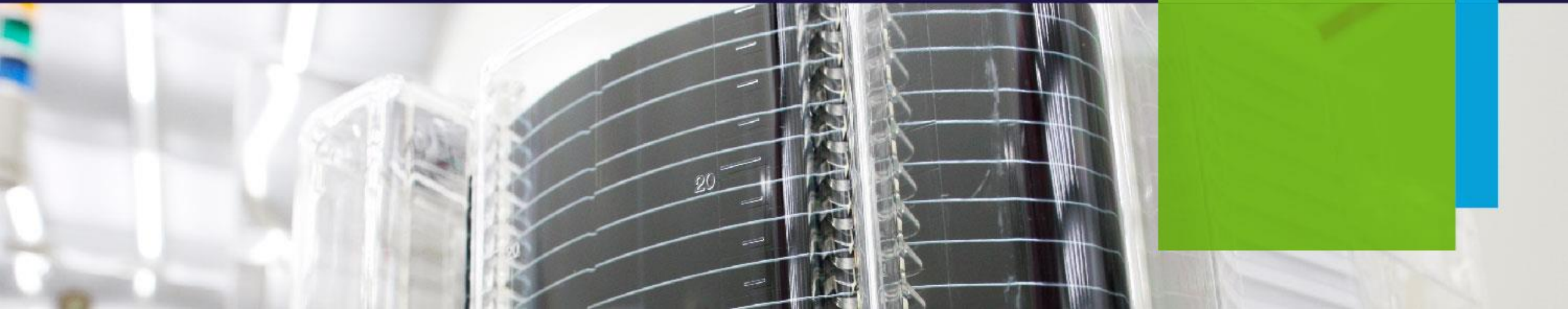


# Medium-term Management Plan

28 May, 2019

Toshiki Kawai  
Representative Director, President & CEO



# Forward Looking Statements

- Disclaimer regarding forward-looking statement

Forecast of TEL's performance and future prospects and other sort of information published are made based on information available at the time of publication. Actual performance and results may differ significantly from the forecast described here due to changes in various external and internal factors, including the economic situation, semiconductor/FPD market conditions, intensification of sales competition, safety and product quality management, and intellectual property-related risks.

- Processing of numbers

For the amount listed, because fractions are rounded down, there may be the cases where the total for certain account titles does not correspond to the sum of the respective figures for account titles. Percentages are calculated using full amounts, before rounding.

- Exchange risk

In principle, export sales of Tokyo Electron's mainstay semiconductor and FPD panel production equipment are denominated in yen. While some settlements are denominated in dollars, exchange risk is hedged as forward exchange contracts are made individually at the time of booking. Accordingly, the effect of exchange rates on profits is negligible.

- Disclaimer regarding IHS Markit data (Page 84, 86)

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- Disclaimer regarding Gartner data (Page 6)

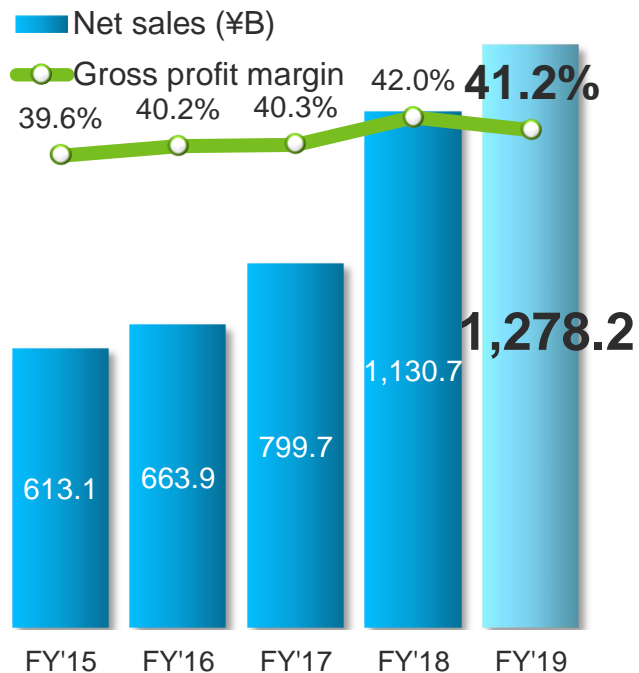
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# Today's Key Messages

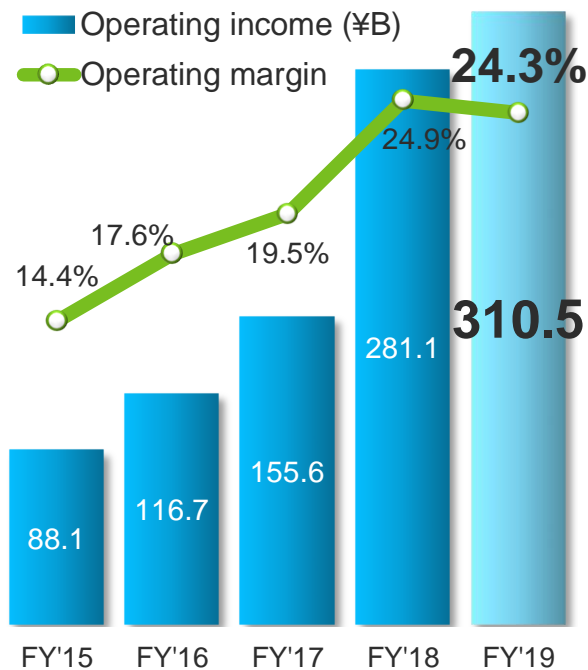
- With the adoption of IoT, AI and 5G the transition to a data society is accelerating. Amid the expansion of semiconductor applications and demand for technological innovation enabling this transition, medium- to long-term growth in both the semiconductor and FPD manufacturing equipment markets can be expected
- TEL's business expansion is progressing well in focus areas. Both sales and profit outperformed market growth
- Revised financial model towards further growth. Aim for world-class operating margin and ROE of over 30% in the medium- to long- term
- Plan to repurchase 150B yen of own shares based on our confidence in future profit growth and in light of our current cash position and growth investment capital

# FY2019 (April 2018 – March 2019) Highlights

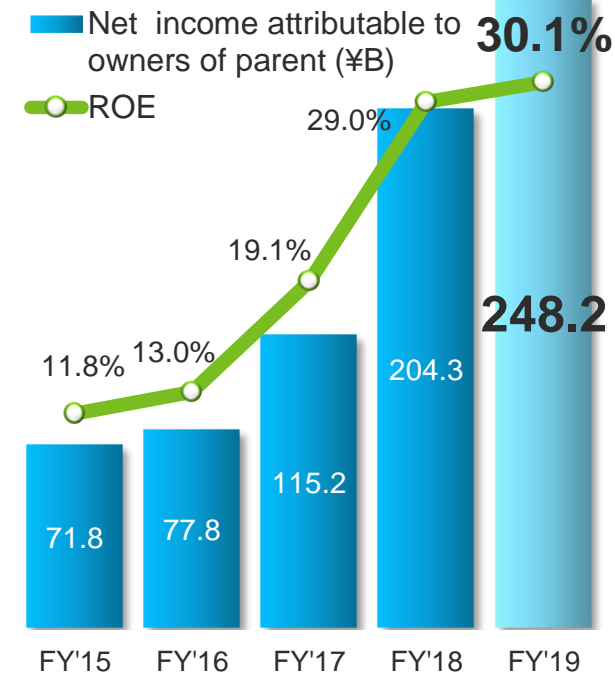
## Net Sales and Gross Profit Margin



## Operating Income and Operating Margin

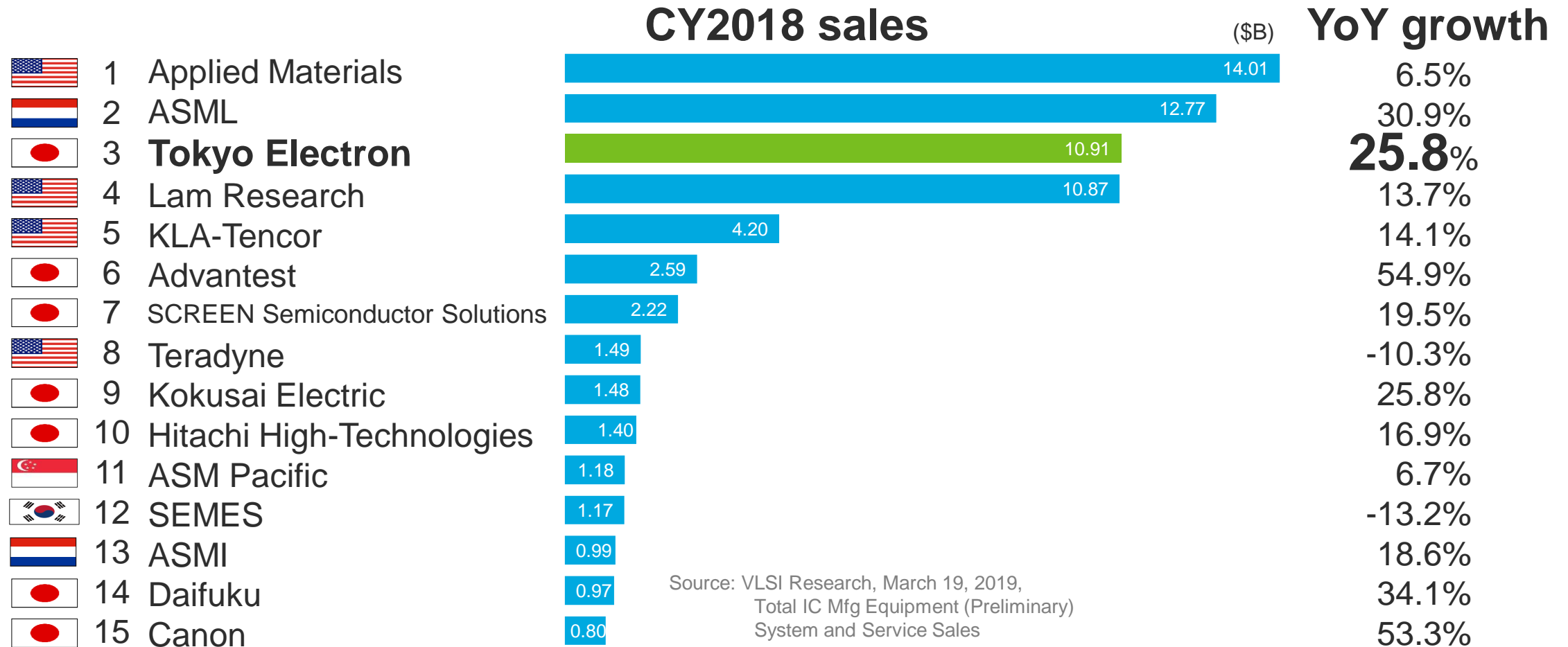


## Net Income Attributable to Owners of Parent and ROE



- Net sales +13% YoY driven by higher competitiveness in the growing SPE\*1 market and expanded share in FPD\*2
- New record highs for gross profit, operating income and net income attributable to owners of parent
- Achieved medium-term ROE target of 30%

# CY2018 SPE Makers Top 15



Source: VLSI Research, March 19, 2019,  
Total IC Mfg Equipment (Preliminary)  
System and Service Sales

Outperformed market growth on steady business expansion

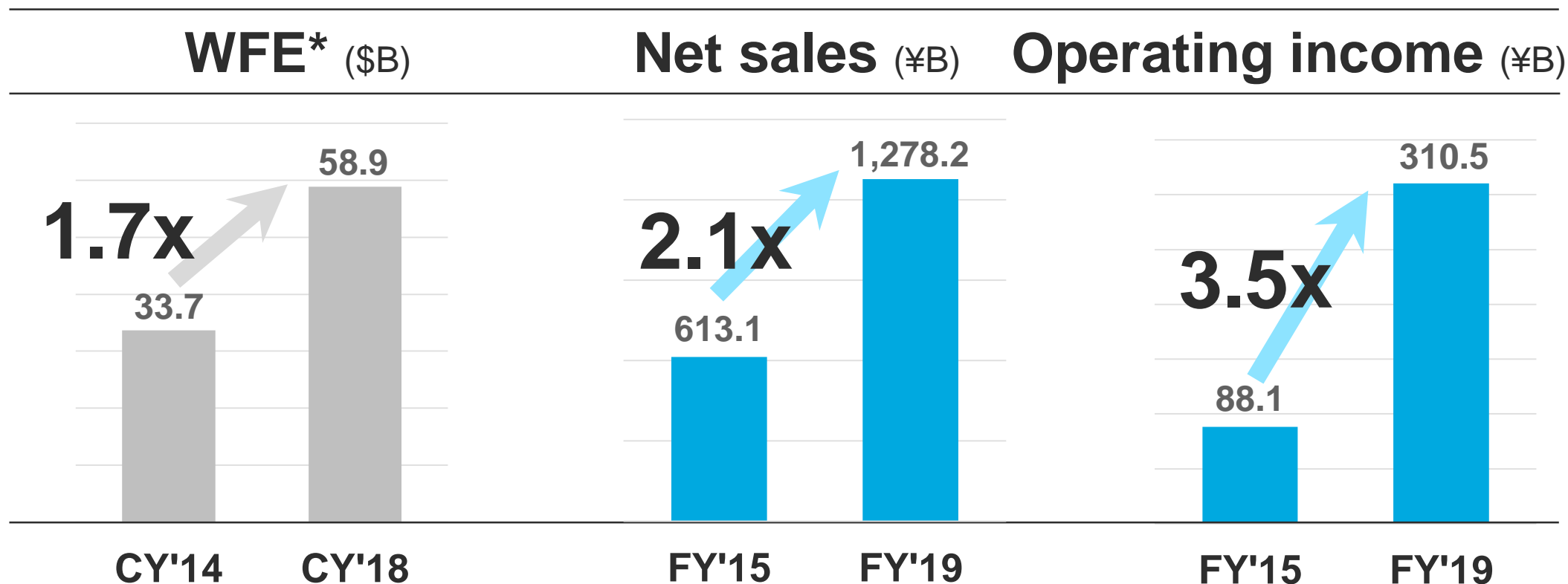
# CY2018 WFE Market Share

	Company	Revenue (\$M)	YoY Growth	Share	YoY Change
1	Applied Materials	10,990	3%	18.5%	↓ -2.4pts
2	ASML	9,743	36%	16.4%	↑ 2.4pts
3	Lam Research	9,001	11%	15.1%	↓ -0.8pts
4	<b>Tokyo Electron</b>	<b>8,967</b>	<b>24%</b>	<b>15.1%</b>	<b>↑ 1.0pts</b>
5	KLA-Tencor	3,264	16%	5.5%	↑ 0.0pts
6	SCREEN Semiconductor Solutions	1,799	29%	3.0%	↑ 0.3pts
7	Kokusai Electric	1,187	22%	2.0%	↑ 0.1pts
8	Hitachi High-Technologies	1,166	13%	2.0%	↓ -0.1pts
9	SEMES	1,129	8%	1.9%	↓ -0.2pts
10	Daifuku	930	35%	1.6%	↑ 0.2pts
Total Market		59,442	16%	100%	

Graph created by TEL based on Gartner Research, Source : Gartner, Market Share: Semiconductor Wafer Fab Equipment, Worldwide, 2018, Bob Johnson et al., 24 April 2019

## Exceeded 15% for the first time on progress in focus areas

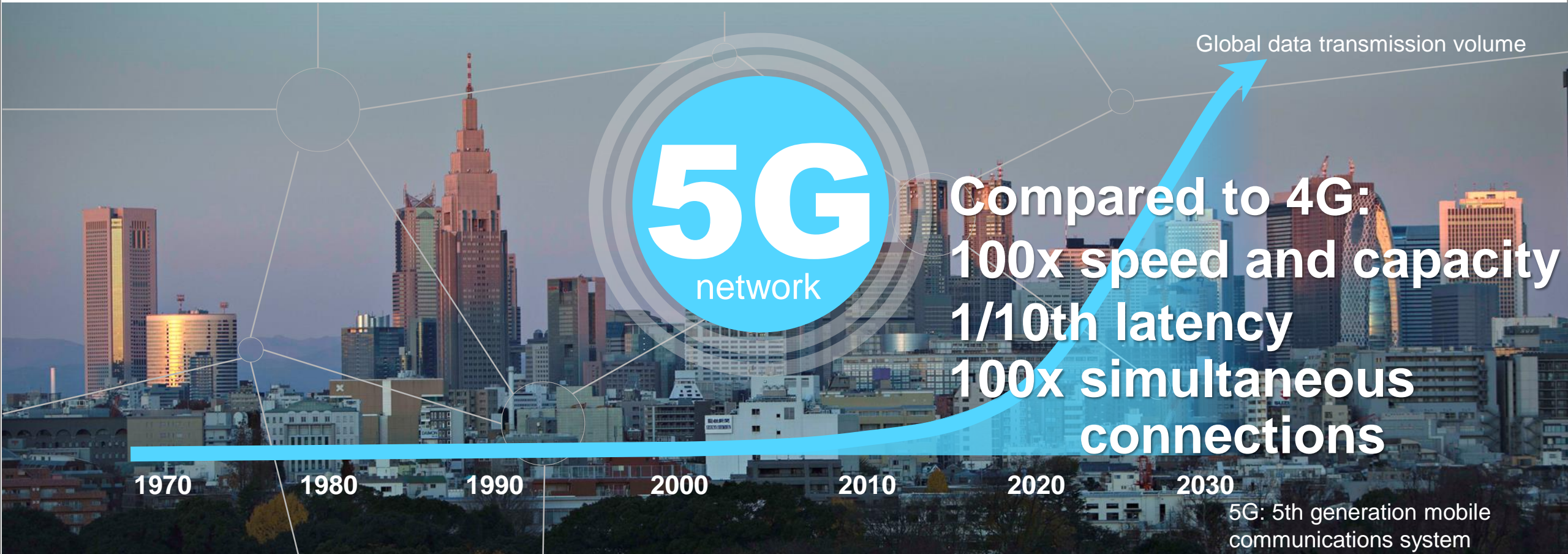
# Growth Over the Past 5 Years



Sales and operating income outperformed market growth on steady increase in market share and improvement in productivity

\* WFE (Wafer fab equipment): The semiconductor production process is divided into front-end production, in which circuits are formed on wafers and inspected, and back-end production, in which wafers are cut into chips, assembled and inspected again. Wafer fab equipment refers to the production equipment used in front-end production and in wafer-level packaging production.

# Launch of 5G: First Step to a Future Beyond Imagination



5G will enable transmission of vast amount of data



# First Year of 8K TV and Foldable

## 8K OLED TV

Quality is 4x that of 4K



- Larger size
- Higher resolution
- OLED
- Design  
(Flexible, foldable,  
free format)

## Foldable smartphone

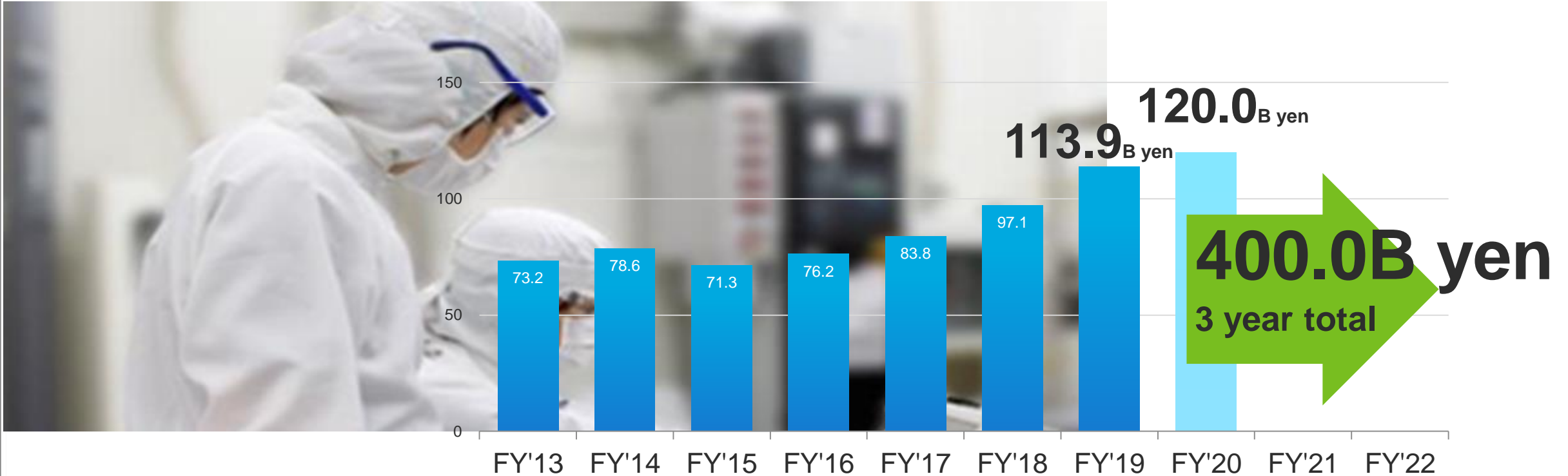


Technological innovation in displays continues

## Revision of Financial Model

- With the adoption of IoT, AI and 5G the transition to a data society is accelerating. Amid the expansion of semiconductor applications and demand for technological innovation enabling this transition, medium- to long-term growth in both the semiconductor and FPD manufacturing equipment markets can be expected
- TEL is looking towards future growth, and intends to continue active investment. Specifically, we intend to conduct 400B yen in R&D investment over the next 3 years
- Amid increasing uncertainty such as US-China trade friction and Brexit, we decided to revise the FY2021 financial model announced last year

# R&D Investment



400B yen in R&D investment over the next three years.  
Realize growth through development of cutting-edge technologies  
looking at future generations

## New Financial Model (within 5 Years)

### Changes

1. Eliminate linkage of WFE and financial model, 2. Set timeframe for achievement within 5 years, 3. Add net sales of 2 trillion yen, operating margin of over 30%, 4. Revise ROE to over 30%

<b>Financial model (within 5 years)</b>			
<b>Net sales</b>	<b>¥1,500.0B</b>	<b>¥1,700.0B</b>	<b>¥2,000.0B</b>
<b>Operating margin</b>	<b>26.5%</b>	<b>28%</b>	<b>&gt;30%</b>
<b>ROE</b>	<b>&gt;30%</b>		

# Semiconductor Technology Roadmap

## Demand for ultra-low power consumption technology



## AI chip (Analog memory)



## DRAM



## NAND



## Logic

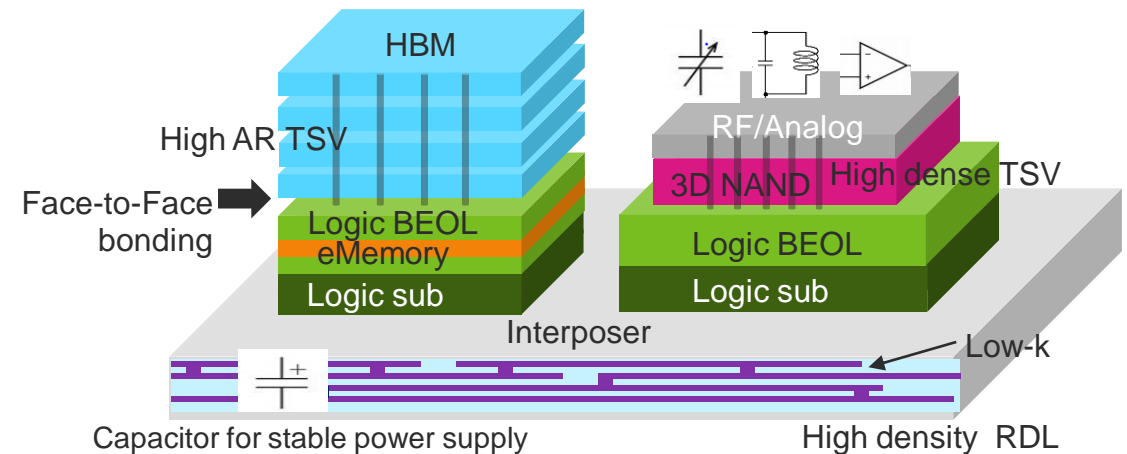


## Patterning



TEL forecasts

## Future device systems for HPC/AI/IoT

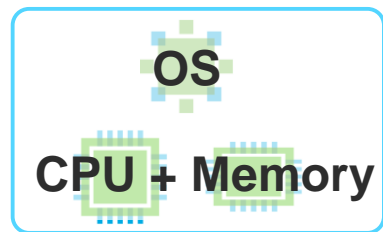


- Systemize technology by integrating chips
- DRAM tower with via
  - Analog/NAND/Logic by stacking
  - Built-in AI (Analog memory)
  - Moore's Law by package scaling

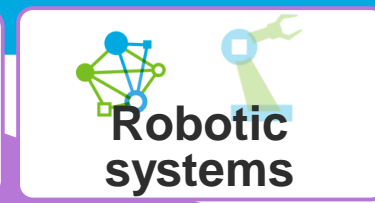
# Market Heading Towards Diversification

## Moore's Law

Improved performance through transistor integration



PC/Mobile systems



## Customization

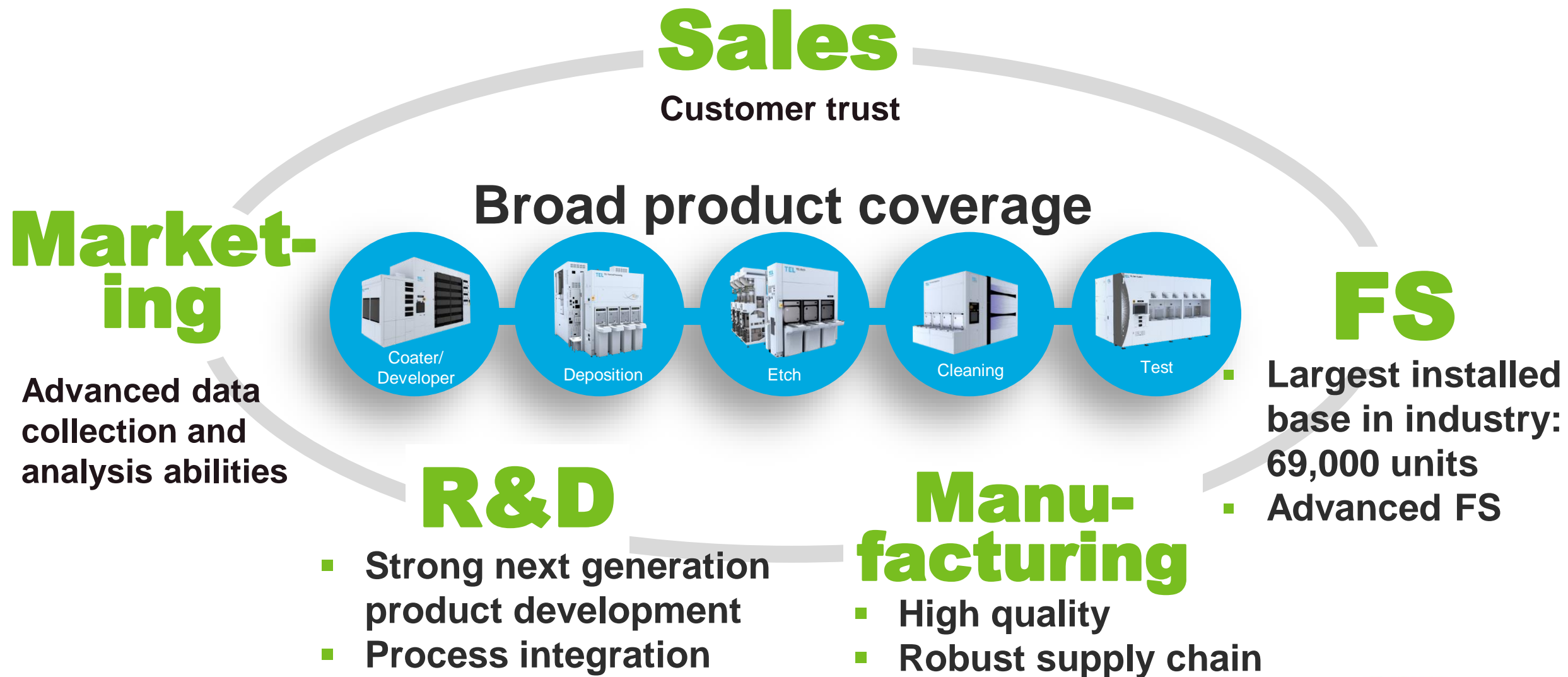
Multi-functionality

## Hyper-mass

Pursuit of ultra-efficient productivity

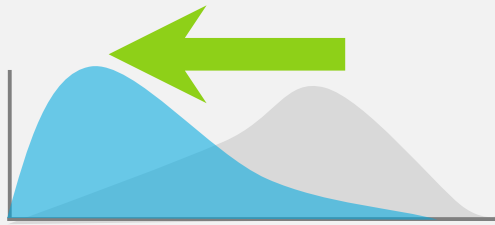
Applications increase, production technology diversifies too

# Maximize Utilization of TEL's Comprehensive Strengths



# Continually Pursuing the Best Products and Best Service

## Front-loading



## Advanced field solutions



- Share roadmap for next several generations with customers
- Promote early engagement
- Realize maximum yield of customer devices and equipment availability from early stage of customers' mass production and reduce burden on the environment
- Further increase investment in human resources/R&D by raising operational efficiency and driving higher per-employee productivity

- Business development leveraging industry's largest installed base of 69,000 units
- TELeMetrics™ remote maintenance
- Predictive maintenance with machine learning

**Vision: A truly global company generating high added value and profits in the semiconductor and FPD industries through innovative technologies and groundbreaking proactive solutions that integrate diverse technologies**



# Increasing Development and Production Capacity

2018

## Miyagi plant



Etch systems

2019

## Yamanashi plant



Deposition systems, gas chemical etch systems, test systems

2020

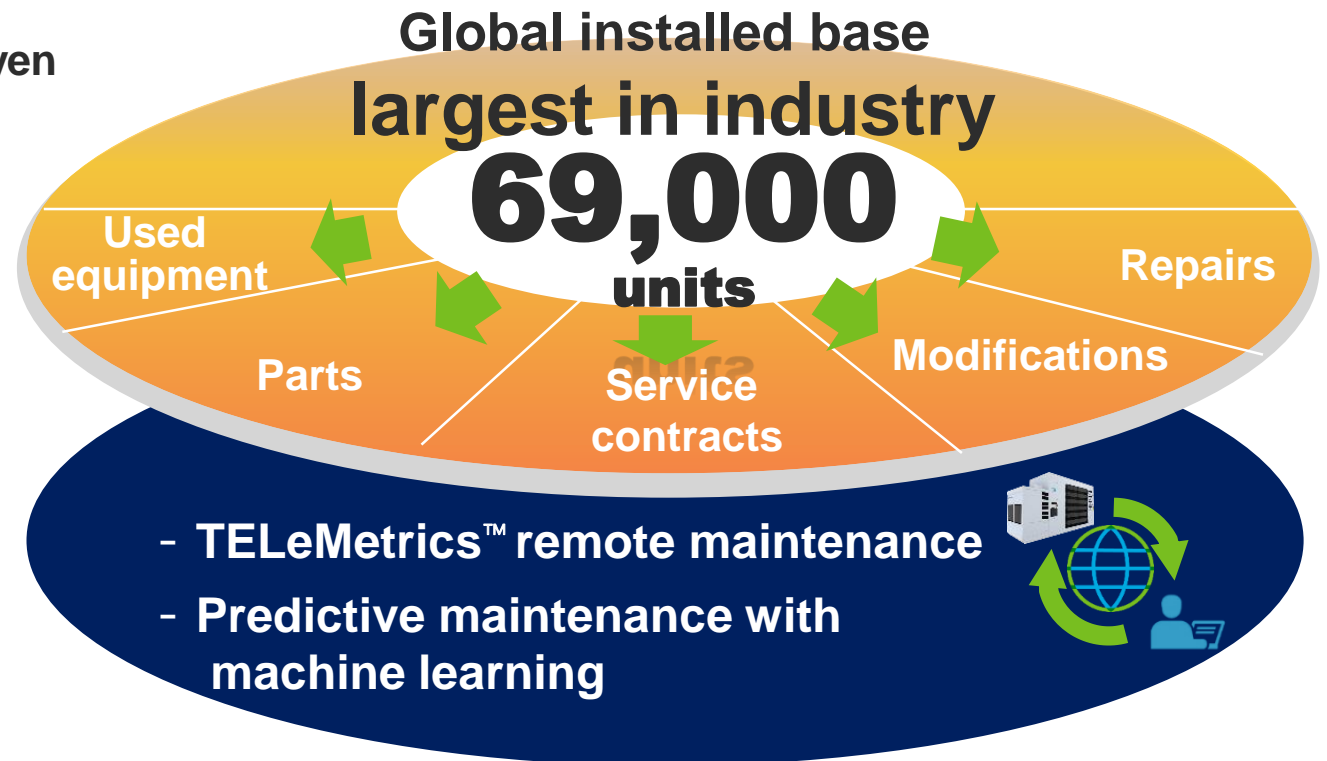
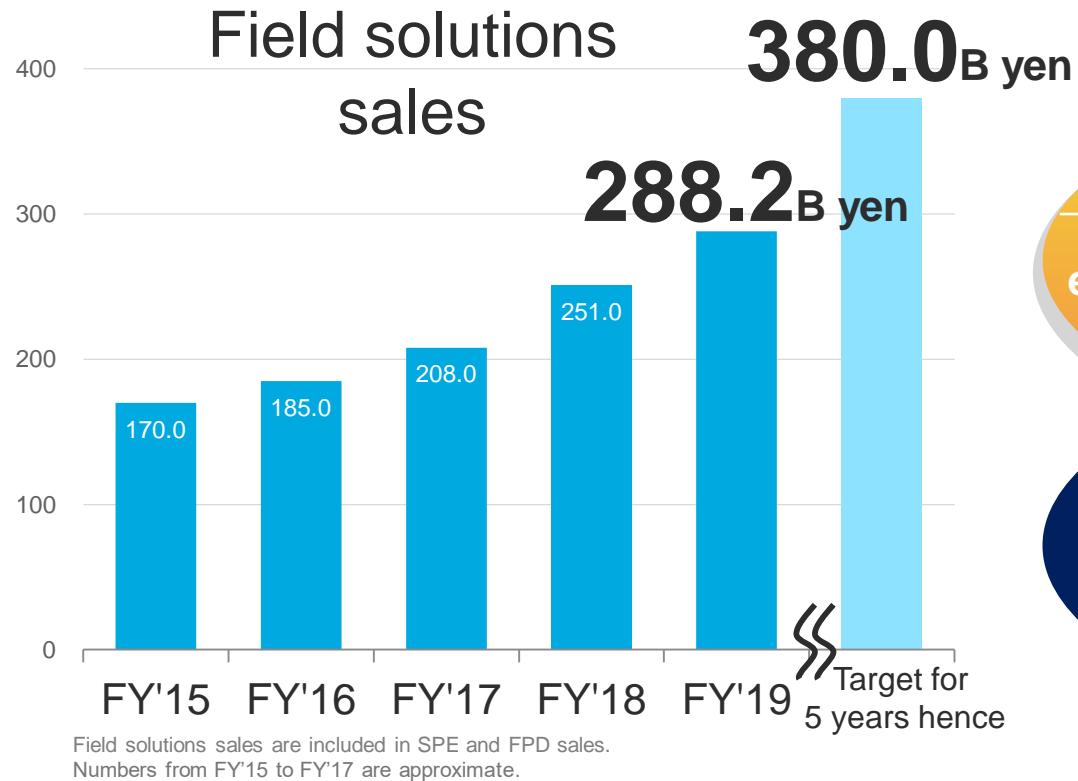
## Tohoku plant



Enhancing development and production structures in growth areas

Expect capex of 40-50B yen/year, depreciation of 35-37B yen/year

# Continually Pursuing the Best Service



Support customers with the latest technology to maximize uptime and increase yield

# Towards Further Raising Corporate Value

## Offence

**Achieve world-class operating margin and ROE of over 30%**

Measures

1. Front-loading
2. Advanced FS



**&**

## Offence

- **Safety first**
- **Compliance**
- **Quality**
- **Engagement**



Indispensable to business sustainability

# Contributing to the Environment

## Reducing semiconductors' energy consumption is a major issue in an era of big data



TEL is realizing a better society through its technological solutions

# Establish Environmental Medium-term Targets for 2030

## Equipment

30% ↓

Reduce per-wafer  
CO<sub>2</sub> emissions (vs 2013)

## Facilities

20% ↓

Total CO<sub>2</sub> emissions (vs 2018)

1% ↓

Reduce energy consumption at  
each facility (per-unit basis)  
(annual target, YoY)

## Long-term goal (2050)

As a leading corporation in environmental management, Tokyo Electron works actively to conserve the global environment.

We strive to contribute to the development of a dream-inspiring society by proactively promoting the reduction of environmental burden of both our facilities and products, and at the same time, providing evolutionary manufacturing technologies that effectively reduce the power consumption of electronic products.

# Share Repurchase Plan

## Plan to implement share repurchase of up to 150B yen

- Type of shares to be acquired: Shares of common stock
- Total number of shares to be acquired: Up to 14 million shares  
(Equivalent to 8.5% of outstanding shares excluding treasury stock)
- Total cost of acquisition: Up to 150 billion yen
- Period of acquisition: From May 28, 2019 to December 31, 2019

We will continue to manage our balance sheet flexibly while considering our ability to generate cash, necessary cash on hand and growth investment capital

# Summary

- Revised financial model with aim of further growth
- TEL is looking towards future growth, and intends to continue stable investment. We intend to conduct 400B yen in R&D investment over the next 3 years
- Aim for operating margin and ROE of over 30% in the medium- to long-term by continually pursuing the best products and best service
- Plan to repurchase 150B yen of own shares based on our confidence in future profit growth

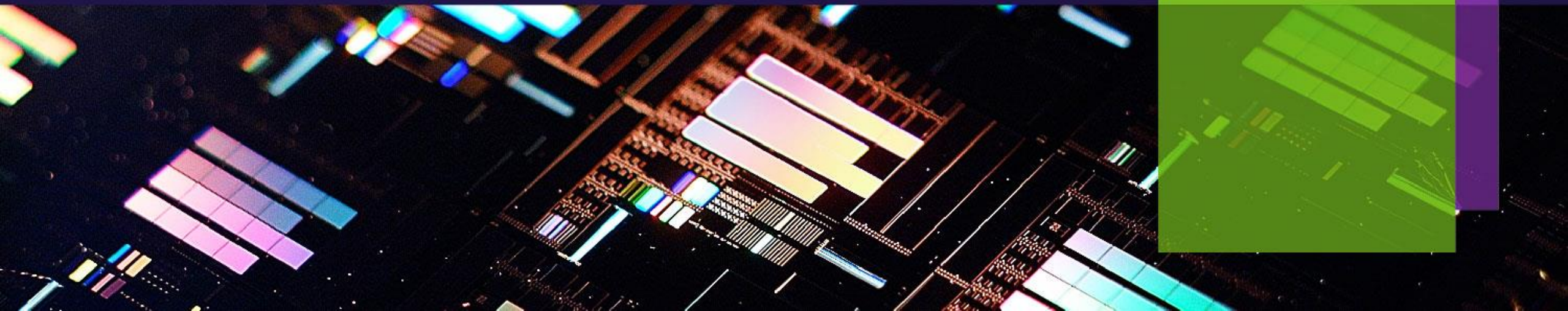
**Aim for sustained growth in corporate value through  
a management base with global-standard strength**

# The Big Picture: Future of the Electronics Industry

May 28, 2019

Akihisa Sekiguchi, Ph.D.

Device Technology GM, Corporate Marketing

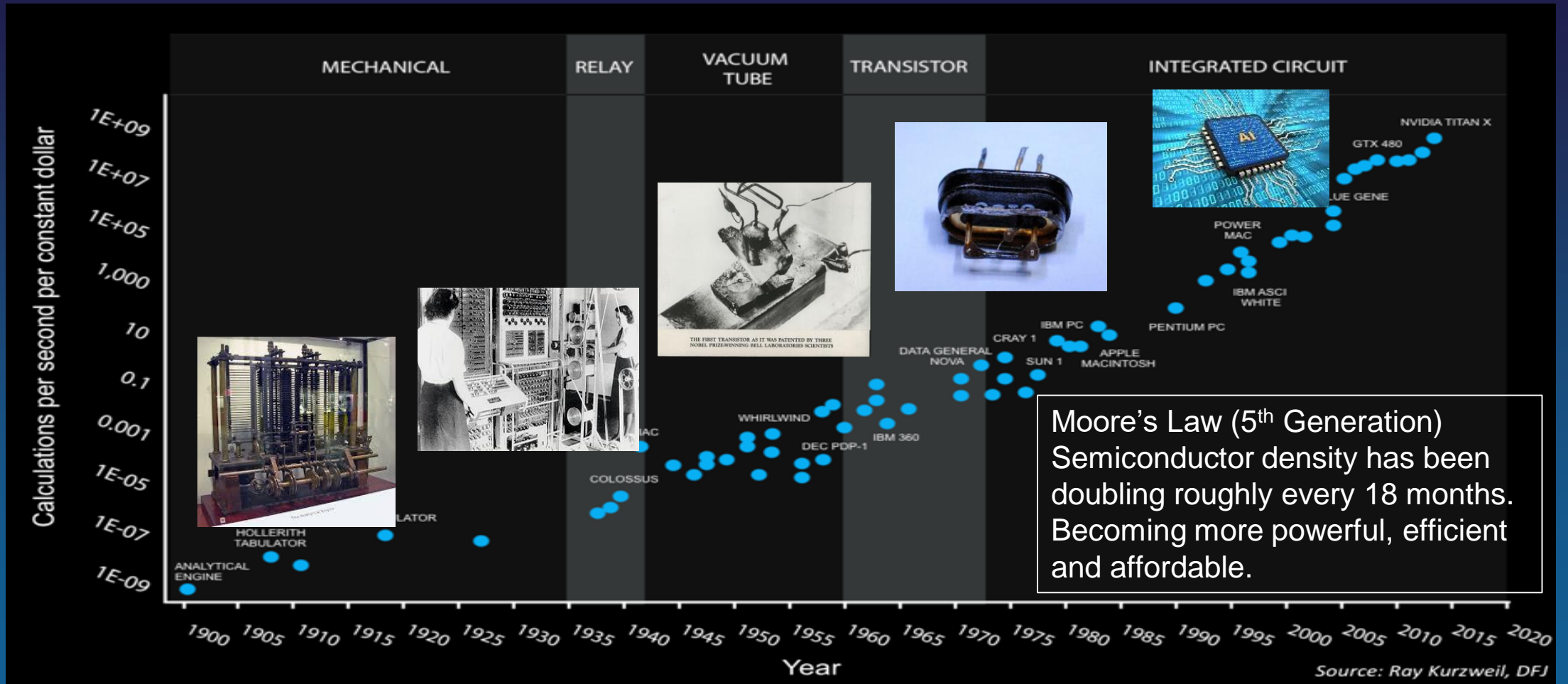




# Outline

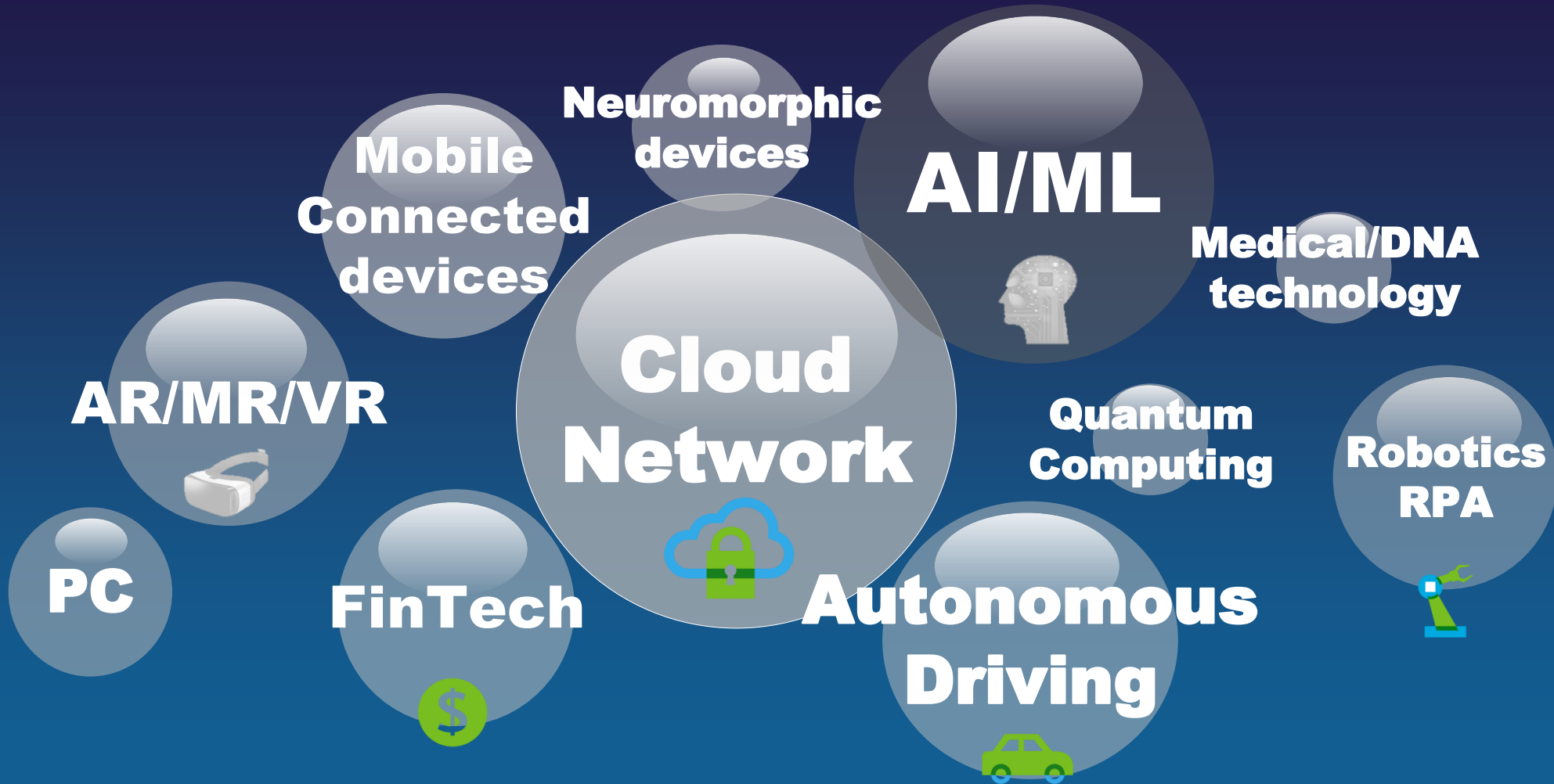
- Introduction: Medium to long term outlook
- Process technology challenges for major device types
  - ✓ Scaling: Lithography and 3D device structures
  - ✓ Process complexity: State-of-the arts semiconductor device fabrication flows
  - ✓ AI: Introduction to the paradigm shift
- Summary

# Evolution of Computational Power Per Fixed Cost



Today's key phrase is PPAC (Power Performance Area Cost)

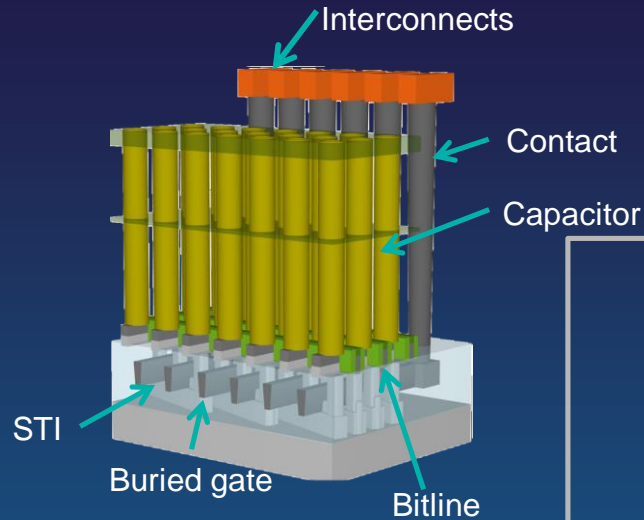
# Technology Landscape



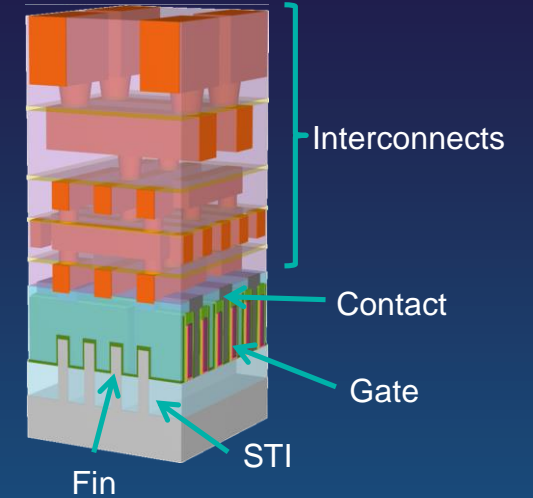
New application is creating enormous amounts of data through synergy

# Mobile Phone Full of Leading-edge Devices

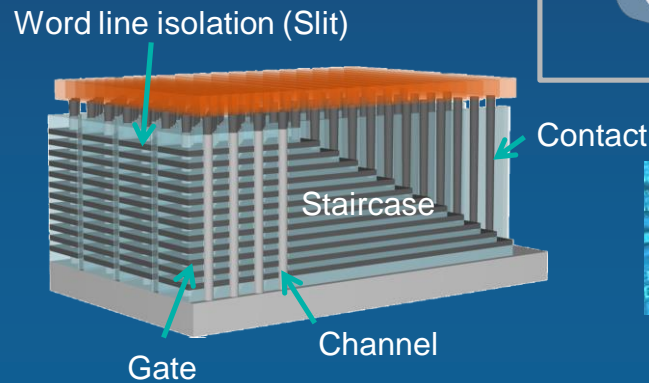
Memory: DRAM  
Working memory



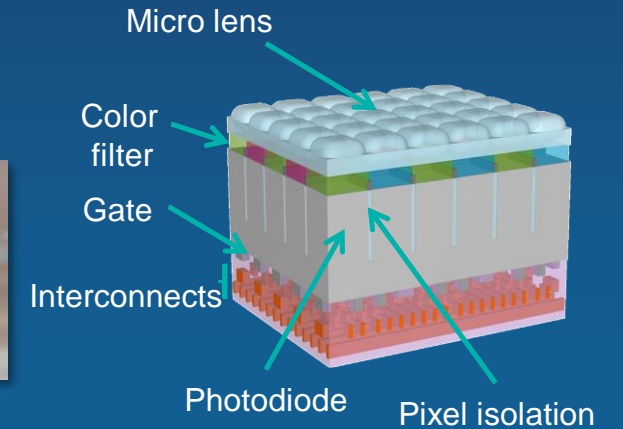
Logic/MPU  
Data processing



Memory: NAND  
Storage memory



CIS Visual  
Image sensor

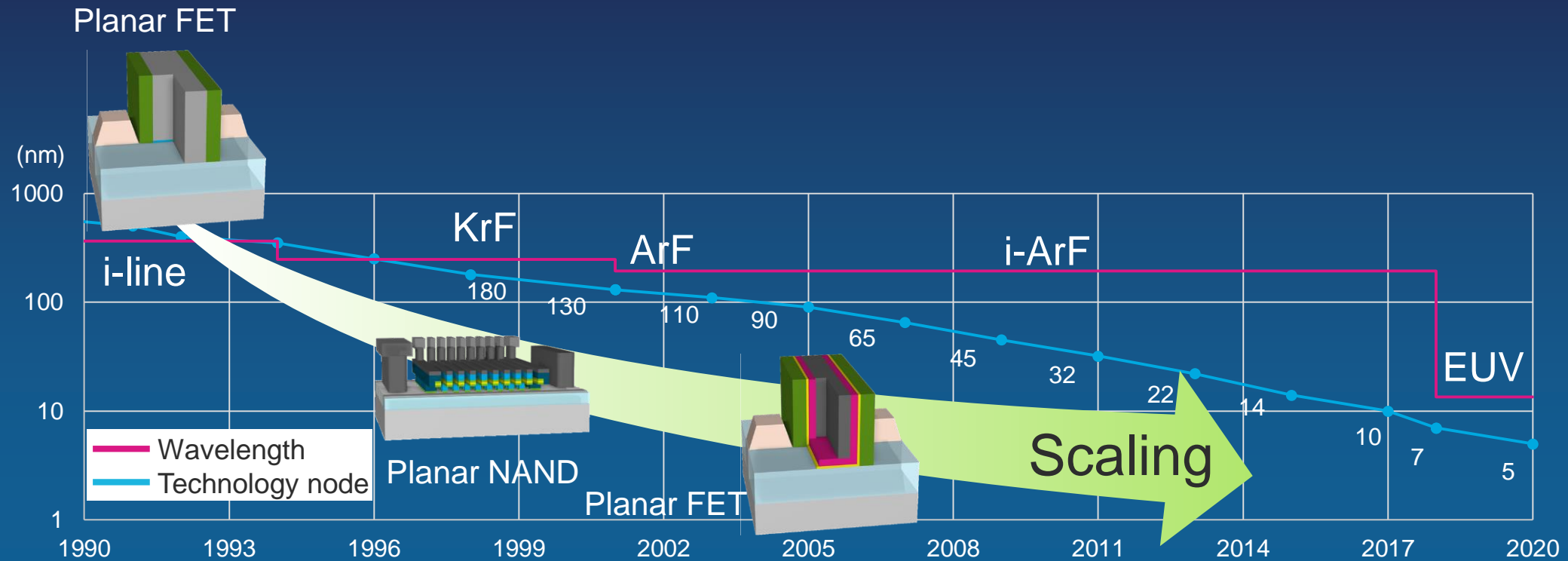


## Evolution towards a portable cognitive device with AI chip on board

# Outline

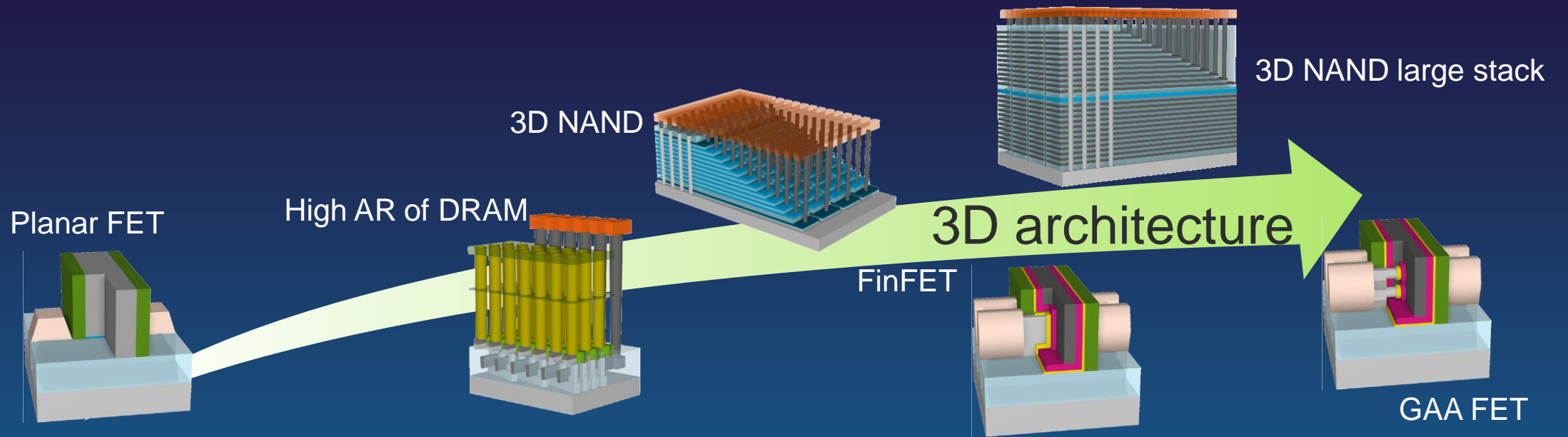
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- Summary

# Scaling Lead by Lithography Tools



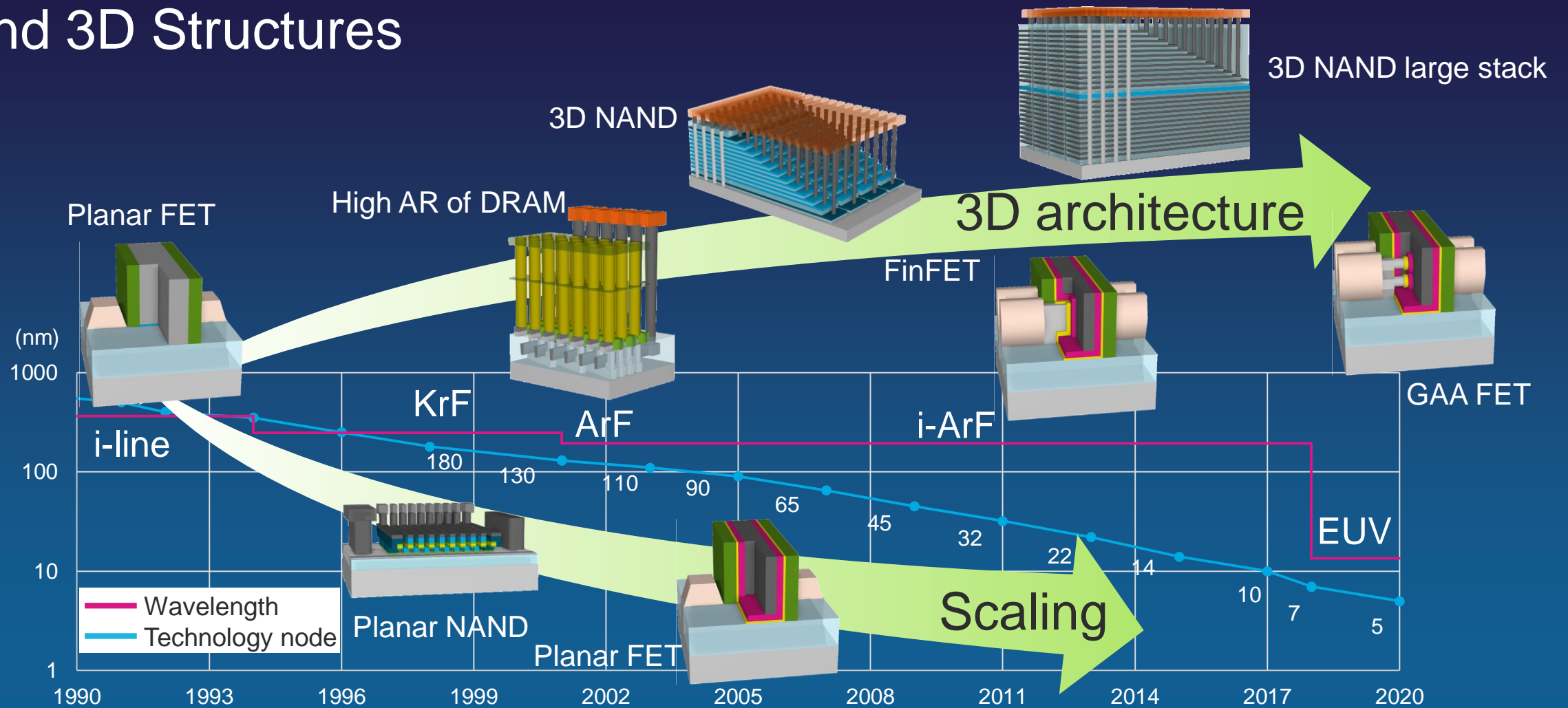
Device evolution has been supported for a long time but...

# Material and Structural Innovation



New material and 3D devices have also contributed to performance gains

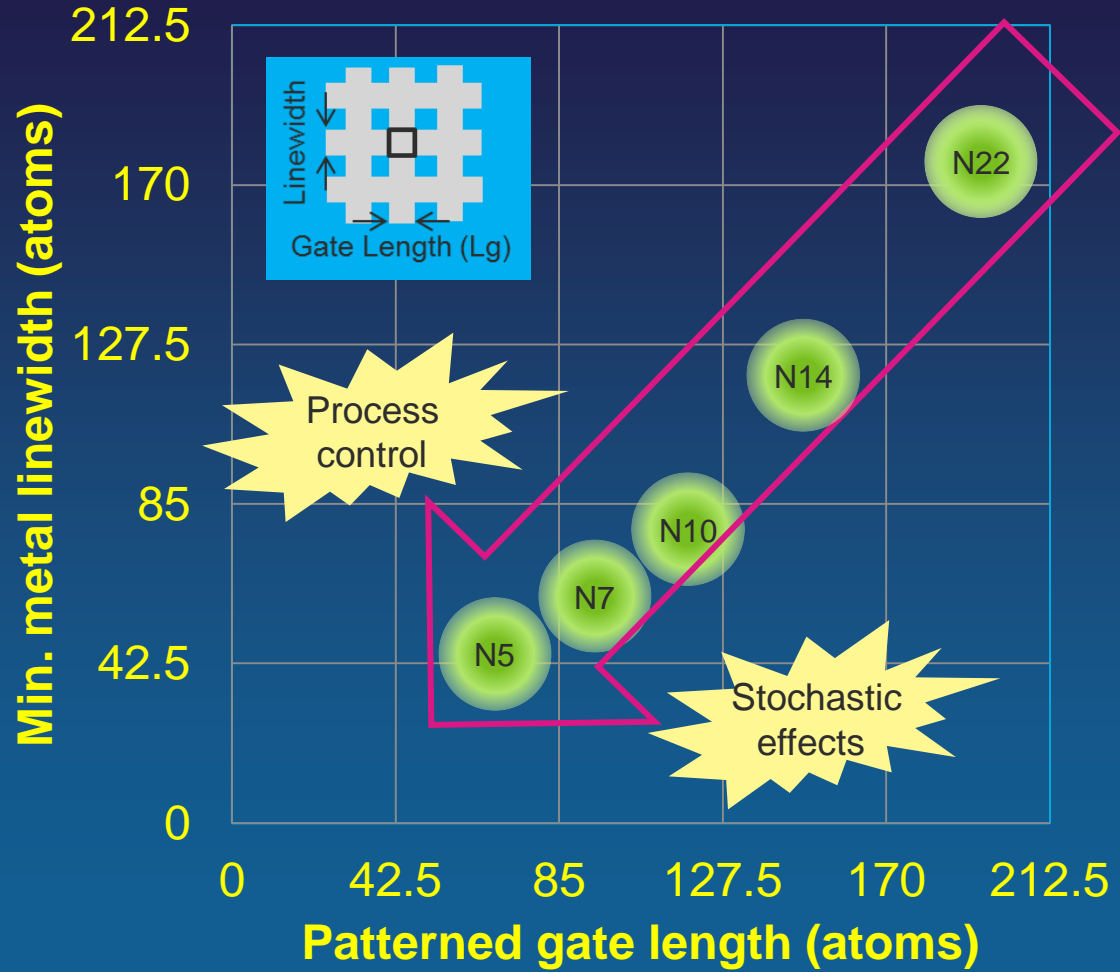
# Performance Enhancement through Scaling, Material Development and 3D Structures



Architecture, design, process are also being actively investigated

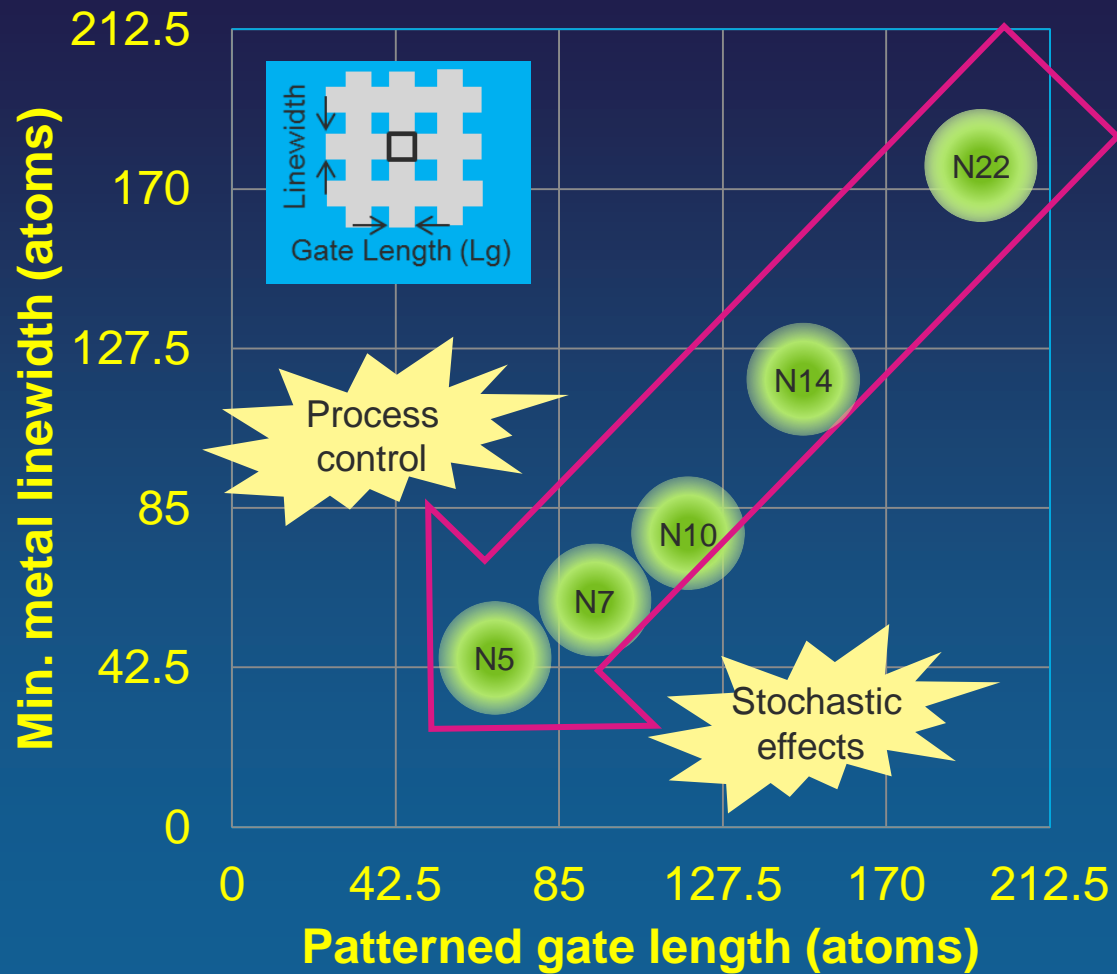


# The Real Meaning of Scaling

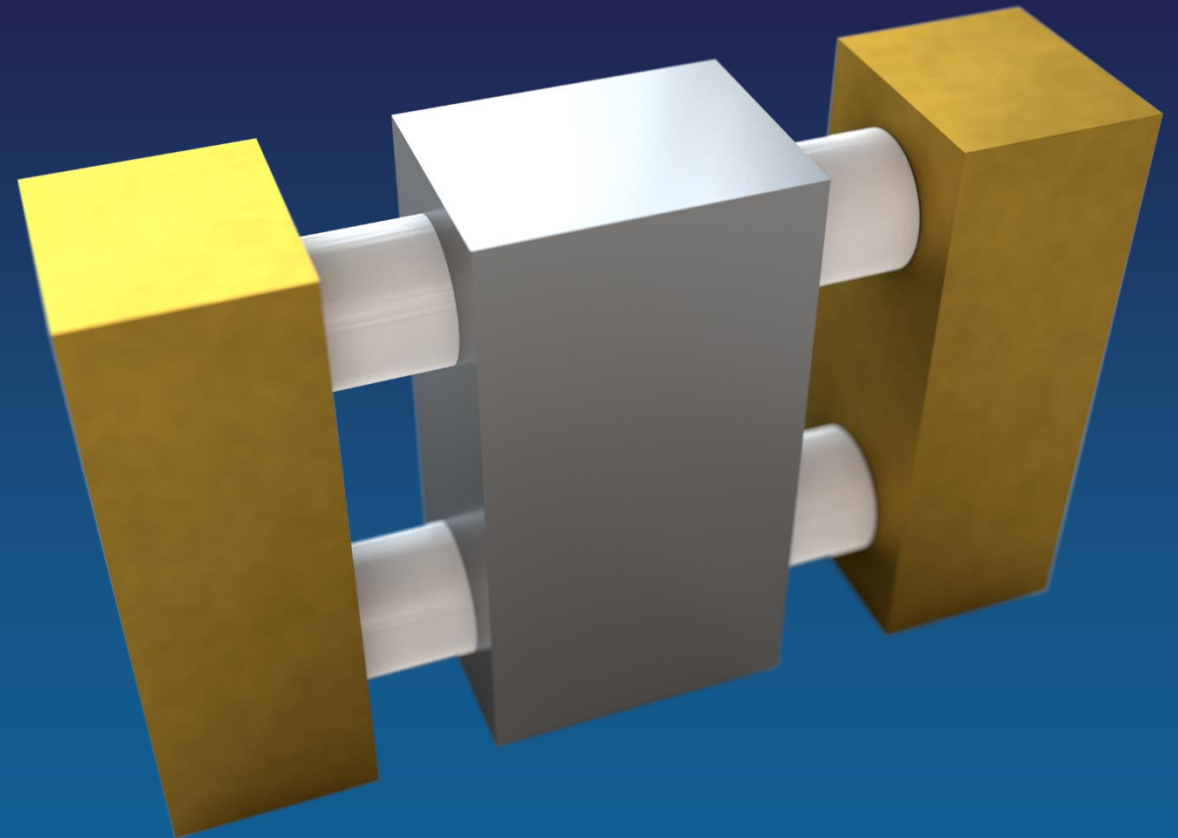


Traditional thinking

# Traditional View of Scaling

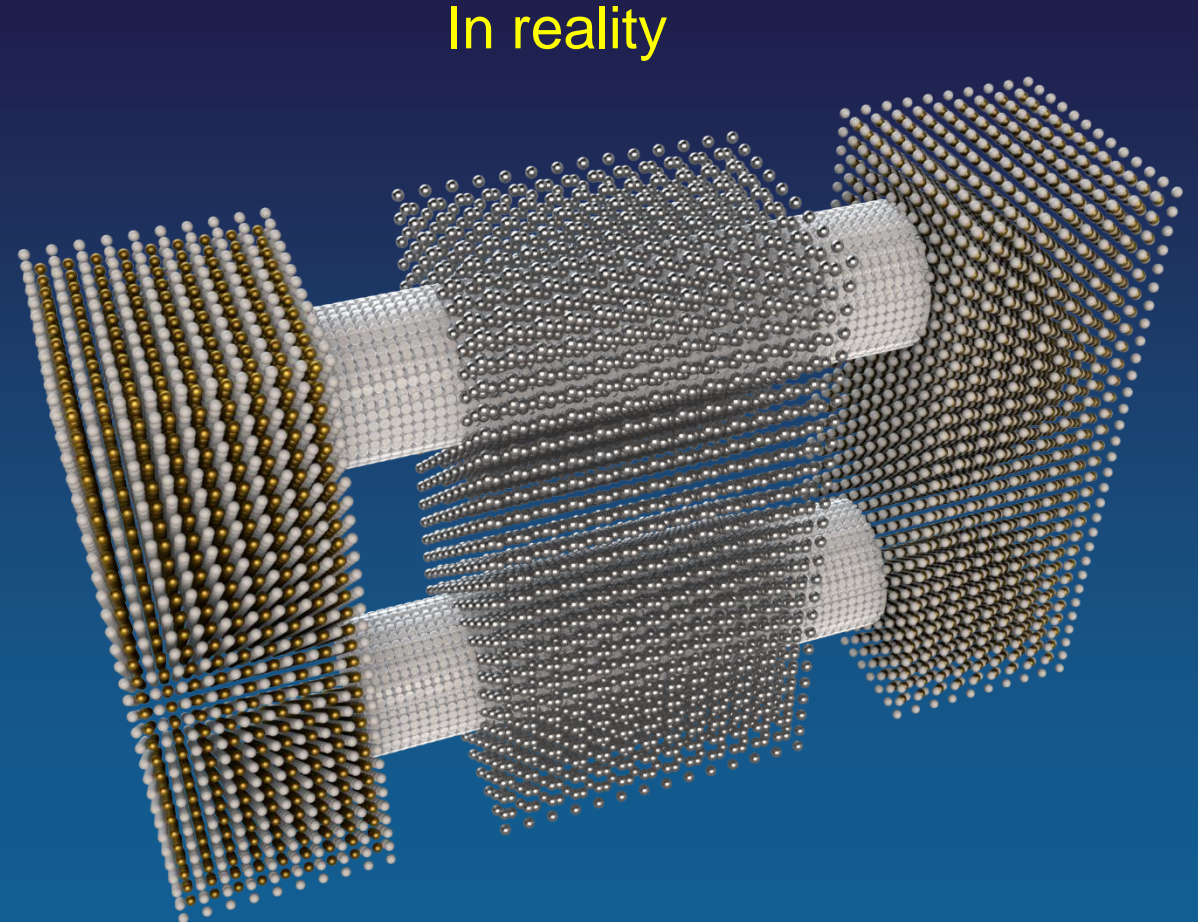
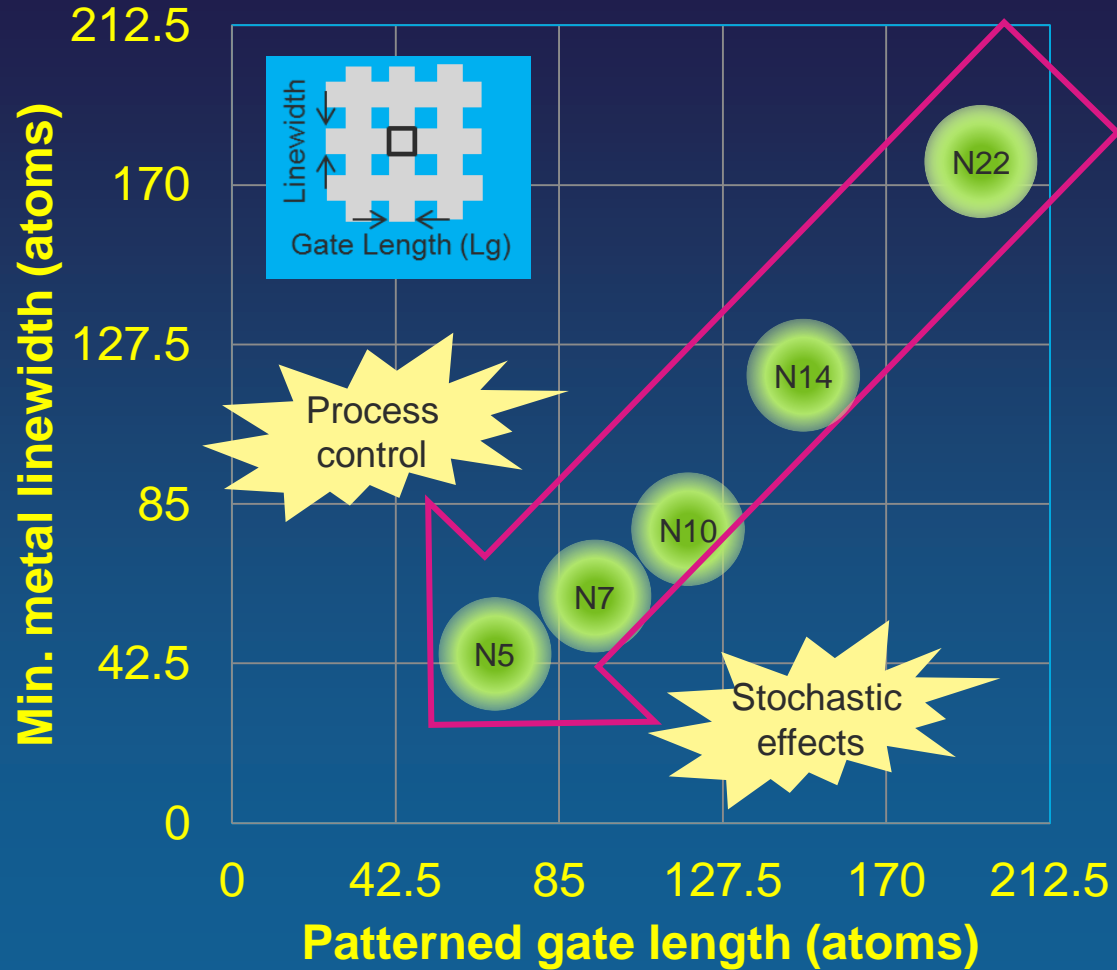


Traditional diagram



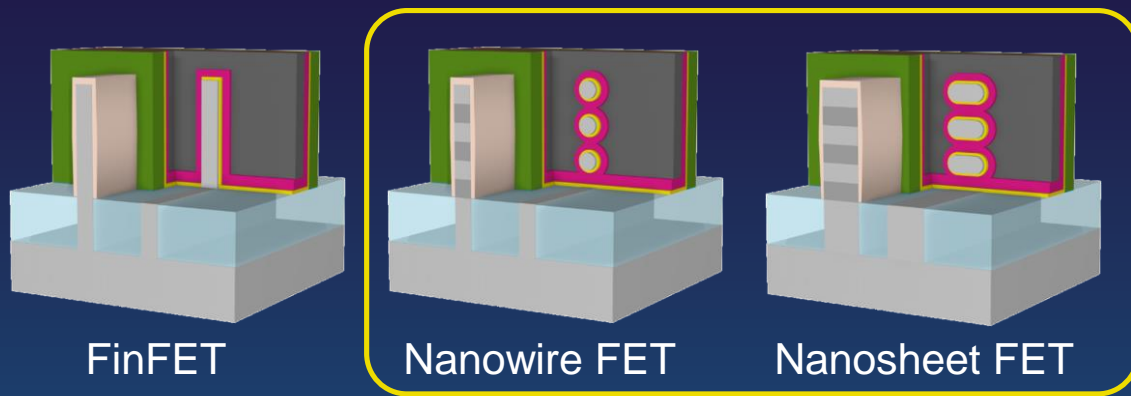
Nanowire example:  $\text{HfO}_2$  used for gate oxide is about  $140\text{\AA}^3$ ...

# The Impact of Scaling to Process

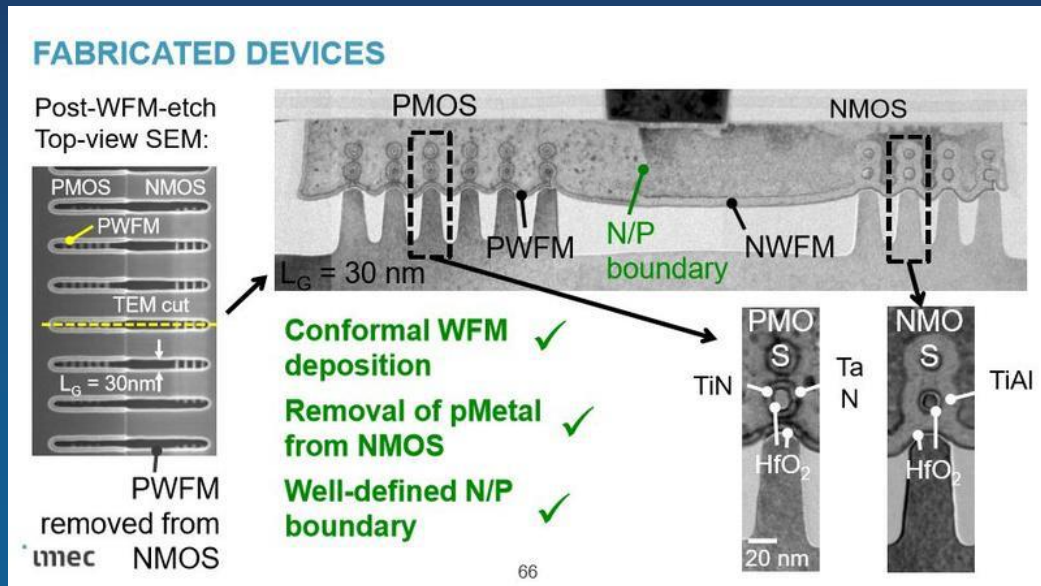
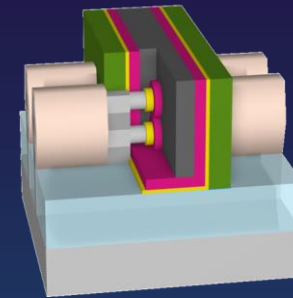


High volume manufacturing requires  $\pm 10\%$  range process control

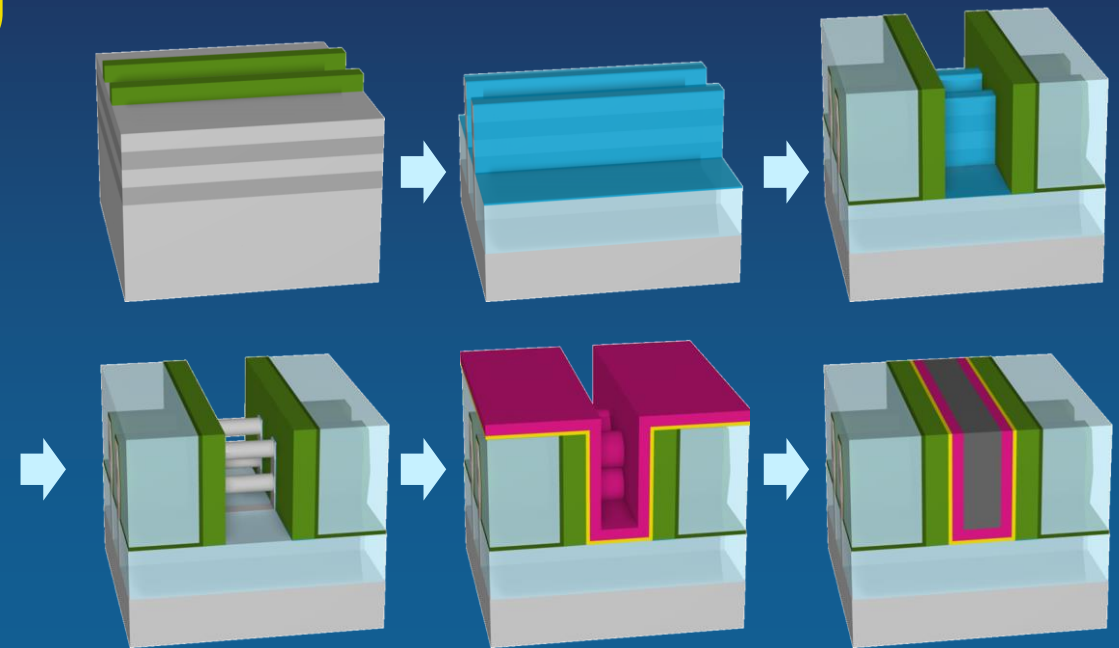
# Next Generation Gate-All-Around Transistor (GAA FET)



Fabrication flow of GAA FET



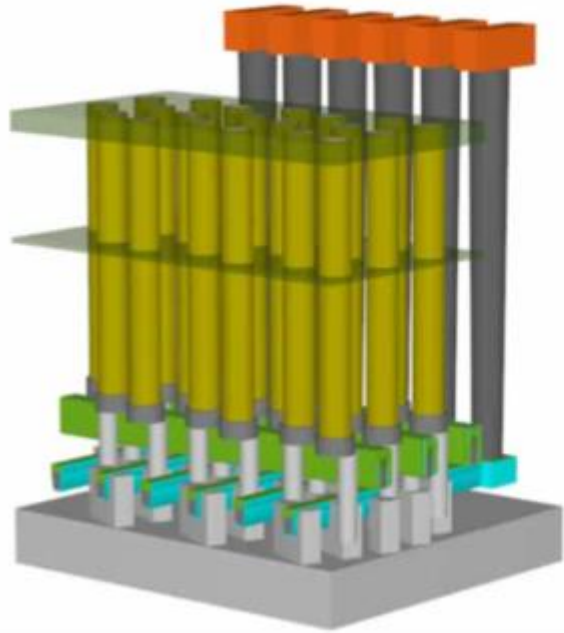
Source: imec



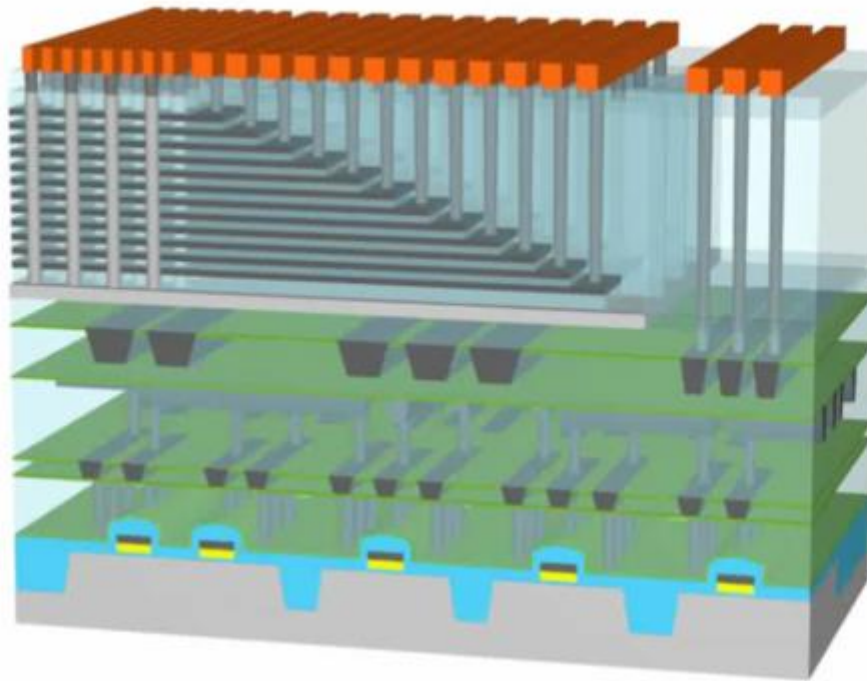
Leading-edge process enables formation of even complex 3D structures

# Fabrication Flows of DRAM, 3D NAND and Logic Device

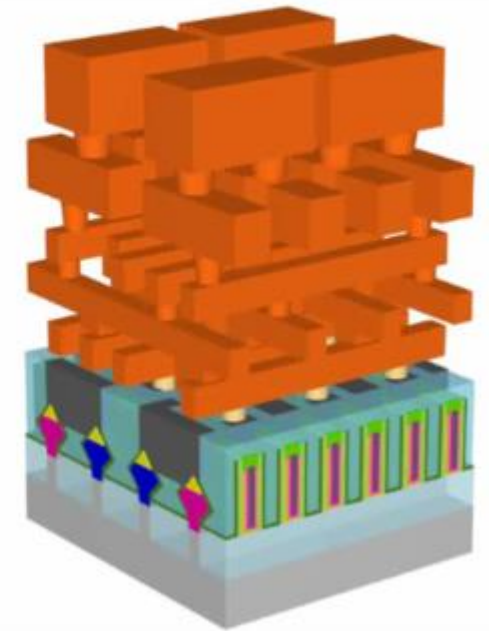
## Video



DRAM



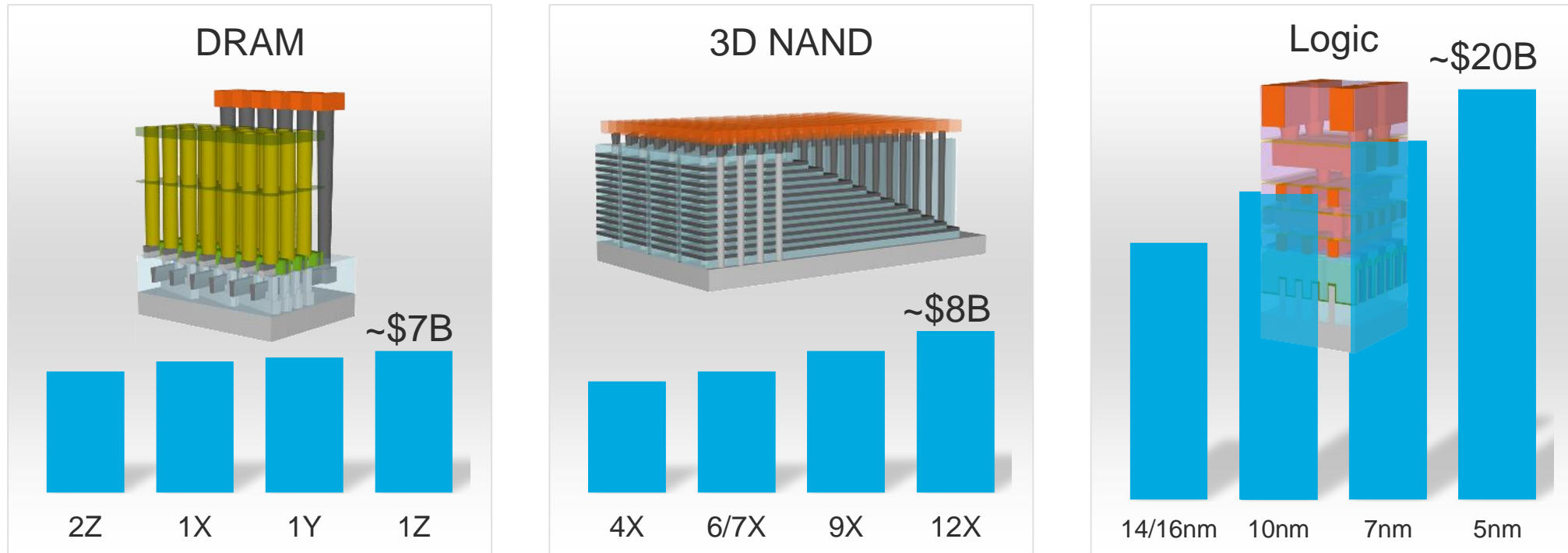
3D NAND



Logic

# Rising Added-value in SPE

WFE investment (100k WSPM\*, greenfield/TEL estimates)



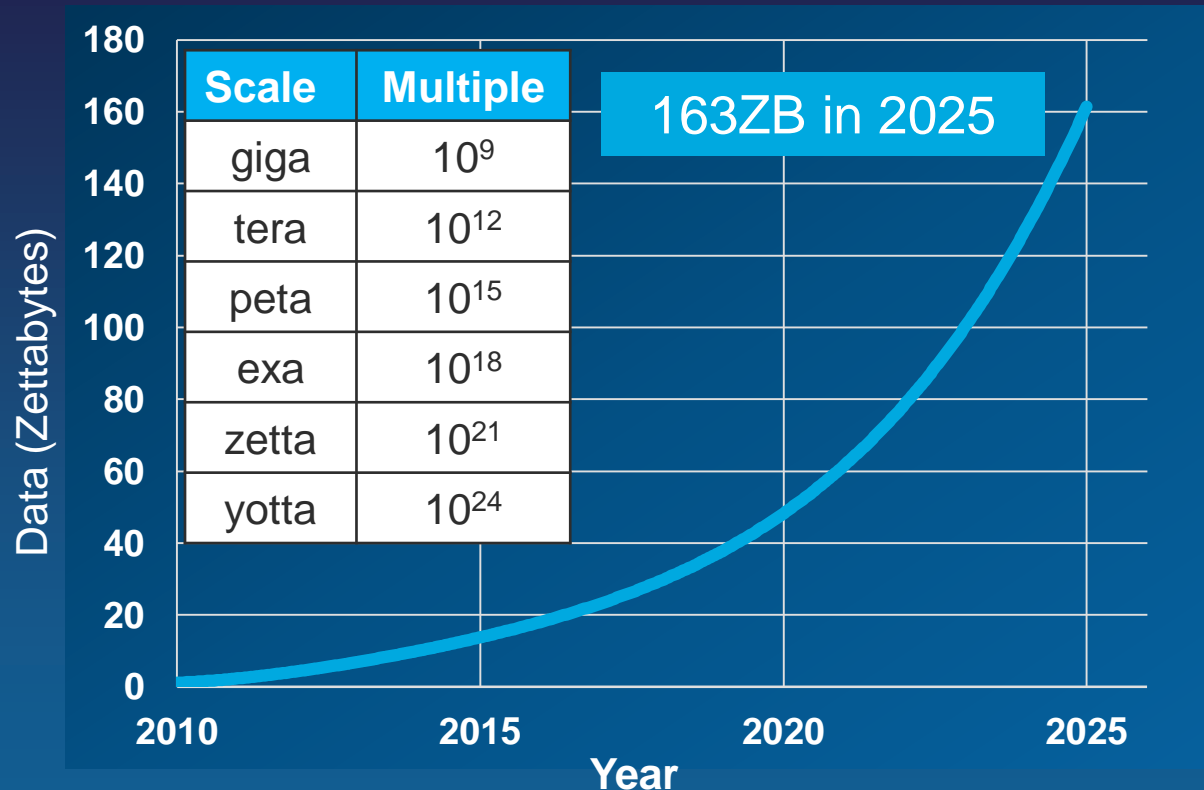
Expanding business opportunities for SPE manufacturers on arrival of new applications and rising level of technological difficulty

# Outline

- Introduction: Medium to long term outlook
- Process technology challenges for major device types
  - ✓ Scaling: Lithography and 3D device structures
  - ✓ Process complexity: State-of-the arts semiconductor device fabrication flows
  - ✓ AI: Introduction to the paradigm shift
- Summary

# Increasing Data Generation

Estimated data generation by year in Zettabytes



Source: StorageNewsletter.com white paper (2017)

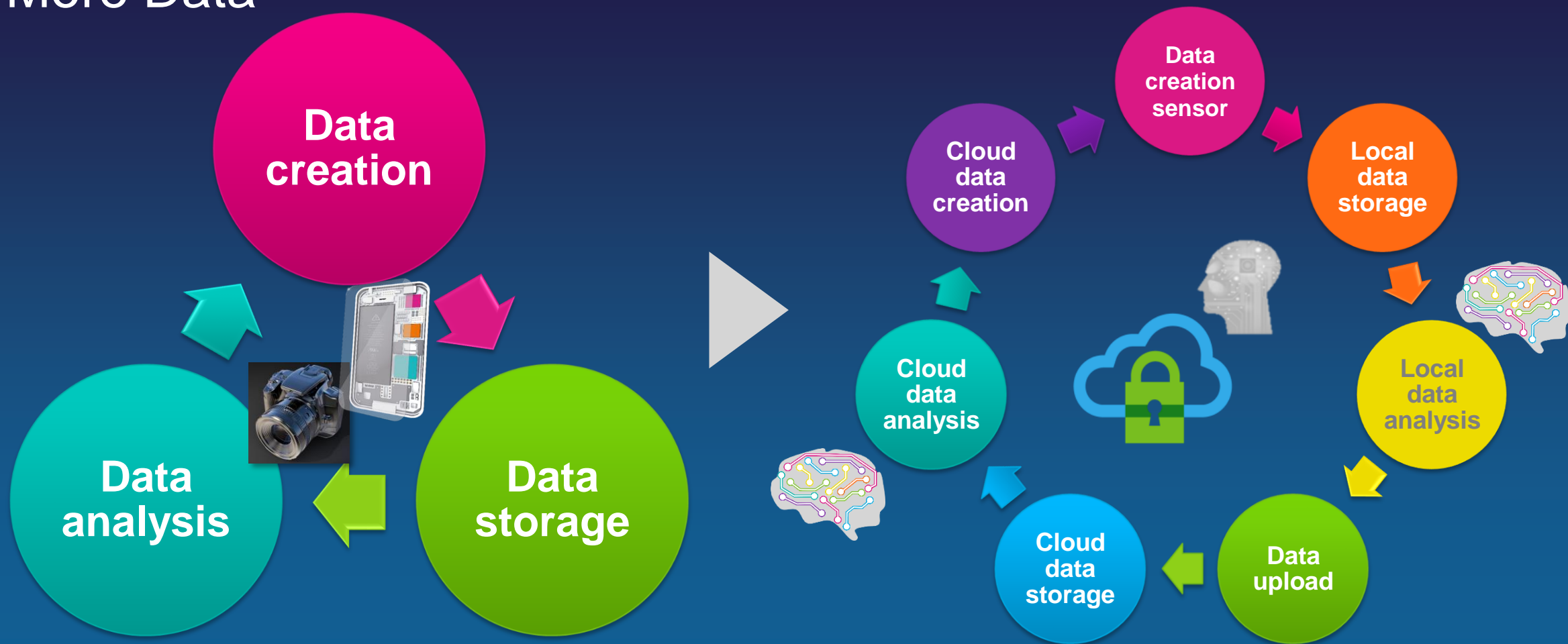
## Drivers:

- **Connecting people** → connecting devices (IoT): by 2025 the average person will interact with connected devices once every 18 seconds, *Metcalfe's law*
- Increase in criticality of data: **“edge”** & **“cloud”**
- **Real-time data** available instantly anywhere it is needed (medical, etc.) where **latency** is an issue
- **Cognitive systems** (AI, ML/DL, language processing) becomes available at the “edge”
- Virtual, Augmented, Mixed Reality (**VR/AR/MR**)
- Information & data **security**
- **Autonomous driving, blockchain, etc...**

Edge and cloud contribute to the growth of data generation through network

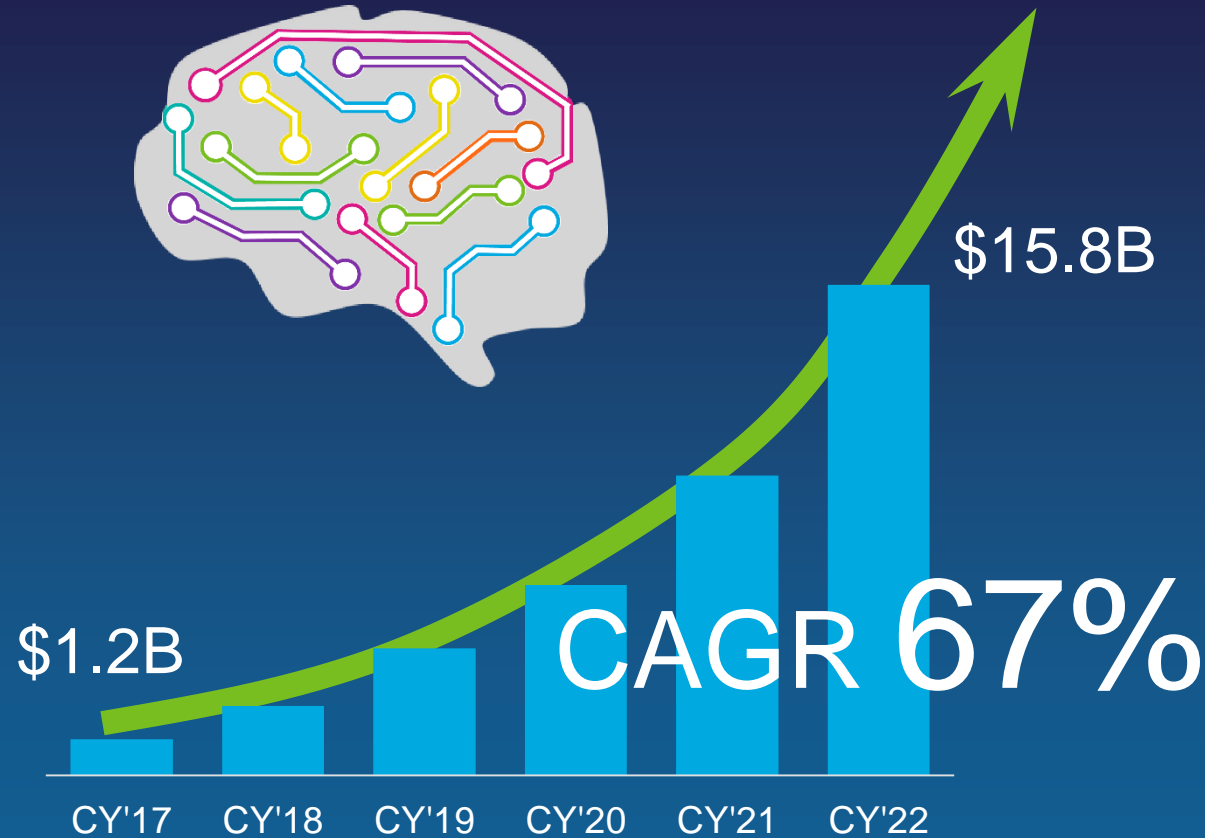


# An Example of Data Creation, Storage, Analysis That Leads to More Data



A variety of algorithms analyze the created data to create even more data

# Artificial/Augmented Intelligence



AI device related development is accelerating (in particular algorithms and applications)

Hardware development active but takes longer time



AI devices expected to grow at an annualized rate of almost 70%

# The Future of Computing



Mukesh V. Khare, Ph.D.  
Vice President  
IBM Research

“AI will transform the world in dramatic ways in the coming years. We are creating a global hub of AI hardware research with an ecosystem to innovate, incubate, and lead in the development of disruptive technologies.”

**IBM Research**  
AI Hardware Center

## Era of AI hardware

# Cognitive Era Roadmap

## ■ Evolution

- ✓ From **Narrow AI** (single task and domain, already done), to **Broad AI** (multi-task and multi-domain, now), to **General AI** (cross domain multi-tasking, ~2050)

## ■ Power requirements

- ✓ Narrow AI tasks such as image net training takes hundreds of kW-hours
- ✓ This may be ok for cloud use, but difficult for edge use
- ✓ For a more flexible edge use, power requirement has to come down by 1000 x

## ■ Proposed solutions

- ✓ Re-optimize the device architecture for neuromorphic computation
- ✓ Develop not only digital computational elements but also non-volatile analog computational elements for lower power usage

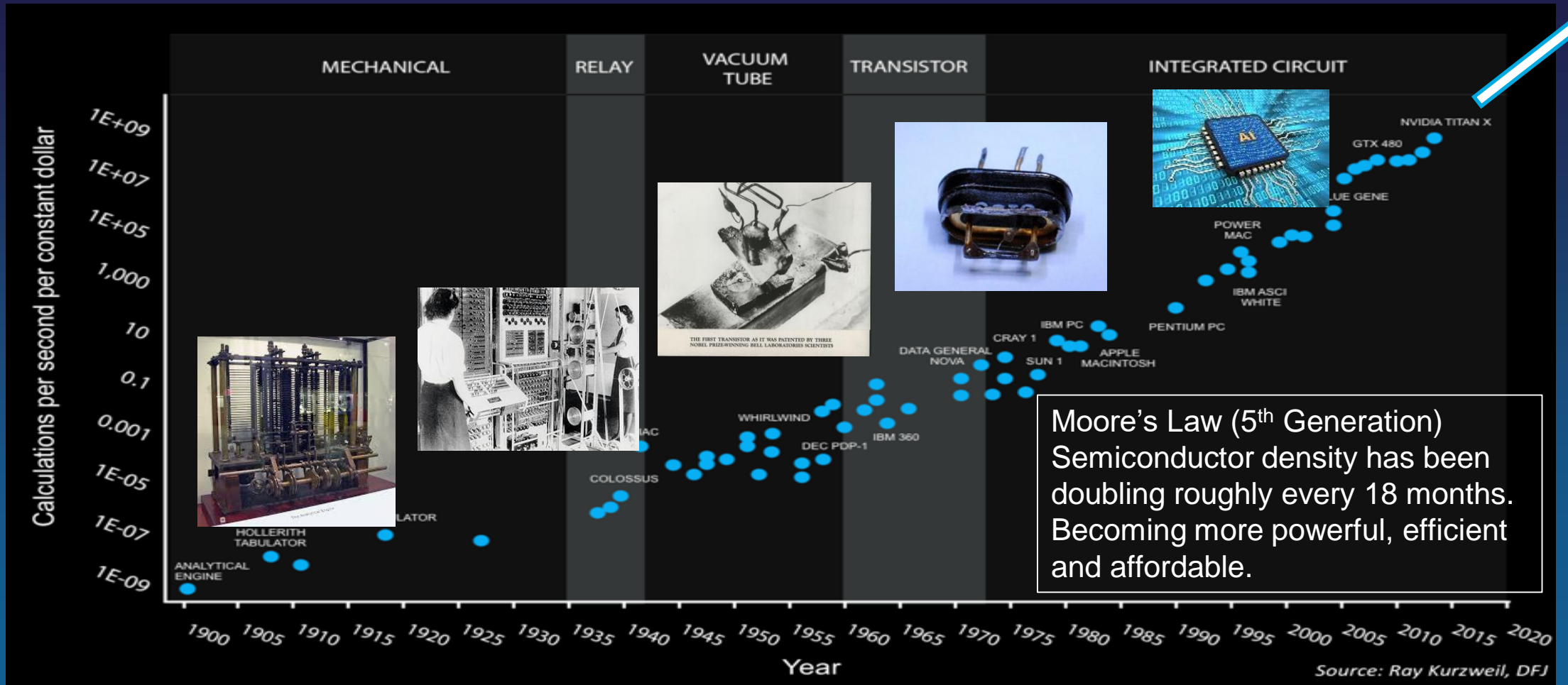
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# Summary

- Electronics industry will continue to grow
- Driver is the synergy between the ever increasing data and the connected devices
- Major devices have been evolving over the many decades thanks to the numerous innovations
- Molecular level process control is only possible with leading-edge tools
- AI semiconductor which is a new category of device will prompt further growth of the industry

# Evolution of Computational Power Per Fixed Cost



Tokyo Electron will continue to provide leading-edge technology solutions

# Technology Enabling Life



Safer mobility



Precision medicine



Ubiquitous education

Technology which contributes to the society



# SPE Business Market Outlook

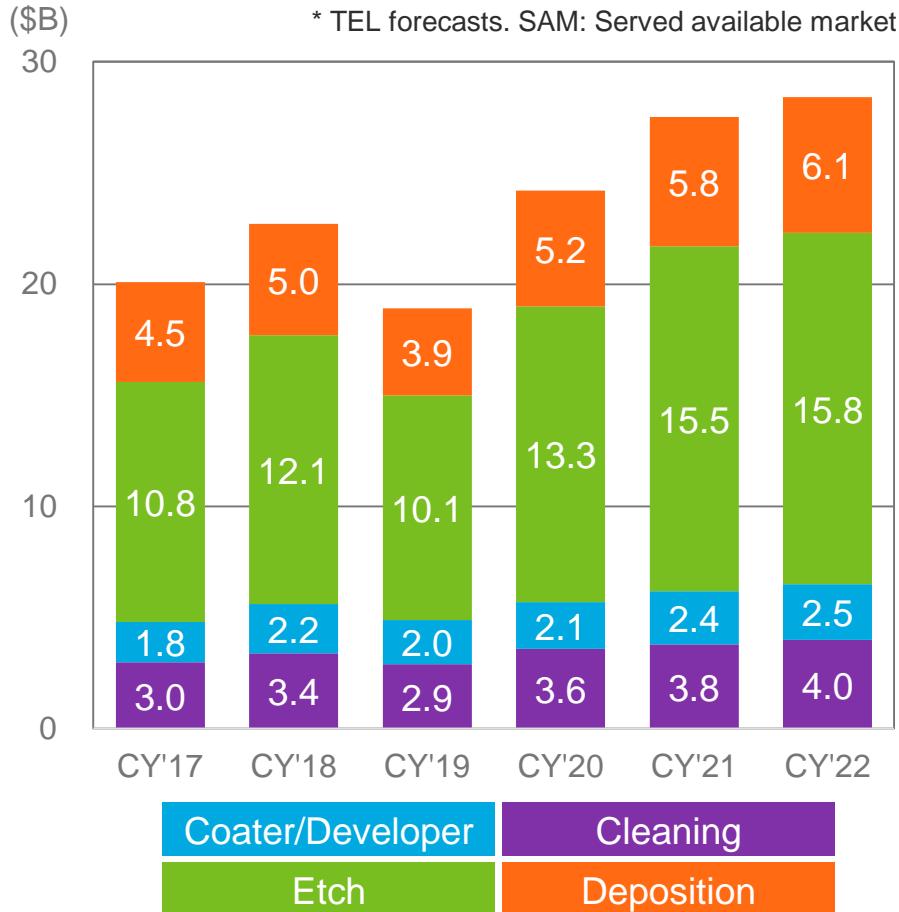
May 28, 2019

Yoshinobu Mitano  
SVP & General Manager, SPE Business Division



# Business Environment and Outlook for TEL's SAM in the SPE Business

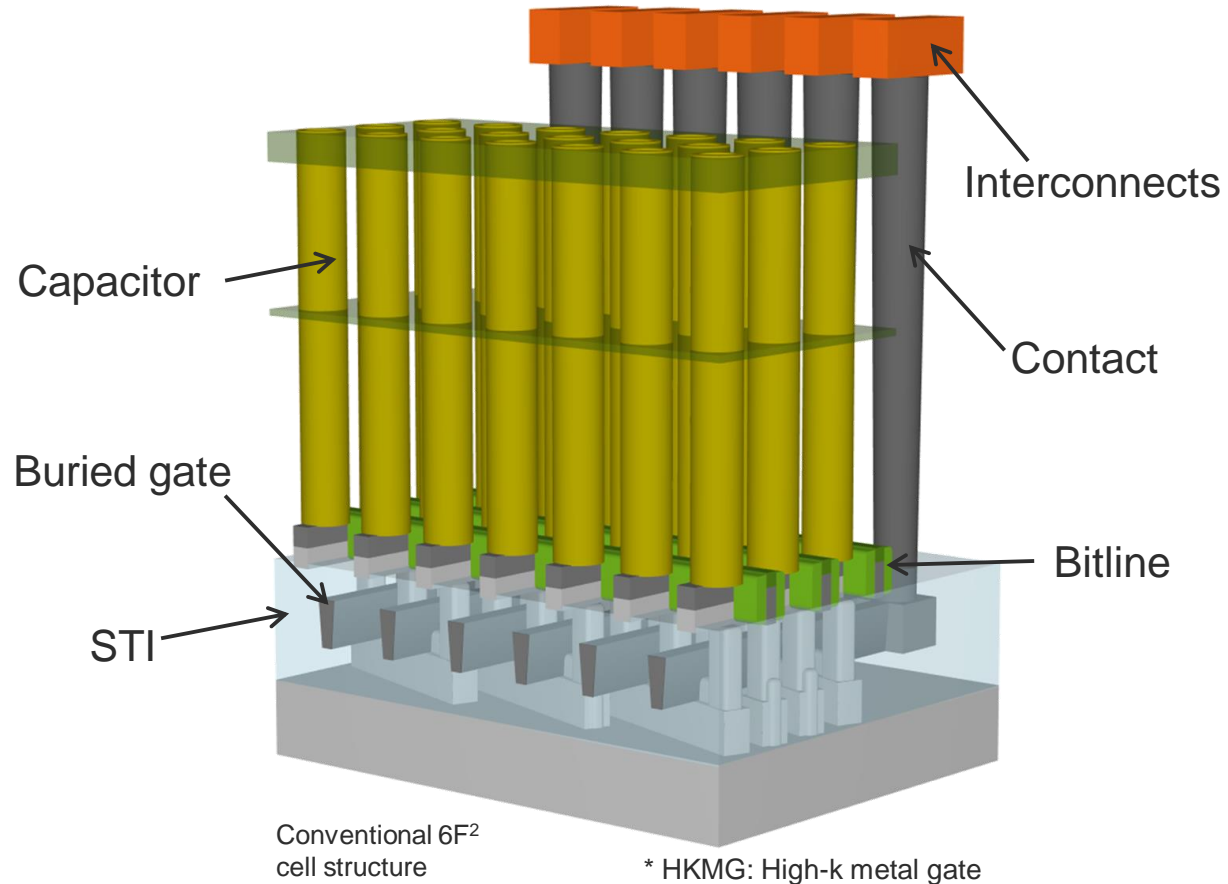
TEL's SAM\* in the semiconductor manufacturing equipment market



## Business environment

- DRAM
  - Copper material adopted to lower resistance of interconnect
  - Capacitor formation is the key to continuing scaling
- NAND
  - Multi-layering has reached over 90 layers
  - Higher aspect ratio etch, high-productivity sacrificial film removal and atomic level control in film formation in 3D structures are crucial for continued increase in density
- Logic/Foundry
  - Increasing complexity of patterning requires co-optimization between unit processes
  - Adoption of EUV lithography for mass production

# DRAM Process Challenges at a Glance



- Scaling increasingly difficult due to capacitor pitch limitation
  - Multi-patterning at Capacitor, WL, BL, STI levels
- To scale capacitor EOT, high-k ( $\text{ZrO}_2/\text{Al}_2\text{O}/\text{ZrO}_2$ ) dielectrics have been introduced with metal (MIM)
- CMOS (periphery) portion moving to HKMG\* & FinFETs to reduce area
- Capacitors will change from cylinders (dielectric on outside and in center) to pillars (dielectric on outside only) with thinner high-k for space saving
  - Aspect ratio increases to >50:1 @D16 node and continues to ~80:1
- All aspects of high aspect ratio structure difficult to fabricate (etch, film deposition, cleaning, ...)

DRAM faces scaling, materials and integration challenges

# NAND Process Challenges at a Glance

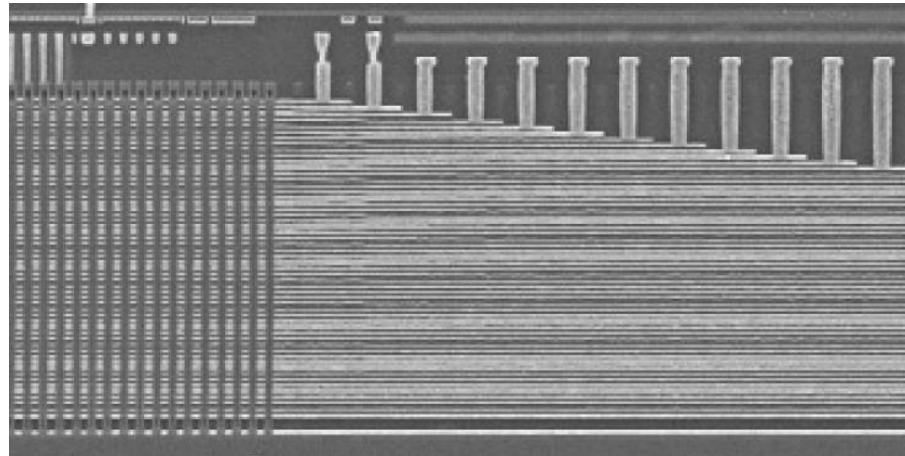
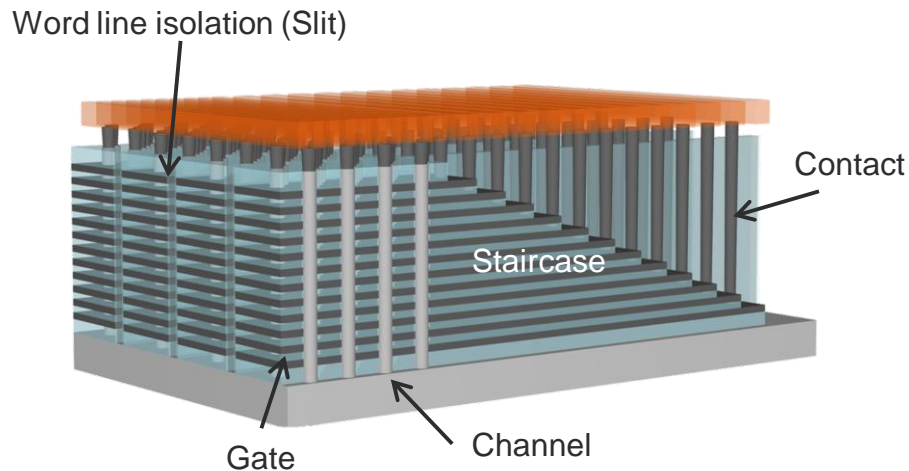


Photo image: TECHINSIGHTS

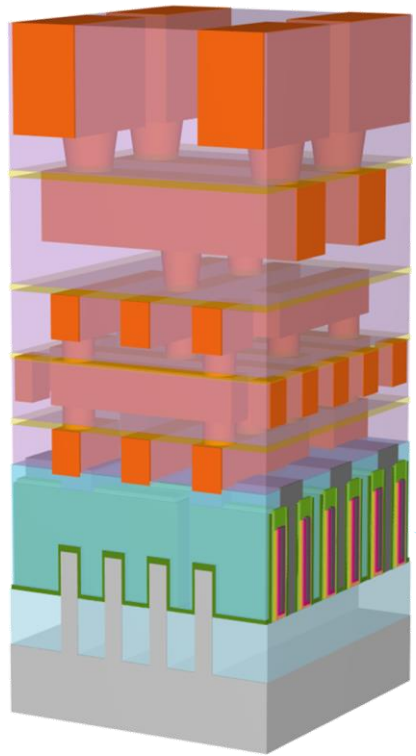
- Scaling is no longer limited by lithography. Rather, it is limited by the number of ONON or OPOP device layers one can stack for higher capacity
- The high aspect ratio of the device structure is proving to be more challenging for every new generation
- CMOS (periphery) portion moving under memory to reduce area creates a difficult thermal budget problem

	2016 - 2017		2018 - 2019		2020 - 2021	2022 - 2023
# of 3D tiers	4X	6X	9X	12X	25X	51X
Hole CD (nm)	65 - 100	65 - 100	65 - 100	65 - 100	65 - 100	65 - 100
Holes between slits	4	4	4 - 8	8	8	8
Vertical pitch (nm)	50 - 70	40 - 60	40 - 60	40 - 50	40 - 50	40 - 50
Bitline CD (nm)	20	20	20 - 40	~40	~40	~40

TEL forecasts

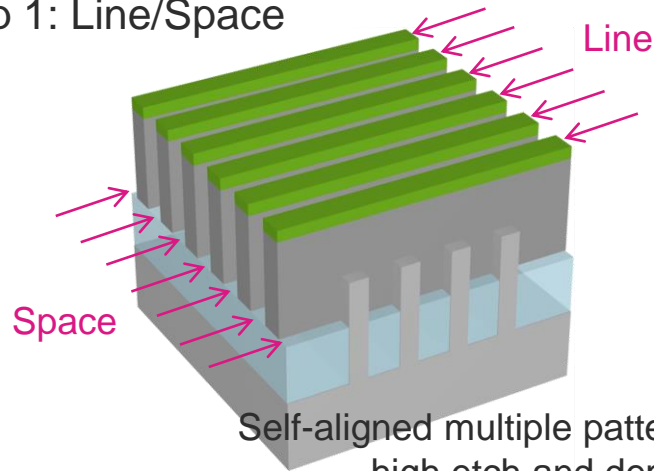
Etch and deposition of the multi-layering progressively difficult as AR increases

# Logic: Overcoming Technological Hurdles (Placement Errors) with EUV



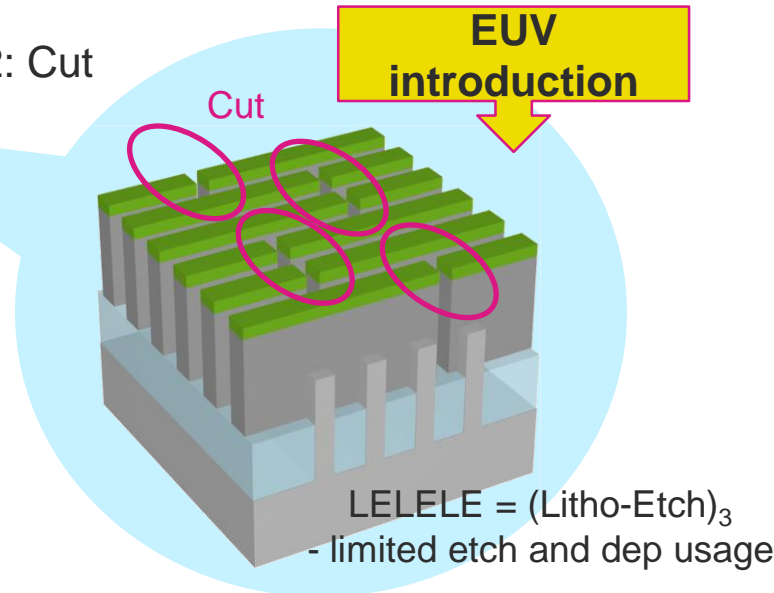
Cross section of a logic structure

Step 1: Line/Space



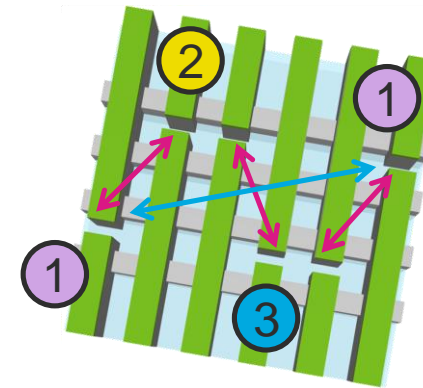
Self-aligned multiple patterning (SAMP)  
- high etch and dep usage

Step 2: Cut



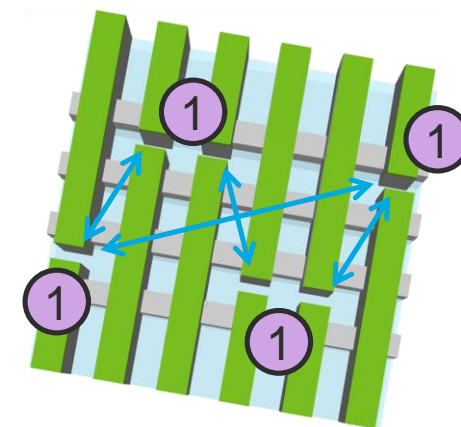
LELELE = (Litho-Etch)<sub>3</sub>  
- limited etch and dep usage

Conventional exposure



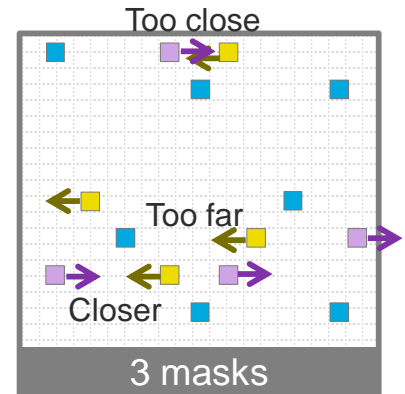
Three exposures: (Litho + Etch) x 3

Exposure using EUV



One exposure: (Litho + Etch) x 1

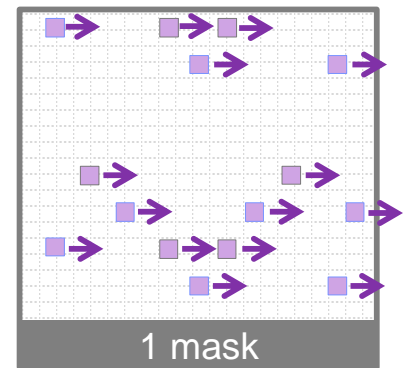
Each exposure process creates placement errors



Lower yield



Placement errors reduced



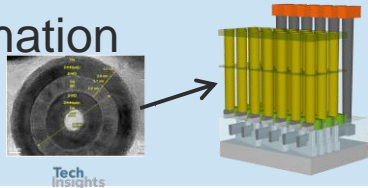
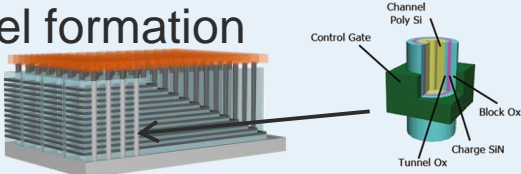
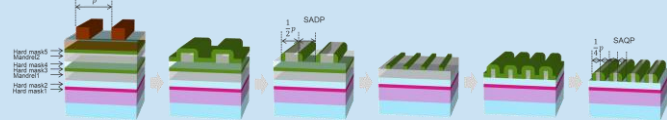
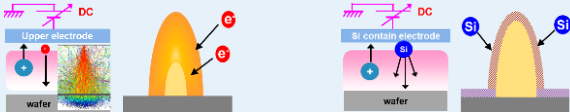
Increased yield



# Effects of EUV Lithography Adoption

- EUV adoption will solve the technological hurdles our customers face (i.e. placement errors), bringing about positive effects for the semiconductor and SPE industries
  - Advancement of scaling
  - Acceleration of customers' investment in next generation technologies through yield enhancement
- The advancement of scaling driven by EUV will further differentiate our products and create business opportunities
  - Greater market share for coater/developer
  - Increase demand for etch, deposition and cleaning equipment
  - Product differentiation driven by evolution of self-aligned patterning technology
  - Business expansion through process integration that leverages our robust product line-up

# SPE Business Strategy

Device	Module	Critical process / Relevant systems
DRAM	Capacitor formation 	High aspect ratio dielectric etch / Tactras™ Vigus™ Collapse-reducing single wafer cleaning / CELLESTA™-i High-k dielectric & electrode deposition / TELINDY™, NT333™, Trias™
NAND	Channel formation 	High aspect ratio oxide & nitride film stack etch / Tactras™ Vigus™ High mobility channel film deposition / TELINDY™ High-k dielectric & charge trap deposition / TELINDY™, NT333™
DRAM Logic	SAQP  Patterning using EUV 	High temp tolerant SoC coating / LITHIUS Pro™ Z Ultrathin film high selectivity etch / Tactras™ Vigus™ Atomic layer deposition (ALD) / TELINDY™ EUV resist coating & development / LITHIUS Pro™ Z Resist hardening + etch / Tactras™ Vigus™

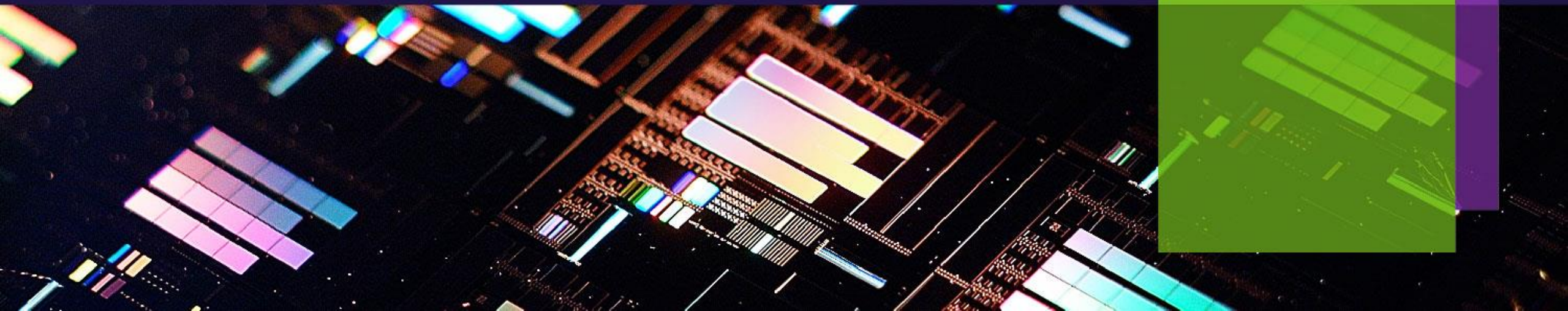
Expand business by differentiating TEL's technology in unit processes and proposing solutions that incorporate integration

# Coater/Developer, Cleaning System Business Strategy

May 28, 2019

Keiichi Akiyama

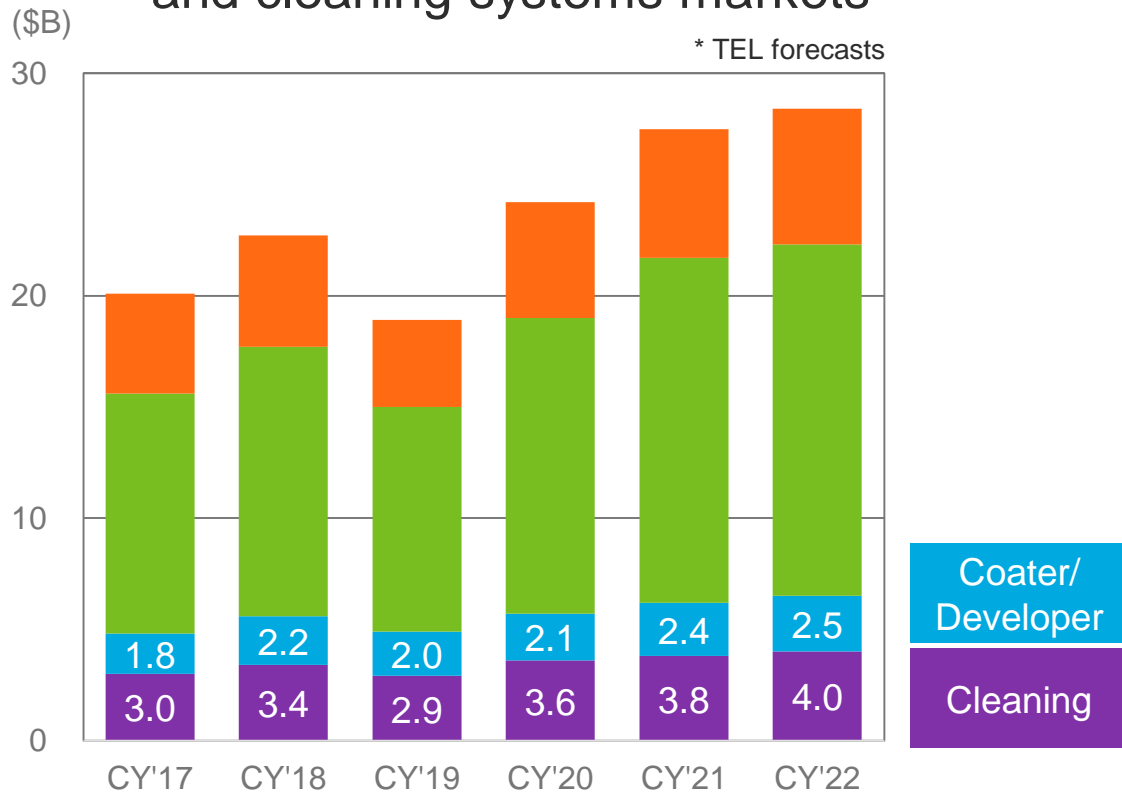
VP & General Manager, CTSPS BU





# Business Environment and Outlook for TEL's SAM in the Coater/Developer and Cleaning System Businesses

TEL's SAM in the coater/developer and cleaning systems markets\*



Coater/Developer  
CLEAN TRACK™  
LITHIUS Pro™ Z

Single wafer cleaning system  
CELLESTA™-i



Batch cleaning system  
EXPEDIUS™-i

## Business environment

- Coater/Developer
  - Adoption of EUV lithography for mass production is accelerating
- Cleaning system
  - Increased demand for bevel cleaning
  - Further demand for drying technology that prevents pattern collapse accompanying scaling

Growth in coater/developer and cleaning systems SAM on demand for increasing density of semiconductor devices

# FY2019 Progress

## ■ Coater/Developer

- Grew market share to 88% amid increased ratio of investment in leading-edge processes
- Maintained 100% share in in-line coater/developer for EUV

## ■ Cleaning system

- Maintained market share of 25%, a five-point increased in CY'17
- Enhanced product line-up
  - Launched CELLESTA™ Pro SPM
- Expanded bevel wet etch applications
  - Expanded its use in wiring materials (metal)

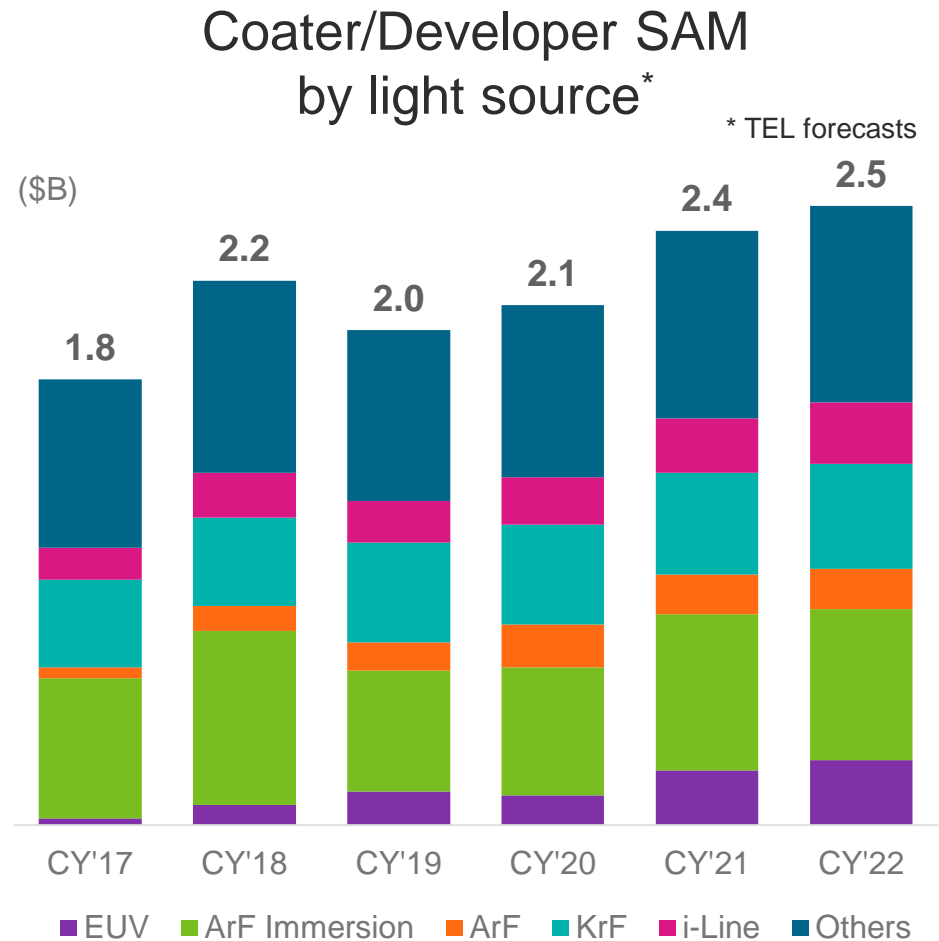


### CELLESTA™ Pro SPM Features

- ✓ High productivity and availability
- ✓ High uniformity
- ✓ Controlled selectivity for metal



# Coater/Developer SAM Outlook



- EUV
  - Growth in line with progress made on scaling
- ArF Immersion
  - Although SAM ratio will gradually fall due to introduction of EUV, market is the largest
- ArF, KrF, i-Line, Others
  - SAM ratios will continue to be high due to expansion of 3D NAND, IoT devices, etc.

# Coater/Developer Strategy

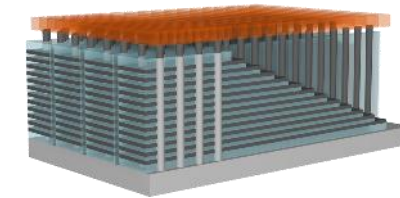
- Promote unification of system platforms
  - Improve value for customers and unify development with latest LITHIUS Pro™ Z series
- Develop value-added products for scaling and 3D structures
  - Address 3D NAND wafer warpage
- Improve quality of service through use of data and automation
  - Promote high-quality support not reliant on technical skill of personnel



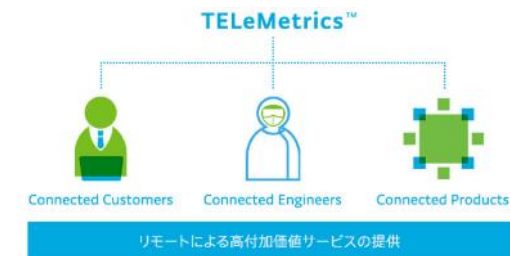
CLEAN TRACK™  
LITHIUS Pro™ Z



CLEAN TRACK™  
LITHIUS Pro™ AP

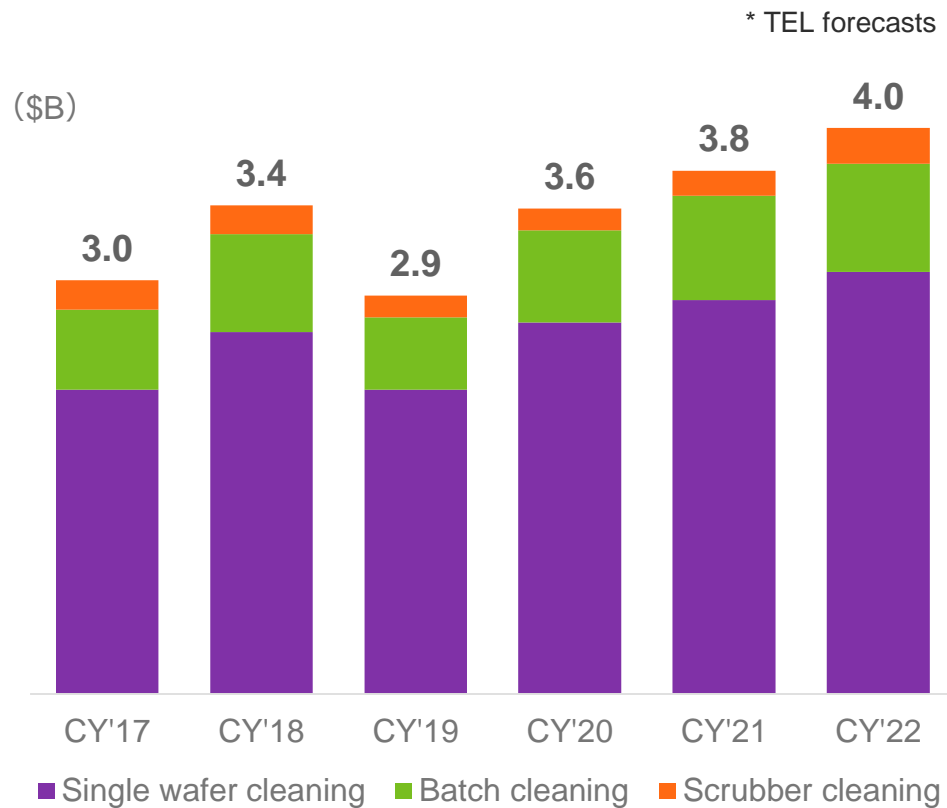


3D NAND



# Cleaning System SAM Outlook

Cleaning system SAM  
by system type\*



No significant changes to SAM ratios for cleaning systems

- Single wafer cleaning
  - Will continue to be the largest market
  - Technological innovation aimed at reducing defects and improving etch/drying performance will continue
- Batch cleaning
  - Demand will continue in the market for wet etch for 3D NAND critical processes
- Scrubber cleaning
  - The importance of physical back/bevel cleaning is increasing in pre-lithography process and other areas

# Single Wafer Cleaning Strategy

## ■ Single wafer cleaning

### – Bevel wet etch

- Expect annual market growth rate of around 10%
- Contribute to improving customers' yields.

Maintain a high market share by differentiating through performance in precisely removing film from the outer part of the wafer

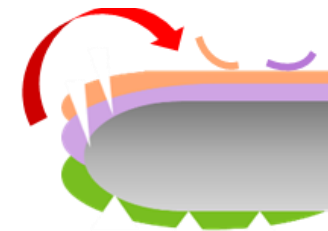
### – Prevent pattern collapse

Expand market share by TEL original technology to reduce collapse of high aspect ratio pattern

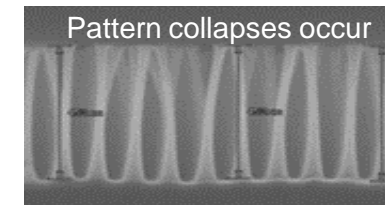
### – Metal etch

Launched new dedicated SPM chambers for controlling selectivity for metal in order to solve reduced yield issues caused by dry etch damage and residue

Without bevel wet etch



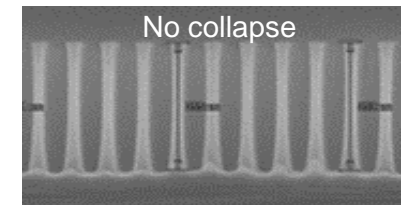
Conventional drying technology



With bevel wet etch



New drying technology



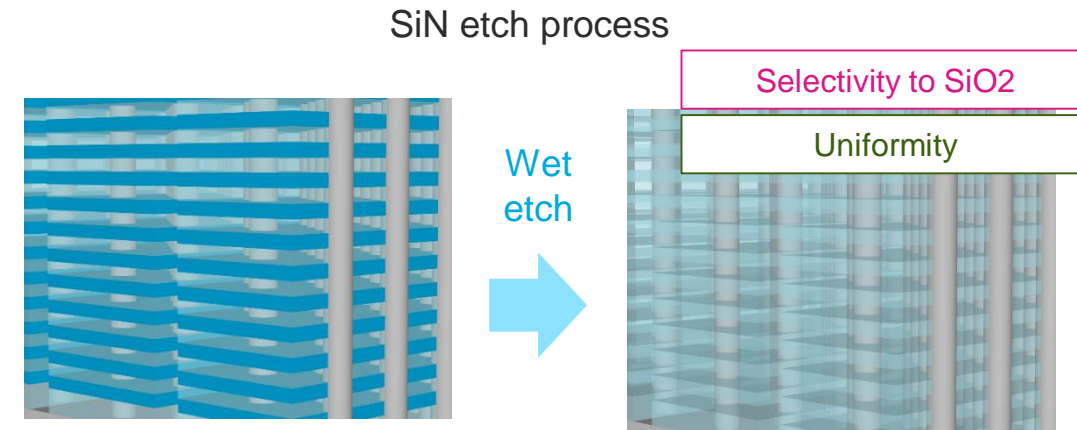
Metal etch process



# Batch and Scrubber Cleaning Strategy

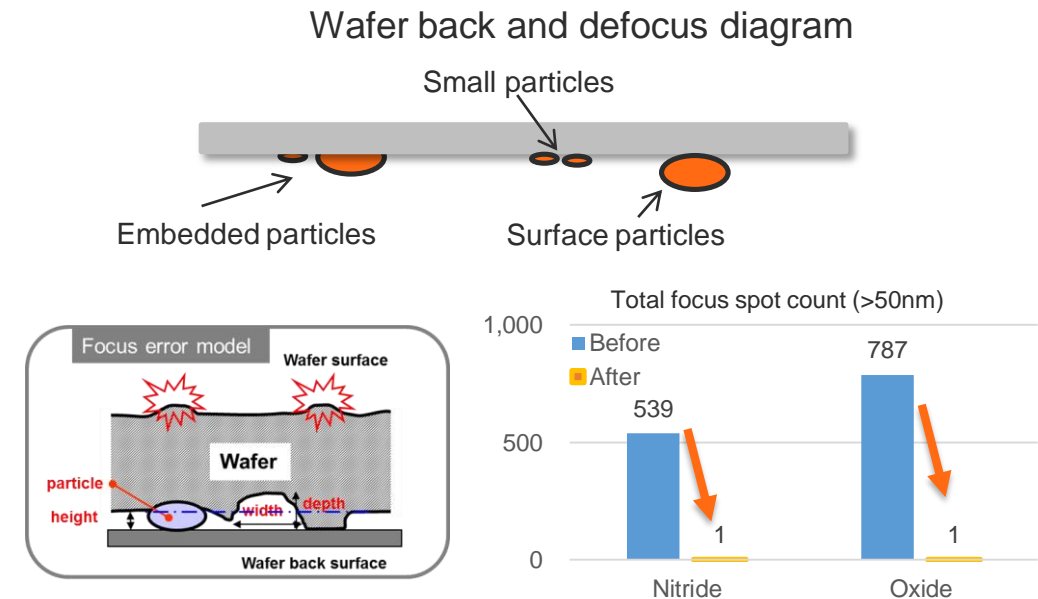
- Batch cleaning

- SiN etch and W etch processes for 3D NAND  
Focus on processes that require long durations and advanced process technology. Differentiate by realizing high uniformity, high selectivity and high productivity in wet etch



- Scrubber cleaning

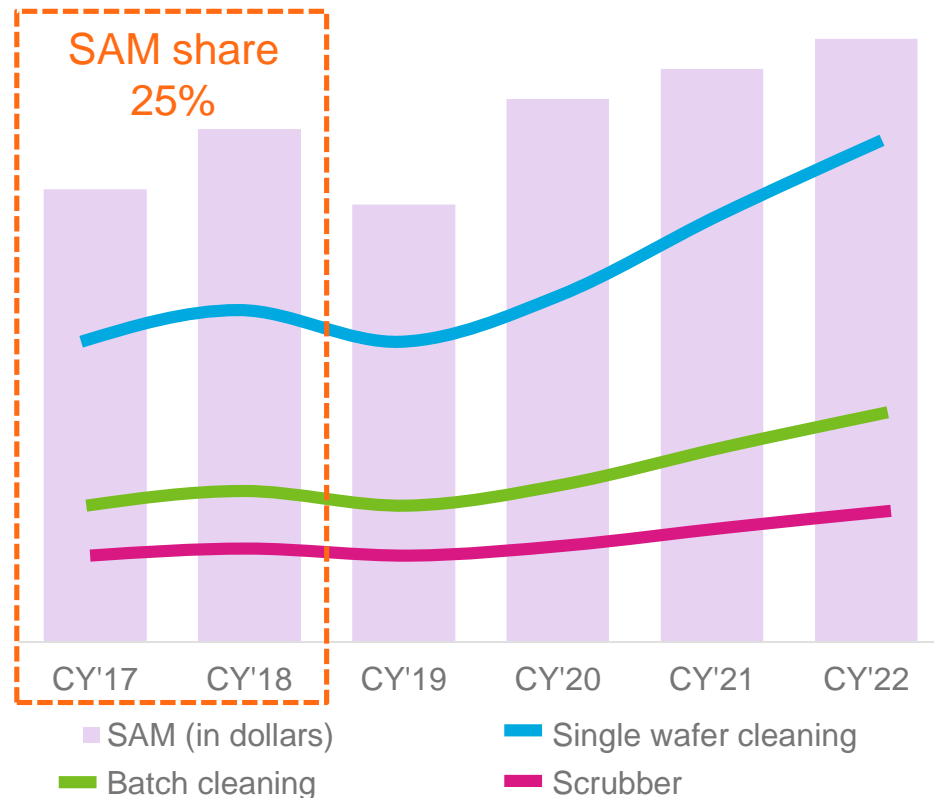
- Pre-lithography process  
Provide high-value solutions such as reducing particles brought in by wafers, contributing to the improvement of exposure tool availability which have grown increasingly important due to the introduction of EUV



# Cleaning System Growth Scenario

Sales targets by system type within  
TEL's SAM for cleaning systems\*

\* TEL forecasts. SAM shown on a dollar basis and sales on a yen basis



- Single wafer cleaning
  - Grow sales with pattern collapse reduction technology and by improving productivity
  - Maintain a high market share for bevel wet etch and expand applications through removal of new materials
- Batch cleaning
  - Expand POR in 3D NAND critical processes
- Scrubber cleaning
  - SAM will grow as importance of back/bevel processing increases due to introduction of EUV

**Aim for 30% SAM share within 5 years**



# Summary

- Coater/Developer  
Continue to develop technology that differentiates TEL in leading-edge technology areas and maintain high value and market share
- Cleaning system  
Continue to differentiate via technological development, focusing on processes where customers need a high level of technological support, such as improving yield
- Synergies  
Raise efficiency of development and production by sharing BKM\* and promoting unification of development, production and management of coater/developer and cleaning systems

\* BKM: Best known method

# Etch System Business Strategy

May 28, 2019

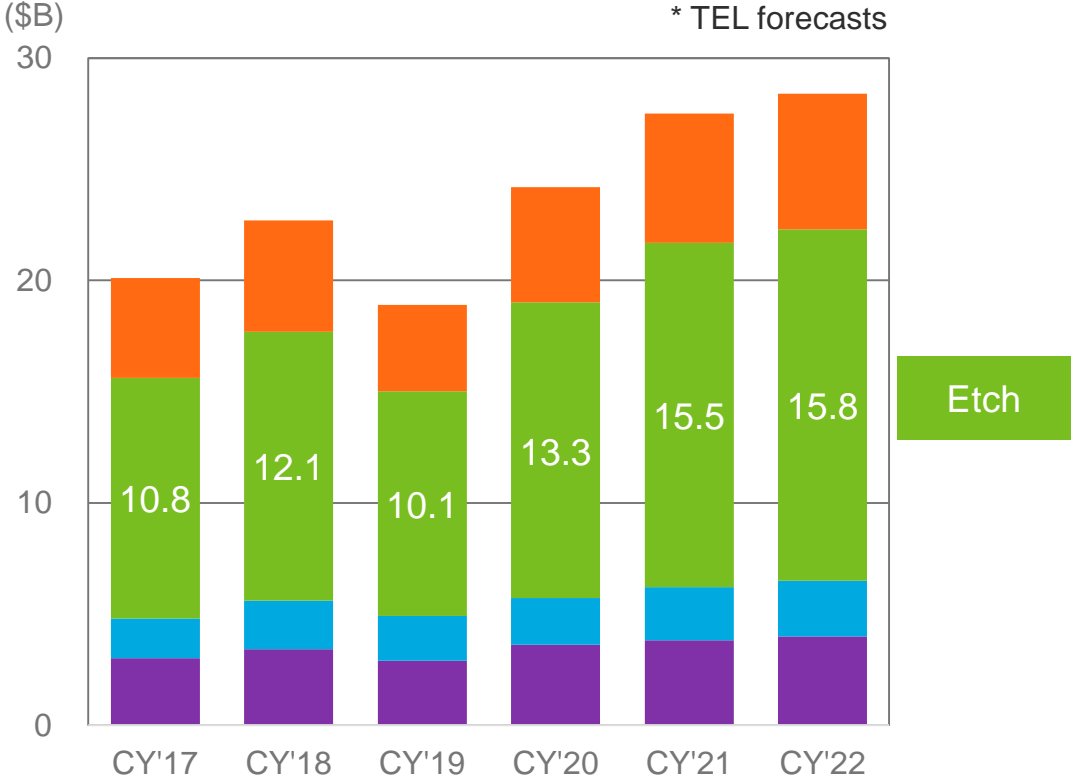
Isamu Wakui

VP & General Manager, ES BU



# Business Environment and Outlook for TEL's SAM in the Etch System Business

## TEL's SAM in the etch systems market\*



Tactras™ Vigus™



Certas LEAGA™

### Business environment

- Investment in HARC process growing due to increases in number of 3D NAND layers and production capacity
- Increase in patterning process accompanying logic scaling
- SAM in CY'22 forecast to be 50% greater than in CY'19

**SAM in the etch business to continue growing due to increase in HARC and patterning processes**

## FY2019 Progress

- Achieved medium-term market share target of 30% in CY'18 by focusing on HARC process, patterning process and interconnect process, all of which leverage TEL's strengths
- Expanded market share in 3D NAND 6X/9X generations by differentiating through process performance and productivity
- Increased sales in DRAM copper interconnect process, where we captured market share by leveraging knowledge of logic

# FY2019 Progress

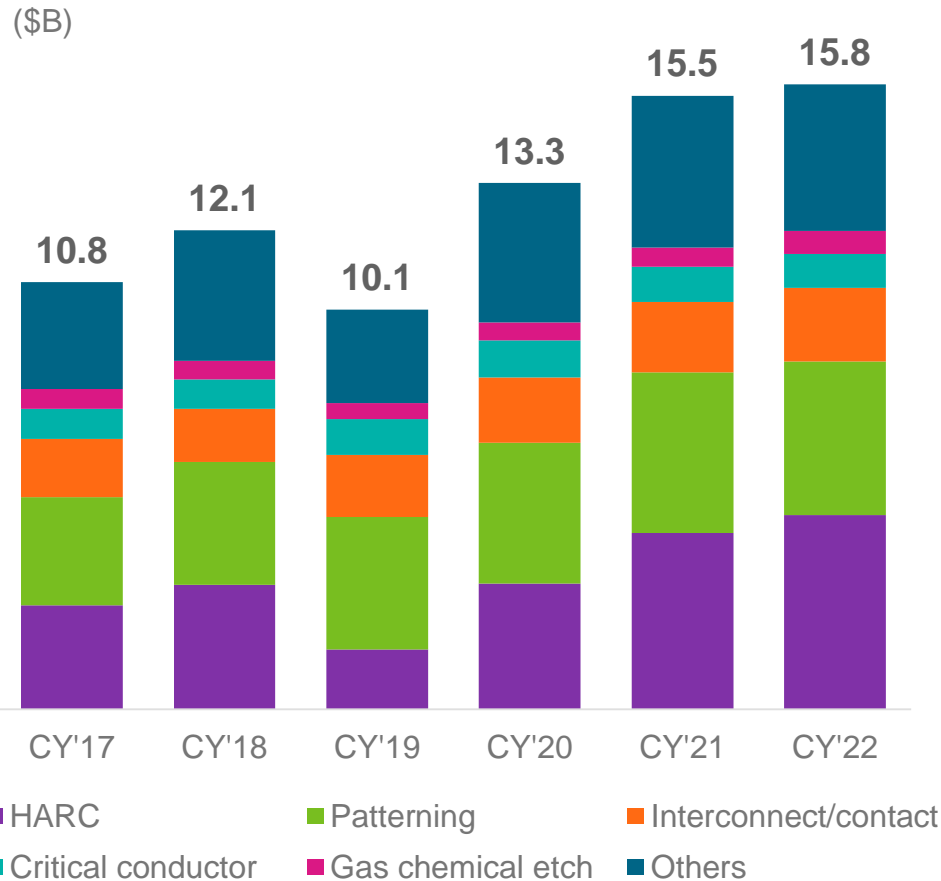
## Video

Increasing Development and  
Production Capabilities at the Miyagi  
Plant (Etch Systems)

# Etch System SAM Outlook

Etch system SAM by process type\*

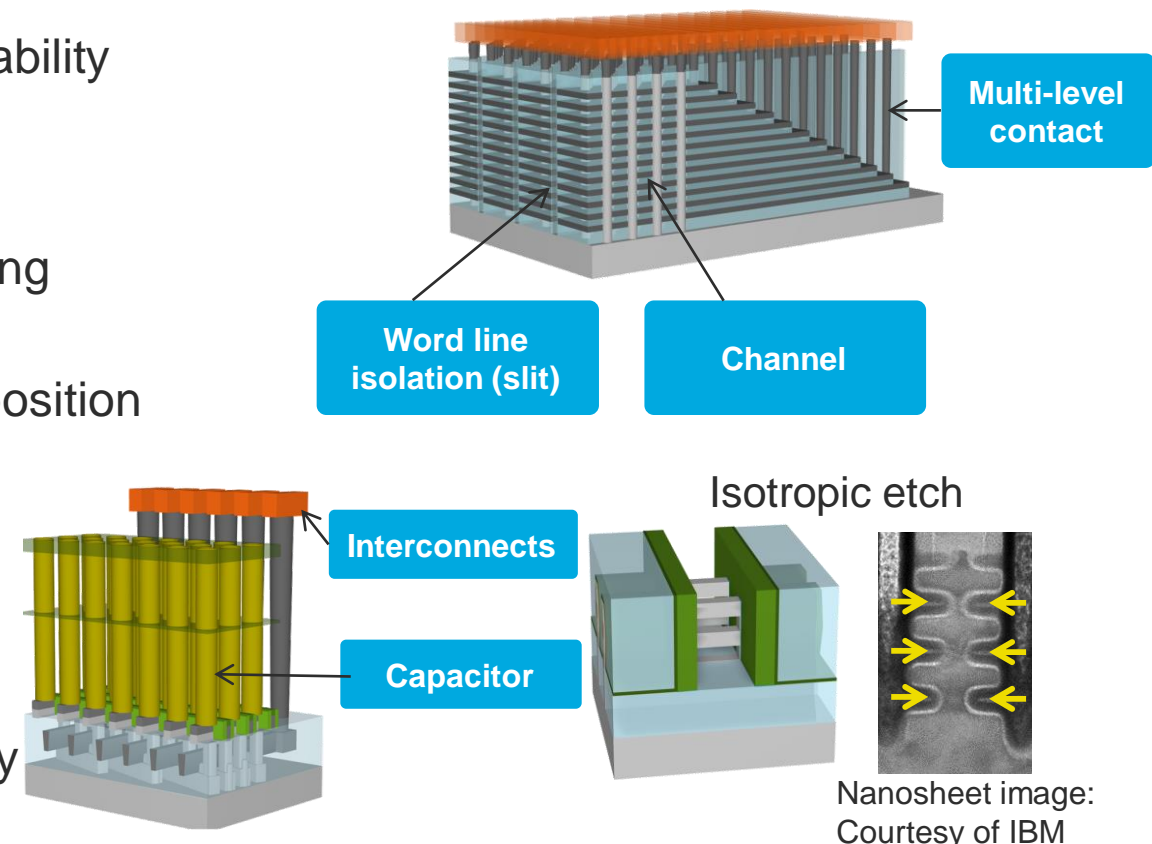
\*TEL forecasts



- HARC process
  - SAM will increase due to advancement of 3D NAND and DRAM scaling
- Patterning process
  - Multi-patterning will continue to be used, even after the adoption of EUV for mass production, and SAM will remain at high levels
- Interconnect/contact process
  - SAM will grow due to adoption of copper dual damascene interconnects for DRAM and increasing number of logic interconnects layers
- Critical conductor process
  - Stable investment will continue despite low SAM ratio
- Gas chemical etch process
  - Growth trend for SAM due to introduction of 3D structures in devices

# Etch System Strategy

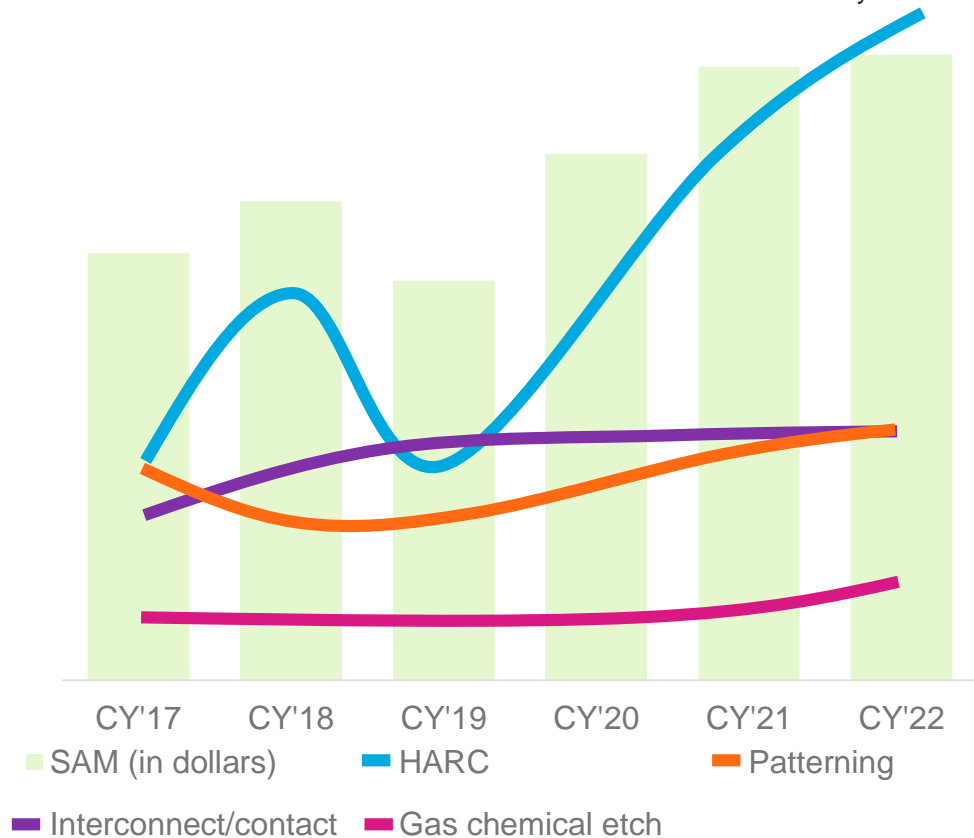
- HARC process
  - 3D NAND (multi-level contact, word line isolation), DRAM (capacitor): Continue to differentiate through process performance and productivity
  - 3D NAND (channel): Launch new systems that can differentiate by providing both precise process controllability and even higher productivity
- Patterning process
  - DRAM: Reduce customer production costs by combining etch steps
  - Logic: Differentiate through integration of etch and deposition technologies
- Interconnect/contact process
  - Apply knowledge cultivated in logic to DRAM
- Gas chemical etch process
  - Create a new market through plasma assist technology



# Etch System Growth Scenario

## Sales targets by process type within TEL's SAM for etch systems\*

\* TEL forecasts. SAM shown on a dollar basis and sales on a yen basis



Focus on processes with growing SAM and aim to capture a high SAM share

- HARC process
  - Increase sales by growing 3D NAND and DRAM SAM and capturing new PORs
- Patterning process
  - Expand SAM share by offering production cost reductions
- Interconnect/contact process
  - Maintain high market share with growing SAM and by differentiating technology
- Gas chemical etch process
  - Increase sales by creating new markets

## Aim for 30-35% SAM share within 5 years



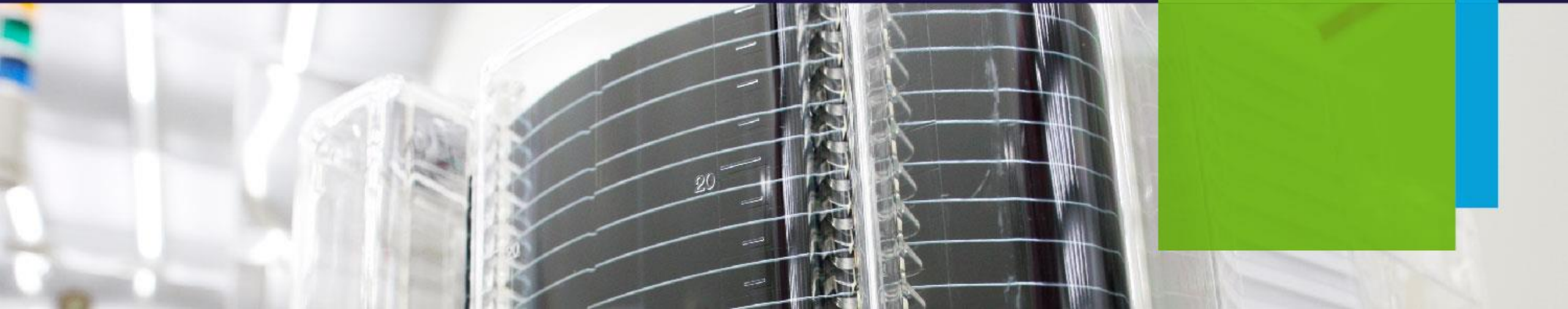
# Summary

- SAM in the etch business to continue growing due to increase in HARC and patterning processes
- Achieved medium-term market share target of 30% in CY'18 by focusing on HARC process, patterning process and interconnect process, all of which leverage TEL's strengths
- Focus on processes with growing SAM and aim to capture a high SAM share

# Deposition System Business Strategy

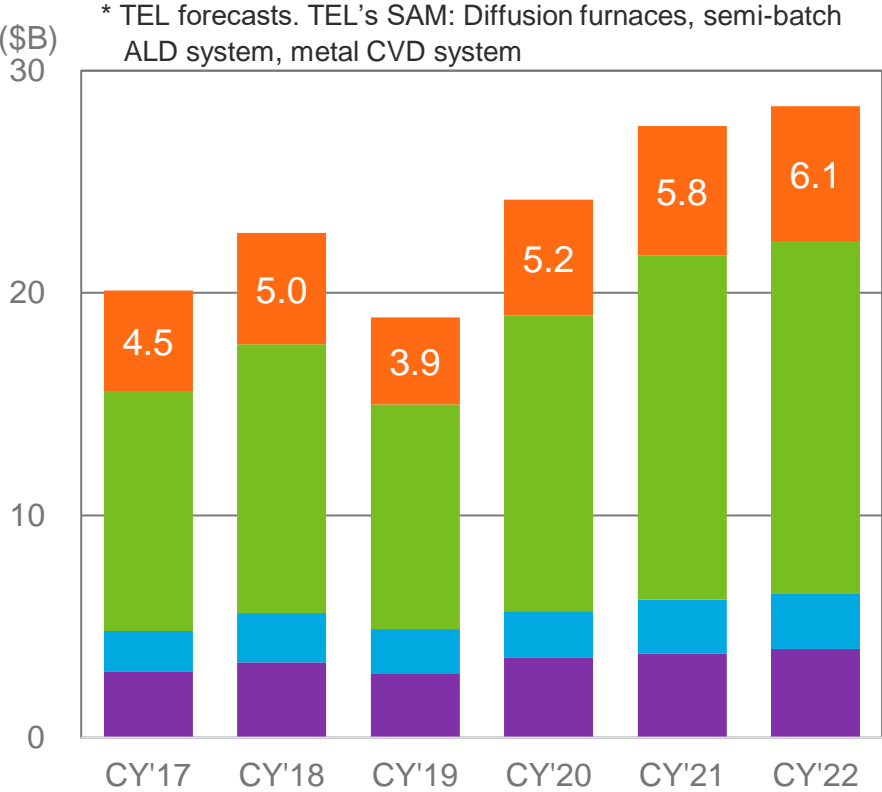
May 28, 2019

Hiroshi Ishida  
VP & GM, TFF BU



# Business Environment and Outlook for TEL's SAM in the Deposition System Business

## TEL's SAM in the deposition systems market\*



Deposition



NT333™

TELINDY PLUS™



Triase+™

### Business environment

- Increasingly scaled and complex device structures are increasing the number of deposition processes. In particular, demand for ALD, which has excellent performance, is growing
- Customers are choosing the most appropriate technology for each process among batch, semi-batch and single wafer to balance performance and cost

The number of deposition processes is increasing as device structures become increasingly scaled and complex. Demand for ALD in particular is growing

# FY2019 Progress

- Streamlined production, meeting strong demand for systems
- Successfully captured business in the memory market, which experienced particularly high demand, thereby growing market share
- Secured business in multiple new functional film processes of major customers
- Started construction of new production buildings at the Yamanashi (Fujii) and Tohoku plants in response to growing market for deposition systems

New building at the  
Yamanashi (Fujii) plant

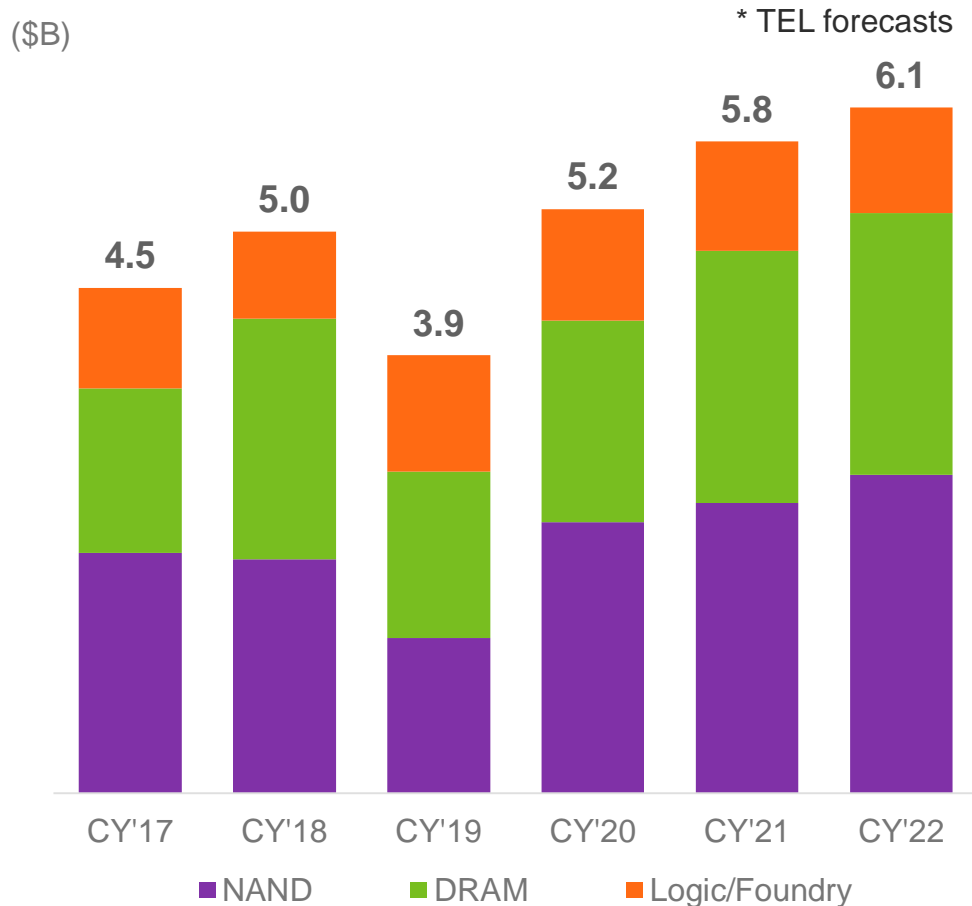


New building at  
the Tohoku plant



# Deposition System SAM Outlook

## Deposition system SAM by application\*



### ■ NAND

- Investment for 3D NAND scaling will continue. Particularly, demand for high quality dielectric film, mainly with ALD, is increasing for high aspect ratio step

### ■ DRAM

- Scaling will continue. Investment is expected in new structures and materials to improve capacitor performance

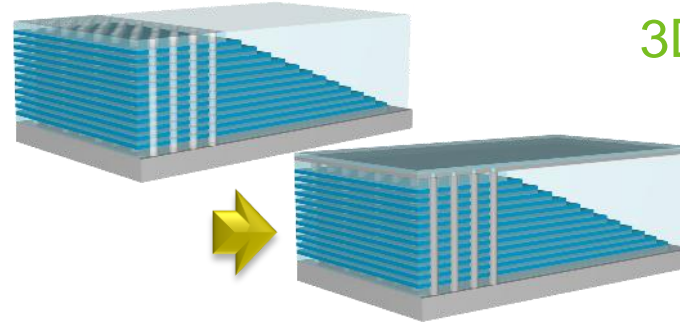
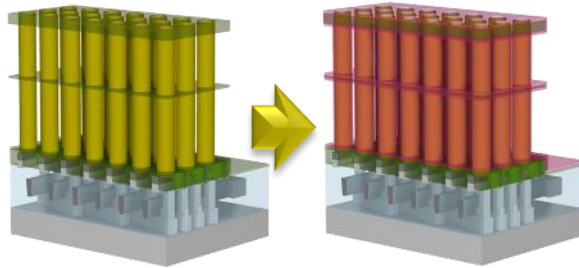
### ■ Logic/Foundry

- SAM ratio will decrease, but stable investment expected. Continued demand for technological innovation to suppress resistance increase in thin wire

# Deposition Business Strategy

## DRAM

- Lower temperatures
- High-k dielectric film
- Capacitor electrode

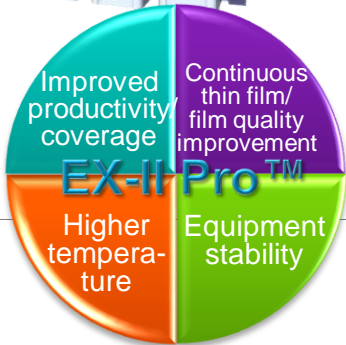
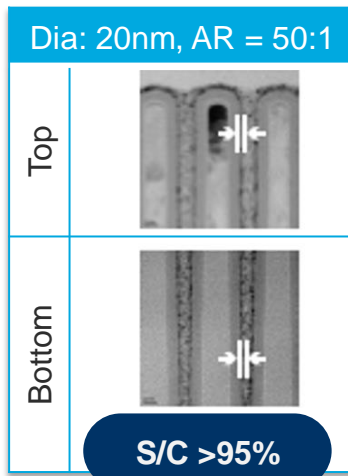


## 3D NAND

- Channel silicon film
- Charge trap film
- Block high-k dielectric film
- Buried oxide film
- Buried silicon film

### Single-wafer System

Triase<sup>+</sup>™ EX-II Pro™ TiN



### Vertical Furnace

TELINDY PLUS™ Super Large Batch



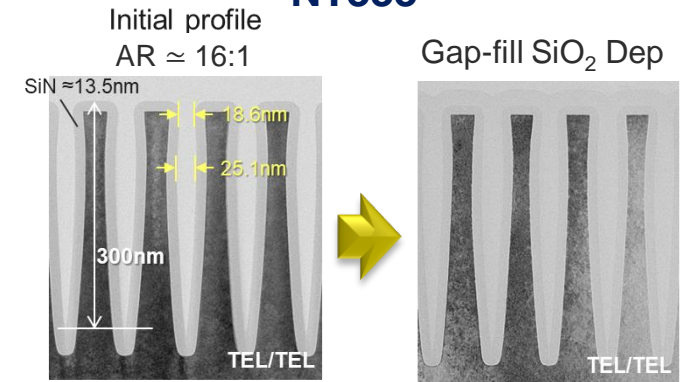
100/125



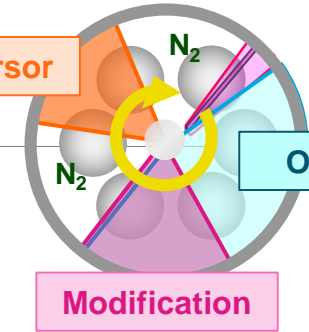
150/175

### Semi-batch System

NT333™



Si precursor



Oxidation

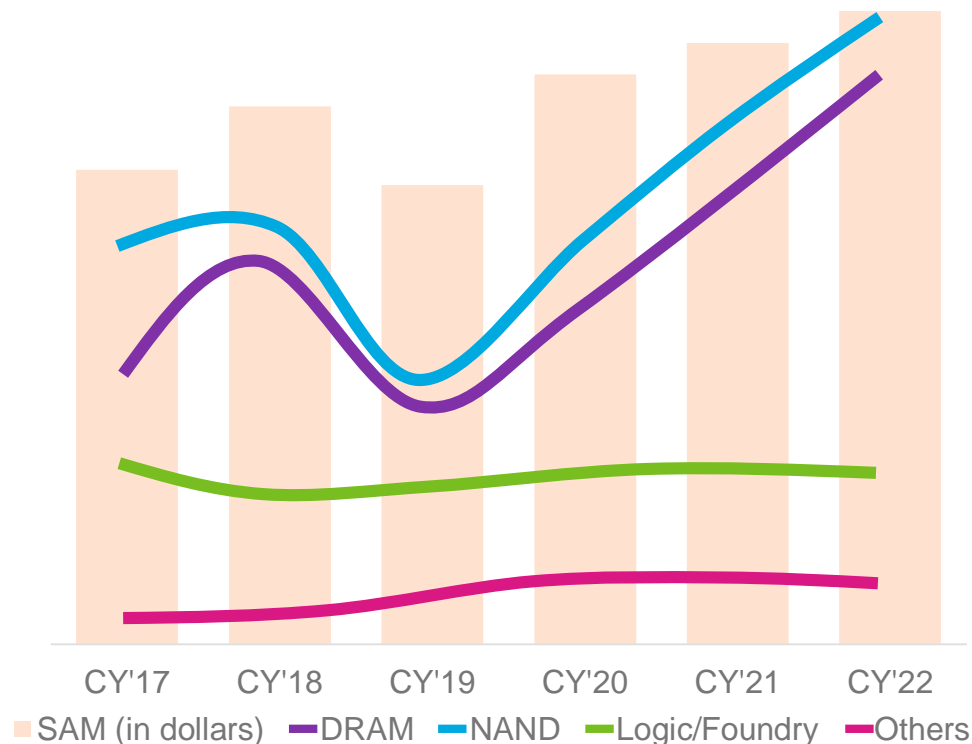
Modification

Provide high value-added technology by leveraging our advantage of having batch, semi-batch and single wafer technologies

# Deposition System Growth Scenario

Sales targets by application within  
TEL's SAM for deposition systems\*

\* TEL forecasts. SAM shown on a dollar basis and sales on a yen basis



- Expand business by choosing the most appropriate method among batch, semi-batch and single wafer, and providing high value-added technologies
- In deposition technologies, which are becoming increasingly advanced, accelerate development of new materials and new deposition method by leveraging our strengths. Aim for further growth
  - Deposition of new metal material to achieve lower resistance
  - New deposition methods to promote scaling, such as anisotropic deposition and selective deposition
  - Pre-treatment technology to realize better electric characteristics

Focus on high value-added deposition processes,  
aim for 40%+ SAM share within 5 years

# Summary

- The number of deposition processes is increasing as device structures become increasingly scaled and complex. Demand for ALD in particular is growing
- Expand business by leveraging our strength of being able to choose the most appropriate method among batch, semi-batch and single wafer, and providing high value-added technologies
- In deposition technologies, which are becoming increasingly advanced, accelerate development of new materials and new deposition methods by leveraging our strengths
- Increase production capacity by building new production buildings at the Yamanashi (Fujii) and Tohoku plants in response to growing deposition market, aim for sales expansion



# FPD Business Strategy

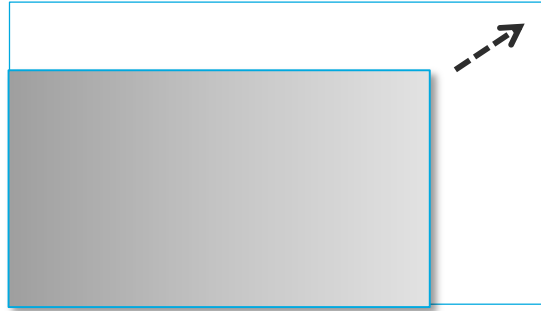
May 28, 2019

Tsuguhiko Matsuura  
VP & GM, FPD Business Division

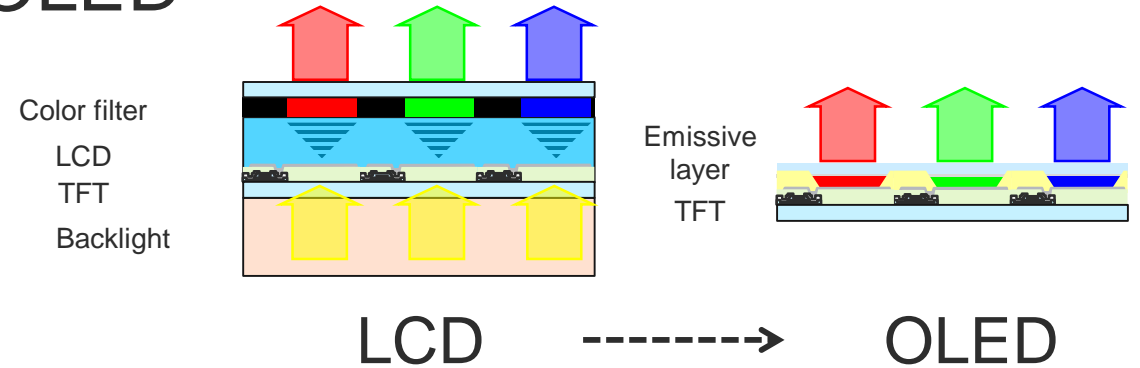


# Display Trends

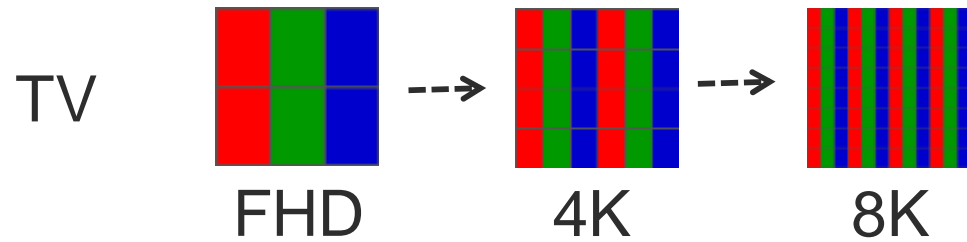
Increasing screen size



OLED



Increasing resolution



Mobile, VR      300 ppi -----> 1,000 ppi

Design flexibility

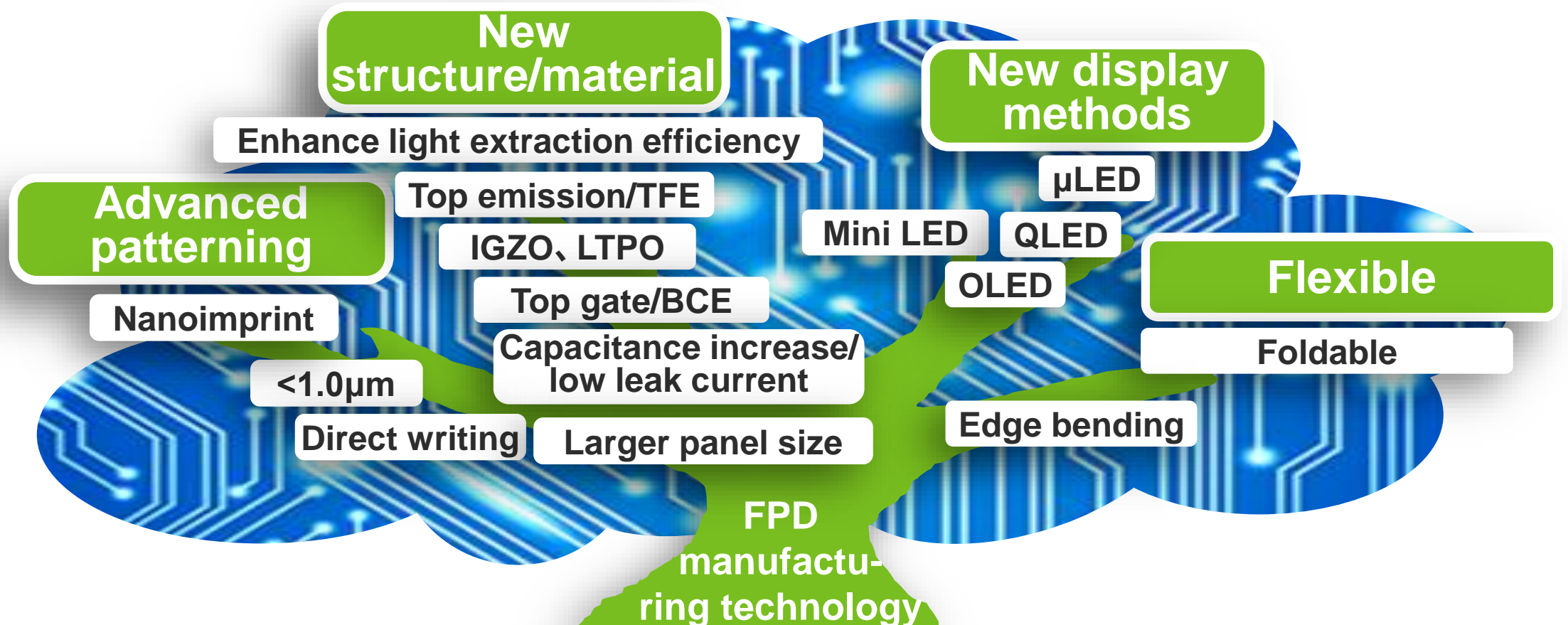


Flexible, free format



Technological change in displays increasing business opportunities

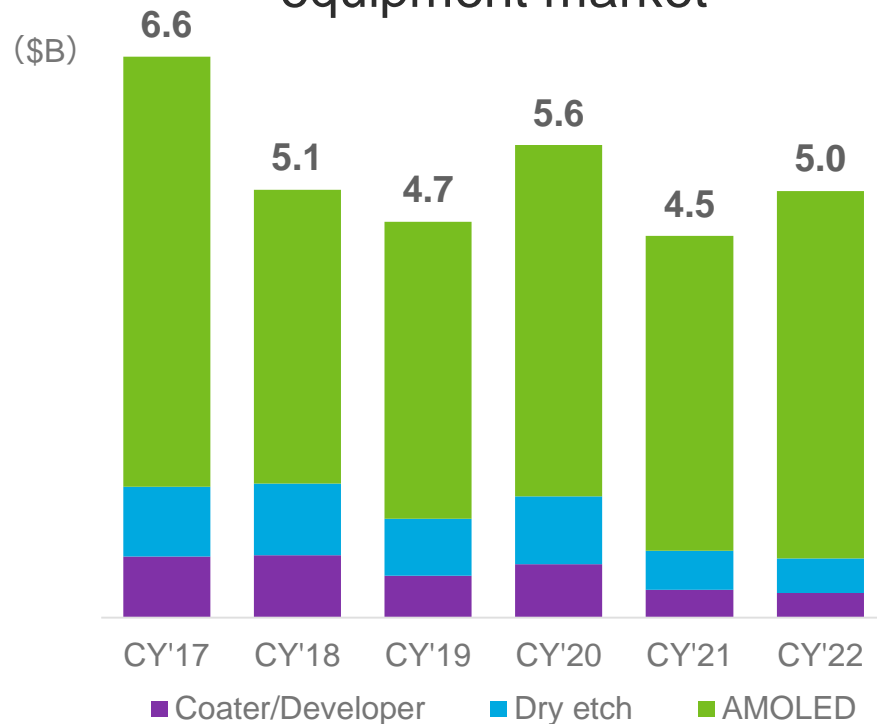
# Display Evolution and Diversification of Process Technology



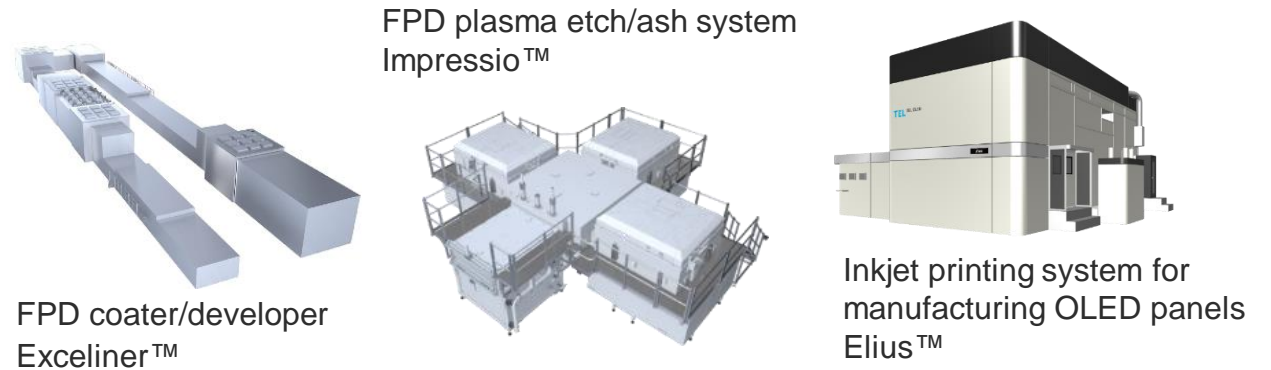
Diverse new technologies will enable display evolution

# Business Environment and Outlook for TEL's SAM in the FPD business

TEL's SAM in FPD manufacturing equipment market



Data based on IHS Markit, Technology Group, Display Supply Demand Equipment Tracker Q4 2018. Results are not an endorsement of Tokyo Electron Limited. Any reliance on these results is at the third party's own risk. Visit [technology.ihs.com](http://technology.ihs.com) for more details.



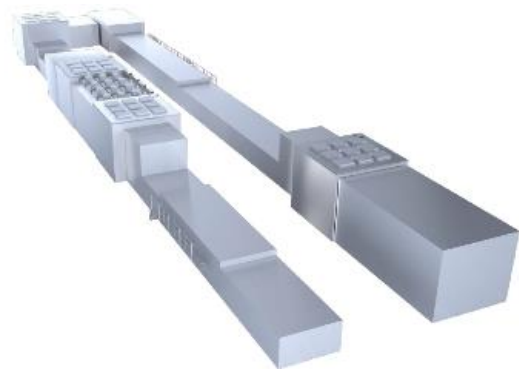
## Business environment

- Resolution in large displays increasing, OLED market expanding
- Evolution of mobile displays

Technological innovation continues mainly in large displays and mobile displays

# FY2019 Progress

- Achieved medium-term operating margin target of 20%
- Established a leading position in G10.5
- PICP™\* etch system product development steady
- Launched Elius™ 1000 G4.5 inkjet printing system for manufacturing OLED panels, which accommodates high resolution



FPD coater/developer  
Exceliner™



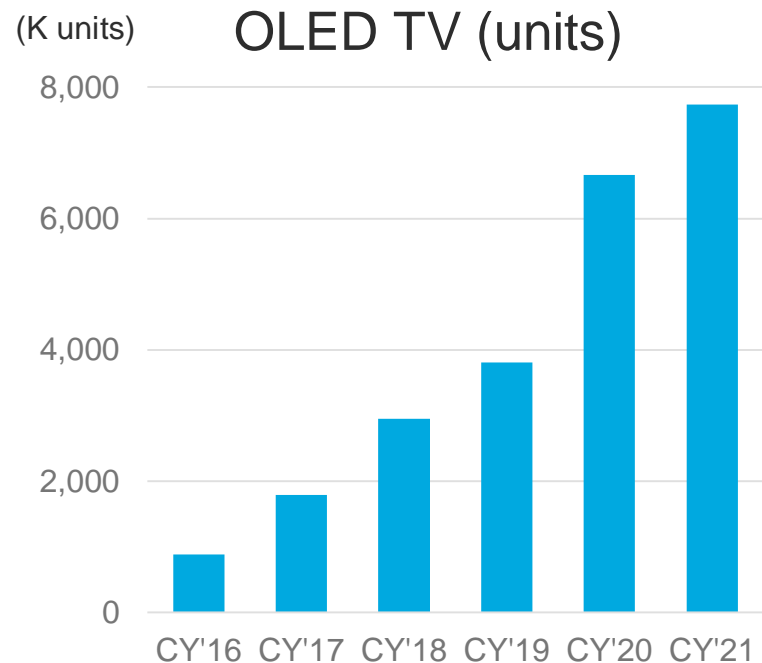
FPD plasma etch/ash system  
Impressio™



Inkjet printing system for  
manufacturing OLED panels Elius™

# Business Opportunity: Increasing Resolution in Large Displays, Growth of OLED TV Market

- OLED TV market will further grow. 8K TV market will launch
- Mark shift to OLED in high-end monitors, automotive displays and public displays



Data based on IHS Markit, Technology Group, Display Long-Term Demand Forecast Tracker Q4 2018. Results are not an endorsement of Tokyo Electron Limited. Any reliance on these results is at the third party's own risk. Visit [technology.ihs.com](http://technology.ihs.com) for more details.

## Growth strategy

- Deploy PICP™ plasma etch system in G8.5/G10.5
- Launch inkjet printing system accommodating high resolution (200 ppi and above)


Promote development activities that reflect technological trends in large panels

# Business Opportunity: Evolution of Mobile Displays

High resolution, full-screen, OLED, embedded fingerprint sensors, lower power consumption, foldable



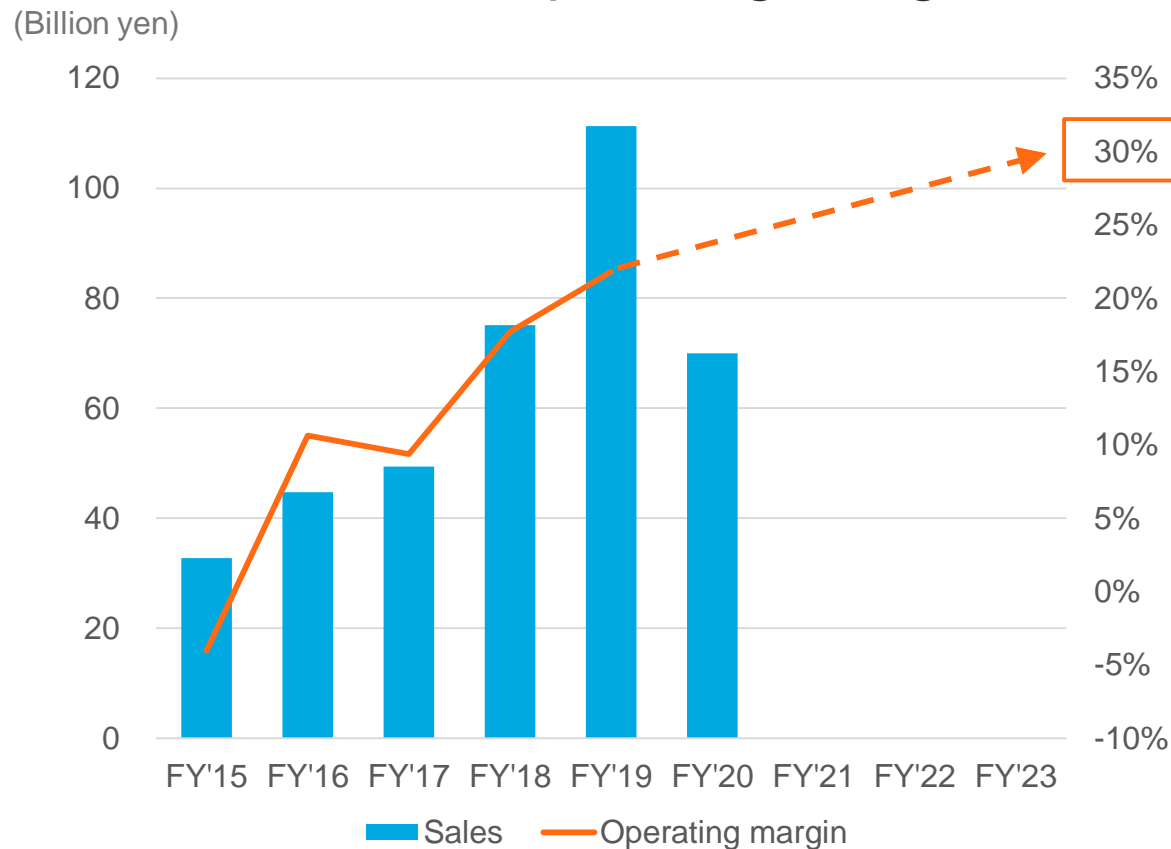
## Business strategy

- Increase number of masks and dry etch processes
  - Scaling and patterning precision improvement is required. Respond to LTPS and IGZO
- 
- Improve performance of dry etch system and coater/developer. Introduce SPE technologies

Opportunities for differentiation will expand as technological requirement becomes more sophisticated

# FPD Manufacturing Equipment Growth Scenario

## Sales and operating margin



- Raise competitiveness of dry etch system and coater/developer
- Create inkjet market for large OLED displays
- Launch new products that reflect evolution of displays

**Aim for 30% operating margin within 5 years**



# Summary

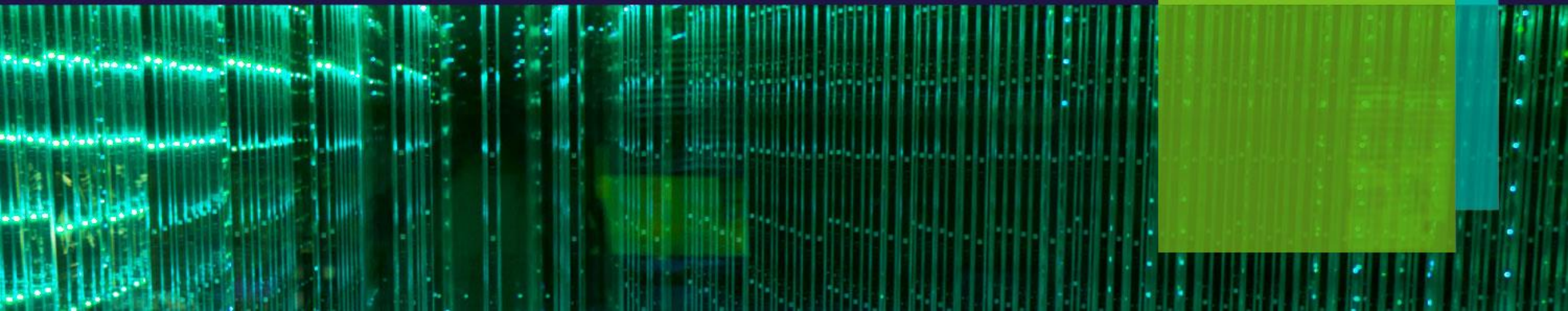
- Increase market share and profitability in growing market. Aim for 30% operating margin
- Focus on areas in cutting-edge manufacturing processes where we can leverage our technological advantages
  - Raise competitiveness of dry etch system and coater/developer
  - Create inkjet market for large OLED displays
  - Launch new products that reflect evolution of displays

# Field Solutions Business Strategy

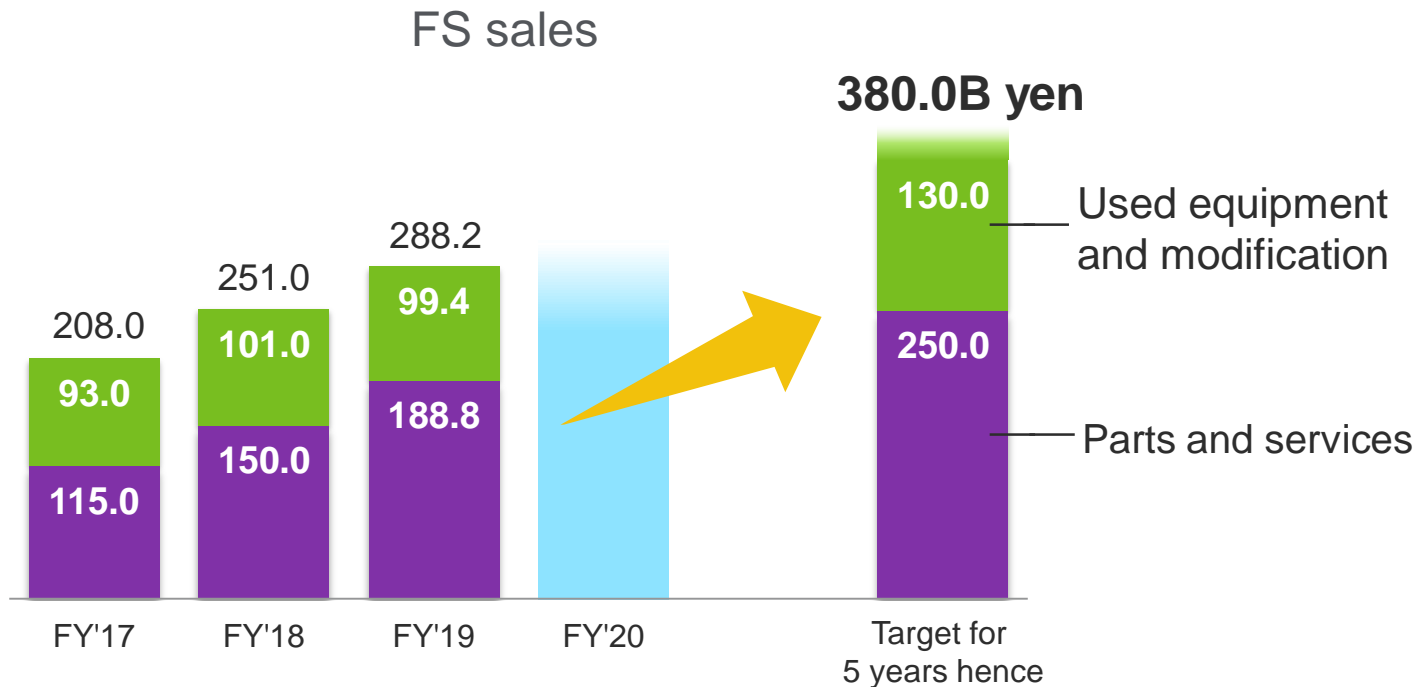
May 28, 2019

Kiyoshi Sunohara

Corporate Director, SVP & General Manager, Field Solutions Business Division  
Subleader, Business Innovation Project



# Field Solutions (FS) Sales Results and Growth Strategy



## Growth strategy key points

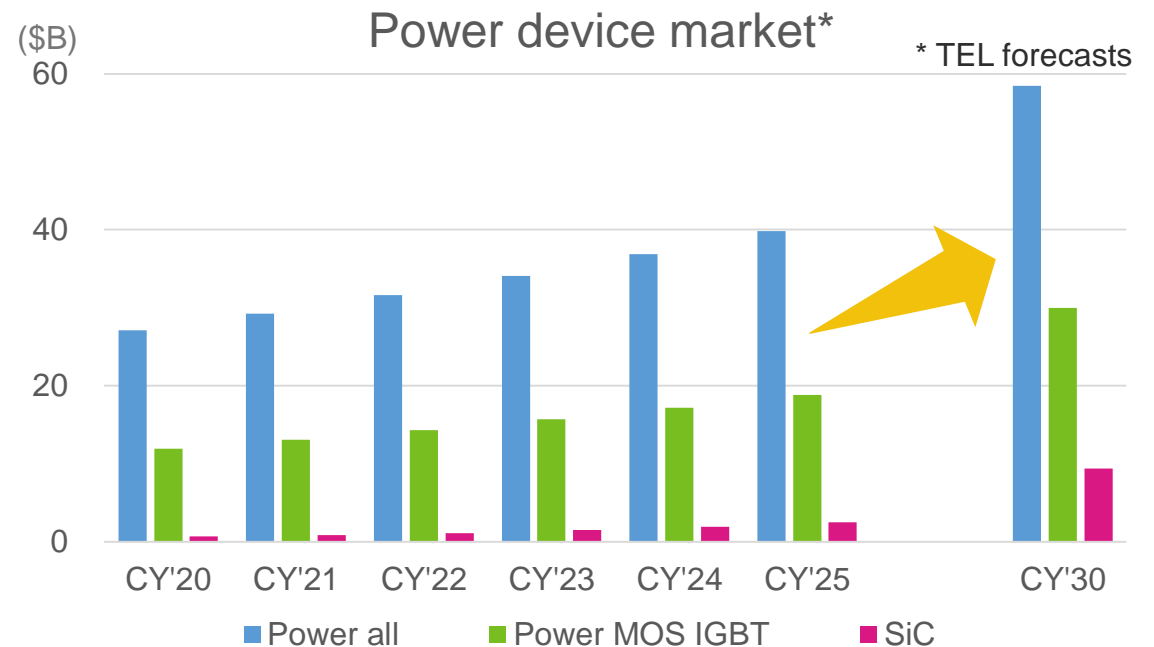
- Grow SAM through increase in installed units (installed base of 69,000 units)
- Respond to new customer needs
  - 200mm renewal equipment
  - Comprehensive contract services
- Enhance business efficiency by cooperating with Business Innovation Project

Leverage our strengths as an equipment manufacturer to increase earnings in both the used equipment/modification and parts/services segments

# Used Equipment/Modification Business

Automotive, smartphones, sensors, MEMS, communications markets growing

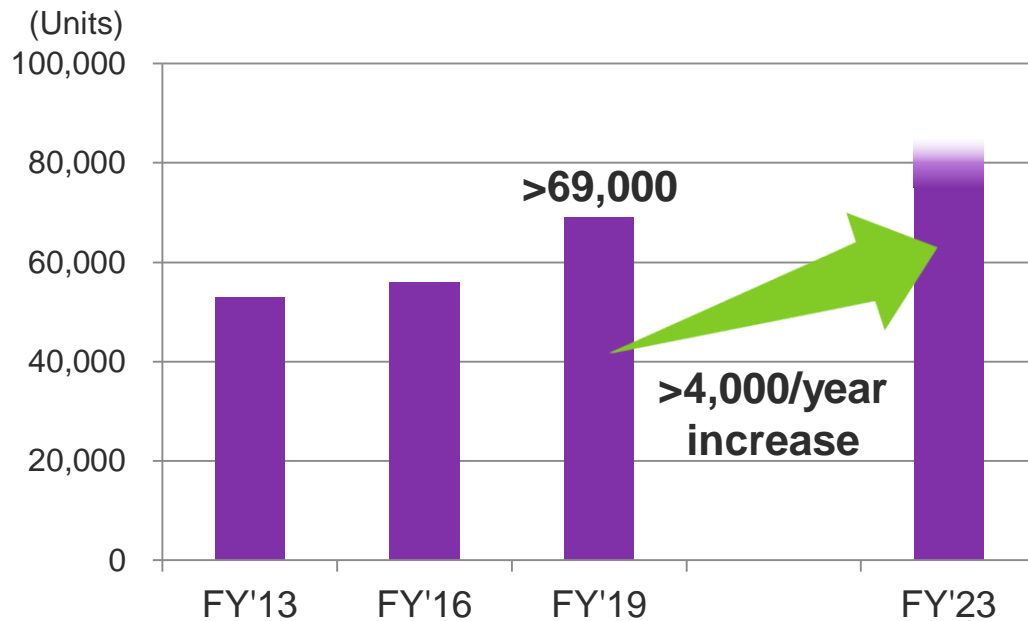
- 200mm renewal equipment
  - Diffusion furnaces, deposition system
  - Cleaning system
  - Etch system
  - Coater/Developer
- Capture power device market
  - SiC etch
  - SiC epitaxial deposition



# Parts/Services Business Model 1

Largest installed base in the industry

Expand SAM on increase in installed base



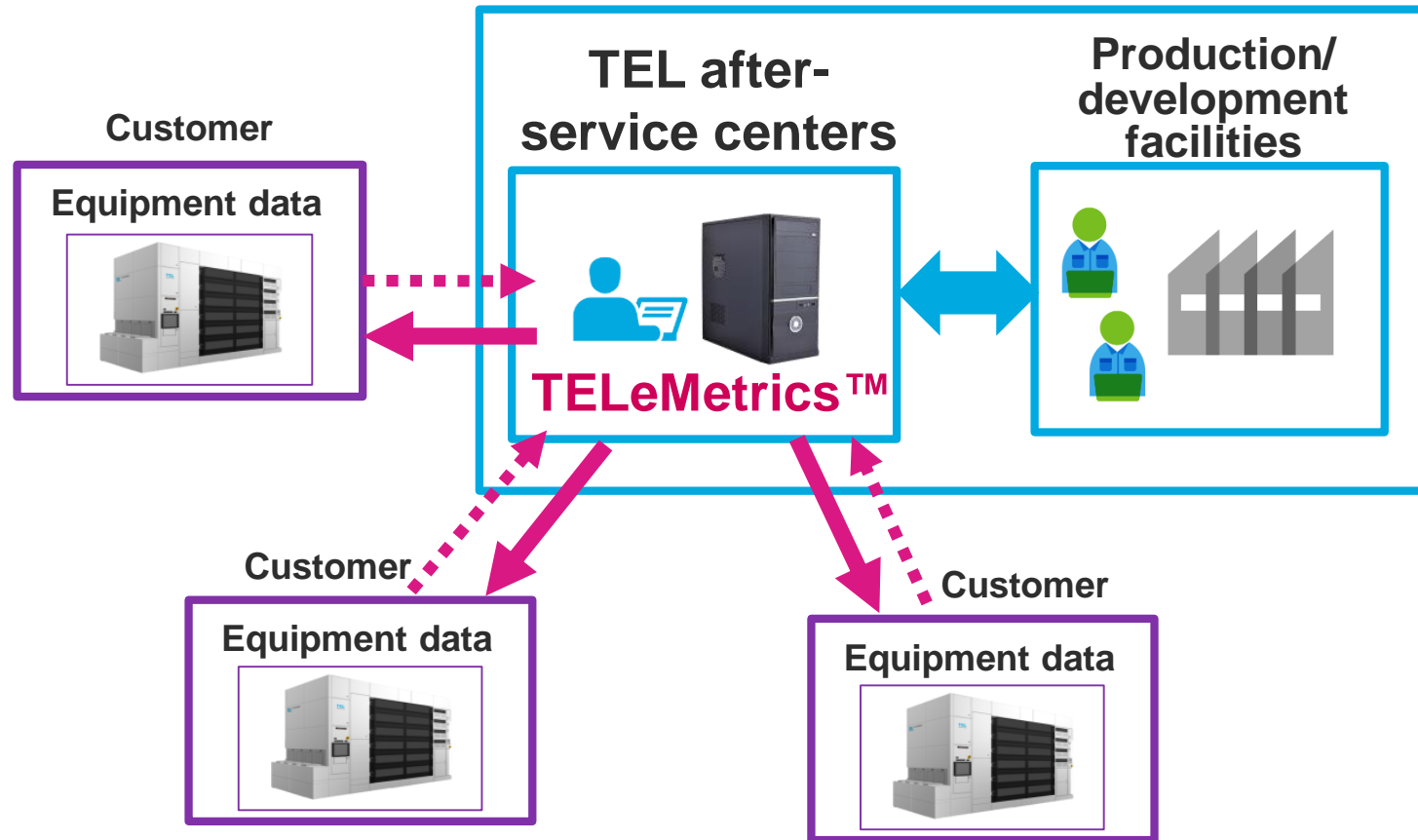
- Promote comprehensive contract services
  - Provide linked services from equipment delivery to after-maintenance
  - Provide high value-added services that meet customer needs by combining equipment diagnostic functions using TELeMetrics™ and AI, with parts and repairs
  - Ensure stable earnings by using multi-year contracts to maintain/grow share
- Repair
  - Grow share through repair/cleaning/refurbishing business localization
  - Shorten lead-time and realize cost reductions

Enhance business efficiency: raise income through introduction of systems that boost business efficiency

# Parts/Services Business Model 2

## TELeMetrics™ service

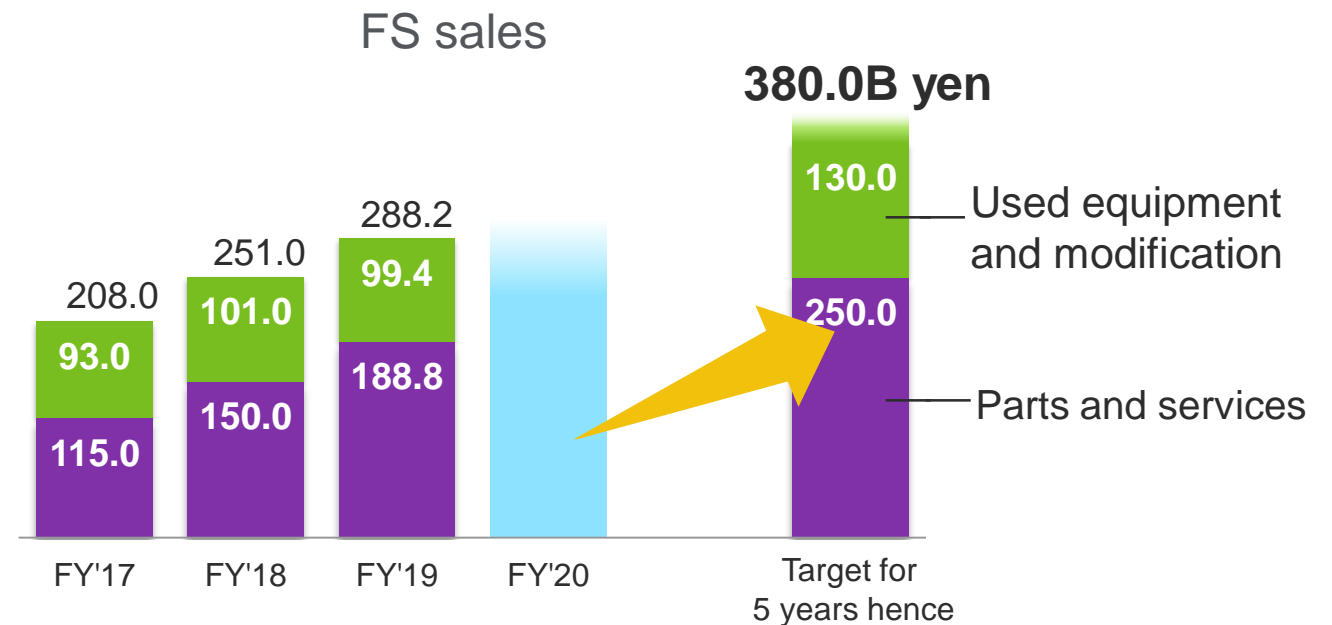
Monitor operation status of customer equipment in real-time and provide high value-added services



- Change to results-based compensation business
  - Assured uptime
  - Predictive maintenance (including AI functions)
  - Improved throughput
  - Chamber-to-chamber matching
  - Fewer defects

# Summary

- Respond to expansion in SAM on increase in installed base
- Grow used equipment/modification business
- Promote comprehensive contract services
- Enhance business efficiency



**TEL**™

**TOKYO ELECTRON**