

# Automated Generation of R Client Packages for RESTful APIs

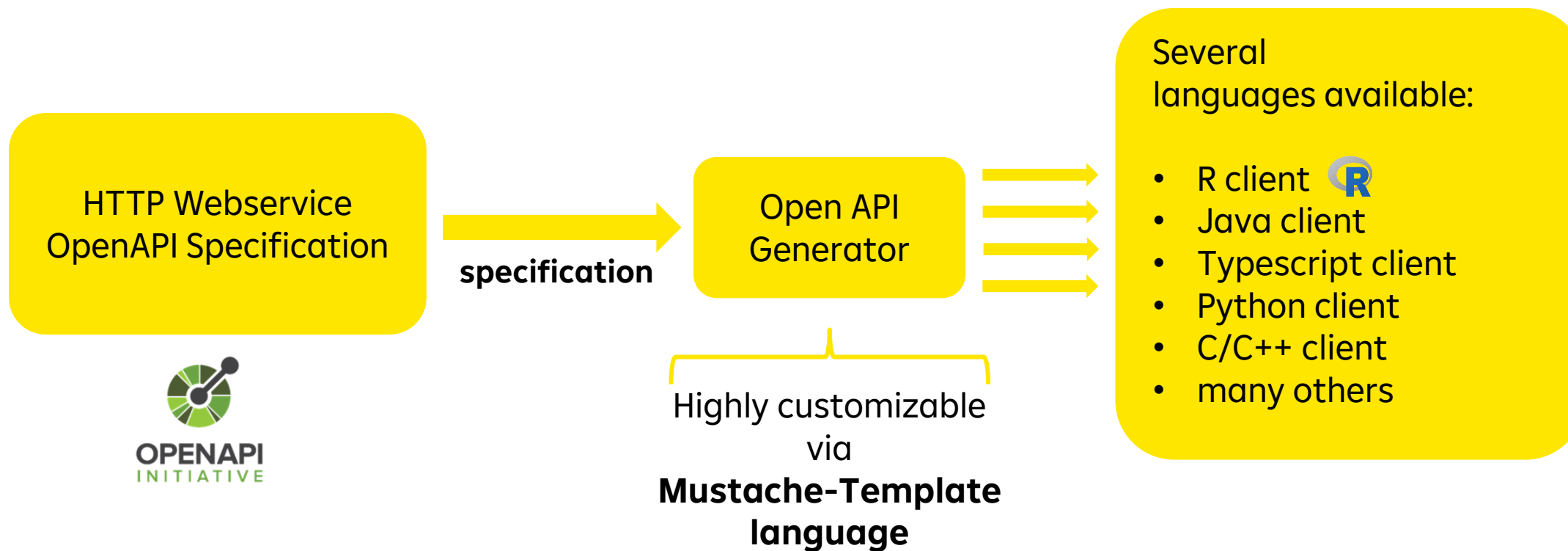
Dr. Simon Haller

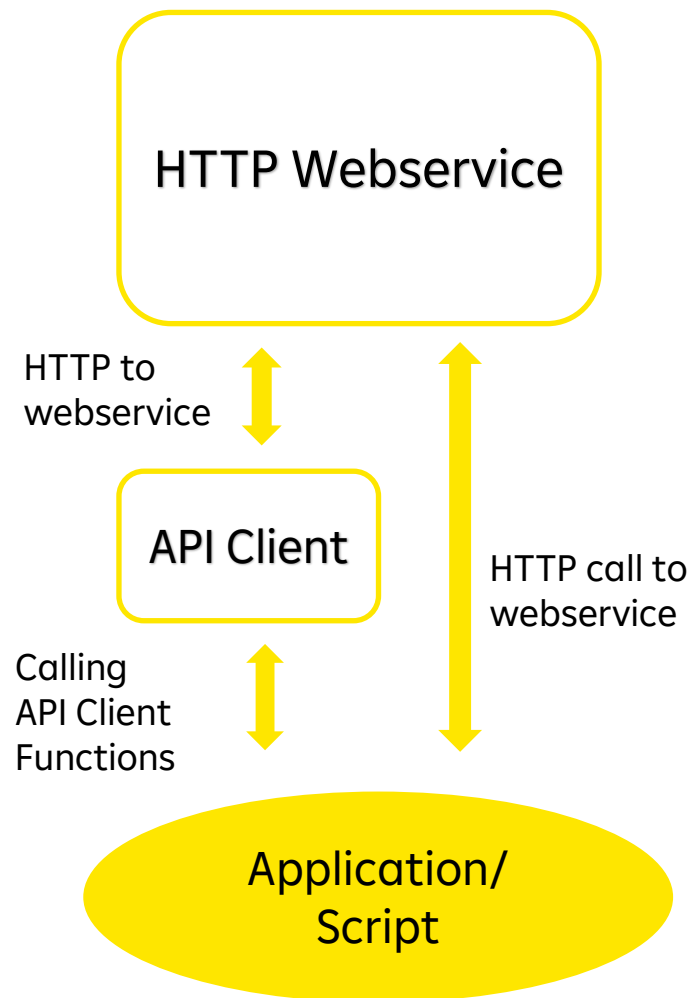
This presentation is intended for information purposes.

This presentation constitutes neither a public offer nor a solicitation to submit an offer in the sense of the Austrian Capital Market Act (KMG), the Stock Exchange Act or any other comparable foreign law. An investment decision regarding a financial product must be made on the basis of an approved, published prospectus and not on the basis of this presentation.

This presentation does not constitute a personal recommendation/investment advice regarding the purchase or sale of financial instruments in the sense of the Securities Supervision Act. This presentation shall not form the basis for any kind of contract or commitment whatsoever.

This presentation is not a substitute for the necessary advice on the purchase or sale of a financial product. Your banking advisor can provide individualised advice which is suitable for investors and investments.





## OpenAPI Specification (former Swagger Specification)

- a specification for a machine-readable interface definition language for describing, producing, consuming and visualizing a web service;
- started 2010 - most recent version 3.1.0. (since 2021-02-15);
- Provides a standardized UI (Swagger UI) to allow both developers and non-developers to interact with the API;
- standardization of the API interface enables the use of automatic code-generation tools - since all operations, responses and requests are defined;
- It provides a standardized service definition document: `openapi.json`.

## Stuff Management API 0.1.0 OAS 3.1

/openapi.json

### Stuff

GET	/stuff/get	Get Stuff	⌵
POST	/stuff/post	Post Stuff	⌵
DELETE	/stuff/delete	Delete Stuff	⌵
GET	/stuff/list	Stuff List	⌵

### default

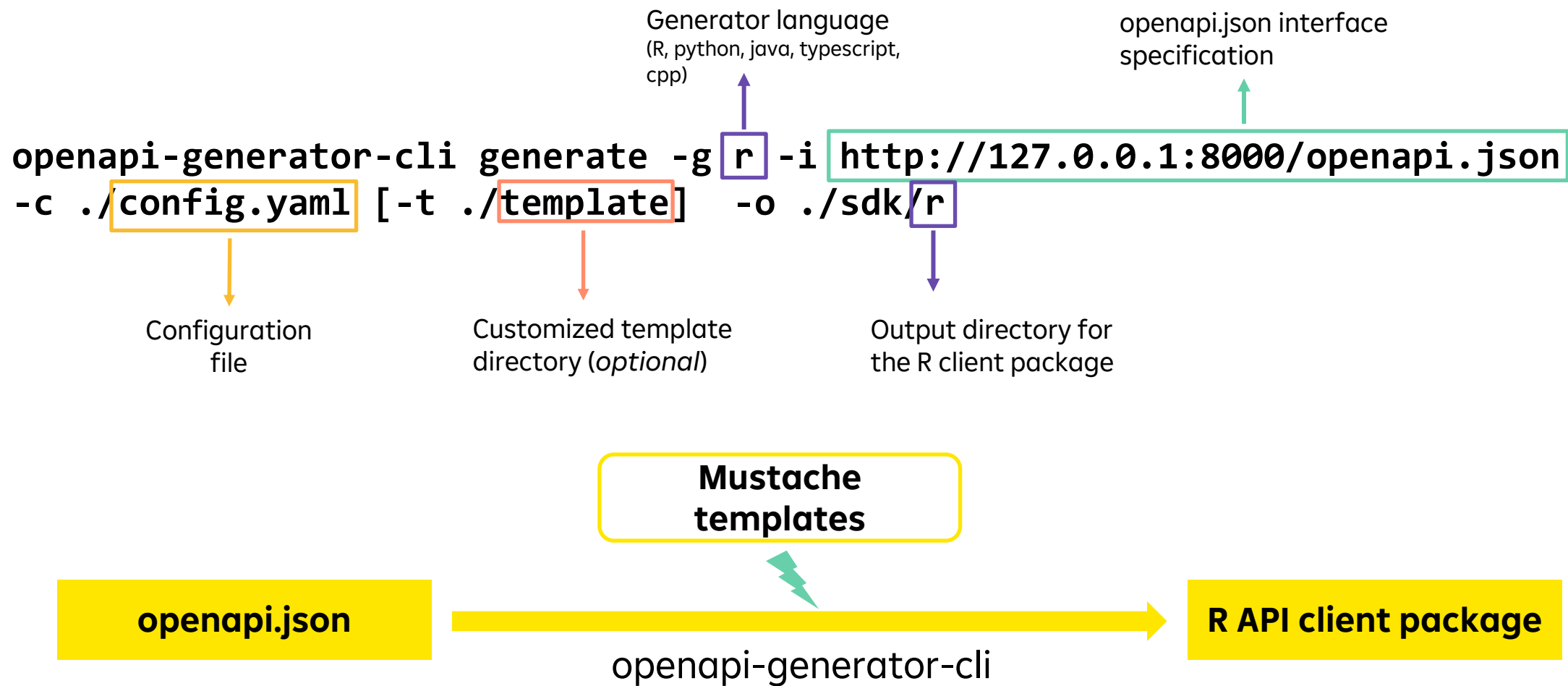
GET	/ping	Get Health Check	⌵
-----	-------	------------------	---

### Schemas

Dataframe	>	Expand all	object
HTTPValidationError	>	Expand all	object
ValidationError	>	Expand all	object

- The swagger UI is automatically generated from the API specification file "openapi.json" and displayed on a http endpoint
- Developer reference and documentation
- Can be used to call the endpoints for manual testing
- Type Schemata for responses and request parameters
- Documentation of Error Codes

## The automatic code generation process



Restful API Backend



Autogenerated R Client

## Stuff Management API 0.1.0 OAS 3.1

/openapi.json

### Stuff

**GET** /stuff/get Get Stuff

**POST** /stuff/post Post Stuff

**DELETE** /stuff/delete Delete Stuff

**GET** /stuff/list Stuff List

### default

**GET** /ping Get Health Check

### Schemas

**Dataframe** > Expand all object

**HTTPValidationError** > Expand all object

**ValidationError** > Expand all object

```
> library("stuffsdk")
> base_path = "http://127.0.0.1:8000"
> client <- ApiClient$new(base_path)
> api<-StuffApi$new(client)
>
> api$listStuff()
[1] "a" "b"
> api$getStuff("a")
[1] 1 2 3
> api$postStuff(id="a", data.frame("col1"=c("a","b","c"),"col2"=1:3) )
NULL
> api$getStuff("a")
$col1
  X0 X1 X2
.  a  b  c

$col2
  X0 X1 X2
.  1  2  3

> |
```

1. Dump the default template for R to a directory (./template)

**openapi-generator-cli author template -g r -o ./template**

2. Edit / adapt the template files (*if necessary*)

The template directory resembles an R package structure with mustache templates: R code mixed with mustache template tags (in `{ }`).

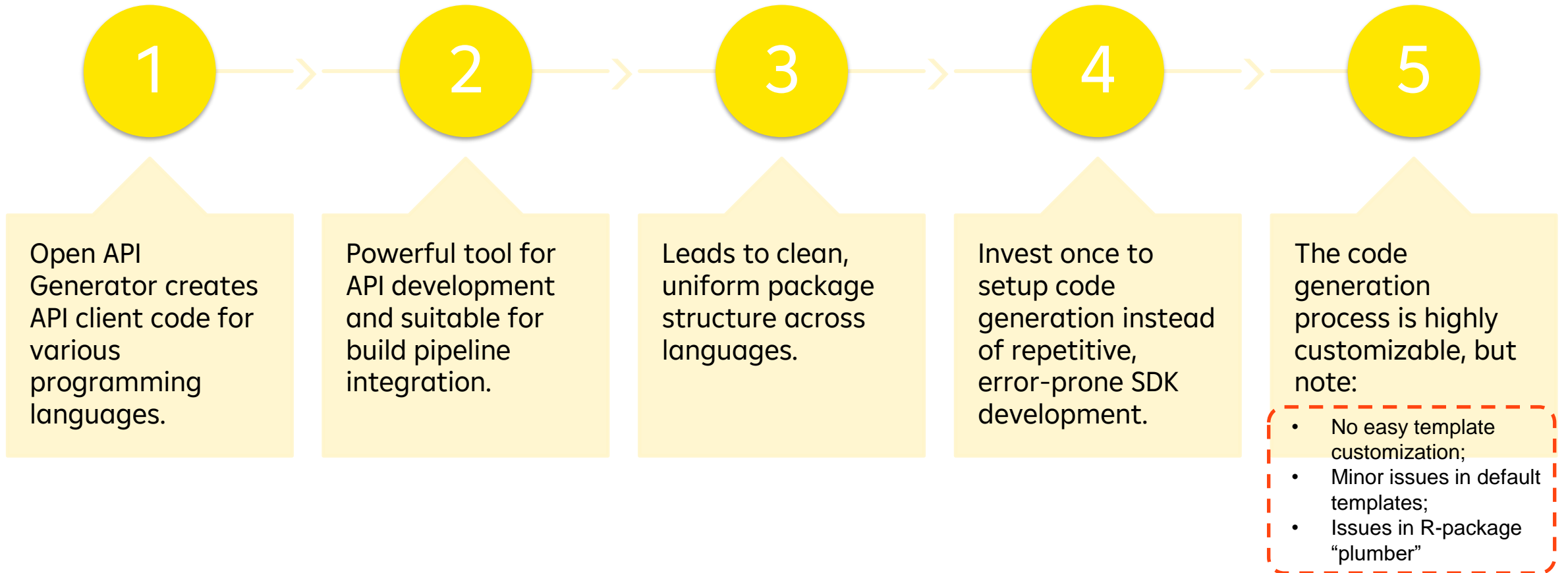
```
## @param ... Other optional arguments
## @return API response ({{{returnType}}}{^returnType}}void{/{returnType}}) with additional information such as HTTP status
## @export
{{{operationId}}}{WithHttpInfo} = function({{#requiredParams}}{paramName},
                                           {{/requiredParams}}{#optionalParams}}{paramName}
                                           = {^defaultValue}}NULL{/{defaultValue}}{defaultValue}},
                                           {{/optionalParams}}{#vendorExtensions.x-streaming}}stream_callback = NULL,
                                           {{/vendorExtensions.x-streaming}}{#returnType}}data_file = NULL,
                                           {/{returnType}}...) {
  args <- list(...)
  query_params <- list()
```

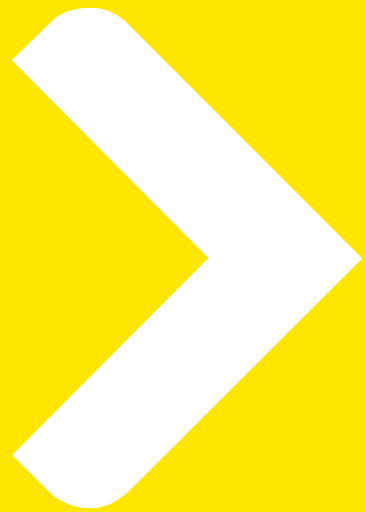
3. Debugging the package generation process

to offer extra debugging details for better understanding of the code generation process

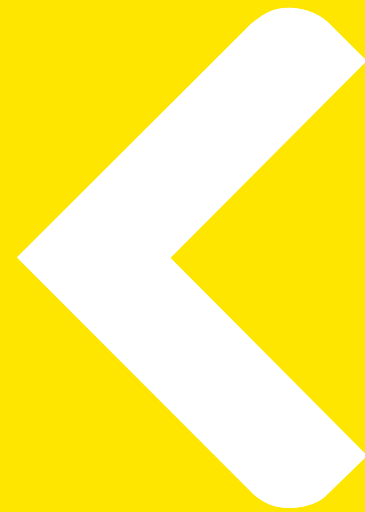


## Key take aways





**Thank you!**



## Disclaimer Financial Analysis

Responsible for this publication: Raiffeisen Bank International AG („RBI“)

RBI is a credit institution according to §1 Banking Act (Bankwesengesetz) with the registered office Am Stadtpark 9, 1030 Vienna, Austria.

Raiffeisen RESEARCH is an organisational unit of RBI.

Supervisory authority: As a credit institution (acc. to § 1 Austrian Banking Act; Bankwesengesetz) Raiffeisen Bank International AG is subject to the supervision by the Austrian Financial Market Authority (FMA, Finanzmarktaufsicht) and the National Bank of Austria (OeNB, Oesterreichische Nationalbank). Additionally, RBI is subject to the supervision by the European Central Bank (ECB), which undertakes such supervision within the Single Supervisory Mechanism (SSM), which consists of the ECB and the national responsible authorities (Council Regulation (EU) No 1024/2013 - SSM Regulation). Unless set out herein explicitly otherwise, references to legal norms refer to norms enacted by the Republic of Austria.

This document is for information purposes and may not be reproduced or distributed to other persons without RBI's permission. This document constitutes neither a solicitation of an offer nor a prospectus in the sense of the Austrian Capital Market Act (Kapitalmarktgesetz) or the Austrian Stock Exchange Act (Börsegesetz) or any other comparable foreign law. An investment decision in respect of a financial instrument, a financial product or an investment (all hereinafter “product”) must be made on the basis of an approved, published prospectus or the complete documentation for such a product in question, and not on the basis of this document.

This document does not constitute a personal recommendation to buy or sell financial instruments in the sense of the Austrian Securities Supervision Act (Wertpapieraufsichtsgesetz). Neither this document nor any of its components shall form the basis for any kind of contract or commitment whatsoever. This document is not a substitute for the necessary advice on the purchase or sale of a financial instrument, a financial product or advice on an investment. In respect of the sale or purchase of one of the above mentioned products, your banking advisor can provide individualised advice suitable for investments and financial products.

This analysis is fundamentally based on generally available information and not on confidential information which the party preparing the analysis has obtained exclusively on the basis of his/her client relationship to a person.

Unless otherwise expressly stated in this publication, RBI deems all of the information to be reliable, but does not make any assurances regarding its accuracy and completeness.

In emerging markets, there may be higher settlement and custody risk as compared to markets with established infrastructure. The liquidity of stocks/financial instruments may be influenced, amongst others, by the number of market makers. Both of these circumstances can result in elevated risk in relation to the safety of investments made in consideration of the information contained in this document.

The information in this publication is current as per the latter's creation date. It may be outdated by future developments, without the publication being changed.

Unless otherwise expressly stated ([www.raiffeisenresearch.com/special\\_compensation](http://www.raiffeisenresearch.com/special_compensation)), the analysts employed by RBI are not compensated for specific investment banking transactions. Compensation of the author or authors of this report is based (amongst other things) on the overall profitability of RBI, which includes, inter alia, earnings from investment banking and other transactions of RBI. In general, RBI forbids its analysts and persons reporting to the analysts from acquiring securities or other financial instruments of any enterprise which is covered by the analysts, unless such acquisition is authorised in advance by RBI's Compliance Department.

RBI has put in place the following organisational and administrative agreements, including information barriers, to impede or prevent conflicts of interest in relation to recommendations: RBI has designated fundamentally binding confidentiality zones. These are typically units within credit institutions, which are isolated from other units by organisational measures governing the exchange of information, because compliance-relevant information is continuously or temporarily handled in these zones. Compliance-relevant information may fundamentally not leave a confidentiality zone and is to be treated as strictly confidential in internal business operations, including interaction with other units. This does not apply to the transfer of information necessary for usual business operations. Such transfer of information is limited, however, to what is absolutely necessary (need-to-know principle). The exchange of compliance-relevant information between two confidentiality zones may only occur with the involvement of the Compliance Officer.

## SPECIAL REGULATIONS FOR THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND (UK):

This document does not constitute either a public offer in the meaning of the Austrian Capital Market Act (in German: Kapitalmarktgesetz; hereinafter „KMG“) nor a prospectus in the meaning of the KMG or of the Austrian Stock Exchange Act (in German: Börsegesetz). Furthermore this document does not intend to recommend the purchase or the sale of securities or investments in the meaning of the Austrian Supervision of Securities Act (in German: Wertpapieraufsichtsgesetz). This document shall not replace the necessary advice concerning the purchase or the sale of securities or investments. For any advice concerning the purchase or the sale of securities of investments kindly contact your RAIFFEISENBANK. Special regulations for the United Kingdom of Great Britain and Northern Ireland (UK): this publication has been either approved or issued by Raiffeisen Bank International AG (RBI) in order to promote its investment business. Raiffeisen Bank International AG, London Branch is authorised by the Austrian Financial Market Authority and subject to limited regulation by the Financial Conduct Authority (“FCA”). Details about the extent of our regulation by the Financial Conduct Authority are available from us on request. This publication is not intended for investors who are Retail Customers within the meaning of the FCA rules and should therefore not be distributed to them. Neither the information nor the opinions expressed herein constitute or are to be construed as an offer or solicitation of an offer to buy (or sell) investments. RBI may have affected an Own Account Transaction within the meaning of FCA rules in any investment mentioned herein or related investments and or may have a position or holding in such investments as a result. RBI may have been, or might be, acting as a manager or co-manager of a public offering of any securities mentioned in this report or in any related security.

**SPECIFIC RESTRICTIONS FOR THE UNITED STATES OF AMERICA AND CANADA:** This document may not be transmitted to, or distributed within, the United States of America or Canada or their respective territories or possessions, nor may it be distributed to any U.S. person or any person resident in Canada, unless it is provided directly through RB International Markets (USA) LLC, a U.S. registered broker-dealer ('RBIM'), and subject to the terms set forth below.

**SPECIFIC INFORMATION FOR THE UNITED STATES OF AMERICA AND CANADA:** This research document is intended only for institutional investors and is not subject to all of the independence and disclosure standards that may be applicable to research documents prepared for retail investors. This report was provided to you by RB International Markets (USA) LLC, a U.S. registered broker-dealer ('RBIM'), but was prepared by our non-U.S. affiliate, Raiffeisen Bank International AG (RBI). Any order for the purchase or sale of securities covered by this report must be placed with RBIM. You can reach RBIM at 1177 Avenue of the Americas, 5<sup>th</sup> Floor, New York, NY 10036, 212-600-2588. This document was prepared outside the United States by one or more analysts who may not have been subject to rules regarding the preparation of reports and the independence of research analysts comparable to those in effect in the United States. The analyst or analysts who prepared this research (i) are not registered or qualified as research analysts with the Financial Industry Regulatory Authority (“FINRA”) in the United States, and (ii) are not allowed to be associated persons of RBIM and are therefore not subject to FINRA regulations, including regulations related to the conduct or independence of research analysts.

The opinions, estimates and projections contained in this report are those of RBI only as of the date of this report and are subject to change without notice. The information contained in this report has been compiled from sources believed to be reliable by RBI, but no representation or warranty, express or implied, is made by RBI or its affiliated companies or any other person as to the report's accuracy, completeness or correctness. Securities which are not registered in the United States may not be offered or sold, directly or indirectly, within the United States or to U.S. persons (within the meaning of Regulation S under the Securities Act of 1933 [the 'Securities Act']), except pursuant to an exemption under the Securities Act. This report does not constitute an offer with respect to the purchase or sale of any security within the meaning of Section 5 of the Securities Act and neither shall this report nor anything contained herein form the basis of, or be relied upon in connection with, any contract or commitment whatsoever. This report provides general information only. In Canada it may only be distributed to persons who are resident in Canada and who, by virtue of their exemption from the prospectus requirements of the applicable provincial or territorial securities laws, are entitled to conduct trades in the securities described herein.

## EU REGULATION NO 833/2014 CONCERNING RESTRICTIVE MEASURES IN VIEW OF RUSSIA'S ACTIONS DESTABILISING THE SITUATION IN UKRAINE

Please note that research is done and recommendations are given only in respect of financial instruments which are not affected by the sanctions under EU regulation no 833/2014 concerning restrictive measures in view of Russia's actions destabilising the situation in Ukraine, as amended from time to time, i.e. financial instruments which have been issued before 1 August 2014.

We wish to call to your attention that the acquisition of financial instruments with a term exceeding 30 days issued after 31 July 2014 is prohibited under EU regulation no 833/2014 concerning restrictive measures in view of Russia's actions destabilising the situation in Ukraine, as amended from time to time. No opinion is given with respect to such prohibited financial instruments.

INFORMATION REGARDING THE PRINCIPALITY OF LIECHTENSTEIN: COMMISSION DIRECTIVE 2003/125/EC of 22 December 2003 implementing Directive 2003/6/EC of the European Parliament and of the Council as regards the fair presentation of investment recommendations and the disclosure of conflicts of interest has been incorporated into national law in the Principality of Liechtenstein by the Finanzanalyse-Marktmissbrauchs-Verordnung.

If any term of this Disclaimer is found to be illegal, invalid or unenforceable under any applicable law, such term shall, insofar as it is severable from the remaining terms, be deemed omitted from this Disclaimer; it shall in no way affect the legality, validity or enforceability of the remaining terms.



## Information requirements pursuant to the Austrian E-Commerce Act

Raiffeisen Bank International AG

**Registered Office:** Am Stadtpark 9, 1030 Vienna

**Postal address:** 1010 Vienna, POB 50; Phone: +43-1-71707-0; Fax: + 43-1-71707-1848

**Company Register Number:** FN 122119m at the Commercial Court of Vienna

**VAT Identification Number:** UID ATU 57531200

**Austrian Data Processing Register:** Data processing register number (DVR): 4002771

**S.W.I.F.T.-Code:** RZBA AT WW

**Supervisory Authorities:** Supervisory authority: As a credit institution (acc. to § 1 Austrian Banking Act; Bankwesengesetz) Raiffeisen Bank International AG is subject to the supervision by the Austrian Financial Market Authority (FMA, Finanzmarktaufsicht) and the National Bank of Austria (OeNB, Oesterreichische Nationalbank). Additionally, RBI is subject to the supervision by the European Central Bank (ECB), which undertakes such supervision within the Single Supervisory Mechanism (SSM), which consists of the ECB and the national responsible authorities (Council Regulation (EU) No 1024/2013 - SSM Regulation). Unless set out herein explicitly otherwise, references to legal norms refer to norms enacted by the Republic of Austria.

**Membership:** Austrian Federal Economic Chamber, Federal Bank and Insurance Sector, Raiffeisen Association

Statement pursuant to the Austrian Media Act

**Publisher and editorial office of this publication:** Raiffeisen Bank International AG, Am Stadtpark 9, A-1030 Vienna

**Media Owner of this publication:** Raiffeisen RESEARCH – Verein zur Verbreitung von volkswirtschaftlichen Analysen und Finanzmarktanalysen  
Am Stadtpark 9, A-1030 Vienna

**Executive Committee of Raiffeisen RESEARCH – Verein zur Verbreitung von volkswirtschaftlichen Analysen und Finanzmarktanalysen:**  
Gunter Deuber (Chairman), Helge Rechberger (Vice-Chairman)

Raiffeisen RESEARCH – Verein zur Verbreitung von volkswirtschaftlichen Analysen und Finanzmarktanalysen is constituted as state-registered society. Purpose and activity are (inter alia), the distribution of analysis, data, forecasts and reports and similar publications related to the Austrian and international economy as well as financial markets.

Basic tendency of the content of this publication: Presentation of activities of Raiffeisen Bank International AG and its subsidiaries in the area of conducting analysis related to the Austrian and international economy as well as the financial markets.

Publishing of analysis according to various methods of analyses covering economics, interest rates and currencies, government and corporate bonds, equities as well as commodities with a regional focus on the euro area and Central and Eastern Europe under consideration of the global markets.

**Producer of this publication:** Raiffeisen Bank International AG, Am Stadtpark 9, A-1030 Wien

**Editor: Simon Haller; RBI Vienna; Completed 5.07.2024, 06:00 PM CET; First dissemination: 5.07.2024, 09:00 AM CET**