

## Nowa calculator technical documentation

*This calculator is intended solely as guidance. The data should not be cited in financial contracts or other binding agreements. Norges Bank is not liable for any errors or discrepancies in the calculations.*

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### Nowa calculator technical documentation

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## 1. Background

Since Nowa is an overnight rate, a number of counterparties will need to calculate periodic interest rates in order to avoid the daily exchange of interest. In calculating periodic rates, the working group on alternative reference rates (the ARR group) has recommended the use of compound rates. The Nowa calculator is intended as an aid for the market to increase its understanding of how compound periodic rates are calculated.

The Nowa calculator allows users to specify the interest period and other parameters included in the rate calculation. Default values for the parameters in the calculator are set equal to the ARR group's recommendations for market conventions for the calculation of periodic rates, which are presented in the table below.

<b>Parametre</b>	<b>Convention</b>
Day count convention	Act/365
Working day convention	Modifised following bank day
Periodic rate	Compounded average
Interest convention	Shifted observation period
Days shift	Two days

The calculations are based on the daily Nowa rate as published by Norges Bank. Norges Bank took over as administrator of Nowa on 1 January 2020 and historical data extend back to 2 January 2020.

## 2. Method for calculating compounded averages

Nowa is, as mentioned, a daily interest rate. By investing NOK 1 today, you get NOK 1 + interest back tomorrow. Tomorrow, you invest NOK 1 + interest which earns interest until the next day. By using Nowa as a reference rate in contracts with e.g. quarterly interest payments, it is common to calculate interest on accrued but not exchanged interest. The periodic Nowa rate is then calculated as the compounded average of the Nowa observations during the interest period.

In the calculator, the following formula is used to calculate the annual compound average interest rate in the period between dates  $x$  and  $y$ , which is determined by the selected rate convention and indicate start and end dates for the observation period.

$$\text{Annual interest rate}_{x,y} = \left[ \prod_{j=x}^y \left( 1 + \frac{\text{Nowa}_j * n}{D} \right) - 1 \right] * \frac{D}{d_c}, \quad (1)$$

where

- $\text{Nowa}_j$  = Nowa for date  $j$ , as published on date  $j + 1$
- $n$  = Number of calendar days for which  $\text{Nowa}_j$  applies.  
This day weight can vary based on selected rate convention
- $D$  = Number of calendar days included in the calculation of annual interest rate.  
As selected in the day count convention parameter:  $D = \{360, 365\}$
- $d_c$  = Number of calendar days in the observation period
- $j$  = A series of dates representing banking days in the observation period

## 3. Explanation of parameters

Optional parameter	Explanation
<b>Start date</b>	First day of the interest period
<b>End date</b>	Last day of the interest period.
<b>Number of observation shift/lookback/lockout/delayed payment days</b>	<p>The definition of this parameter varies depending on the selected interest convention.</p> <p>For interest conventions “observation shift”, “lookback” and “lockout”, the number of days will refer to how many days prior to the end date of the interest period that the settlement amount becomes known.</p> <ul style="list-style-type: none"> <li>- For example, if the last day of the interest period is day <math>t</math> and a two-day observation shift/lookback/lockout is used, the settlement amount becomes known on day <math>t-2</math>.</li> </ul> <p>Note that when the “delayed payment” interest convention is selected, the number of days will only change the settlement date and have no impact on the calculation of the interest rate.</p>

	<ul style="list-style-type: none"> <li>- If, for example, the last day of the interest period is day t and a two-day delayed payment is used, the settlement amount becomes known on day t, two days before the settlement on day t+2.</li> </ul> <p>See Section 4 for a more detailed explanation of the different interest conventions.</p>
<b>Principal</b>	Loan amount included in the calculation of accrued interest.
<b>Interest conventions</b>	See Section 4 for an explanation of interest conventions.
<b>Spread</b>	The spread is added after the annual compound interest rate has been calculated.
<b>Day count convention</b>	Number of days included in the calculation of the annual interest rate. The convention used for calculating Nowa is ACT/365, whereas ACT/360 is used for Nibor.
<b>Date rolling</b>	<p>Method for date rolling.</p> <ul style="list-style-type: none"> <li>• <u>Modified following banking day</u>: If the start or end dates fall on a weekend or a holiday, it is adjusted to the following banking day. If the following banking day is in a new month, the date is moved to the preceding banking day.</li> <li>• <u>Preceding banking day</u>: If the start or end dates fall on a weekend or holiday, they are adjusted to the preceding banking day.</li> </ul> <p>Banking days are used as they correspond with Nowa publication dates.</p>
<b>Rate floor</b>	<p>Allows the user to indicate a rate floor defining a minimum interest rate. The minimum rate can be set as either positive or negative. The calculator permits either a daily or annual rate floor.</p> <ul style="list-style-type: none"> <li>• <u>Daily</u>: If one or more of the daily Nowa observations end up below the selected minimum interest rate, the minimum rate is then used as the observation for the applicable dates in the calculation of the annual interest rate.</li> <li>• <u>Annualised</u>: If the calculated compounded average rate ends up below the selected minimum interest rate, the minimum rate is then used as the annual interest rate.</li> </ul>
<b>Minimum interest rate</b>	The agreed minimum interest rate for the rate floor, see <i>Rate floor</i>
<b>Rounding</b>	The number of decimal places shown in the annual rate. The rounding selection will not impact the rounding used in the annual rate calculation process.

#### 4. Interest conventions

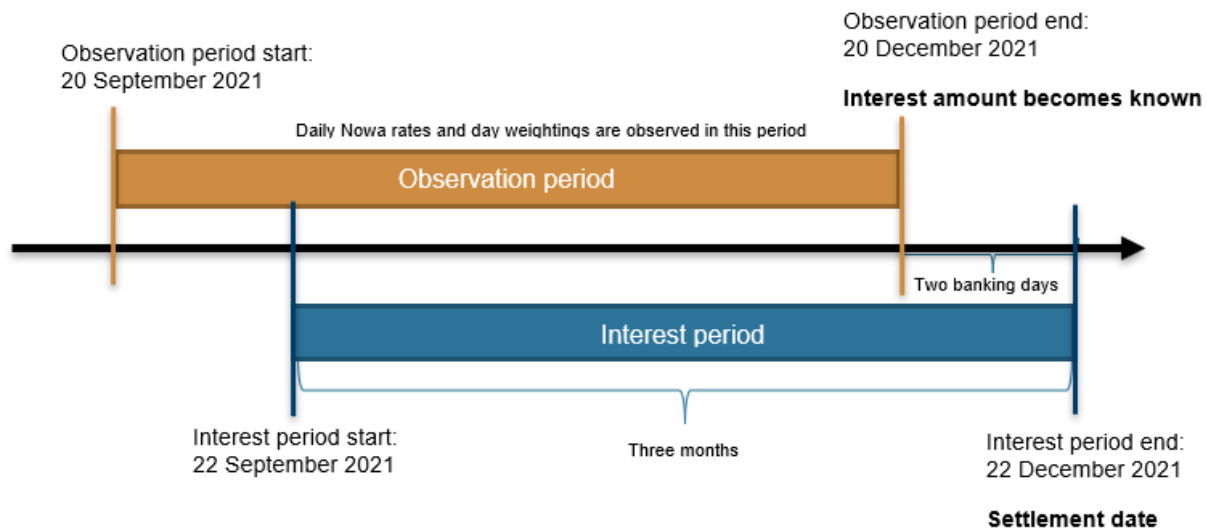
In calculating periodic interest rates for contracts referencing Nowa, the ARR working group has recommended to use a backward-looking calculation. This implies that the interest amount is known only at the end of the interest period, which may lead to administrative challenges for settlements with short deadlines. There are various conventions that can be used to solve this issue. The Nowa calculator offers a choice of four different interest conventions: shifted observation period, lookback, delayed payment and lockout. These conventions are described below. A more detailed description of the conventions can be found in the ARR working group's [Guide for using Nowa in financial contracts and as a fallback solution](#).

#### 4.1 Shifted observation period

When this method is applied, the observation period is shifted back by a given number of days in order to ensure that the payment is known sufficiently in advance of settlement. In the example below, a two-day observation shift is used, which means that the end of the observation period is moved from day T to day T-2. Since Nowa is published on the following banking day, the final interest observation is on day T-3 (published on day T-2). In this way, the interest amount will become known two days before the settlement date. Note that with this convention, day weighting of the interest rate follows the observation period, ie that the rate observed is given the same weight as the one given by the calendar. For example, the weighting for a rate observed for a Friday will be three days.

*Chart 1: Shifted observation period*

*The example in the chart shows a three-month interest period between 22 September 2021 and 22 December 2021 with a two-day observation shift*



#### 4.2 Lookback

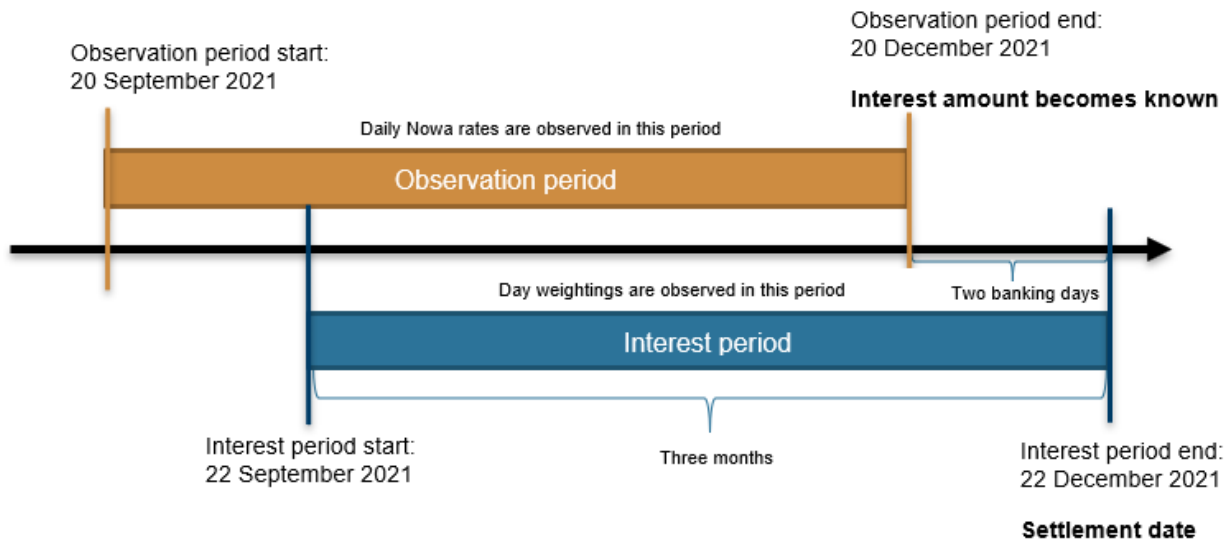
Lookback resembles a shifted observation period as it also reads from the most recent interest observation for a given number of days prior to the end of the observation period. In the example below, a two-day lookback is used. This means that the observation period end date is moved from T to T-2. Since Nowa is published on the following banking day, the final interest observation is from day T-3 (published on day T-2). In this way, the interest amount will become known two days before the settlement date.

The difference between lookback and shifted observation conventions is the day weighting. For lookback, the number of days is based on the interest period rather than the observation period, and the rate's day weighting is thus "incorrect" (see chart). This means that the number of days in the observation period will always correspond with the number of days in the interest period, which is not the case for the shifted observation period convention<sup>1</sup>.

<sup>1</sup> Some refer to lookback as "lookback without observation shift" to differentiate the convention from the shifted observation period, which certain others refer to as "lookback with observation shift".

### Chart 2: Lookback

The example in the chart shows a three-month interest period between 22 September 2021 and 22 December 2021 with a two-day lookback

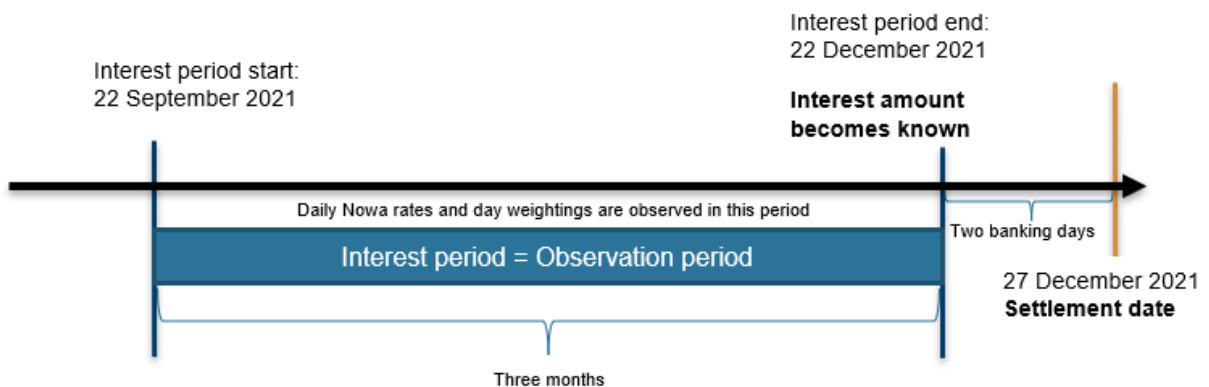


### 4.3 Delayed payment

With the delayed payment convention, all daily Nowa observations during the interest period will be included in the calculation of the periodic interest rate. Since the last observation for the interest period is published on the settlement date, making the payment can be challenging. The convention therefore states that the interest payment must be made a given number of banking days after the end of the interest period. In the calculator, this is set in the parameter “Number of days delayed payment”.

### Chart 3: Delayed payment

The example in the chart shows a three-month interest period between 22 September 2021 and 22 December 2021 with a two-day delayed payment



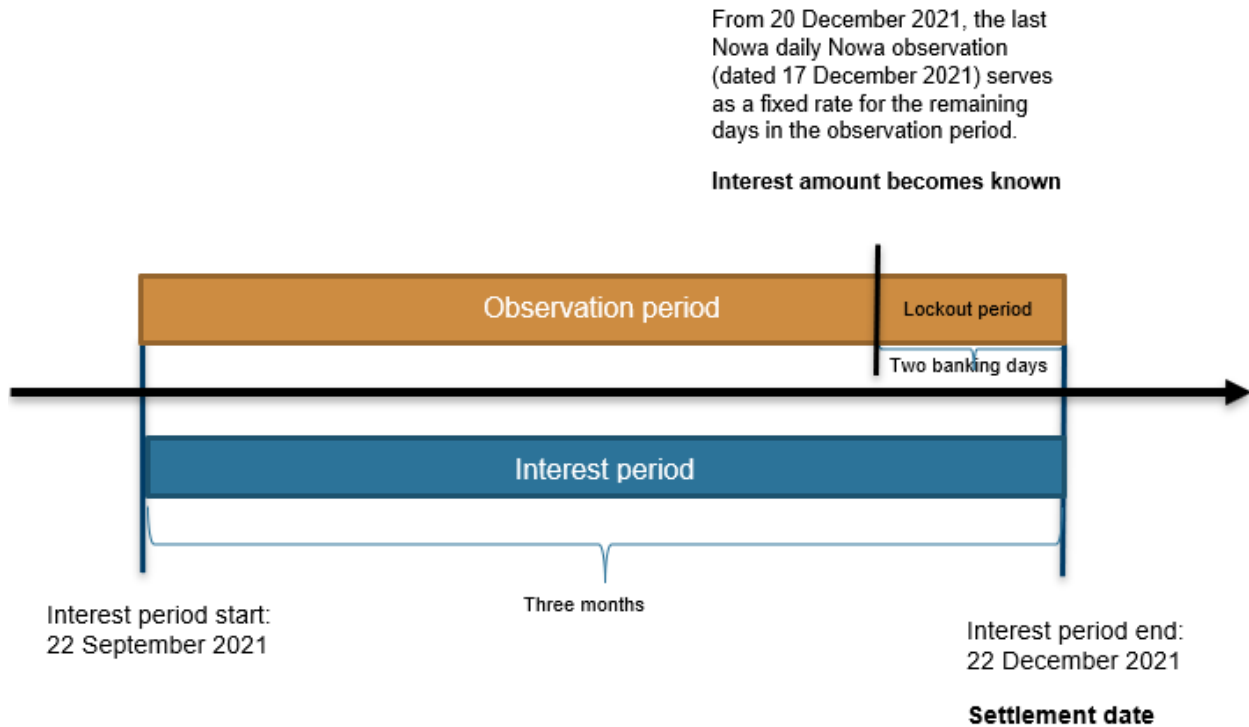
### 4.4 Lockout

A given number of days before the end of the interest period, the last Nowa observation will serve as a fixed interest rate for the last banking days in the period. In the example below, a two-day lockout is used, which means that the last rate observation, from two days before the settlement date, serves as a fixed rate. Since Nowa is published on the following banking day, in

reality, the final interest observation is on day T-3 (published on day T-2). In this way, the interest amount will become known two days before the settlement date.

Chart 4: Lockout

The example in the chart shows a three-month interest period between 22 September 2021 and 22 December 2021 with a two-day lockout.



## 5. Explanation of the result

<b>Interest period start</b>	First day of the interest period. If the selected date falls on a weekend or holiday, the date is moved using the "Date rolling" parameter.
<b>Interest period end</b>	Last day of the interest period. If the selected date falls on a weekend or holiday, the date is moved using the "Date rolling" parameter.
<b>Annual interest rate</b>	The annual compound rate, in percent.
<b>Total interest rate</b>	The annual rate with a premium, in percent.
<b>Accrued interest</b>	Interest amount in NOK.
<b>Days observation period</b>	Number of calendar days in the observation period, which may vary depending on the selected interest convention.
<b>Days interest period</b>	Number of calendar days in the interest period.
<b>Settlement date</b>	Date for settlement. The settlement date is the same as the rate period end date except for when the interest convention selected is "Delayed payment".
<b>Compounding factor</b>	Corresponds with the formula product $(1)^n$ . The compounding factor is calculated as the product of all preceding factors through the observation period.

## 6. Example of calculating compounded Nowa 3M

Here, an example illustrates the calculation of accrued interest on a NOK 1 million loan. The loan uses Nowa as the reference rate with an agreement for quarterly interest payments. The loan is granted on 22 September and the first interest payment is due on 22 December 2021. For calculation of the interest rate for the compounding period, the use of a two-day observation shift has been agreed upon. The observation period is thus shifted back to 20 September 2021 – 20 December 2021. Calculated interest becomes known on the last day of the observation period, which gives the borrower two days to settle the payment

There are a number of ways to determine the interest rate for the compounding period. The observation shift interest convention makes possible the use of Norges Bank's compounded index for calculating the rate for the compounding period. Read more on how this is done in the [technical documentation](#) for the compounded index.

If one wishes to calculate the periodic rate manually, the formula ( 1 ) shown in Section 2 can be used. In practice, the formula is used by gathering daily Nowa observations in the observation period to make a compounding factor that corresponds with the formula product.

$$\text{Compounding factor}_{j+1} = \text{Compounding factor}_j * \left( 1 + \frac{\text{Nowa}_j * n}{D} \right) \quad (2)$$

The last compounding factor in the observation period is then put into formula (1) instead of the formula product.

In the example, NOK 1 million is borrowed on 22 September, which a two-day observation shift changes to 20 September. On the next banking day (21 September), quoted Nowa can be read for 20 September, which was 0.00%. By using the ACT/365 day count convention, the first compounding factor becomes  $1 + 0.00\% * 1 \text{ day} / 365 = 1$ . This will further bear interest at  $1 +$  accrued interest between 21 and 22 September:  $1 * (1 + 0.00\% * 1 \text{ day} / 365) = 1$ .

Calculations for the entire period are subsequently made in the same manner, where a factor of  $1/365$  is used for regular banking days and  $3/365$  when the daily Nowa rate extends over a weekend. The last day in the three-month period is 22 December. However, the observation period ended two days earlier, on 20 December, when the compounding factor is calculated based on accrued interest in the entire interest period ( $1 +$  accrued interest in the interest period  $= 1.0005755043) * (1 + 0.50\% * 3 \text{ days} / 365) = 1.0006166239$ , where 1.0005755043 is the compounding factor 17 December 2021. As this is a Friday, Nowa is weighted for 17 December (0.50%) by 3 days. Finally, the last compounding factor in the period is entered into the formula ( 1 ):

$$(1,0006166239 - 1) * \frac{365}{91} = 0.24733\%,$$

where 91 is the number of calendar days in the observation period. With a NOK 1 million loan, a three-month annual interest rate amounts to 0.24733%, and accrued interest comes to  $1,000,000 * 0.24733\% * 91 / 365 = \text{NOK } 616.63$ . This amount is paid on the settlement date of 22 December 2021.

## 7. Frequently asked questions

### **Can Norges Bank's compounded index be used instead of this calculator?**

Norges Bank's compounded index for Nowa can be used to find the Nowa rate for a given compounding period only if the "observation shift" or "delayed payment" interest conventions are used. In contracts, direct reference can be made to the compounded index, while the calculator is intended solely as guidance.

### **Why does the rate from Norges Bank's compounded index and this calculator differ?**

Minor discrepancies can arise because of differences in decimal rounding. For the compounded index, each index value will be rounded to eight decimal places. The Nowa calculator uses all available decimal places in calculations until the final compounding factor is rounded to 10 decimal places. Both sources use "bankers' rounding" as a rounding method.

### **Nowa is published on the following banking day. Does this mean that if a two-day observation shift is selected, the interest amount in practice only becomes known one day before settlement?**

Regardless of whether "observation shift", "lockout" or "lookback" are selected, the number of shifted days refers to how many days before the end of the interest period that the settlement becomes known. In other words, with a two-day shift and an interest period end date of Friday, 18 February 2022, the settlement becomes known on Wednesday 16 February (based on observation of Nowa from Tuesday 15 February 2022). This means that the calculation method for the lockout convention differs slightly from the definition used by the International Swaps and Derivatives Association.

## 8. Useful links

[Nowa – daily observations](#)

[Nowa – Compounded Nowa averages](#)

[Nowa – Nowa compounded index](#)

[Technical documentation for the Nowa compounded index Nowai and compounded Nowa averages](#)

[Web page of the working group on alternative Norwegian krone reference rates](#)

[ISDA – Documenting RFR derivatives using different approaches to compounding/averaging under the 2006 ISDA Definitions](#)