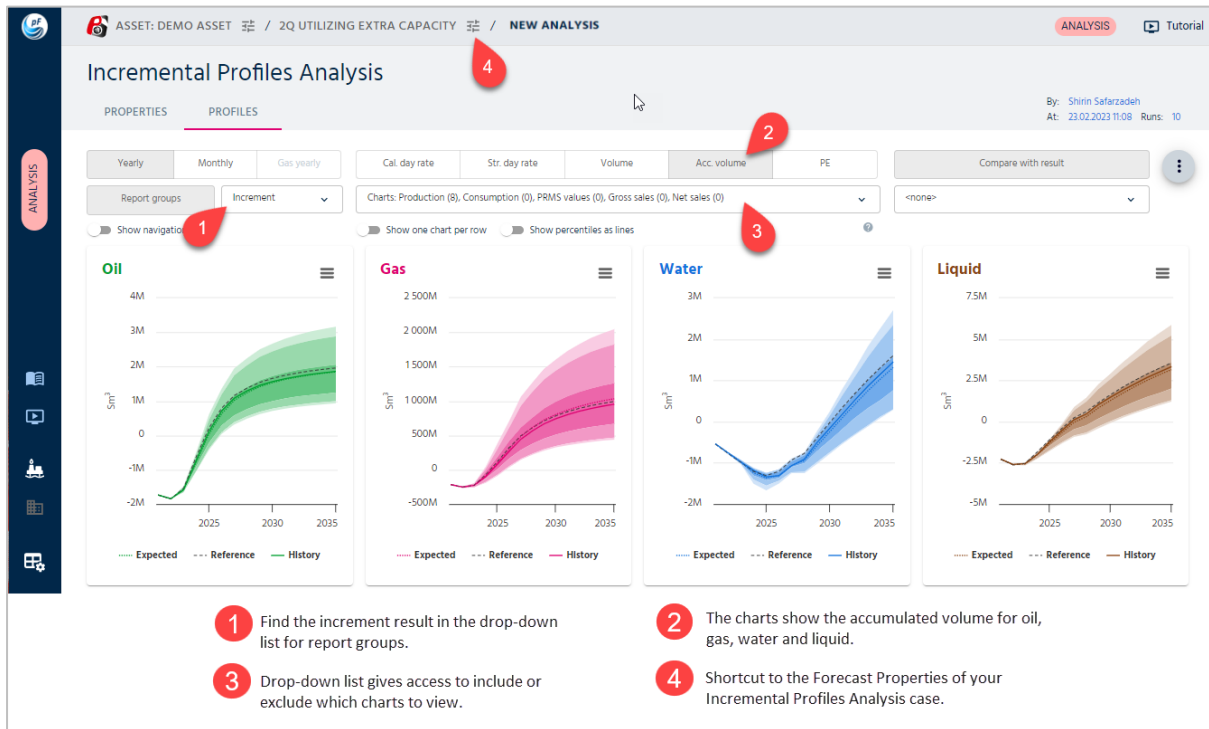


Figure 7.7 Viewing the increment's accumulated volume.

8. Corner Cases

This chapter presents how to deal with corner cases and how to combine functionalities in pForecast to model specific activities.

8.1. Slot Recovery

In case of modeling a sidetrack (Figure 8.1), pForecast can automatically shut down the existing well when the drilling of the new wellbore starts. Note that the new wellbore is secondary, and since the drilling times have uncertainty, we don't know exactly when to shut down the old wellbore. In such cases, you would normally want to keep producing as long as possible. The solution is to connect these events by selecting the drilling start of the second wellbore as the cut-off condition.

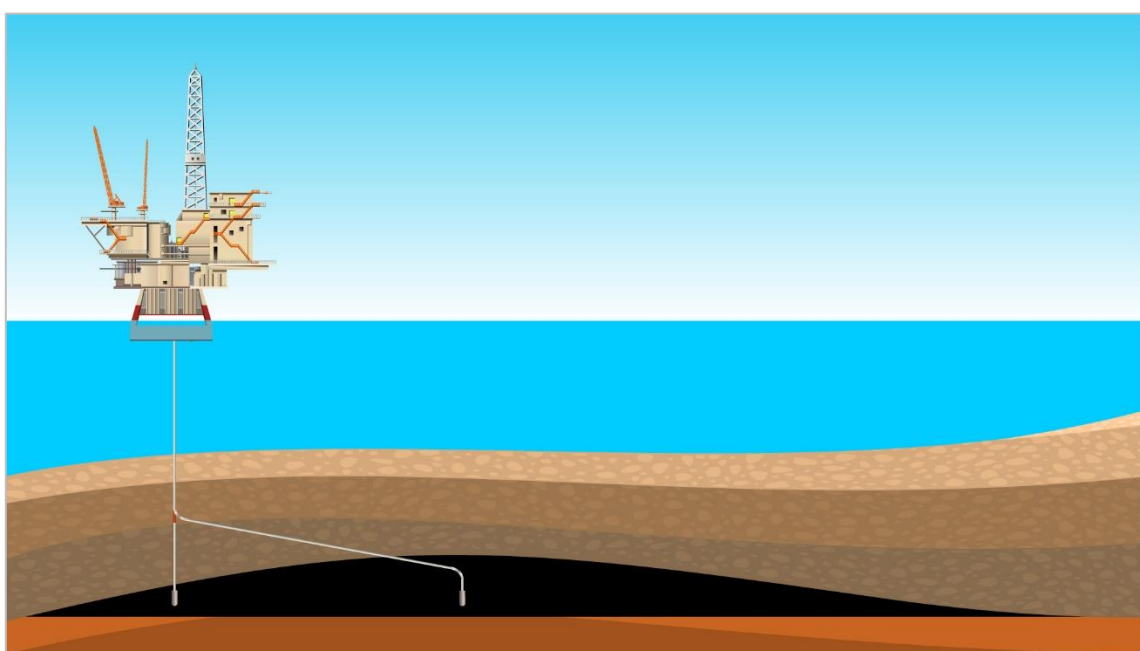


Figure 8.1: Slot recovery or sidetrack.

To model a slot recovery in pForecast, first, you need to create a new wellbore. Figure 3.20 illustrates how to do so. Next, you need to select the “Production Potential” tab and select the profile used for the existing well you want to shut down. Then, under the Cut-off section, use the “At drilling start of well” option. There you can choose a new wellbore; the one which is to replace the old wellbore. See Figure 8.2.

Forecast Properties

FORECAST | **PRODUCTION POTENTIAL** | FORECAST WELLS | DRILLING | CAPACITY | SEPARATION | PRODUCTION EFFICIENCY | PRODUCTION CORRELATION | INTERVENTION JOBS

PRODUCTION POTENTIAL PROFILES

NAME	TYPE	GENERIC	USE COUNT	CREATED	MODIFIED
A1					

Created: 22.11.2022 10:12 (Shirin Safarzadeh). Modified: 22.11.2022 10:13 (Shirin Safarzadeh)

General

Profile name: A1 | Profile type: Decline curve | Primary phase: Oil

Cut-off

At volume (Sm³): [] | At rate (Sm³/day): [] | On date: dd.mm.yyyy | At drilling start of well: <none>

Capacity limitation priorities

Default GOR (Sm³/Sm³): [] | Default water cut (%): [] | Priority group: Normal | Priority switch date: dd.mm.yyyy | New priority group: Normal

1 Under Forecast Properties, select the “Production Potential” tab.

2 Select the name of the new wellbore .

Figure 8.2: Modelling a slot recovery.

8.2. Capacity Upgrade

In connection with a capacity upgrade, it is necessary to define a shut-in period during the process of upgrading.

To model this, the old capacity should be valid before the shut-in period, while the new capacity should be valid from the end of the shut-in period. But since the duration of the shut-in period has uncertainty, the last day of the shut-in period will not be exactly known. To handle this issue, under the “Capacity” section we assign the “valid from-day” of the constraint to the start date of the shut-in period rather than to the end, even if the end would be the most correct time of change (see Figure 3.18).

Since it doesn’t matter which capacity we have during the shut-in; this approach will not compromise the validity time of the constraints before and after the shut-in.

To make this work, it is important to keep a fixed time for the start of the shut-in and use the same time for the new constraint. Figure 8.3 gives more details about how to model capacity upgrades in pForecast software.

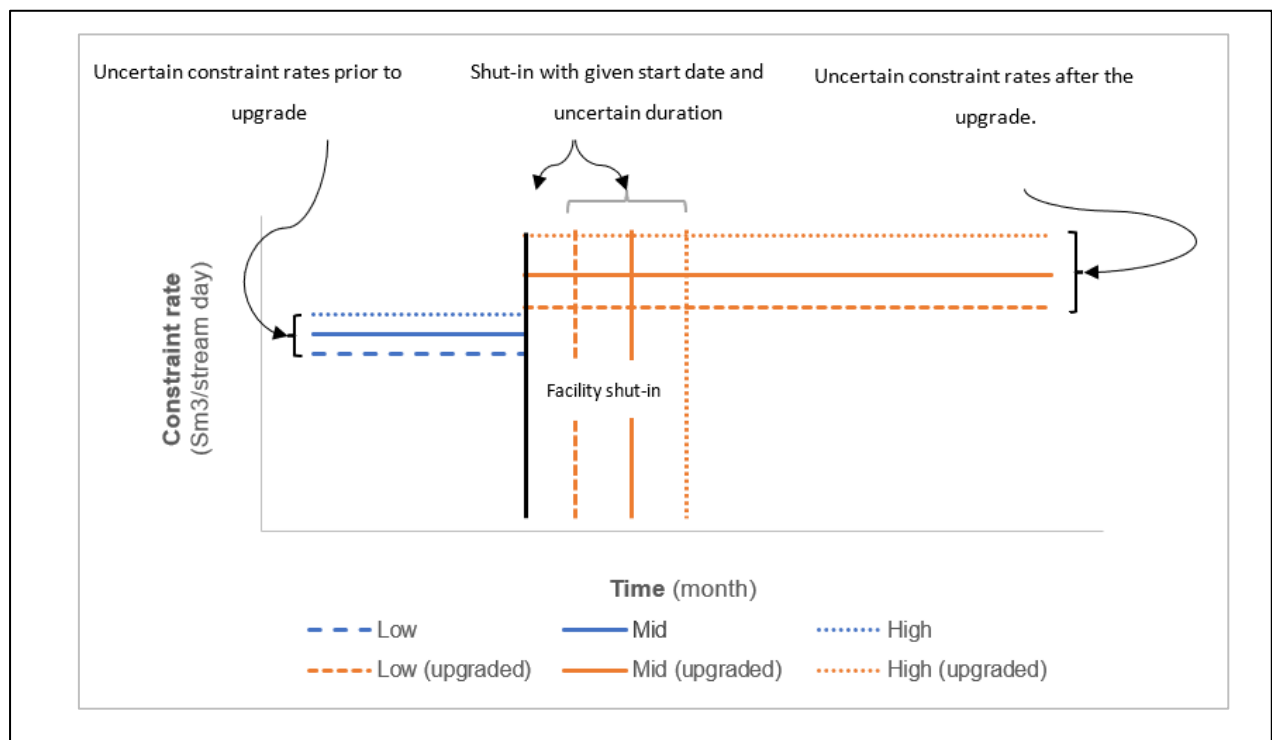


Figure 8.3: Capacity upgrade with facility shut-in during upgrade.

9. Glossary

The glossary summarizes the most used terminology in the pForecast software.

Asset: An asset in this context is a group of fields that share data.

Business Unit: Business unit and asset are used interchangeably.

Capacity limitation priorities: If capacity constraints limit your production, you have several ways of prioritizing the order in which wells will be choked. If you specify the default GOR or water cut, these values will be used instead of the calculated water cut or GOR. The priority groups are considered before GOR and water cut in a two-step prioritization approach. A low priority means being among the first wells to be choked and vice versa.

Cluster: Clusters are used to group wells and to constrain the production and injection to the capacity of that group. Clusters can be routed to other clusters; there can be up to four levels of clusters in a facility.

Corporate Analysis: Corporate roll-up analyses are cumulations of values for a selected set of assets. The users can create as many roll-ups as they wish for corporate-wide analyses and reports.

Cut-off: There are four criteria you may specify to cut the well production permanently: at a given rate, at a given volume, on a given date, and at drilling start of another well.

Field: An area in which there are one or several reservoirs. You import data for one field at a time. The field information is used for reporting purposes.

Gas Formation Volume Factor (B_g): This is the ratio of the gas volume at the reservoir condition to its corresponding volume at the standard condition ($P = 101.325$ kPa and $T = 288.15$ K). In pForecast, it is used for Voidage Management.

GOR: Gas-Oil ratio (R_s): This is the ratio of the volume of gas that comes out of the solution to the volume of oil at standard conditions ($P = 101.325$ kPa and $T = 288.15$ K)

Oil Formation Volume Factor (B_o): This is the ratio of the oil volume at the reservoir condition to its corresponding volume at the standard condition ($P = 101.325$ kPa and $T = 288.15$ K). In pForecast, it is used for Voidage Management.

PE: Production Efficiency.

PVT: This is the abbreviation for pressure, volume, and temperature.

Regularity: In pForecast, we use regularity for constraints on injection, which can be between zero and one. If you want to specify regularity for production, you should specify PE (Production Efficiency).

RNB: It is mandatory for operating companies in Norway to submit their forecasts to the Revised National Budget ([RNB](#)). In pForecast, a structure of RNB profiles and projects can be defined under the RNB tab.

Rs: Rs and GOR are used interchangeably.

TAR: A turnaround or a “TAR” is a very expensive process in which an industrial plant or refinery goes through a scheduled shutdown in order to perform maintenance on the facility. During this time, production must come to a complete stop.

Voidage factor: In pForecast, the voidage factor is a user input that means the same as Voidage Replacement Ratio (VRR). It is defined as follows:

$$\text{VRR} = \frac{\text{Injected reservoir volume}}{\text{Produced reservoir volume}}$$

Voidage group: Used to group producing wells and injector wells on the same reservoir in connection with Voidage Management. A specific voidage factor (VRR) will be assigned to each voidage group.

Volume-based profile: By turning on this toggle, the total volume of the production potential will be preserved even if there are limitations on the production. Such limitations could be production efficiency, shut-down periods, and potential reductions due to capacity limitations.

WTC: Water Cut. The ratio of water produced compared to the volume of total liquids produced.

About us

We help the petroleum industry generate the best possible forecasts for the most complex reservoirs. pForecast is a Software as a Service (SaaS) solution to digitalize, simplify, and standardize how production forecasts are generated and utilized. pForecast performs a full lifetime simulation of the production and injection forecast, including historical data, in keeping with the industry's ever-increasing need for agility. Powersim Software is the software company and developers behind the pForecast solution.

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