# Global Coal Plant Potential for Coal-to-smr transition: focusing on i-smr as a representation of the technology

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**Abstract**

The global goal of achieving carbon neutrality by 2050 has led to a push for carbon-free energy sources to replace fossil fuels. Small Modular Reactors (SMRs) have the potential to support this energy transition by repurposing retired coal plants. This study identifies the size of coal plants in 53 countries where replacement with an i-SMR is suitable in terms of site-screening criteria. Using population density, capable faults, floodplains, and peak ground acceleration as siting criteria, we find that 108 GW could be considered for SMR siting, out of the 899 GW of coal plants retiring (or retired) between 2021 and 2050. The U.S. has 62.4 GW of coal plants available for SMR siting, which is sufficient to cover its nuclear capacity requirements of the IEA's 2050 net-zero scenario (NZE), 13.8 GW. In China, 2.5 GW of coal plants could be suitable for SMR siting, which is less than its nuclear capacity requirements of NZE, 110.6 GW.

## INTRODUCTION

The global goal of achieving carbon neutrality by 2050 has led to a push for carbon-free energy sources to replace fossil fuels. Small Modular Reactors (SMRs) have the potential to support this energy transition by repurposing retired coal plants due to the fact that those two types of power plants have almost identical siting requirements. As the majority of SMRs are still in the developmental phase and a few of SMR vendors are beginning to construct their first-of-a-kind SMR at the retired coal plants, it has been challenging to ascertain the extent of the Coal-to-SMR (C2S) transition. In particular, there has been no comprehensive global study to quantify the coal plant resources that can be converted to SMRs, in order to assess the contribution of such C2S approach on global energy transition.

In this study, we estimate how many retiring coal plants in the world can be considered suitable repurposing for SMR deployment. This study is interested in i-SMR and identifies the size of coal plants in 53 countries where replacement with an i-SMR is suitable in terms of site-screening criteria regarding population density, capable faults, floodplains, and safe shutdown earthquake. We believe that this study can provide the insights related to the feasibility of C2S and eventually the deployment strategies in the repurposing approach for SMRs.

## Discussion of Repurposing retiring coal plants

SMRs present a significant advantage by repurposing existing coal-fired power plants, which are becoming stranded assets, and replacing coal-based power with carbon-free sources, thereby facilitating the energy transition. Leveraging this strength, SMR suppliers are conducting demonstration projects of their reactor designs on retiring coal plants. In November 2021, TerraPower announced plans to build a demonstration plant for its sodium-cooled fast reactor, Natrium (345-500 MW), on the coal plant owned by PacifiCorp in Kemmerer, Wyoming.

In parallel with these projects, academic research on SMR deployment continues. DOE (2022) assessed the feasibility of replacing operating or decommissioned coal-fired power plants in the U.S. with SMRs. Using the OR-SAGE model, DOE (2022) set the requirements and criteria for siting SMRs on coal plants and collected related geographic information system (GIS) data to comprehensively evaluate if the criteria were met. The study found that approximately 80% (263 GW of capacity) of the 370 coal plants were suitable for conversion to SMRs. Belles et al. (2021) employed a similar methodology to evaluate the potential for replacing coal-fired power plants owned by the Tennessee Valley Authority (TVA) with SMRs.

## Input data and method

### Siting Criteria

This study adopts some of the siting requirements presented by EPRI (2022) to examine the feasibility of SMR siting on coal-fired power plant. EPRI (2022) provides guidelines on the decision-making process, siting requirements that comply with the Code of Federal Regulations and NRC regulations (10 CFR Part 100 and Regulatory Guide 4.7), and methods for evaluating each requirement when selecting sites for large nuclear and SMR facilities from the perspective of power companies. EPRI (2022) outlines 42 siting requirements categorized into four major groups: Health and Safety Criteria, Ecological Criteria, Socioeconomic Criteria, and Engineering and Cost-Related Criteria.

For this study, four siting requirements are selected for the SMR siting analysis: the proximity to capable fault lines, the level of safe shutdown earthquake at the site, the population distribution around the site, and the presence of floodplains within the site. We assume that sites should meet all these criteria to be considered as suitable for SMR conversion. By employing such criteria, this study aims to conservatively evaluate the suitability of retiring coal-fired power plants for SMR conversion. The spatial analysis in this study is conducted using GeoPandas, a spatial analysis support library in Python.

### Input Data and Screening Method

This study utilizes data from the January 2023 Global Coal Plant Tracker (GCPT) for coal-fired power plants. GCPT tracks information on approximately 13,800 coal-fired power units across 107 countries biannually. The GCPT provides details such as capacity, commissioning year, (planned) closure years at the unit level, and latitude and longitude at the plant level.

The GCPT data are pre-processed as follows for this paper’s purposes. First, the capacity of coal-fired power plants is calculated by summing only the capacity of units classified as "operating" or "retired," excluding "under construction" or "permitted." Second, the closure year for a coal-fired power plant is determined by the year the last unit at that site was closed. Third, sites with a capacity below 680 MW are excluded from the analysis, assuming they are unsuitable for i-SMR. According to the global market entry strategy for i-SMR, it aims to enter the coal power replacement market with the standard design that includes four modules within a single reactor, which implies the coal plant capacity for i-SMR replacement should not be too small. Based on this information, this study assumes 680 MW is a minimum capacity for feasible replacement and only includes coal plants meeting this threshold. Fourth, the closure year for coal-fired units is derived from GCPT data. In the event of a data point being absent, an estimation is made by appending 30 years to the commissioning year, which is the typical lifespan of a coal-fired power plant. Fifth, it is also assumed that sites that have been closed for over a decade by 2030, which is the anticipated year of SMR commercialization, will have already been repurposed. In particular, the time window of coal plants’ retirement that we are interested in is between 2021 and 2050. Finally, coal plants in Germany (due to its nuclear phase-out policy) and South Korea (due to no government plan deploying SMR domestically until this study initiated) are excluded. As a result, the pre-processed dataset includes 1,143 coal-fired power plants (899 GW) across 53 countries.

As shown in Table 1, the 53 countries pre-processed from the original GCPT are categorized into three groups based on the policy-based potential to deploy SMRs. One is “NPP Operating Countries”, in which the introduction of SMRs is more likely taking advantage of their operating experience and regulatory systems regarding nuclear power plants. This group include 24 countries such as the United States, China, and Russia. Another group is “Countries with SMR Plan”, which do not operate nuclear power plants currently but have significant contracts or projects underway to introduce SMRs. Five countries, Indonesia, Poland, Thailand, the Philippines, and Sri Lanka, are categorized into this group. Lastly, the remaining 24 countries that do not fall into either group are referred to as “Unclassified Countries”.

TABLE 1. Country groups based on the policy-based potential to deploy SMRs

|  |  |
| --- | --- |
| Country Group | Country |
| NPP Operating Countries(24 countries) | South Africa, Netherlands, Taiwan, Russia, Romania, Mexico, United States, Bangladesh, Bulgaria, Brazil, Spain, Slovenia, United Arab Emirates, United Kingdom, Ukraine, India, Japan, China, Czech Republic, Canada, Turkey, Pakistan, France, Hungary |
| Countries with SMR Plan(5 countries) | Sri Lanka, Indonesia, Thailand, Poland, Philippines |
| Unclassified Countries(24 countries) | Greece, New Zealand, Denmark, Dominican Republic, Laos, Malaysia, Morocco, Moldova, Mongolia, Vietnam, Bosnia and Herzegovina, Serbia, Ireland, Uzbekistan, Israel, Italy, Zimbabwe, Chile, Kazakhstan, Cambodia, Kosovo, Kyrgyzstan, Portugal, Australia |

For population distribution data, this study uses the "Unconstrained Individual Countries (1 km resolution, UN adjusted)" from WorldPop (2020). Assuming global population distribution remains similar to 2020, these estimates are used to assess the population-related siting criteria near coal-fired power plants. Fault line data is collected from the "Global Active Faults" dataset by the Global Earthquake Model Foundation (2020). Floodplain data is obtained from the European Commission's Joint Research Centre (2016) "Flood Hazard Map of the World: 100-year Return Period." Lastly, the "Global Seismic Hazard Map" by the Global Earthquake Model Foundation (2023) is used for safe shutdown earthquake data.

Before screening the sites based on the siting criteria, the coordinates of coal-fired power plants from the GCPT dataset are used to establish a 1 km radius around each site and we consider this area as the plant’s land available for potential SMR placement. For population density, the threshold set by EPRI (2022) of 500 people per square mile (193 people per square kilometre) is used. If this threshold is exceeded, the site is deemed unsuitable for SMR placement due to overpopulation. Any coal plant with capable fault longer than 1,000 ft (304.8 m) within 8 km of the site is unsuitable for SMR siting. For floodplains, a site is considered unsuitable if it lies within a floodplain with a 100-year flood return period. With regards to safe shutdown earthquake, the surface of a coal plant should meet 0.5 g in terms of peak ground acceleration. Sites that meet these four screening criteria are deemed suitable for SMR replacement.

### Reference for comparison: IEA’s net-zero scenarios

We refer to the required nuclear capacity in IEA’s net-zero scenarios to measure whether replacing the screened coal plants with SMRs is enough to fulfil the requirement. More specifically, we compare the coal plant capacity suitable for SMR replacement with the nuclear power capacity required to achieve carbon neutrality as outlined by the IEA (2021). IEA (2021) suggested three scenarios aiming at evaluating the level of carbon neutrality by 2050. ‘Net Zero Emissions by 2050 Scenario’ (NZE) represents a pathway for the global energy sector to achieve net zero CO2 emissions by 2050. The NZE scenario aims for global carbon neutrality by 2050, achieving 100% energy access by 2030, and limiting global temperature rise to 1.5°C by 2030. ‘Stated Policies Scenario’ (STEP) considers existing policy instruments and objectives. The Announced Pledged Scenario (APS) is a scenario where governments have announced and committed to nationally determined contributions (NDCs) and fully implement carbon neutrality objectives. Recognizing the inadequacy of APS in achieving carbon neutrality by 2050,

IEA (2021) presents the (annual) nuclear power requirements in terms of generation (TWh) for each scenario. To convert this into capacity (GW), this study applies the following equation assuming that the nuclear capacity factor is 80%: $Capacity (GW)=\frac{Generation (TWh)}{24 hours ×365 days × 80\% ×1000}$.

## Main result

In this section, we suggest how much coal plants retiring between 2021-50 are suitable for C2S by screening those sites in terms of SMR siting criteria. Using the preprocessed GCPT data and GIS data related to site-screening criteria, the amount of global coal capacity that could potentially be utilized for i-SMR is depicted in Table 2. The total amount of retired coal capacity in the 53 countries from 2021 to 2050 is 899 GW, but it is reduced to 108 GW after the site-screening criteria are applied. Of the screened capacity, 70 GW (about 64.8% of 108 GW) will be retired in the 2021-30 when most SMR vendors are targeting to deploy their first-of-a-kind reactors.

TABLE 2. The amount of retired coal capacity in the 53 countries screened by the four site-screening criteria (unit: GW)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Periods |  2021-30 | 2031-40 | 2041-50 |  Total |
| Global coal capacity of the preprocessed GCPT | 326.0 | 134.7 | 438.3 | 899.0 |
| Screened coal capacityBy the site-screening criteria | 70.4 | 27.8 | 10.0 | 108.3 |

When it comes to the NPP Operating Countries, Table 3 shows that 17 countries except Canada, China, Russia, Ukraine, and the United States are unsuitable for C2S.[[1]](#footnote-2) China has the largest coal capacity of 378 GW before screening. However, only 2.5 GW (0.7% of 378 GW) of coal plants remain suitable for C2S after screening as the population criterion excludes a significant amount of coal plants in China. Likewise, the population criterion is critical for other NPP Operating Countries except Bulgaria and Canada. In particular, Brazil, Hungary, South Africa, the United Arab Emirates, and the United Kingdom could consider repurposing 100% of their retiring coal capacity for SMRs if they can fulfill the population criterion. The active fault lines criterion appears to be the important factor in Bulgaria, Japan, Slovenia, Taiwan, and Turkey in that it makes unsuitable more than 90% of their retiring coal capacity for C2S. The safe shutdown earthquake is a major factor for only a few countries including Japan, Mexico, and Taiwan.

TABLE 3. The screened coal capacity of the NPP Operating Countries (unit: GW)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | Capacity Excluded by Each Siting Criterion |
| 　Country | Coal Capacity(a) | ScreenedCapacity(b) | (b)/(a) | Population(c) | (c)/(a) | Floodplain(d) | (d)/(a) | Fault Line(e) | (e)/(a) | Safe Shutdwon Earthquake(f) | (f)/(a) |
| Brazil | 1.7 | 0.0 | 0.0% | 1.7 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Bulgaria | 2.5 | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% | 2.5 | 100.0% | 0.0 | 0.0% |
| Canada | 6.4 | 5.6 | 88.3% | 0.0 | 0.0% | 0.7 | 11.7% | 0.0 | 0.0% | 0.0 | 0.0% |
| China | 377.7 | 2.5 | 0.7% | 375.2 | 99.3% | 88.8 | 23.5% | 69.5 | 18.4% | 0.0 | 0.0% |
| Czech Republic | 4.4 | 0.0 | 0.0% | 4.4 | 100.0% | 1.0 | 21.9% | 0.0 | 0.0% | 0.0 | 0.0% |
| France | 4.7 | 0.0 | 0.0% | 4.7 | 100.0% | 1.3 | 26.9% | 0.9 | 18.1% | 0.0 | 0.0% |
| Hungary | 0.9 | 0.0 | 0.0% | 0.9 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| India | 37.8 | 0.0 | 0.0% | 37.8 | 100.0% | 4.6 | 12.2% | 1.3 | 3.3% | 0.0 | 0.0% |
| Japan | 25.5 | 0.0 | 0.0% | 25.5 | 100.0% | 0.0 | 0.0% | 23.5 | 92.2% | 10.1 | 39.6% |
| Mexico | 5.4 | 0.0 | 0.0% | 5.4 | 100.0% | 2.8 | 51.7% | 0.0 | 0.0% | 2.8 | 51.7% |
| Netherlands | 6.1 | 0.0 | 0.0% | 6.1 | 100.0% | 1.4 | 22.3% | 1.4 | 22.3% | 0.0 | 0.0% |
| Romania | 4.9 | 0.0 | 0.0% | 4.9 | 100.0% | 1.3 | 26.1% | 0.0 | 0.0% | 0.0 | 0.0% |
| Russia | 15.6 | 11.1 | 71.0% | 4.5 | 29.0% | 1.1 | 7.1% | 1.2 | 7.8% | 0.0 | 0.0% |
| Slovenia | 1.4 | 0.0 | 0.0% | 1.4 | 100.0% | 0.0 | 0.0% | 1.4 | 100.0% | 0.0 | 0.0% |
| South Africa | 33.8 | 0.0 | 0.0% | 33.8 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Spain | 3.5 | 0.0 | 0.0% | 3.5 | 100.0% | 0.0 | 0.0% | 1.2 | 32.7% | 0.0 | 0.0% |
| Taiwan | 13.1 | 0.0 | 0.0% | 13.1 | 100.0% | 0.0 | 0.0% | 13.1 | 100.0% | 8.9 | 68.0% |
| Turkey | 5.0 | 0.0 | 0.0% | 5.0 | 100.0% | 0.0 | 0.0% | 5.0 | 100.0% | 0.0 | 0.0% |
| Ukraine | 22.6 | 2.5 | 11.0% | 20.1 | 89.0% | 4.1 | 18.1% | 0.0 | 0.0% | 0.0 | 0.0% |
| United Arab Emirates | 1.2 | 0.0 | 0.0% | 1.2 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| United Kingdom | 8.6 | 0.0 | 0.0% | 8.6 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| United States | 210.0 | 62.4 | 29.7% | 127.6 | 60.7% | 82.0 | 39.0% | 3.4 | 1.6% | 1.3 | 0.6% |

Table 4 shows the screening results for Countries with SMR Plan. Out of four countries, Poland can consider converting 23.4% of its retiring coal capacity into SMRs. The remaining 76.6% are excluded by the population criterion. Similarly, Indonesia, the Philippines, and Thailand have 100% of their retiring coal capacity excluded by the population criterion. In addition to that, 100% of the Philippines' coal plants do not meet both active fault lines and safe shutdown earthquake criteria. On the other hand, Thailand can consider converting 100% of its retiring coal capacity into SMRs once it can resolve the population-related issue.

TABLE 4. The screened coal capacity of the Countries with SMR Plan (unit: GW)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | Capacity Excluded by Each Siting Criterion |
| 　Country | Coal Capacity(a) | ScreenedCapacity(b) | (b)/(a) | Population(c) | (c)/(a) | Floodplain(d) | (d)/(a) | Fault Line(e) | (e)/(a) | Safe Shutdwon Earthquake(f) | (f)/(a) |
| Indonesia | 4.4 | 0.0 | 0.0% | 4.4 | 100.0% | 0.0 | 0.0% | 1.1 | 23.9% | 0.0 | 0.0% |
| Philippines | 1.3 | 0.0 | 0.0% | 1.3 | 100.0% | 0.0 | 0.0% | 1.3 | 100.0% | 1.3 | 100.0% |
| Poland | 23.1 | 5.4 | 23.4% | 17.7 | 76.6% | 1.9 | 8.2% | 0.0 | 0.0% | 0.0 | 0.0% |
| Thailand | 1.4 | 0.0 | 0.0% | 1.4 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |

Table 5 summarizes the screening results of Unclassified Countries: Australia (32.2%), Ireland (100%), Italy (38.4%), and Kazakhstan (100%) have the potential to convert retiring coal plants to SMRs. Except Ireland, Kazakhstan, and Kosovo, the population criterion plays a significant role in determining the eligibility of C2S. The screening results in New Zealand and Serbia are significantly affected by the floodplain criterion, while the active fault line criterion is the major factor to exclude 100% of coal plants in Bosnia and Herzegovina, Greece, Kosovo, New Zealand, and Uzbekistan. In Chile, the entire coal plants are excluded by the safe shutdown earthquake criterion.

TABLE 5. The screened coal capacity of the Unclassified Countries (unit: GW)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | Capacity Excluded by Each Siting Criterion |
| 　Country | Coal Capacity(a) | ScreenedCapacity(b) | (b)/(a) | Population(c) | (c)/(a) | Floodplain(d) | (d)/(a) | Fault Line(e) | (e)/(a) | Safe Shutdwon Earthquake(f) | (f)/(a) |
| Australia | 23.9 | 7.7 | 32.2% | 12.0 | 50.3% | 0.0 | 0.0% | 14.8 | 61.8% | 0.0 | 0.0% |
| Bosnia andHerzegovina, | 0.7 | 0.0 | 0.0% | 0.7 | 100.0% | 0.0 | 0.0% | 0.7 | 100.0% | 0.0 | 0.0% |
| Chile | 2.4 | 0.0 | 0.0% | 2.4 | 100.0% | 0.0 | 0.0% | 0.7 | 30.1% | 2.4 | 100.0% |
| Denmark | 1.5 | 0.0 | 0.0% | 1.5 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Greece | 3.7 | 0.0 | 0.0% | 3.7 | 100.0% | 0.0 | 0.0% | 3.7 | 100.0% | 0.0 | 0.0% |
| Ireland | 0.9 | 0.9 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Israel | 4.9 | 0.0 | 0.0% | 4.9 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Italy | 6.9 | 2.6 | 38.4% | 4.2 | 61.6% | 0.0 | 0.0% | 1.0 | 14.2% | 0.0 | 0.0% |
| Kazakhstan | 7.5 | 7.5 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Kosovo | 1.5 | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% | 1.5 | 100.0% | 0.0 | 0.0% |
| Malaysia | 3.0 | 0.0 | 0.0% | 3.0 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Moldova | 1.6 | 0.0 | 0.0% | 1.6 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| New Zealand | 1.0 | 0.0 | 0.0% | 1.0 | 100.0% | 1.0 | 100.0% | 1.0 | 100.0% | 0.0 | 0.0% |
| Portugal | 2.0 | 0.0 | 0.0% | 2.0 | 100.0% | 0.0 | 0.0% | 0.7 | 34.5% | 0.0 | 0.0% |
| Serbia | 4.0 | 0.0 | 0.0% | 4.0 | 100.0% | 4.0 | 100.0% | 3.0 | 75.0% | 0.0 | 0.0% |
| Uzbekistan | 2.1 | 0.0 | 0.0% | 2.1 | 100.0% | 0.0 | 0.0% | 2.1 | 100.0% | 0.0 | 0.0% |
| Vietnam | 1.0 | 0.0 | 0.0% | 1.0 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Zimbabwe | 0.9 | 0.0 | 0.0% | 0.9 | 100.0% | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |

In Table 6, we compare the difference in nuclear power generation capacity needed to achieve the Announced Pledged Scenario (APS) and the Net Zero Emissions by 2050 Scenario (NZE) in 2050 with the current policy scenario (STEP). The results indicate that among the 53 countries in the pre-processed GCPT data, the U.S. has 62.4 GW of coal plants available for SMR siting, which is sufficient to cover its nuclear capacity requirements of the IEA’s APS and NZE scenarios both, 13.8 GW. In China, however, 2.5 GW of coal plants could be suitable for SMR siting, which is less than its nuclear capacity requirements of APS and NZE, 121.7 and 110.6 GW, respectively. Based on our siting analysis, population in China is a major factor to make coal plants unsuitable for SMR replacement.

TABLE 6. Comparison between screened coal capacity and IEA’s required nuclear capacity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Country | Gap in required capacity between scenarios(GW) | Screened coal plant capacity(GW)[c] | Comparison withAPS-STEP[a] / [c] | Comparison withNZE-STEP[b] / [c] |
| APS-STEP[a] | NZE-STEP[b] |
| World | 190.3 | 228.1 | 108.3 | 175.8% | 210.7% |
| North America | 11.8 | 12.3 | 68.0 | 17.3% | 18.1% |
| United States | 13.8 | 13.8 | 62.4 | 22.1% | 22.1% |
| Central and South America | 5.1 | 6.2 | 0.0 | - | - |
| Brazil | 2.5 | 2.5 | 0.0 | - | - |
| Europe | 6.4 | 8.0 | 11.4 | 55.9% | 69.9% |
| European Union | 4.7 | 4.7 | 0.0 | - | - |
| Africa | 3.6 | 6.2 | 0.0 | - | - |
| Central Asia | 6.3 | 13.8 | 0.0 | - | - |
| Eurasia | 8.9 | 29.4 | 18.6 | 47.9% | 158.2% |
| Russia | 8.0 | 27.1 | 11.1 | 72.2% | 244.7% |
| Asia-Pacific | 148.2 | 152.2 | 10.2 | 1450.8% | 1490.0% |
| China | 121.7 | 110.6 | 2.5 | 4829.4% | 4388.9% |
| India | 26.1 | 27.7 | 0.0 | - | - |
| Japan | 9.1 | 9.1 | 0.0 | - | - |
| Southeast Asia | 3.4 | 5.6 | 0.0 | - | - |

## conclusion

This study explores the potential of SMRs as an attractive option for energy transition to achieve 2050 net-zero goals. In particular, we measure the extent of converting the retiring coal plants to SMR, C2S, by applying site-screening criteria and focusing on i-SMR as a representative of SMRs. We show that 108 GW of coal plants in the 53 countries could be suitable for SMR siting, out of the 899 GW of coal plants retiring (or retired) between 2021 and 2050.

We categorize 53 countries into three groups based on the policy-based potential to introduce SMRs to figure out which site-screening criteria play a significant role for C2S. When it comes to the NPP Operating Countries and Countries with SMR plan, it is the population-related criterion that critically determines the screened coal capacity for C2S. This implies that if SMR’s safeguards are improved so that it sufficiently satisfies the population-related regulation, more coal plants in those countries turn into the ideal sites for C2S.

Also, we compare the capacity of screened coal plants suitable for C2S with the nuclear power capacity required to achieve carbon neutrality as outlined by the IEA. As a result, the United States has 62.4 GW of coal plants available for SMR siting, which is sufficient to cover its nuclear capacity requirements of the required nuclear capacity. On the other hand, 2.5 GW of coal plants in China could be suitable for SMR siting, which is less than its nuclear capacity requirements.

References

1. Belles, R., Omitaomu, O., & Worrall, A. 2021. “TVA Coal-Fired Plant Potential for Advanced Reactor Siting”. Oak Ridge National Laboratory.
2. DOE. 2022. “Investigating benefits and challenges of converting retiring coal plants into nuclear plants”. Idaho National Laboratory.
3. EPRI. 2022. “Advanced Nuclear Technology: Site Selection and Evaluation Criteria for New Nuclear Energy Generation Facilities (Siting Guide): 2022 Revision”.
4. Global Earthquake Model Foundation. (2020). Global Active Faluts Database. https://www.globalquakemodel.org/product/active-faults-database.
5. Global Earthquake Model Foundation. (2023). Global Seismic Hazard Map. https://www.globalquakemodel.org/product/global-seismic-hazard-map.
6. Global Energy Monitor. (2023). Global Coal Plant Tracker January Edition. https://globalenergymonitor.org/projects/global-coal-plant-tracker/download-data/.
7. IEA. 2021. “World Energy Outlook 2021”.
8. IEA. 2022. “Projected Cost of Generating Electricity-2020 Edition”.
9. Joint Research Centre. (2016). Flood hazard map of the World: 100-year return period. https://data.jrc.ec.europa.eu/dataset/jrc-floods-floodmapgl\_rp100y-tif.
10. WorldPop. (2020). Population Counts: Unconstrained Individual Countries (1 km Resolution). www.worldpop.org.
1. Of the 24 countries in NPP Operating Countries, Bangladesh and Pakistan are excluded from the results in Table \_\_\_ because they do not have any coal-fired plants retiring between 2021-50. [↑](#footnote-ref-2)