Techno-scientific promises and (anti)nuclear communities:
Small Modular Reactor promises in Canada and Finland

REFORM group meeting
Salzburg, 3-6 October 2022
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PROMISES. The making of sustainability transitions with (false?) expectations: Critical analysis of historical and current promises of nuclear technology

Applying approaches of science and technology research (STS), especially the sociology of expectations and the theory of epistemic communities, the project examines the structure and implications of promises of nuclear technologies for politics and society. Historical analysis of promises relating to nuclear technologies, as an incarnation of the techno-scientific optimism of the modern era, provides tools for steering socio-technical innovation towards sustainability, in a post-modern society with its complex relationship with the future.

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The overarching question of the PROMISES project

What lessons can be learned for today's efforts at steering innovation *towards sustainability from the analysis of* promises *in the* nuclear sector, *along the path from the modernist towards today's presentist* period of historicity?

1. **Promises:** argumentation and construction
2. **Communities**: promise-constructors and promise-deconstructors

The PROMISES project

Topics, policy areas

- Empirical analysis on SMRs: today's promises

- Analysis of secondary sources: historical (and current) promises of
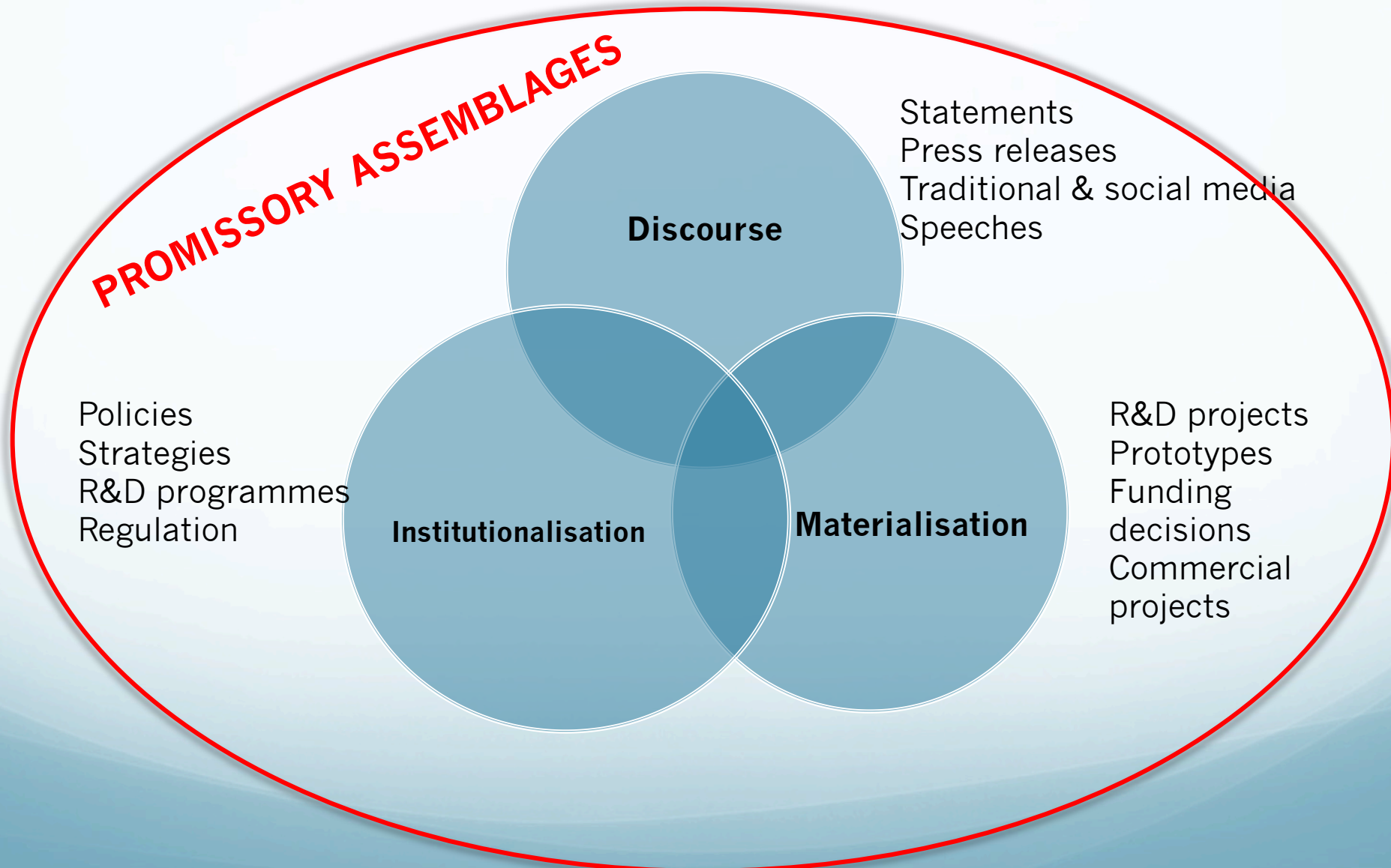 - fast breeders
  - fusion
  - waste management

SMR case study countries

- Canada

- Finland

- France

- Sweden

- UK

PROMISES: Key assumptions and starting points

- *Promising is necessary* for techno-scientific innovation, but it carries the risks of overpromising, disappointment, and polarisation of debate

- *Techno-scientific* promises are *collectively constructed*, not merely "given" to somebody

- Promises are *performative*, i.e. more than mere talk: institutionalisation, materialisation of promises – "sociotechnical assemblages"

- Promises bind together the *past, present, and future*

- Promise-constructing and –deconstructing (epistemic and other) *communities:* the *constructive role of controversies?*

Promises are more than just talk or discourse!

PROMISSORY ASSEMBLAGES

Discourse

Statements
Press releases
Traditional & social media
Speeches

Policies
Strategies
R&D programmes
Regulation

Institutionalisation

Materialisation

R&D projects
Prototypes
Funding
decisions
Commercial
projects

Epistemic communities

loose networks of experts and professionals united by shared norms, causal assumptions, convictions concerning reliable ways of acquiring knowledge, and a shared policy enterprise (Haas 1992)

Such communities

- construct, maintain, shape, and circulate promises

- (often) cross national borders

- (often) penetrate governmental structures and politics

Epistemic and other communities...

- Communities of conviction
- Communities of promise
- Communities of consensus
- Communities of practice
- Project communities
- Professional communities
- Advocacy coalitions
- Bureaucratic groups
- etc.

Nuclear promises: changing preconditions across eras of historicity

Modernism

- bold visions, future as an opportunity
- trust in progress via techno-science
- shared values
- time to construct promise-networks
- techno-science as THE solution

Presentism

- future as a threat
- mistrust/scepticism towards techno-sciences
- fragmentation & lack of shared values
- need to show immediate results & commercial viability
- techno-science as a source of partial solutions at best

Promise-construction in today's "presentist" era is much more challenging than during the modernist era of techno-scientific optimism

SMRs = nuclear-sector's adaptation to the presentist regime of historicity?

- SMRs promise to be cheaper, safer, more financeable, quicker to construct, multifunctional, compatible with decentralised energy systems...

- Not THE solution, but an essential element of the solution

- The role of historical legacies: a sector with a long history of failed (and *successful*?) promising
  - Fast breeders
  - Fusion
  - High-level waste management

Umbrella promises and specific promises

The "umbrella" SMR promise

- Cheaper, faster, safer, more flexible, multifunctional, compatible with decentralised grids, capable of load following…

- "We just need *X number of* prototypes/FOAKs, to get the ball rolling…"

- SMRs as a broad, vague category
    - 10-300 MWe (but, could be more, or less…)
    - Modularity: assembly-line model & several units on one site

Specific SMR promises = reactor designs

Light-water SMRs

- Pressurised or boiling water technologies

- Build on existing, operating technology => no need for significant innovation

Rolls Royce, NuScale, GE Hitachi, Holtec

Advanced SMRs

- Lead-cooled

- Molten salt

- Sodium-cooled

- (Very) High Temperature

- Build on fast breeder and similar technologies => need major technical development

Terrestrial Energy, Ultra-Safe Nuclear Corporation, Moltex Energy, X Energy, LeadCold Nuclear Inc., Advanced Reactor Concepts Ltd.

Canada and Finland

- Sparsely populated, advanced, high-trust, pro-nuclear, technology-believing SMR enthusiasts(?)

- SMRs described as THE future of nuclear technology in both countries

- Similarities and differences between FIN and CAN, in terms of SMR development
  - First plants to be deployed by the end of the 2020s
  - Finland: district heating; Canada: multiple functions

- Importance of history

	Canada	Finland
(Nuclear) history	One of the pioneers of nuclear development: CANDU heavy-water reactors Advanced waste repository plans	Excellent track record of existing reactors OL3 EPR: traumatic megaproject… World's first waste repository (2024)
Energy resources	Nuclear 15% Diversity of other sources: Quebec & BC hydro, Ontario nuclear & hydro; Alberta oil; Saskatchewan coal+gas	Nuclear 35-40% of electricity; diversity of other sources
Political institutions	Provinces => energy supply Federal govt => nuclear Quebec (anti-nuclear)! Indigenous communities!	Unitary state Strong municipal autonomy
Trust in institutions	Relatively high	High

Finland and SMRs

- Revision of the Nuclear Energy Act (by 2027)
  - Key objective: regulatory reform to facilitate the licensing of SMRs

- R&D funding (e.g. PIEMOS project); active participation in EU-level SMR research

- Municipal council initiatives in favour of SMR-based district heating projects

- Green Party ecomodernists advocating for SMRs...

- Fortum – more recently also TVO has expressed interest

Canada: 19 nuclear reactors, in two provinces

SMR plans in Finland and Canada

	Canada	Finland
SMRs, what for?	Replacing old reactors; power for extractive industries; electrification of off-grid communities	For district heating in residential agglomerations
Technology developer?	Yes: Moltex, Terrestrial Energy…	No, but LUT university and state research institute VTT each have their experimental reactor projects
(Epistemic) communities	Well-established nuclear science & engineering community Relatively pro-nuclear policy, but Quebec firmly against	State-industry-alliances Ecomodernists advocating for SMRs
Public opinion	Rather SMR-favourable (but depends on the survey…)	Rather SMR-favourable
Siting and local communities	Existing nuclear and coal plant sites Indigenous communities	District heating in Helsinki region, perhaps other major cities

Canada's collaborative SMR policy process

"Collaboration, that's what we Canadians know how to do"

SMR Roadmap (2018)

*"Nuclear energy in Canada is a **strategic asset**. Canada is a Tier 1 nuclear nation, with a full-spectrum industry that we leverage for significant economic, **geopolitical**, and social and environmental benefits."*

Voting Members

Non-voting Members

Canadian Roadmap & the SMR promise

*SMRs are: "smaller nuclear reactors that **involve** lower capital investment and modular designs to control costs; they **can compete** with other low-cost forms of electricity generation; they incorporate enhanced safety features; and they **could enable** new applications, such as hybrid nuclear-renewable energy systems, low-carbon heat and power for industry, and offset diesel use in remote communities and mine sites."*

Unlike with a lot of SMR promise speech, relatively careful and "moderate" formulations, which recognise that the virtues of SMRs are mainly potential, and yet-to-be-proven

The Canadian 3-stream approach to SMR policy development

| Stream	Applications	SMR technology & pilot project operation date	Potential fleet deployment locations
1	Grid-based electricity	GE Hitachi BWRX-300 Darlington, ON, 2028; 300 MW	Ontario Saskatchewan: four units in 2034-2042 Alberta
2	Grid-based electricity & heat (advanced SMRs)	ARC-100 Point Lepreau, 2029	New Brunswick: 2 units Nova Scotia Saskatchewan/Alberta For export?
2	Spent fuel recycling & grid-based electricity	Moltex WaTSS & SSR-W Point Lepreau, NB, early 2030s	New Brunswick Ontario
3	Off-grid electricity & heat	Global First Power MMR Chalk River, ON, 2026 Ultra Safe Nuclear Corporation (USNC) Westinghouse eVinci Burlington, ON, 2027	Northern areas of provinces Territories Mines Shipping & marine applications

SMR Action Plan (2021)

"The Action Plan is the result of a pan-Canadian effort bringing together key enablers from across Canada, which we call **"Team Canada" – the federal government, provinces and territories, Indigenous Peoples and communities, power utilities, industry, innovators, laboratories, academia, and civil society."**
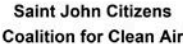
SMR Strategic Plan (2022)

A Strategic Plan for the Deployment of Small Modular Reactors

Prepared by the Governments of Ontario, New Brunswick, Alberta and Saskatchewan

Local/provincial public opinion on SMRs

Helsinki metropolitan area

What would be your stand on the Small Modular Reactors (SMRs), if one would be sited in your residential area?

- Positive
- Neither positive nor negative
- Negative

46%

31%

23%
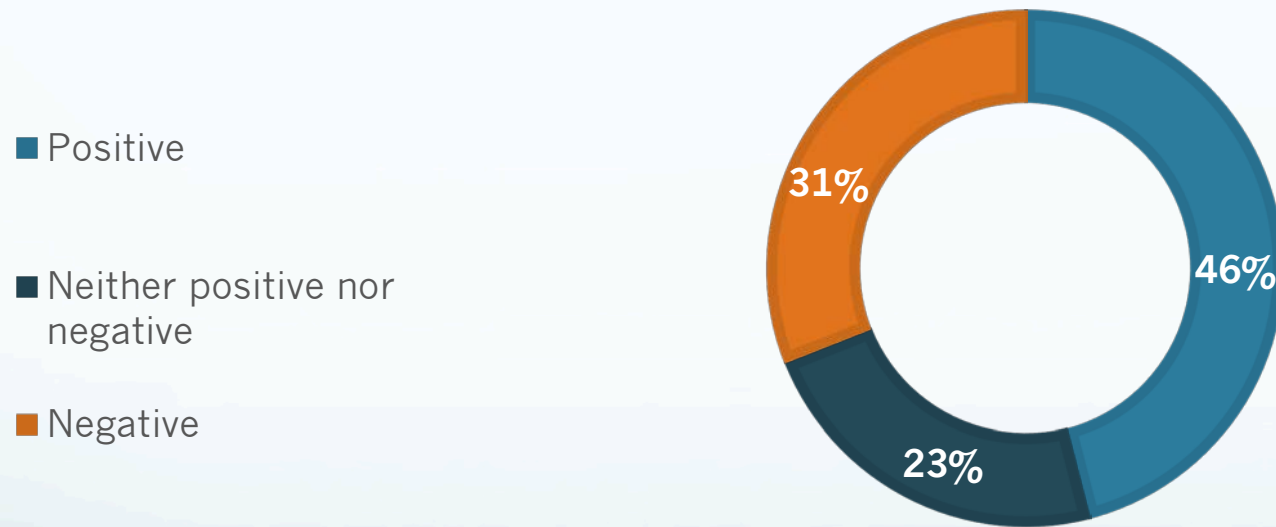
Survey conducted in November 2021
Target population: Helsinki metropolitan area, the Finnish-speaking residents (ages 18-75)
Response rate: 36% for Helsinki, 44% for Espoo and 35% for Vantaa (N=1600).
63% of the respondents supported their respective cities' carbon neutrality targets (Espoo and Vantaa by 2030, Helsinki by 2035)
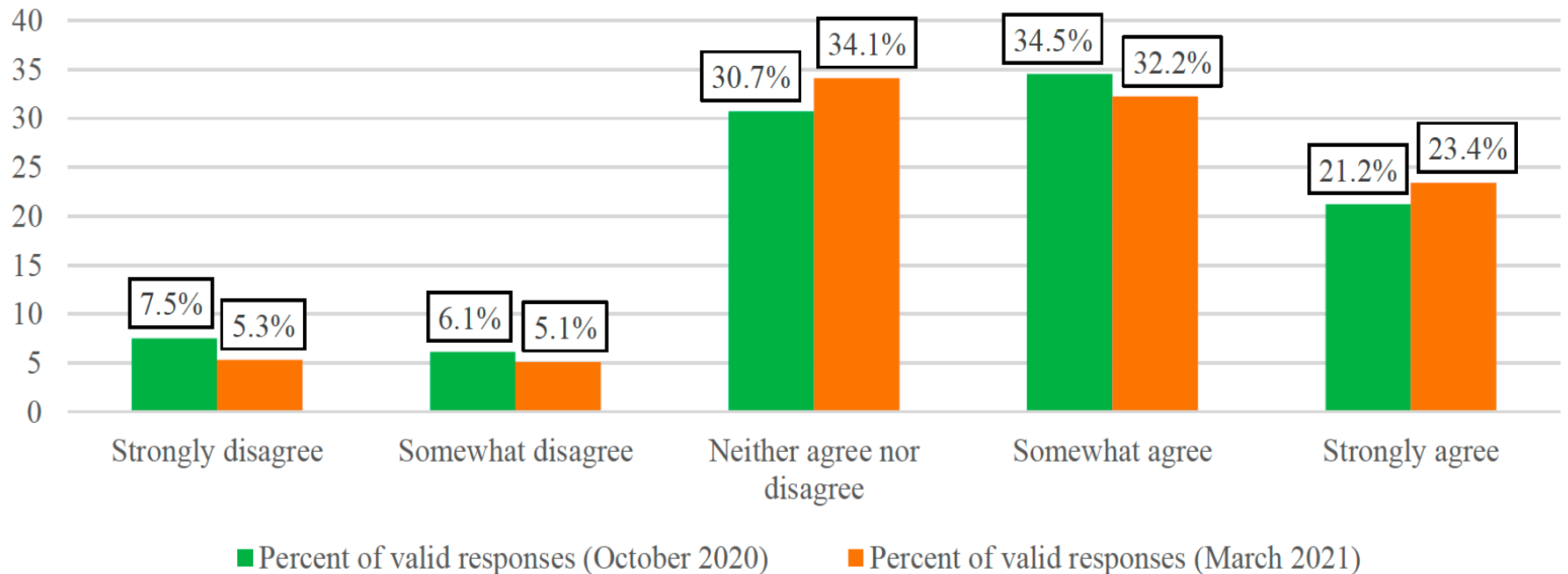
Saskatchewan

Figure 1: Opinion on SMRs replacing coal energy generation
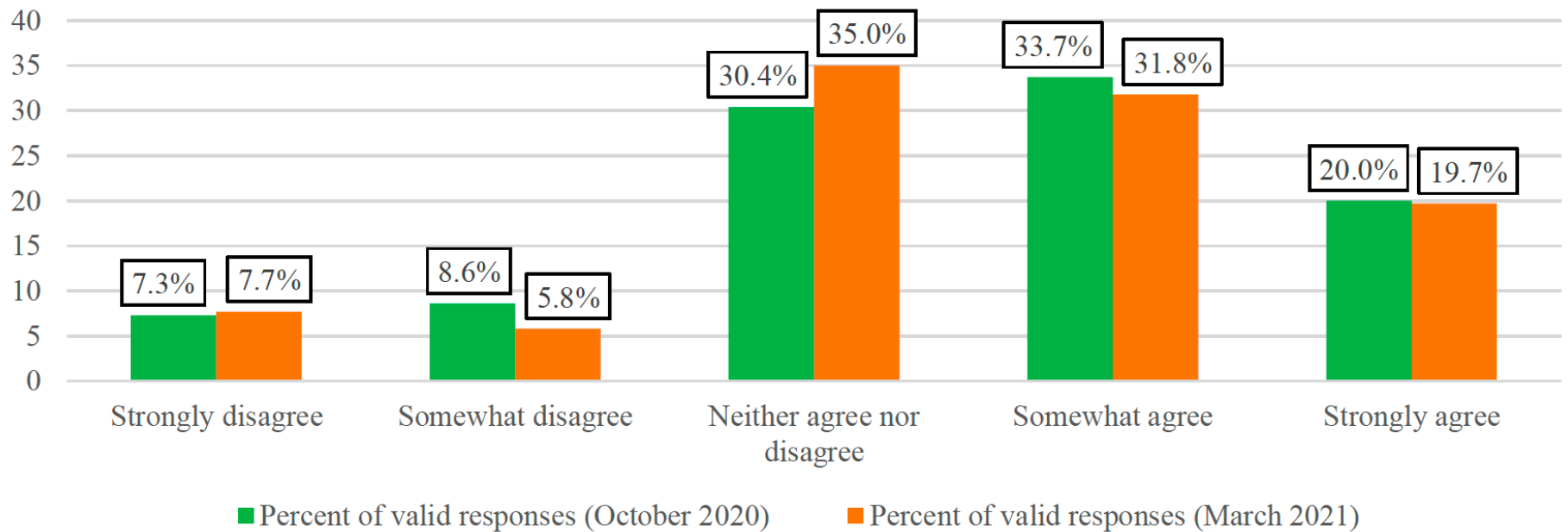
Source: C-Dem Saskatchewan Election Study 2020 (N =1003). Viewpoint Saskatchewan Survey 2021 (N = 656). Weighted data. Figures correspond to respondents' answers to the statement: "Saskatchewan should use small modular reactors to replace coal energy generation on the provincial electrical grid."

Saskatchewan

Figure 2: Opinion on SMRs generating energy for remote communities

Legend:
- Percent of valid responses (October 2020) — green
- Percent of valid responses (March 2021) — orange

Response	October 2020	March 2021
Strongly disagree	7.5%	5.3%
Somewhat disagree	6.1%	5.1%
Neither agree nor disagree	30.7%	34.1%
Somewhat agree	34.5%	32.2%
Strongly agree	21.2%	23.4%

Source: C-Dem Saskatchewan Election Study 2020 (N = 1003). Viewpoint Saskatchewan Survey 2021 (N = 660). Weighted data. Figures correspond to respondents' answers to the statement: "Saskatchewan should use small modular reactors for generation in remote communities."

Varying replies, depending on the province, and the framing of the question...
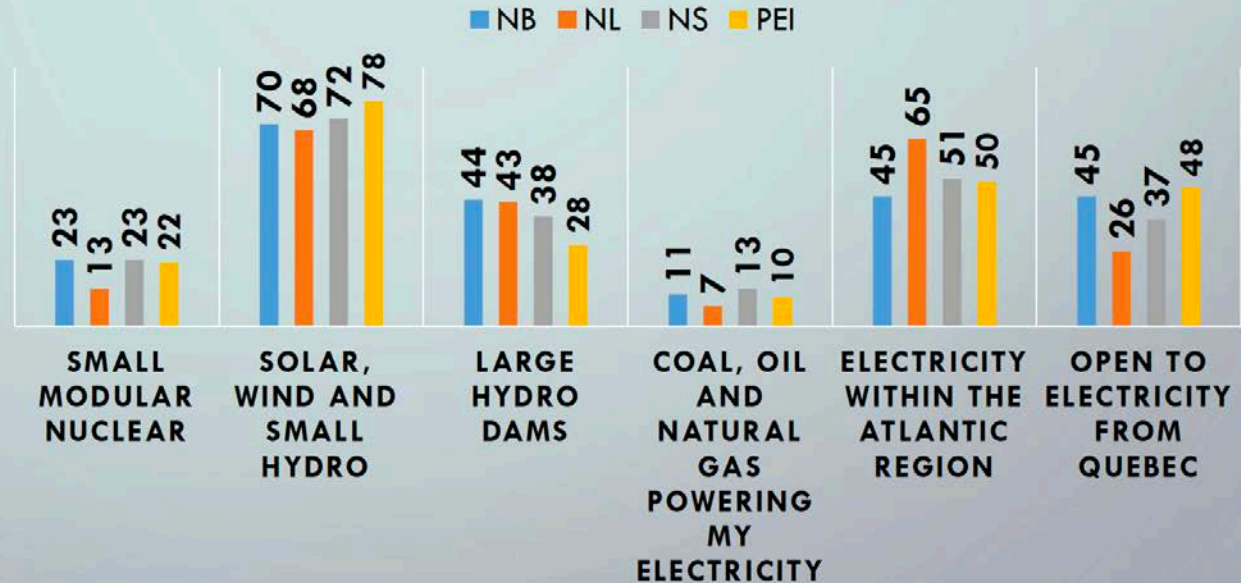
New Brunswick

HOME GROWN RENEWABLES, THEN REGIONAL CONNECTION TO HYDRO; NL NEGATIVE TOWARD QC HYDRO

1/3 NEUTRAL

SMRS: LESS THAN ¼ AGREE;

SMRS: DISAGREE: NB, 32%, NL, 40%, NS, 34%, PEI, 38%)

I WANT (SOURCE) POWERING MY ELECTRICITY OR OPEN TO (TOTAL AGREE, %)

Legend: ■ NB ■ NL ■ NS ■ PEI

Source	NB	NL	NS	PEI
SMALL MODULAR NUCLEAR	23	13	23	22
SOLAR, WIND AND SMALL HYDRO	70	68	72	78
LARGE HYDRO DAMS	44	43	38	28
COAL, OIL AND NATURAL GAS POWERING MY ELECTRICITY	11	7	13	10
ELECTRICITY WITHIN THE ATLANTIC REGION	45	65	51	50
OPEN TO ELECTRICITY FROM QUEBEC	45	26	37	48

"Public understanding of Atlantic electricity issues"
Louise Comeau, Conservation Council of New Brunswick, July 2021

Saskatchewan

A 2019 telephone survey of 1,014 Saskatchewan residents:

- SMRs ranked behind solar, hydro, natural gas, wind, and geothermal in pure preference

- When asked to choose a power source to provide safe, reliable, and cost-efficient electricity for the future, however, SMRs ranked behind only natural gas and solar

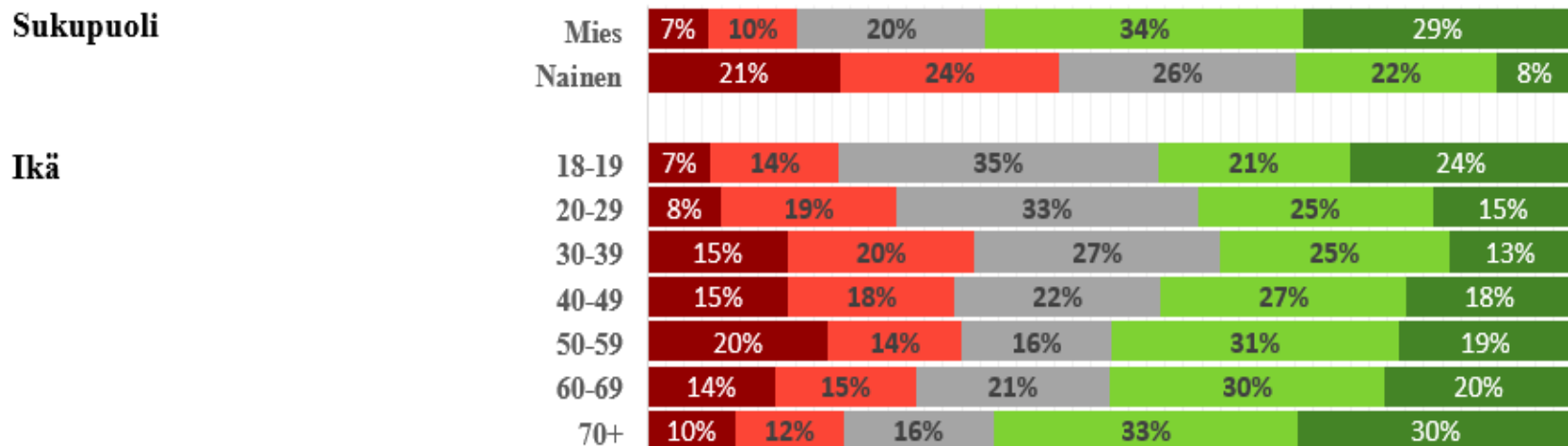Hurlbert, Margot, and Dale Eisler. "Small Modular Nuclear Reactors in Saskatchewan's Future?" Johnson Shoyama Graduate School Research Publications, November 2, 2020. https://www.schoolofpublicpolicy.sk.ca/research/ publications/policy-brief/are-small-modular-nuclear-reactors-in-saskatchewans-future.php.

SMRs & the nuclear "gender gap"?

In the Helsinki metropolitan area, 45% of women but only 17% of men had a negative or very negative opinion towards their home municipality hosting an SMR

Miten suhtautuisitte pienydinvoimalan käyttöönottoon omassa asuinkunnassanne?

Legend: ■ Erittäin kielteisesti ■ Kielteisesti ■ En myönteisesti enkä kielteisesti ■ Myönteisesti ■ Erittäin myönteisesti

Sukupuoli

	Erittäin kielteisesti	Kielteisesti	En myönteisesti enkä kielteisesti	Myönteisesti	Erittäin myönteisesti
Mies	7%	10%	20%	34%	29%
Nainen	21%	24%	26%	22%	8%

Ikä

	Erittäin kielteisesti	Kielteisesti	En myönteisesti enkä kielteisesti	Myönteisesti	Erittäin myönteisesti
18-19	7%	14%	35%	21%	24%
20-29	8%	19%	33%	25%	15%
30-39	15%	20%	27%	25%	13%
40-49	15%	18%	22%	27%	18%
50-59	20%	14%	16%	31%	19%
60-69	14%	15%	21%	30%	20%
70+	10%	12%	16%	33%	30%

The difference is not explainable by any of the other analysed sociodemographic variables (age, education, profession, etc.)

Outstanding questions and tentative conclusions

SMR waste? SMR geopolitics?

SMR waste management remains an unresolved issue; when the topic is addressed:

- Finland: **waste business** – could provide NWM services to other countries
- Canada: the promise of **reprocessing and "waste recycling"** thanks to advanced SMR technologies

- Contested and controversial paper by Krall et al. 2022,* which highlights SMR waste problems

Geopolitics, SMR supply chains, and economic viability of SMRs?

- Dependence of SMRs on complex, global supply chains

*) Lindsay M. Krall, Allison M. Macfarlane & Rodney C. Ewing. 2022. Nuclear waste from small modular reactors. PNAS, Vol 119. https://doi.org/10.1073/pnas.2111833119

Conclusions and questions to you

- Promises matter – one may say promises are not realistic, but is this the most relevant question? *Promises make and are made of reality*

- Canada, and perhaps Finland, are likely to proceed to the deployment of prototypes, with climate change as a key argument

- The role of contestation in nuclear promising: any room for constructive controversies?

- Vital role of regulatory harmonisation, streamlining, and standardisation => international communities!

- The role of the state: if SMRs are to have a future, solid state backing will be needed – how far are we (willing to) go(ing) down the line towards authoritarianism?

History and promising: from modernism, through presentism, towards ???

To be viable, SMRs are likely to require considerable (unprecedented?) state support, in many forms (financial risk mitigation, safety regulation reform, R&D and prototype funding, PPPs…)

New authoritarianism and the growing role of the state? How far are we willing to go? Are we leaving presentism behind, and entering a new era of…???

Is presentism soon a thing of the past? Is promising making a come-back, thanks to concerns over climate change and energy security/sovereignty?

- In fact, has Finland ever been presentist? Mankala; the primacy given to the energy-intensive export industry; long-term planning…

- On the other hand, the dominant energy policy discourse in Finland: "markets first; the govt has never had to intervene…"

Communities

International/national
Sources of community
cohesion

National and international communities: distinct functions

1. **National** networks of *tangible resource mobilisation* (financing, policies, R&D projects...)

2. **International** networks of cheerleading, internal cohesion, raising spirits, and building credibility & legitimacy for national-level action

   - conferences, social media, new pro-nuclear NGOs
   - IAEA, NEA, WANO, WENRA, ENSREG, INRAG...

(International) communities & regulatory harmonisation

Regulatory streamlining, harmonisation and standardisation as a key prerequisite for successful promising & deployment of SMRs

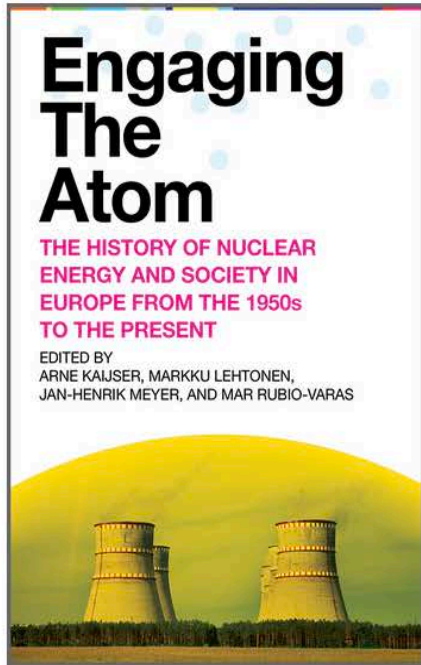Central international role of the Canadian regulator!

Overregulation blamed by many in the nuclear community for the industry's troubles:

- Regulation should be guided by science, not by "irrational fears and political expediency" (Ahab Abdel-Aziz, Canada, 2022)
- "we've allowed too much democracy to get in, and we've produced these very baroque processes that are involved in permitting upfront" (Senior nuclear industry rep., 2022)
- deploying SMRs at the needed scale and pace requires "hacking some of this nonsense out of the front and actually making decisions rational" (ibid.)

What unites a community, and makes it cohesive and powerful?

- Political mission
- *Epistemic beliefs*
- Profession
- National interest
- Economic interests
- *Identities* (professional, national/regional, ideological, gendered…):
  - The Canadian collaborative identity
  - Ecomodernism vs. the traditional nuclear-sector culture
  - Gender: nuclear bros vs. feminine ecomodernists?

Engaging the Atom

The History of Nuclear Energy and Society in Europe from the 1950s to the Present

| Summary | Contents | Editors | Reviews | Excerpt |

Summary

With the aim of overcoming the disciplinary and national fragmentation that characterizes much research on nuclear energy, *Engaging the Atom* brings together specialists from a variety of fields to analyze comparative case studies across Europe and the United States. It explores evolving relationships between society and the nuclear sector from the origins of civilian nuclear power until the present, asking why nuclear energy has been more contentious in some countries than in others and why some countries have never gone nuclear, or have decided to phase out nuclear, while their neighbors have committed to the so-called nuclear renaissance. Contributors examine the challenges facing the nuclear sector in the context of aging reactor fleets, pressing climate urgency, and increasing competition from renewable energy sources.

**Engaging
The
Atom**

THE HISTORY OF NUCLEAR
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EUROPE FROM THE 1950s
TO THE PRESENT

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JAN-HENRIK MEYER, AND MAR RUBIO-VARAS

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