

Covid-19 report: Update on the current epidemic status in Luxembourg

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Background information

This report has been elaborated by the Research Luxembourg Covid-19 Task Force to inform the Luxembourg Government about the current epidemic status in Luxembourg as an update to the last report from 25 November. It gives a short overview on the most important epidemic indicators and contains projections for the current epidemic status **based on data available up to 1 December**.

Main conclusions

- **The exponential epidemic dynamics reported last week has further continued during the current week.** Thus, the 7-day average of daily cases for the current week has again significantly increased to 366 cases/day compared to 302 cases/day for last week with a clear indication of an exponential regime.
- **R_{eff} of today has remained rather constant with 1.14** compared to 1.17 on Thursday of last week, and the **7-day average value of R_{eff} has slightly decreased to 1.11** compared to 1.16 of last week (Figure 1). These persistent high R_{eff} values and increasing daily case numbers indicate a significant exponential dynamics.
- The linear **trend of cumulative cases** estimated by curve fitting for the last four weeks has further and significantly increased to a slope of 261 cases/day compared to 210 cases/day for last week's estimate. Together with the constant linear increase in daily cases, this indicates a significant epidemic regime (Figure 2 and 3).
- The 7-day average for the **normal care hospitalization demands** has significantly increased (48.4 cases on average for this week compared to 38.4 cases for last week) whereas **the average ICU occupancies** remained rather constant (11.1 cases on average for this week compared to 10.5 cases for last week). As noted last week, increases in hospitalizations are expected to occur with a delay of 10 to 14 days and therefore the recent increase is driven by the significant increase of cases observed 2 weeks ago and is likely to further increase given the current exponential epidemic regime.
- Based on the volatile level of the epidemics, the current **midterm projections of daily cases continue to** exhibit a significant increase in the anticipated epidemic dynamics compared to last week's projections. Thus, the current projections exhibit an increase in the anticipated peak of daily cases in the next weeks of around 420 cases/day compared to 360 cases/day from last week's projections (Figure 4). Based on the development of the last months, it is anticipated that the current dynamics is more leaning towards the pessimistic scenario with an expected peak of more than 700 cases in January. Note that these projections do not consider future changes in social behavior or in more transmissible virus variants explicitly.
- The corresponding **projections of the hospital demands** exhibit an increase for normal care to around 75 cases in January from the current projections compared to 65 cases from last week's projection (Figure 5). Based on the age distribution of cases with its current trend towards younger people, the projection for intensive care units remained rather constant and indicate around 28 cases in January similar to the projections from last week (Figure 6). For the more pessimistic scenario, these peaks increase to more than 120 cases for normal care and 50 cases in ICU. Note that hospitalization and specifically ICU demands depend strongly on the age structure of the cases and the vaccination status of the population. Hence, it is particularly

important that vulnerable people are vaccinated and remain cautious in their social interactions to prevent severe cases and an increase in hospital demands.

- The average **positivity rate** has further increased to above 9% compared to a level of around 8% last week (Figure 7).
- The total number of **estimated active cases** has further increased to 4920 cases for this week compared to 3891 cases for last week (Figure 8).

Given the dominant prevalence of the Delta variant of 100% and the continuing exponential regime, the current epidemic situation is on a very severe volatile level. Together with the other indicators, the currently high case numbers indicate a more significant epidemic rebound, which bears the danger that contact tracing cannot break infection chains efficiently. Hence, sustained efforts in social distancing, in following hygiene measures as well as vaccination uptake (including booster shots) remain essential to stabilize the epidemic situation. This is also particularly important with respect to potential 'escape variants' for which vaccines might be less effective as currently discussed for the Omicron variant of concern and with respect to waning immunity of vaccinated people. Thus, the monitoring of breakthrough infections, virus variants and assessing their transmissibility will be a key element for sustained mitigation of the pandemic during the up-coming months.

Graphical analysis of epidemic indicators

Below, the epidemic indicators are visualized and analyzed in more detail including the midterm projections for daily cases and hospitalization.

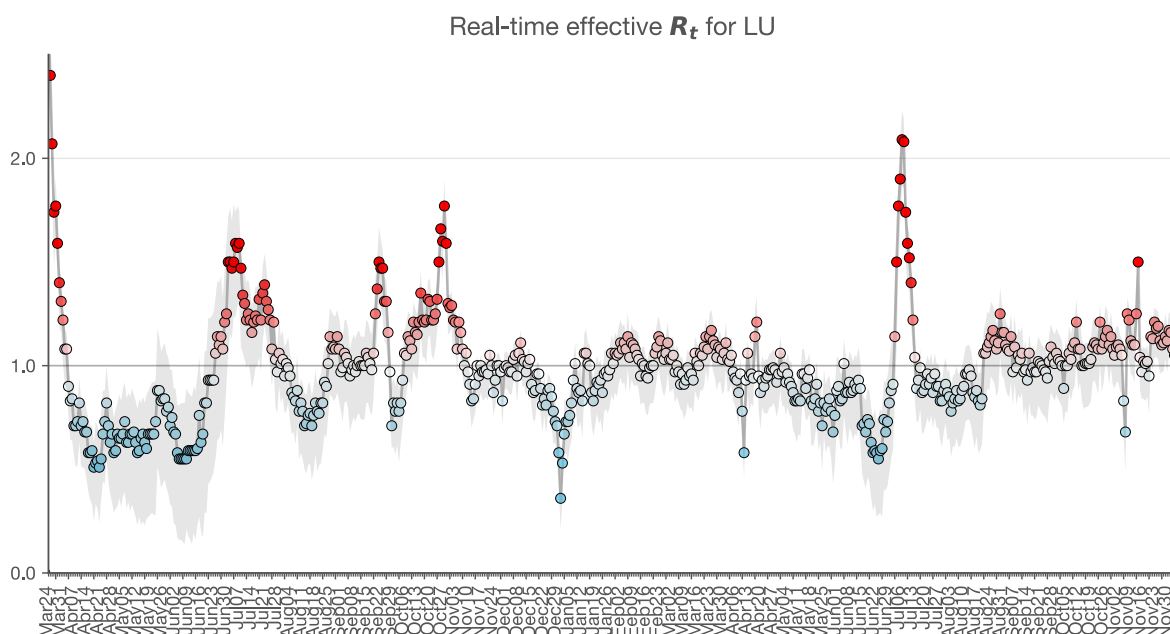


Figure 1. For the current week, the effective reproduction R_{eff} has remained rather constant at 1.14 today compared to 1.17 on Thursday of last week. The 7-day average of the current week has slightly decreased to 1.11 compared to 1.16 of last week. Note that effective mitigation requires values below 0.8.

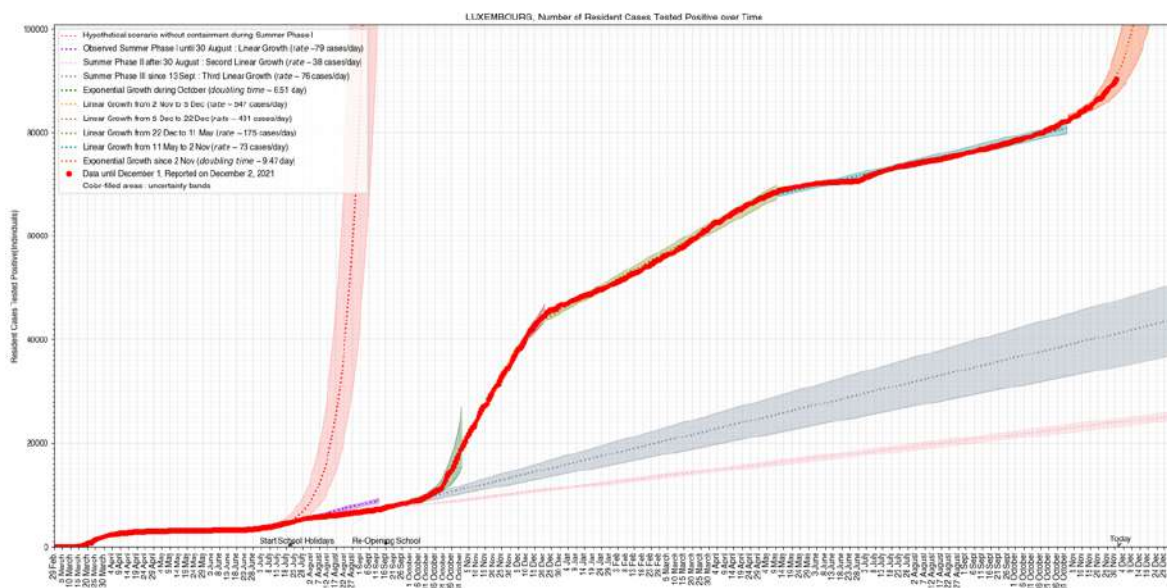


Figure 2. Official COVID-19 case numbers up to 1 December (red dots) were approximated with an adapted model for short-term forecasts for the different phases of the epidemics (color coded). For the current week, the linear fitting for the last month indicates an increased slope with 261 cases/day compared to 210 cases/day from the corresponding estimate of last week. **The continuing increase in the slope is actually indicating the exponential behavior as shown by the corresponding exponential (orange).**

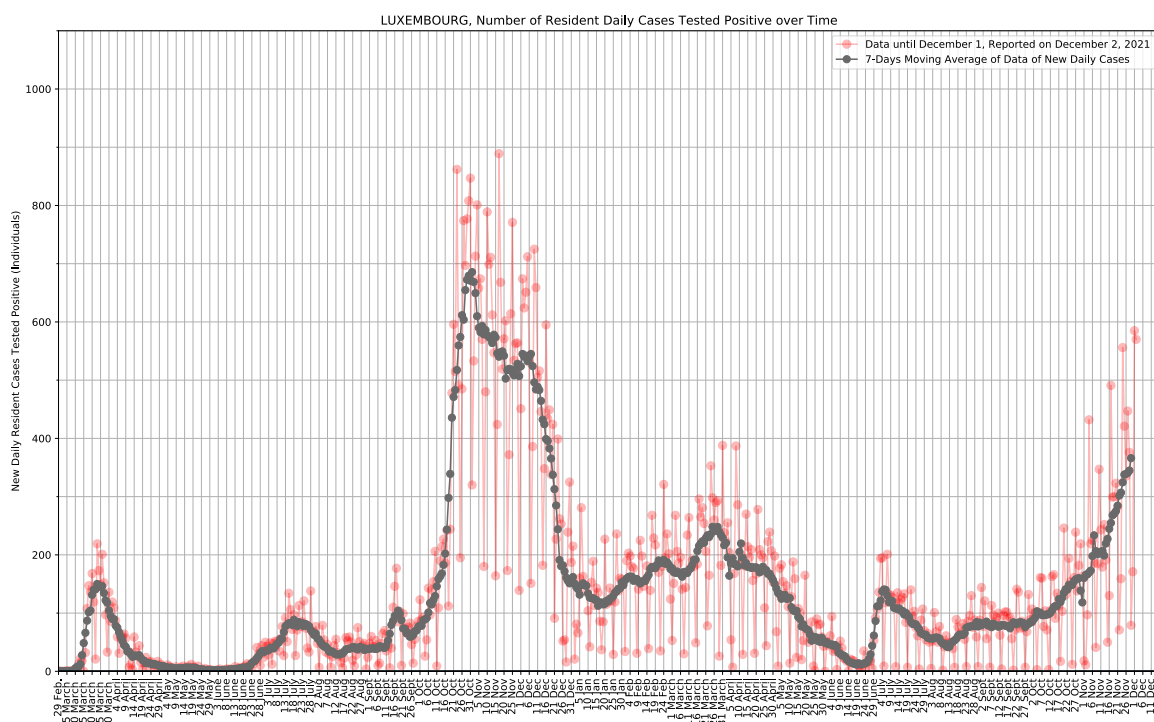


Figure 3. The daily COVID-19 case numbers up to 1 December (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve and that an exponential behavior would correspond to a straight line. **For the current week, the 7-day average of daily cases (grey) increased to an average of 361 cases/day for the last 7 days compared to 302 cases/day for the week before.** The observed linear behavior indicates a trend towards an exponential dynamics.

To assess the future epidemiological development in Luxembourg, we parameterized an extended epidemiological SIR model with data from Luxembourg by a Kalman filter. The model considers high and low risk groups, the number of vaccinated people of 70% of the entire population (including

minors) is vaccinated. Furthermore, the vaccine efficacy against transmission is inferred from Luxembourg data as 44% and 68% for the first and the second dose, respectively, and the efficacy against severe outcome as 74% and 85%, respectively. Based on these assumptions and the current age-distribution of infected persons of the last two weeks, the model integrates the dynamics of daily cases, hospitalizations and ICU occupancy and projects the future development of the epidemics. Note that the model does not consider future changes in social behavior or vaccine efficacies explicitly and that the projections are accompanied by uncertainties as shown by the confidence intervals, which currently correspond to a 10% decrease or increase in social interactions for the optimistic and pessimistic scenarios, respectively (Figures 4 to 6).

The midterm **projections of the 7-day average of daily new cases** (Figure 4) estimate the current level of social interactions and consider the vaccination status. The current projections reflect the observed increase in daily cases and the exponential behavior of the epidemic dynamics. Thus, the current projections for **the 7-day average of daily cases** for the next weeks exhibit again an increase in the peak of around 420 cases/day in January and a subsequent slow decay (Fig. 4 left) compared to a peak of around 360 cases/day as anticipated from last week's projections (Fig. 4 right). In the currently volatile epidemic regime, small changes in social interactions can have a significant impact as shown by the optimistic and pessimistic scenarios. In the pessimistic scenario, the current upper bound corresponds to a 10% increase in social interactions and shows that an epidemic rebound with an increased peak of nearly 800 daily cases could occur in January compared to the anticipated peak of around 720 cases/day from the projections of last week. The continuing increase of the projections during the last weeks indicates the deterioration of the epidemic situation with a persistent exponential dynamics, which might be also induced by immunity waning of vaccinated people.

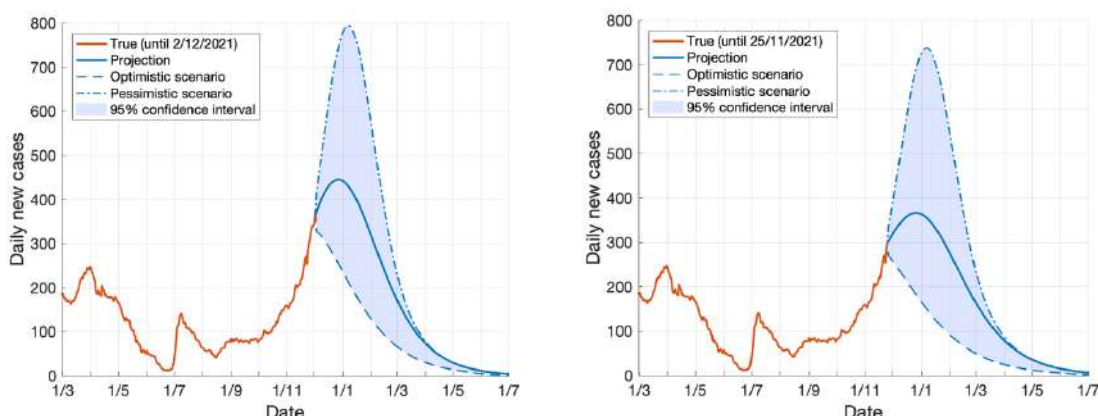


Figure 4. Comparison of midterm projections for the 7-day average of daily cases from this week (left) and last week (right) based on an extended epidemiological SIR model parameterized to the situation in Luxembourg data by a Kalman filter. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 10% decrease and increase in social interactions for this week's and last week's projections, respectively. **The comparison indicates an increase in the epidemic dynamics for the next weeks with an anticipated peak in January of around 420 cases/day on average (left) compared to around 360 cases/day in the projection from last week (right).**

The model **projection for normal care** also reflects the increased epidemic dynamics observed within the current week (Fig. 5) where the current projection (Fig. 5 left) indicates a slight increase in the normal care demand with a peak of around 75 beds in January and a subsequent decreasing trend compared to around 65 beds from last week's projection (Fig. 5 right). This dynamic is based on the case numbers shown in Figure 4 and the current age distribution of cases. For the normal care demands, the volatile epidemic level bears also the potential for a significant increase in hospitalizations as shown by the pessimistic scenarios with a 10% increase in social interactions, which could lead to an increase in hospital demands of more nearly 140 beds in January (Fig. 5 left) similarly to the pessimistic scenario of last week (Fig. 5 right). Note that hospitalizations depend

strongly on the age distribution of cases since older people are more likely to develop severe symptoms and that changes in the age structure can induce changes in the projections accordingly.

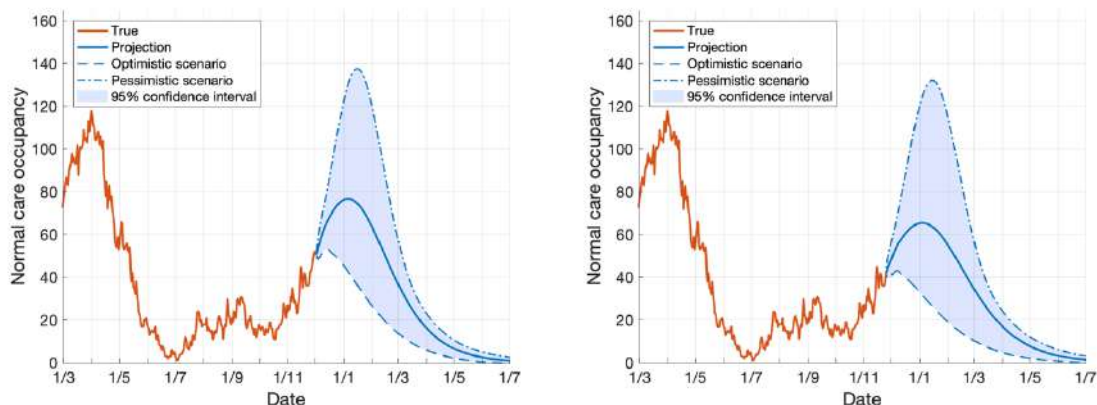


Figure 5. Comparison of midterm projections for the 7-day average of normal care demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 10% decrease and increase in social interactions, respectively for this week. **The comparison indicates a slight increase in the peak of normal care demands of around 75 beds in January (left) compared to 65 beds in the projections from last week (right).** The volatile epidemic regime could lead to a significant increase in normal care demands as shown by the pessimistic scenario with a 10% increase in social interactions leading potentially to nearly 140 cases in January.

The corresponding **projection for ICU demands** exhibits a more stable behavior than the case numbers and normal care demands since the age distribution of cases exhibits a trend towards younger people. Thus, despite increasing case numbers the absolute number of vulnerable older people has not significantly changed and therefore the current projection exhibits a potential demand of 28 ICU beds in January (Fig. 6 left) similar to the projection of last week (Fig. 6 right). The volatile epidemic level also bears the potential for a more significant increase in ICU demands as shown by the pessimistic scenario with a 10% increase in social interactions, which could lead to more than 50 ICU cases in January (similar to the estimate of the pessimistic scenario of last week's projection). Note that hospitalization and specifically ICU demands depend strongly on the age structure and vaccination status of cases. Hence, it is particularly important that vulnerable people are vaccinated and remain cautious in their social interactions to prevent severe cases.

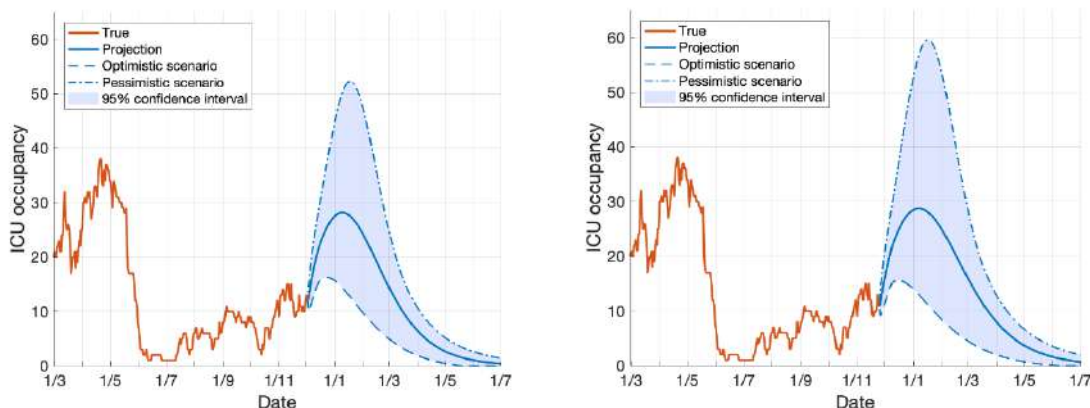


Figure 6. Comparison of midterm projections for the 7-day average of ICU demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario and the optimistic (dashed line) and pessimistic scenarios (dotted-dashed line) correspond to a 10% decrease and increase in social interactions, respectively for this week. **The comparison exhibits a rather constant ICU demand of anticipated 28 ICU beds in January from projections of this week (left) and similar to last week's projections (right).** The current pessimistic scenario with a 10% increase in social interactions also shows a potential increase to more than 50 ICU beds in January.

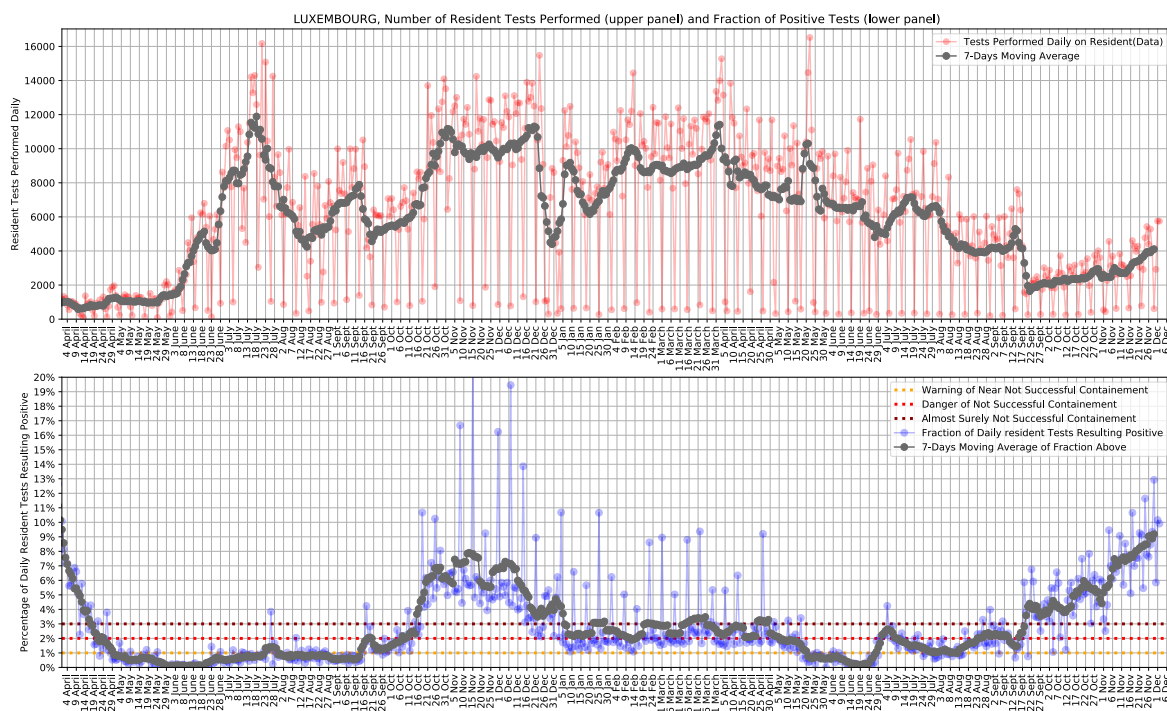


Figure 7. Number of daily tests performed (top) and overall normalized positive tests (bottom). During the current week, the 7-day average of the positivity rate (grey) has increased to above 9% compared to a level of 8% for last week.

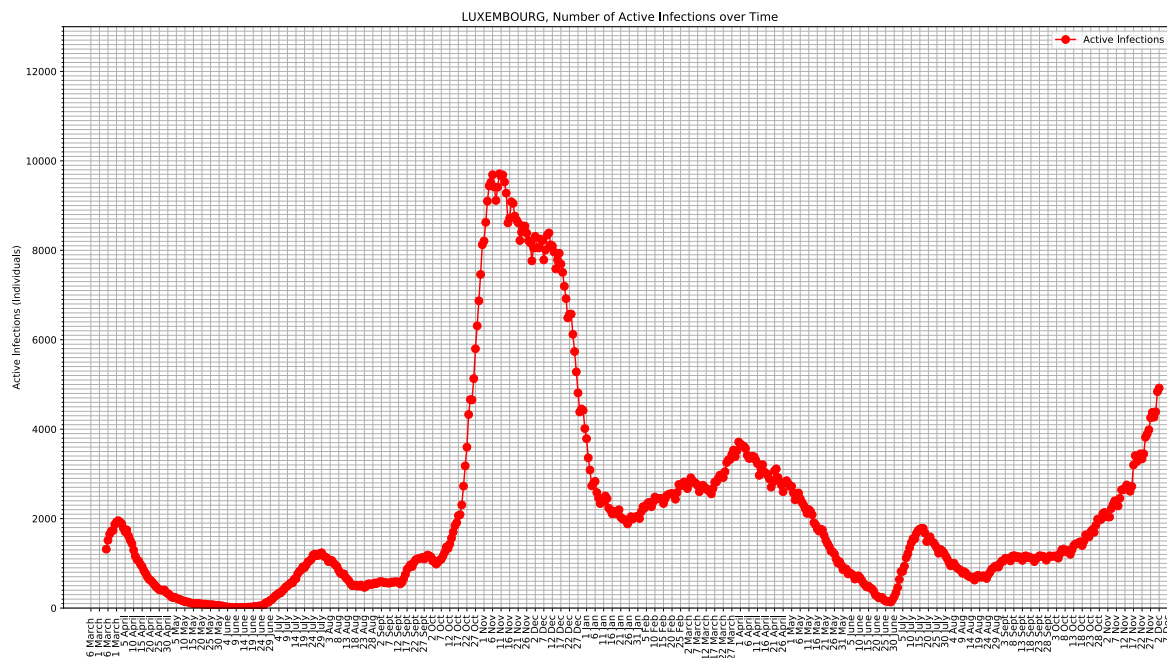


Figure 8. During the current week, the number of estimated active cases has further increased to 4920 cases compared to 3891 cases for last week.

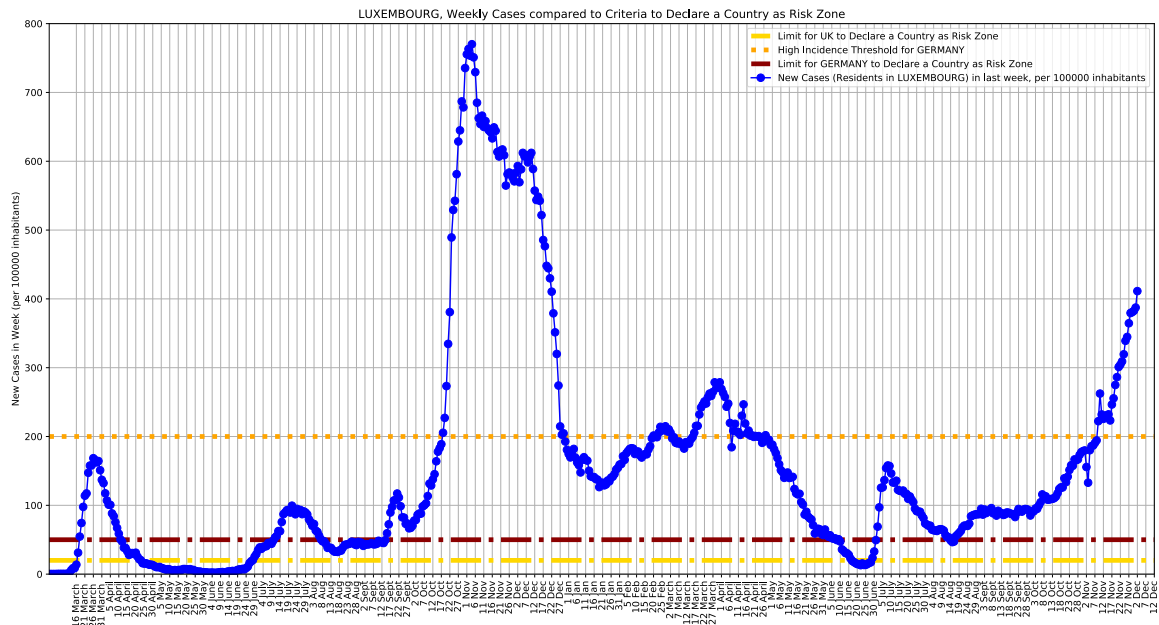


Figure 9. Number of weekly cases per 100,000 inhabitants that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and per 100,000 inhabitants (dark red line). **During the current week, the number of weekly cases per 100,000 inhabitants has just increased to above 400 cases for this week compared to 330 cases for last week.**