

Global Trends in Industrial Markets

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Albert Bruneau, NEOTISS

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We have used for this presentation among other sources testimonies of some of our customers.

We want to thank all of them for their contribution.

From Vallourec Heat Exchanger Tubes to NEOTISS



Industrial Titanium – Perimeter

Power Generation



**Nuclear
Power Plant**



**Thermal Power
Plant**

Desalination



Thermal MSF/MED

Process



Chemical



LNG



Oil & Gas



PTA



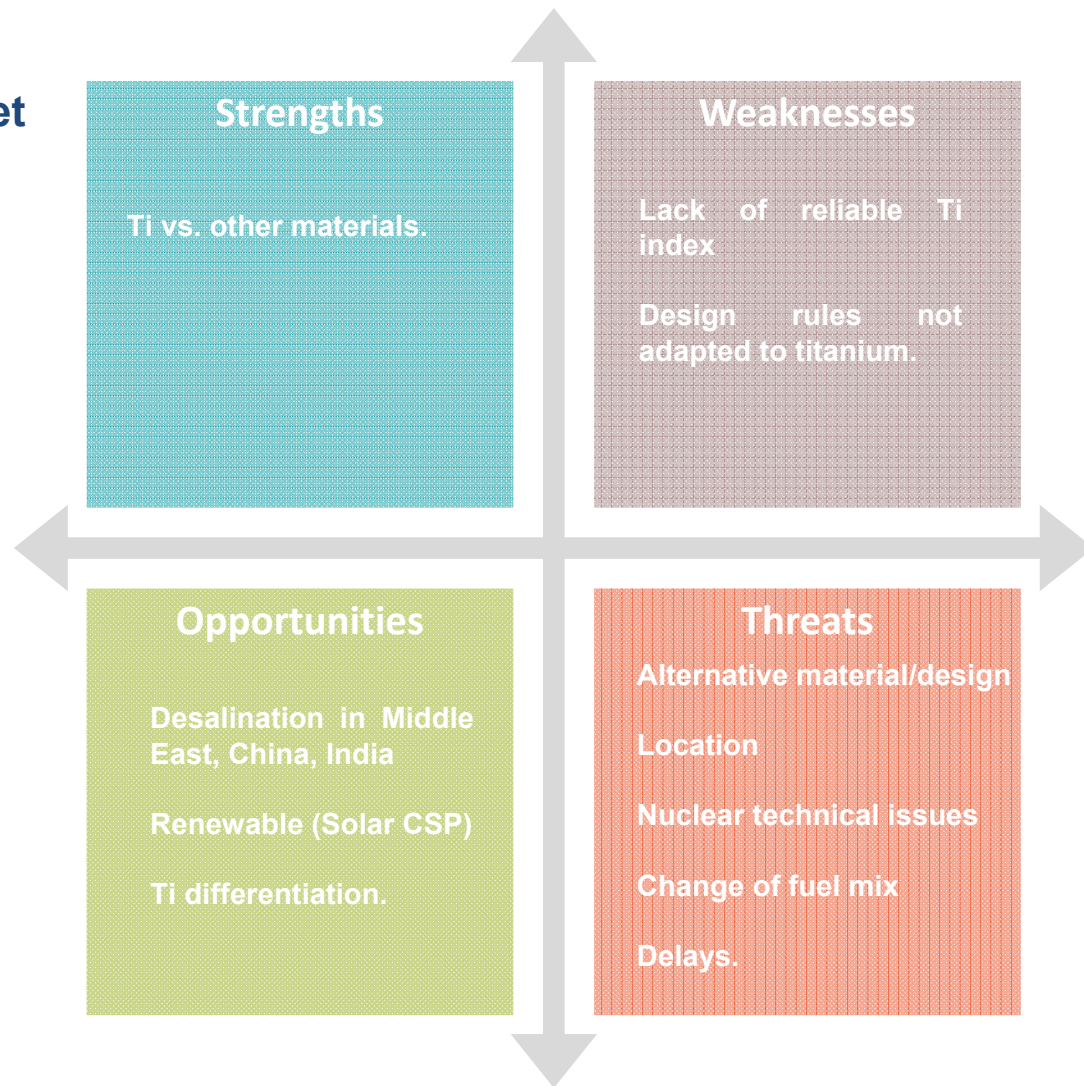
Pool Heater

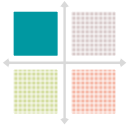


District Cooling

Ti SWOT for Industrial Market

What's new since last year?



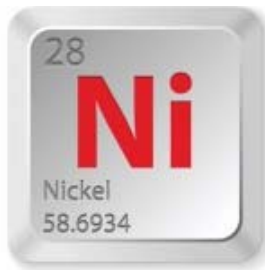


Ti SWOT for Industrial Market: Strengths - Ti relative competitiveness

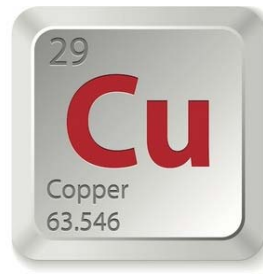
None differentiated general trend down



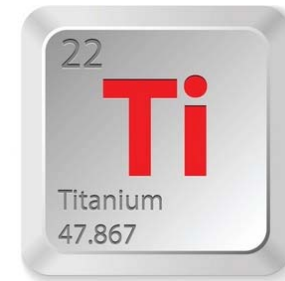
- Compared to 2 years ago, Titanium kept its competitive advantage but followed the trend of other materials.

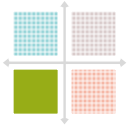


Ni index over 2 years
- 40%



Cu index over 2 years
- 30%





Ti SWOT for Industrial Market: Opportunity - Titanium differentiation

Slow Progress

NEW GRADES



- No improvement or new launch on the field.

NEW PRODUCTS



- Heat exchange improvement through material deformation
 - Helix tubes
 - Dimpled plates.



ALTERNATIVE DESIGNS

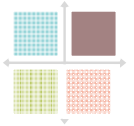


- LNG vaporizers
 - Promotion of IFV design using Ti against the most common ORV design.

NEW PROCESSES

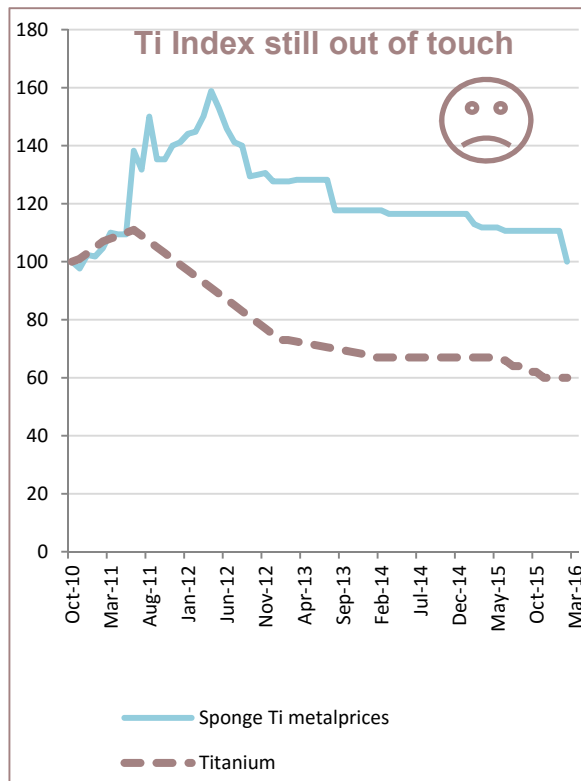


- Plates Cladding
 - Could favor Ti as becoming a more competitive option.



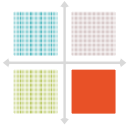
Ti SWOT for Industrial Market: Weakness – Reliable Ti Index & Design rules

Few improvement since last year



More thermal heat exchange projects in 0.4mm





Ti SWOT for Industrial Market: Threats - Alternative material / Design

Less favorable environment

- Alternative “new steel” under development claimed “as strong as Ti”
- Negative impact of oil&gas activity drop:



TI DESALINATION MARKET

- Middle East countries impacted by low oil prices.



TI POWER MARKET

- The clean energy revolution is immune to cheap natural gas.

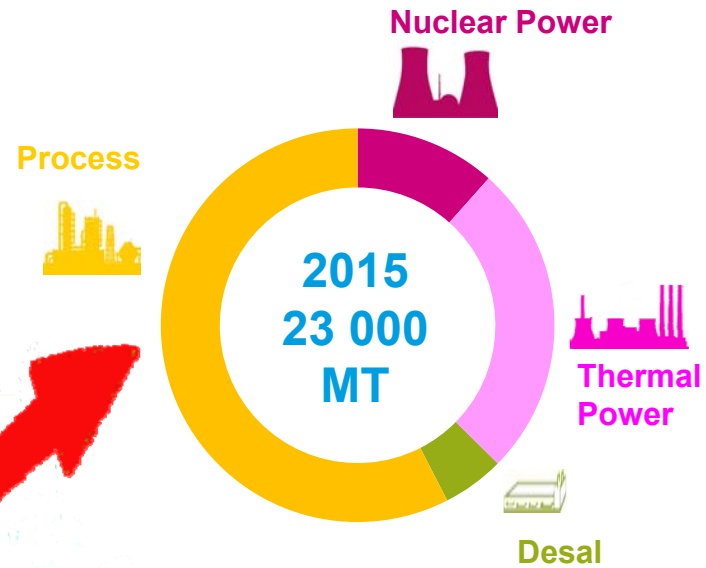
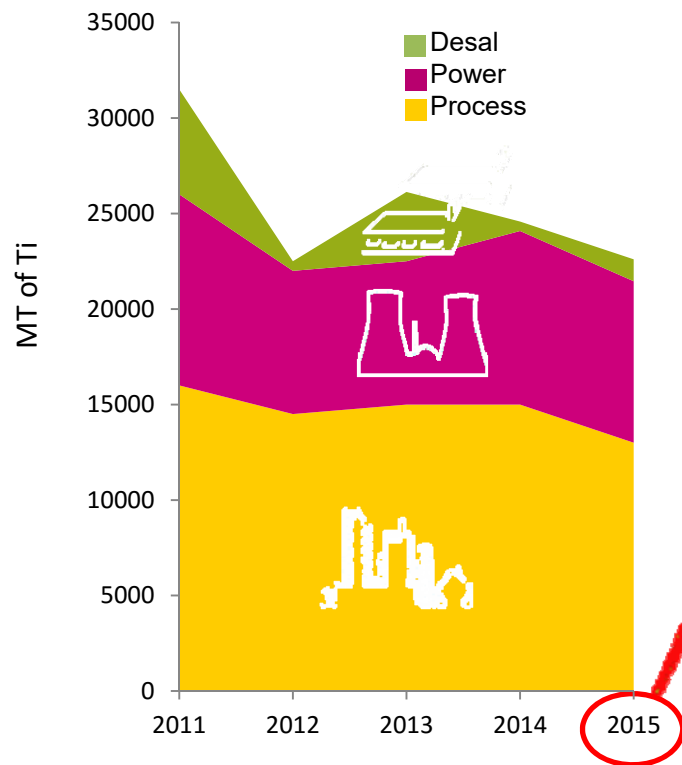


TI PROCESS MARKET

- Petrochemical applications direct impact.

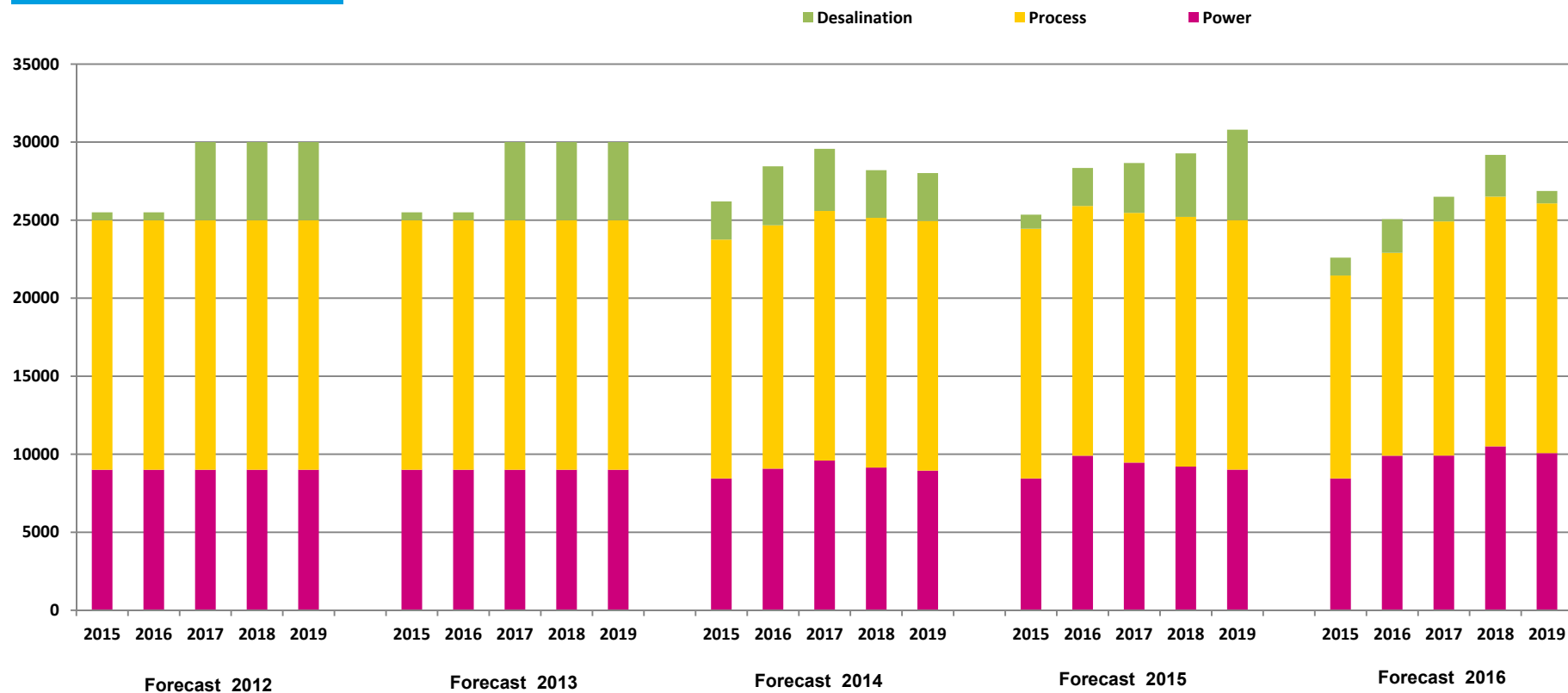


Industrial Titanium – Current Market



- Demand has significantly decreased compared to 2014
- Process strongly down due to low oil price
- Only partly compensated by desalination and Nuclear power consumption.

Industrial Titanium Forecast Accuracy



Stability on powergeneration, Clear trend on process, High fluctuations on desalination

Ti Desalination market:

Reminder: titanium consumption depends on the chosen technology & material



- Titanium consumption depends on capacity to convince end users to use thermal technology and to switch material.
- Copper release into the sea in Gulf Coast can favor Ti against other material.
- But information are contrasted :

More than 10 000 km of titanium tubes for Facility D desalination plant in Qatar.

When fully completed in 2018, Facility D will produce 130 MIGD (million imperial gallons per day) of water. It is located about 15km south of Doha.



Ti Desalination market:

Reminder: titanium consumption depends on the technology & material chosen



- Al Jubail tubes finally remained in Copper Nickel as in the initial design despite titanium competitiveness...



- Ras Laffan RO project has been preferred to Ras Abu Fontas A3 MED project.



- Al Khiran 1 project postponed in Kuwait.

Desalination market:

Change of paradigm due to oil&gas crisis and RO technology development



- **RO keep growing in the Middle East allowing them to save energy and win flexibility**
 - RO technology is good enough for drinking water
 - In the UAE, it is already specified RO for new projects
 - Saudi and Kuwait will probably move in this direction

- **In the future, thermal technology may be mainly used for small units for industrial applications**

- **Among thermal technologies, MED is better positioned due to improved energy efficiency.**

→ **Less titanium consumption for desalination applications in the coming years**

Ti Power market: Impact of COP21



Paris climate deal signed by nearly 200 nations

What has been agreed to : aim to limit the increase to 1.5°C

Main consequence for Power Generation market :

- Renewable will account for ~80% of power generation investment to 2030 in major economies
- **Not much has been said about nuclear power.** Its capacity to provide base load power makes it a stable and low-carbon energy supply. However, safety and investment concerns don't play in favor of Nuclear.



Ti Power market: Impact of COP21



“Plans to reduce its greenhouse gas emissions by 37% by 2030 [...] Following the Fukushima accident, **there are limits now to the extent that Korea can make use of nuclear energy**”. The country decided to increase the production of renewables.



U.K. government announced that **coal-fired power generation will cease by 2025**.



No new coal-fired power plant allowed to be build.



China decided “to lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level”.

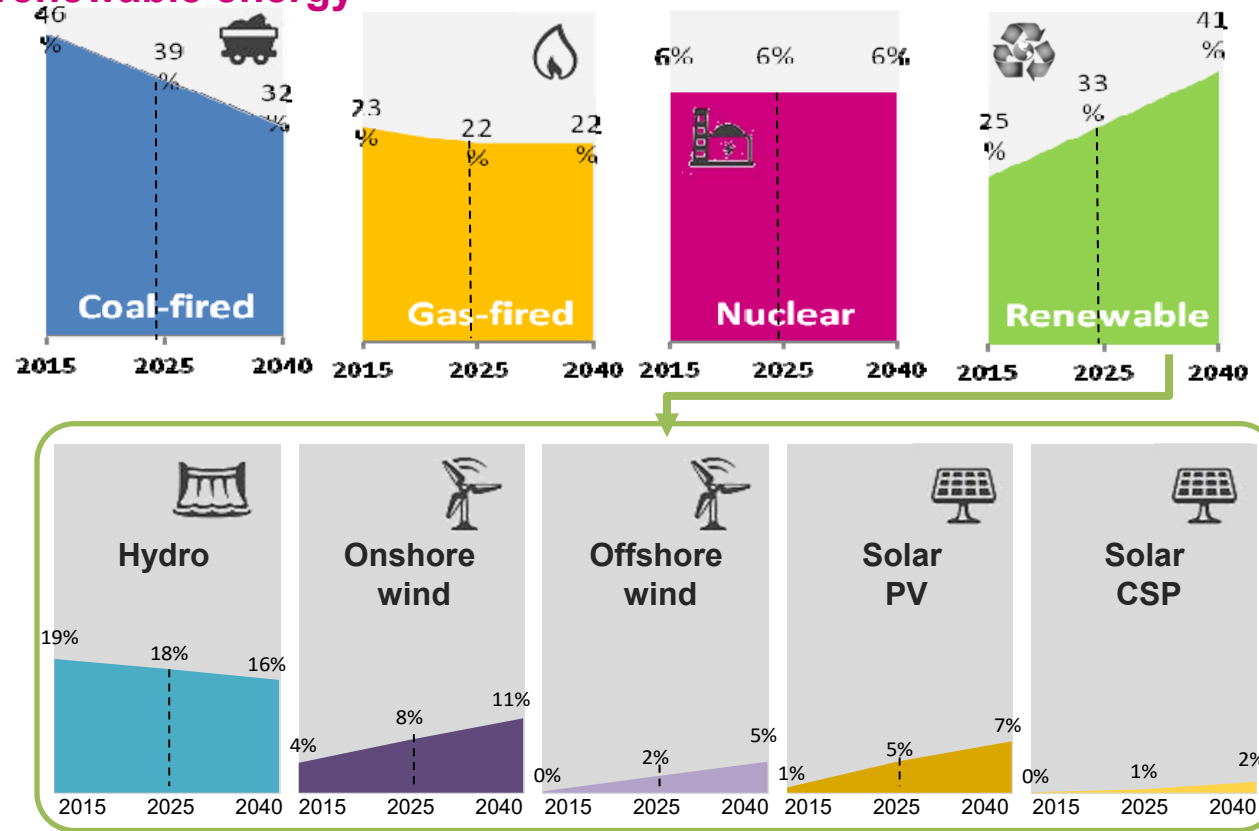
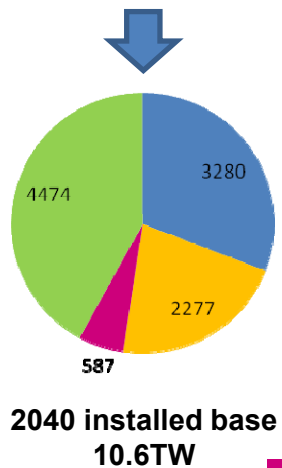
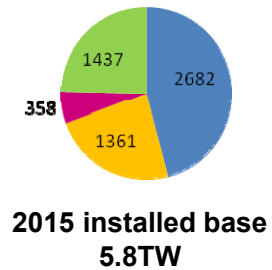
Developing nuclear power, expanding the use of natural gas, developing renewable and modernizing its coal-fired plants by 2020.



“India decided to reduce the emissions intensity of its GDP by 20–25%, over 2005 levels. [...] The aim is to achieve 175 GW renewable energy capacities in the next few years”. They **focused on renewable and nuclear power**.



Ti Power market: The increasing part of renewable energy

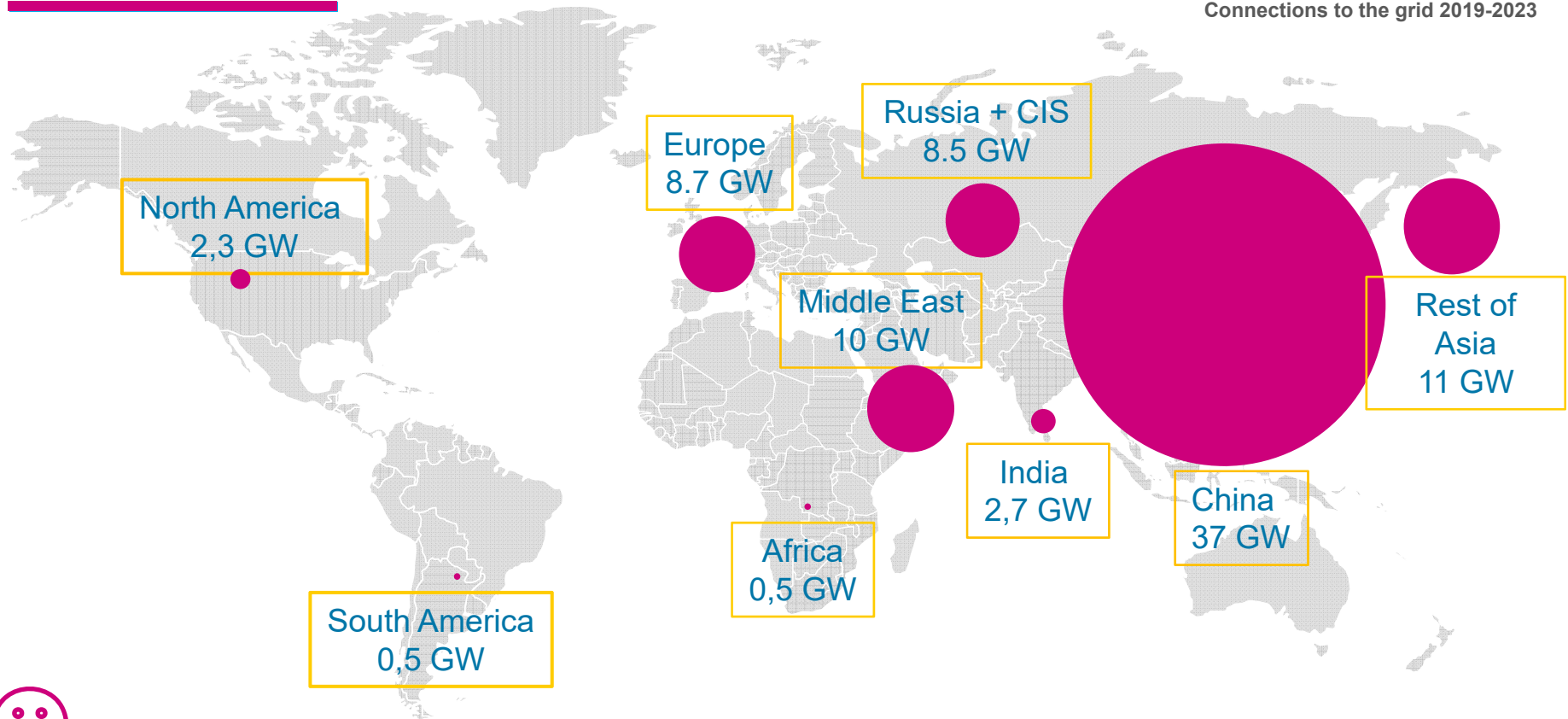


- The installed base of fossil fuel power plants will represent a lower part of the fuel mix
- Nuclear share will stay stable

Ti Power market: Nuclear remains a key source of energy for many countries



Connections to the grid 2019-2023



Nuclear share will remain stable thanks to large investments in China, Middle East, and Russia.

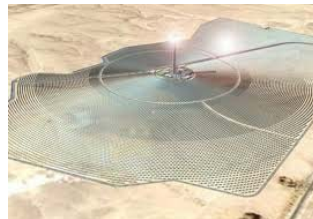
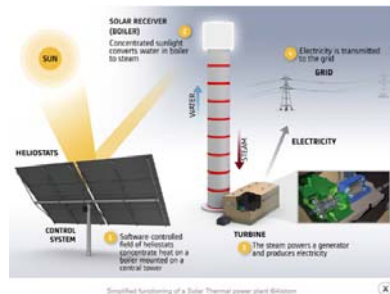


Ti Power market: Opportunities to catch in renewable energy for titanium



CSP SOLAR POWER

- Concentrating Solar Power (CSP) technology converts concentrated solar radiation into heat to produce electricity
- Some tubes requirement, including in titanium.

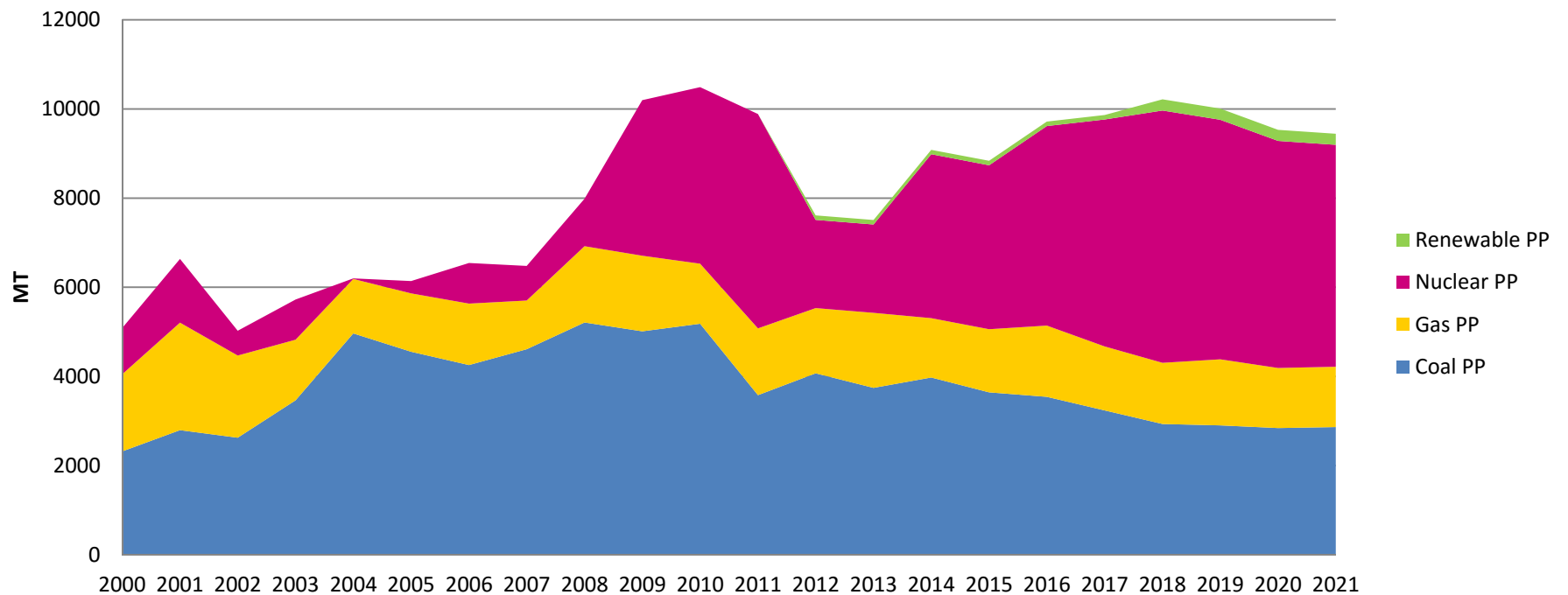


OCEAN THERMAL ENERGY CONVERSION

- Uses the T° difference between cooler deep and warmer surface seawaters to run a heat machine and generate electricity.
- Titanium first choice as unmatched corrosion resistance to seawater.



Ti Power market: Titanium consumption per fuel

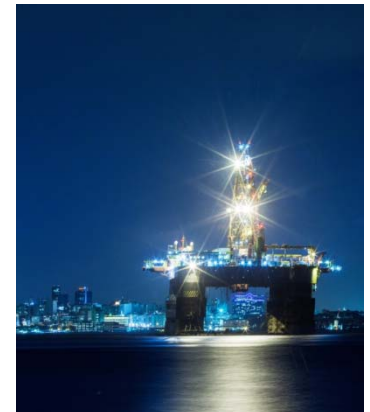


- Most of renewable projects will not use titanium
- Nuclear will remain the key driver of titanium consumption

Ti Process market



- Many process applications are strongly linked to oil & gas market:
 - LNG plants
 - Deepwater platforms and FPSO
 - OCTG. Tubing for oil & gas wells.
 - Sensitive heat exchangers in petrochemical & chemical facilities
 - PTA (Pure Terephthalic Acid)
 - Urea, fertilizer plan
 - Chlorine plants



→ Low oil price and depressed oil&gas market, drop Ti consumption on process market for these associated applications.

Ti Process market



- Even if some applications still consume large amount of titanium like the 5th gas train in Kuwait which has just been awarded, these kind of projects remain limited. Previous gas train in Kuwait was awarded 5 years ago.

GAS TRAIN



- Mina Al-Ahmadi Refinery.
- Separation of liquid products (Propane, Butane and KNG) from the feed & supply lean gas to the end users (Power Plants) & Petrochemicals (Ethane)
- Several hundred Tons of welded and seamless Ti tubes.





Ti Process market



OCTG – HPHT WELLS

- Titanium offers:
Light / Corrosion resistance / Low T° expansion
Uniform mechanical / Erosion resistance
- Good alternative to nickel-base alloys as downhole tubulars for HPHT and deep wells.
- **But limited new projects as long as oil barrel will remain below 60US\$.**



UREA - FERTILIZER

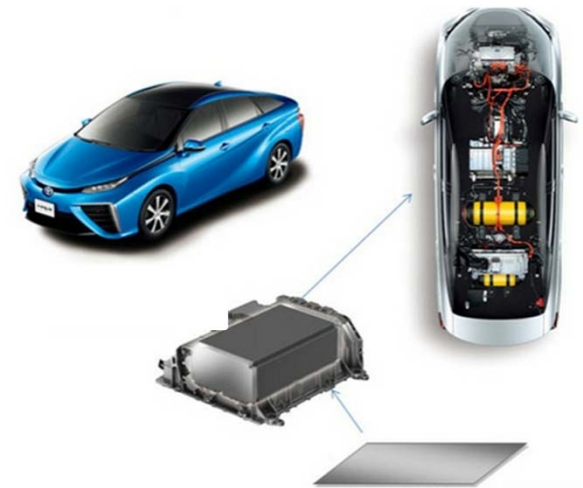
- Ti good corrosion resistance in urea + tolerates low oxygen levels.
Used in Ammonia Strippers or Urea reactors.
- Large production capacity coming on-line from 2008 wave of investment in China and Middle East.
- **Limited new investments foreseen in coming years.**



Ti Process market: New applications – Automotive Market



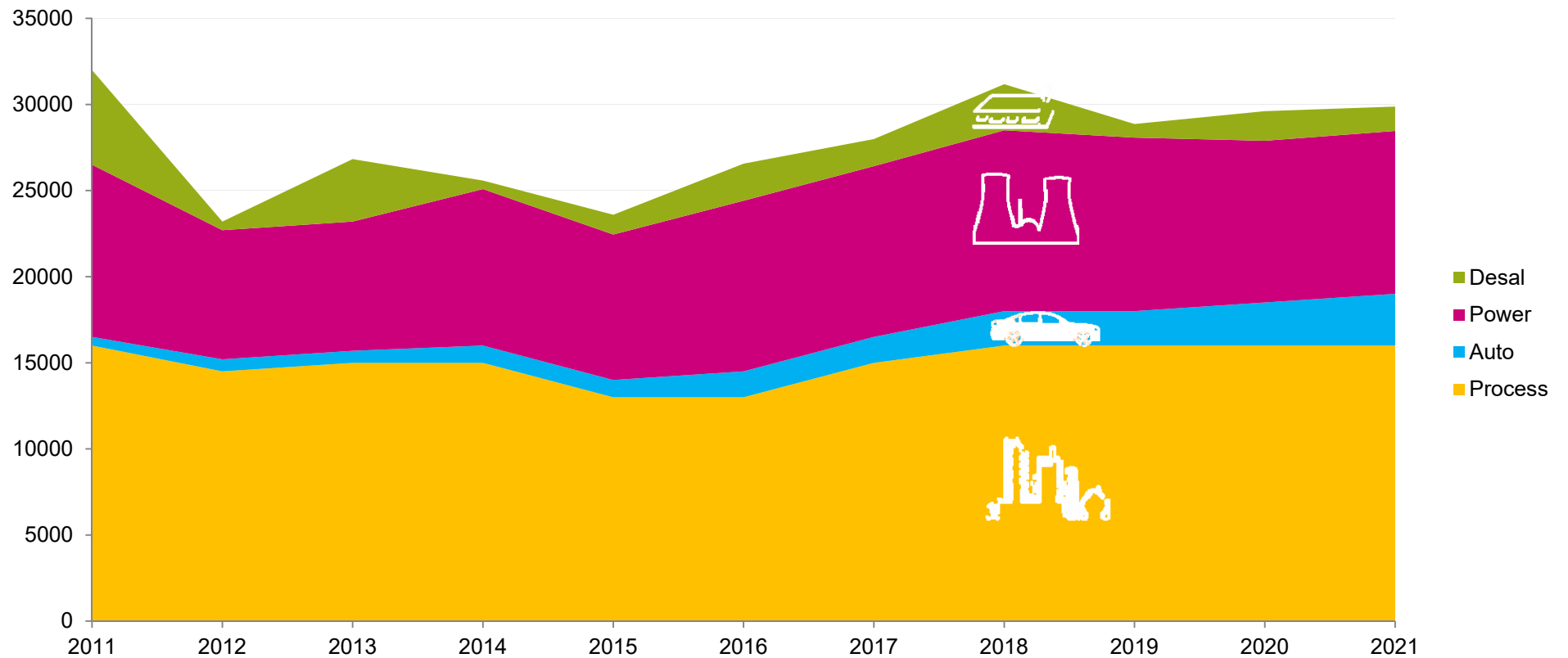
- Ti found its first application to the engine parts of racing cars in the early 80's.
- Then expanded to the muffler systems of sport bikes, engine valves, springs...
- More recently fuel-cell vehicles titanium materials show opportunities of volume & application development.



→ Ability to grow to represent several thousand of metric tons over coming years



Industrial Titanium Demand till 2021



THANK YOU

