現址式氣體處理設備節能減碳方案

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September 27th, 2022

EDWARDS

Sustainability Is A Broad Topic.

- Topics are taken from the materiality matrices of leading semiconductor companies.
- Areas of interest include environmental, human, regulatory, and business practice focusses.

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The challenge for a company within the semiconductor industry

Scope 2 *Indirect*

Emissions from generating electricity, steam, and cooling for own use.

Upstream Activities

Scope 3 *Indirect*

- Purchased goods and services
- Transport and distribution
- Capital Goods
- Waste from operations
- Fuel and energy-related
- Employee commuting
- Leased assets
- Business travel

Upstream Activities

Scope 1 *Direct*

CO_2, CH_4, N_2O, PFC, HFC, SF_6, NF_3

Company facilities

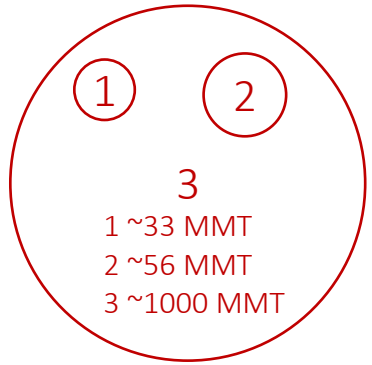
Company vehicles

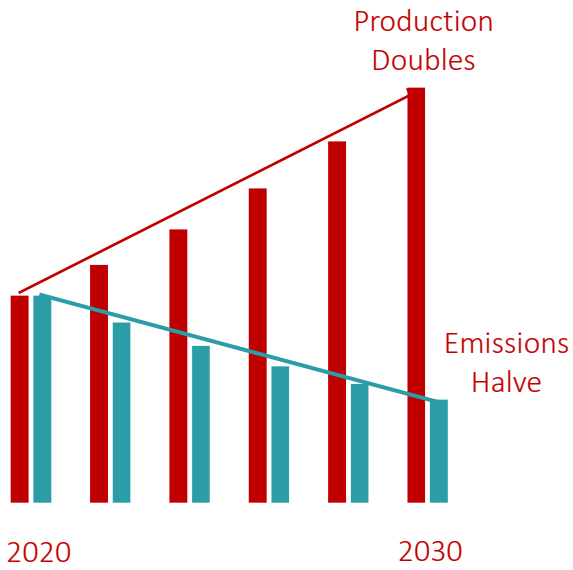
Reporting Company

Scope 3 *Indirect*

- Use of sold products
- Transport and distribution
- Leased assets
- Franchises
- End of life processing
- Investments
- Processing of sold products

Downstream Activities





- Need to have complete and consistent reporting of GHG releases and Scope 1, 2, 3
- Within the industry - Scope 3 >> scope 2 > scope 1
- Emissions need to halve in the next decade for a 1.5°C pathway – the industry capacity doubles

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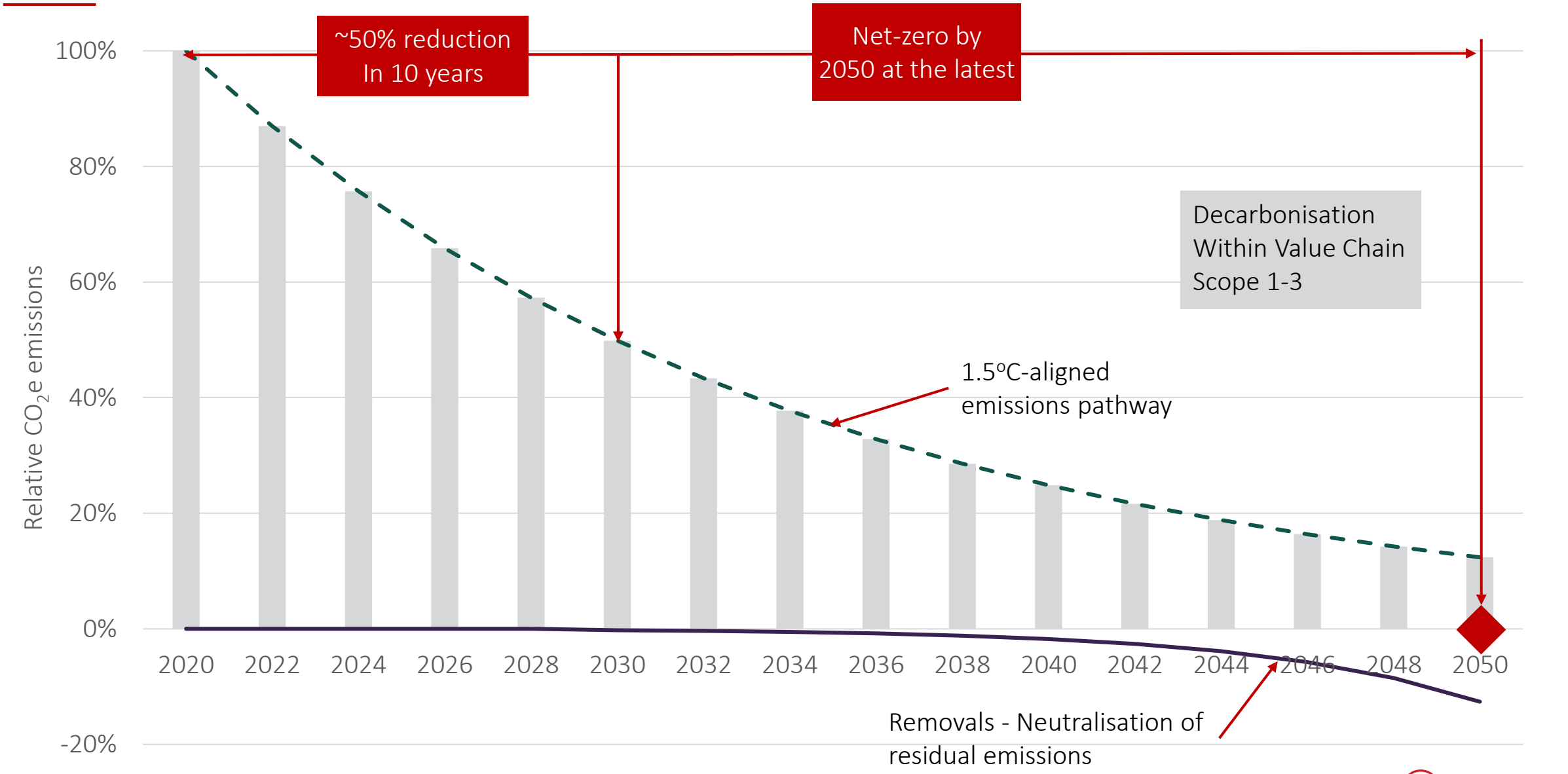
SBTi Net Zero Standard

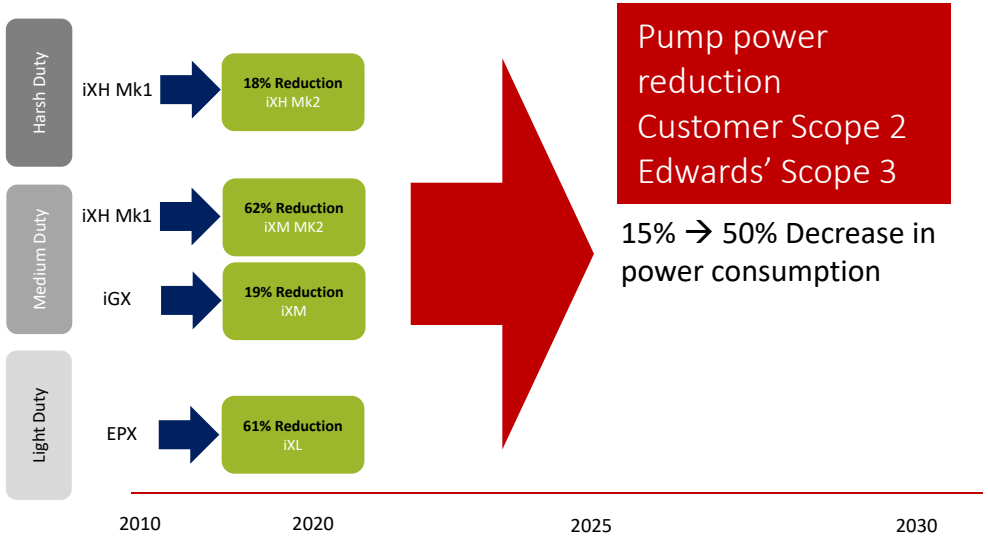


Edwards' Contribution

Renewable Electricity	Annual CO_2e saving (tonne)
Cheonan – Korea	18,682
Yachiyo – Japan	3,067
Cheonan – Korea	2,115
Brno – Czech Republic	870
Ina – Japan	639
Loyang – Singapore	699
Burgess Hill – UK	614
Yongin – Korea	527
Hillsboro – US	407
Clevedon – UK	367
Eastbourne – UK	364
Niagara – US	199
Jhunan – Taiwan	190
Dublin – Ireland	169

- *By 2030, Edwards semiconductor business* will reduce its GHG emissions by 46% for Scope 1 and 2 and 28% for scope 3[1]
- Our operations target (Scope 1 and 2) is consistent with a 1.5°C target reaching net zero by 2050[2]
- Our Scope 3 target is consistent with <<2°C warming.

1. Edwards as part of Atlas Copco science-based targets commitment, base year 2019
2. Global Warming of 1.5 ºC — (ipcc.ch)



Etch Burner Abatement
40% energy reduction
Customer Scope 2
Edwards Scope 3

DRE improvements
Customer Scope 1

Non-fossil fuel abatement
(Electrical - Where low-C power is available – customer Scope 2, Edwards' Scope 3)

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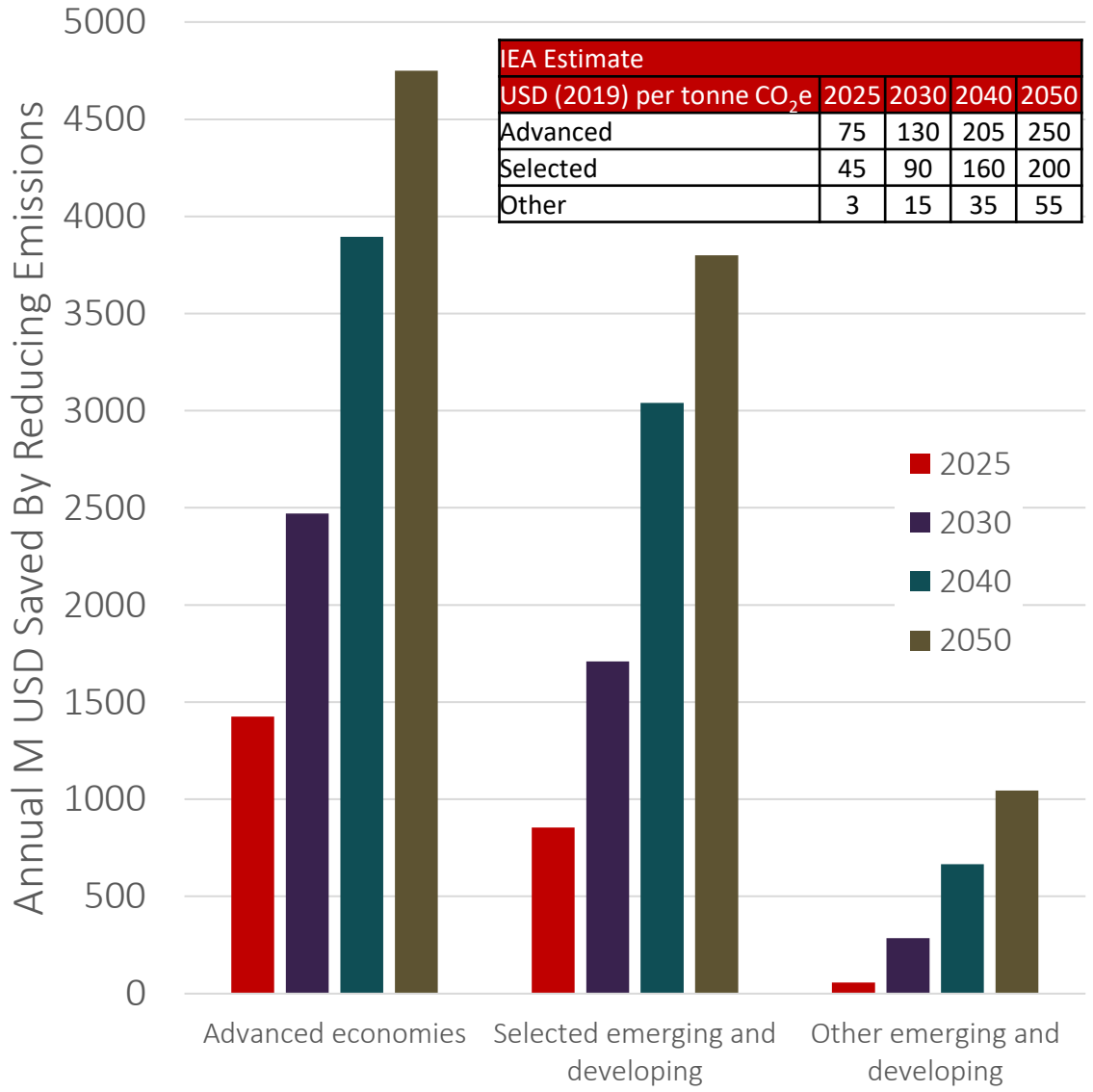
The value of emissions prevented as carbon price changes

Annual Emissions Prevented By Edwards Abatement Million MT CO_2e



IEA Estimate				
USD (2019) per tonne CO_2e	2025	2030	2040	2050
Advanced	75	130	205	250
Selected	45	90	160	200
Other	3	15	35	55

ATLAS ENERGY SAVING ON ETCH

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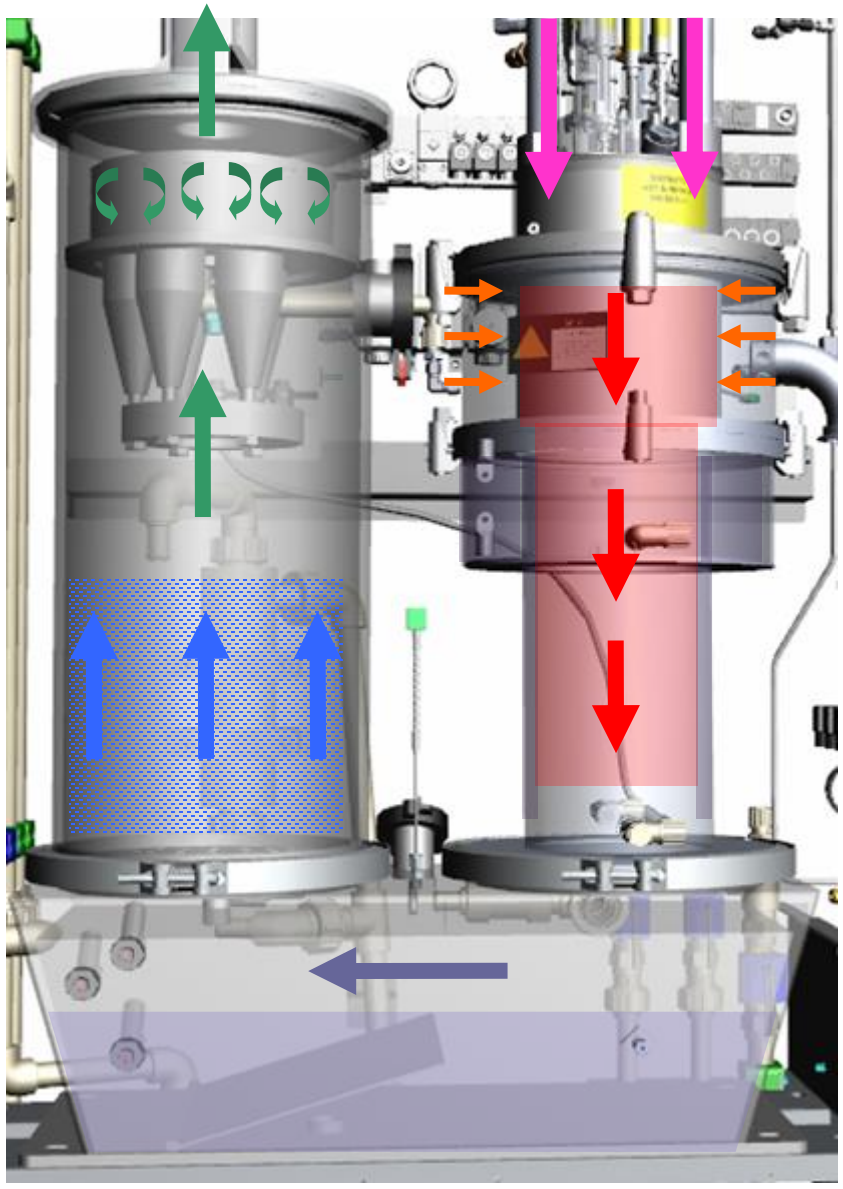
Atlas – Gas abatement process

Demist air cyclone

Detoxified gas

scrubbed by-products

high surface area
wet scrubbing



Untreated process gas

Fuel + Air

Reaction zone

Combustion by-products

cooled by-products

Water

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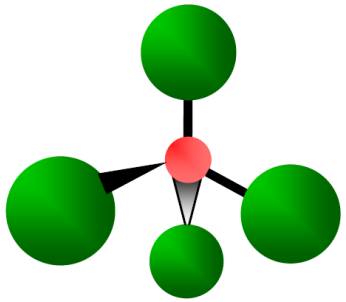
PFC molecules destruction

PFC like CF_4, C_2F_6 and SF_6 have a strong molecular bond

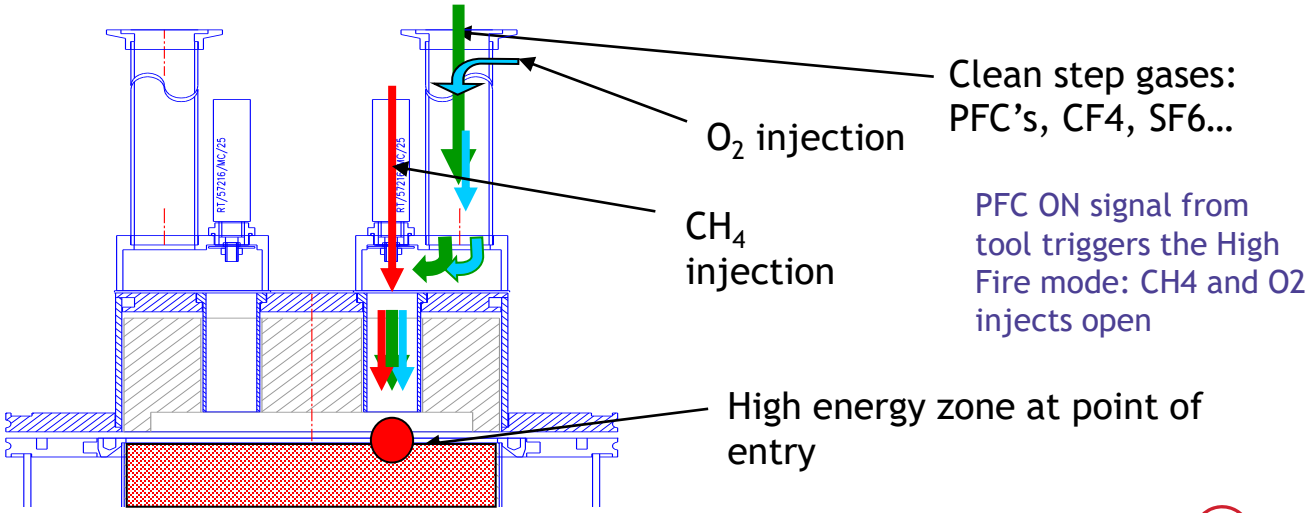
- Breaking these molecules needs extra energy
- This is why Atlas uses “high fire” mode
- Injection of Fuel + Oxygen at the nozzles



CF4

High fire mode provides the extra energy, locally, close to the nozzles..

- Temperature rises locally
- Chemical environment is very reactive locally



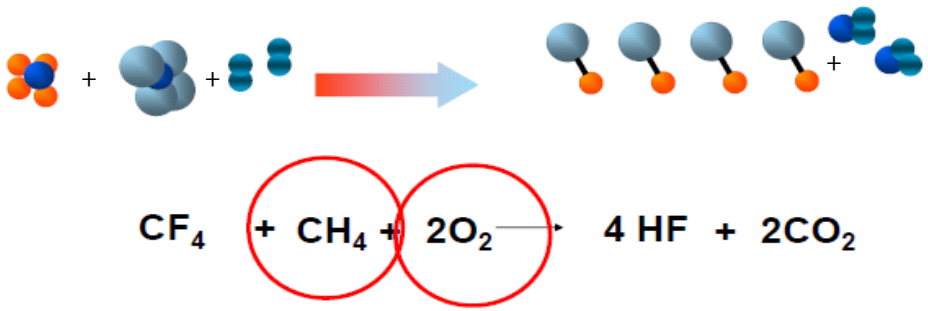
Atlas Etch – PFC Mode abatement

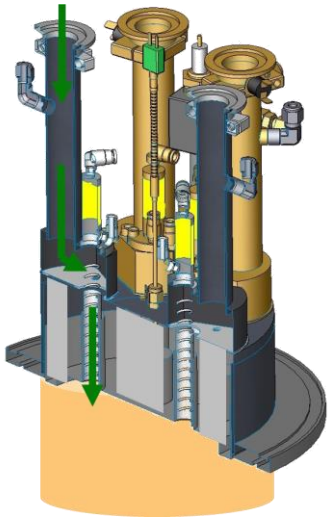
Standard Mode

- Inward fired combustion provides energy of activation and reactive/ combustion

PFC abatement Mode (triggered PFC ON by signal from process tool)

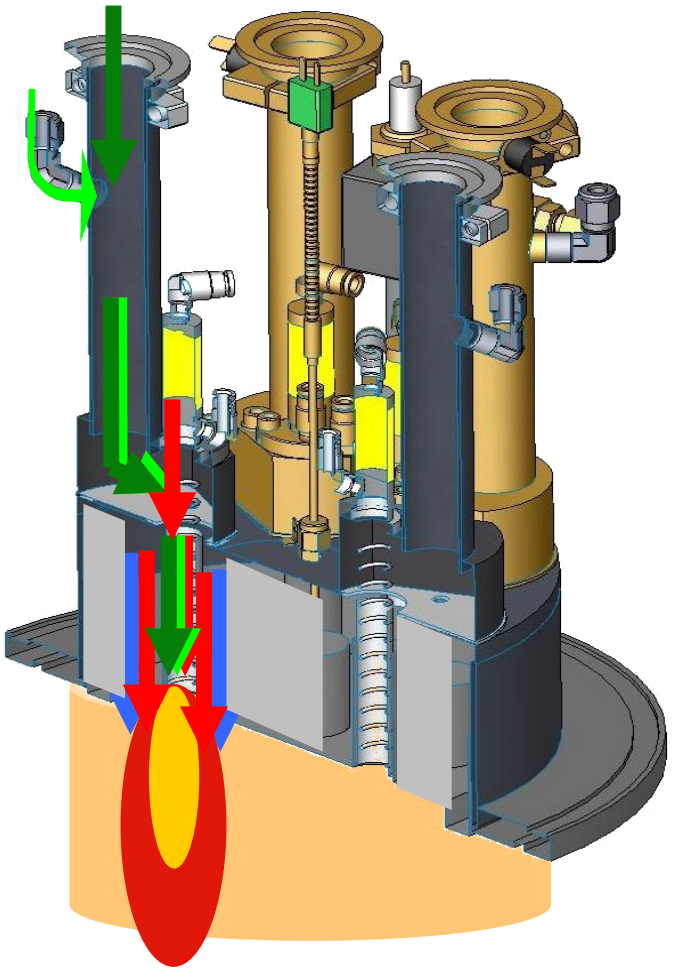
- High intensity flame created on the end of the nozzle
- Premixed flow of oxygen
- Lance and concentric flow of fuel gas





Standard Mode

PROCESS FLOW – Quadrant
O_2 INJECT - Premixed
Fuel Inject – Lance
Fuel Inject – Concentric Nozzle



PFC Mode

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Atlas Energy Saving on Etch - ULF

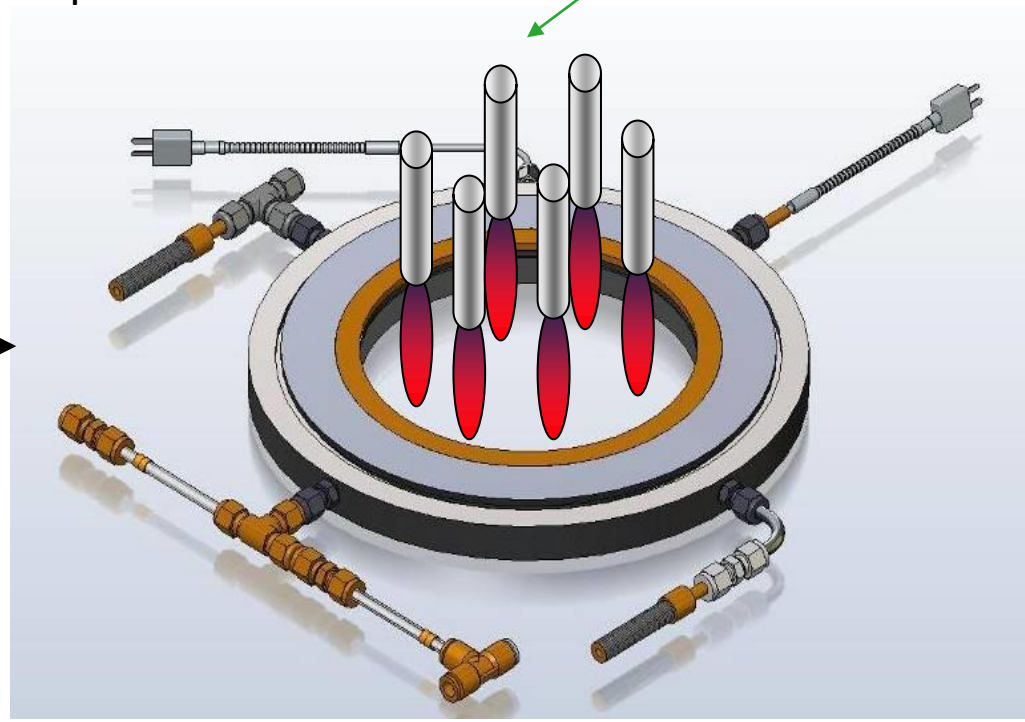
ULF (ultra Low Fuel) - reduction of Atlas burner to an annular pilot plate

- Smallest possible size, ~4slm methane consumption
- Circular pilot surrounds entering process gases
- Ensures ignition of all flammable gases
- Fuel-rich mix reduces powder deposition

- Unique “inward fired” technology
- Alzeta ceramic liner
- No corrosion
- Excellent powder handling

Conventional Burner

ULF pilot



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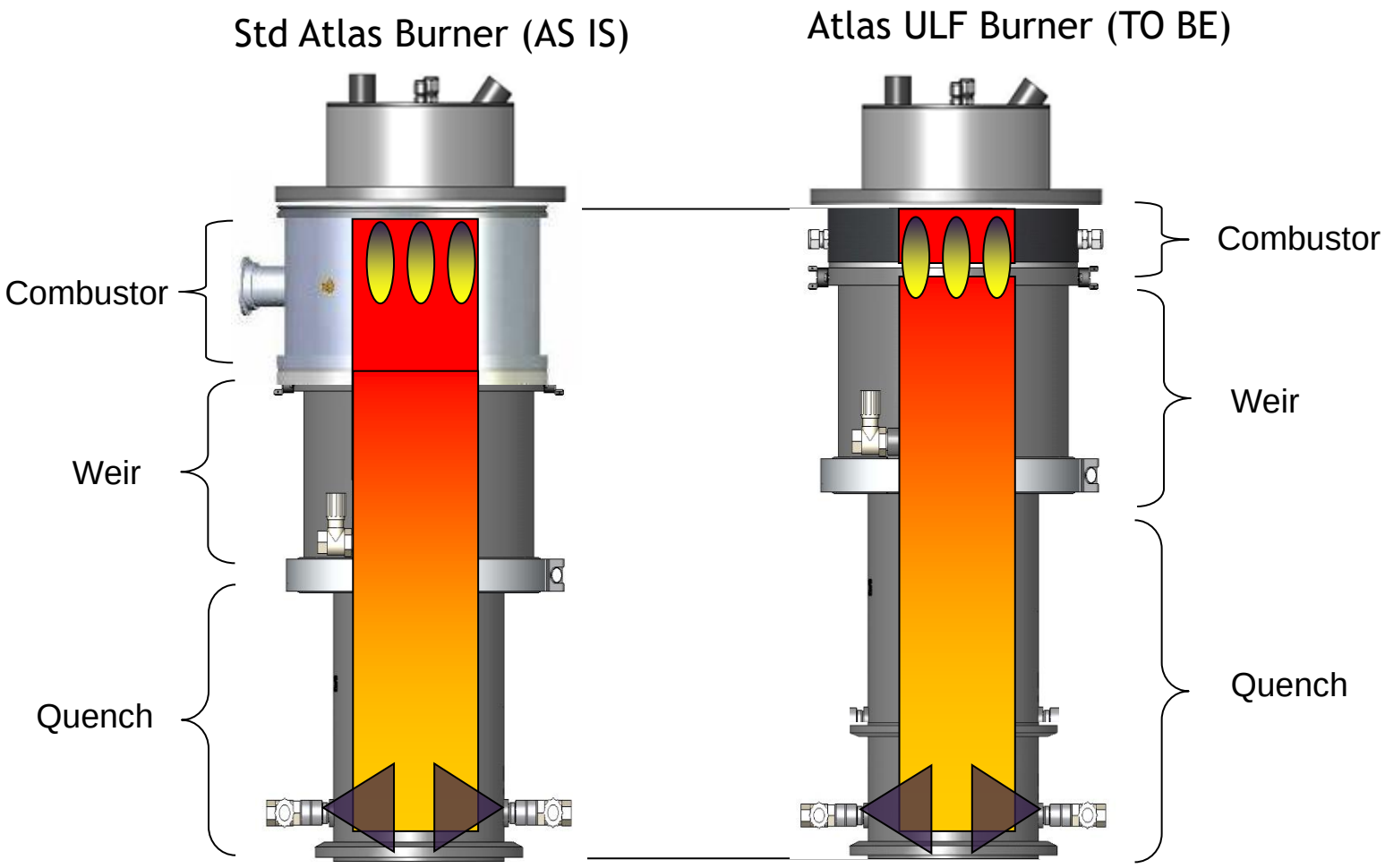
Atlas Energy Saving on Etch - ULF

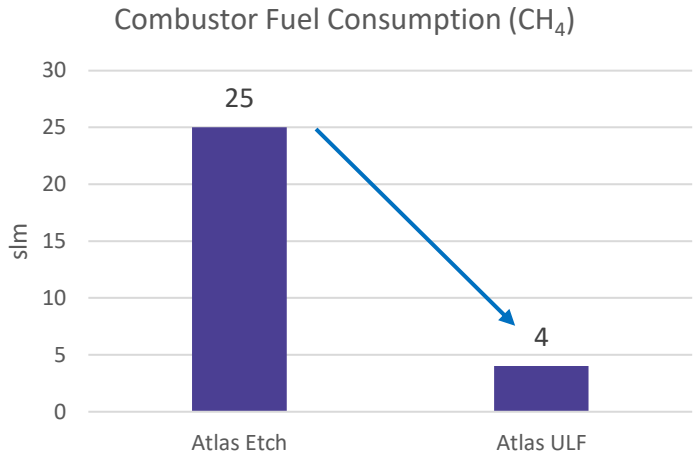


Atlas Energy Saving on Etch - ULF

Comparison of utility consumption

Utility/Atlas Model	Atlas Etch	Atlas ULF
Power	-	↘
CH4 (combustor)	-	↘
CH4 (inject)	-	→
O2	-	→
CDA	-	↗
N2	-	→
PCW	-	↘
Make-up water	-	→
Waste water drain	-	→
Exhaust flow rate	-	↘

↗ increase
↘ decrease
→ not change



	CH4 flowrate (slm)	Annula Consumption (m3)	CO2e (ton CO2e/yr)
Atlas Etch	47.1	24,482	46.2
Atlas ULF	27.1	14,101	26.6
reduced	**20.0**	**10,381**	**19.6**

* based on 70% high-fire with 3 inlets and 99% uptime
**SEMI S23: calculation by CH4/O2/CDA/PCW usage only

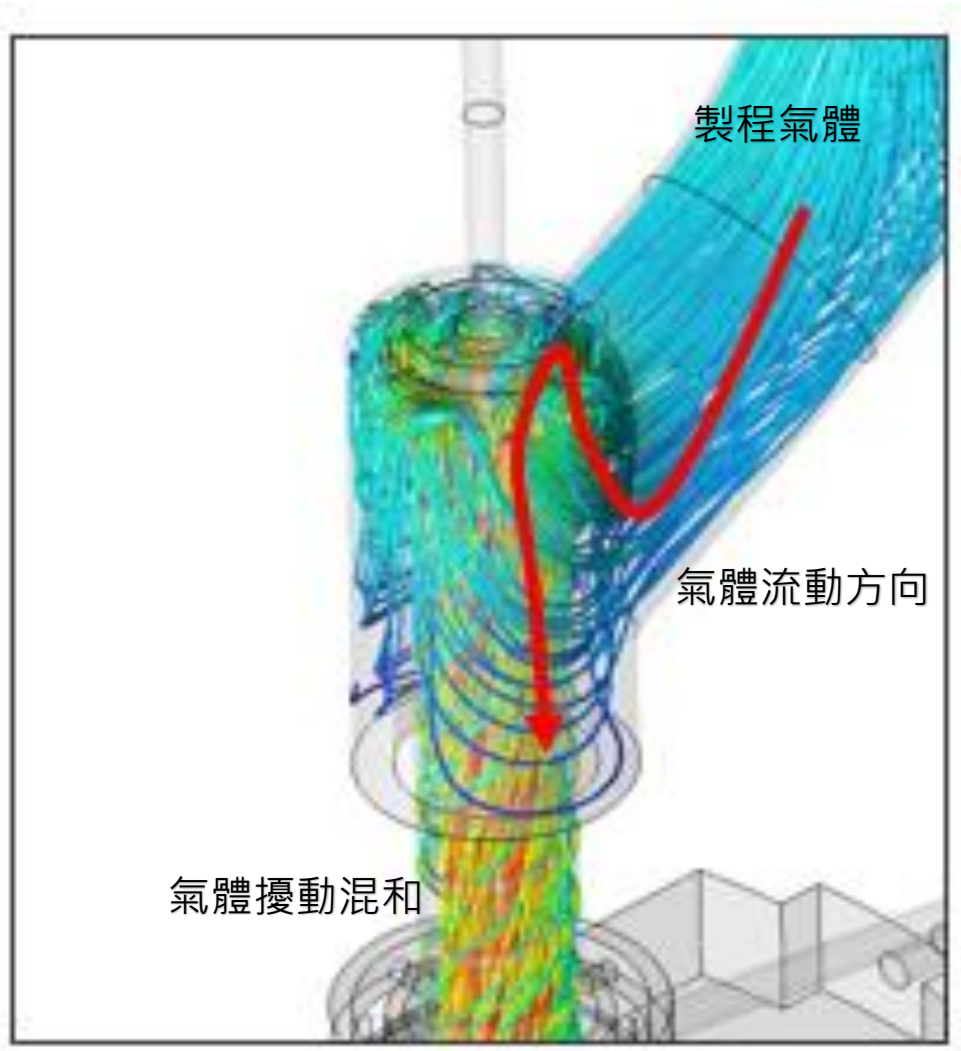
Atlas Energy Saving on Etch – Swept Inlet

- Approach focused on fuel reduction strategies for Atlas Etch product
  - Generic inlet design ⇨ Swept inlets

- Etch swept inlets – designed to improve mixing of process & inject gases
  - The same DRE performance achieves up to 20% fuel/oxygen reduction
  - Same independent control of inject gases but CFD modelling lead to shifted inject location for optimised mixing
    - Tuned fuel & O_2 settings

- Primary Benefits
  - 20% reduction of fuel/oxygen inject flow rate and lower NOx CO emissions
  - or higher capacity (20% increased) with identical inject flow rate
  - or higher DRE performance

Etch specific inlet: Swept Inlet



Summary

Energy saving on Etch abatement

- Atlas ULF
  - Upgradeable on existing Atlas systems
  - Fuel reduction from 25slm to ~4slm
  - CO2e reduction ~19.6 (ton/yr) per system
  - New system capacity of Atlas ULF is up to 300/600 slm
- Atlas with Swept Inlet (ongoing)
  - Upgradeable on existing Atlas systems (Swept Inlet + ULF)
  - 20% reduction of fuel/oxygen inject flow rate and lower NOx CO emissions
  - or higher capacity/total inlet flow rate (20% increased) with identical inject flow rate
  - or higher DRE performance
- Reduce emissions by adopting signaling and reducing purges
  - Use of tool signals
  - Minimise upstream purges and dilution (with CF4 DRE >95%, max CF4 flow rate@12slm per Atlas Etch system)

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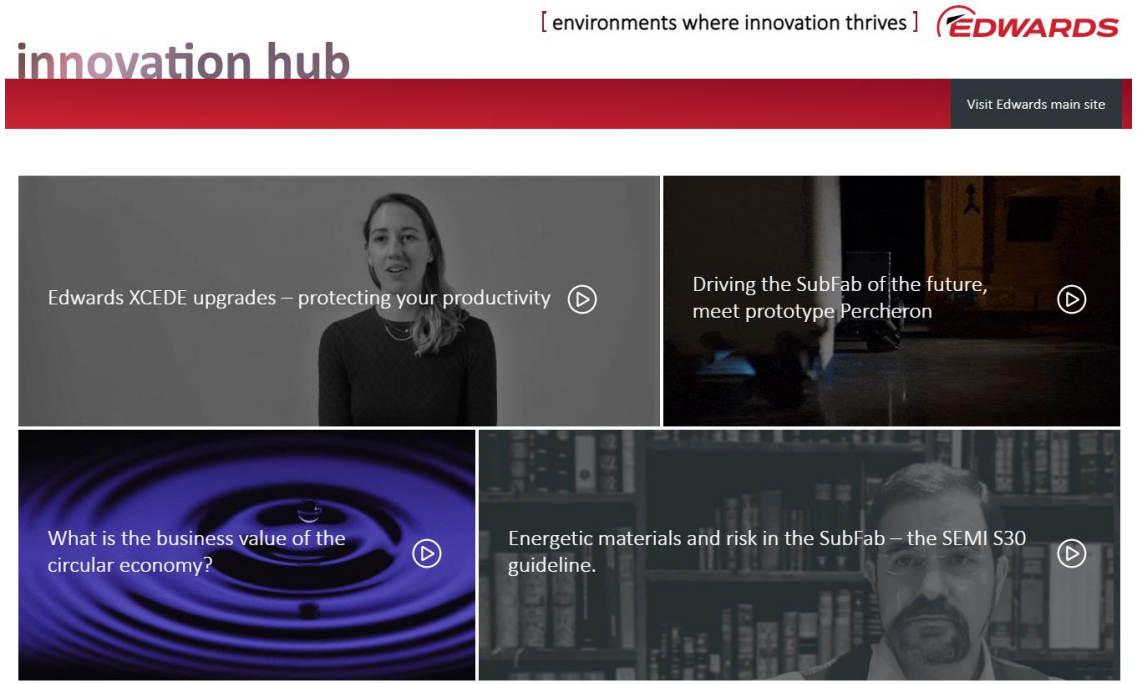

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