

How to enable SMR technologies

Small Modular Reactor (SMR) and Heating, Future Opportunities

LAPPEENRANTA FUTURE ENERGY SOLUTIONS

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Työ- ja elinkeinoministeriö
Arbets- och näringsministeriet

Type of energy source used by each economic sector



Electricity supply 2021

Total consumption 87 TWh

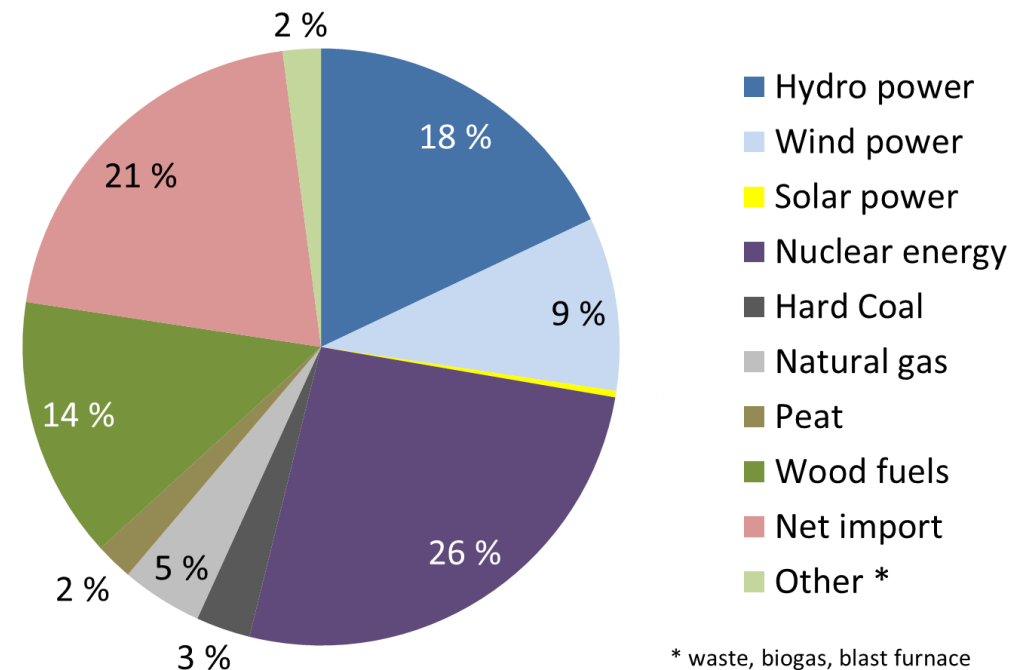
Domestic generation 69 TWh

- 87 % ghg-emission free
- 54 % renewable energy

New nuclear power plant unit soon in operation

A large number of wind power plants currently under construction and in planning phase

Source: Statistics Finland



* waste, biogas, blast furnace and coke oven gas, coke etc

C&E strategy FI – accepted in June 2022



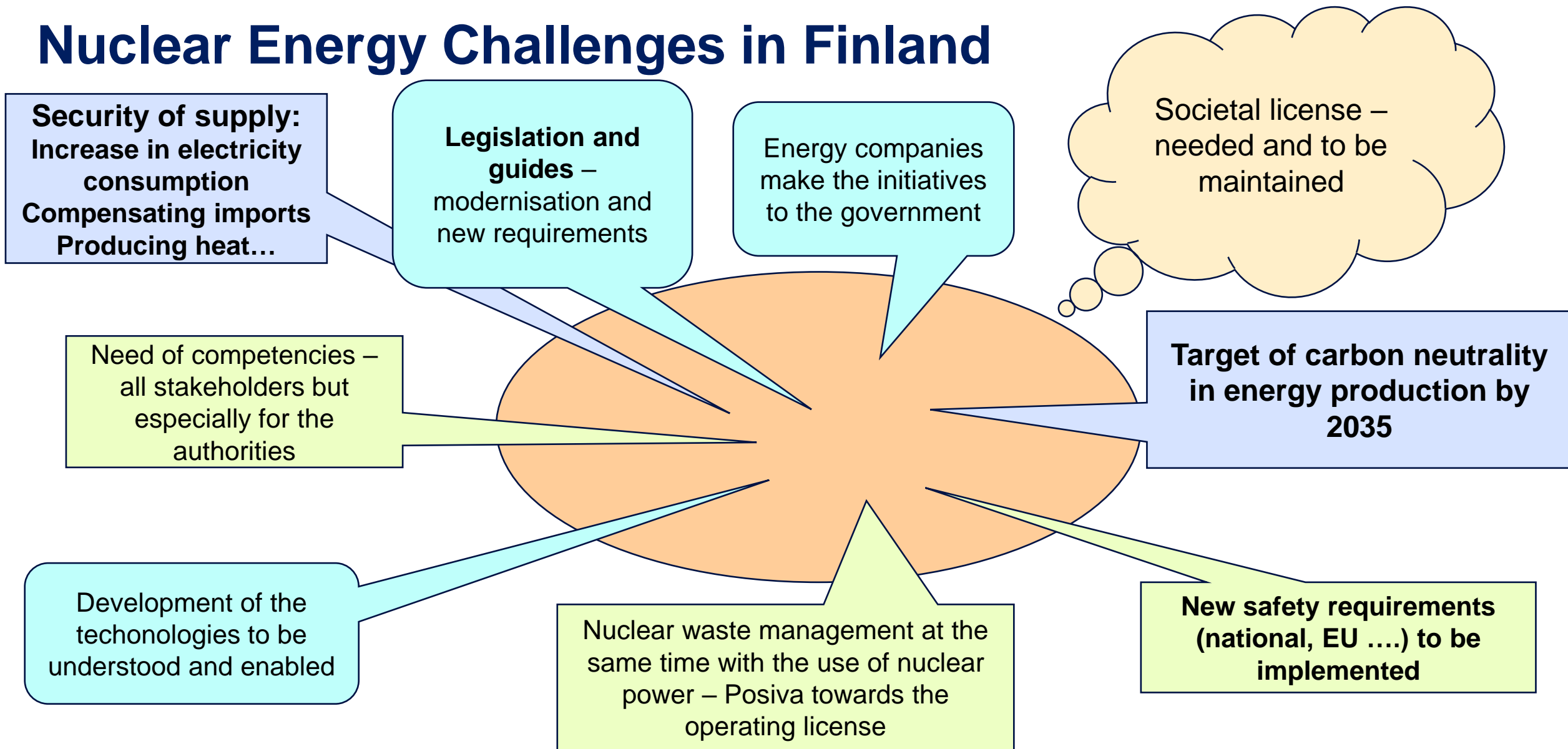
- **MEAE completed energy and climate strategy work in June 2022 with the aim of carbon neutral Finland in 2035, this is achieved in economical and equal manners (both regionally and socially).**
- **The goal of the the climate and energy strategy is to find 6-7 million tn new CO2-emission cuts and to ensure the security of supply aspects.**
- **The goal of Government is to shape the political decisions for these targets.**
- **At the same time substitutes for the Russian fuel and electricity imports – stopped in spring 2022 – are sought.**
- **Nuclear is part of the energy strategy both using the existing NPPs but also looking new ones and technologies, SMRs. For nuclear regulation is needed and Nuclear Energy Act will be renewed.**
- **The C&E strategy is used for the reporting and for the update of national energy and climate plan.**

Nuclear Energy projects in Finland



- The OL3 EPR plant unit's commercial electricity production starts end of 2022 (?). 1600 MW domestic and clean electricity production.
- Posiva first in the world for spent nuclear fuel repository and disposal is progressing – operating license application submitted on 30th December 2021. We anticipate the operation to start around 2024/25.
- Fortum Loviisa EIA decision was made on 18th January at MEAE. Two applications for the future of Loviisa site; the NPP units + the operating waste disposal facility were made in March 2022.
- Debate on SMR technologies is the "hot potato". A Government funded study on SMRs and licensing needs was reported in June 2022 and the work continues.
- In Sweden the Government accepted the license for SKB for the SNF repository in Forsmark on 27th January 2022.
- Sweden looking for new nuclear projects 2022 >> both extending the operation and new build.

Nuclear Energy Challenges in Finland



What is a SMR and how to benefit it?



SMR = SMALL MODULAR REACTOR

Small Reactor = a trend for the future:

- **Drivers:** avoiding high costs and long implementation schedules for large scale NPPs, searching base load to be compatible with the renewables.
- **Needs:** to produce energy CO₂-emission free, to produce electricity and/or heat in a reliable manner, to look the future needs for hydrogen economy. (elsewhere: cooling, desalination... locally).

Reactor scale	Electrical MW	Thermal MW
Micro	0.1-50	0.2-100
Small	50-300	100-900
Medium	300-800	900-2000
Large	800-1700	2000-4500

Table Modified from Energiforsk SBN: ISBN 978-91-7673-013-3

Modularity:

- **Stepwise and serial production options**
- **Safety assessment and licensing would be more straight forward for serial production**

Name/Company	Reactor Design	Module Power	Coolant/ Moderator	FOAK ETA	Applications
SMR/ Rolls Royce	Pressurized water	1276 MWth / 443 MWe	Light water	2030	Electricity and/or heat production
ACP100/ CNNC	Integral pressurized water	385 MWth / 125 MWe	Light water	2025	Electricity and/or heat production
NuScale Power Module	Integral pressurized water	200 MWth / 60 MWe	Light water	2026	Electricity and/or heat production
KLT-40S Rosatom	Pressurized water/ on a barge	150 MWth/ 38 MWe	Light water	2019	Electricity and/or heat production
DHR400/CNNC	Pool-type water	400 MWth	Light water	2021	District heating/ cooling
EDF/NUWARD	Pressurized Water Reactor	340 MWe (2 x 170 Mwe)	Light water	Basic design mid-2020s	Electricity and heating/ cooling
HTR-PM/CNNC	<i>Pebble bed high temp. gas-cooled</i>	<i>250MWth/ 105 MWe</i>	<i>Helium / Graphite</i>	<i>2019</i>	<i>Process heat</i>
Electricity, IMSR/Terrestrial Energy	<i>Molten salt pool type</i>	<i>400 MWth / 190MWe</i>	<i>Fluoride fuel salt / Graphite</i>	<i>Late 2020s</i>	<i>Electricity and/or heat production</i>

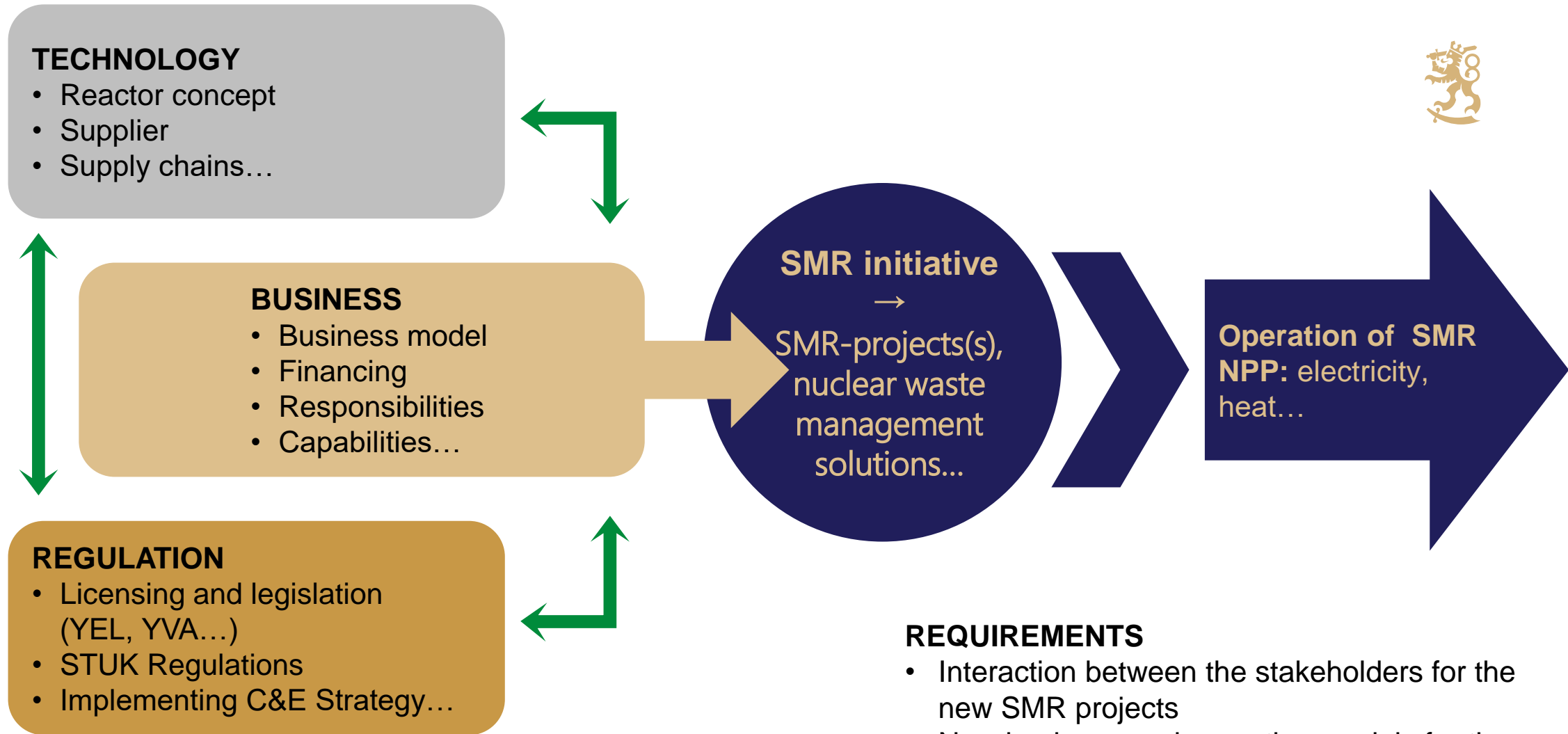
Key Challenges for SMRs



- 1. Technology – availability of mature technology, costs, licentiability**
 - Vendor readiness for pre commercial research, development and deployment
- 2. Business – needs to produce energy and means to make a reliable project and business case**
- 3. Society - Public and political awareness and acceptance**
- 4. Stakeholder/user awareness and readiness to utilize - operator/energy consumer.... and market readiness**
- 5. Regulations to enable new technologies and new models to accomplish a project and operate a unit**
- 6. Need for multiple orders to benefit of serial production and modularity.**
- 7. Need for nuclear waste solution(s) for modular/distributed NPPs.**



Society; needs and acceptance



Thank you!

