Poster #119, Category: “TOOL”

ESH Assessment of EUV Lithography

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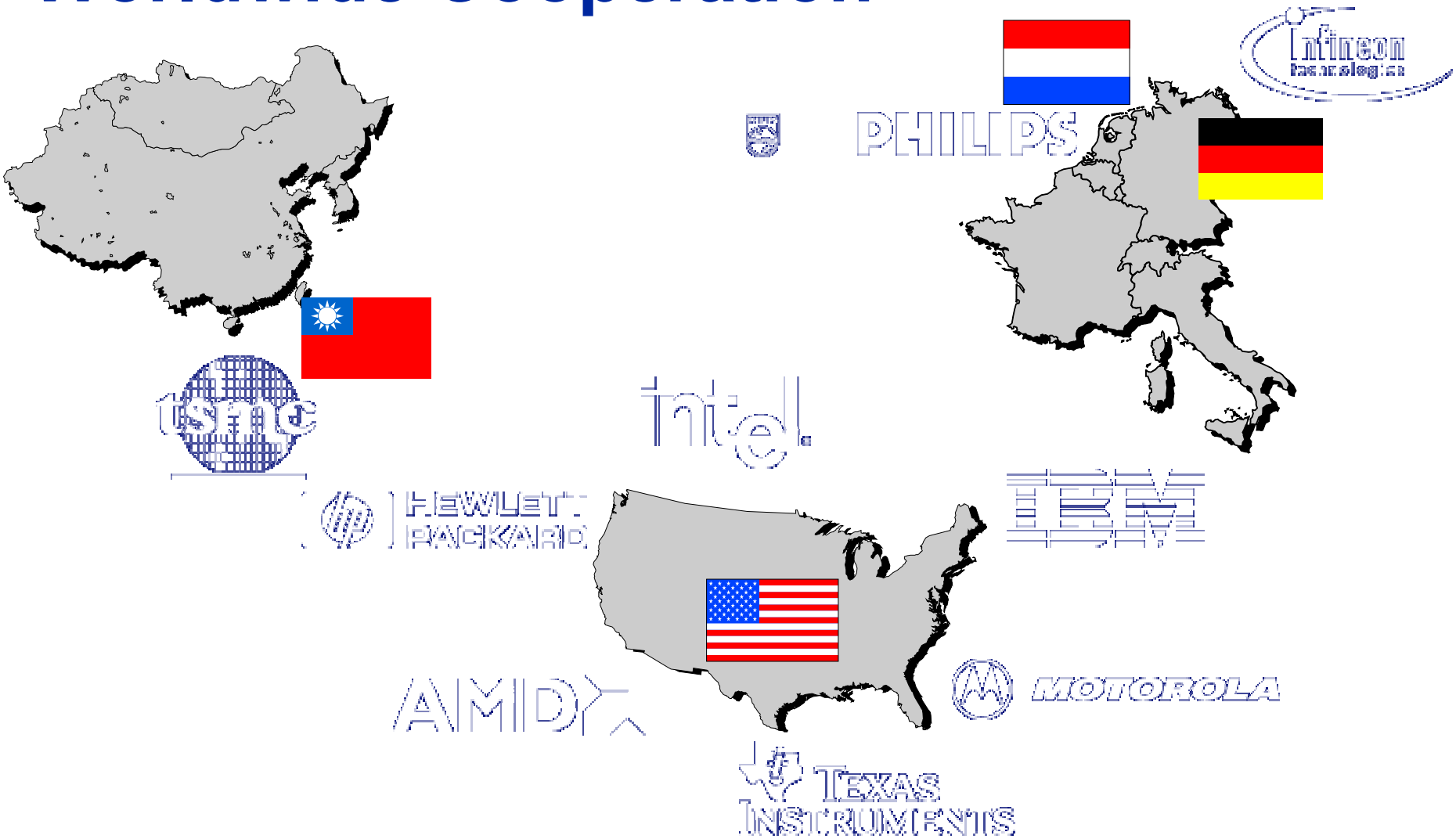
INTERNATIONAL SEMATECH

International SEMATECH Worldwide Cooperation



Vision

International SEMATECH is the world's leading consortium for developing technology infrastructure to enable the International Technology Roadmap for Semiconductors

Mission

The members of International SEMATECH cooperatively set global industry direction and accelerate technology solutions in infrastructure, lithography, materials, and manufacturing to ensure a strong and vibrant semiconductor industry.

In fulfilling this mission, International SEMATECH provides maximum value for our members and a challenging workplace for employees/assignees.

Staffing, Location, Facilities

- Staff of 550, of which about 120 are assignees on rotation from member companies
- $130-140M budget - funding is largely from membership dues
- Convenient Austin, Texas location, a significant center for the semiconductor manufacturing and tool industry
- Facilities include wafer fab and advanced tooling

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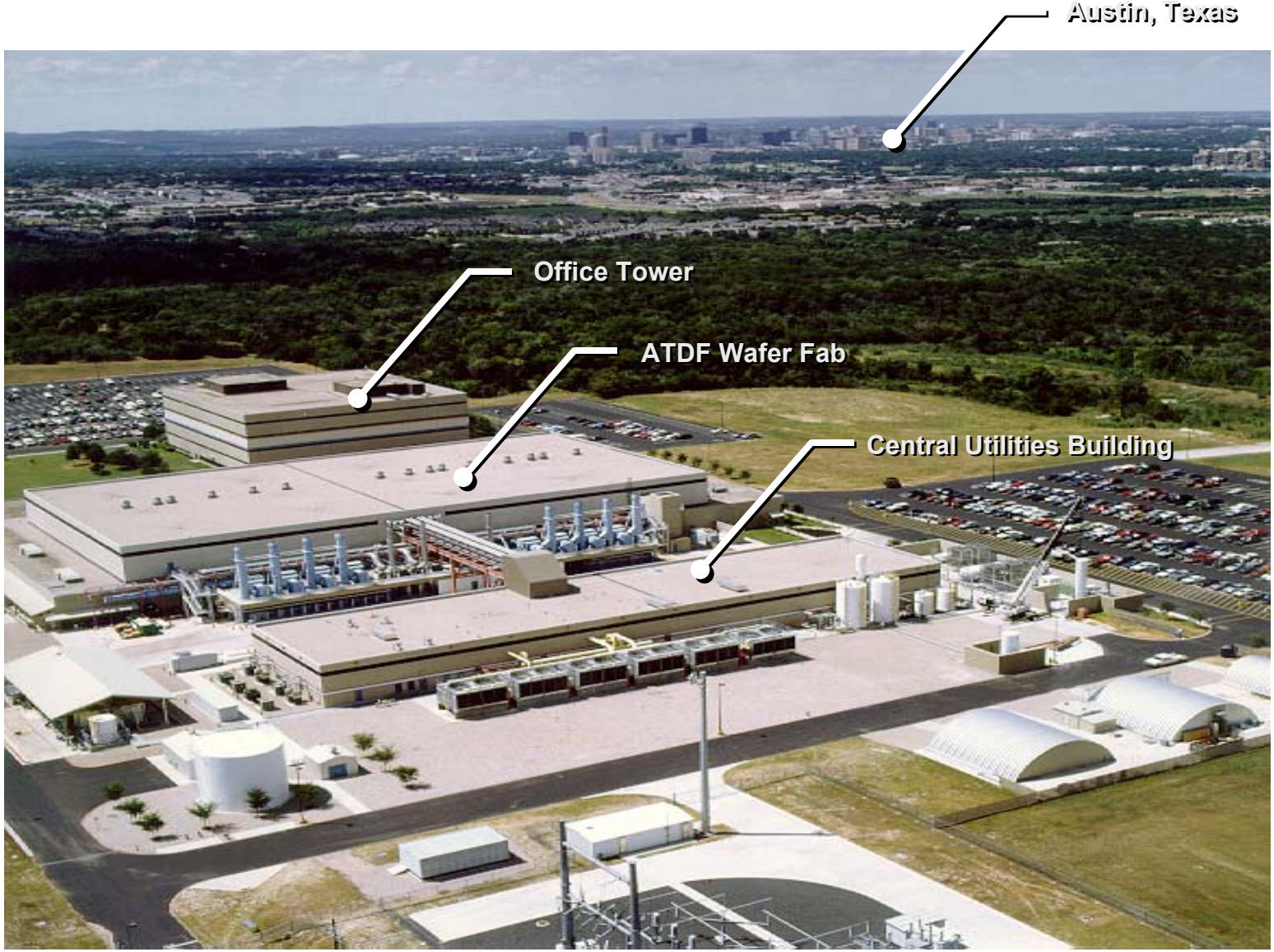
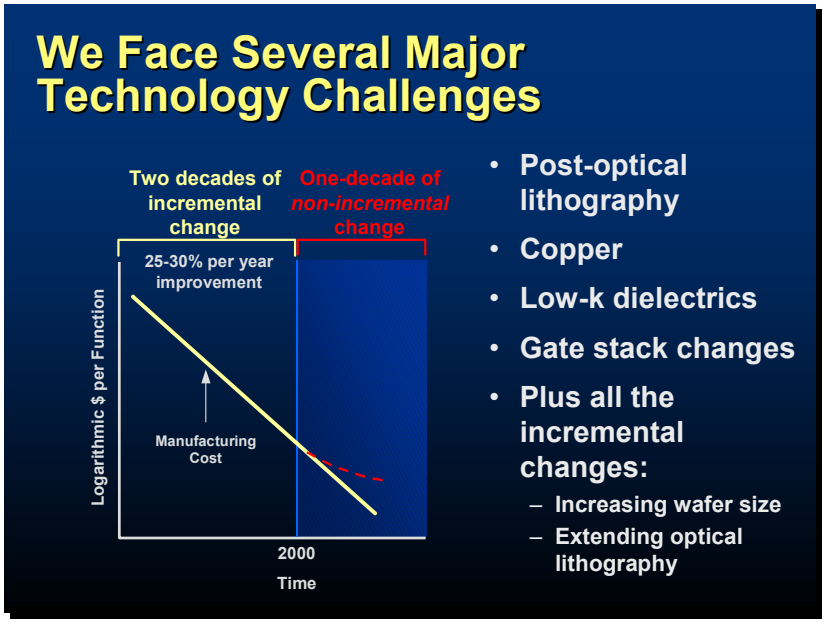


SEMATECH's Key Focus Areas

- 157nm Lithography
- Mask Cost and Availability
- NGL Lithography (EUV / EPL)
- Low-K Material (<2.5)
- Future Gate Stack (incl. USJ capability)
- Manufacturing Effectiveness



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Our Environment, Safety and Health (ESH) Program

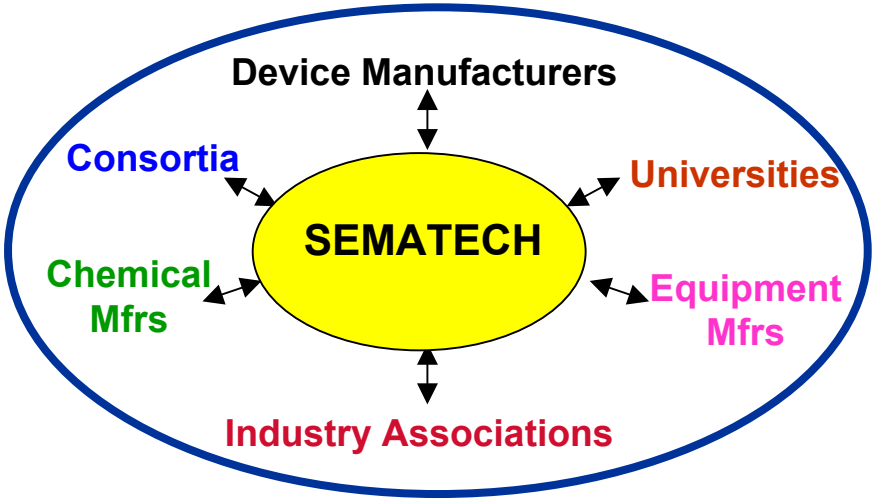
Vision: **Greener, Safer Semiconductor Fabs**

Our Goals are to:

1. **Prevent potential ESH showstoppers**
2. **Minimize negative ESH impacts and costs**
3. **Avoid cost due to ESH risk & future liabilities**
4. **Reduce fab cost through reductions in energy, water, and chemical consumption**
5. **Allow member companies greater flexibility in considering technology options and making strategic business decisions**

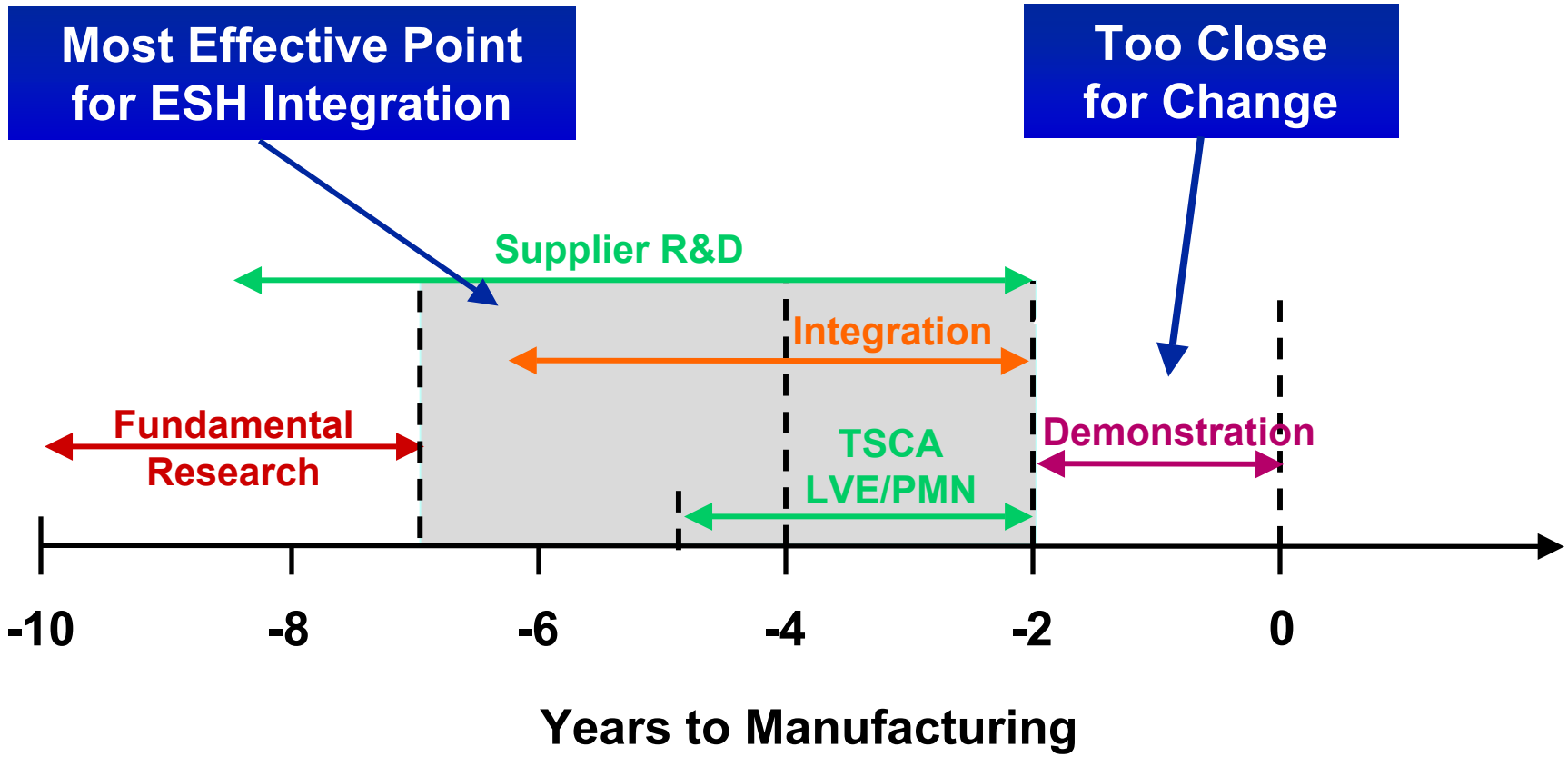
Recent SEMATECH Projects

- **ESH Assessments**
  - Advanced Interconnect
  - Advanced Lithography
  - Advanced Gate Stack
- **Energy Use Reduction**
- **Water Use Reduction**
- **PFC Emissions Reduction**
- **Alternative Wafer Cleaning**
- **Equipment ESH & Metrics**
- **Life Cycle Assessment**



ESH Integration through Collaboration

Technology Development Cycle & ESH Integration



Courtesy of SIA/SEMI PFOS Committee

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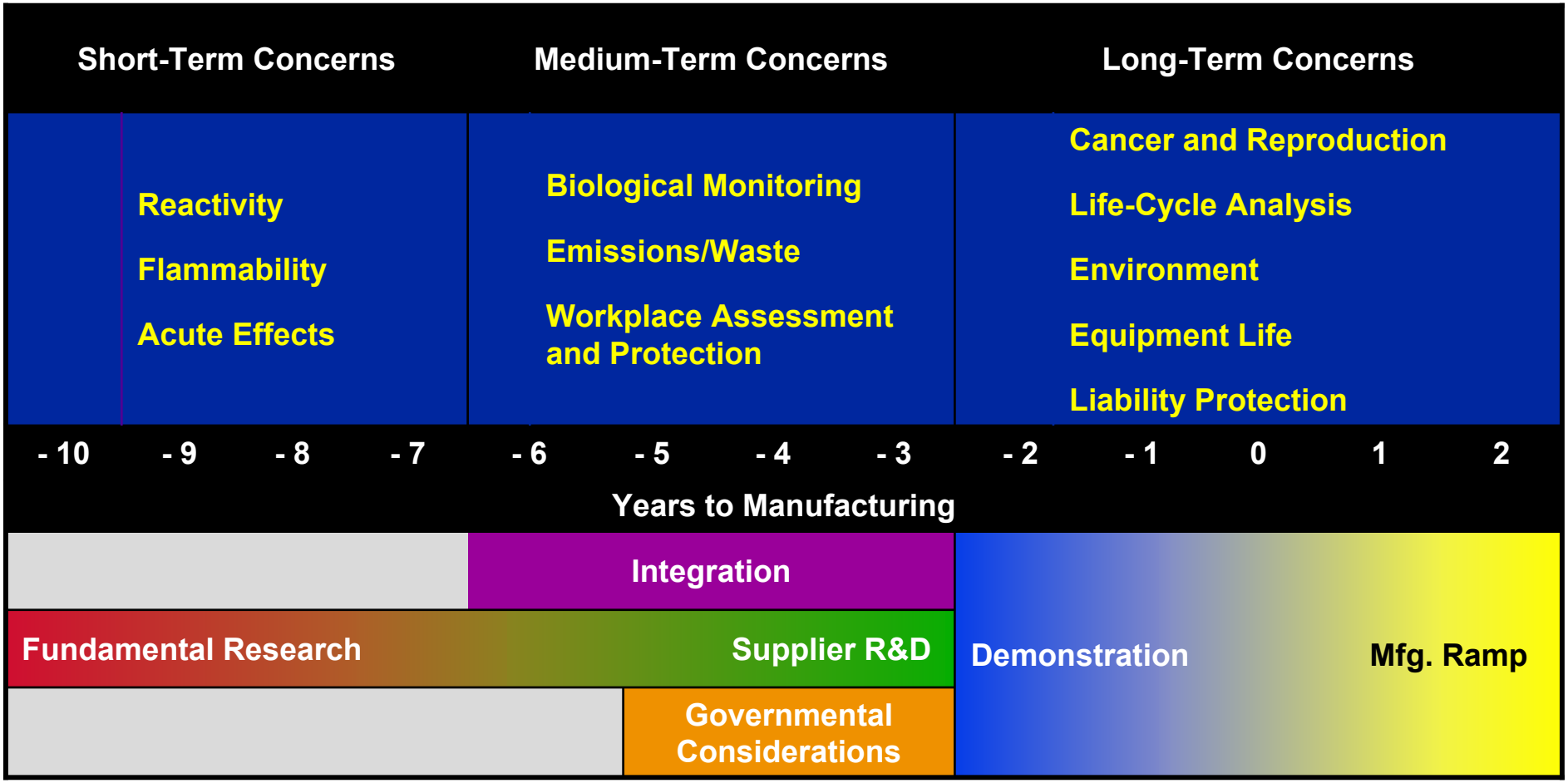
Timing of Data Requirements for New Materials and Processes



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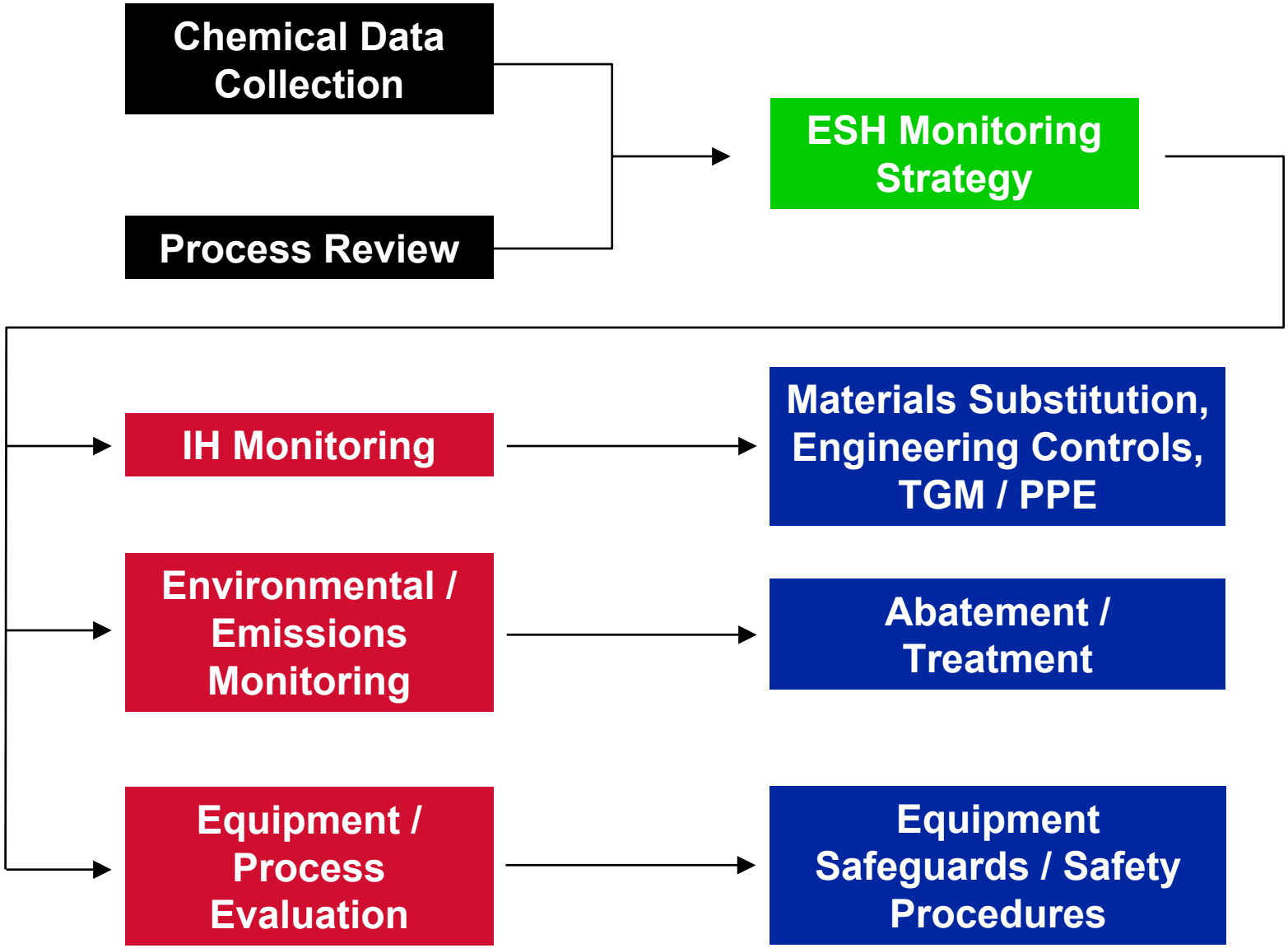
ESH Assessment of New Technologies

Lithography, Gate Stack, Interconnect

Environmental	Safety	Health	Industry
Chemical Consumption Water Consumption Energy Consumption Waste Management Abatement Options Life Cycle Assessment	Tool Safety Ergonomics Equipment Design Standards: – S2/S8 Criteria – Radiation and Laser Safety – Hazardous Energy Control – Etc. Equipment ESH Performance Chemical Storage and Delivery	Chemical ESH Data Assessment Employee Exposure Emissions/By Products Process Chemicals and Materials Exhaust Testing Fixed Chemical Monitoring Options	Global ESH Policies ESH Assessment Strategies Restricted Chemicals (PFCs, others) ESH Cost of Ownership

ESH Evaluation Process



International SEMATECH's ESH Group

- **Current Focus:**
  - **ESH Assessment of Advanced Technologies** (157nm & EUV lithography, advanced gate stack, low k interconnect) to identify potential ESH impacts
  - **Chemical Management**
    - To promote the reduction in the use of chemicals
    - To promote the switch to more ESH benign alternatives
  - **Resource Conservation**
    - To reduce the global warming gas emissions
    - To ensure manufacturing sustainability
  - **Worker Protection**
    - To ensure equipment is safe and ergonomically correct

Utility Requirements

- We check the tool's utility requirements:
  - electrical energy, cooling water and exhaust air
- We are interested in tool energy consumption:
  - To identify opportunities for energy reduction in the various tool components (e.g., turbo & roughing pumps)
  - Electrical load of R&D EUV tool is ~4-5x that of conventional stepper
  - Electrical load of commercial tool is expected to be 10x that of R&D tool
- We would like to see the non-critical components of the tool go into a "sleep" mode when the tool is on stand-by or idling
- We would like to see the heat from the tool be removed through cooling water rather than by radiation to the clean room or through an heat exhaust

Ionizing Radiation & Plasma Debris

- The EUV tool operates at 13.5 nm wavelength, which is considered to be a "soft" X-ray radiation
- It is very important that there be adequate shielding to prevent the escape of any ionizing radiation from the tool
- The tool needs interlocks, which ensure that personnel exposure to radiation during maintenance of any part of the tool is avoided
- The light source will be generated by a Xenon plasma, which produces debris
- We will analyze the debris to determine that it is non-hazardous and represents no danger to the health of the maintenance personnel

Resist Evaluations

- **We do a characterization of the volatile organic compounds being released during the application of the resist (spin-on and bake process) to determine:**
  - Species being emitted
  - Quantity of each chemical being emitted
- **We do industrial hygiene (IH) monitoring inside and around tool to ensure that:**
  - The tool operator is not exposed to any toxic emissions
  - Readings are below established personnel exposure limits (e.g., TLV or PEL)

Safety Analysis

- We try to understand the S2/S8 safety and ergonomics review that is being performed for the light source and the combined tool
- This review is being performed by a qualified, 3rd party consultant to ensure the tool meets minimum SEMI guidelines for safety and ergonomics (especially important for tool maintenance)
- We will monitor the follow-up to any deficiencies identified by the consultant to ensure that the tool meets all the safety & ergonomic requirements before it is shipped

Summary

- We are in the process of assessing the new EUV lithography technology from an ESH point of view
- We hope to identify ESH impacts early on and provide guidance to the technologists during the technology development
- Through increased understanding of the technology we hope to arrive at the most cost-effective mitigation of any ESH impacts
- Goal is to: Promote design for ESH through early interaction with technologists and tool developers.