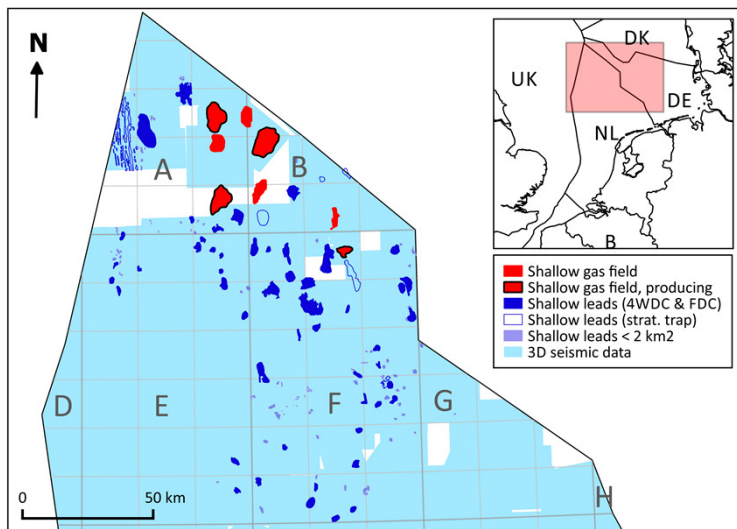


# Regional overview Cenozoic shallow gas fields

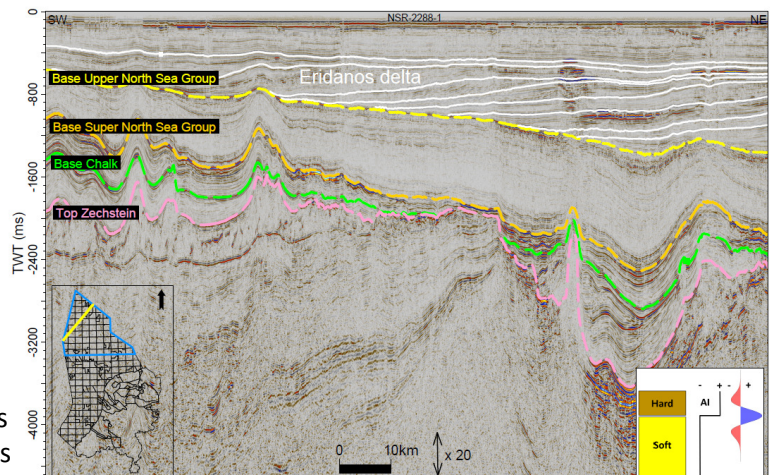
Cenozoic sediments in the Dutch North Sea host abundant seismic amplitude anomalies, or bright spots, of which many are proven to be related to hydrocarbons and the majority exhibit a DHI characteristic of gas emplacement.



The Netherlands was the first country in the North Sea region in which these accumulations have been developed. Currently, four Dutch shallow fields are producing, and additional fields are planned to come on stream in the coming years. The play has proven to be a valuable **resource** and with several tens of undrilled shallow leads, largely covered by 3D seismic data, it is worth further evaluating the development potential of the play.

## Geological setting

Most of the shallow anomalies in the area occur in formations that are deposited in a Mio-Pliocene fluvial-deltaic system, generally referred to as the Eridanos Delta. The Delta system covers a large part of the current Southern North Sea and comprises an alternation of shales and clean-to-shaly sands. These stacked sandy layers form the reservoirs, sealed by intermittent shales. The gas column height within each sand is controlled by the critical fracture pressure of overlying shale layer, increase of the column height results in seal breach and venting of gas into shallower layers. Shallow gas primarily has a biogenic origin, there are however also indications that also gas with a thermogenic origin has entered the system.

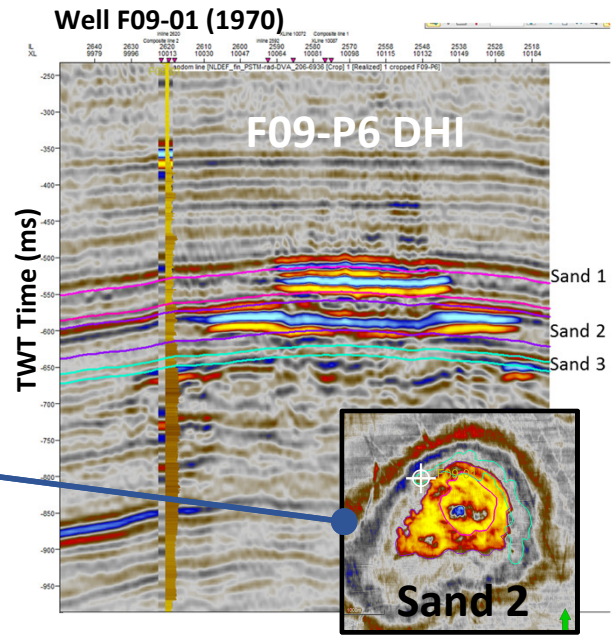
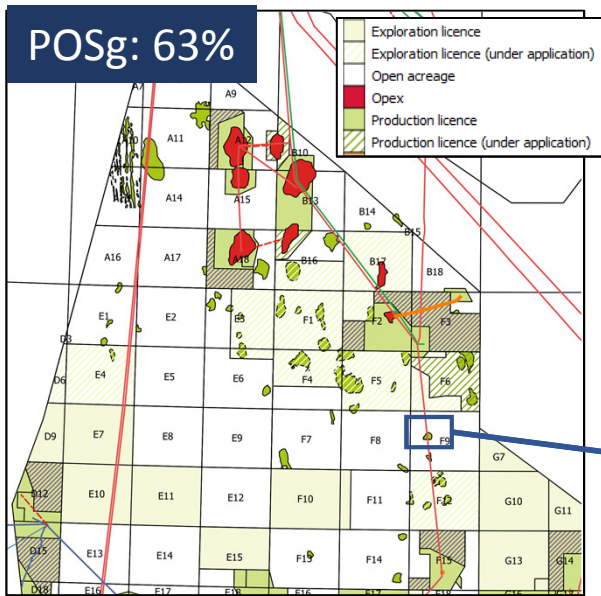


## Shallow gas play elements in the Northern Dutch offshore

Risking of shallow gas lead F09-P6		
<b>Structure</b>	90%	<ul style="list-style-type: none"> <li>Seismic data hosts abundant amplitude anomalies, or bright spots that indicate the presence of gas.</li> <li>4-way dip closure, presence of seismic amplitude anomalies and DHI's suggest underfill</li> </ul>
<b>Charge &amp; migration</b>	100%	<ul style="list-style-type: none"> <li>Well F09-01 (drilled next to bright spot) has gas shows up to 2%. Attributed to the rich organic content of the clays</li> <li>Amplitude partly conform structure</li> <li>Pull down, gas shows in well next to bright spot</li> </ul>
<b>Seal presence &amp; efficiency</b>	70%	<ul style="list-style-type: none"> <li>Intermittent clay layers present in the Pliocene section act as effective seal for these stacked reservoirs.</li> <li>Hydrocarbon column heights dynamically controlled by critical fracture pressure of intermittent shale layers acting as seal, thus controlling the level of underfill</li> </ul>
<b>Reservoir presence</b>	100%	<ul style="list-style-type: none"> <li>Presence of continuous stacked sands with sufficient thickness, N/G and porosity (20-25%) verified by seismic and wells nearby.</li> </ul>

# Shallow gas Lead F09-P6

The undiscovered F09-06 lead is mapped in the open F09 offshore block. This lead could be developed with a single well, possibly in combination with nearby oil leads F09-Stelvio and F08-Ventoux.

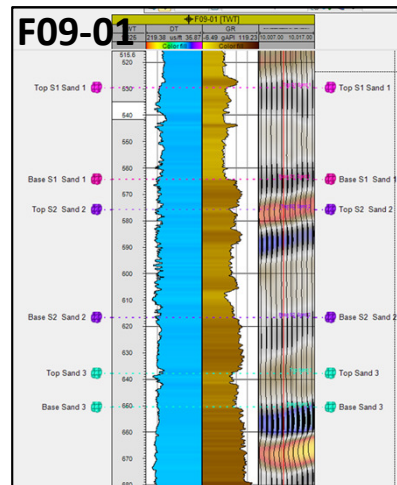


## Volumetric Assessment

Conformable hydrocarbon related “bright spot” present in Cenozoic fluvio-deltaic **intercalated** sands and shales (Eridanos delta) @ depth of circa 650m

For volumetric GIIP assessment “Standard” shallow gas parameters are used for porosity (20-25%), thickness and Sg (~50-80%) (from producing fields shallow gas A12-FA and F02a-B Pliocene).

GIIP (bcm)	P10	P50	P90
F09-P6	0.4	0.7	1.2



POSg : 63%

**Key Risk:** Gas saturation Sg can be as low as circa 10% and give similar DHI response

## Work Program Requirements

- Apply for an exploration license
- Study additional potential in block on deeper targets:
  - F09- Stelvio, Jurassic oil prospect, Lower Graben sands (STOIP 18-49 MMbbl)
  - F08-Ventoux, Jurassic oil lead, Lower and Upper Graben sands and Kimmeridgian sands (STOIP 15-65 MMbbl)
- Gas saturation (Sg) can be potentially be de-risked using CSEM and/or gravity measurements.
- The shallow depth of the opportunity lends itself to a simple low-cost well penetration to de-risk N/G and Sg using standard logging tools.

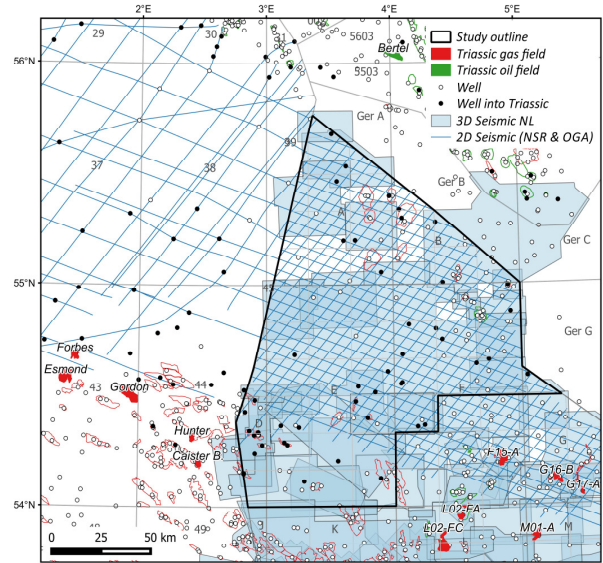
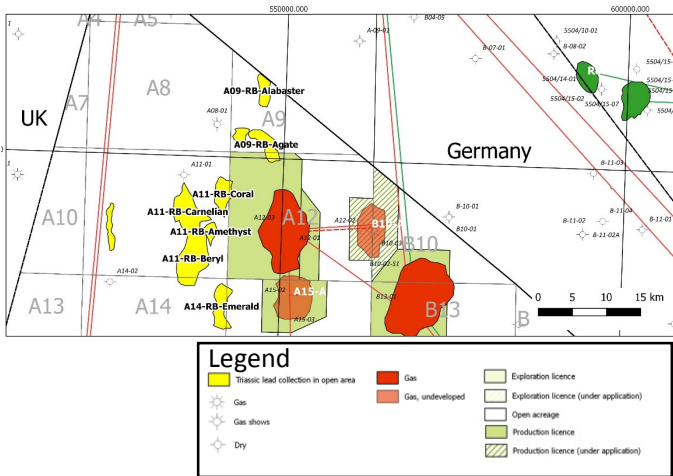
## Economic Overview

- Single well development
- Accumulation is located 29km from the nearest platform.
- Based on existing producing shallow gas fields a RF of 65% can be assumed.
- Shallow gas accumulations typically comprises 99% methane.
- Marginal field tax allowance: 25 (40% probably from 1.1.2020)
- Stand-alone development maybe marginally economically attractive and could require other discoveries nearby
- **Key Risks:** Sand production.



# Asset Overview: A09-RB-Agate and A11-RB-Beryl, Triassic

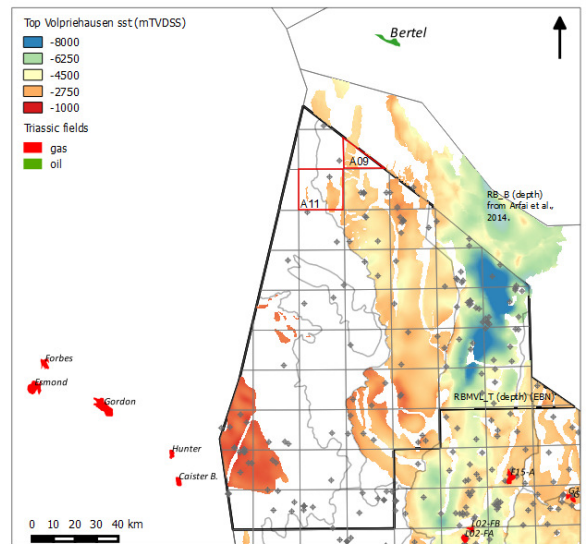
The Triassic in the northern Dutch offshore remains significantly under-explored, although it is a proven play elsewhere in the Southern North Sea. Numerous Triassic leads have been identified in the open A09 and A11 blocks which are located in proximity of nearby infrastructure.



Extensive 3D and 2D seismic coverage over Triassic leads

## The Triassic in the Dutch offshore

- The Triassic play is the second-most prolific system in the Southern North Sea Basin (ca 2.5 bcm gas production per year, offshore only, which is ca 22% of total offshore production).
- Recent analyses show that the Lower Triassic sediments in the northern Dutch offshore may contain over-looked resources with the potential presence of reservoir sands sourced from the North, structural traps around complex salt bodies and charge from mature Lower Carboniferous source rocks. Röt evaporites are present in large parts of the northern Dutch offshore and these are proven seal for many of the Triassic fields elsewhere.
- Within the A09 and A11 blocks several leads can be drilled from a single location. There is a strong risk-dependency between the leads hence a discovery would de-risk and open up a significant volume portfolio.
- Despite humble in-place volumes per lead, the aggregated volumes are material and would warrant economic development.



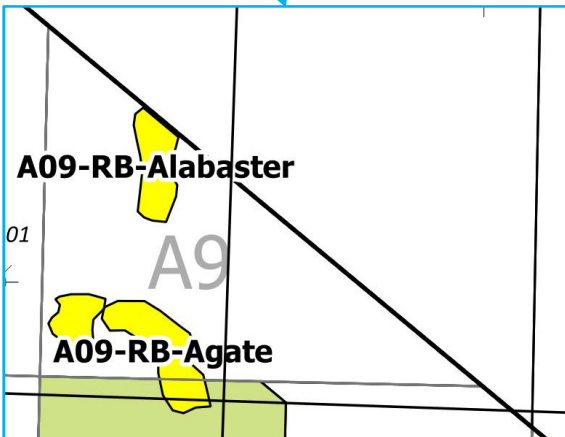
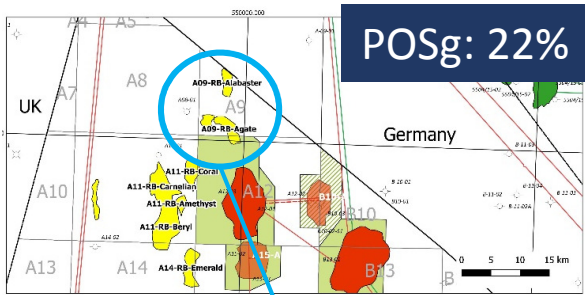
Good geological understanding at the regional play level

## Risking of Triassic play elements

<b>Structure</b>	80%	<ul style="list-style-type: none"> <li>Seismic data supports the presence of traps analogous to the successfully tested traps in the Southern North Sea area.</li> <li>Identification of traps is partly based on 2D data and no wells have drilled Triassic strata in A09 and A11 to date.</li> </ul>
<b>Charge &amp; migration</b>	80%	<ul style="list-style-type: none"> <li>Wells A09-01 and UK 39/07-01 drilled 30 m and 23 m of coal respectively, proving the presence of Lower Carboniferous gas-prone source rocks. The presence of high contrast seismic facies suggests the presence of coal and allows to map these coals regionally.</li> <li>Basin modelling suggests SR currently in gas maturity window.</li> <li>Seismic data indicates the presence of many Zechstein windows to allow HC migration.</li> </ul>
<b>Seal presence &amp; efficiency</b>	50%	<ul style="list-style-type: none"> <li>Seismic interpretation supports the presence of Röt salt (bright reflector) which is a proven seal in other Triassic fields elsewhere in the North Sea area.</li> <li>Gas fields in the UK are sealed by a thin layer of Lower Cretaceous Marls.</li> <li>Well data is scarce and overpressures may have caused seal breach and limitation to the hydrocarbon column height to be retained below top seal.</li> </ul>
<b>Reservoir presence</b>	90%	<ul style="list-style-type: none"> <li>Adequate reservoir rock parameters successfully tested in nearby wells. Lateral continuity is likely as indicated by convincing seismic control, although well density is sparse.</li> <li>Seismic data shows the presence of local depocentres. A15-01 drilled a local depocentre and proved the presence of Triassic reservoir rocks with good reservoir quality. However the A15-01 well did not encounter hydrocarbons.</li> </ul>

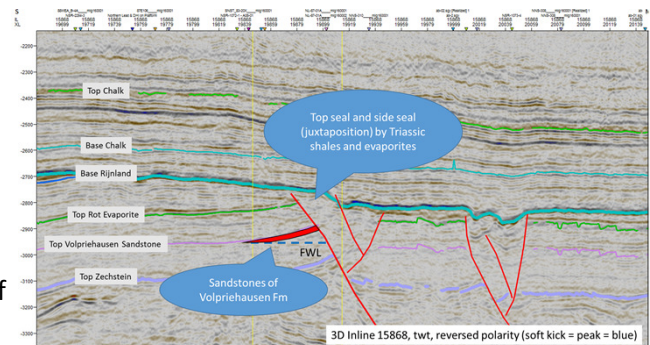
# A09-RB-Agate, Triassic

The undiscovered Agate lead is the largest of 3 leads mapped in the open A09 offshore block. These leads could be drilled with slanted wells from a single drilling platform.



## Block activity

- The A-quadrant is relatively underexplored, with circa 12 Exploration wells drilled, typically one well/500km<sup>2</sup>. Data for these wells is public.
- The nearest well (A08-1) well was drilled in 1996 into an Upper Jurassic 4-way dip closure on top of a Zechstein salt diapir.
- The closest infrastructure is the A12a platform which drains gas from the Tertiary A12-FA field (Shallow gas). The A12a jacket leg platform is unmanned and has processing capability. Distance from A12a to A9 is approximately 16 km.
- The A09 block is fully covered with 3D seismic acquired in 1993, publicly available, and PSTM reprocessed in 2012.

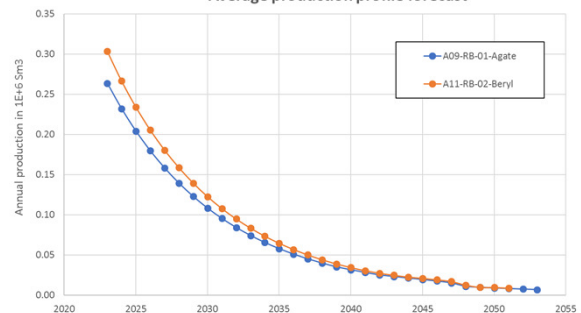


## Volumetric assessment

- Primary targets:** Mixed fluvial/eolian sandstones of the Volpriehausen Fm.
- Secondary targets:** Detfurth, Hardeggen and Solling Fm.
- Estimated recovery factors of 60-70%
- In the success case these structures are charged with natural wet gas with ca. 5% non-HC gasses (CO<sub>2</sub>, N<sub>2</sub>).

Risked recoverable bcm	P90	P50	P10
A09-RB-Agate	0.1	0.3	0.8
Total in block	0.5	1.5	4.4

Average production profile forecast



## Economic overview

- The aggregated expected volume of the leads in the block (1.5 bcm in A09) is significant, with a strong inter-lead risk dependency.
- A successful first well would open up the portfolio, and the combination of at least two discoveries per block would warrant a multi-well, stand-alone platform development concept.
- The Minimum Economic Field Size in this area has been estimated ca 1 bcm (recoverable) based on the following assumptions:

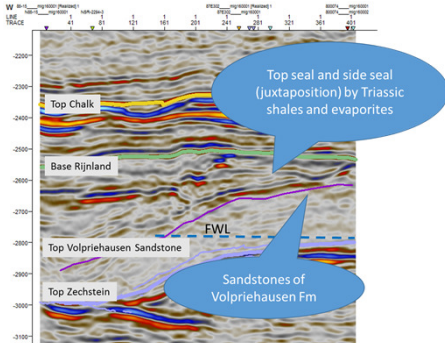
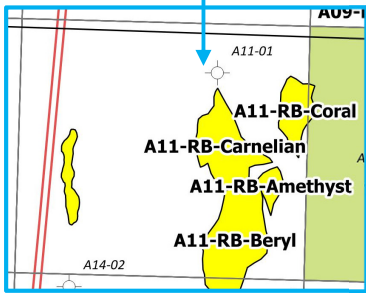
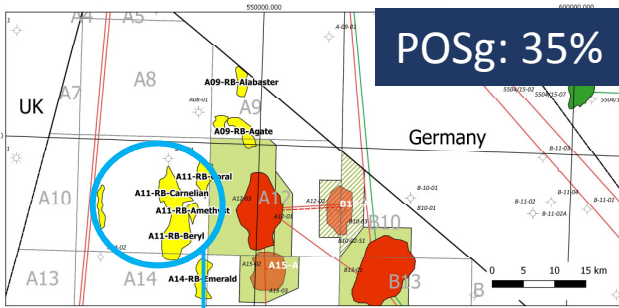
Drilling start	2021	Avg. decline	15%
Est. Qi	0.25 bcm/ yr	Gas price	€0.19 /m3
RVIR cut-off	10%	Marginal allow.	25%-40%

## Work program Requirements

- Apply for exploration license.
- Reprocess 3D vintage data.
- Drill exploration well to de-risk lead portfolio, to be converted into a production well (in success case).
- In success case, A09 could support stand-alone development. The prospects can be drilled with deviated wells from a single, central platform location. An alternative option would be a tie-back to A12 facilities in case A09 volumes < P50 volumes.
- The A12 facilities are capable of handling the higher reservoir pressures expected from the Triassic.

# A11-RB-Beryl, Triassic

The undiscovered Beryl lead (area ca. 27.1 km<sup>2</sup>) is the largest of 5 leads mapped in the open A11 offshore blocks



2D line NSR09-21068-1-PRCMIG, twt, reversed polarity (soft kick = peak = blue)

## Block activity

- The A-quadrant is a relatively under-explored area with circa 12 wells targeting pre-Tertiary levels; typically ca 1 well/500km<sup>2</sup>. Data for these wells is publicly available.
  - The closest A11-1 well was drilled in 1981 to a deeper (Lower Carboniferous) combined dip/fault closure target. The closest infrastructure is the A12a platform which drains gas from the Tertiary A12-FA field (Shallow gas). The A12a jacket leg platform is un-manned with processing capability. Distance from A12a to A11 is ca 11 km.
  - The A11 block is partly covered with 3D seismic acquired in 1998, publicly available, and PSTM reprocessed in 2012.
  - The entire block is covered with a high density grid of 2D seismic lines of various vintages.

## Volumetric assessment

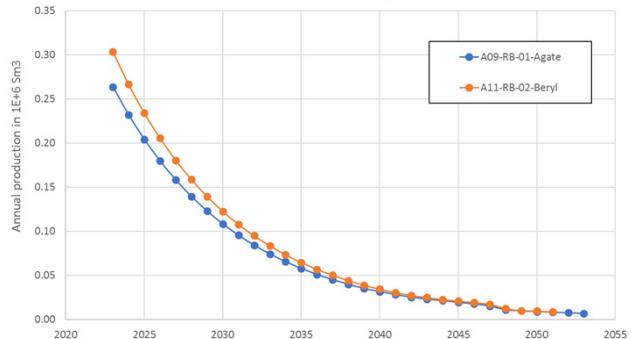
- Primary targets:** Mixed fluvial/eolian sandstones of the Volpriehausen Fm.
- Secondary targets:** Detfurth, Hardeggen and Solling Fm.
- Estimated recovery factors of 60-70%
- In the success case these structures are charged with natural wet gas with ca. 5% non-HC gasses (CO<sub>2</sub>, N<sub>2</sub>).

Riskd recoverable bcm	P90	P50	P10
A11-RB-Beryl	0.1	0.3	0.8
Total in block	0.5	2.3	5.5

## Work program Requirements

- Apply for exploration license.
- Reprocess 3D vintage data.
- Drill exploration well to de-risk lead portfolio, to be converted into a production well (in success case).
- In success case, A09 could support stand-alone development. The prospects can be drilled with deviated wells from a single, central platform location. An alternative option would be a tie-back to A12 facilities in case A09 volumes < P50 volumes.
- The A12 facilities are capable of handling the higher reservoir pressures expected from the Triassic.

Average production profile forecast



## Economic overview

- The aggregated expected recoverable volume of the leads in the block (2.3 bcm in A11) is significant, with a strong inter-lead risk dependency. A successful first well would open up the portfolio, and the combination of at least two discoveries per block would warrant a multi-well, stand-alone platform development concept.
- The Minimum Economic Field Size in this area has been estimated ca 1 bcm (recoverable) based on the following assumptions:

Drilling start	2021	Avg. decline	15%
Est. Qi	0.3 bcm/yr	Gas price	€0.19 /m3
RVIR cut-off	10%	Marginal allow.	25%-40%