**SMALL MODULAR REACTOR AND NUCLEAR FUSION STARTUP COMPANIES**

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Besides the traditional nuclear vendor companies developing nuclear power technology, also many startup companies entered the nuclear energy development scene in the past two decades. We analysed a number of features of startup companies developing small modular reactors (SMR) and nuclear fusion technology, including their country of origin, founding year, technology and investment type. The collected information described in this paper is currently being compiled into a database - the Nuclear Startup Database (NSDB), which will offer search and visualization functionalities by country of origin, technology (PWR, MSR, LMFR, ...), and application (power generation, heat production, seawater desalination, ...).

Publicly available information has been collected for 21 SMR startup companies and 32 nuclear fusion startup companies. Information on many SMR designs can be found in the IAEA publication “Advances in Small Modular Reactor Technology Developments” [1]. Information on the respective fusion technologies appeared to be described to a lesser extent and sometimes not available at all. When sorted by country, the USA had the most startup companies in both SMR and nuclear fusion (Table 1).

TABLE 1. SMR AND FUSION STARTUP COMPANIES BY COUNTRY

|  |  |  |
| --- | --- | --- |
| Country | Number of SMR Companies | Number of Fusion Companies |
| Australia | 0 | 1 |
| Canada | 4 | 3 |
| Denmark | 2 | 0 |
| Estonia | 1 | 0 |
| France | 0 | 1 |
| Germany | 1 | 1 |
| Japan | 0 | 1 |
| Luxembourg | 1 | 0 |
| South Africa | 2 | 0 |
| Spain | 0 | 1 |
| Sweden | 1 | 0 |
| UK | 0 | 3 |
| USA | 9 | 20 |

Analysing the age of the various startup companies (Figure 1), we observed that among 21 SMR startup companies 6 were founded in the period 2006~2010. More than half of these companies were founded between 2011~2015. For nuclear fusion the number of startup companies has been growing only recently, 17 of them being founded between 2016~2020.

*FIG. 1. Number of Companies by Founding Year*

Looking at the SMR reactor type, it appeared that the Molten Salt Reactor was the most common type in development for SMR startups (Figure 2). Next common were high temperature gas cooled reactors, liquid metal cooled reactors, and pressurized water reactors. It must be kept in mind that also the traditional nuclear industry is developing SMR, and the PWR is more common in this sector. The section “Other” includes companies that have no particular design yet or other types such as the pebble-bed molten salt reactor.

*FIG. 2. SMR Reactor Types [TO BE UPDATED BY SUYOUN]*

When sorted by power output (Figure 3), 5 of the SMR reactor models had an electrical output from 0~50 MW(e) and 5 had an output ranging 51~100MW(e). Another 3 of the models have outputs between 101~200MW(e) and 3 have outputs of 201~300MW(e). While most SMRs have an output of 300MW(e) or less, Terrapower’s Natrium reactor has an electric output of 345MW(e).

*FIG. 3. SMR Power Output MW(e)*

Looking to the origin of their funding (Figure 4), it was found that among the SMR companies, 5 received funding from their government only, and 5 received funding from private companies or individuals. Seven companies received funding from both government and private companies or individuals. On 5 startup companies no information on investors was available. Among fusion startup companies, only 3 received pure government funding, and 9 received funding from private companies or individuals. Seven received funding from both government and private companies.

 *FIG. 4. Origin of investments on SMR and Nuclear Fusion Companies*

Types of funding rounds were sorted in the way that it was done in the Crunchbase website [2]. A grant is when a company, investor, or government agency provides capital to a company without taking an equity stake in the company. An angel round is typically a small round designed to get a new company off the ground. Investors in an angel round include individual angel investors, angel investor groups, friends, and family. Seed rounds are among the first rounds of funding a company will receive, generally while the company is young and working to gain traction. Round sizes range between $10k–$2M, though larger seed rounds have become more common in recent years. A seed round typically comes after an angel round (if applicable) and before a company’s Series A round. Venture funding refers to an investment that comes from a venture capital firm and describes Series A, Series B, and later rounds. This funding type is used for any funding round that is clearly a venture round but where the series has not been specified. Corporate fundings are similar except it is done by companies, not venture investment firms. Equity crowdfunding platforms allow individual users to invest in companies in exchange for equity.

When sorted by number of fundings for SMR companies (Figure 5), grant by government had the highest of 13. Next were venture rounds that refer to investment from venture capital firms but not knowing which series funding it is, with a number of 12. There were 3 seed round investments, which is among the first rounds of funding of a company. There were two corporate rounds where a company invested and not a venture capital firm. There was one angel round where an individual invested a small amount to a starting company. For nuclear fusion companies there were 5 rounds of grant by government, 6 rounds of seed investments, and series funding of which one company lasted until series G. Two companies were financed through crowdfunding.

*FIG. 5. Funding Rounds on SMR and Nuclear Fusion Startup Companies*

Comparing SMR startups to nuclear fusion startups, recently there is a more rapid increase in nuclear fusion startup companies. SMR companies comparatively get more funding from governments while there are more private investors for nuclear fusion companies. The majority of the funding rounds for SMR companies are grants by government whereas nuclear fusion companies have more series funding and are also financed through crowdfunding.

References

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Advances in Small Modular Reactor Technology Developments. A Supplement to: IAEA Advanced Reactors information System 2020 Edition, (2020).
2. CRUNCHBASE KNOWLEDGE CENTER, Glossary of Funding Types (2021).