

# 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 week's report from 3 December. It gives a short overview on the most important indicators and contains projections and an analysis of the current epidemic status **based on data available up to December 9**.

## Main conclusions

- The linear regime of the epidemic dynamics reported for the last weeks has continued during the current week. Despite this stabilization, the estimated number remains high with 544 cases/day compared with last week's projection of 550 cases/day and indicates a volatile epidemic state. This observed stagnation despite the additionally implemented measures indicates that further social efforts are needed to mitigate the current epidemic wave and to bring down the numbers into a better controllable regime.
- $R_{\text{eff}}$  stays rather constant with 0.9 for today compared to 0.94 from last week, which corresponds to a doubling time of 11.5 days (compared to 10.3 days last week). Also the  $R_{\text{eff}}$  average of the current week does not exhibit a significant change (1.01 this week compared to 1.0 for the week before).
- The total number of estimated active cases has stabilized during the current week but remains high with a level above of 8000 cases.
- If the current trend would continue in the coming days/weeks, our mid-term model for daily cases exhibits again a slightly more pessimistic projection compared to last week's projections but still with a decreasing trend in the case numbers for the next weeks. [Note that this model reflects the possible evolution of the pandemic in case the current trend – and thus the current societal behavior – continues.] The model takes the implemented measures and resulting societal behavior changes only implicitly into account. **Surprisingly, the last implemented measures seem to not have a strong effect so far and do not lead to a further relaxation of the epidemic dynamics.** The expected effect might be compensated by increased shopping activities for the holiday season. It should remain our common goal to contribute to push down the curve further towards a more stable regime. **Societal behavior can change the curve in one or the other direction.**

## Analysis of the current situation

Overall, **the epidemic dynamics has further stagnated in its volatile regime** as shown by

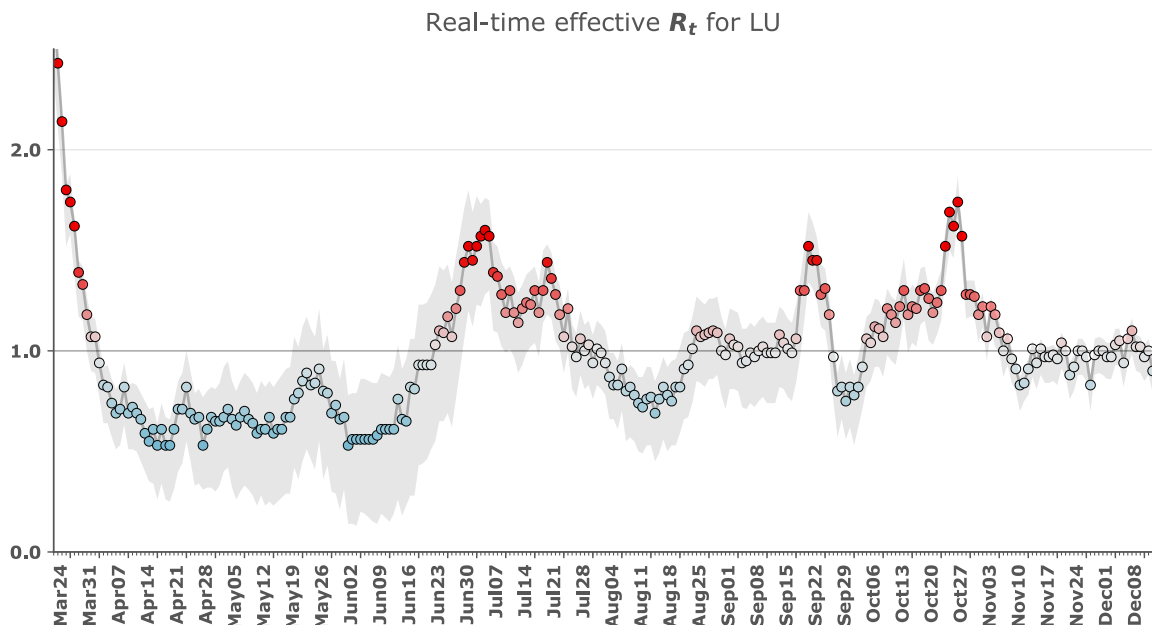
- (i) a rather stable  $R_{\text{eff}}$  value of 0.9 (Figure 1) (compared to 0.94 last week) that corresponds to a doubling time of 11.5 days compared to 10.3 days last week



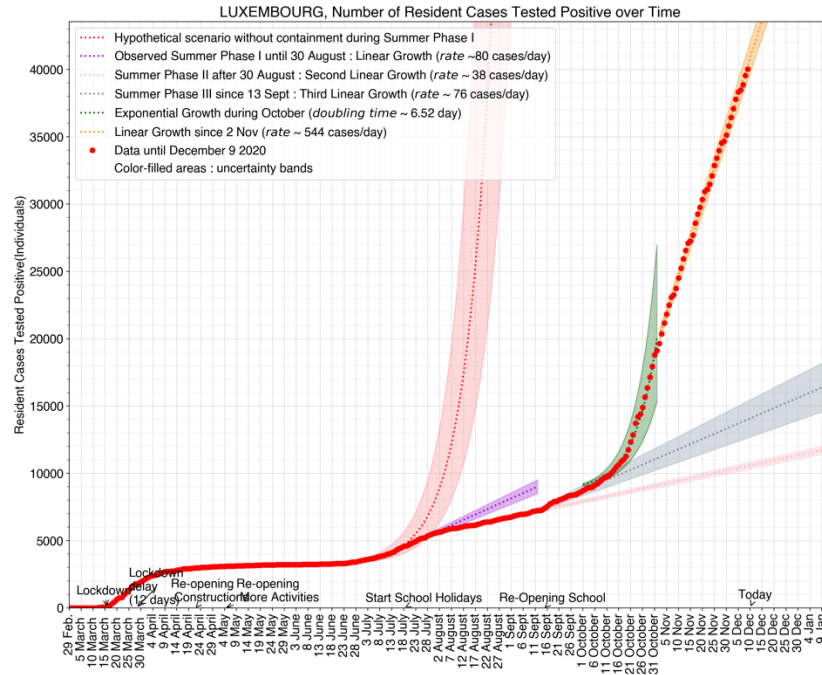
- (note that the current situation remains very fragile and effective mitigation requires values smaller than 0.8),
- (ii) the analysis of daily new cases and corresponding projections by curve fitting that exhibits a rather stable linear behavior with 544 cases/day (compared to 550 cases/day) for inhabitants (Figures 2 and 3),
  - (iii) the midterm projection by an epidemiological SIR model exhibits a small increase of case numbers compared to last week's projections but with a remaining trend of slowly decreasing daily case numbers over the next weeks (Figures 4),
  - (iv) a stable positivity rate of around 7% (Figure 5),
  - (v) a stagnation in the number of estimated active cases (Figure 6).

This analysis indicates a further stagnation of the epidemic situation with no significant relaxation and therefore the situation remains at a rather volatile state with a large number of daily new cases. The biggest danger would be a return to exponential growth, which, at this stage, could quickly overwhelm the healthcare system. In particular, the sustained linear dynamics with a rather constant high number of daily cases indicates that **the recent measures are not yet as effective as required and that mitigation of the epidemic wave relies on further social efforts in reducing physical interactions, respecting hygiene measures and active participation in large scale testing to prevent bottlenecks in the healthcare system and contact tracing capacity.** Only if we manage to push the curve further down, a potential fast and strong rebound of the wave can be prevented. Therefore, it is important to continue to monitor the epidemic dynamics over the next weeks and assess the effectiveness of implemented measures and change in social interactions.

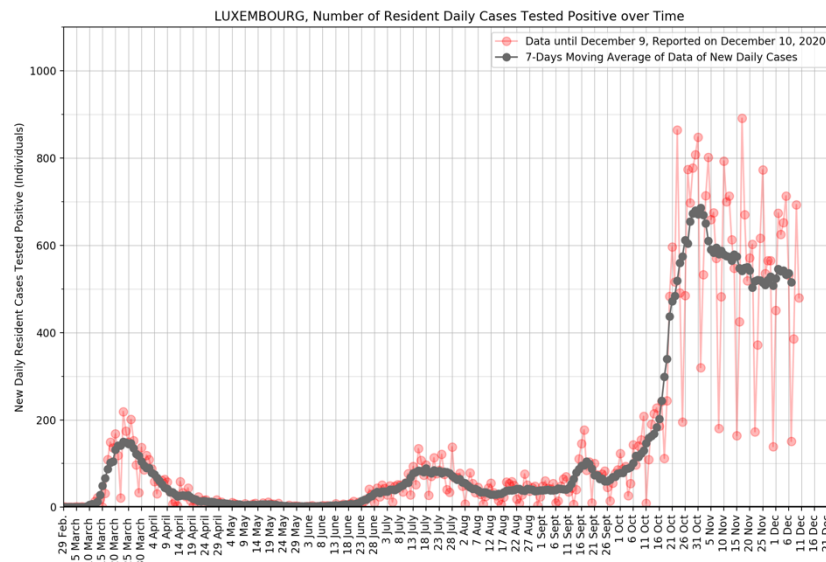
**Note that the presented analysis takes the current measures and the change in people's behavior only implicitly in consideration, based on the changes in the daily cases numbers.**



**Figure 1.** During the current week, the effective reproduction number in Luxembourg slightly decreased from 0.94 to 0.9 (for inhabitants only) which corresponds now to a doubling time of 11.5 days (compared to 10.3 days last week). Note that these values indicate a fragile and volatile epidemic regime where small changes can lead to a rebound of the epidemic wave. Effective mitigation requires values below 0.8.



**Figure 2.** Official COVID-19 case numbers up to December 9 (red dots) were approximated with an adapted model for short-term forecasts. From 14 June on an initial exponential increase was observed as a second wave (red line). From mid to end of July the daily increase of cases showed an increase of 80 cases/days (summer phase I, magenta line) and from beginning of August to mid of September a linear increase of 38 cases/days (summer phase II, orange line). After the end of the vacation period mid of September, the situation seemed to have a similar behavior as the summer phase I with 76 cases/day (summer phase III, grey line) until beginning of October. The development during October indicated an accelerated exponential behavior (green) with a high number of daily cases. **Since beginning of November, the dynamics exhibits a linear behavior (orange line) but with a rather constantly remaining high number of 544 cases/days (compared to 550 cases/day projected last week).**

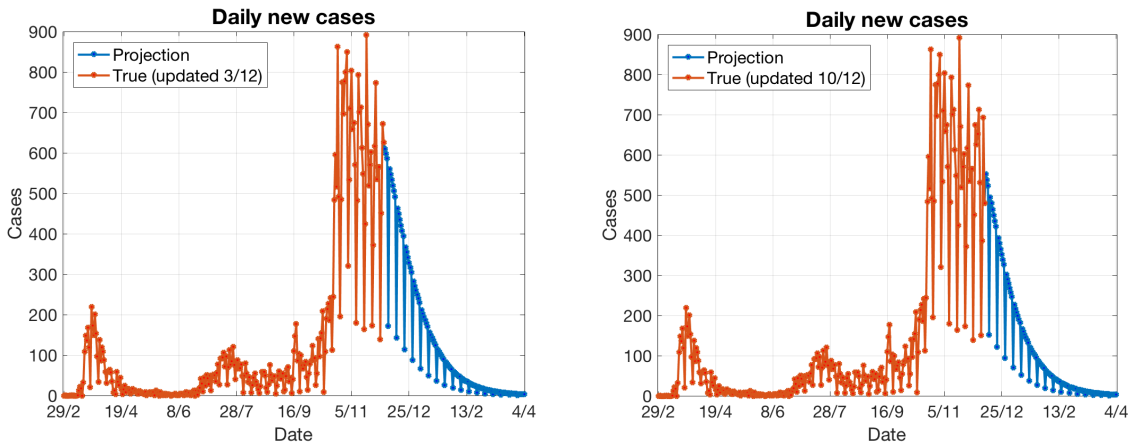


**Figure 3.** The daily COVID-19 case numbers up to December 9 (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve such as during the vacation period with 38 cases/day and an exponential behavior would correspond to a straight line such as for end of September to beginning October. During October, the curve clearly exhibited a non-linear increase in daily cases which corresponded to an accelerated exponential dynamics. **For the first weeks in November, the numbers exhibited a small but consistently decreasing trend but for the last 3 weeks the numbers stagnated at a high level of around 550 cases/day.**

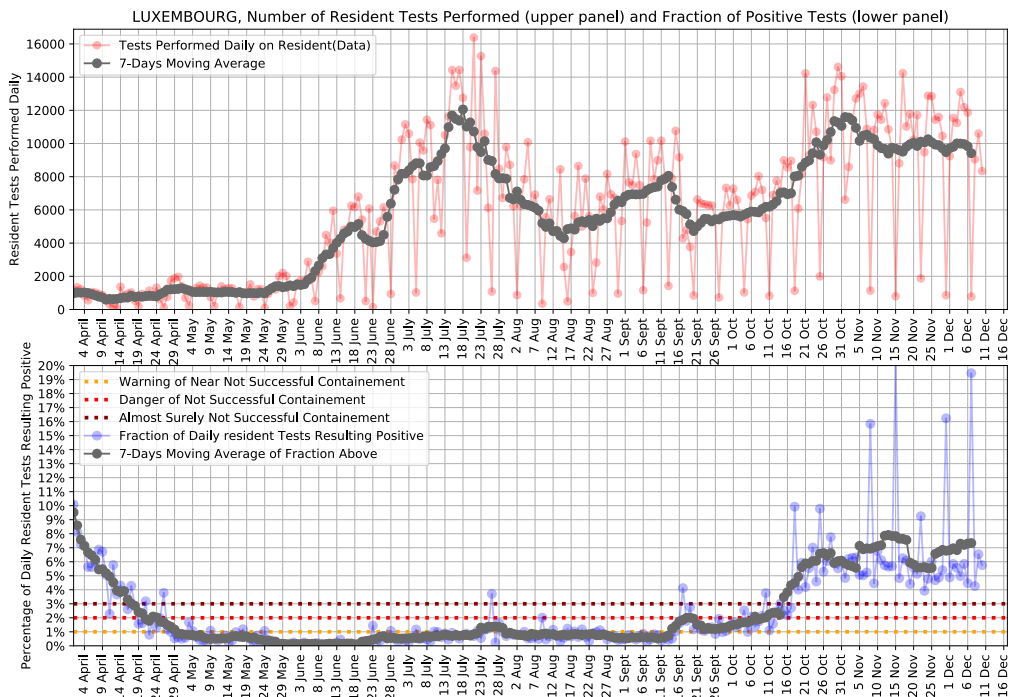


To estimate the midterm dynamics, we also apply an SIR model and parameterized it by a Kalman filter. The observed stagnation during the last 2 weeks leads again to a slightly more pessimistic projection compared to last week as shown in Figure 4.

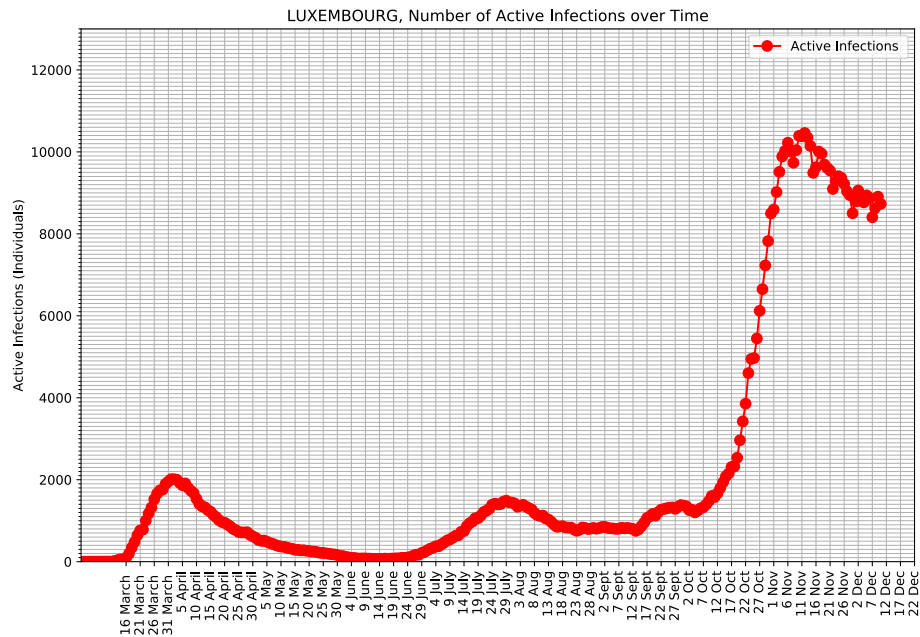
**Note: The beneficial effect of measures and a potential change in people’s behavior on the epidemic dynamics is only included implicitly in these graphs by the change of the dynamics.**



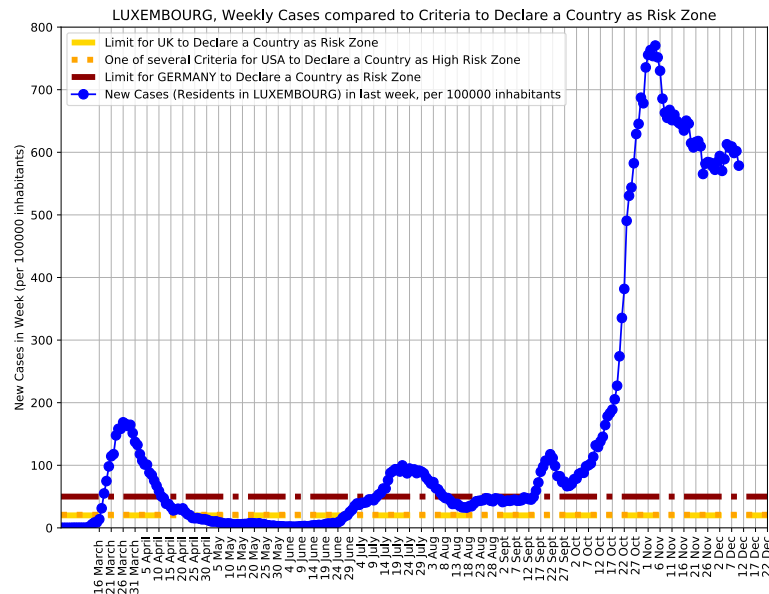
**Figure 4.** Comparison of midterm projections for daily cases from last week (left) and this week (right) based on an epidemiological SIR model parameterized by a Kalman filter based on cases of inhabitants only. The comparison exhibits again a more pessimistic projections compared to last week due to the stagnation of the daily case numbers. Thus, the current projection estimates around 400 daily cases around Christmas compared to 300 cases from last week’s projection.



**Figure 5.** The number of daily tests performed (top) and overall normalized positive tests (bottom). After the intermediate relaxation to around 1% end of September, the positivity rate has continuously increased to approximately 7% by the end of October and plateaued since then.



**Figure 6.** After the decreasing trend for the estimated active cases since beginning of November, the current week exhibits a rather constant level.



**Figure 7.** The number of weekly cases per 100,000 inhabitant (blue line for inhabitants only) that is used by different countries to declare thresholds for risk zone definitions such as Germany with 50 cases per week and 100,000 inhabitants (dark red line). Luxembourg has surpassed this threshold since the week of 17 September and has reached more than 700 cases per week and 100,000 inhabitants beginning of November. For the current week, the level has further stagnated at a high level indicating the volatile regime.