環保生態

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??????????????????????????????????????????????????

???????IEA?????????????????????????????????IEA

??????????????????????????????????????2030????? 61%?? 2050 ????

88%?2050 ?????????????????????? 10%??



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8%????????????2022??406GW??2030????515GW?2050????812GW????OECD???

(NEA)??????????????????????????2050??????????????479GW???IEA

??????????????60%???

??????????????IEA?NEA????????????????????2022???**??????????????Lawrence Livermore National Laboratory, LLNL?????????National Ignition Facility, NIF?**????????????????????2.05MJ??????????????????3.15 MJ ????????????????????300MJ

????????????????????????????????

???????????2060?2070?????IEA??????????(Technology Readiness Levels)????2??????????????????????????2050????????????????????????????????????**Eric Wesoff**????????????????????????????????????????????????

??????????????????????(advanced reactor)??????????????????????????????????50~300MW

????????????????????????????????????????????????????????

?1. ?????????

| | 第三代+ | | 第四代 | | |
|---|---|---|---|---|---|
| | 大型輕水式反應爐 | 輕水式小型核能機組 | 高溫氣化反應爐 | 溶鹽式反應爐 | 微型 |
| 裝置容量 | 1GW | 70~300 | 80~270 | 200~800 | 1~50 |



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| | | | | | |
|---|---|---|---|---|---|
| 燃料類別 | LEU | LEU | HALEU | HALEU | HALEU |
| 冷卻劑 | 水 | 水 | 氣，氦氣 | 金屬或鹽 | 多樣 |
| 機組案例 | Vogtle 3,4號 | NuScale | X-energy | TerraPower | BWTX |

整理自DOE 2023

????????SMR

??????????????

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??????????????????????NuScale?VOYGR????????SMR????????????

## NuScale的教訓 – 延遲與昂貴

NuScale?2000???????SMR???????????Utah Associated Municipal Power Systems

(UAMPS) ????????????????????????????6?77MW

??????????????????462MW

????????????????????????????(certification)

??????????????????2016???50MW?????????????77MW?????2023?1

??????????????Standard Design Approval (SDA)

Application?????????????????????????5??????NuScale?????2029



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????????????????????NuScale?????????????SMR?????????????????

?2. NuScale??????????

| NuScale?????? | ?????? |
|---|---|
| 2008 | 2015~2016 |
| 2010 | 2018 |
| 2018 | 2026 |
| 2020 | 2029 |

**IEEFA, 2022**

SMR?????????????????????????????????????????????????????(The Institute for Energy Economics and Financial Analysis, IEEFA)??NuScale????????????????NuScale?2020??????????12?60MW ??????????720?????????????????61?????2021 ?????????????????????462MW????????????53??????2023?1 ?????????????????????93??????IEEFA???NuScale?????????2021??? 58USD/MWh????89USD/MWh?????????40??????????????????



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120USD/MWh????????????????????????

????????????????????????????????Environment Working Group???????????Arjun Makhijani????????????????????????M.V. Ramana???????????????????NuScale??NRC???????????????NuScale ????????????????????????????????

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NuScale??????????????SMR????????????????????????????????

??????????????Allison

M. Macfarlane ??????????????????????(PNAS)??????????????????(Nuclear waste from

small modular reactors

)????????????????????????????2?30??????????????????????-129??-79

????????????????????????????????????????????

??????????SMR?????????SMR????????????????????????10??????????EPZ?????

SMR???????????EPZ????SMR??????????????????EPZ?????SMR

Generation

mPower???????EPZ???????1000????????????????????????SMR????????????????????

?SMR???????NRC???53????????????????????????Part 53 – Risk Informed, Technology-

Inclusive Regulatory Framework for Advanced

Reactors

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??53??????????SMR



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## SMR????????

SMR

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???????2022

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????????????????????9000????5000??????????3000

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??????SMR

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????????? CCS ?????????????IEA

???????????????

????????????????????????????????

???????????????? 2050 ?????????????60%?????5%

????????????????????10%??????? 2040 ?????????

????SMR?????????????????????2050

????????????????????????????????????????????????



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