OECD/NEA Update: $^{99}Mo/^{99m}Tc$ Demand and Production Capacity Projection

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- Kevin Charlton
  - Senior Analyst - Nuclear Energy Agency (NEA) of the OECD
  - Secretariat - High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR)
- Previous Experience in Medical Radioisotopes (since 1977)
  - The Radiochemical Centre (TRC), England: became
  - Amersham International plc: Radiopharmaceutical, Radioisotope, Radiochemical and Radiation Source producer (now GEHC)
  - Amercare Ltd, England: Glove Box systems for Nuclear Pharmacies
  - Mallinckrodt Medical UK, England: Distributor of Medical Radioisotopes
  - Mallinckrodt Medical BV, The Netherlands: ^{99m}Tc Generator Producer
  - NRG, The Netherlands: Operator of HFR Reactor – Irradiator
  - Vice Chairman of the AIPES Reactor and Isotope Workgroup

- The NEA is a specialist agency of the Organisation for Economic Co-operation Development (OECD), an intergovernmental organisation of industrialised countries based in Paris
- The NEA MISSION - To assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal basis required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purpose

Demand and Capacity 2015-2020

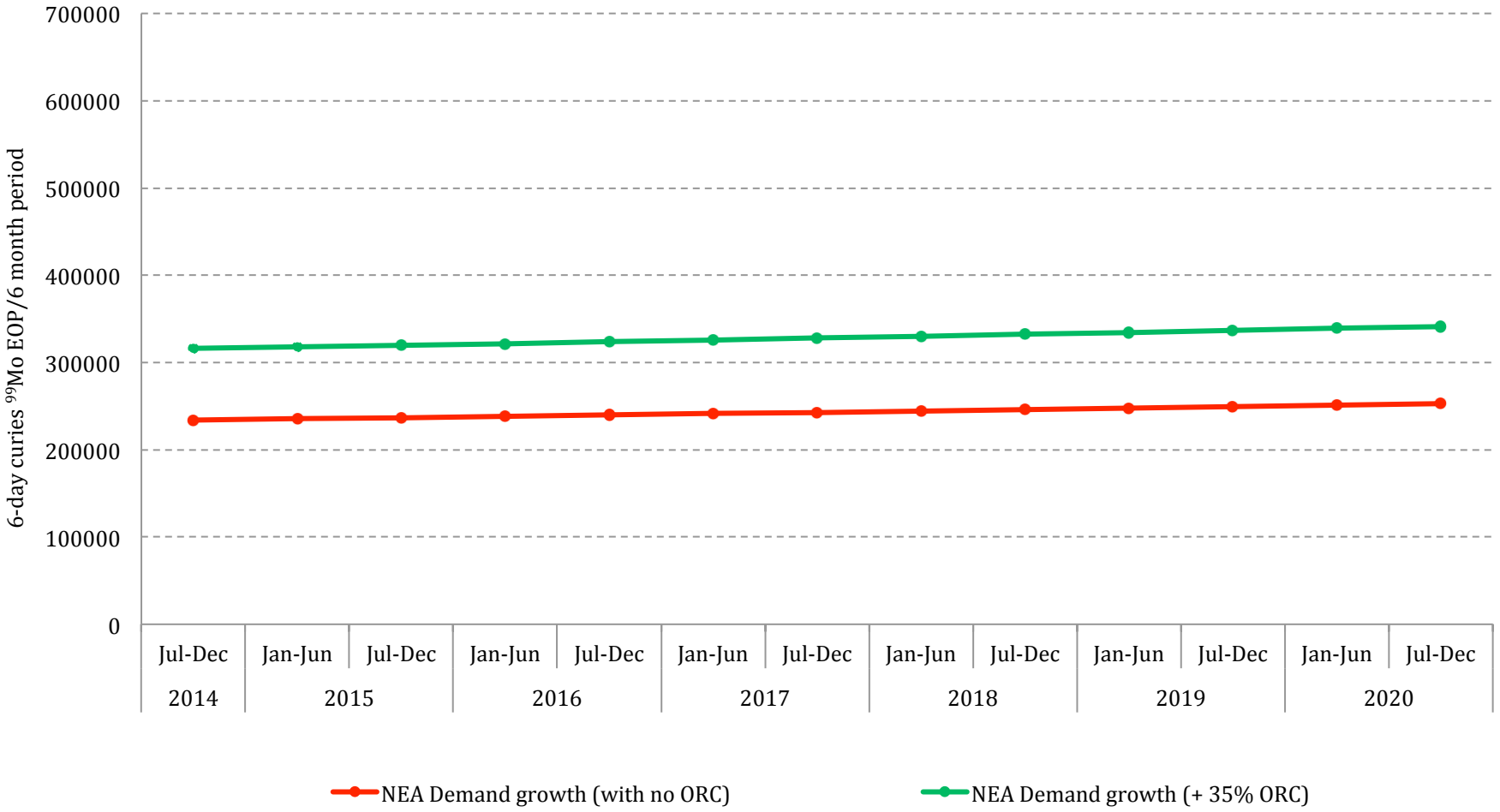
- Data collection process
  - Analysis was at the Irradiator and Processor level, current irradiator and processor capacity tables were reviewed and corrected by participants, including prospective changes
  - Retrospective % capacity-use data on a Quarterly basis was provided by most market participants for 2012, 2013 and 2014
  - Forecast estimates of % capacity usage for 2015 and 2016 were provide by some participants
  - Prospective Irradiator and Processor project timeline plans were reviewed and collected in a single structured format and new tables developed

Demand 2015-2020

- A revised Demand and Capacity Projection 2015-2020 has been prepared and completed a final round of review
  - Revised demand level was established by retrospective analysis of reactor and processor capacity usage – demand growth rate unchanged from previous report
  - The report identifies the total market demand for the last 3 years has been structurally lower than previously estimated:- now 9,000 6-day Ci ^{99}Mo per week EOP demand compared to 10,000 6-day Ci ^{99}Mo per week EOP previously estimated
  - This demand level is supported by the near full market supply achieved in 2013 and 2014 in periods of substantial challenge

Demand 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC, 2015-2020



Capacity 2015-2020

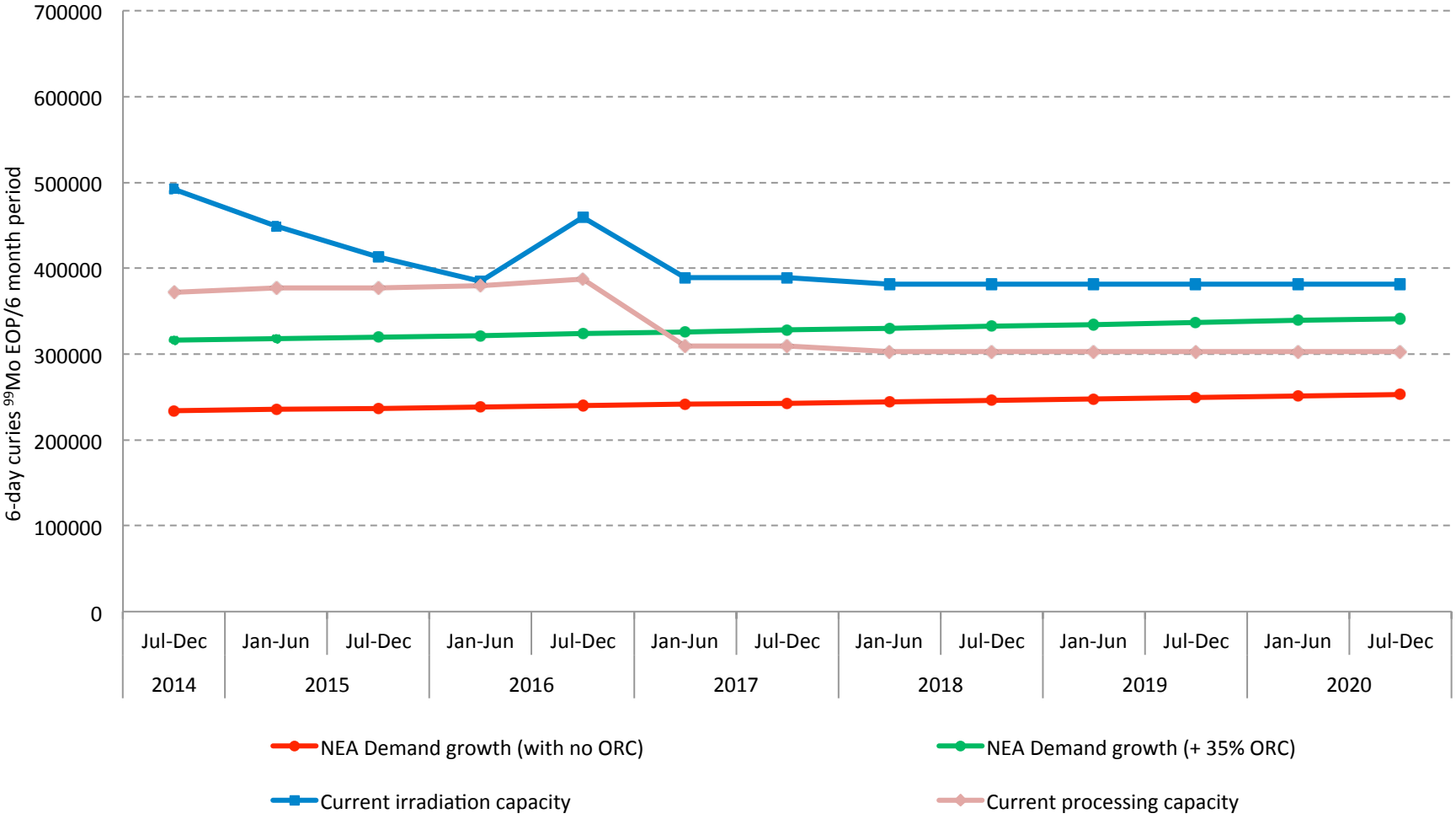
- Capacity projections 2015-2020 prepared for a number of scenarios for both irradiation and processing capacity
  - Scenario A: Existing supply chain only (existing facilities)
  - Scenario B: “Technological challenges” - existing supply chain + qualified new production projects (same structure as 2014)
  - Scenario C: “Project delays” to new projects (B + 1 year delay)
    - To assume additional delays is well justified, project timeline slippage was clear between this and the previous analysis (2014)
  - Some adjustments to assumed LEU conversion effects

Capacity 2015-2020

- Major Changes
  - Substantial additional irradiation and processing capacity added by some existing supply chain participants
  - Negative LEU conversion effects reduced (to -10%)
  - New irradiation and processing capacity projects showed delays of at least 1 year compared to the 2014 data
    - Detail shown in the tables that are Appendix 1 of the new report
  - Canadian announcement about potential change to NRU operational period and “contingency capacity”

Demand and Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v current irradiation capacity and current processing capacity, 2015-2020: Scenario A

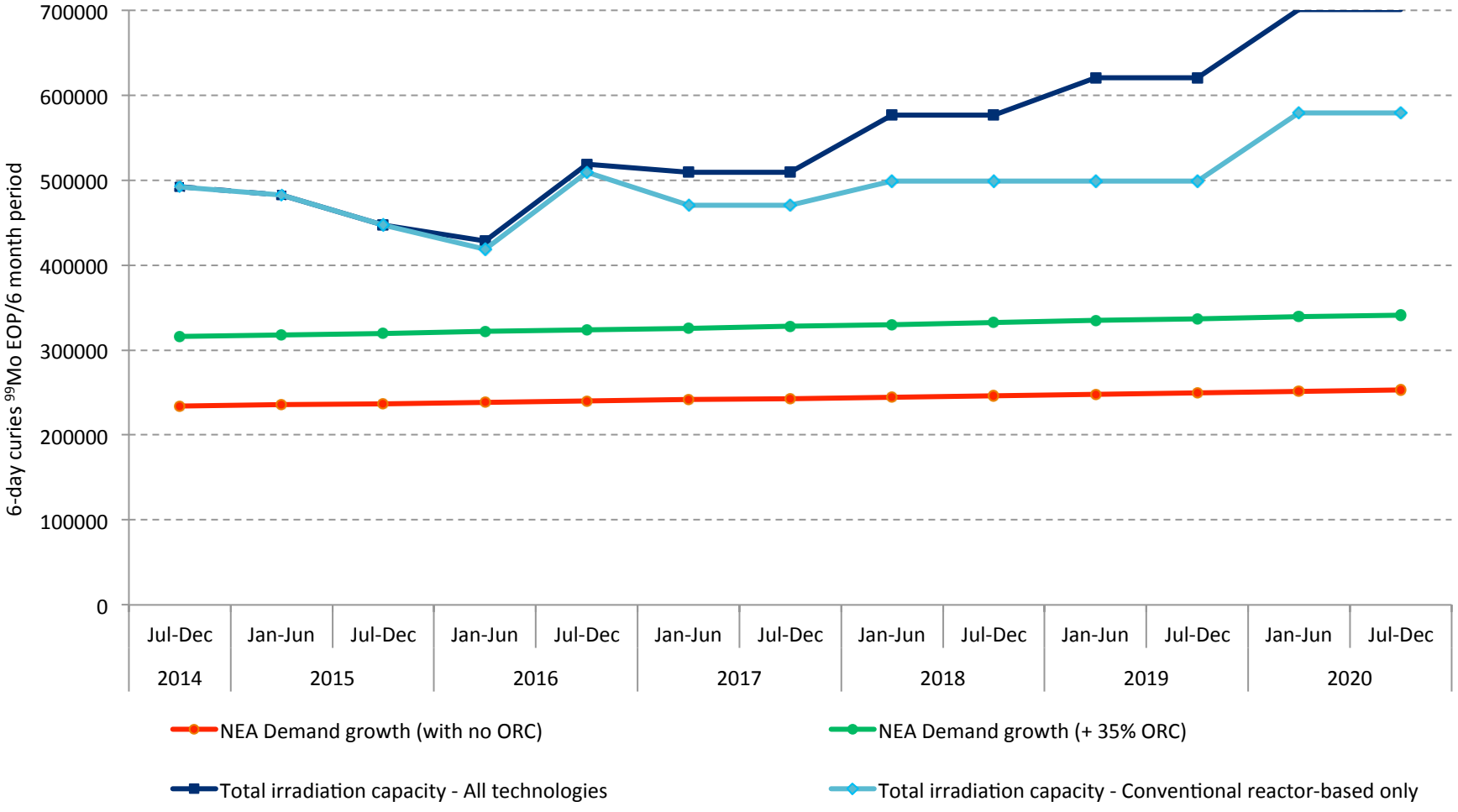


Demand and Capacity 2015-2020

- Scenario A – current capacity only
  - The current irradiator and processor supply chain, if well maintained, planned and scheduled, will be able to manage limited unplanned outages of a reactor, or a processor in the 2015-2016 period
  - This capacity to manage adverse events will reduce to only being able to manage an unplanned reactor outage from 2017 and the processing capacity will have some limited scope to manage an unplanned event from 2017 onwards

Demand and Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v irradiation capacity – total and conventional reactor-based only, 2015-2020: Scenario B

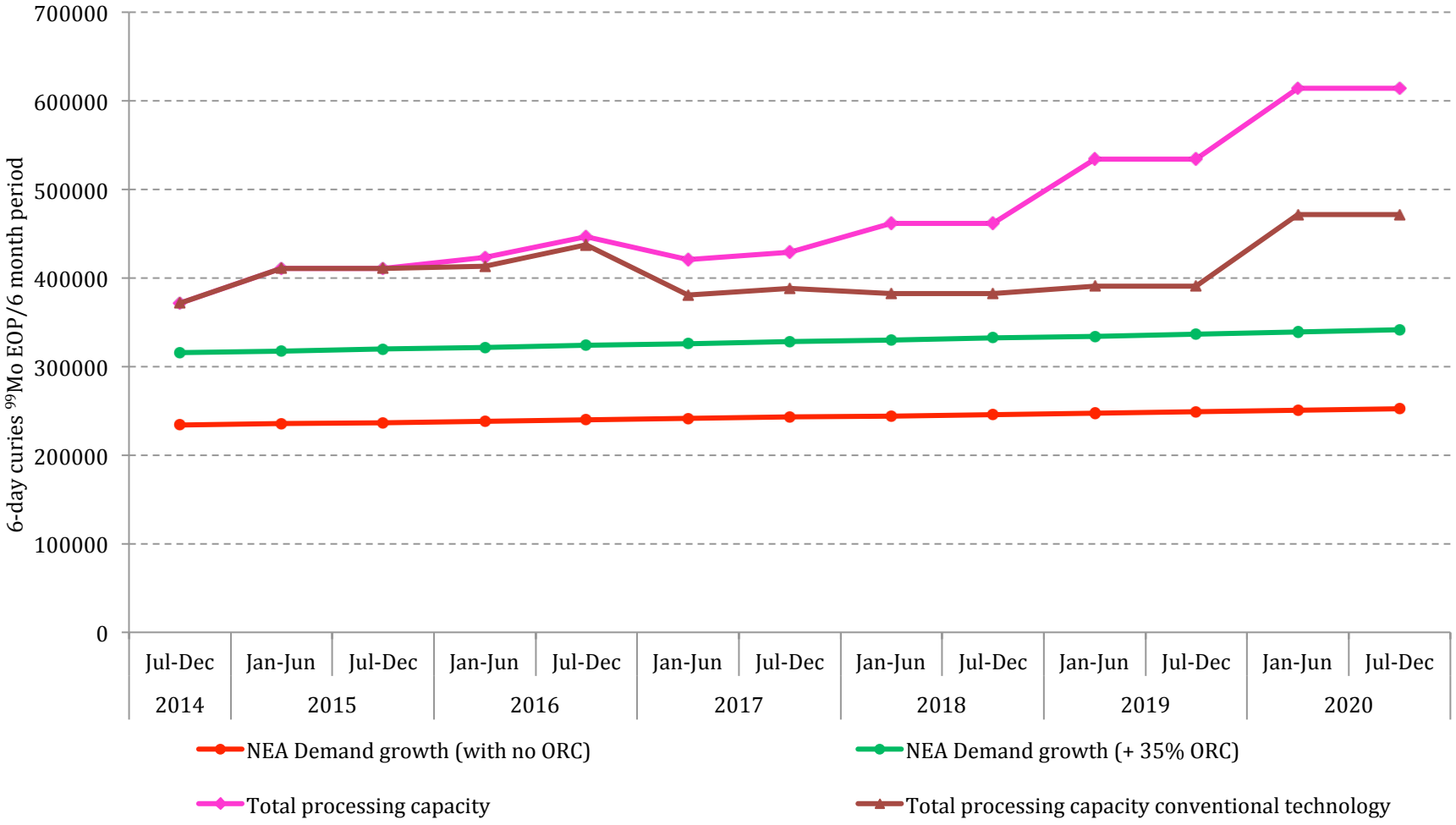


Demand and Capacity 2015-2020

- Scenario B – irradiation capacity “technology challenges”
  - Without all planned new irradiation projects being included, the global capacity of both irradiation capacity “technology challenges” projection lines look to be sufficient to meet projected demand +35% ORC throughout the six-year forecast period
  - Notwithstanding the expected exit from the market of the OSIRIS and the NRU reactors, the planned new capacity in Australia, Asia, Europe and North and South America, should more than compensate for the capacity reductions seen in the reference Scenario A

Demand and Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v processing capacity – total and processing capacity – conventional only, 2015-2020: Scenario B

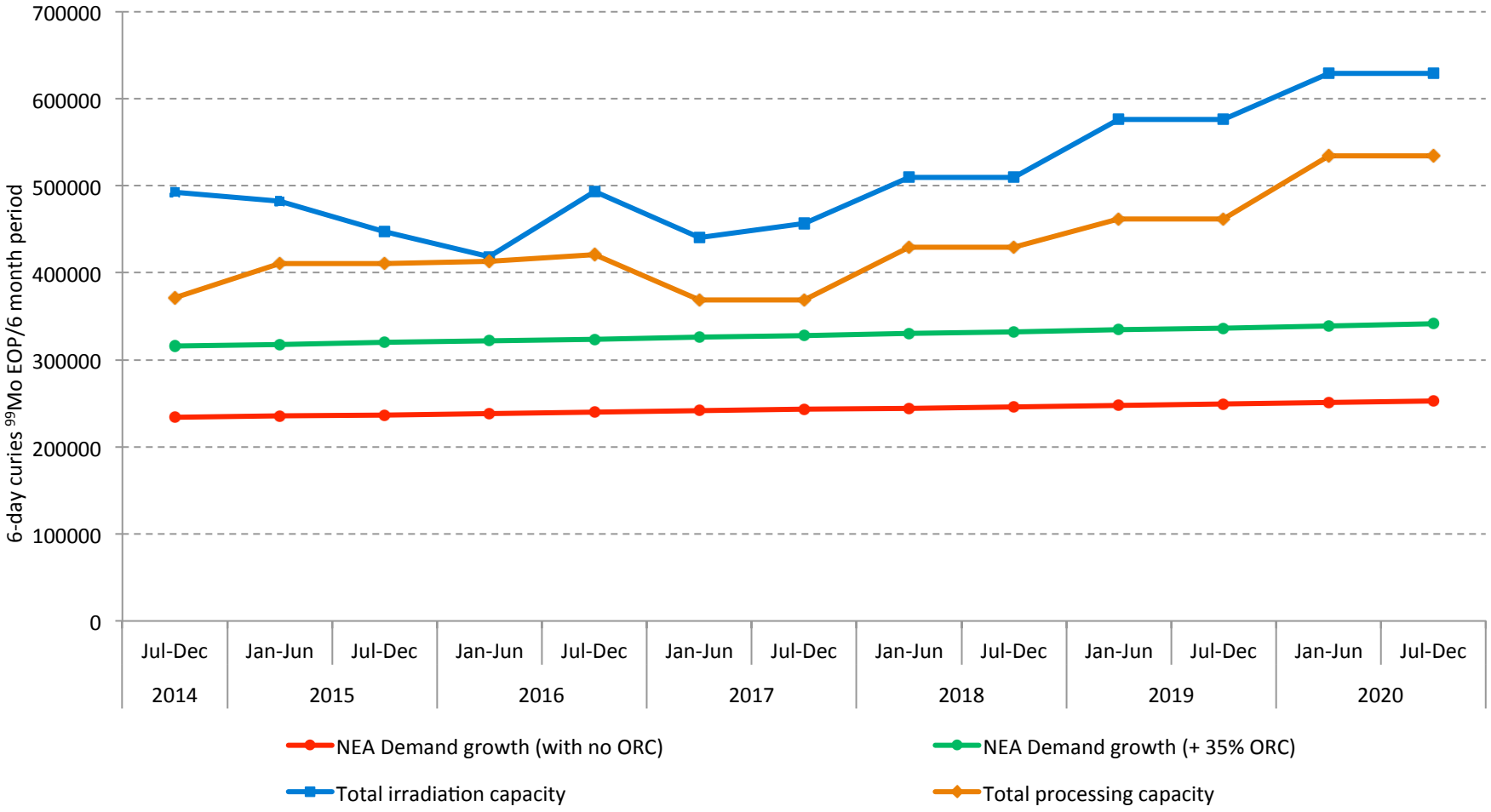


Demand and Capacity 2015-2020

- Scenario B – processing capacity "technology challenges"
  - Even without all planned new processing projects being included, "technology challenges" processing capacity looks to be sufficient to meet the projected demand +35% ORC requirement, throughout the six-year forecast period
  - The cessation of processing in Canada in 2016 is partially offset by increased processing capacity in the existing fleet and additional processing capacity in Australia (2017)
  - From 2017, the additive processing capacity from "alternative technology" projects primarily in the United States is progressive and quite substantial

Demand and Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v total irradiation capacity and total processing capacity – projects delayed: Scenario C

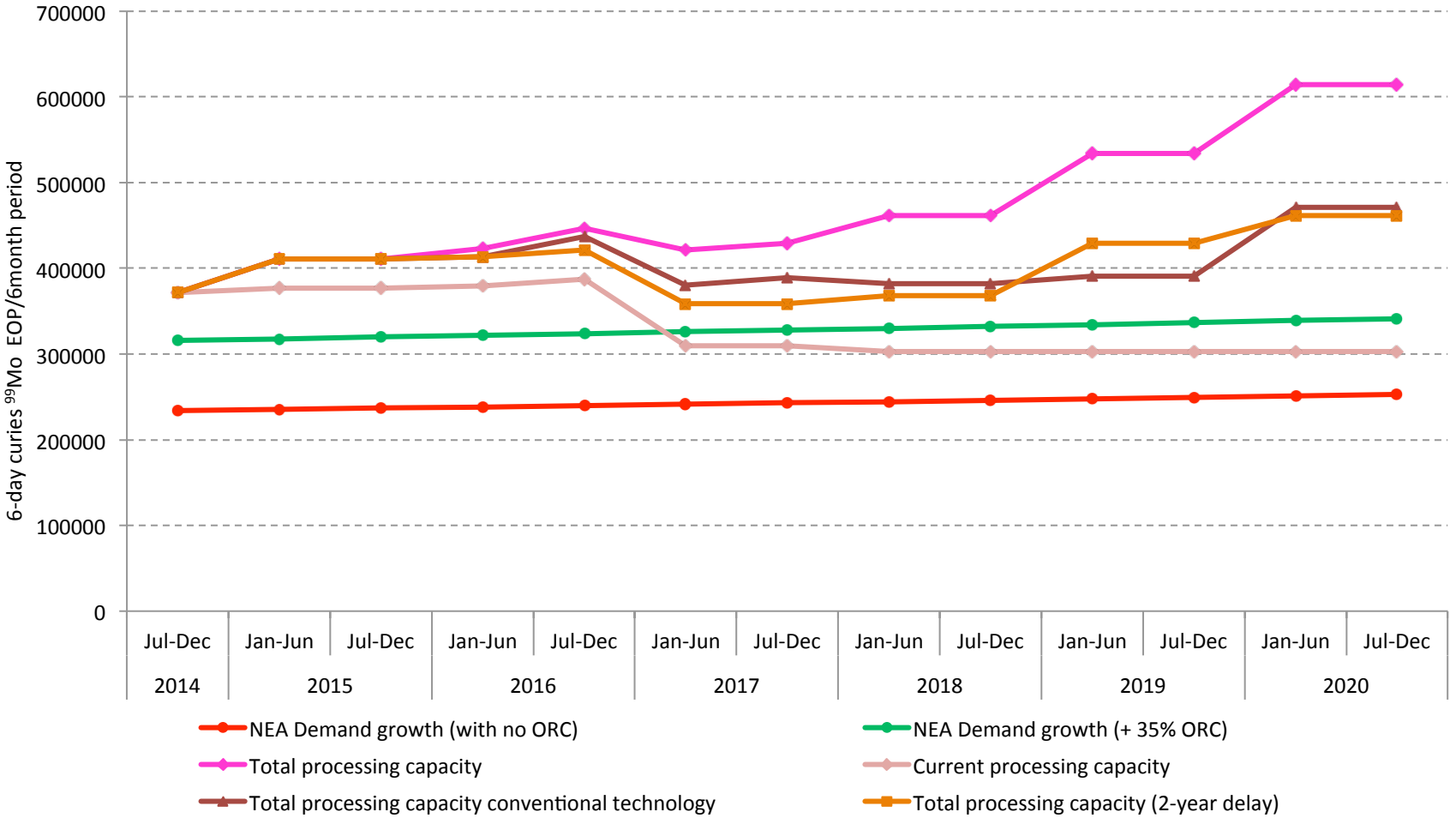


Demand and Capacity 2015-2020

- Scenario C – projects delayed (1-year)
  - Compared to scenario B, irradiation and processing capacity under scenario C are almost identical in 2015 and 2016
  - Both then decrease significantly in the January-June 2017 period because this scenario models the effect of a one-year commissioning delay of the additional Australian capacity
  - Total irradiation and processing capacity both then recover progressively, primarily due to the introduction of alternative technology that has been delayed

Demand and Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v processing capacity – current, total, total conventional only and total two-year delay: Scenarios A+B+C(two-year delay)



Demand and Capacity 2015-2020

- Scenario C – projects delayed (adjusted 2-year)
  - The impact of assuming only new processing capacity from conventional technologies has a similar pattern to assuming two years total delay in all processing projects
  - The effect of a “two-year total delay” is slightly deeper, but recovers earlier than the “conventional technologies only” projection
  - Both projections confirm a reduction in overall processing capacity occurs when projects are delayed and identify the value of additional capacity from alternative technologies

Demand and Capacity 2015-2020

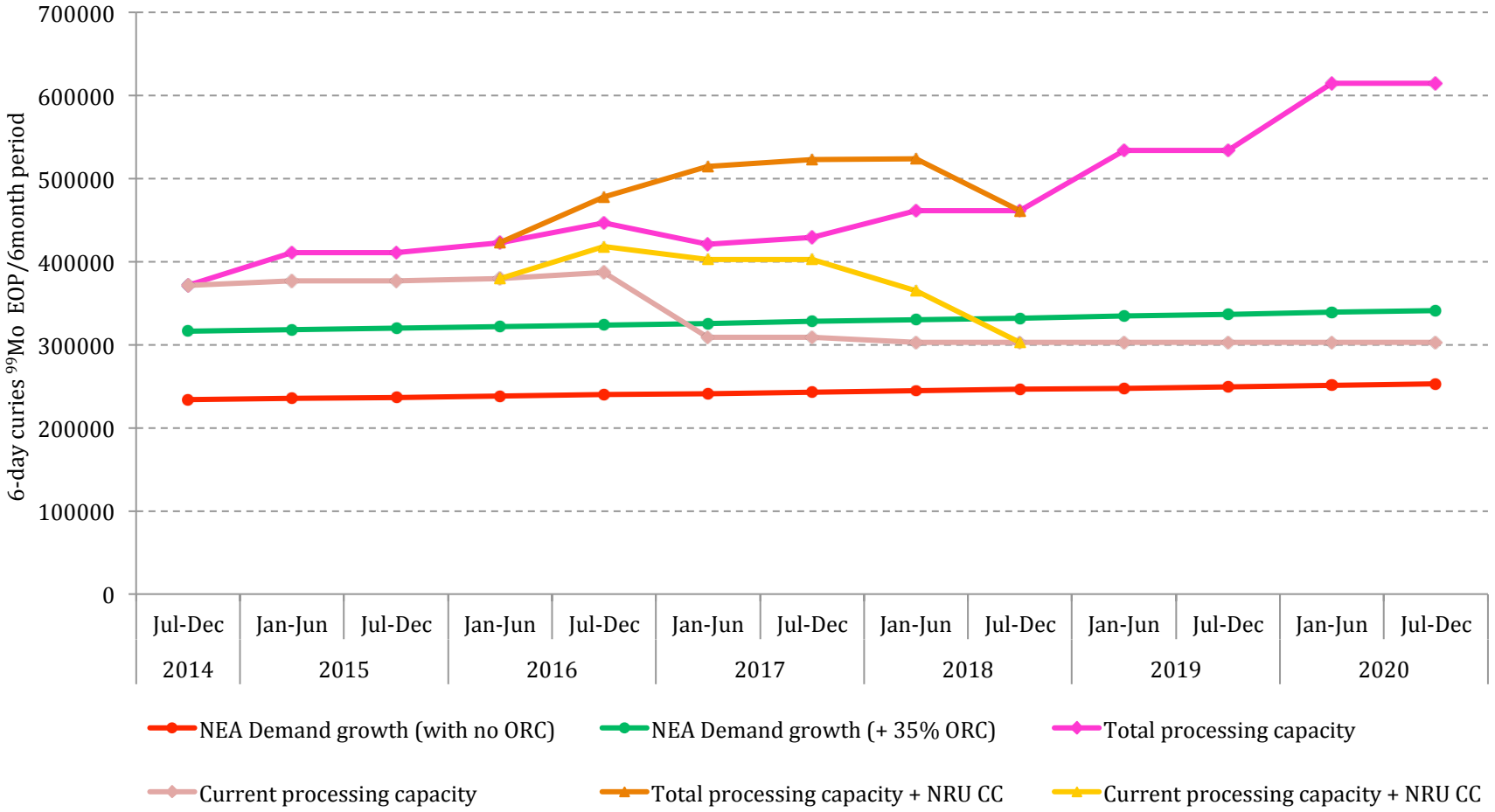
- Potential NRU Contingency Capacity
  - On 6 February 2015, Natural Resources Canada announced adjusted plans for the NRU reactor that affected the potential supply of ^{99}Mo, proposing a “supply of last resort” from NRU supported by the CNL and Nordion processing capacity
  - Subject to licencing approvals, it is proposed to operate the NRU reactor from 31 October 2016 to 31 March 2018 for non-^{99}Mo purposes, keeping the NRU reactor in “hot operation”
  - Associated facilities required for ^{99}Mo processing would be kept in a “hot standby” mode for the same period

Demand and Capacity 2015-2020

- Potential NRU Contingency Capacity
  - NRU Contingency Capacity (NRU CC) would only be made available under special conditions of market supply shortage:- unexpected circumstance of significant shortages and only if alternative technologies or other sources of supply were not available to meet demand
  - As a result, a form of additional contingency capacity could be available on top of the ORC held elsewhere in the supply chain
- The NEA considered that it would be useful to model the effect upon processing capacity of this NRU CC

Potential NRU Contingency Capacity 2015-2020

Current demand (9 000 6-day Ci ^{99}Mo/week EOP) and demand +35% ORC v processing capacity – current and total, with and without NRU CC



Demand and Capacity 2015-2020

- Potential NRU Contingency Capacity
  - The possible extension of the NRU operating period could be a useful stop-gap in the 2017 and early 2018 period, with the potential provision of substantial contingency capacity
  - In the event that slow progress is made with alternative technologies, or when all processing projects are substantially delayed, then the projected processing capacity would fall back to reference levels in 2018

Demand and Capacity 2015-2020

- Other Conclusions
  - Overall, while the supply situation looks to be under control; it will continue to require careful and well considered planning to minimise security of supply risks
  - A high degree of cooperation between the supply chain participants will be essential for the foreseeable future
  - The market situation will require regular monitoring, along with regular review of the progress of bringing the proposed new production capacity to market

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Thank you for your attention