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## **An overview of safeguard challenges and opportunities for small modular reactors**

Small Modular Reactor (SMR) technology is gaining momentum for its ability to provide reliable, eco-friendly, and cost-efficient energy solutions. However, its adoption presents distinct challenges and opportunities at the intersection of technological innovation and regulatory considerations. This review explores key aspects, such as the nuanced discussion of proliferation risk, challenges in safeguards implementation, resource constraints, exploration of novel technologies and designs, and the necessary adaptation of existing frameworks. SMRs pose challenges due to their inherent characteristics, including potential concealability and intricate designs. The need to tailor existing safeguards frameworks to accommodate these features adds complexity, exacerbated by resource constraints hindering effective implementation. Despite these challenges, SMR technology offers opportunities to enhance nuclear safeguards. Proliferation-resistant fuel cycles, self-contained fuel designs, standardized reactor designs, and remote monitoring technologies are avenues to fortify safeguards. International cooperation is crucial in navigating SMR challenges and maximizing benefits. Sharing best practices, collaborative technological advancements, and exchanging critical information are essential for a cohesive global approach. Advanced remote monitoring and data analytics become indispensable in this new era of safeguards technology, overcoming resource constraints and facilitating the adaptation of frameworks to novel SMR designs. In conclusion, while SMR technology introduces challenges, it also presents avenues for substantial progress. Emphasizing opportunities to enhance proliferation resistance, streamline implementation, and foster international collaboration is vital. The global community's concerted efforts are essential for the secure and responsible deployment of SMRs within the evolving future energy mix, striking a strategic balance between technological advancements and rigorous safeguards measures.

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