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The EU Nuclear Supply Chain and its perspectives on SMRs

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Chairman of the Board

Outline

- The expected European Market
- The SMR Business Model
- The European Supply Chain
- The Resilience of the Italian nuclear supply chain

What kind of nuclear market in Europe in the next decade?

- The market will be largely growing under the pressure of two main drivers:
  - European policies towards Sustainable Energy
  - Energy security concerns

- Investments in New Builds (both large and small size reactors) will happen
  in the same time frame
  throughout many European countries

- The transnational links in Europe have been reinforced after the Fukushima accident (EU directives, peer reviews, cooperation among national regulators…)

- No longer national markets, but a single, even articulated, European market

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Market sizing

- Current decarbonized energy in Europe accounts for 1650 TWh*
- By 2050, additional 1700 Twh are needed to meet Net Zero targets*
- Taking into account the replacing of older NPPs (80 GW), the Nuclear Alliance is presently indicating a target of 150GW new nuclear plants
- A growth rate in the range of 6 GW/year, even if already achieved in the 70ies, represents a significant challenge for the European Supply chain
- SMR could contribute, in various scenarios, in the range of 30-60 GW

** as per recent studies from EU SMR Prepartnership*

SMR: what are they going to change?

- SMR competitiveness shall be pursued through a number of substantial changes to the current approach for large plant design & construction
- ***Standardization*** will be a must, in order to achieve the economical benefits deriving from series production
- Not only standard plant design, but also *standard components*, so to limit tailorization of the detail design (e.g. phisical interfaces, piping stress analysis, operational procedures) and possibly to implement modular construction
- But…*standardization can conflict with maximizing localization*, which often results in concessions to Country customized choices

SMR: what are they going to change? (cont.)

- To meet the electricity demands through a larger number of smaller reactors, a *higher number of components* would likely be necessary
- This will further augment the ***additional capacity*** required from the supply chain
- Furthermore, ***serial production of critical components*** would likely require dedicated factories
- This would result in a quite different organization of the production facilities from the current project-based approach: e.g. *stock production*, to shorten plant delivery times

Business as usual?

The historical approach of the main Vendors (not only Western ones) to nuclear projects in most European countries:

- exporting their domestic projects (sometime even their licensing frame)
- approaching each opportunity as a Specific Project
- localization based on existing capabilities in the target Country
- for those parts which cannot be localised, preferential use of the domestic supply chain

…..Not anymore!!!

- The contemporary demand for new nuclear plants in Europe is going to create *capacity bottlenecks*, which can be solved only by maximizing **synergies among the various supply chains**, both in
  - exploiting the currently available capacity, and
  - planning investments for further capacity

- As Europe is evolving towards a single market place, **consensus shall be created** not only at country level but also **at European level**: involvement of various suppliers from different countries is instrumental *to spread the social return throughout Europe*

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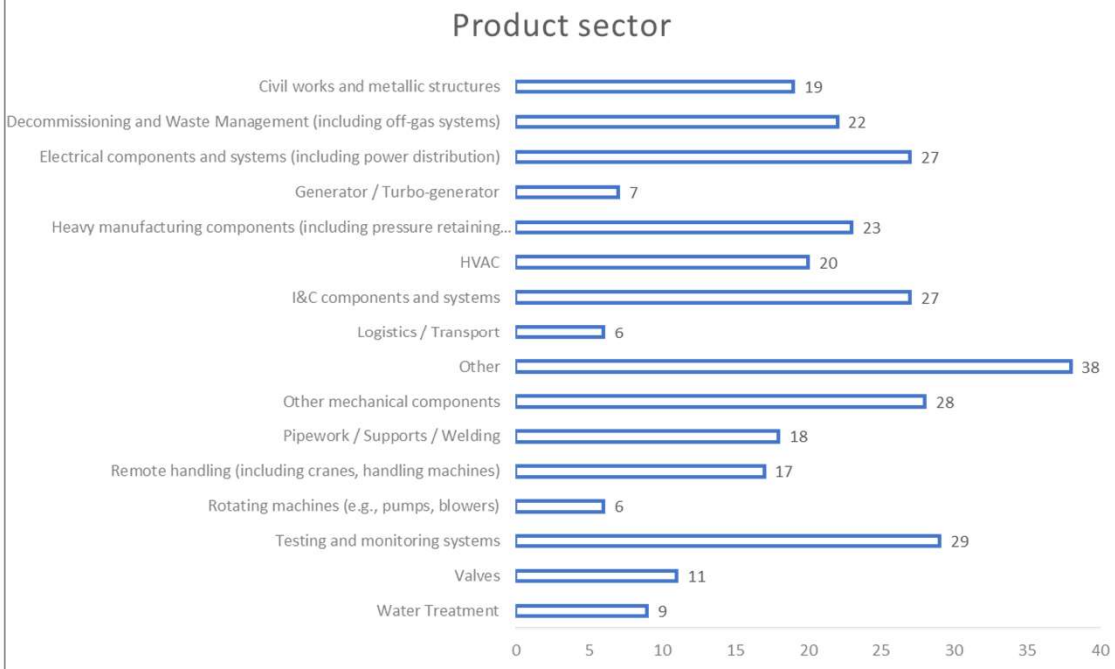
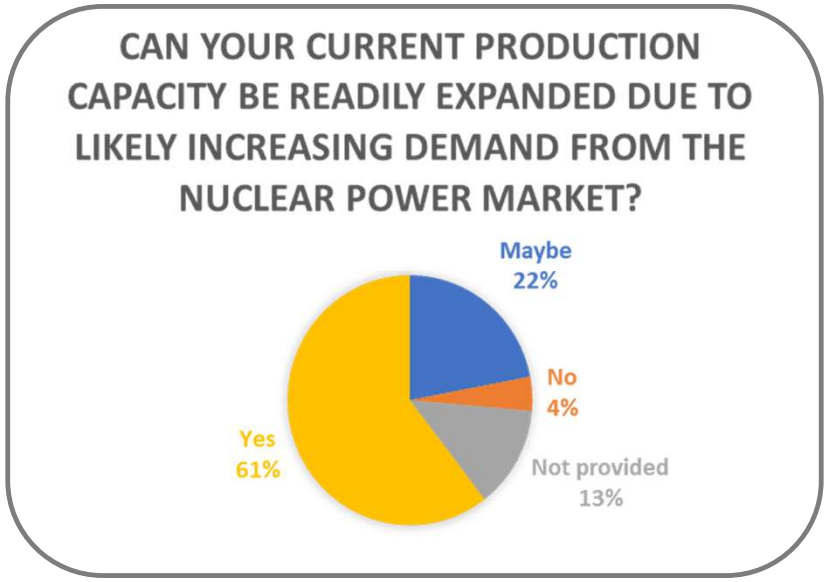
The current status of European supply chains

Some results from the SMR Pre-Partnership study on Supply Chain Adaptation

❑ *Extended capability, limited capacity*



❑ *Available to invest in new capacity, if needed*



A new business approach

- Competitiveness of future NPPs will be pursued through series effects
- Large part of these effects materialize in the Supply Chain
- Need to transfer the benefits to the final Customers

WIN/WIN Partnerships between Vendors and Suppliers

- ***establish a Supply Chain from the early stages***, giving the suppliers the chance to optimize their contribution
- ***provide visibility*** of the broader market, stimulating investments
- ***promote synergies*** among various suppliers

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Industrial models for SMR delivery

Make option
Strategic partnerships aiming to consolidate critical supplies

- Secure some supply chain capacity
- Limited risk transfer
- Transactional spirit

Make and buy option
Strategic partnerships aiming to lead wider supply chain on main packages of work

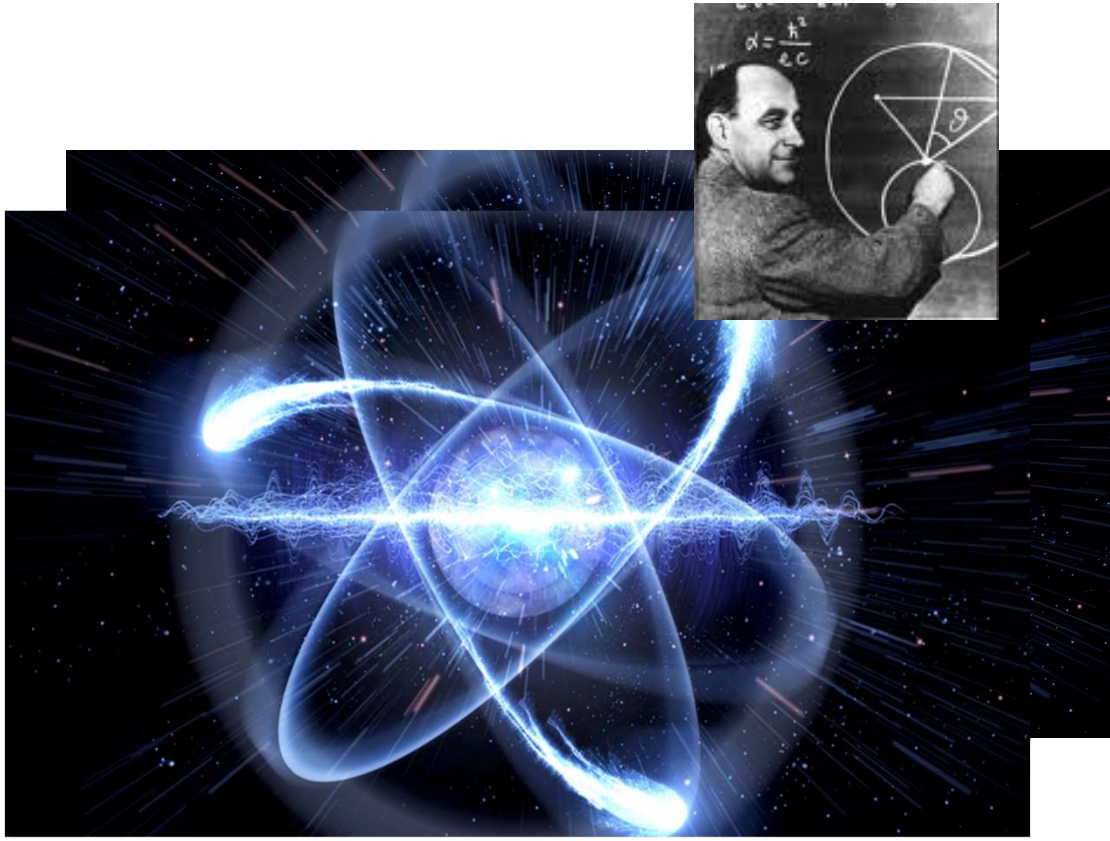
- Secure a wide industrial support
- Transfer of partial risks (industrial/manufacturing)
- Access to long term skilled suppliers

Tier 1 partner
Strategic partnerships aiming to erect, deliver, commission portion of the plant

- Secure the trans-national political support
- Support to international development
- Support to international delivery

What about Italy ???

- Most people (including Italians) think that a country which abandoned nuclear generation almost 40 years ago has little to say in terms of industrial capacity in such a sector.
- Nothing could be more wrong.
  As of today, the Italian nuclear supply chain is ready to provide a qualified contribution to the success of upcoming EU programs.



A history of resilience

Full-life costs of decom: 7.9 b€
Forecast to completion (‘35): 2.3 b€
IT SOGIN qualified suppliers: 700+

Tot. vol. of waste: 95 000 m^3 (82% LLW)
Invest. for National Repository: 1.3 b€
National repository footprint: 150 hectars

Occupational benefits
- 4 000 resources during construction
- 700 resources during operation

New build opportunities and power upgrade or plant life extensions abroad:

- 1983-96 – Cernavoda Unit 1 construction
- 2001-07 – Cernavoda Unit 2 construction
- 2009-18 – Westinghouse AP1000 in Sanmen
- 2008-13 – Mochovce NPP completion
- 2016-19 – Embalse power upgrade
- 2017-24 – Hinkley Point C
- 2017-23 – Krsko safety upgrade

ITER Total Budget (1) 21

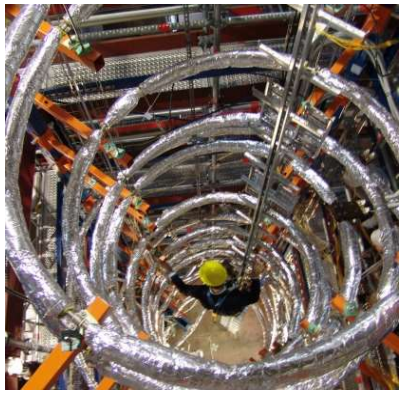
ITER Construction Budget 15

7,2 Awarded Tenders

1,6 Tenders awarded to Italian Industry

40 years at the forefront of passive safety

170 m3 pool hosting PCC hex



FOAK HCSG

SIET
sperimentiamo le tue idee

3 Dec. 2013,
SIET conformity to
10CFR50 App. B

ENEA

VAPORE facility
Designed by Ansaldo in 1985 to test spargers for depressurization systems

Op. pressure: up to 180 bar
Op. temperature: up to 357°C
Steam flow rate: up to 300 kg/s

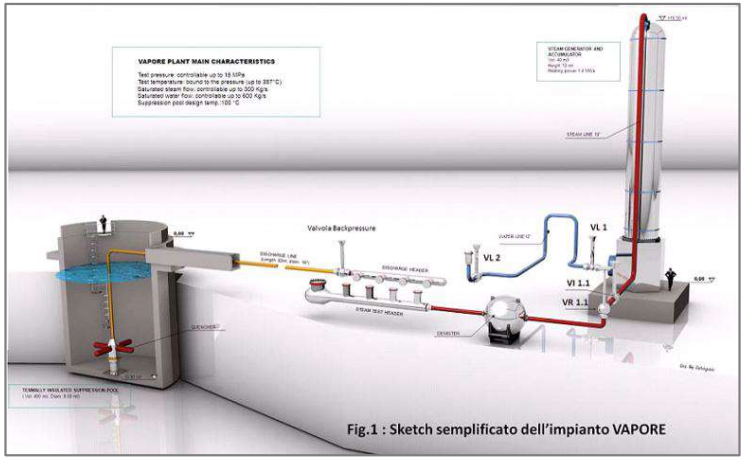
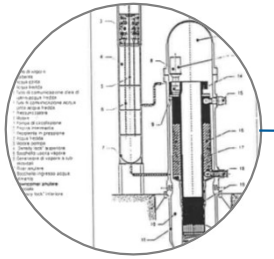


Fig.1 : Sketch semplificato dell'impianto VAPORE

1980s Prototypes of advanced passive systems

1990s Support to AP600 design certification



2000s Early concepts of integral SMRs

2011 Supply of AP1000 passive residual heat removal HX

2016 From design to commissioning of AP1000 FOAK Metal Containment

Pioneering LFR technology

Dedicated line of research on LFR technology:	FYs 2006-2018
Total national funding to date:	20+ M€
Total EURATOM funding to Italian organizations:	10+ M€
PhD scholarships:	50+
Technical deliverables:	200+

Synergic development effort:

- Academia: CIRTEN
- Research centers (ENEA as leading player): IIT, CSM, CRS4
- Industry: Ansaldo Nucleare, SRS Srl, CrioTec, Greenpumps, ATB Riva Calzoni, Mangiarotti among the main ones.

RACHELE lab scale

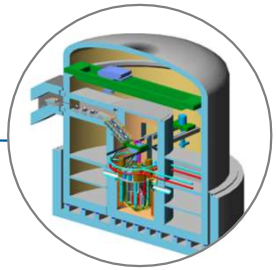
HELENA loop type facility

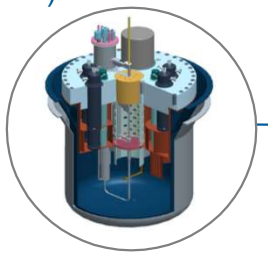
CIRCE pool type facility

1980s Co-development of Superphenix (LMFBR)

First sudies of subcritical systems (Energy Amplifier by Nobel C. Rubbia)

1990s





2000s Long lasting collaboration with EU HLM community

Strong involvement in EURATOM funded projects

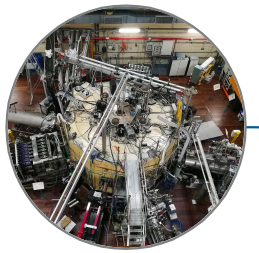
2010s

ESNII
European Sustainable Nuclear Industrial Initiative

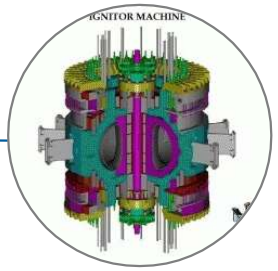
2020s Experimental infrastructure supporting the technology developmet

Opportunities in Fusion

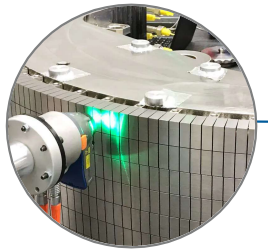
Vacuum Vessel for ITER reactor in Cadarache
Contract started in 2010
Total budget: 250+ M€
Consortium: Ansaldo Nucleare (Leader), Mangiarotti, Walter Tosto
More than 120 active sub suppliers during the whole project lifetime



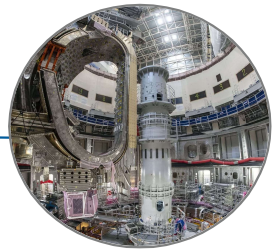
1990s — FTU in Frascati, design and engineering for JET in UK



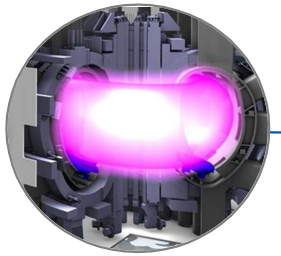
2000s — Engineering and design of IGNITOR (high field Tokamak)



2000s — Prototypical components for ITER in Cadarache



2010s — High tech supplies for ITER in Cadarache



2020s — Engineering and design of DTT in Frascati

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A competitive, high quality Supply Chain

Tectubi and IBF serving the French fleet

Oct. 2021 — Stress corrosion cracking discovered in safety injection lines of French reactors

Summer 2022 — 32 reactors out of 56 were off-line in the middle of the EU energy crisis (gas prices peaking at 350 €/MWh)

2022 — EDF's generation dropped to 279 TWh (almost 20% less than in 2021)

May 2023 — All incriminated piping repaired and reactors back on-line

EDF massive strategy of preventive replacement of the sensitive pipe sections

Massive need of forged austenitic stainless pipes (safety calss 1)

TECTUBI RACCORDI S.p.A.

Italian company with 50+ years in the production of fittings, supplying EPR and AP1000 in compliance with ASME Sect. III NCA 3800, China NNSA and RCC-M

IBF TUBACEX GROUP

Italian company with 40+ years experience in the production of fittings and special components, supplied for Westinghouse AP1000 reactors in China and USA

Italian supply chain surveyed in the EU SMR pre-partnership

11 Organizations

50%
With a turnover of 50-100 M€
With a workforce of 100-1000 employees

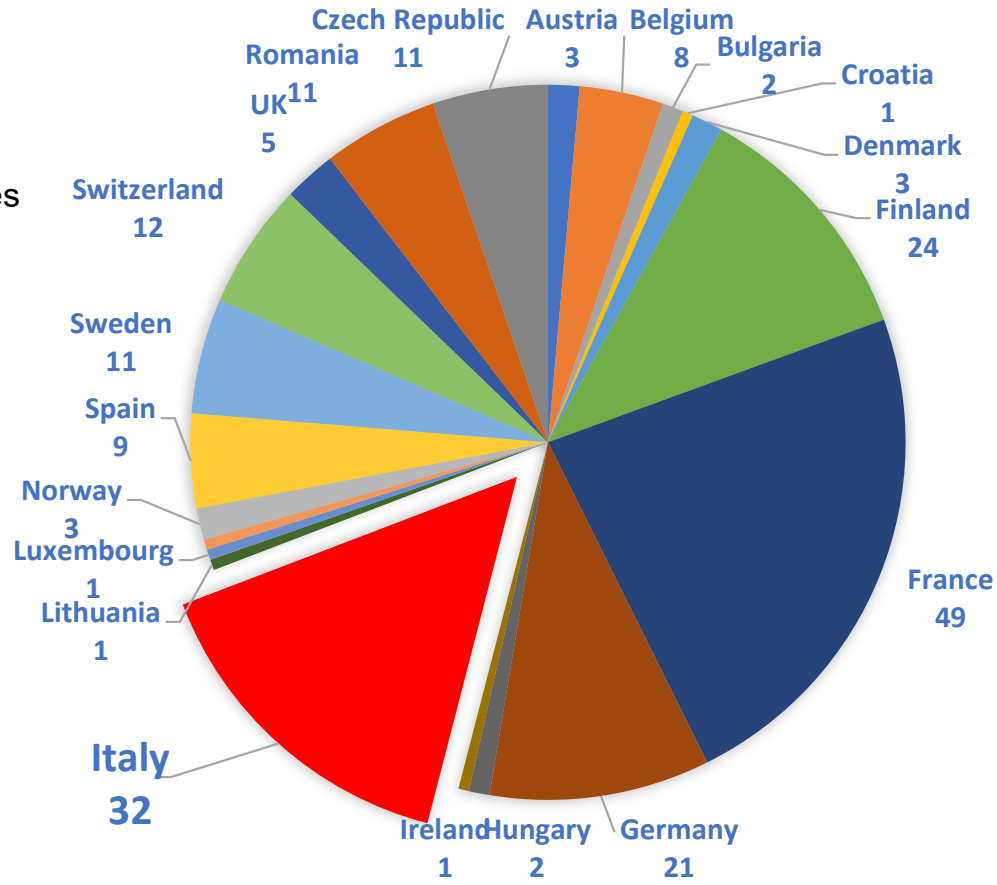
66%
Could rapidly expand their production capacity

50% knowledgeable of PWR technology

80% knowledgeable of more than one technology

75%
ASME and/or RCC-M

35%
IEEE and/or IEC



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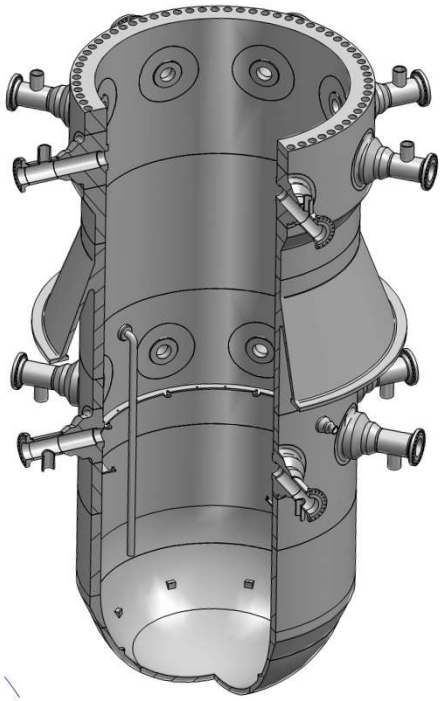
Italian nuclear supply chain for SMRs

Business case on RPV Main data

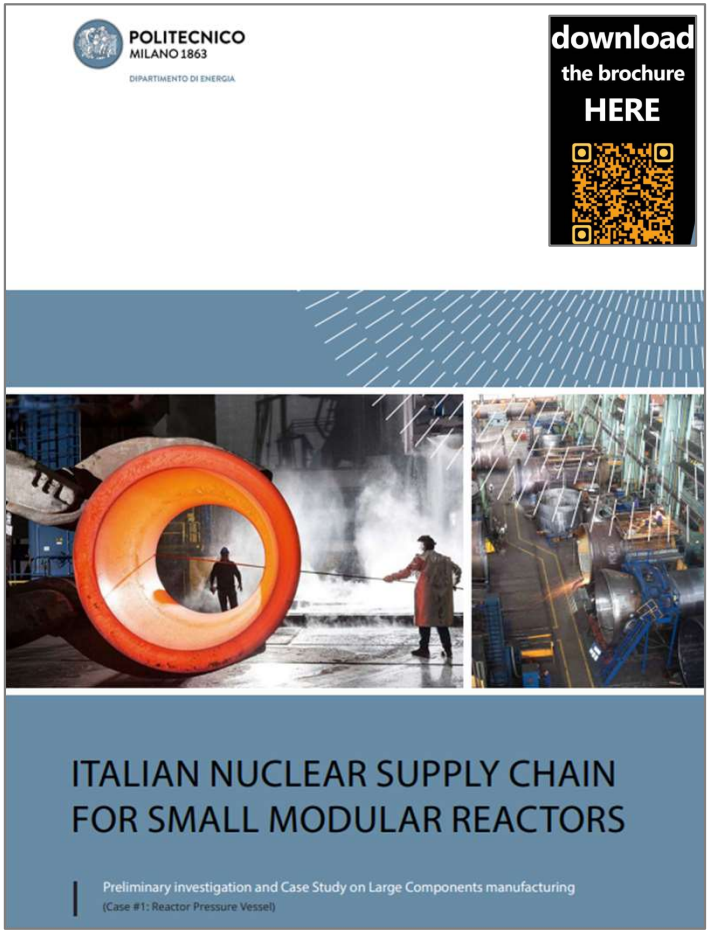
Overall height	13 500 mm
Inside diameter	3 700 mm
Nominal thickness	170 mm
Min. cladding thickness	6 mm
Design pressure	17.3 MPa
Design temperature	343 °C
RPV material	SA 508, Tp.3, Cl.2
Cladding material	Stainless steel



25 companies ready to deliver SMR nuclear components

ansaldo energia · AIR COM COINOX · ATB RIVA CALZONI · BREMBANA&ROLLE · TECTUBI RACCORDI S.p.A. · CAEN SyS Systems & Spectroscopy Division · CECOM · CESTARO ROSSI · FOMAS GROUP · De Pretto industrie · DEMONT · FRANCHINI ACCIAI · FINCANTIERI SI evolving integration · OCEM POWER ELECTRONICS · MB · GEATOP · GIVA GROUP · forge monchieri · SOFTEC · RINA · SIET · SIMIC · walter tosto

\+ 8 SMR RPV/YEAR



Estimated number of Reactor Pressure Vessels for SMR the Italian Nuclear Supply Chain is capable to produce per year.

To sum up…

- Supply chain will be a critical feature for upcoming nuclear programs in Europe
- But it will also play a foundamental role in their success,
  - by fostering a broader and more stable support to nuclear policies
  - by achieving competitiveness through series construction of NPPs
- Partnering is the key challenge, it must be addressed from the beginning
- An European supply chain will likely emerge, synergies among various supply chains will help
- *The Italian Supply Chain can play a key role in a new European scenario*