DuPont Reflections on Photovoltaics

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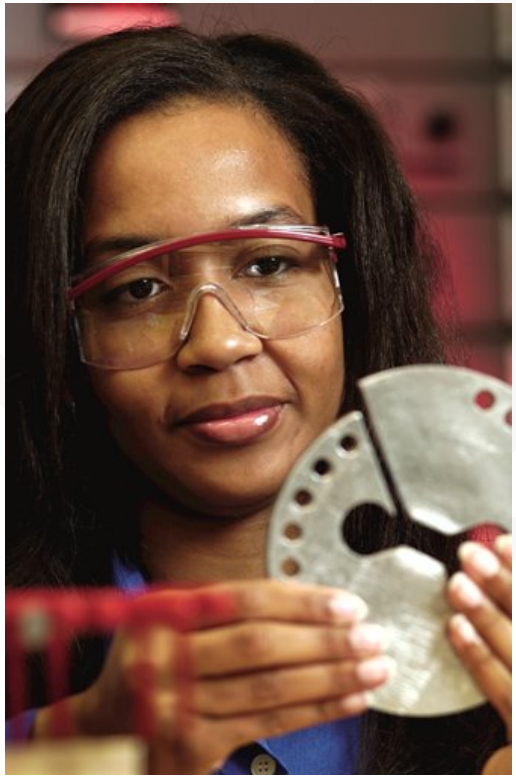
Electronics and Communication
April 23, 2009

The Vision of DuPont

**To be the world's most dynamic science company,
creating sustainable solutions
essential to a better, safer, healthier life for people everywhere.**



Mega Trends Create Growth Opportunities

Growth in developing countries

Increased food production

Greater safety and security

Renewable energy and materials

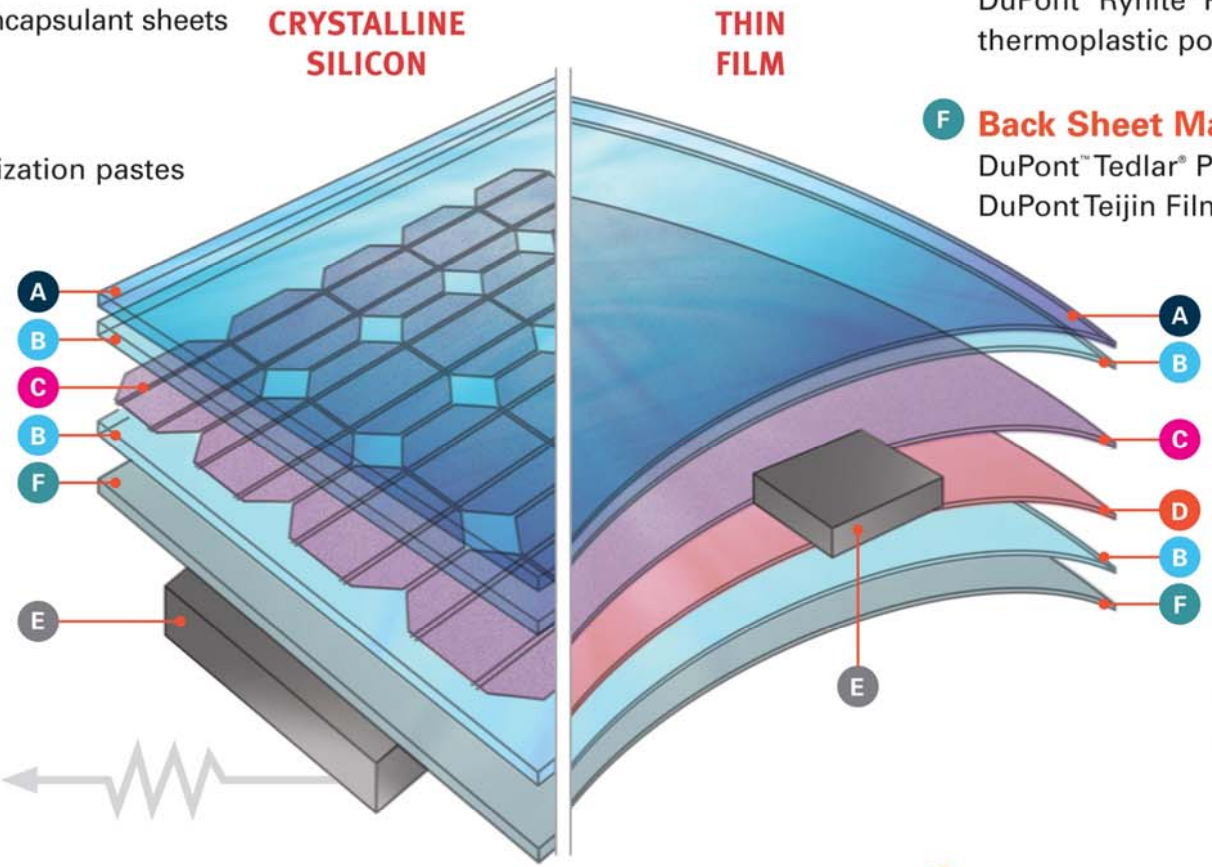
Increased total energy demand

The DuPont portfolio of innovative materials for photovoltaic modules

A Front Sheet Materials
DuPont™ Teflon® films

B Photovoltaic Encapsulants
DuPont™ PV1000 Series EVA resins
DuPont™ PV5200 Series encapsulant sheets
DuPont™ PV5300 Series encapsulant sheets

C Metallization Pastes
DuPont™ Solamet® metallization pastes



D Thin Film Substrates
DuPont™ Kapton® polyimide films
DuPont Teijin Films™

E Junction Box and Structural Support Materials
DuPont™ Rynite® PET
thermoplastic polyester resins

F Back Sheet Materials
DuPont™ Tedlar® PVF films
DuPont Teijin Films™

G High Performance Seals for Cell Manufacturing Equipment

energy for a thriving world™

DUPONT
The miracles of science™

An industry leader in several critical materials

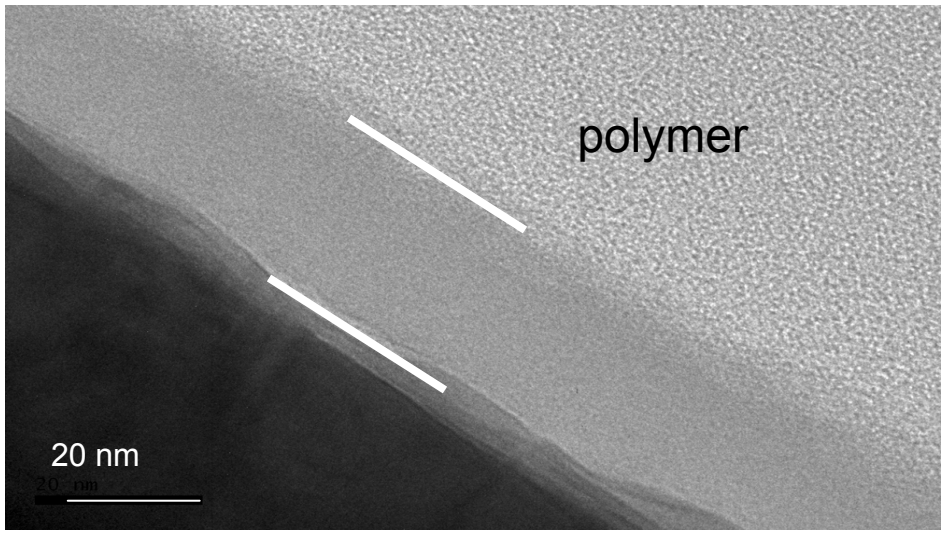
Thin film PV requires unique technology solutions

Objective

Develop a flexible, protective front sheet for thin film modules with moisture barrier properties of glass

- Developing ~95% transmissive front sheet with good adhesion to encapsulant
- Very low moisture vapor transmission rate

85°/85% humidity testing demonstrates stability of CIGS encapsulated with nm thick layer equivalent to glass



New materials require substantial investment

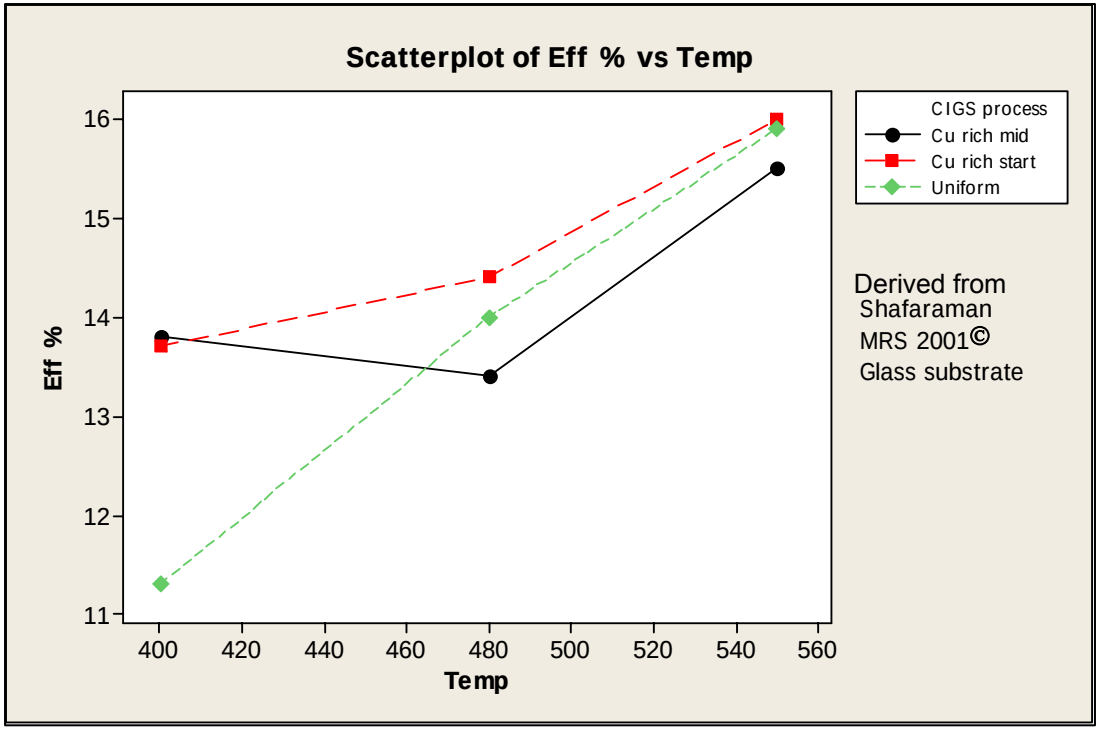
Reduced Cost Through Enabling Roll-to-Roll Processing

Objective

Develop a non-conductive substrate film that can be roll-to-roll processed to manufacture thin film cells with higher efficiency using monolithic integration (with NREL).

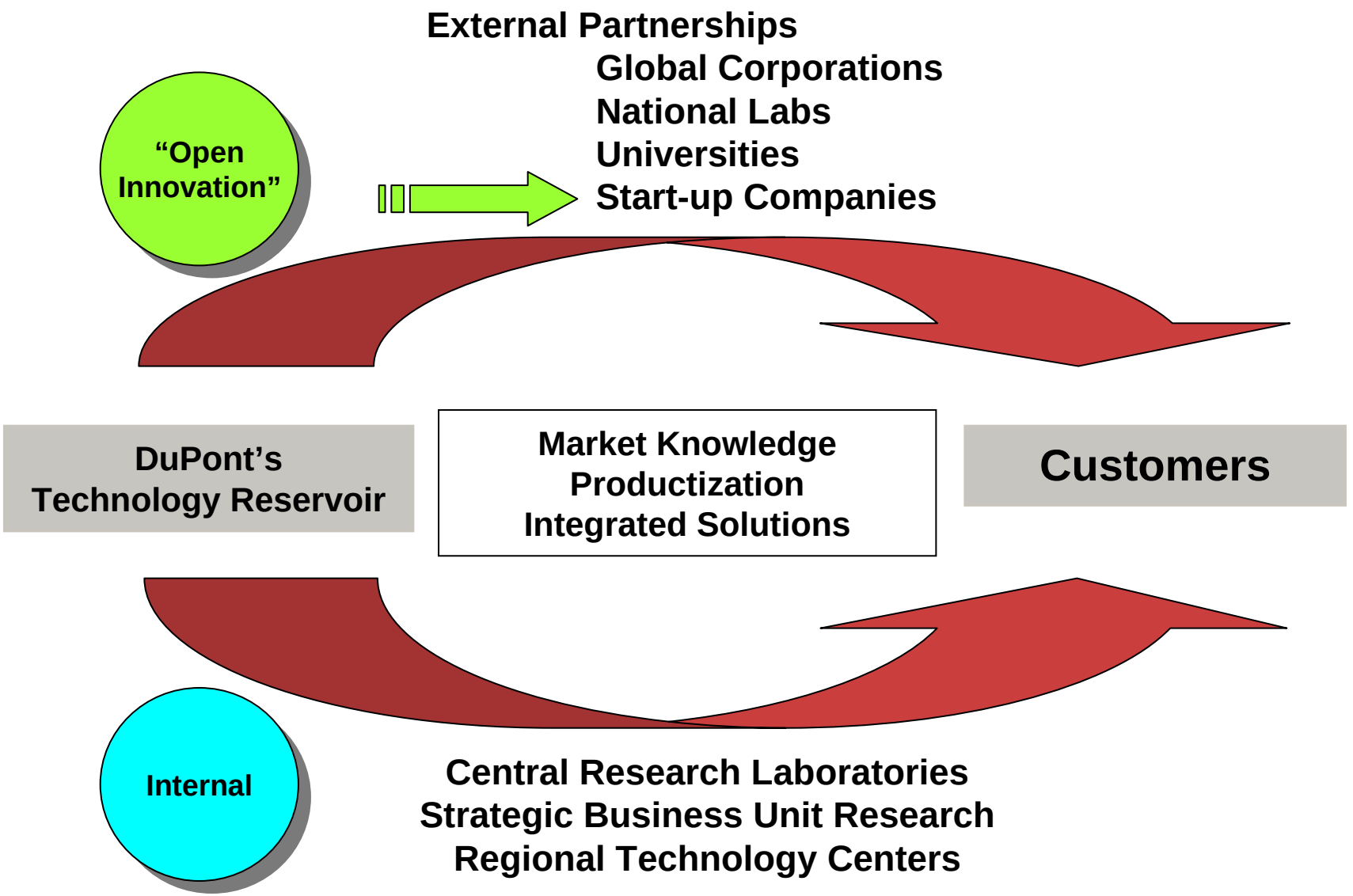
Substrate enabling cells with ≥5% higher efficiency (12-15%)

- >550°C Deposition temperature



Efficiency increases through step-change in substrates

Partnering for Growth



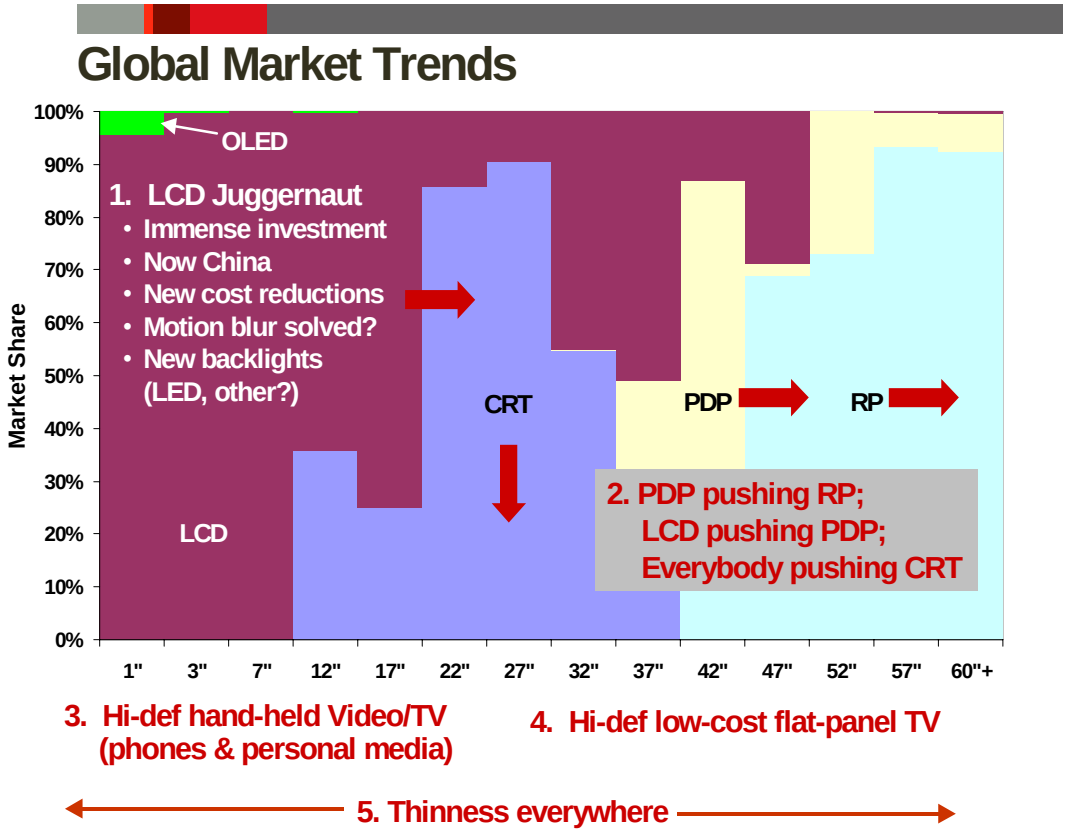
Open Innovation key to rapid development

Issues in a Fast-Moving Industry

Rapid pace of change can make technology (and investment) obsolete

Display industry experience is informative

- Heavy investment required- technology/market uncertainty abounds
- Disincentive to invest further in innovation- focus more on incremental changes



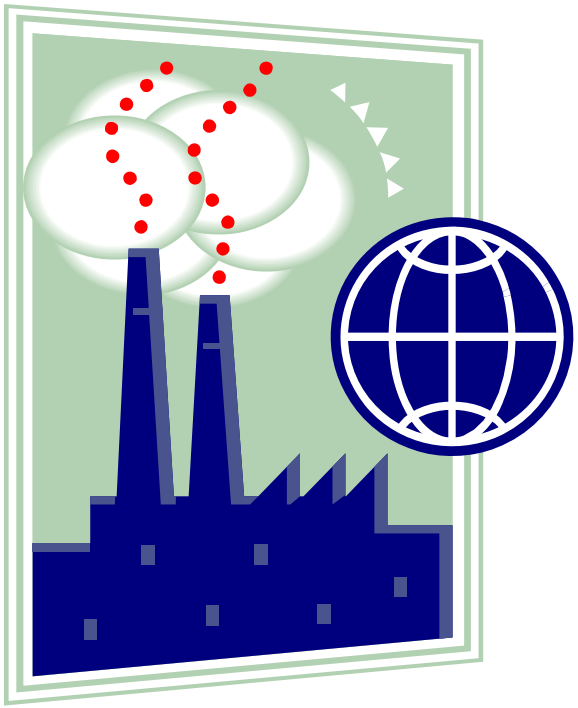
Government support can help de-risk R&D

Tech rate of change

Low
(Mature)

Med
(Growth)

High
(Embryonic)



Government supported research

Gov. Labs, Universities
Industry CR&D

Consortia

Low | Med | High

Market rate of change

Government support can play role in managing risk

Very Efficient Solar Cells

-Power for the Warfighter

- Permanent base power: Independence from the grid for essential base functions
- Expeditionary base power: Cuts fuel and resupply requirements
- Battery power charging

DuPont - University of Delaware Consortium

hp invent

emcore

NREL

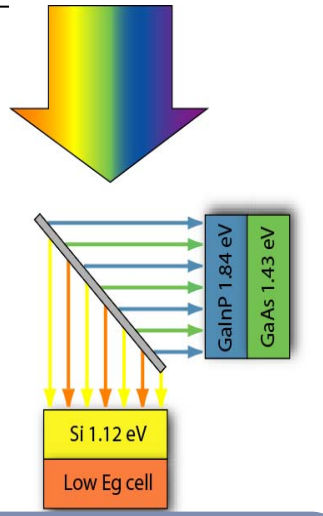
Experienced World Class Team

- Comprehensive: from first principles through manufacturing
- Focus on integration and manufacturing capabilities
- Universities and industry with a common goal

Bottom Line: Team goal to invent, develop and transfer to production new solar cell module

Novel system architecture

- Integrates highest performance technology in each λ range



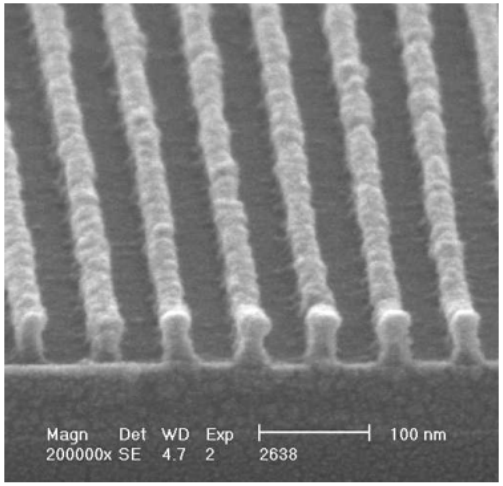
DARPA does well with driving consortia and development support

Value of a Roadmap to Drive Innovation

An Example from the Semiconductor Industry

For sub 65 nm HP, had options:

- 157 nm lithography
- 193 nm lithography with water immersion and double imaging
- 193 nm lithography with high index fluid immersion
- EUV
- Nanoimprinting



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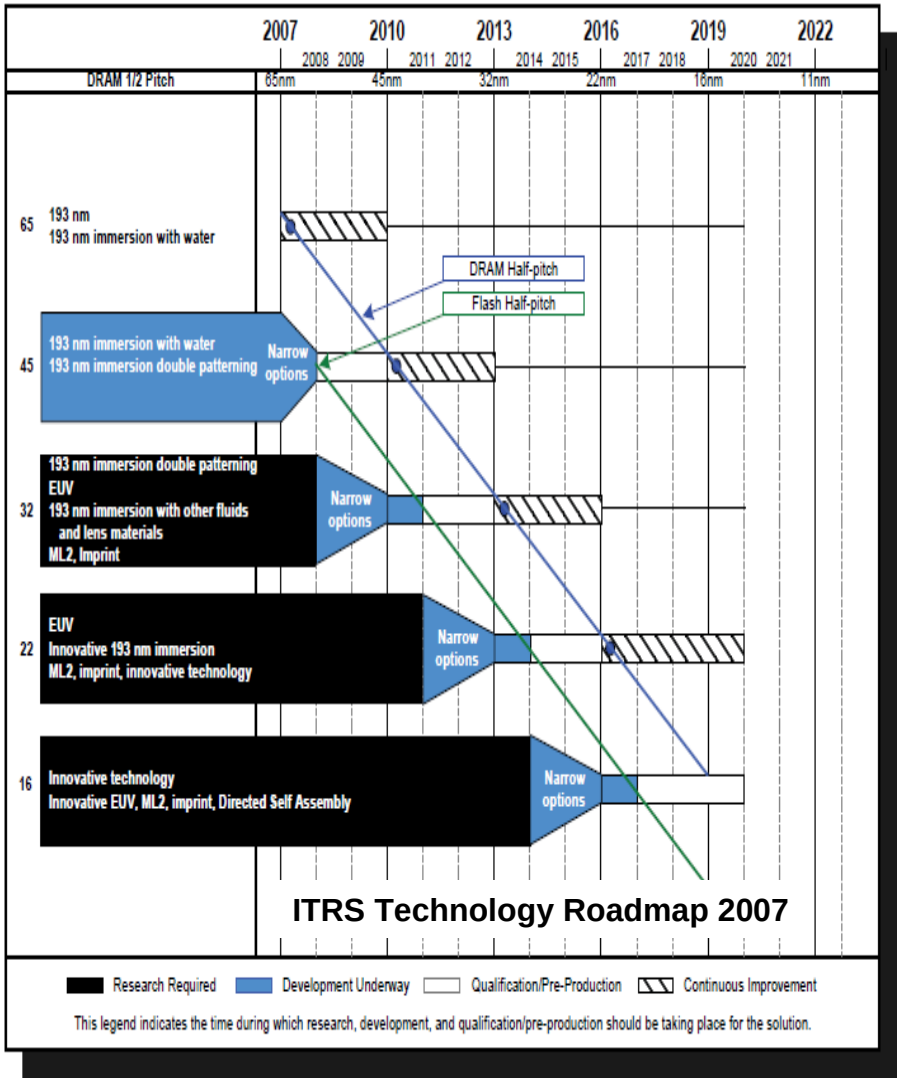
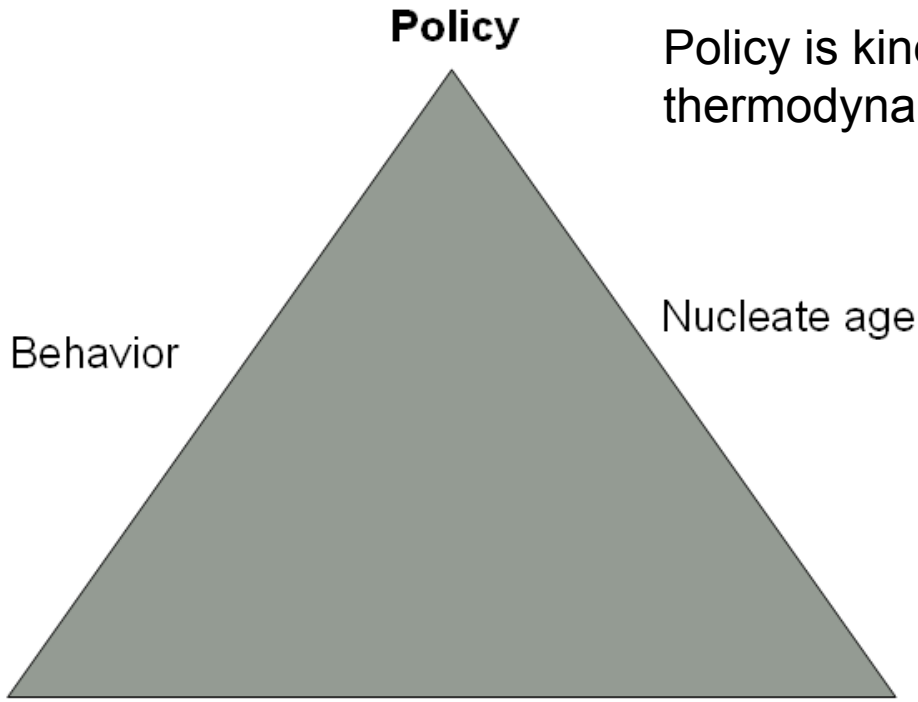


ITRS Roadmap makes clear objectives, timing, and technology steps

Roadmap allows failure to be addressed at R&D stages

Some closing thoughts



Policy is kinetically, but not thermodynamically important

Provide base load of market to incent the development phase
Bonus and investment tax credits

Support universities and gov. labs as feeders of people & technology;
Help de-risk “Valley of Death”

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