

**TRACTEBEL**



**ABDAN**

Associação Brasileira  
para Desenvolvimento  
de Atividades Nucleares

# Perspectives on Small Modular Reactors (SMR)

10/03/2021



PUBLIC



INTERNAL



RESTRICTED



CONFIDENTIAL



# Responsible Designer of the Belgian Nuclear Fleet

## Key figure

**60+ years**

Responsible designer

**28**

Countries

**1,000**

Employees globally

**€180M**

Revenues

# Tractebel at a glance

Integrated vision of the energy landscape





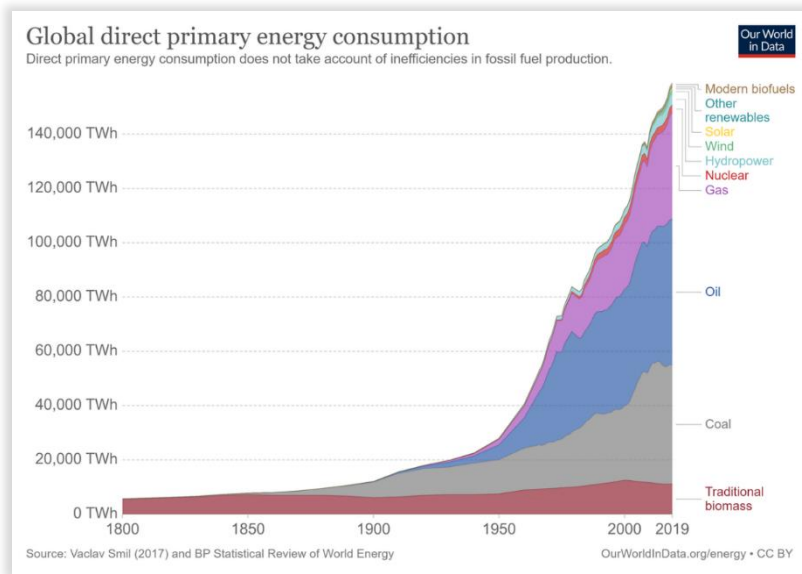


**Technologies have always emerged to address a given context, by building upon the existing technologies of their time**

# XX<sup>th</sup> century context: the two drivers

## The drivers for current operating fleet of reactor

### Past Driver #1: Need for abundant energy



### Past Driver #2: Price stability & security of supply



Archive image from 1973 oil crisis

# XXI<sup>th</sup> century context [2/2]

## New drivers for new nuclear technologies

### Today Driver #1: recreate trust in nuclear safety

**wnn**  
world nuclear news

Energy & Environment | New Nuclear | **Regulation & Safety** | Nuclear Policies | Corporate | Uranium & Fuel | Wa

### Second explosion rocks Fukushima Daiichi

14 March 2011

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First published: 3:08am GMT

UPDATE 1: 3:25am Addition of background information

UPDATE 2: 3:49am Technical details on pressure

UPDATE 3: 4:34am Injuries, radiation rates and pressure data

UPDATE 4: 12:00pm Subsequent radiation readings

UPDATE 5: 7:06pm Change of headline from Explosion rocks third Fukushima reactor

**Another hydrogen explosion has rocked the Fukushima Daiichi nuclear power plant, this time at the third reactor unit. Initial analysis is that the containment structure remains intact.**

### Today Driver #2: Alleviate the fear of nuclear waste being a burden for future generations





# Technology?

## From a constraint...



Apollo Guidance Computer, **0.043MHz** clock speed. Image: NASA

# Back to the Future

Doel 1/2 & Tihange 1 construction in the 70s... with pencils & paper



Doel 1 & 2



Tihange 1



# Technology?

## To a leverage

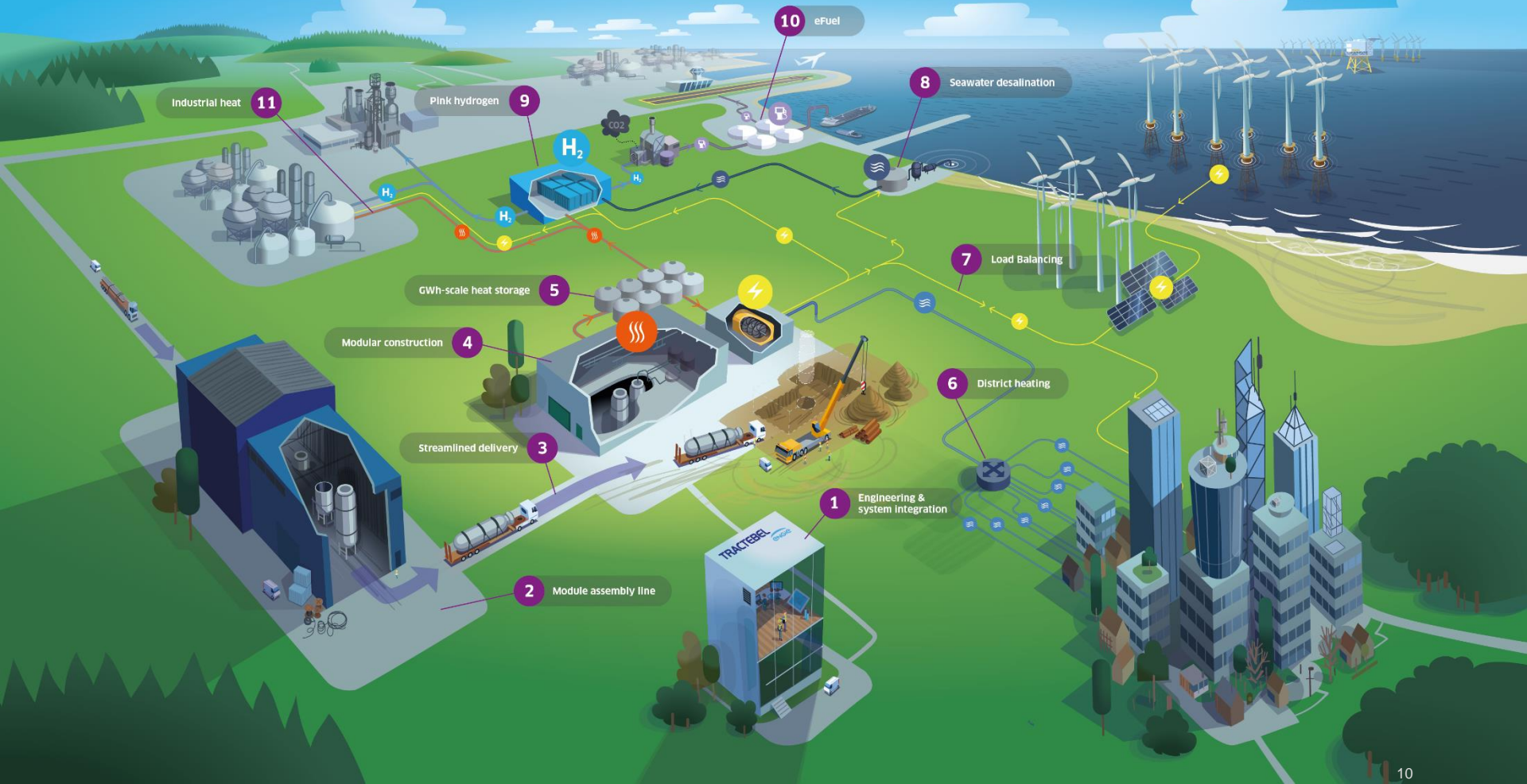


Apollo Guidance Computer, **0.043MHz** clock speed. Image: NASA



Samsung Galaxy S20, **2.73GHz** clock speed. Image: David Imel / Android Authority

# Tractebel's Vision for Small Modular Reactors



# To deep-dive the question of SMRs

## Tractebel White Paper

<https://tractebel-engie.com/files/attachments/.3456/Tractebel-The-rise-of-nuclear-technology-2-0.pdf>



**Chapter 1 - The vibrant international race for Advanced Nuclear**

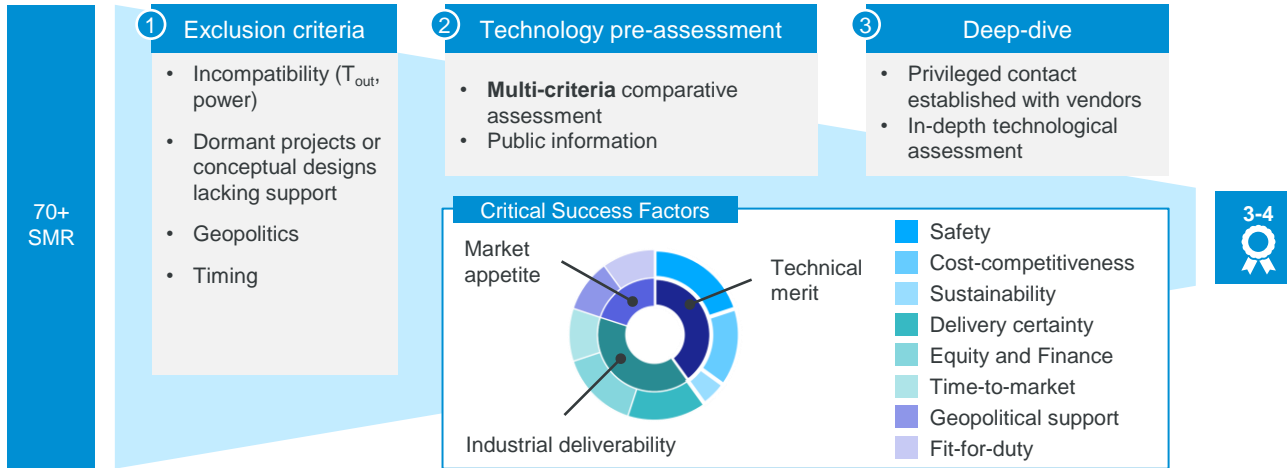
**Chapter 2: Beyond Baseload electricity production**

**Chapter 3: European Heat Market**

**Chapter 4: Low-carbon Hydrogen for eMolecules**



# How to know which technology make sense for *your* needs?



# Nuclear Energy Beyond Electricity Generation

>500 TWh/y

Of final energy Consumption  
from Brazilian Industry

Of which **2/3**

Are non-electric consumption

Source: IEA, Brazil country profile,  
2021

>280 Mt H<sub>2</sub>/y

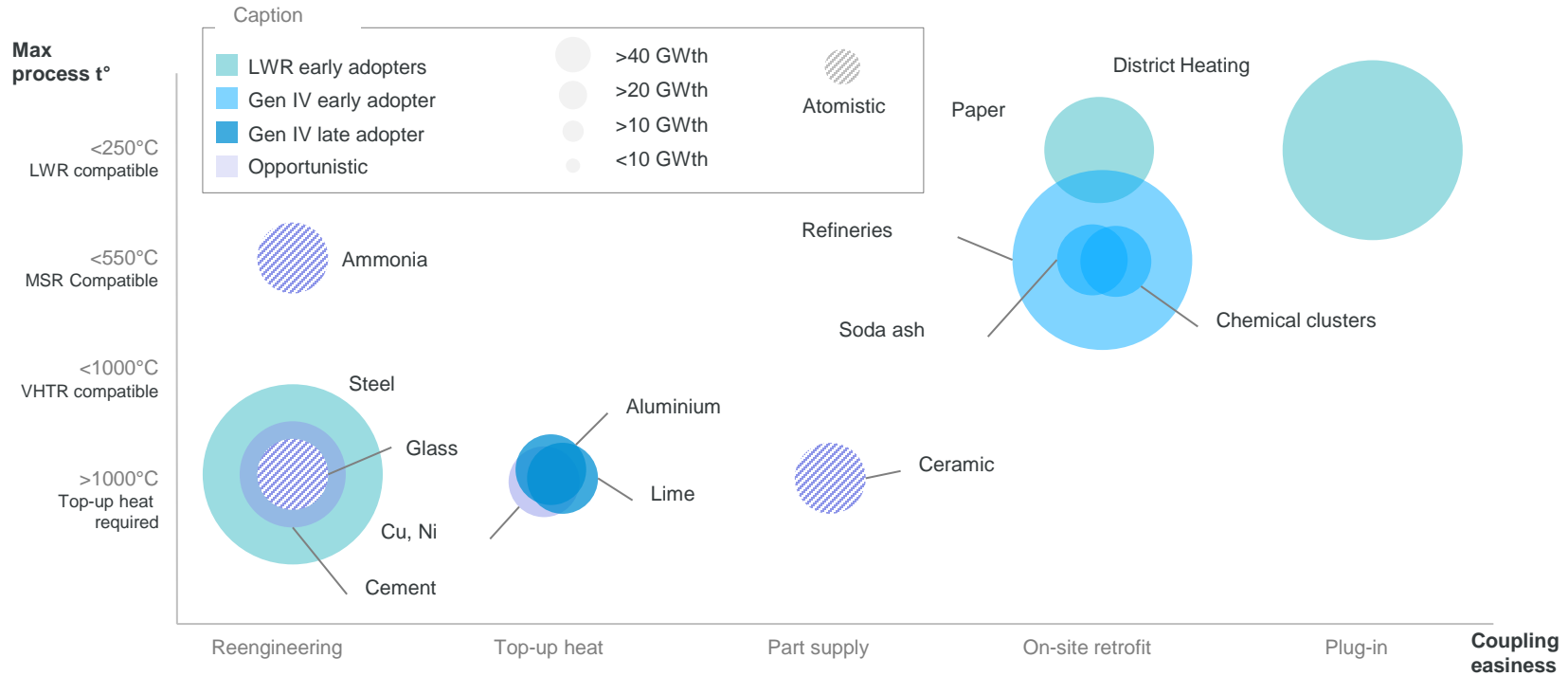
Worldwide Market Estimate  
for 2050

>5500 TWh<sub>e</sub>/y

Clean electricity estimate to  
produce half of that hydrogen

Source: IEA – Energy Technology  
Perspectives 2020, September 2020

# Industrial sectors affinity with SMR-based co-generation

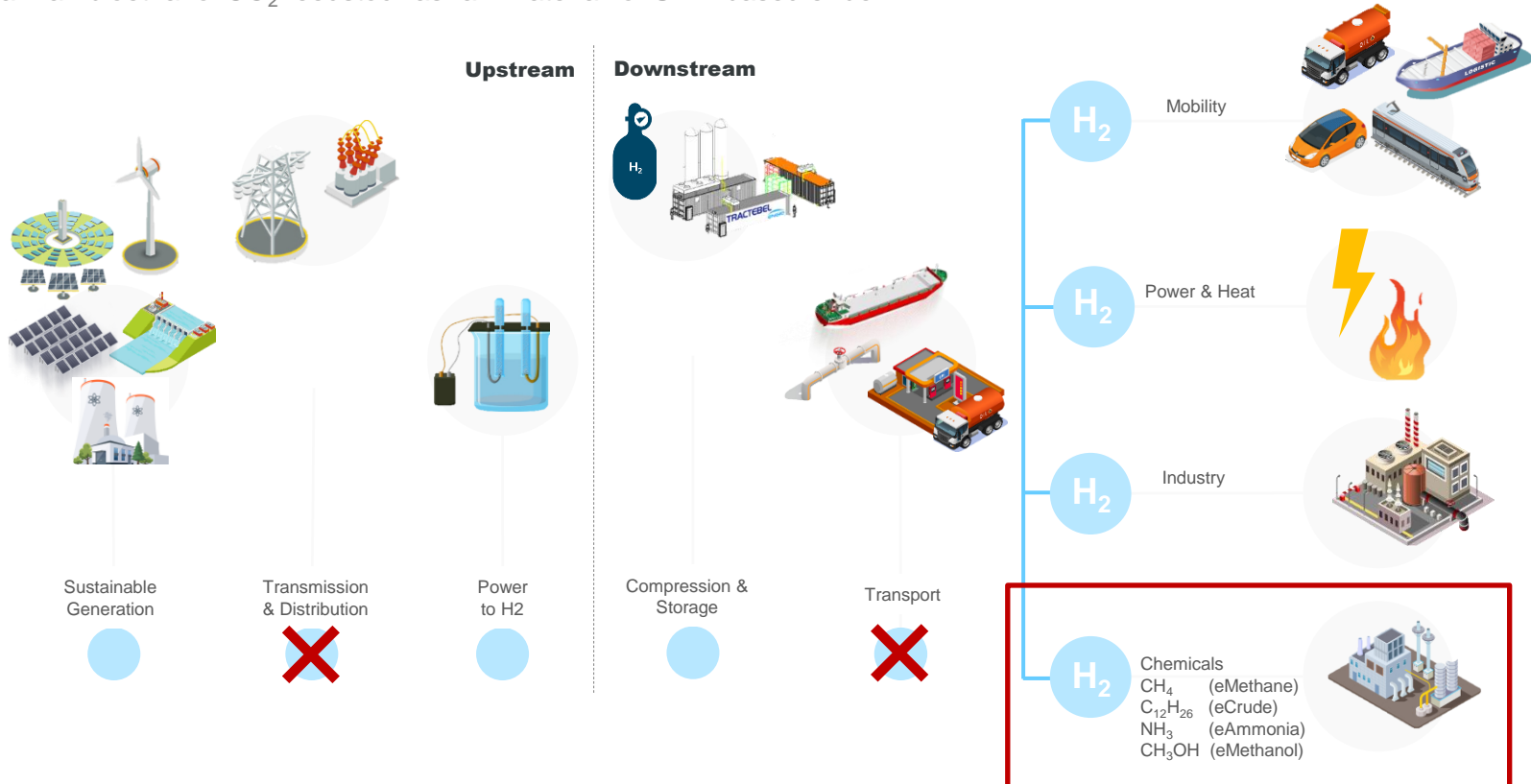




# Zoom on H<sub>2</sub> market potential for SMR

## Identifying business models when breaking-down value chains

Brazilian bioethanol CO<sub>2</sub> feedstock as raw material for SMR-based eFuel?



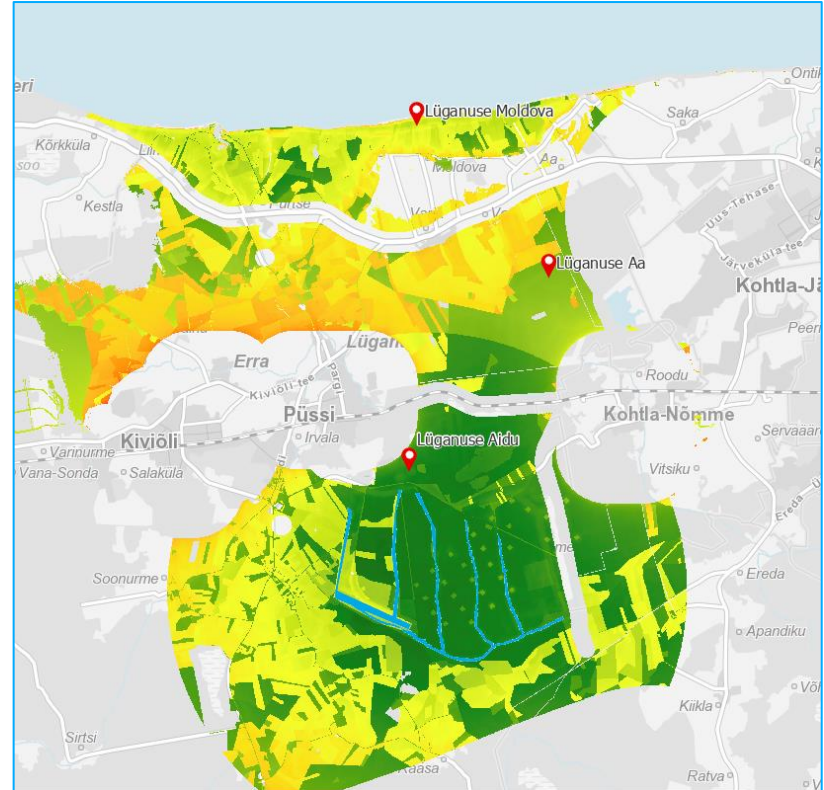
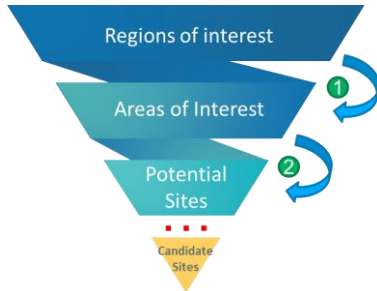
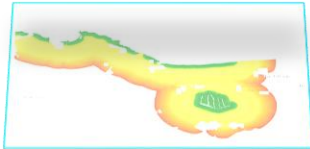
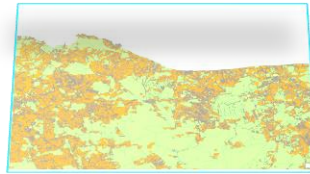
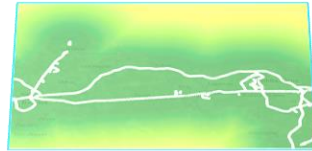
## A Gis Suported Site Selection Procedure for SMRs

Case study: Fermi Energia in Estonia

**IAEA Safety Standards**  
for protecting people and the environment

Site Survey and Site Selection for Nuclear Installations

Specific Safety Guide  
No. SSG-35



# Sequence to succeed in new projects

## Getting SMRs as an option for Industrial Applications: starting point

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



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

### System integration

- Technical interface management
- Site specific layout influence

### Business case demonstration

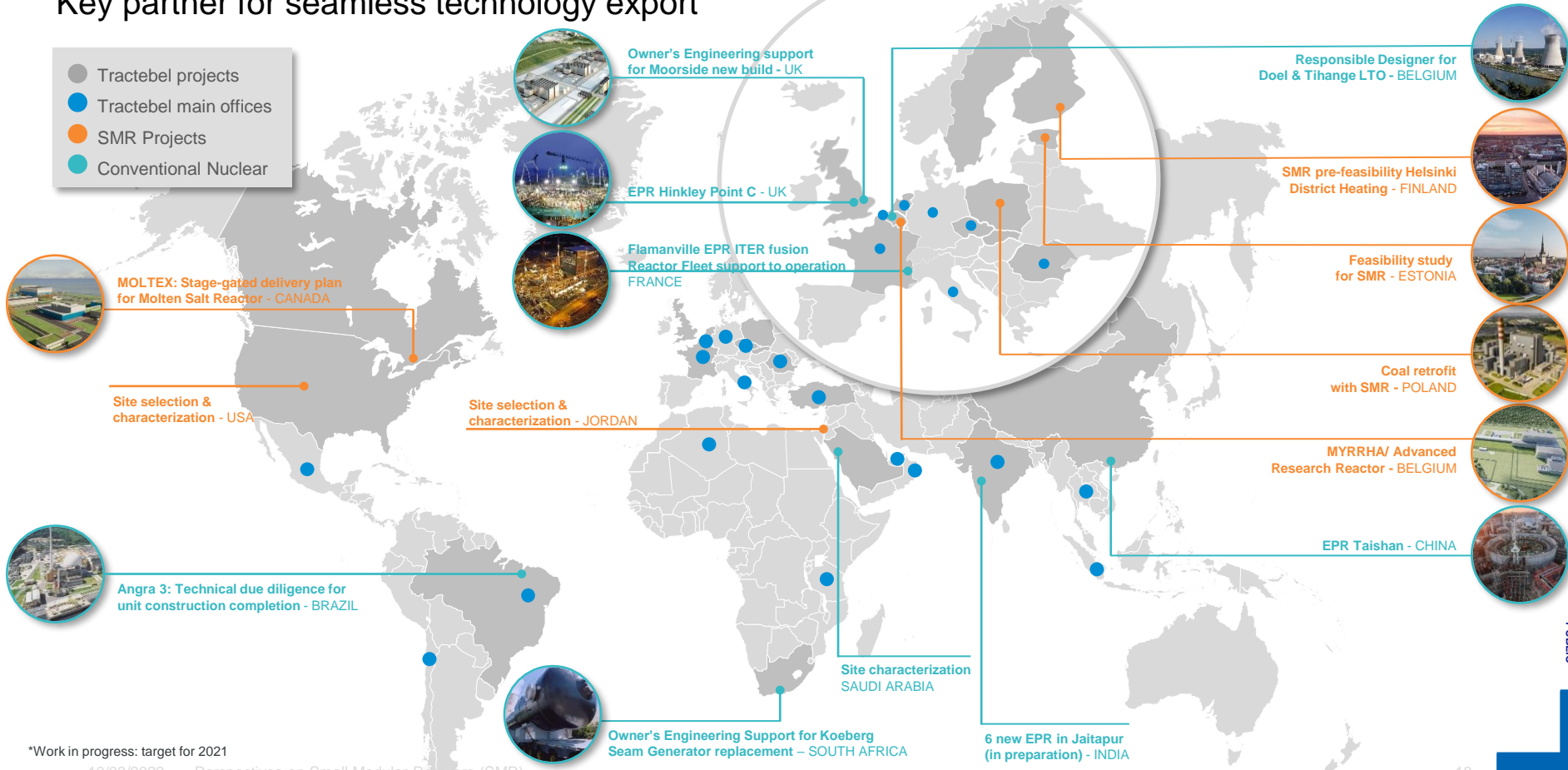
- Stakeholders structure
- Offtake strategy
- Finance & premium opportunities



# Tractebel's international footprint

Key partner for seamless technology export

- Tractebel projects
- Tractebel main offices
- SMR Projects
- Conventional Nuclear



\*Work in progress: target for 2021

# Coal retrofit with SMR in Poland

Sites assessment of two coal power plants in Poland for suitability of retrofitting with SMR solution

CLIENT	<b>SYNTHOS Green Energy</b>
LOCATION	<b>Poland</b>
PERIOD	<b>2020 – on-going</b>
SERVICES PROVIDED	<b>Site description - First assessment of site suitability</b> <b>Plant description - Understand and assess the existing plant:</b> <ul style="list-style-type: none"><li>• <b>Systems and components</b></li><li>• <b>Plant output and performance</b></li><li>• <b>Residual lifetime and environmental permits</b></li><li>• <b>Layout</b></li><li>• <b>End-User requirements and constraints</b></li></ul> <b>Scenarii definition &amp; comparative assessment and recommendation for executable SMR solution</b>





# Small Modular Reactor Pre-feasibility for Industrial Applications

Pre-feasibility guidance for SMRs as an option to decarbonize two chemical production assets (US & EU)

CLIENT

**WORLD LEADER IN  
CHEMICAL INDUSTRY  
US & EU**

LOCATION

PERIOD

**2021 – on-going**

SERVICES  
PROVIDED

**Definition of suitability requirements  
for the two chemical assets**  
**SMR technology evaluation and down-  
selection**  
**System integration and project specific  
design**  
**Roadmap For SMR Deployment**



# Tractebel Value Proposition



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

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

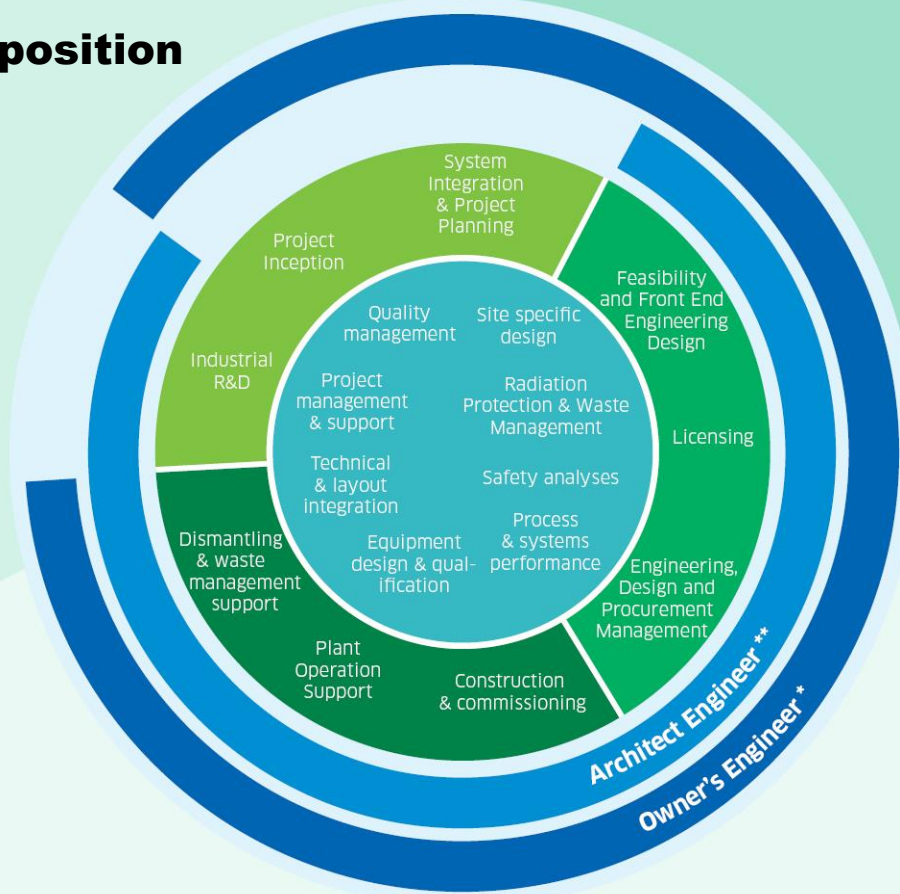


Due Diligence  
Site selection & characterization  
Environmental Impact Assessment & Licensing  
Operational readiness  
EPC Management



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

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





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