



Striving to Streamline SMR Deployment

Nuclear Innovation Conference – 5-6 June 2024



PUBLIC



INTERNAL



RESTRICTED



CONFIDENTIAL

Key figures

60+ years

Responsible designer

28

Countries

>1,100

Nuclear Experts

€200M

Revenues

Responsible Designer* of the Belgian Nuclear Fleet

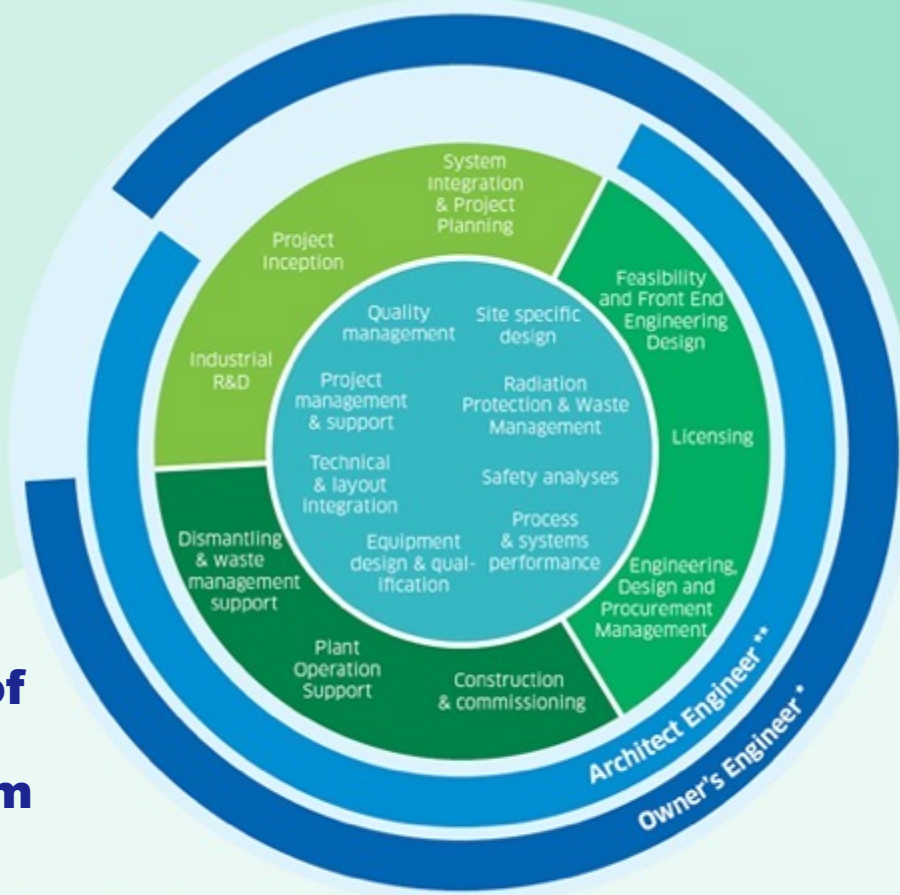
*The role of Responsible Designer means that the Conception, Design and Engineering of any modification to the Belgian Nuclear is handled by Tractebel and defended by Tractebel in front of the Safety Authorities



SMR developer looking for cutting edge expertise and a trustworthy partner for larger market deployment

Industrial R&D
End-to-end design & Constructability
Project planning & structuring
Operating Procedures

Tractebel vision of the emerging nuclear ecosystem



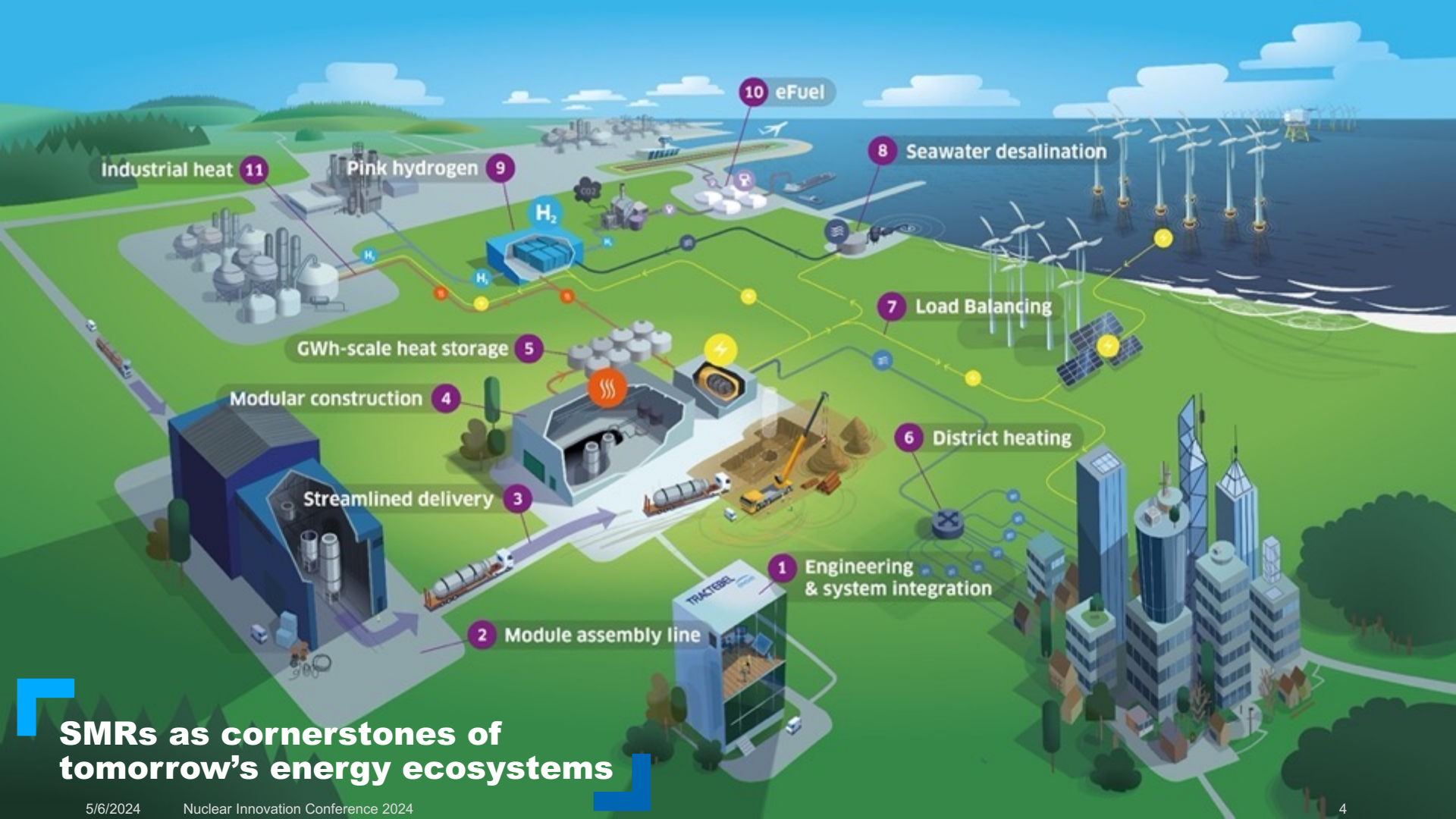
Utilities & industrial off-takers looking for options to decarbonise their assets

Master Planning
Technology assessments
Pre-Feasibility & Feasibility Studies
Technical & Regulatory Consultancy
Organizational development

Established nuclear operators looking for a competent partner to deliver projects on high-quality, time and budget



Due Diligence
Site selection & characterization
Environmental Impact Assessment & Licensing
Operational readiness
EPC Management



Industrial heat 11

Pink hydrogen 9

10 eFuel

8 Seawater desalination

7 Load Balancing

GWh-scale heat storage 5

Modular construction 4

6 District heating

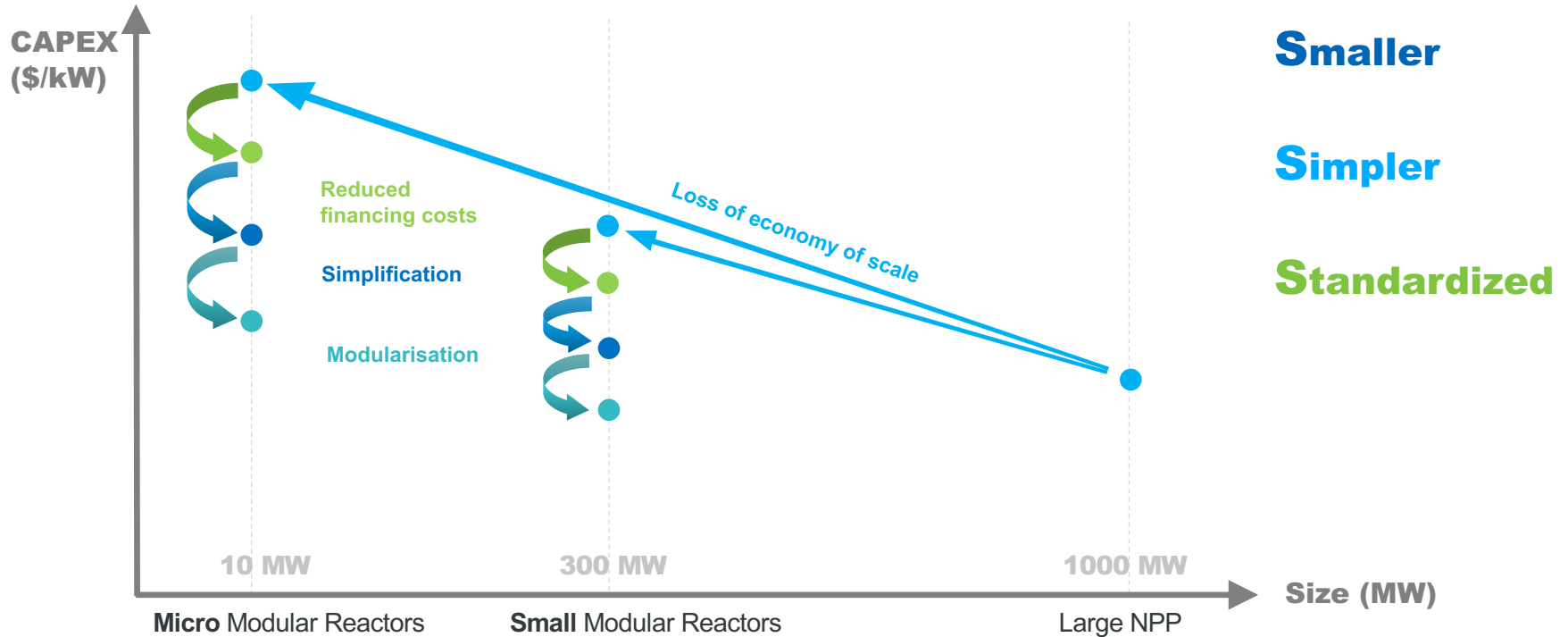
Streamlined delivery 3

1 Engineering & system integration

2 Module assembly line

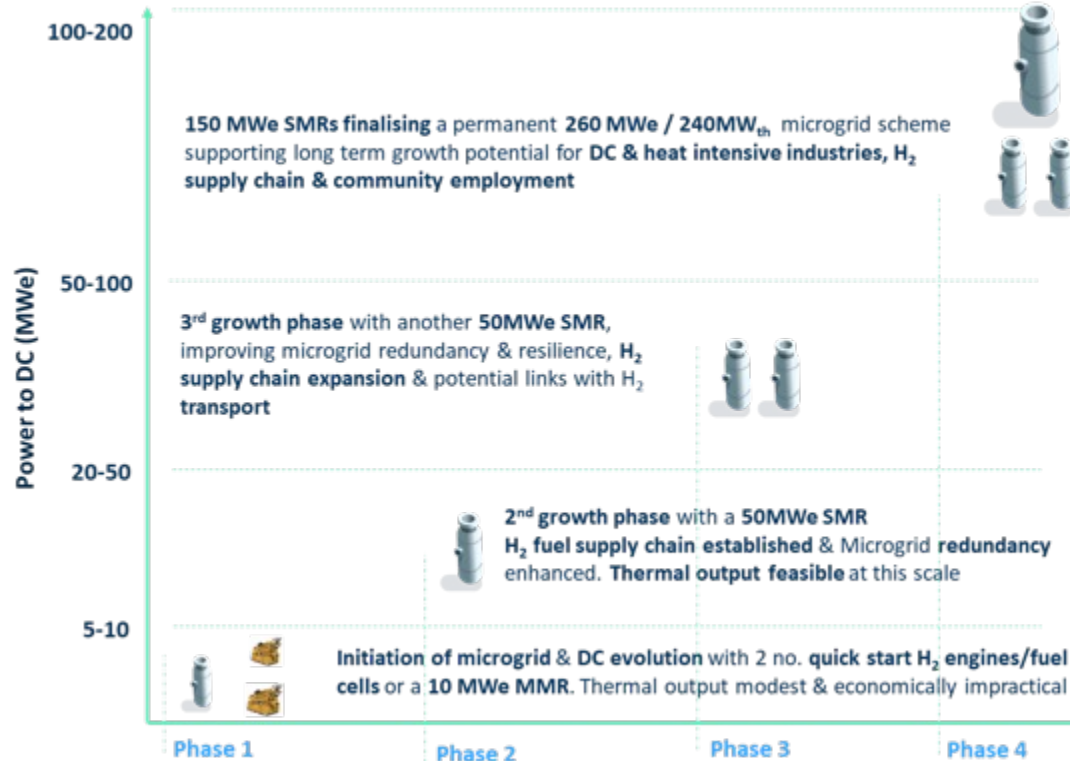
SMRs as cornerstones of tomorrow's energy ecosystems

How SMRs embrace the product-based approach?



An SMR-based Microgrid timeline supporting the gradual evolution of a DC within a wider industrial cluster

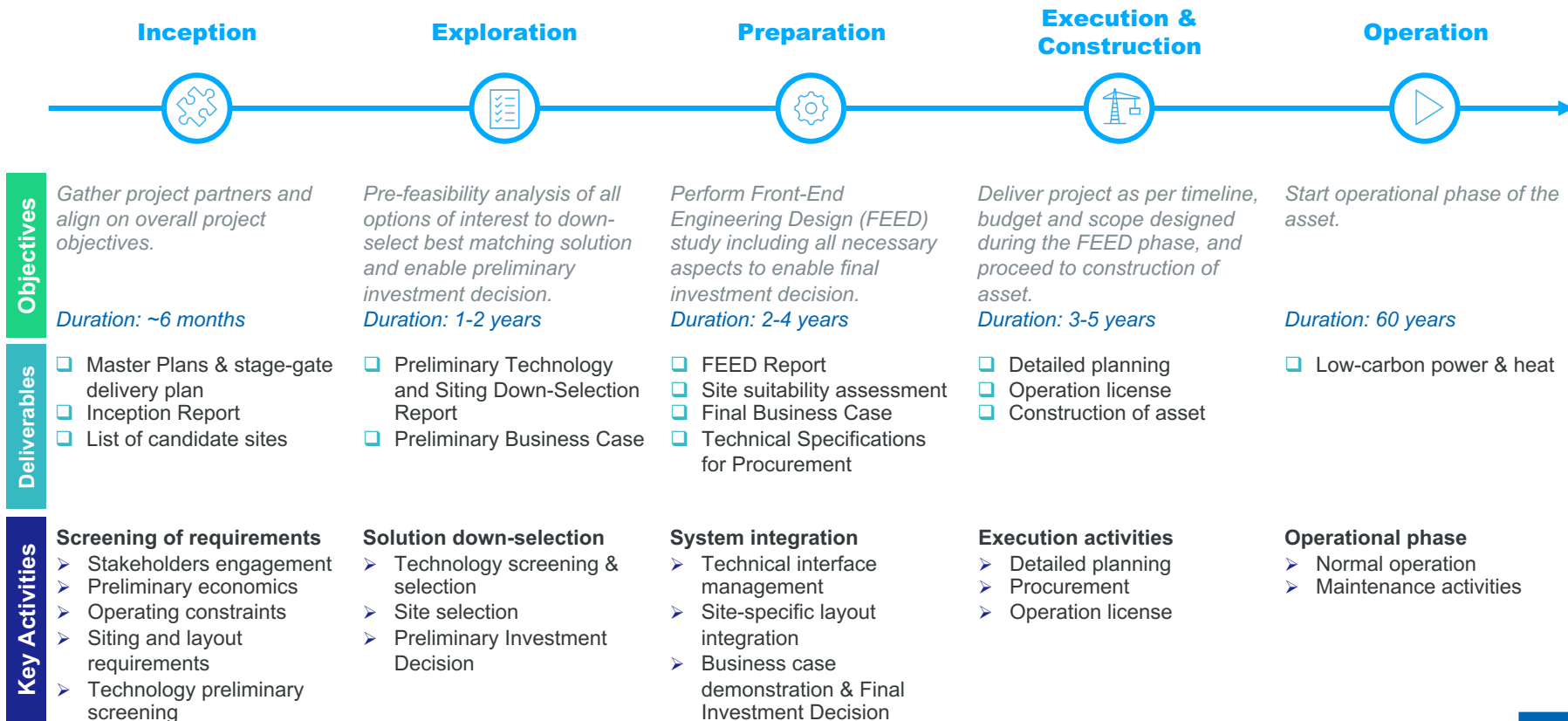
DC growth vector



Industrial Cluster Growth vectors



Typical Delivery Roadmap of an SMR project



Demand-driven case studies of multi-purpose SMRs:

Energy Vector

e⁻

Electrons



Hot water



Steam



Solar salts



Hydrogen



eFuel

Attributes

- | | | | | | |
|--|--|--|---|--|--|
| <ul style="list-style-type: none"> • Fungible • Grid (country) • Mature | <ul style="list-style-type: none"> • Locally mutualizable • Network (city) • Mature • 60-120°C | <ul style="list-style-type: none"> • Locally mutualizable • Local (industrial site) • Mature for non-nuclear • 150°- 580°C | <ul style="list-style-type: none"> • Local • Local (site) • Mature in CSP • 450°- 650°C | <ul style="list-style-type: none"> • Transportable • Network (region) • Maturing • Room t° - 950°C | <ul style="list-style-type: none"> • Transportable • Trade (world market) • Early pilots • Various |
|--|--|--|---|--|--|

Prospects

- | | | | | | |
|--|---|--|--|---|---|
| <ul style="list-style-type: none"> • Utilities (existing and emerging) • Fossil plants to be retrofitted | <ul style="list-style-type: none"> • Utilities • Cities | <ul style="list-style-type: none"> • Petrochemical clusters • Paper factories • Soda ash plants • Aluminium plants | <ul style="list-style-type: none"> • Industrial sites • High-penetration renewable hybrid system: ports... | <ul style="list-style-type: none"> • Steel mills • Fertilizers plants | <ul style="list-style-type: none"> • CO₂ deposits: limestone industries, ethylene oxide, bioethanol plants... |
|--|---|--|--|---|---|

Key pre-requisites

- **Industrial partners** for input parameter collection
- Inductive reasoning rather than deductive: generalise from specific case study

Collaboration opportunities

- Pre-project activities: financing schemes, regulations, licensing
- Local industrial partner canvassing (network mutualization)
- Technology developers: technology-related input parameters collection

Sequence to succeed in new projects

Getting SMRs as an option for decarbonization

Objective

Assemble project partners and align on overall project story

Analyze all options deemed to be of interest, screen them and aim at choosing an only to be developed during the Feasibility

Build-up on the most appropriate solution that has been extracted during PFS. Launch additional (survey) campaigns before FEED.

Provide the entire technical, commercial, legal permit, economic, operational, project and contractual requirements to enable partners to confirm FID of the development.

Deliver on time, on budget and on specifications the project designed within Front End Loading activities

We are here



Deliverables

- Master Plans
- Candidate sites
- Inception report
- Stage-gated delivery plan

Activities

Suitability requirements

- Operating constraints (availability, reliability, temperature regime...)
- Siting and layout requirements

SMR design screening

- Compatibility with requirements
- Candidate or representative design selection

Siting

- Site prioritization for further assessment
- Assessment of available land

System integration

- Technical interface management
- Site specific layout influence

Roadmap establishment

- High level overview of project phases and activities
- No-regret actions for first next phase

Tractebel SMR Digital Suite

Reducing barrier to entry for embarking private actors



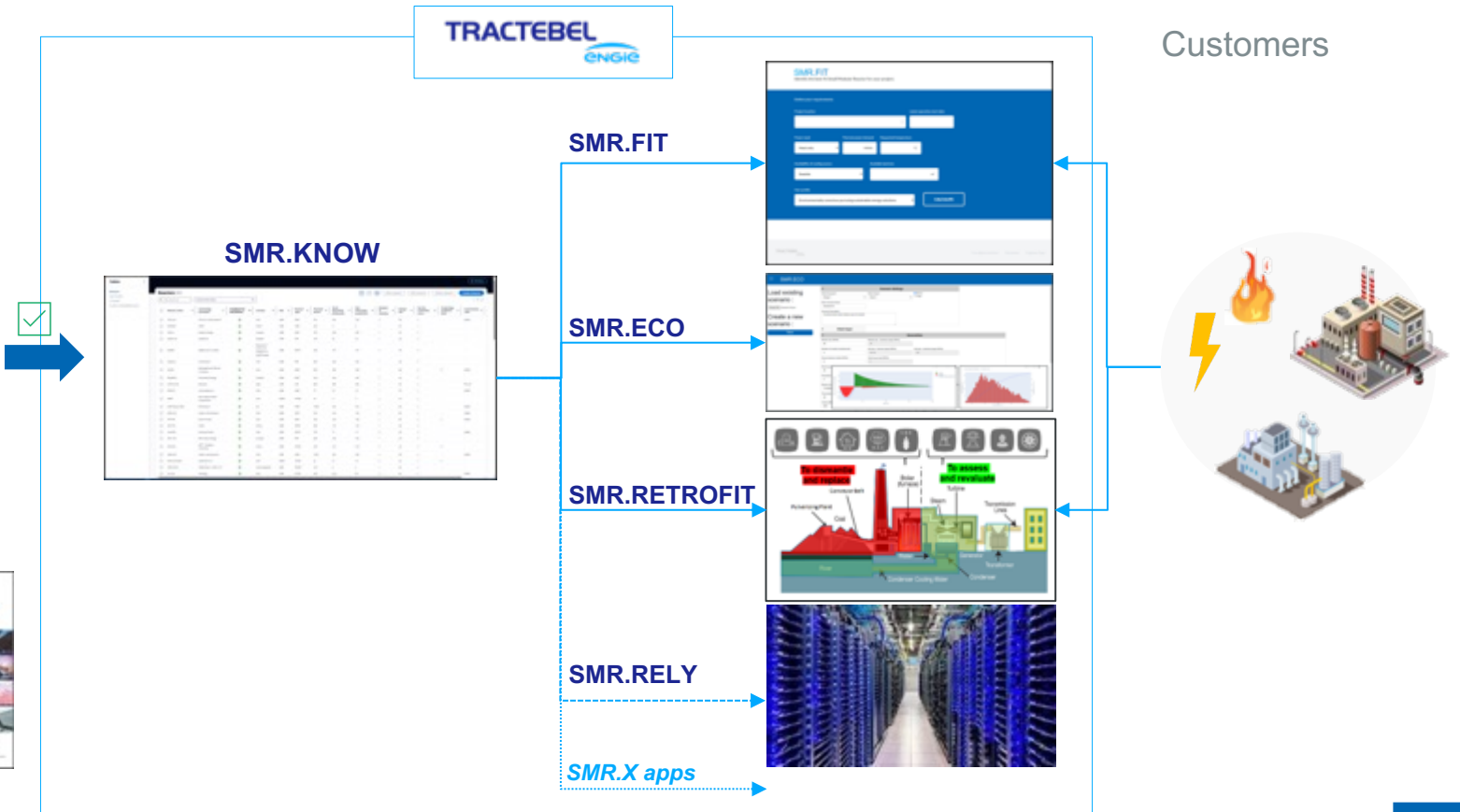
<https://digital.tractebel-engie.com/>



Tractebel SMR Digital Suite

SMR Vendors

- SMR technologies design data
 - From SMR vendors
 - From public sources (IAEA, NEA, etc)
- SMR projects information and key milestones



Customers



SMR.FIT

Identify the best-fit Small Modular Reactor for your project



For more information:
<https://digital.tractebel-engie.com/solutions/smr-fit/>

70+ SMR

1 User requirements

- Collect relevant data from user
- Establish assumptions, scenarios and associated list of requirements for SMR selection
- Define exclusion criteria
- Produce Request for Information for Vendors

2 Technology selection

1. Preliminary filter through **exclusion** criteria (e.g. no-passive safety...)
2. First pass high-level **multi-criteria** comparative assessment based on public information
3. Second pass detailed comparative assessment based on RFI

3 Integration with user

- Comparative analysis of lifecycle benefits (economics, carbon emissions)
- Site survey and selection based on vendor PPE
- Colocalization studies
- Deployment schedule

Critical Success factors

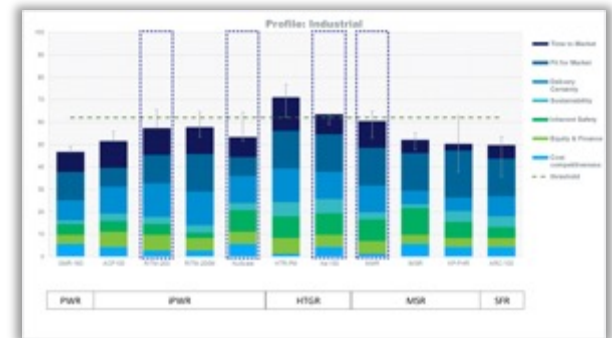


- **Safety**
- **Delivery certainty**
- **Public acceptance**
- **Equity & Finance**
- **Cost-competitiveness**
- **Time-to-market**
- **Sustainability**
- **Fit-for-purpose**

Top 5



Automated Raking Process based on Project/Client specificities



Extensive SMR Design Database



SMR.ECO

Assess the profitability of your Small Modular Reactor project

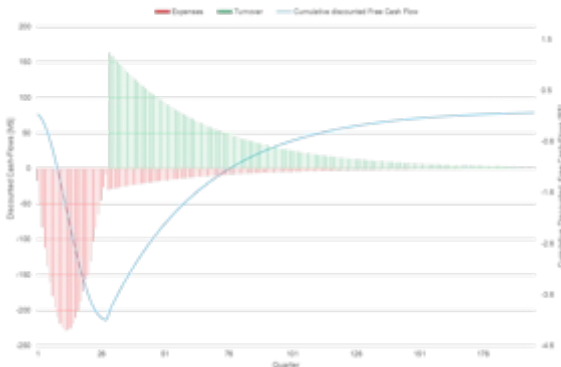
Input

Inception	
One-digit Cost Category examples	
Code	Category
10s	Pre-Construction Costs
20s	Direct Costs
30s	Indirect Services Costs
40s	Owner's Costs
50s	Supplementary Costs
60s	Financial Costs
70s	O&M Costs
80s	Fuel Costs
90s	Capital Costs

Feasibility	
Two-digit Cost Category examples	
Code	Category
21	Structures and improvements
22	Reactor equipment
23	Turbine Generator Equipment
24	Electrical Equipment
25	Heat Rejection System
26	Miscellaneous Equipment
27	Special Materials
28	Simulator
29	Contingencies

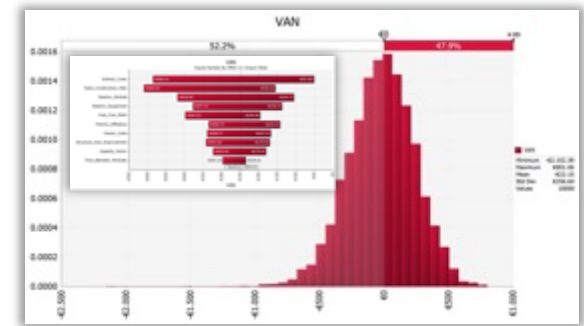
Investment Decision	
Three-digit Cost Category examples	
Code	Category
221	Reactor equipment
222	Main Heat Transport System
223	Safety Systems
224	Radioactive Waste Processing Systems
225	Fuel Handling Systems
226	Other Reactor Plant Equipment
227	Reactor Instrumentation and Control (I&C)
228	Reactor Plant Miscellaneous Items

Output



SMR.ECO determines the Levelized Cost of Energy (LCOE) for Small Modular Reactors.

For more information, visit: [SMR ECO - Tractebel Engie Digital Solutions](#)



PUBLIC



Engineering a carbon-neutral future



TRACTEBEL
ENGIE

The rise of nuclear technology 2.0

Tractebel's vision on Small Modular Reactors

Tractebel Business Line/Nuclear | December 2023



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RED

Powering the 4th industrial age

Forging a Data Centre Partnership with Advanced Nuclear Technologies

