Prairies Economic Development Canada

Développement économique Canada pour les Prairies

# Assessment of Alberta and Saskatchewan's industrial potential to participate in an emerging Canadian SMR supply chain

## Final Report

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Prairies Economic Development Canada | Développement économique Canada pour les Prairies

# Assessment of Alberta and Saskatchewan's industrial potential to participate in an emerging Canadian SMR supply chain

## Executive Summary and Key Take Aways

Canada has committed to achieving net-zero emissions by 2050 and has reaffirmed its position to accelerate a path to a 100 percent net zero carbon electricity future. Nuclear, and specifically Small Modular Nuclear Reactors (SMRs), are being evaluated to supplement baseload and firming electricity requirements to achieve Canada's net-zero goals underpinned by policy such as the SMR Roadmap, Action Plan and the Canada Energy Regulator. Canada has a long history as a Tier 1 nuclear country that services the full nuclear fuel lifecycle, including the development of new nuclear technology. The provinces of Alberta and Saskatchewan have signaled their intent to collaborate with other provinces to advance SMRs as a clean energy option. Both provinces have signed on to the SMR Memorandum of Understanding along with Ontario and New Brunswick. This study was commissioned by *Prairies Economic Development Canada* to assess the opportunities and challenges that exist for industries within Alberta and Saskatchewan to participate in a pan-Canadian SMR supply chain. While remaining technology agnostic, the study takes a cross-sectoral approach to summarize emerging and unique requirements for entering the SMR supply chain, provides an assessment of the industry, and reviews the risks and opportunities that are emerging globally and domestically within the nuclear and SMR industry.

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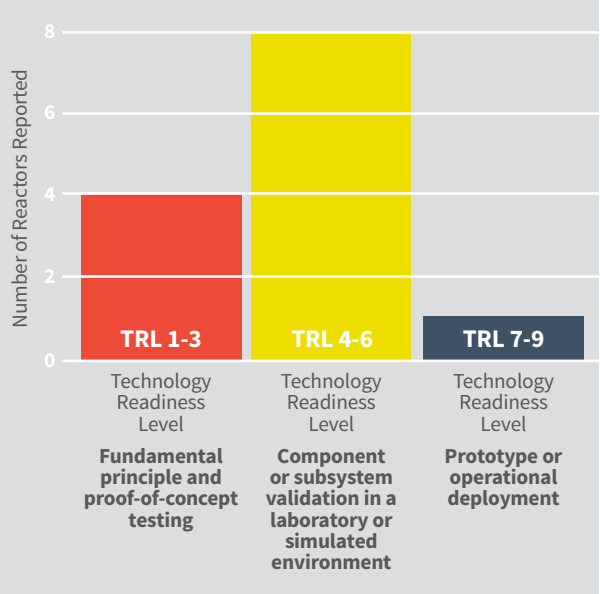
# The Opportunity

The global market for SMRs is estimated to reach **$150 billion (CAD)** per year by 2040. This estimate includes deployments for on-and off-grid applications, such as remote mines and remote communities. Canada has conservatively estimated the domestic market to be $5.3 billion (CAD) between 2025 and 2040. Projections and estimates suggest the market could be 35 GWe for off-grid applications and 6.6 GWe for on-grid SMR demand. Currently, the regulator is evaluating 12 SMR technologies through the pre-licensing vendor design review. As per a recent SMR feasibility study, three streams have been identified for initial SMR deployment in Canada. This creates significant opportunity for the Canadian industry to capture a large portion of this emerging market as it grows domestically and abroad through its existing nuclear supply chain, and to leverage our strong manufacturing, construction, and resource-based industries located in Alberta and Saskatchewan.

Both Alberta and Saskatchewan are committed to a low carbon future and have made initial steps to phase out coal power usage by 2030. Furthermore, private industries, including oil and gas, mining, and heavy industry, have also committed to reducing their carbon footprint through emerging and new technologies.

These carbon reduction initiatives include developing SMR technology to boost uranium production, enhance research and development, and promote local economic development.

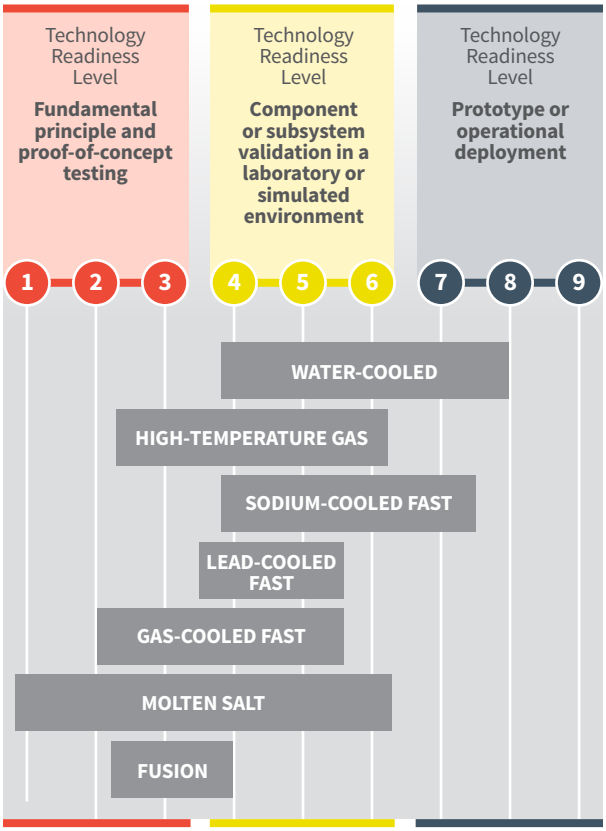
The current Canadian nuclear industry, which is made up of 200+ suppliers, was developed around large nuclear and primarily serviced Pressurized Heavy Water Reactors, developed by Atomic Energy of Canada Ltd. (AECL). SMRs are characterized as nuclear reactors that are less than 300MWe and thus require different approaches to ensure cost competitiveness with other forms of energy. The most significant difference between large nuclear and SMRs is their intent to be almost completely built using traditional serial manufacturing techniques. This involves constructing modules in a controlled factory setting for deployment at site, which drastically reduces on-site labour and installation that would typically expose projects to uncertainty, risk, cost escalations, and delays. Factory manufacturing can reduce costs while increasing quality, which means that the existing Canadian nuclear supply chain will need to assess, re-tool, and re-train to seize emerging opportunities around SMRs as with other Tier 1 countries.




### SMR technologies Readiness

(Courtesy Canadian SMR Roadmap: On-Grid Applications Workshop Report)

Supply chain readiness will depend on the technologies selected and the maturity of that technology with respect to design.

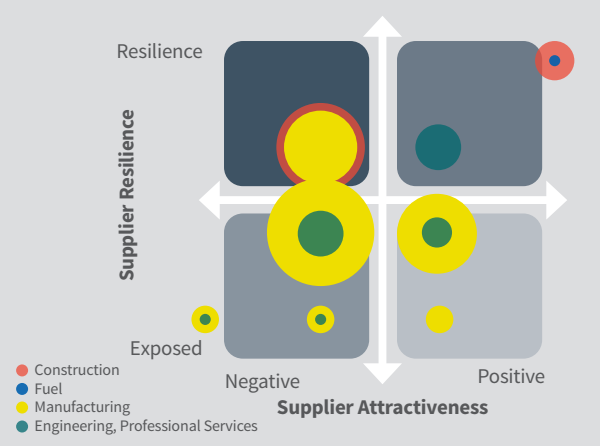


# Alberta and Saskatchewan Potential to Support a Pan-Canadian SMR Supply Chain

The following inputs were used to study the industrial potential of Alberta and Saskatchewan in the nuclear supply chain: the PrairiesCan SMR Asset Map, the Hatch Global Procurement Intelligence database of suppliers in Alberta and Saskatchewan, industry profiles including applicable economic data, and the Organization of Canadian Nuclear Industries (OCNI) supplier directory and finally relevant literature. For industry, major categories of typical SMR equipment, materials, and services were mapped to suppliers that could potentially meet this demand within both provinces. Through this assessment, industry was further decomposed and the strengths, weaknesses, threats, and opportunities for industry were highlighted. Stakeholders were also engaged to inform the overall results.

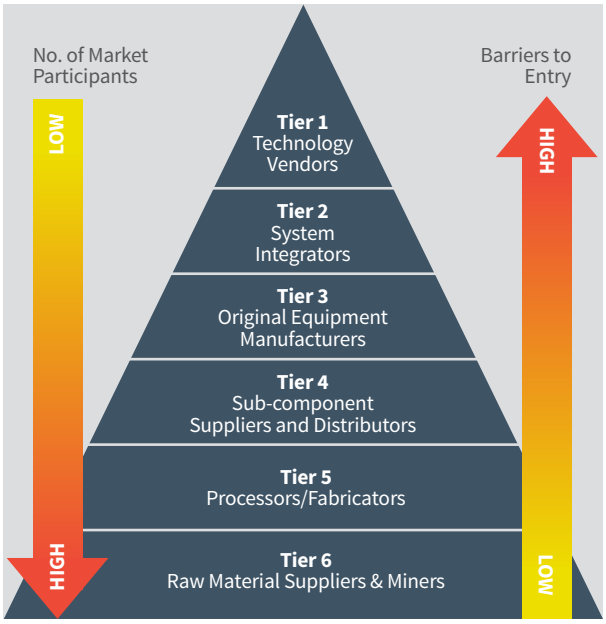
## A need to overcome barriers to entry

From the assessment, many suppliers from the sample set did not possess the required certifications, qualifications, or quality assurance management system to support higher tiers of the nuclear supply chain. Therefore, their attractiveness and resiliency to compete in the current environment were limited. However, some industries (such as mining of uranium and construction) have suppliers that possess commensurate management systems and certifications and are well-positioned to access current and future opportunities.




**Supplier resilience vs. attractiveness**

A desktop assessment of suppliers was undertaken to understand the attractiveness and resilience of industry. Supplier attractiveness increases positively as suppliers implement respective management systems and obtain experience. Supplier resilience increases from the exposure of many global competitors. To be resilient means that there is limited competition outside the region. The size of the bubble corresponds to the magnitude of suppliers in this industry.




**Supplier Tiers and Barriers to Entry** (Courtesy of IAEA)

Suppliers in higher tiers of the supply chain are subject to higher standards and barriers of entry using a graded approach for quality.

For those suppliers that do not possess the requisite management system, if they overcome the required barriers for entry, industries in Alberta and Saskatchewan will be well positioned to access the potential SMR domestic and global markets.

## Opportunity to vertically integrate the fuel supply chain for domestic security and export potential

Canada has the third largest reserve of high-grade uranium and is the second largest producer in the world. The Proterozoic Athabasca Basin contains uniquely rich deposits, which are mostly concentrated in Saskatchewan, where it is mined and milled. Conversion and fuel fabrication are currently undertaken in Ontario, with enrichment completed outside Canada. With Ontario committing to moving forward with a technology that uses enriched uranium, Canada will have to adjust its non-proliferation commitments. This presents an opportunity for Saskatchewan to capture more value in the fuel supply chain. It would be opportunistic to evaluate and site a conversion and fuel fabrication facility in either province. Furthermore, pursuing enrichment of uranium would enable security of Canada's domestic nuclear fuel supply and provide security to other nations. With uranium demand for reactors projected to increase in the next two decades, seizing the opportunity to vertically integrate the fuel supply chain would further increase the economic benefit to the region.

## Industry is positioned to support balance of plant

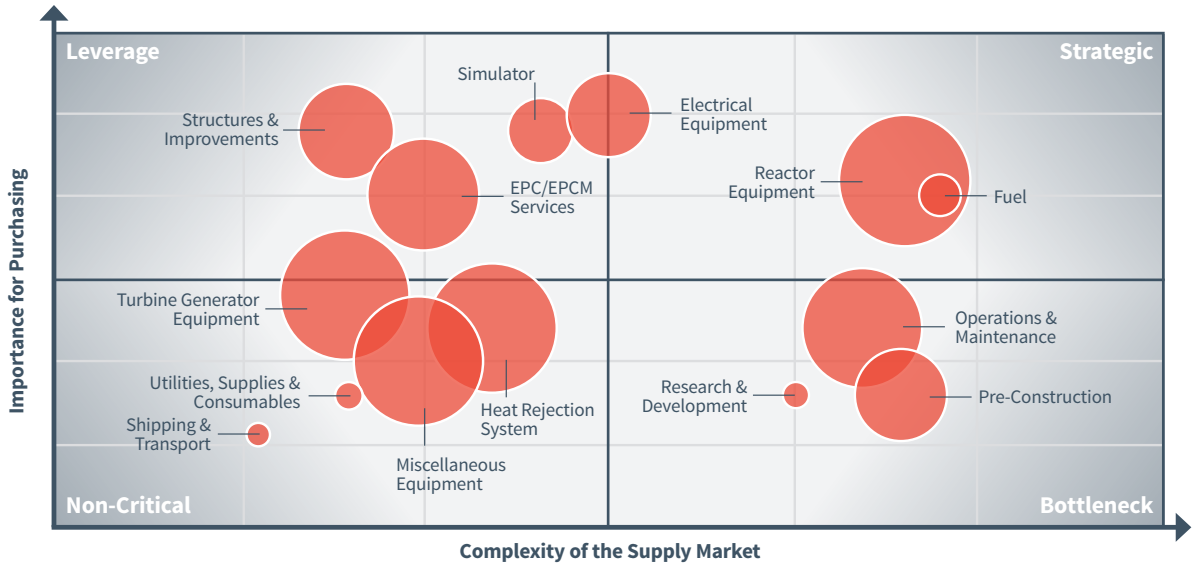
Alberta and Saskatchewan have very strong industrial economies. An analysis of the current economic landscape of the two provinces shows the current industrial capabilities in terms of labour capacity centered around manufacturing, construction as well as oil and gas and mining. These industries have been successful in delivering complex mega projects in adjacent sectors, such as mining and oil and gas. Given many of the aspects associated with the conventional island of nuclear draw synergies and adjacencies to these sectors. Industries within the two provinces are well positioned to support many aspects of a new SMR build, including site infrastructure, buildings, and structures, and balance of plant equipment.

| High ■ ■ ■ ■ Low | Opportunity |
|---|---|
| Pre-Construction | |
| Construction Direct | |
| Structures and Improvements | |
| Reactor Equipment | |
| Turbine Generator Equipment | |
| Electrical Equipment | |
| Heat Rejection System | |
| Miscellaneous Equipment | |
| Special Materials | |
| Simulator | |
| Construction Indirect | |
| Supplementary (Transport, warehousing, Insurance etc.) | |
| Operations and Maintenance | |
| Fuel | |
| Finance | |
| Research and Development | |

## Well positioned for modularization and assembly and creating hubs with further interconnection

The need to produce SMRs in a standardized manner provides a unique opportunity for industries and suppliers of Alberta and Saskatchewan to enter a supply chain that is emerging for the balance of Canada. A key differentiator that separates industries in Alberta and Saskatchewan from the balance of suppliers in Canada is the capability and experience using modularization to achieve schedule improvements. Furthermore, since industrial clusters are centered around both the Saskatoon and Edmonton areas, where modularization facilities are available, there is a strong opportunity to create local industry interconnections through modularization hubs in these regions. Localized hubs would further strengthen ties between manufacturing, wholesale trade, construction, professional services, warehousing and logistics, research and development, and education.

**Complexity of purchasing vs. supply market**




A sample set of suppliers were assigned major categories of typical SMR equipment, material and services that could be supplied to meet demand within the two provinces. These major categories were assessed with respect to the complexity of the supply market and the expected importance for purchasing. Complexity of supply market is gauged by supply scarcity, pace of technology and/or materials substitution, entry barriers, logistics or complexity and monopoly or oligopoly conditions. Strategic importance of purchasing means the value added by product line, the percentage of raw materials in total costs and their impact on profitability or project success. This chart called a Kraljic chart can be sub-divided into 4 quadrants (leverage, non-critical, strategic, bottleneck).
The respective categories of supply together with the number of suppliers represented by the size of the bubbles are plotted to understand 3 dimensions: (a) The size of the supplier market to support SMR equipment, material and services, (b) the presumed importance of these equipment, material and services to buyers within the supply chain and (c) the complexity (e.g. scarcity) of these equipment, material and services to the market.

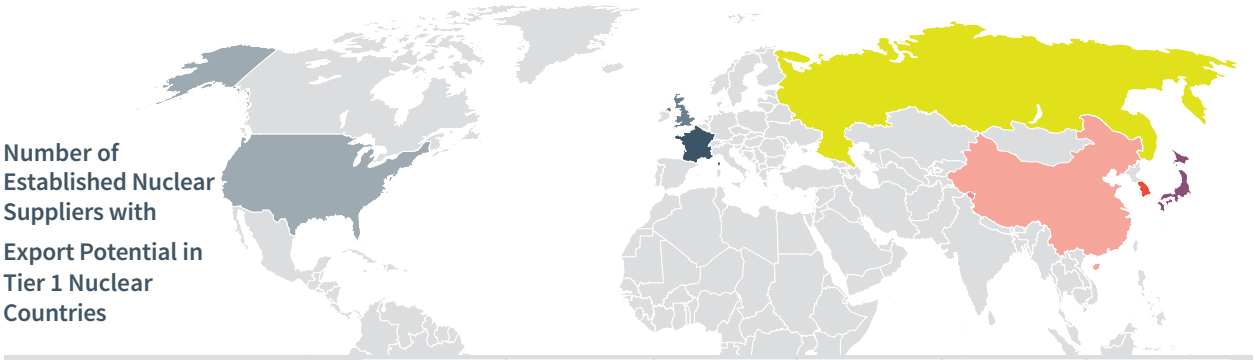
# End-use case for SMRs is different

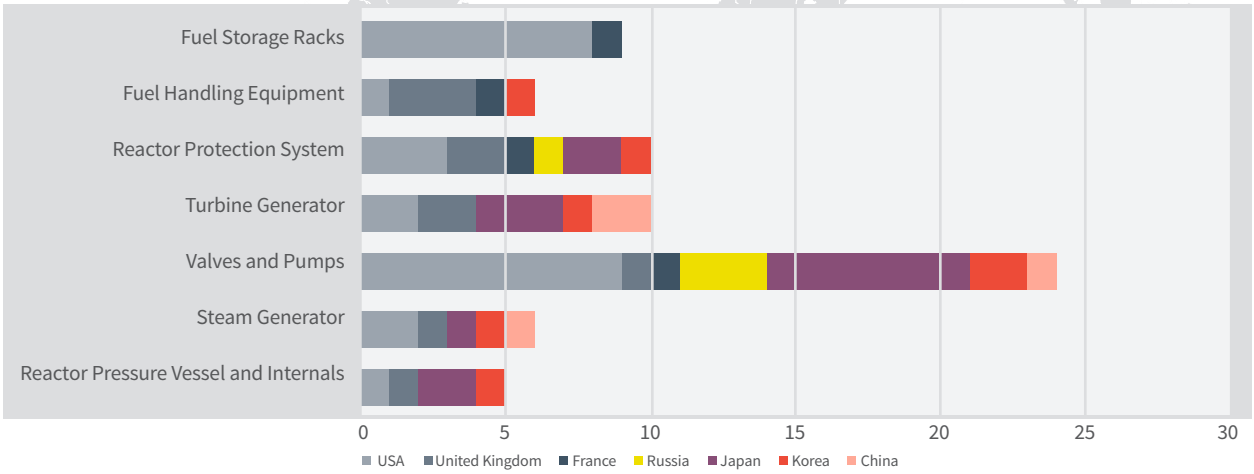
End-use cases for SMRs were studied from the perspective of Alberta and Saskatchewan. The applications for SMRs in both provinces are broad and can be leveraged beyond grid-scale electricity generation. The end-use opportunities that show the most potential over the next 10 years are process heat and power for industrial establishments, and district heating. Applications of these end uses may offer a unique export opportunity for training, development, and perhaps consultancy to countries undertaking similar decarbonization efforts. Canada is currently stewarding a Hydrogen Strategy, which intends to strengthen hydrogen as a key part of Canada's path to net-zero carbon emissions by 2050. Although SMRs can be coupled with various hydrogen technologies, the economics of producing hydrogen via SMRs remains challenging compared to steam methane reforming.

# Global risks and opportunities

The global trend is to reduce the role of fossil fuels in electricity generation. Nuclear, and more specifically SMRs, are considered to support this transition, particularly in Asia and Africa. Among the nuclear Tier 1 countries, an evaluation was conducted to assess current nuclear supply chain capabilities, gaps, and export relationships that could challenge a pan-Canadian supply chain. Countries that were studied include the United States, United Kingdom, China, Russia, France, South Korea, and Argentina. Quality assurance barriers aside, many of these countries possess strong capabilities for supplying reactor components and material. Together with their ability to achieve economies of scale, these components will be a challenge for suppliers in Alberta and Saskatchewan to undertake for the initial first-of-a-kind (FOAK) deployments. However, as identified earlier, the export potential for fuel, training, modularization, and services could be leveraged if experience and capability is developed within the two provinces.

**Number of Established Nuclear Suppliers with Export Potential in Tier 1 Nuclear Countries**






An assessment of Tier 1 nuclear countries was undertaken to understand the supply chain offerings within these countries that could add further competition to the Canadian SMR supply chain and pose as additional threats to Alberta and Saskatchewan suppliers. The majority of these Tier 1 nuclear countries have established mature reactor equipment experience. This further reinforces the conclusion that this area of the supply chain will be difficult to penetrate for new Alberta and Saskatchewan SMR suppliers.

# Summary of Key Take Aways

- Optimistically, Alberta and Saskatchewan could supply 68 % of the capital new build of SMRs within the region, such as pre-construction, construction direct and indirect, fuel, structures, turbine generator/balance of plant equipment etc. To achieve the efficiencies required under serial production and modularization, suppliers must build on existing capability and capacity in adjacent industries, and must overcome the barriers to enter, and integrate, into the supply chain.
- Vertically integrating the fuel supply chain within the region would encourage further economic development. Adding enrichment capabilities in Canada would increase the access to the value chain for Low-Enriched Uranium (LEU) by an additional 24%. Canada currently retains approximately 58% of the existing value chain. The ability to produce High-Assay Low-Enriched Uranium (HALEU) would increase access to the value chain in order of magnitude, and expand Canada's energy exports, jobs, and gross domestic product.
- Industries must be agile to policy shifts, changing requirements, and recognize challenges and gaps that need to be overcome to seize the SMR opportunity including:
  - Technical readiness of vendor designs
  - Capacity limitations associated with other industry and infrastructure mega-projects
  - Achieving optimal conditions for Nth-of-a-kind (NOAK) Costs.

## Recommendations

The study culminates in a list of recommendations to increase the industrial potential for Alberta and Saskatchewan suppliers to enter the nuclear supply chain. The following is an overview of the recommendations:

- **Industry requires strategic coordination across all provinces.** Specifically:
  - A council operating under a term of reference bringing together federal and provincial governments, owners and operators, end-users, and industrial suppliers.
  - A localization plan developed with targets.
- **Industry needs market certainty and transparency in order to seize the opportunity to leverage.** Specifically:
  - SMR Owners and Operators identified.
  - SMR technologies selected.
  - SMR order backlog identified for applicable end uses.
  - A level 1 schedule developed for all SMR deployments in Alberta and Saskatchewan.
  - Identify needs for selected SMR technologies.
  - A common forum identified to communicate future tenders.
- **Industry needs to be ready to deliver in order to support a Pan-Canadian SMR supply chain.** Specifically:
  - Interest from suppliers to enter the SMR supply chain provided.
  - Implementation of a program to allow suppliers to measure their own operations against standards, and requirements to supply within the nuclear industry, along with support for closing respective gaps.
  - A funding map established to support new suppliers.
  - Enabling new SMR suppliers to gain experience under oversight of qualified mature suppliers.
  - Development of a manufacturing transition plan for selected SMR technologies.
  - Inventory of assets available for SMR supply chain developed.
  - Certification bodies established and resourced to qualify new and existing suppliers.
  - A plan developed to coordinated interim waste management.
- **Government, at a federal level, needs to promote Canada's industrial potential at an international level.** Specifically:
  - A universal set of codes and standards established for Canadian and International SMR deployment.
  - A cluster defined with a purpose and mission.
  - An export policy developed with localization targets.
  - Actions to mitigate global threats and/or seize global opportunities.
- **Canada needs to address obstacles and opportunities for existing industry already engaged in the fuel supply chain to create additional value in both provinces.** Specifically:
  - Canada becomes an enriching nation.
  - Technology is selected for commercial scale enrichment.
  - A business case is developed to vertically integrate the fuel supply chain within Canada, with a focus on siting conversion, enrichment, and fuel fabrication facilities in either province.

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