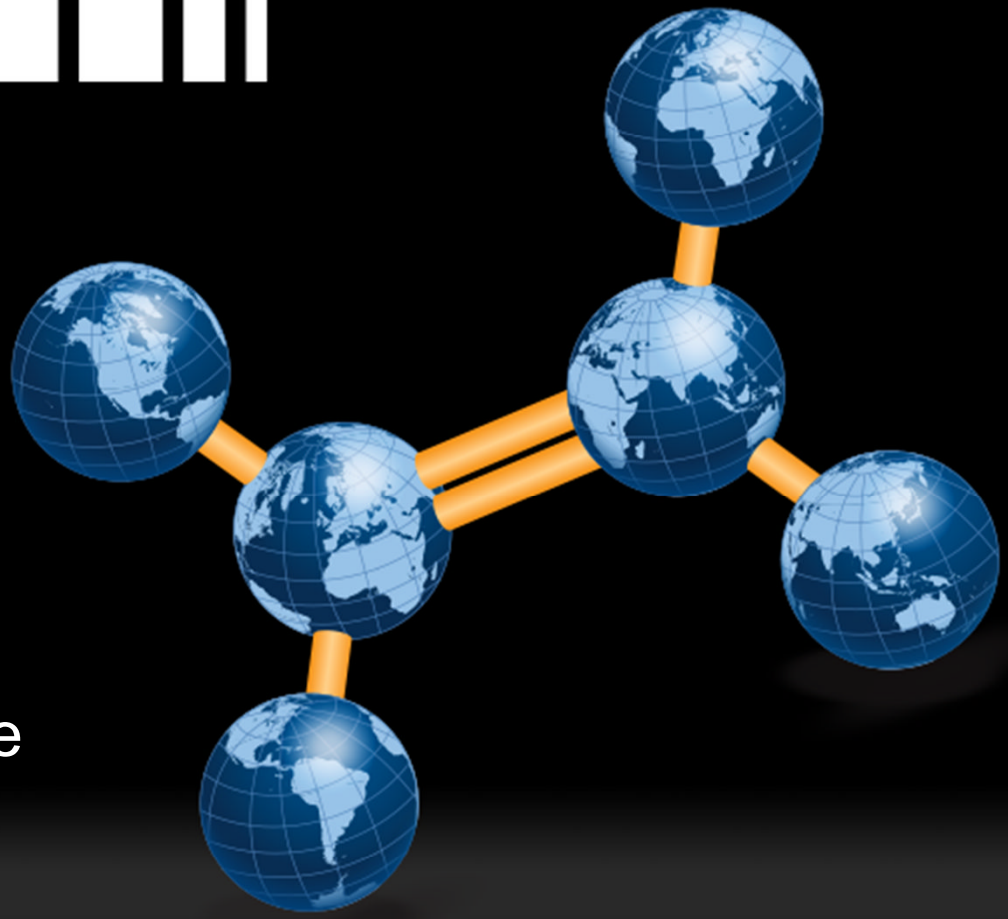
Inaugural Ethylene Forum

A Wider Ethylene Offering



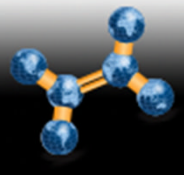
Jean-Paul Laugier

Vice President, Ethylene Product Line

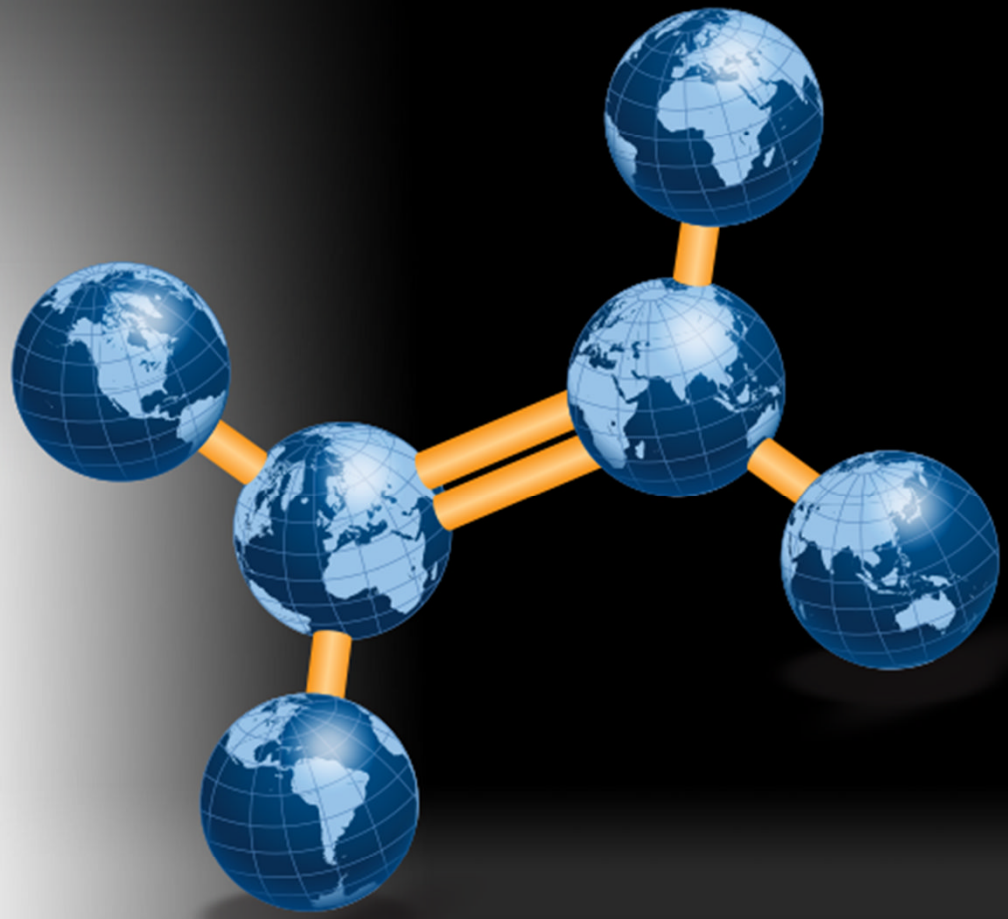
Technip

Agenda

- Ethylene Market
- Technologies
- A Wider Ethylene Offering



Ethylene Market



Worldwide Ethylene Capacity

- Current ethylene capacity 150 MMTA
- Average growing ethylene capacity: 3.5% (recorded over the years)
- Capacity is increased by
  - New grassroots plants
  - Plant expansions
- 2000's most new plants were built in Middle East
- Recent shift to USA due to shale gas
- Future capacity more spread around the world

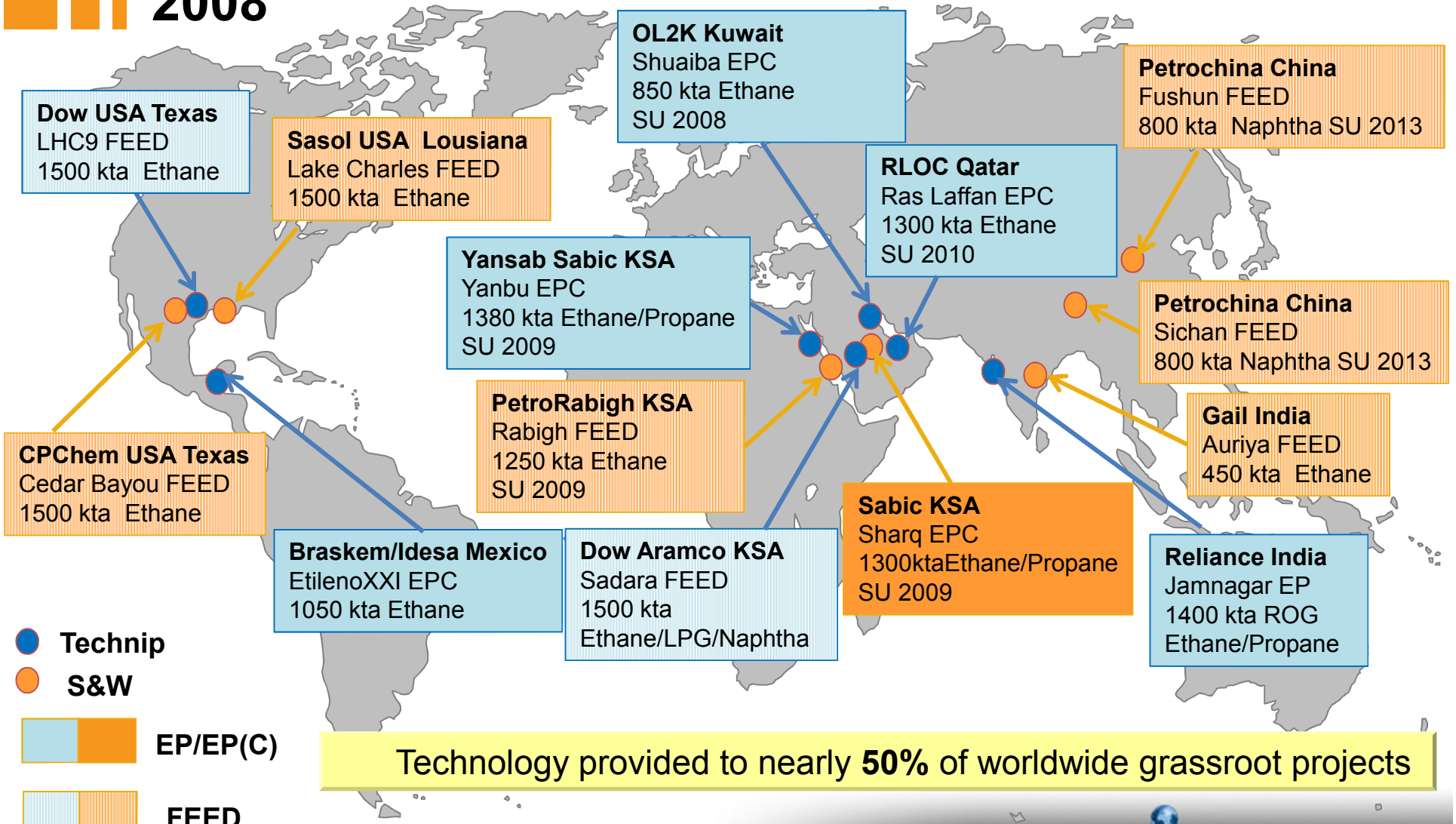
Dual capabilities as Licensor and EPC Contractor

- License
- Front End Engineering Design
- Proprietary Equipment
- Engineering, Procurement & Construction
- Commissioning Operations
- Start-up & Training
- Technology Support Services

Background

	Technip	Stone & Webster
Experience	▪ **40 years** alliance with former KTI, before the successful acquisition in 1999	▪ **70 years** of presence in the Ethylene business, acquired in 2012
Offer	▪ EPC contractor using own technology ▪ Licensing activities with Design & Build approach ▪ Robust EPC name	▪ Technology provider ▪ Mainly oriented towards Licensing activities for 3rd parties ▪ Strong Technology image
Achievements	▪ Complete more than 20 grassroot EPC LSTK projects	▪ Licensed more than 100 grassroots ethylene plants

Previous Ethylene Grassroots Projects since 2008



Technology provided to nearly **50%** of worldwide grassroot projects

Technip

Combined Supply of >360 Cracking Furnaces in 12 years

Technip

Liquid Furnaces
GK6®
> 90 furnaces

Stone & Webster

Liquid Furnaces
USC-U® & SU®
> 110 furnaces

Technip

Gas Furnaces
SMK™
> 100 furnaces

Stone & Webster

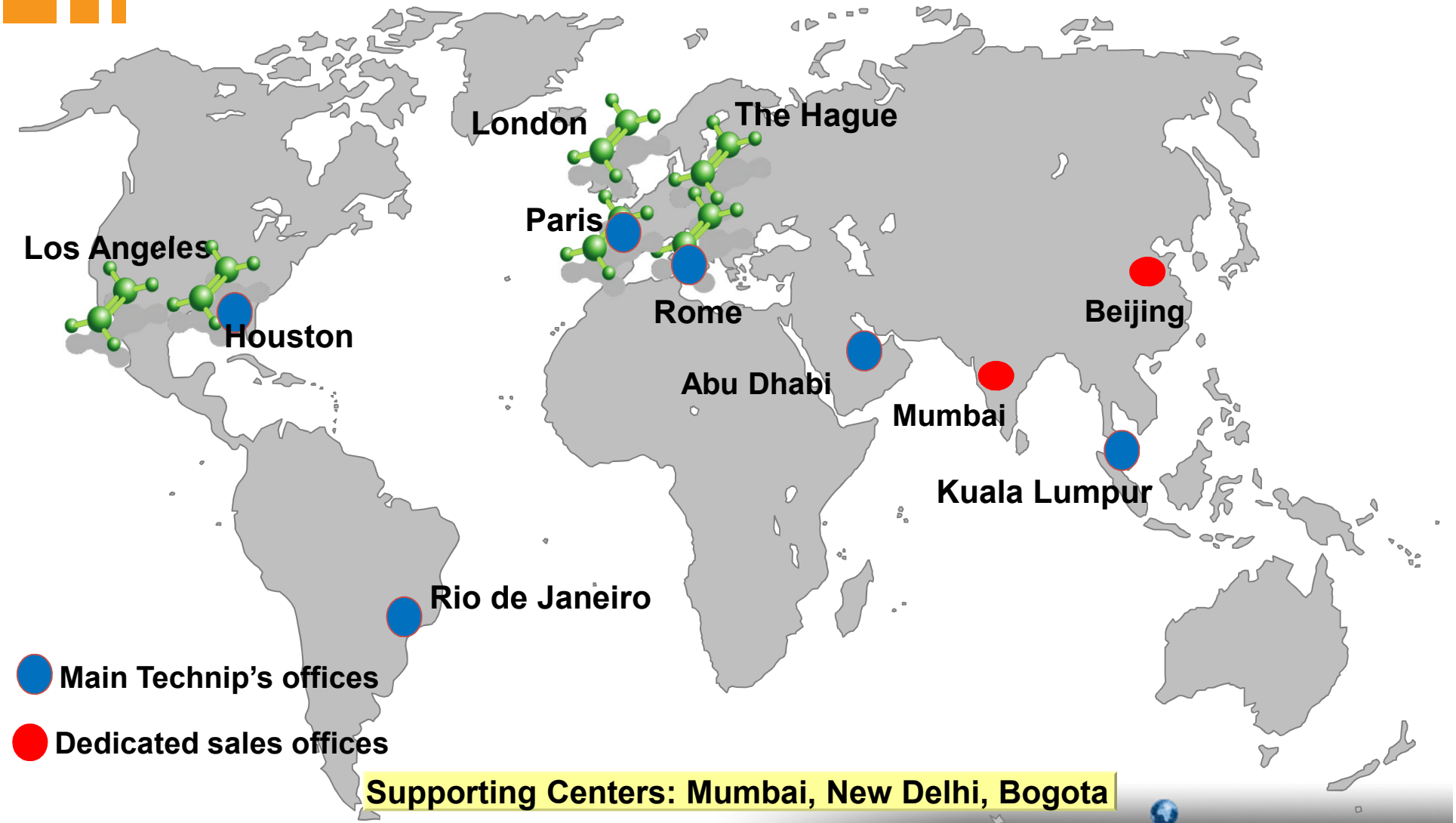
Gas Furnaces
USC-M®
> 60 furnaces

Installed in both grassroots or for upgrade & modernization projects

Technip Stone & Webster Process Technology

- Shared values with our clients:
  - HSE
  - Quality
  - Innovation & Technology
- Ambitions:
  - Offer the best technology offer
  - Grow with licensing supported by EPC capabilities
  - Jointly answering market demand

Ethylene Design Capabilities

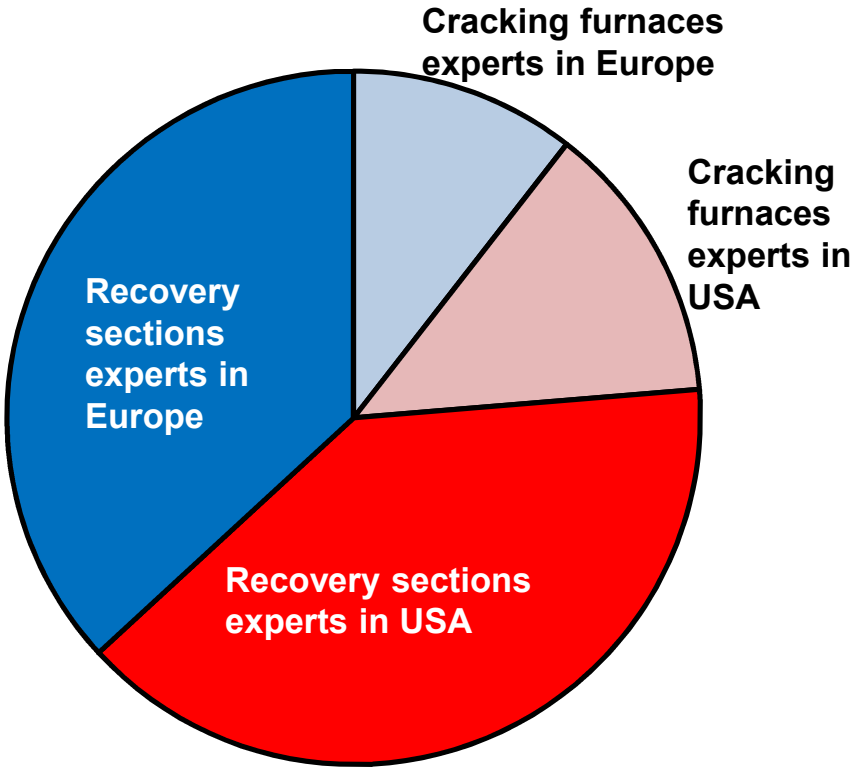


Supporting Centers: Mumbai, New Delhi, Bogota

Technip has a Large Team of Ethylene Design Experts in Europe and in the USA

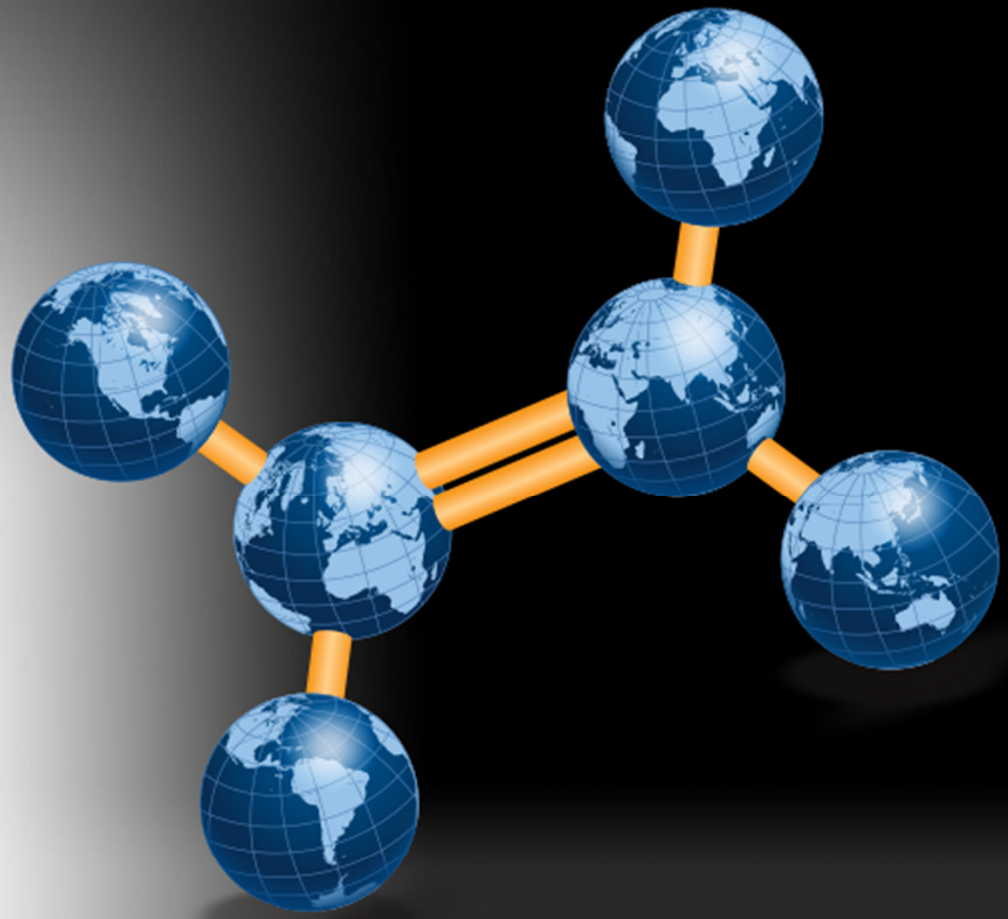
A balanced organization composed of:

- 1/3 Ethylene Experts
- 1/3 Senior and Principle Engineers
- 1/3 Process Engineers

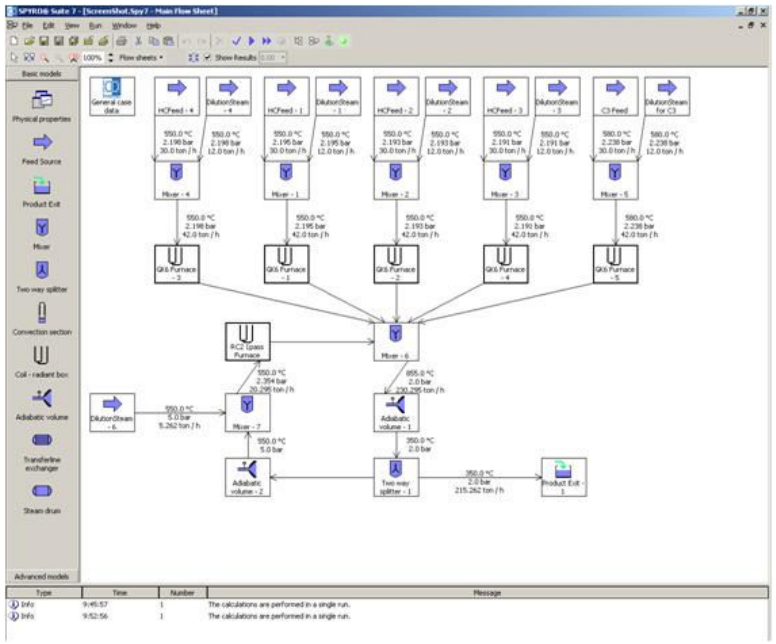


Unmatched level of technology capabilities
~ 200 process experts

Technologies



SPYRO® Proprietary Software for Ethylene



- Proprietary software developed more than 30 years ago by Technip
- Plants & furnaces yields optimization
- Furnace maintenance & planning
- Feedstock scheduling
- Commercialization of SPYRO® by Zoetermeer (NL) and Claremont (US): with dedicated team is working full time, dedicated seminars and training for customers
- > 220 active licences
- SPYRO® is the standard tool for designing furnaces within Technip whatever the technology.

SPYRO® is the Ethylene Furnace simulation standard

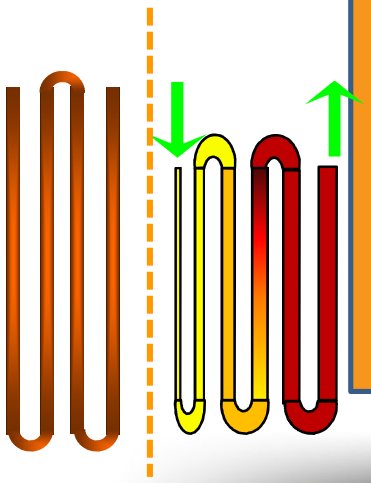
Combined Ethylene Experience Since 2000

Technip	+	Stone & Webster	=	Technip Stone & Webster Process Technology
▪ New plants using Technip technology produce 11.85 MTA ▪ Hydrogenation unit: ▪ Back End *6x units* ▪ Front End *4x units*		▪ New plants using S&W technology produce 8.15 MTA Hydrogenation unit: ▪ Front End *8x units*		▪ **Nearly 50%** of the installed capacity with **20 MTA** of Ethylene ▪ Offering both technologies with **18 plants** awarded

Gas Furnaces Comparison

SMK™ design

- Simple **4**-pass coil
- Diameter 3-1/2” to 4”
- Robust coil & Ease of Maintenance
- Residence time 0.4 – 0.5 s
- In line arrangement
- Low heat flux design
- Conversion
  - Ethane from 60% up to 75%
  - Propane 70% up to 96%
- Typical run length: 60 days
- Flexibility in Ethane, Propane and Butane
- Capacity over 220kta in **single** radiant box

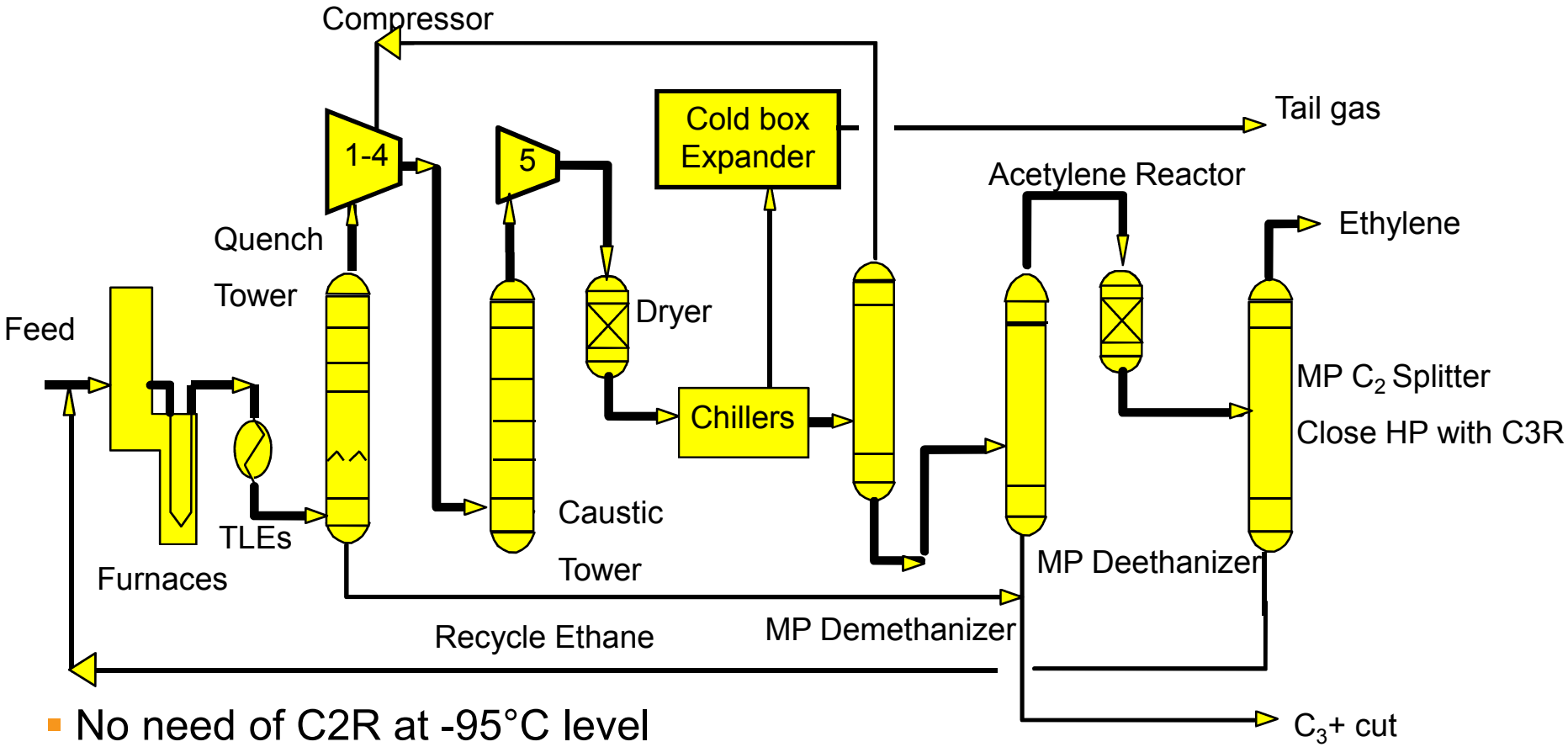


USC-M® Coil

- Simple **6**-pass coil
- Diameter 3-3/8” to 4-1/2”
- Robust coil & Ease of Maintenance
- Residence time 0.4-0.5 s
- In line arrangement
- Low heat flux design
- Conversion
  - Ethane from 60% up to 75%
  - Propane 70% up to 96%
- Typical run length: 60 days
- Flexibility in Ethane, Propane and Butane
- Capacity over 220kta in **twin** radiant boxes

Technip's Process Flow Schemes Gas Cracker

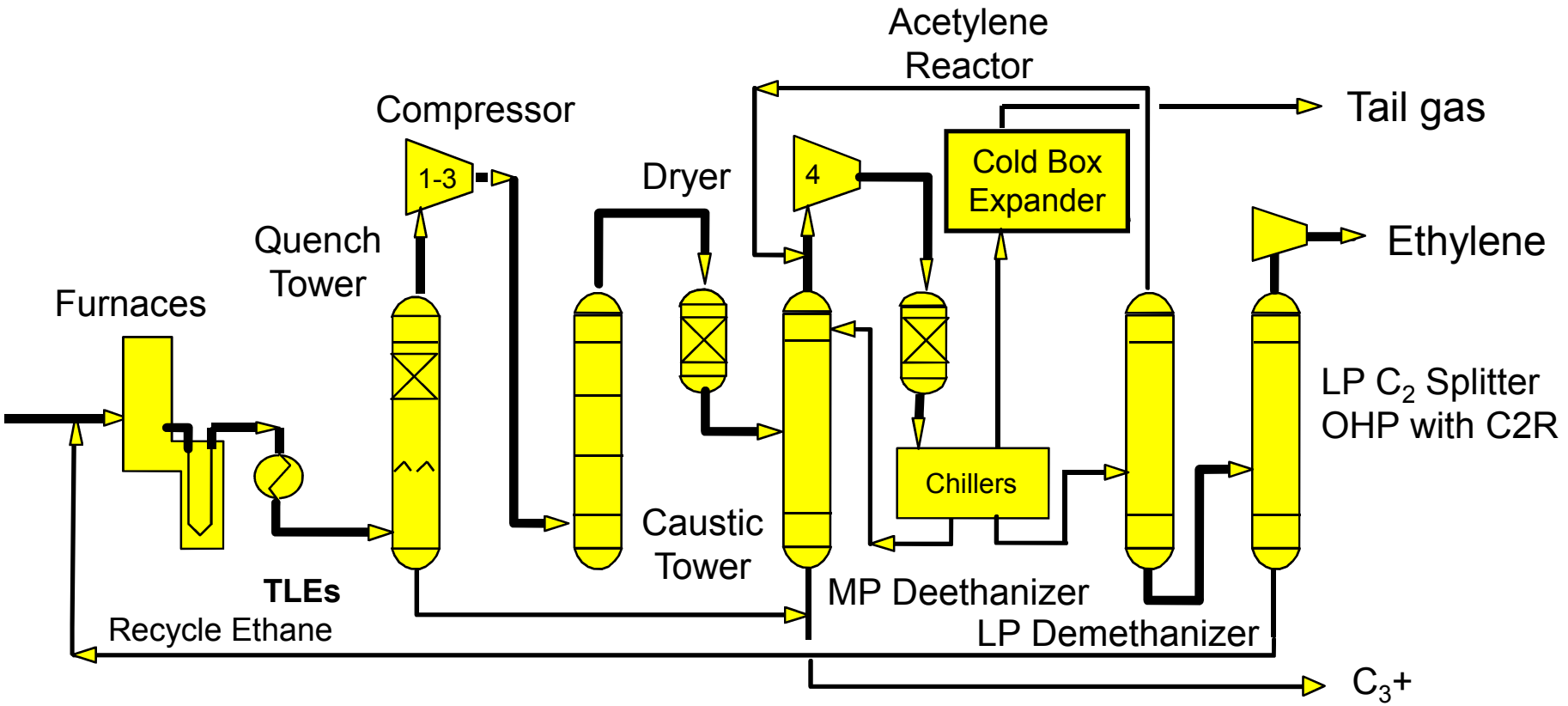
Front End Demethanizer and Back End Hydrogenation



- No need of C2R at -95°C level
- 5 stages CGC
- Adiabatic C2 hydrogenation reactor

Technip Process Flow Schemes Gas Cracker

Front End Deethanizer and Front End Hydrogenation



- No need of C3R at -40°C level, No need of C2R at -95°C level
- 4 stages CGC
- Adiabatic C2 hydrogenation reactor

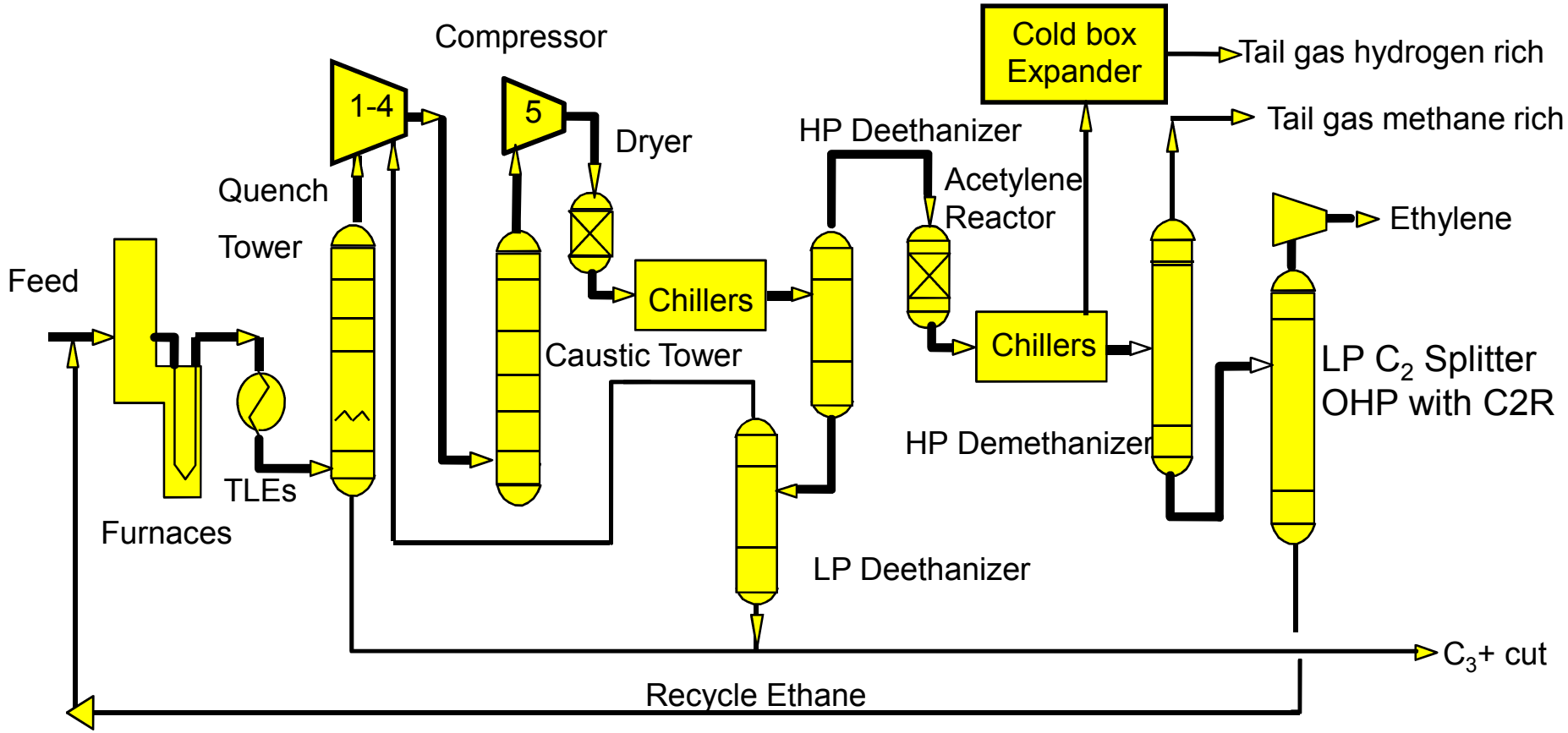
Technip's Front End vs Back End Ethane Crackers

Machines	Characteristics	Back-end Hydrogenation	Front-end Hydrogenation
CGC	Number of stages	5	4
	Number of Casing	3	3
	Driver	single driver, condensing turbine	Single driver or dedicated driver for the 4th stage, condensing turbine
	Power for 1000 kta	42.1MW	40.9MW
	Specific compression power	337 kWh/h/t/C2H4	327 kWh/h/t/C2H4
	% of total power	55%	54%
C2R	Number of stages	2	2
	Number of Casing	1	1
	Driver	back pressure turbine	back pressure turbine or condensing turbine
	Power for 1000 kta	7.1MW	17.3MW
	Specific compression power	57 kWh/h/t/C2H4	138 kWh/h/t/C2H4
	% of total power	9%	23%
C3R	Number of stages	4	3
	Number of Casing	1	1
	Driver	single driver, condensing turbine	single driver, condensing turbine
	Power for 1000 kta	27.1MW	17.9MW
	Specific compression power	217kWh/h/t/C2H4	143 kWh/h/t/C2H4
	% of total power	36%	24%
Total	**Total Power**	**76.3 MW**	**76.1 MW**
	Specific compression power	**610 kWh/h/t/C2H4**	**609 kWh/h/t/C2H4**

Similar Performances

S&W Process Flow Schemes Gas Cracker

Front End Deethanizer And Front End Hydrogenation

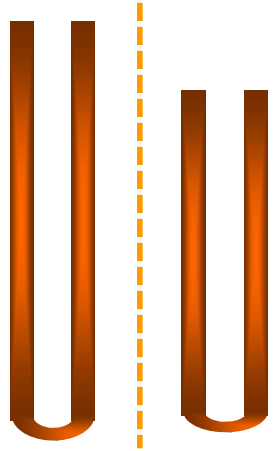


- 5 stages CGC
- Adiabatic C2 hydrogenation reactor
- Dual deethanizers

Liquid Furnaces Comparison

GK6® Coil

- High selectivity 2-pass coil
- Diameter 45mm to 60mm
- Robust coil & Ease of Maintenance
- Residence time 0.20 sec & 0.25 sec
- **Multiple lanes** arrangement
- Typical run length: 45 days to 75 days
- Suitable for conventional and linear TLE
- Flexibility in feed range
- References from Propane up to very heavy feedstock (HVGO)
- Large range of severity
- Severities normally in range of 0.4 to 0.65 depending on feed quality
- Capacity over 200kta in **single** radiant box

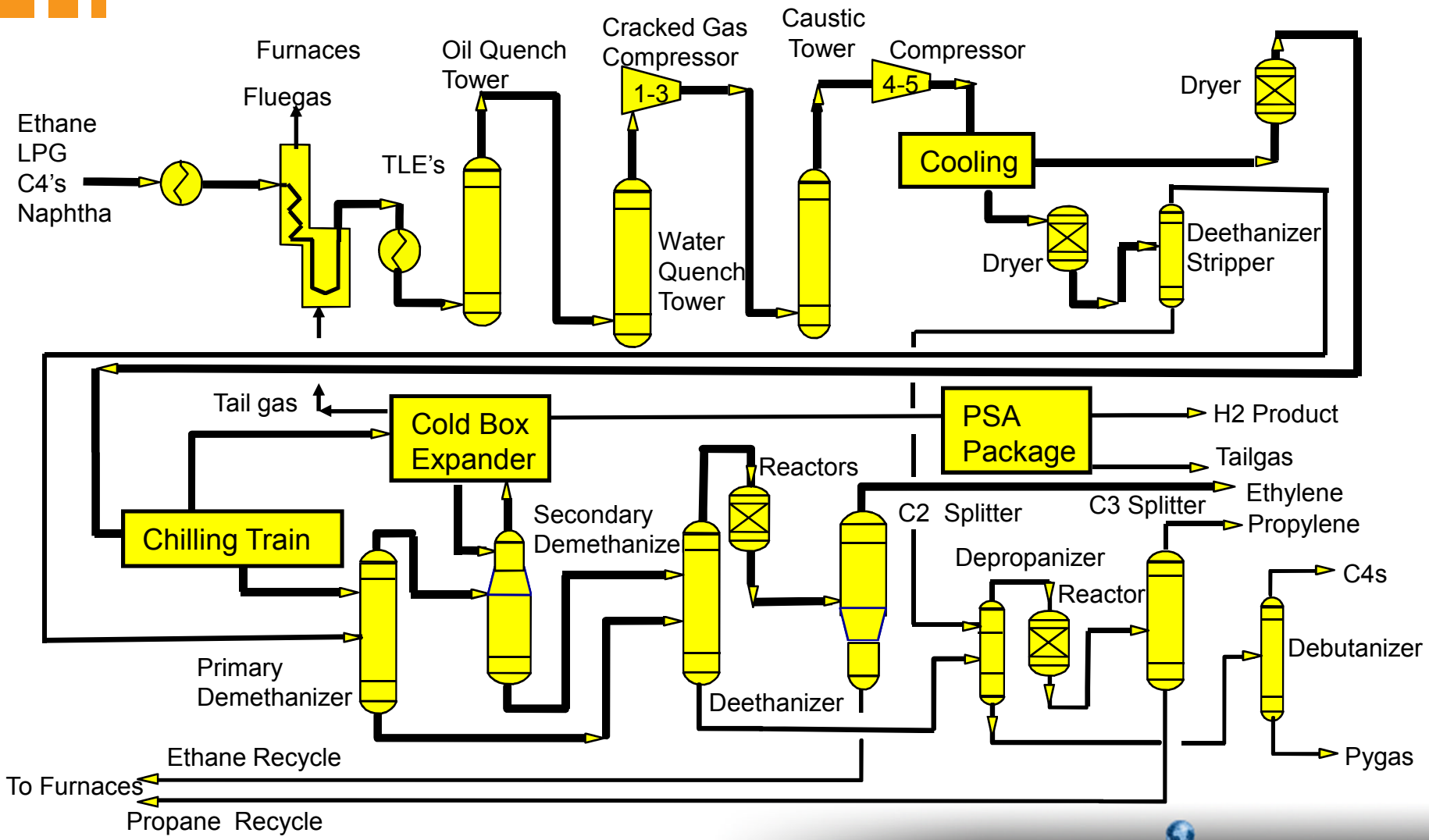


GK6 USC-U

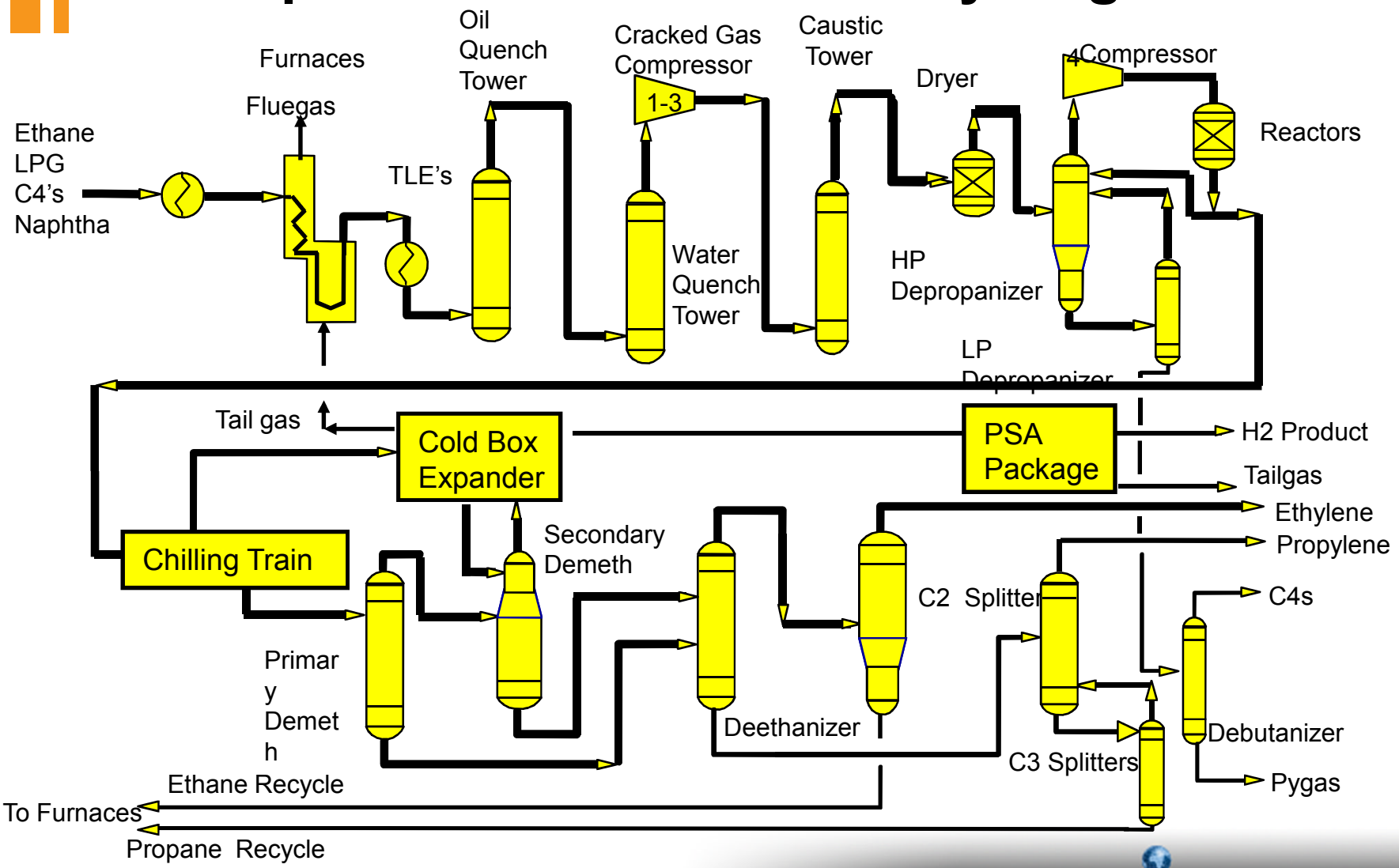
USC-U® & SU®Coil

- High selectivity 2-pass coil
- Diameter 45 mm to 60 mm
- Robust coil & Ease of Maintenance
- Residence time, U coil 0.2 sec & SU coil 0.25
- **Single** arrangement
- Typical run length: 45 days to 75 days
- Based on linear TLE
- Flexibility in feed range
- References from Propane up to very heavy feedstock (HCR, HTC,..)
- Large range of severity
- Severities normally in range of 0.4 to 0.65 depending on feed quality
- Capacity up to over 200 kta in **twin** radiant box

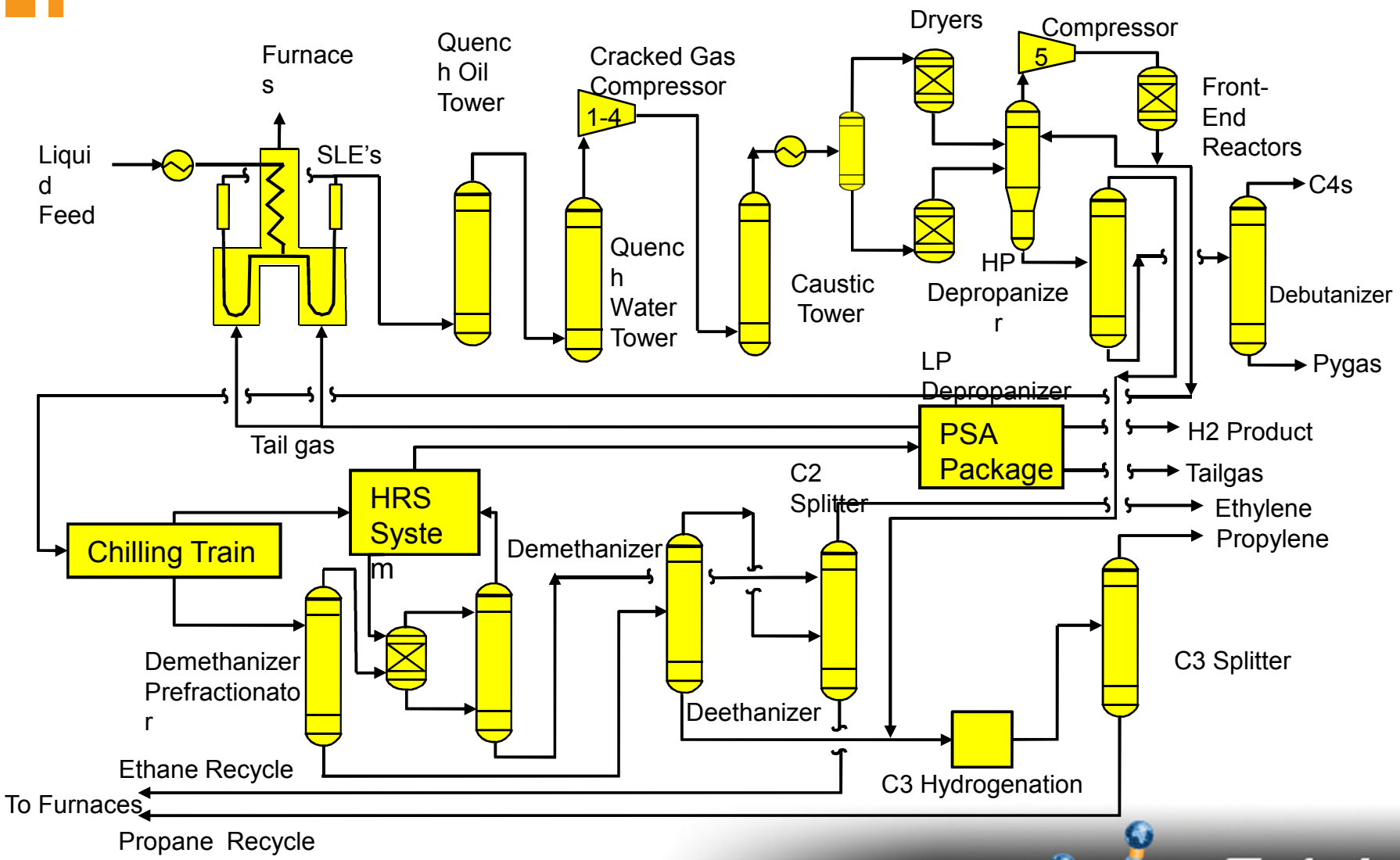
Technip's Scheme Back-end Hydrogenation



Technip's Scheme Front-end Hydrogenation

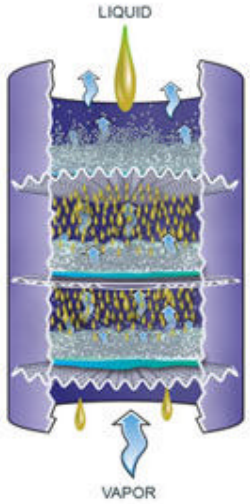


S&W Scheme Front-end Hydrogenation

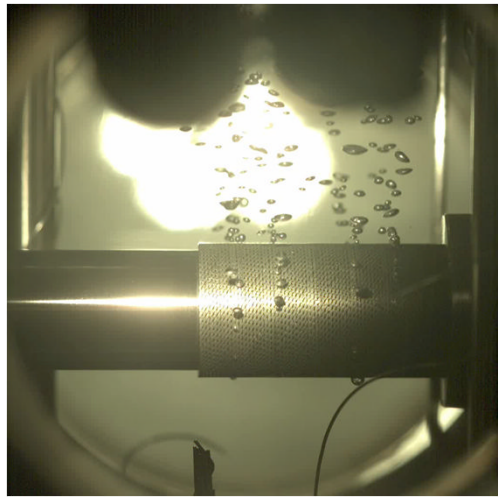


Additional Features Available for all Technologies

- **Stone & Webster**
  - Ripple Trays
  - Quench water treatment
  - Catalytic Process (DCC integrated with cracker)
  - U coil/SLE combination: Exclusive design and patents with BORSIG



- **Technip**
  - Swirl Flow Tube (SFT)
  - Multiple lanes for coils arrangement
  - Wieland tubes

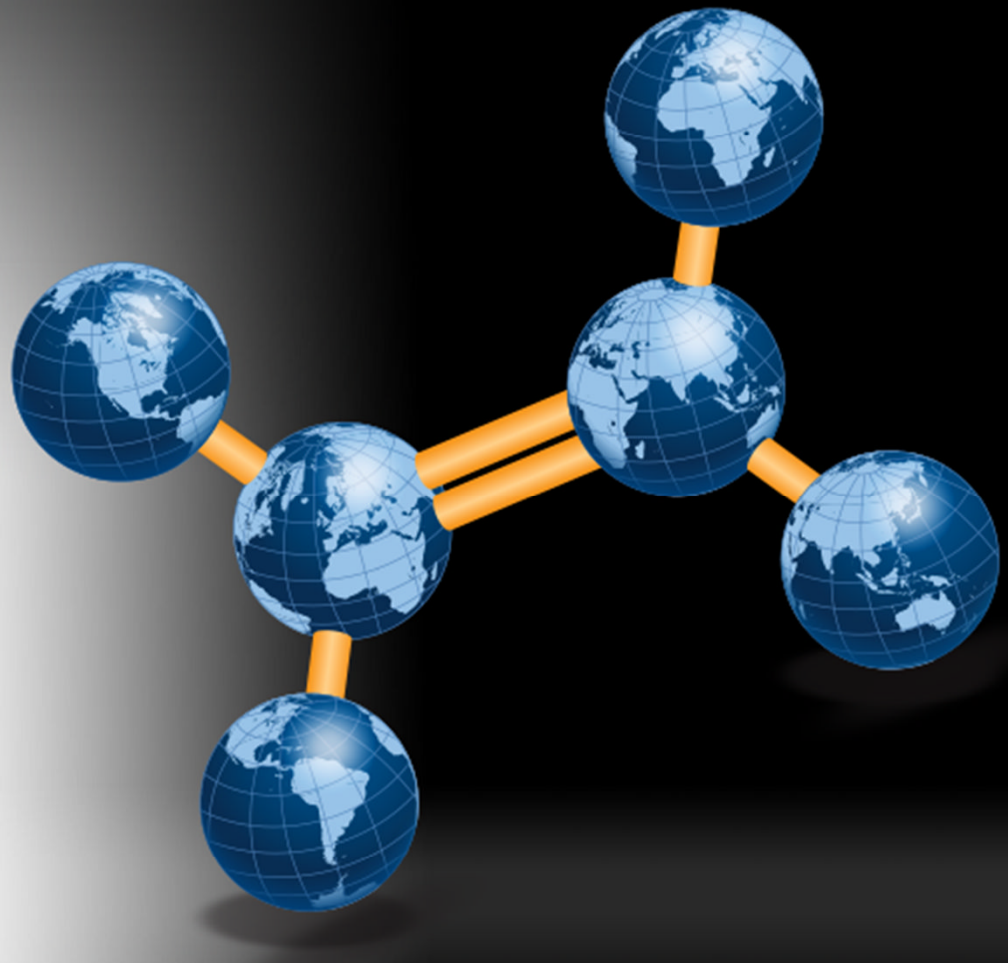


Wider Offer Combining Best Features

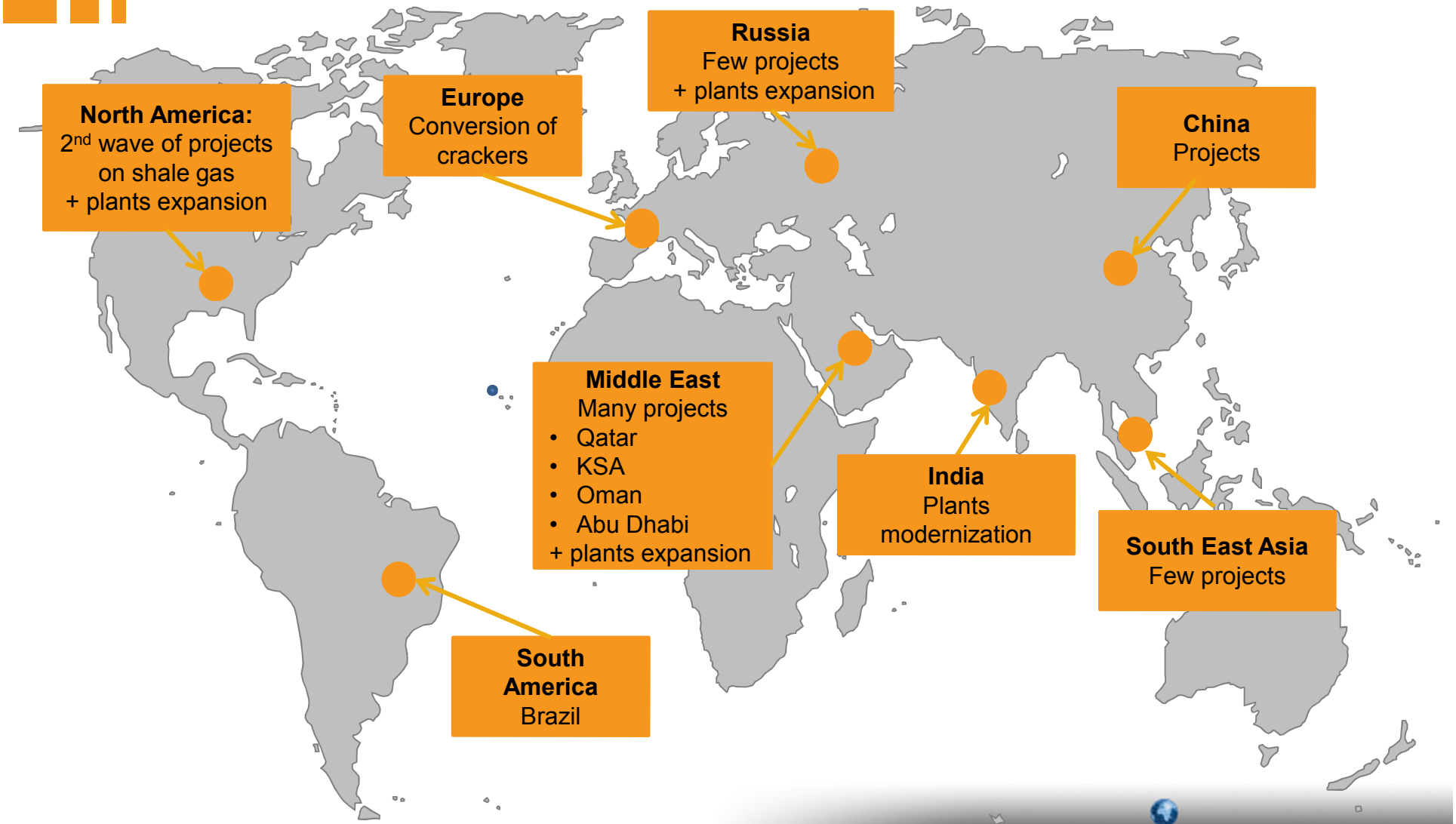
Technologies Summary

- Cracking furnaces: similar concepts but some specific key features
- Similar sequence and adiabatic hydrogenation for the 2 front end schemes with some key features
- Technip maintains, improves and offers both technologies

A Wider Ethylene Offering



Future Ethylene Projects



We Maintain and Improve Both Technologies

- Licensing and/or EPC for both technologies
- Bidding strategy based on customer preference and needs
- The practice of licensing to other 3rd party EPC Contractors is continuing and is applied to the 2 technologies
- Unmatched level of technology capabilities
- Joint R&D

Clients are benefiting from optimized solutions & larger offer

We Maintain and Improve Both Technologies

- Harmonization of Licensing policies
- Align agreements with sub-Licensors and Suppliers
- Utilize common software and harmonizing tools
  - SPYRO®
- Share lessons learned
  - Cracking furnaces
  - Recovery section
- Inter-exchange between Ethylene centers
  - Tendering
  - Execution

Clients are benefiting from optimized solutions

Satisfying Clients' Needs

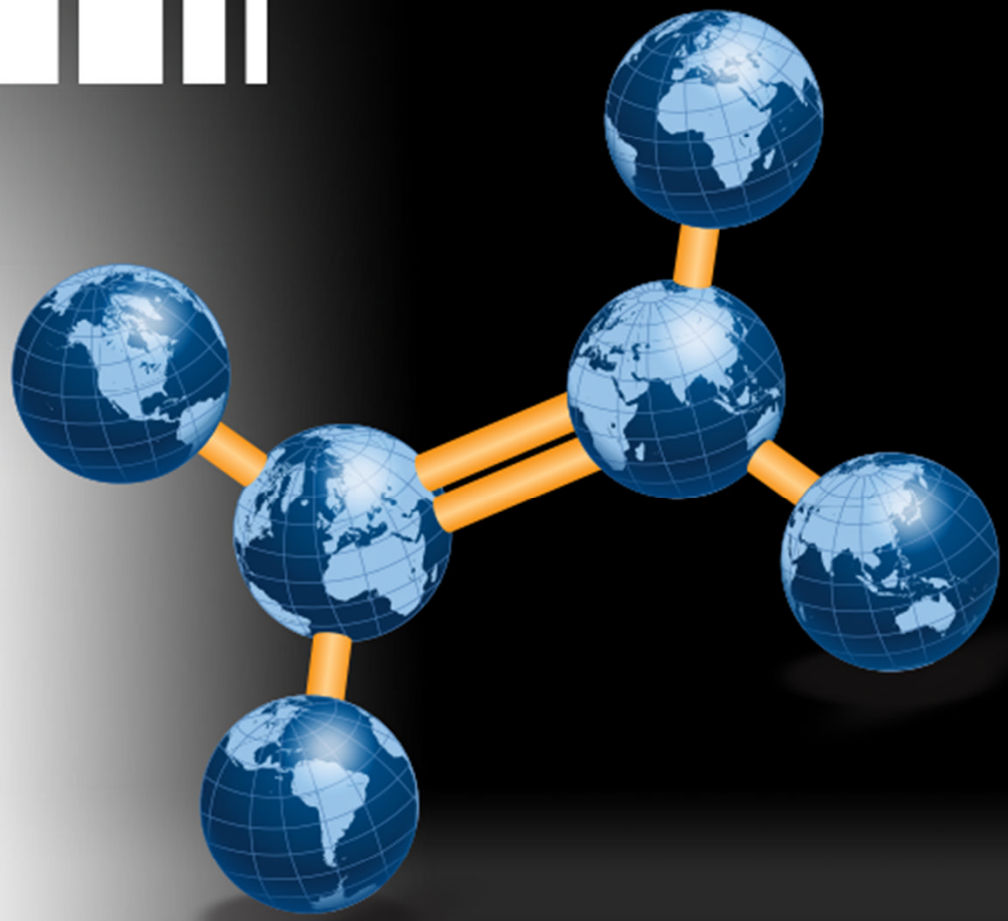
Bidding strategy defined case by case

- Define the role:
  - EPC scope
  - Licensor scope for 3rd party EPC Contractors
- Define the technology:
  - Technip or S&W technology or combination of the two
  - Cracking furnaces from X and recovery section from Y

A Wider Ethylene Offering with both technologies

Inaugural Ethylene Forum

Thank You!



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