



Materials science in the world
of catalysis: technology to
business

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Overview

Materials Science as driver for product development In catalyst applications

Technology as what is at the core and as the art of meeting specific difficult customer needs

Business of converting customers to take risks; together, i.e. what partners do

The world of catalysis – how to be a small (but perfectly formed) global company. Necessity not a choice....

The global HR dept.

Materials Science as driver

Newcomer to catalyst industry

Outsider's perspective = innovation

Business of converting customers to take risks; together

Materials platform that is unique – and we do actually care about materials platform

Unique products (“technologies”) emerging from platforms to answer customer/market driven needs

- Closing the disruptive gap
- Products as intermediaries between platforms and customers' needs
- Boil it down to one task, one only = productization.

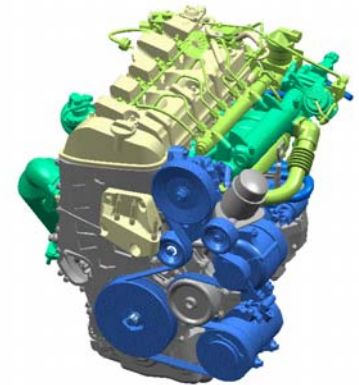
emission standards dominate in all cases

1. Gap between Tailpipe and Engine- out emissions
2. Is there some other technology that can meet that gap?
 - e.g. >2010 SULEV on everything in USA?: <10mg/mile HC
a simple air pump will suffice to get big exotherm!!
 - e.g. HCCI diesel (Cat, PSA..) --- no soot and very low NOx
soot filter goes away; deNOx goes away... ☹
but DOC gets very difficult: CO rich gas; 50degC ☺
3. Based on disruptive gap and assessment of what else can close gap ---- build up picture of where technology drivers (and margin) may be!

Unique products (“technologies”) emerging from platforms to answer customer/market driven needs

- Closing the disruptive gap

*Diesel vehicle emissions control example:
A global problem...*



Engine development is very rapid through time

Tailpipe regulations tighten through time

Catalyst functions to close the gap – soot and NO_x

What does a catalyst developer target?

Prototype Diesel for EU Market

*The Compatibility of the Low Emission &
Low Combustion Noise & High Fuel Economy*

Weight Reduction

Aluminum
Cylinder Block

After Treatment

Oxidation CAT

Variable Geometry
Turbocharger (VGT)

High Efficiency
EGR Cooler

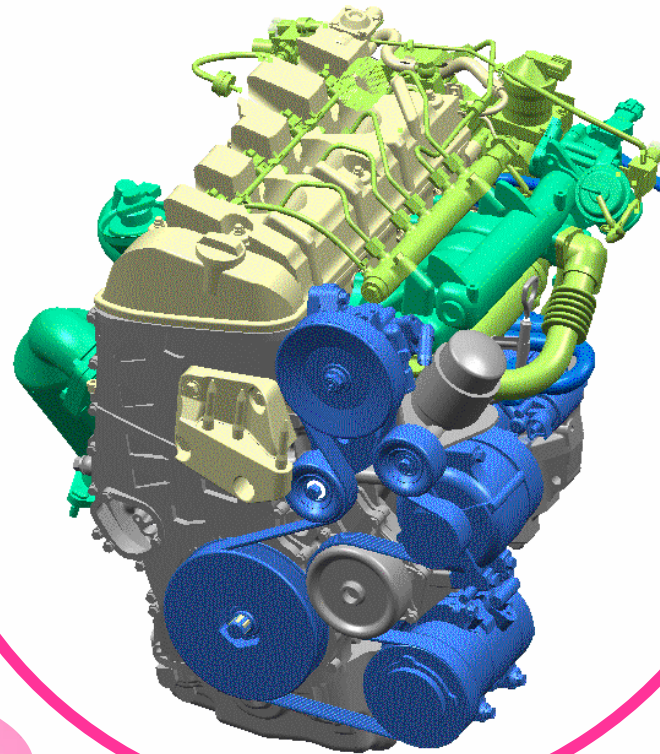
Combustion System

Swirl Control Valve
(SCV)

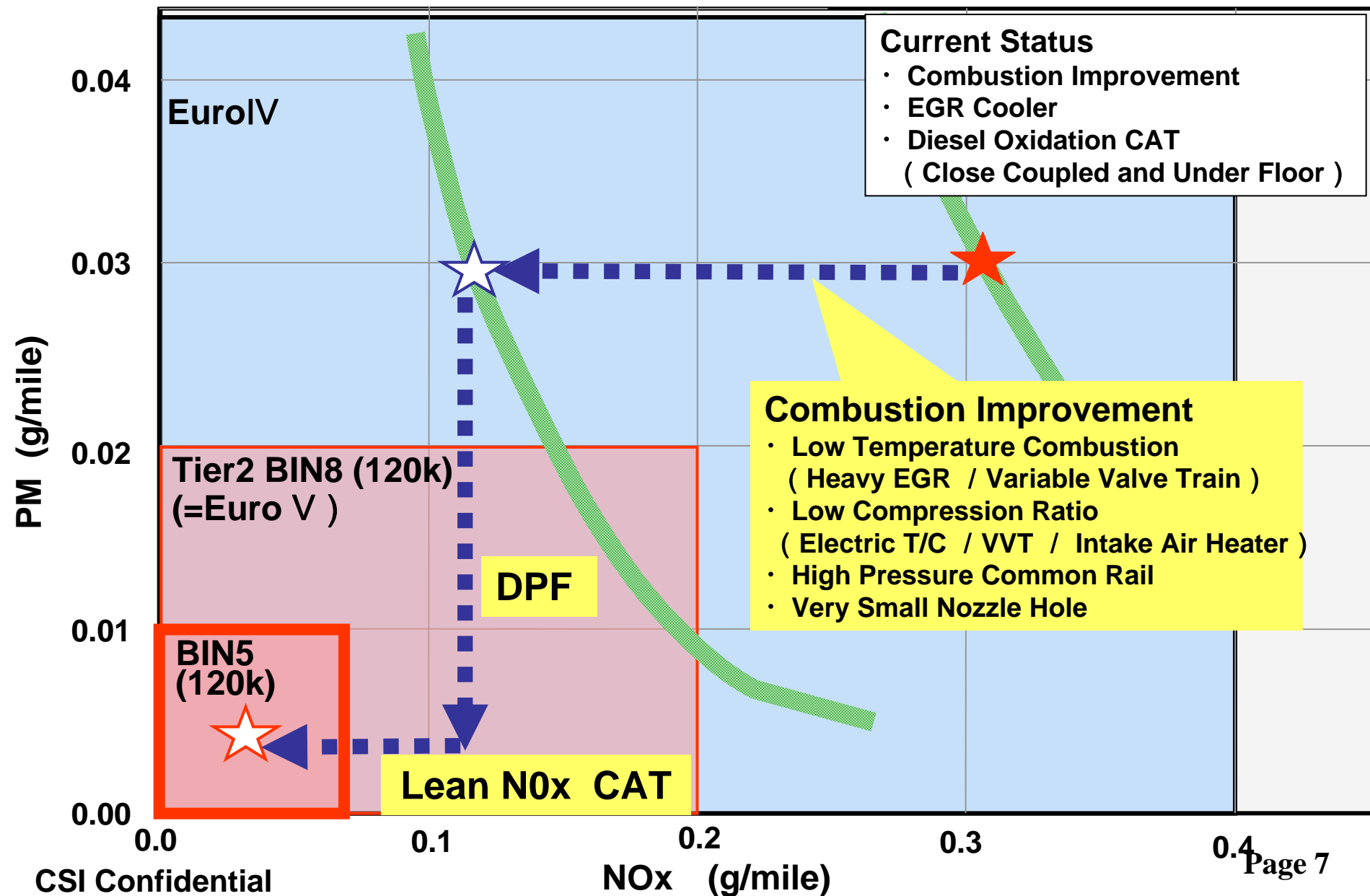
Common Rail System

Combustion Chamber
Optimization

Nozzle Specification
Optimization



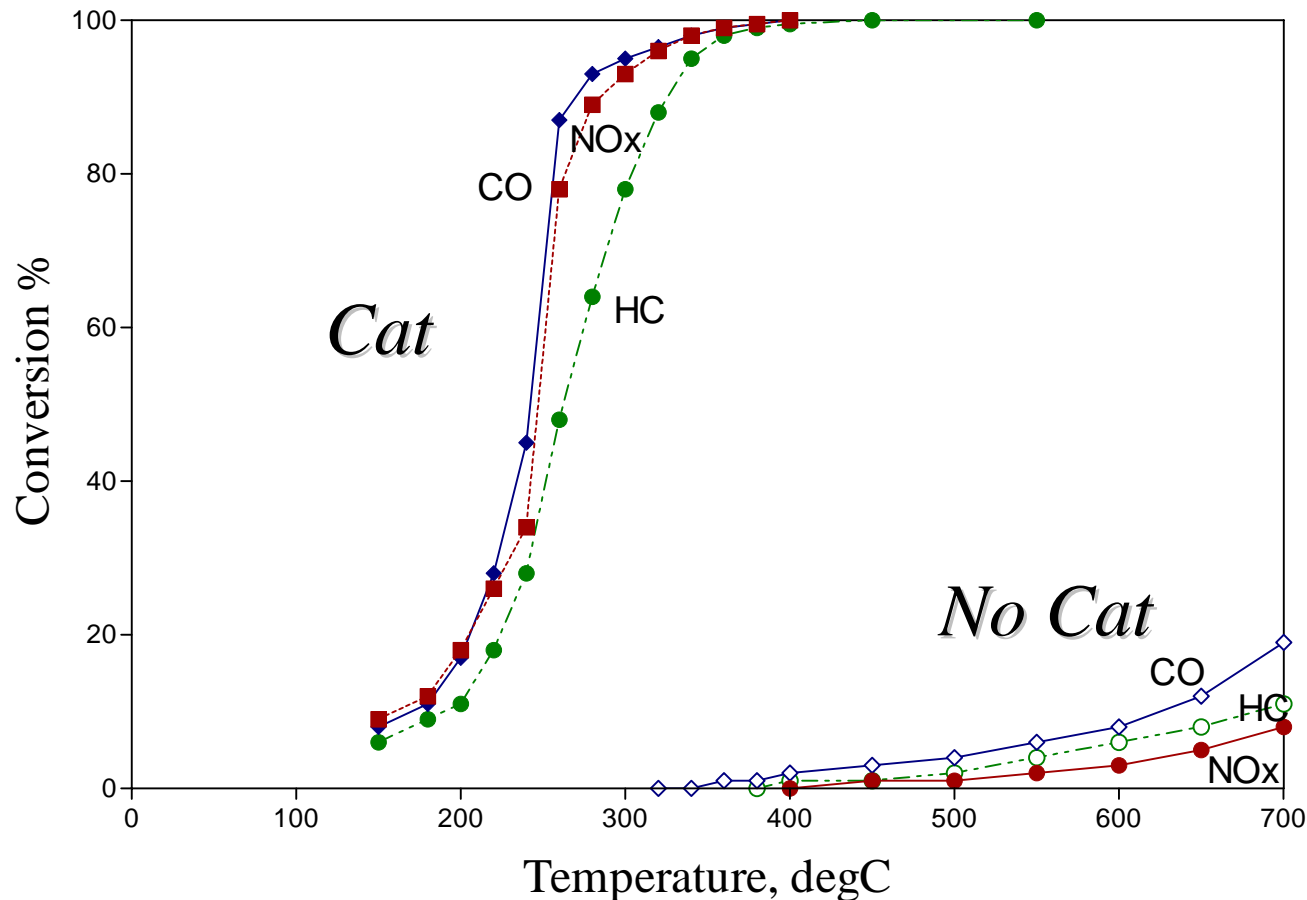
Emissions map for diesel



Catalyst light-off temperature

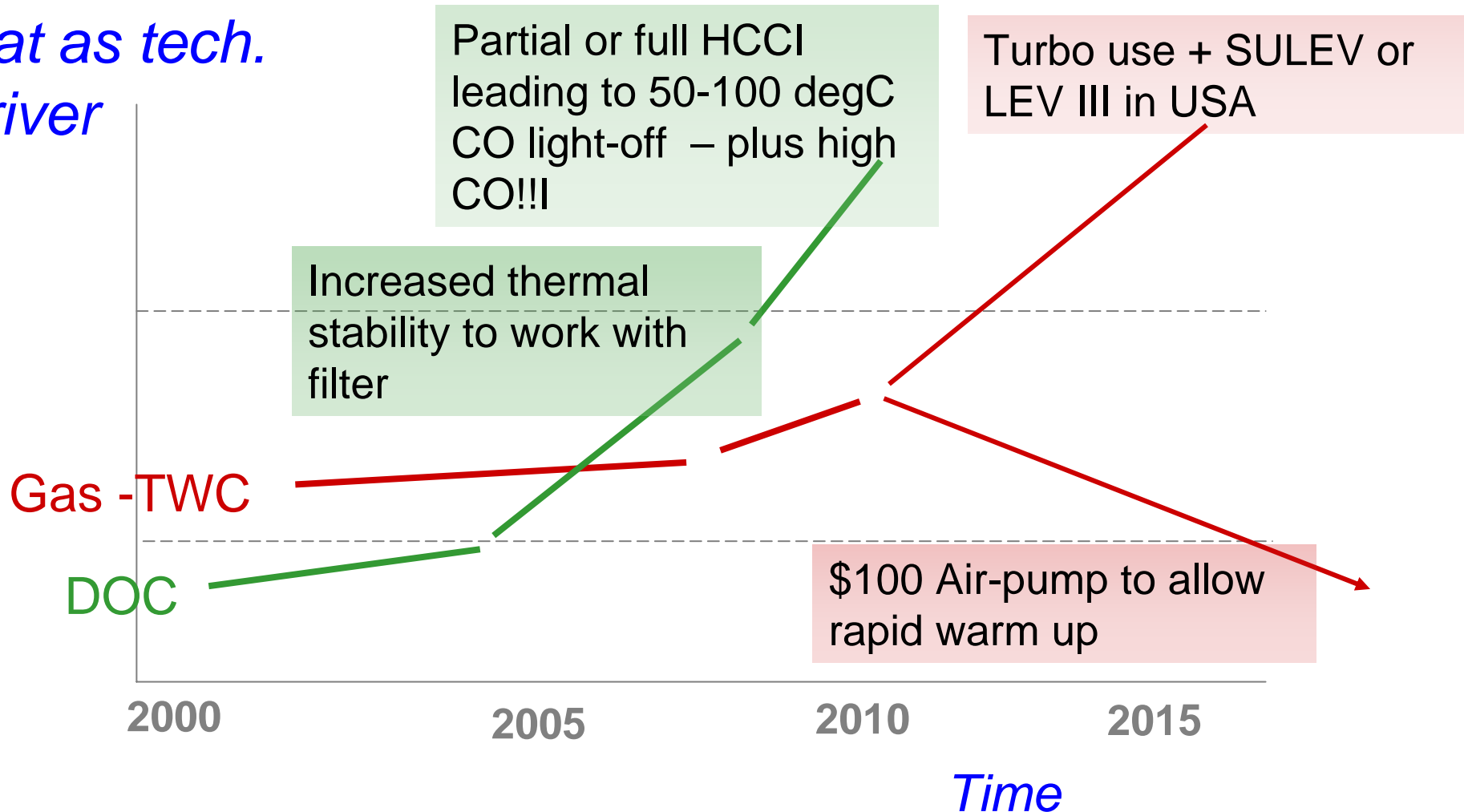
CSI TWC versus no catalyst (gas phase)

120,000hr-1; 0.5Hz; 0.3g/L Pd; 1050degC aged



Technology need based on macro trends

*Cat as tech.
driver*



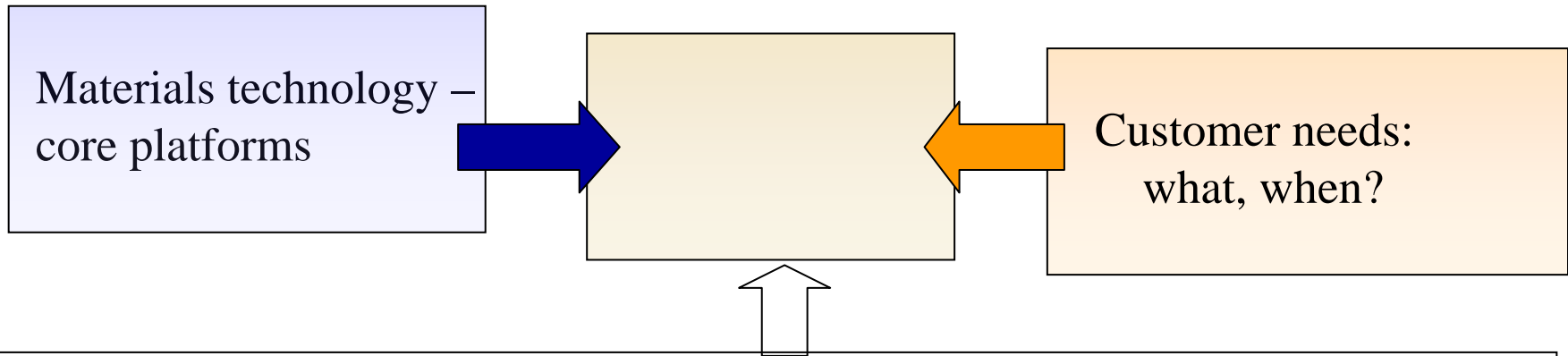
TWC = Three-way Catalyst (NO_x, CO, HC)
But what about competitive technologies

Core technology and business

Platform Technology

Product Technology

Customer Need



Product as act of convergence and linkage. Deliberate design from platforms focused on customer's (business) need

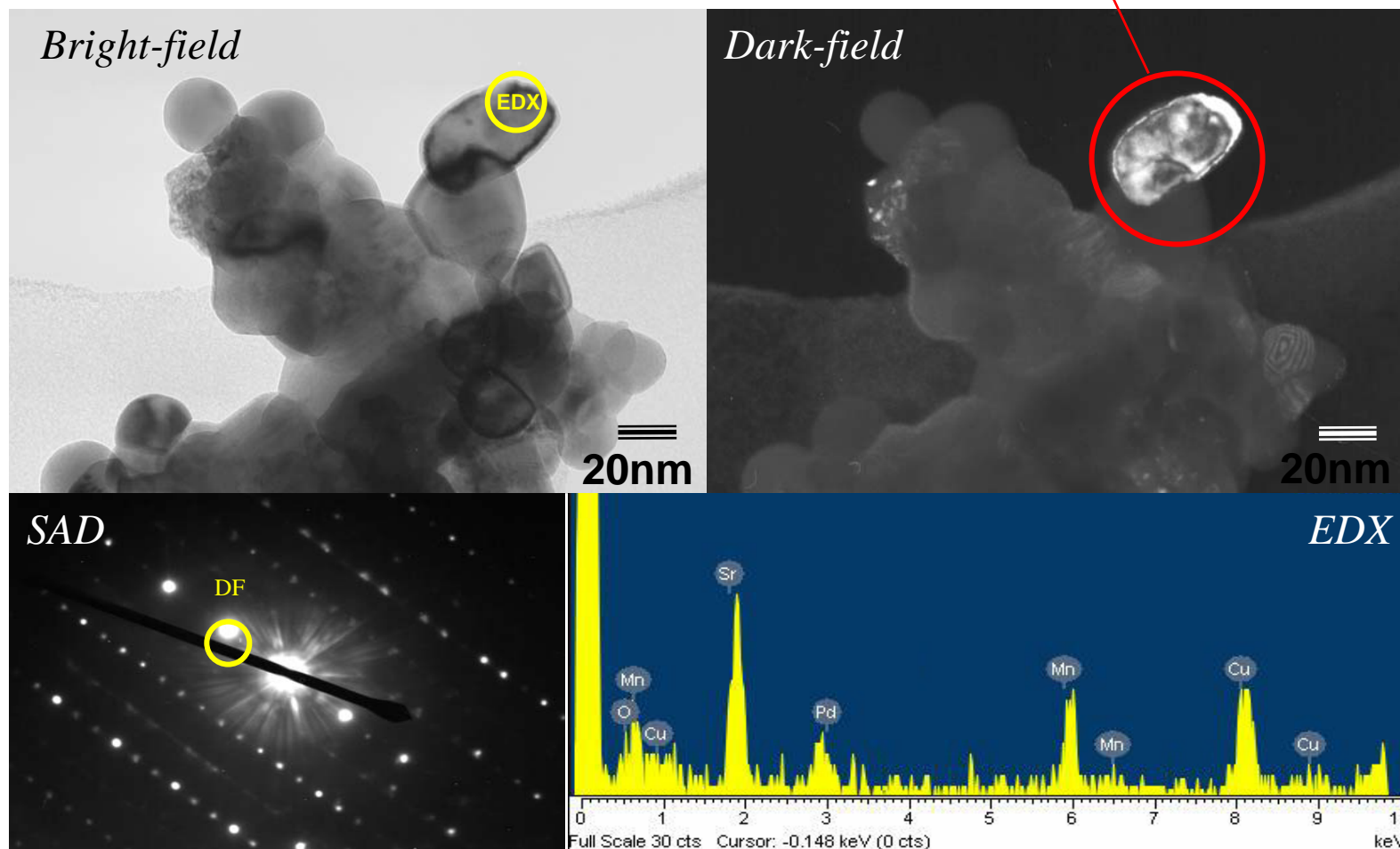
Start by defining customer need (what do they really want and need and when) and know the core technology

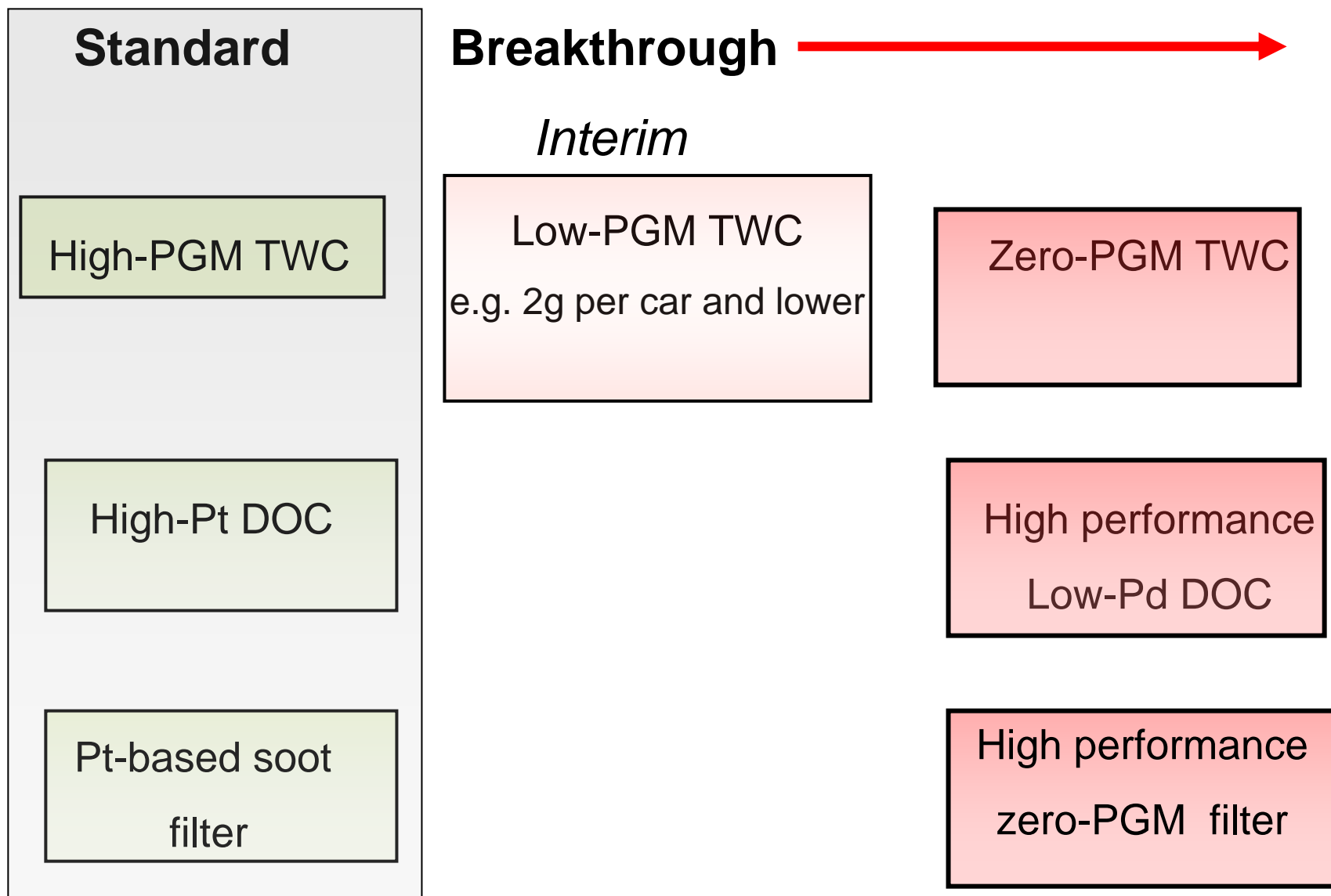
Then build product development team to deliver

CSI-MPC Pd system – example

**Bright-field, dark-field, selected-area diffraction
and EDX data from 2 :1 Perovskite Dr. Joon Choi**

*Location of Pd in perovskite solid
solution. Perovskite part of multi-
phase mixture*





Market/customer needs aren't always predictable or “visible”...

Stresses quality of relationship and interface

Rhodium example:

80% used in catalytic converters

Very volatile – car makers never act together

\$600 per ounce two years ago – now \$4500 an ounce.

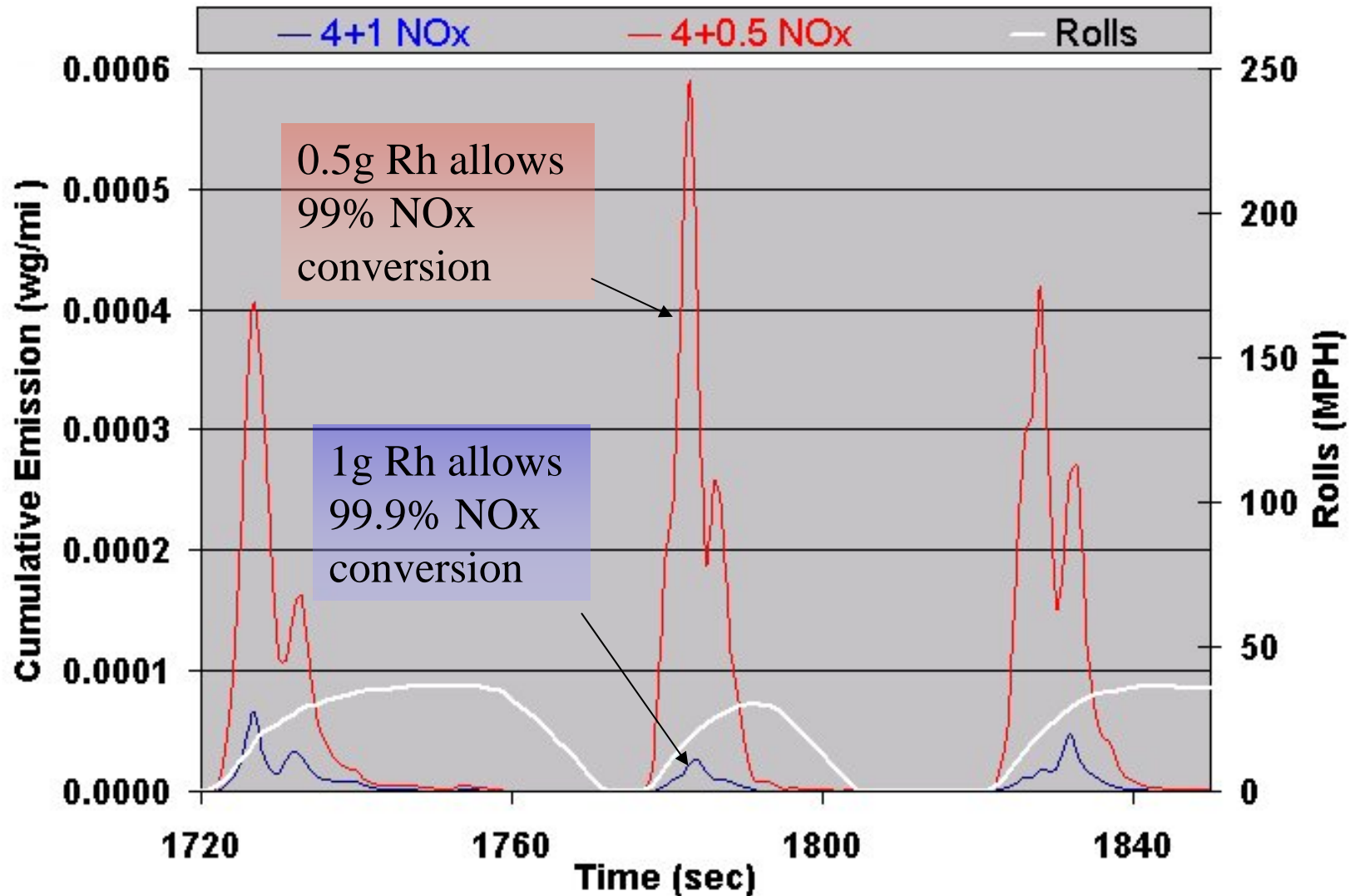
Can catalyst companies reduce Rh usage to answer specific need
= Product development challenge>

Who has best platforms and
who has best productizers ?

The Rhodium addiction

Very high engine-out NO_x transients on V8 truck

1 g Rh per truck to get low tailpipe NO_x with current TWC tech



- A. What are probable technology solutions when conversion/selectivity required increases disruptively?

Overall technology drivers ---- “product strategy A”

- B. In periods of relative calm –TWC - there is still huge value to be gained (Pd/Rh to Pd to non-PGM in TWC)

Product drivers ---- “product strategy B”

- C. Customer driven technology and product strategy – it’s all there is! Build partnerships to maximize co-incidence of value on both sides (show it repeatedly across portfolio)

Customer drivers ---- “product strategy C”

Operate on all three levels:

C is centre!! But drive A and B to keep it right strategically and tactically – the customer isn’t always right..

Deliver operationally

Small and global....

The world of catalysis – how to be a small (but perfectly formed) global company. Necessity not a choice....

Customers are global.

GM, Ford, Honda, Toyota....



Good customers (=partners) may not be domestic.

Build infrastructure with right people locally

“HQ” driven by local team who understand what we really need to do.....they are the authority

Internal culture to support targeted growth

- people to do tough product development



- A. Have to be willing to do difficult projects for partner.
Can't want partnership and then want low-risk projects.
 - Enjoy problem solving and science – mechanisms at the core
- B. But having the partnerships (“customers on a plate”) allows science and calm to dominate product development process – have 12 months on your own instead of 3 months versus 5 other competitors...
- C. Key people that shape culture are researchers (optimists) with inspiration and perspiration (and sense of humour).

Small and global HR needs....

Global nature of technology businesses is a fact

Company HQ needs to be adaptive and respond to authority of local teams



Need to have mix of cultures, personalities to interface with customer teams and business opportunities (dialogue needed).

Product development groups need to have the right global mix