



????????

[illegible]

??

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

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

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

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

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

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

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

????????????????????????????????Environment Working Group????????????Arjun
Makhijani????????????????????????M.V.

Ramana????????????????NuScale??NRC????????????NuScale

??

??NRC????????????Vesna
Dimitrijevic????????????????NuScale

????????????????????NuScale????????????NuScale

??(Ed
Lyman) ???NuScale

??

??

????????????????????????????????????NuScale????????

????????????????NuScale????????????UAMPS????NuScale??2024

????????subscription

level????????80%????UAMPS????25%????NuScale

????????????????????NuScale????????

????????

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

????????Allison

M. Macfarlane ??????????(PNAS)????????(Nuclear waste from
small modular reactors

)????????230????????-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

????

????53????NRC????

??53????SMR

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

????????????SMR

??

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

SMR????????

SMR

??

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

????????????(IPCC)

??

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

??2022

??

????????2022

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

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

????????????????????????????3600????????NuScale

????????????????????????2????????????

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

????????????????????????????????AkademikerPension?????[??](#)

??

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

??????SMR

??

?????????

??

??????

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

??CCS????????????

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

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

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

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

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

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

??

I 參考文獻：

Questions for NuScale VOYGR Reactor Certification: When Will It Be Done? And then, Will It Be Safe?

<https://ieer.org/resource/reports/questions-for-nuscale-voygr-reactor-certification-when-will-it-be-done-and-then-will-it-be-safe/>

IEEFA U.S.: Small modular reactor “too late, too expensive, too risky and too uncertain”

<https://ieefa.org/articles/ieefa-us-small-modular-reactor-too-late-too-expensive-too-risky-and-too-uncertain>

Eye-popping new cost estimates released for NuScale small modular reactor

<https://ieefa.org/resources/eye-popping-new-cost-estimates-released-nuscale-small-modular-reactor>

The misguided push to weaken nuclear safety standards is gaining steam

<https://thehill.com/opinion/energy-environment/4116386-the-misguided-push-to-weaken-nuclear-safety-standards-is-gaining-steam/>

The Department of Energy. 2023. Pathways to Commercial Liftoff: Advanced Nuclear.

International Energy Agency (IEA), 2021. Net Zero by 2050: A Roadmap for the Global

Energy Sector. OECD:Paris

作者 趙家緯 為台灣氣候行動網絡研究中心總監