New CRP: Economic Appraisal of Small Modular Reactor (SMR) Projects: Methodologies and Applications (I12007)

The IAEA is launching a 3-year, Coordinated Research Project (CRP) focusing on the economics of SMRs, including micro-reactors, by providing Member States with an economic appraisal framework for their development and deployment.

S. Dardour, September 2022.
Presentation of the CRP

- Initiated in December 2020, the IAEA CRP entitled ‘Economic Appraisal of Small Modular Reactor (SMR) Projects: Methodologies and Applications’ aims at providing Member States with a canvas and a framework (the COOSMR Framework) for the economic appraisal of Micro- and Small Modular Reactors development and deployment.

- Participating Institutions (47):
  - CNEA, Argentina; ANSTO, Australia; TRACTEBEL, Belgium; EPE, Brazil; KOZLODUY, Bulgaria; CNL, Canada; CNPE, China; SNERDI, China; SPIC, China; U-ZAGREB, Croatia; UJV, Czech Rep.; CREN-K, DRC; FERMI, Estonia; FORTUM, Finland; VTT, Finland; CEA, France; FPL, France; GAEC, Ghana; BATAN, Indonesia; POLIMI, Italy; CRIEPI, Japan; JAEA, Japan; JAEC, Jordan; KISR, Kuwait; CNESTEN, Morocco; SN13, Netherlands; PAEC, Pakistan; NCBJ, Poland; ROSATOM, Russian Fed.; MOZWELI, S. Africa; KAERI, S. Korea; IDOM, Spain; SLAEB, Sri Lanka; CNSTN, Tunisia; U-CARTHAGE, Tunisia; U-ISTANBUL, Turkey; MENR, Turkey; PERIHELION, UK; U-LEEDS, UK; ARC, US; INL, US; KAIROS, US; NECG, US; NINE, US; NUSCALE, US; PILLSBURY, US; TAMU, US.

- Observers (5):
  - BEIS (UK); NREL (US); GIF EMWG; OECD NEA; ASEAN Centre for Energy.

- Secretariat (IAEA):
  - S. Dardour and D. Subbotnitskiy (PESS), M. H. Subki (NPTDS).
Revenues need to be secured

‘De-risking’ is key to access financing

Diversity sources of revenue
Combination of heat, power, and ‘flexibility’

Keep operating, fuel, and other recurring costs as low as possible

Maximize the use of generation assets over the longest possible period

Develop infrastructure and prepare for construction

Costs need to be understood, optimized, and kept under control

Deliver the construction project as soon as possible and with the lowest costs

Construction starts

Operation starts

Cashflow

Time
We can only approximate the probable cost of a program, project, system, equipment, part or task.
Access to cheap capital makes a huge difference to the cost of producing electricity for a new nuclear power project *

Costs have to be balanced against Benefits
Investments in SMR are driven by specific challenges:

Affordable energy prices for consumers

Growing penetration of power generation from variable renewable energy (VRE) sources (increasing need to balance VRE)

Global concerns for climate change (need of progressively substituting fossil-based energy fuels with more sustainable sources)

Security and reliability of supply

---

**Cost-benefit analysis:** A method to evaluate the net economic impact of a project. Expected benefits are estimated and monetised with inflation accounted for, and offset against project costs. The approach is most commonly used to inform in major infrastructure investment in both developed and developing countries.

**Cost-effectiveness analysis:** This method is used where monetising outcomes is not possible or appropriate, most commonly in health. Common measures include “quality-adjusted life years”.

---

Value for money and international development: Deconstructing myths to promote a more constructive discussion
Penny Jackson, OECD Development Co-operation Directorate.

S. Dardour, September 2022.
All electricity technologies produce some GHG emissions on a life cycle basis. Nuclear power, along with hydroelectricity and wind power, emits the lowest quantity of GHGs per kW·h of generation. Emissions are substantially higher for fossil technologies.
Security of supply


- NEA’s indicator of the security of supply for OECD countries: the simplified supply and demand index or SSDI.

- The SSDI shows a remarkable improvement for the great majority of OECD countries over the 40-year time frame of the study: Australia, Canada, Finland, France, Japan, the Netherlands, Sweden, the United Kingdom and the United States.

- This improvement resulted from the introduction of nuclear power for electricity generation, decreasing energy intensity and increased diversification of imported fuels such as coal, oil and gas.
Multi-billion investments in multi-billion infrastructure projects in general, and SMR newbuilds in particular, are a synonym of economic growth and job creation over many decades.

Investments in energy infrastructures tend to stimulate construction, manufacturing, engineering services, generating economic growth across a wide range of economic sectors, beyond the energy sector.

The labour market is also impacted by direct and indirect (or “spillover”) effects, which can be estimated and quantified.
Macroeconomic impact

There is a positive relationship between the growth of transport and electricity infrastructure and economic growth.

Policies that promote spending in these areas have a positive impact on growth, provided they do not create excess capacity.

S. Dardour, September 2022.
Project Deliverables

• Project deliverables:
  – D1: A generic framework (the COOSMR Framework) for the economic appraisal of SMR.
  – D2: Supporting methods, tools, and datasets.
  – D3: Country cases and other case studies, focusing on SMR applications, and illustrating the application of the COOSMR Framework.
  – D4: The CRP report, documenting D1-D3 deliverables, to be published at the end of the project.
Project Developer

Project developers rely on standard financial appraisals focusing on *returns to shareholders*.

Public Sector Decision-Maker

Economic appraisal takes a broader view to include *benefits and costs to society*.

Illustration: huffpost.com
https://www.huffpost.com/entry/its-all-perspective_b_11688054

Perspective matters...
The COOSMR Framework

- The COOSMR Framework is intended to support two distinct segments of end-users, with different needs and expectations:
  - Public sector decision-makers, investigating the relevance of the SMR option in a province, country, or region.
  - Project designers and developers, aiming at demonstrating the business case for SMR, securing funding and financing, and public support for the project.
Methodologies and Applications Working Groups

• The main objective assigned to the 8 Methodologies Working Groups (MWGs) is the development of the COOSMR Framework.

• The framework would suggest a generic process, or a procedure, for investigating the relevance of the SMR option in a given context and for demonstrating the business case for SMR.

• cf. Details of the topics covered by MWGs in the next slide.

• The applications considered in the context of the CRP include:
  – **Power generation** (and the provision of ancillary and other services to the grid);
  – **Process heat production** (for desalination and residential heating and cooling, among other applications);
  – **Hydrogen production**.

• The 4 Applications Working Groups (AWGs) will work towards developing country cases and other case studies, focusing on SMR applications, and illustrating the application of the COOSMR Framework.
CRP Working Groups and ‘Roster Teams’

Methodologies Working Groups

Energy Systems and Markets
- MWG 1: Energy Systems and Markets Modelling
- MWG 2: Policies and Strategies
  Issues of Market Design, Structure, and Suitability
- MWG 3: Costing Methods
  Dealing with Uncertainties
- MWG 4: Cost-Benefit Analyses
  Issues of Social Acceptability and Desirability
- MWG 5: Market Research
  Value Proposition and Strategic Positioning
  Business Case Demo
- MWG 6: Risk Assessment and Risk Mitigation
  Project Structuring and Financing
  Financial Modelling

Costs (and Benefits)
- MWG 7: Factory Fab Economics
  Supply Chain and Localization Economics
  Circular Economy

Economic Competitiveness
- MWG 8: Macro-Economic Impact Assessment

Business Case

Applications Working Groups

- AWG 1: Energy Planning Scenario Analysis
- AWG 2: Power Generation Grid Services, incl. Storage and Ancillary Services
- AWG 3: Heating and Cooling Applications Desalination
- AWG 4: Hydrogen Production Production of Bio/Synthetic Fuels

Working Group ‘Roster Team’

S. Dardour, September 2022.
Methodologies Working Groups (MWGs)

- **Energy Systems and Markets**
  - The first key area of investigation targets *public sector decision-makers* and covers approaches and methodologies for:
    - **MWG 1:** Investigating the (economic) relevance of the SMR option in evolving power systems (relying increasingly on variable generation from renewables) and energy markets.
    - **MWG 2:** Developing policies and strategies that set out what needs to be done to create an (economically) enabling environment for SMR development and deployment.

- **Costs (and Benefits)**
  - The second topic to be addressed by MWGs covers:
    - **MWG 3:** Approaches to cost forecasting and analysis under uncertainty.
    - **MWG 4:** Cost-benefit, or cost-effectiveness, analysis.
  - The methodologies would be benefit both segments of end-users, i.e., *public sector decision-makers*, and *project designers and developers*.

- **Business Case**
  - The 'Business Case' covers two sets of topics:
    - **MWG 5:** Business planning and business case demonstration.
    - **MWG 6:** Enabling access to financing – and 'cheap capital' – for SMR projects.
  - The methodologies developed in the context of this activity would serve primarily the *project designers and developers* end-users’ segment. They might also be of interest to *public sector decision-makers*.

- **Economic Competitiveness, Economic Impact**
  - The fourth key area of investigation, ‘Economics’, targets *public sector decision-makers* and covers two main topics:
    - **MWG 7:** Factory Fabrication Economics, Supply Chain and Localization Economics, and Circular Economy.
    - **MWG 8:** Macro-Economic Impact Assessment.
CRP Development Plan

S. Dardour, September 2022.
thank you!