For Update of SEMI S23-0705

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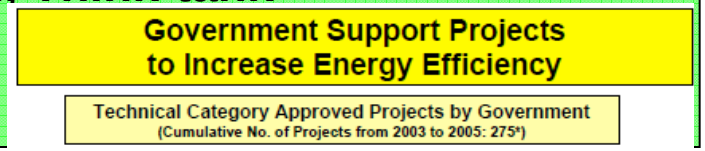
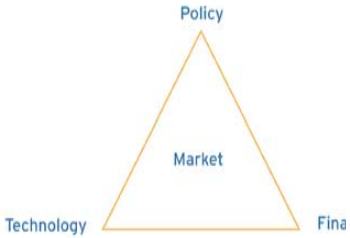
Int'l Scheme for Climate Change Mitigation

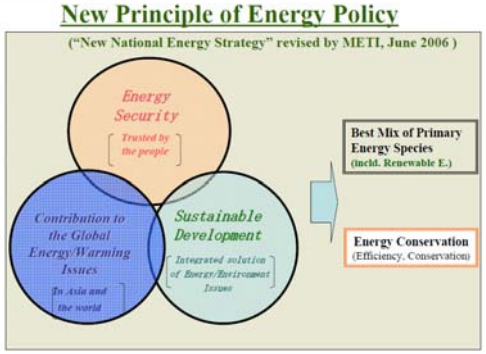
- IPCC（Intergovernmental Panel of Climate Change）
  - Formed under, United Nations Environment Programme (UNEP)
- Kyoto Protocol: Adopted in 1997
  - Aim CO2 emission in 2010 (2008-2012) equivalent to the emission in 1990
- EuP Directive (Eco-Design for Energy using Product)
  - Effective since 08 '05: To consider env. impact through total product life
  - Semiconductor equipment is outside scope. Users products are inside.
- Revised Japanese "Energy saving act": Effective since Apr. '06
  - Our activities to be reported to METI and Land & Traffic Ministry from this year
- WSC (World Semiconductor Council) White Paper for Energy Saving
  - Requirement to SEMI
  - Annual event in electronics industry: ISESH、ITRS
- Toward IEC of "Environmental benign design": Driven by Japan METI
- Movie "An Inconvenient Truth"
- Miscellaneous
  - US EPA "Energy Star", Japan "Top Runner" etc.

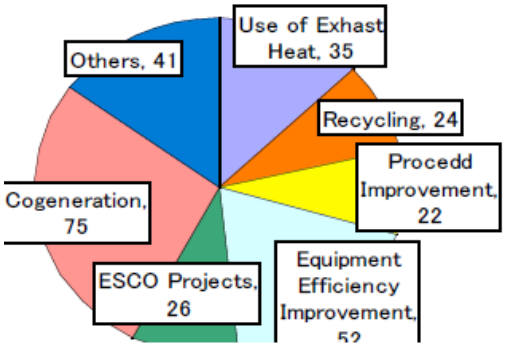
Recent Global Activities

- IPCC Conference
  - Pointed out that climate change would affect significant damage to biogeocenosis in this century
  - Adopted that several ten thousands lives would be lost
    - Adoption including US and China means very huge impact. 500-600 thousands lives would be jeopardized on the original draft, it was rejected by US and China, though.
- Japanese Government
  - Env. Ministry and METI
  - Japan-Sweden Workshop: Sweden King attended @ Imperial hotel, 4/26
    - Strong power from Government, Fund. Think-tank
      - ESCO (Energy Service Company)
      - ISV (In-Situ Verification)









Great Start for Energy Conservation

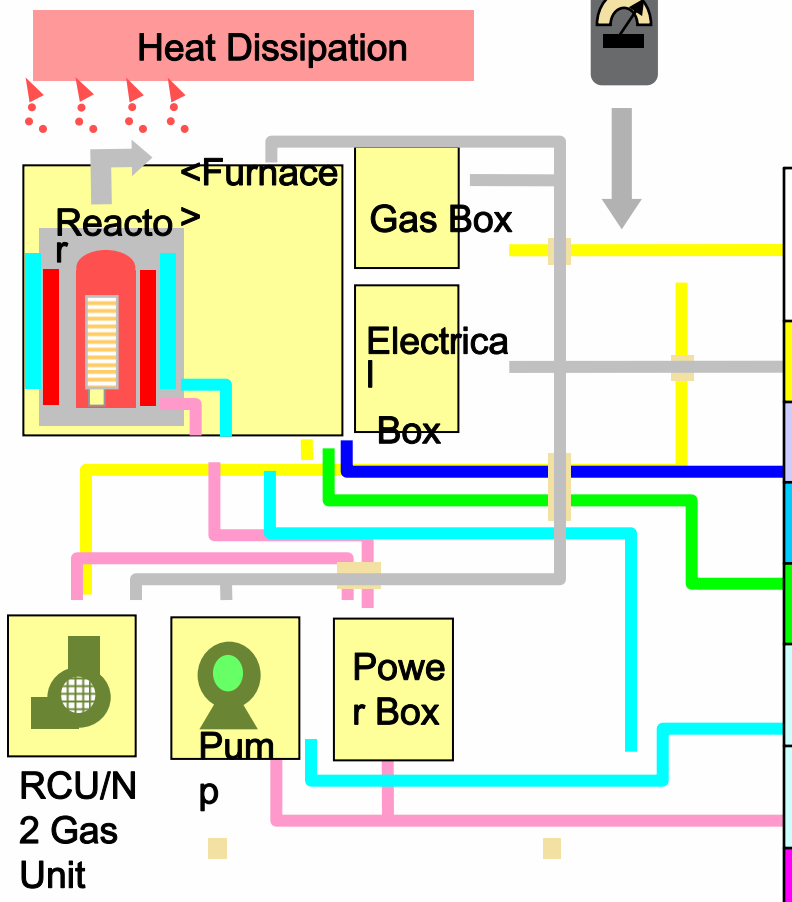
- **SEMI S23: Guide for Conservation of Energy, Utilities and Materials used by Semiconductor Manufacturing Equipment**
- **Requirement from some IDMs for SME purchasing**
- **SEMI S23 deals with two separate aspects of product energy consumption:**
  - **Characterization**: Product energy consumption must be measured and reported according to a standard protocol.
    - The SEMI S23 protocol includes not only electrical energy used by a tool, but also all energy required to supply utilities (PCW, DI, N2, CDA, Exhaust, Vacuum and air cooling systems) to a tool.
  - **Continuous Improvement**: Manufacturers of semiconductor manufacturing equipment must have roadmaps and programs for reducing product energy consumption.

Outlines of SEMI S23

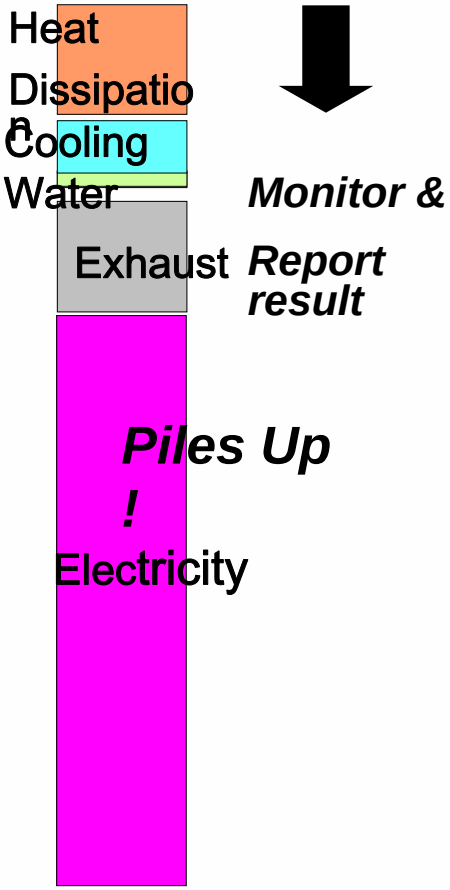
- Enable to represent all kinds of energy as electricity
  - Conversion factor
  - Supplier baseline process
- Roadmap and report
  - LCA
  - Target setting
  - Monitoring and improvement

SEMI S23-0705

Select target product and baseline process → ***Measure*** → ***Select conversion factor and determine equivalent energy*** → ***Set reduction target, Road map***



Utility	Conversion Factor kWh/m3
Gas/ N2	0.25
Exhaust	0.004
Vacuum	0.075
Dry Air	0.147
Cooling water (20-25℃)	1.78
Cooling water (32-37℃)	0.25
Electricity (kWh)	



Monitor & Report result

Piles Up !

Average consumption load / time **x** Total time / year (Process time and Standby time) **x** Conversion Factor **=** Total equivalent energy consumption / year

Request to update SEMI S23-0705 from Japan and NA Industries

- Currently S23 has become very popular and is being used as an equipment purchasing requirement from many device manufacturers. After publication of S23-0305 (S23-0705 was published with a minor change from S23-0305.), advocacies to expect update conversion factors based upon lessons learnt from 300mm wafer fabrication. Also, further considerations for standby mode, model process and so on are expected from organizations and people related to IC industry.

Subjects Suggested for S23 Revision

- Conversion factors to be updated (ISMI and JEITA)
- A “model process” if a device manufacturer compares SME of different companies (Some SME suppliers)
- Criteria for “stand-by mode”
  - It may be discussed after definition or specification in E10 (RAM: Reliability, Availability and Maintainability).

TF Conclusion for S23 Revision

- **Focus on only update of Energy Conversion Factors**

Rational for Updating ECFs

1. **Significant change of clean room structure with reasons of 300mm fabrication, etc.**
   - **Bay style to Ball room**
   - **Cleanliness: Class 1 to Class 1000 (adoption of FOUP system)**
2. **Change of facilities and their control system and improvement of efficiency of various equipment**
   - **UPW (DIW) system, Chiller, Pump, etc.**
3. **Correction of ECF calculation for cooling water**
   - **ΔT is included as a factor for ECF to resolve reported discrepancy in case of using cooling water at small ΔT .**

Japanese WG Proposal for ECFs to be Updated

'Rƒs [Conversion Factor Calculati...

Utilities		Existing ECF (kWh/m^3)	Proposed ECF (kWh/m^3)	Rational
	Exhaust	0.004	0.0033	Equipment efficiency improvement
	Vacuum	0.075	0.045	Equipment efficiency improvement
	Dry Air	0.147	0.147	No-change
	Cooling Water (20-25C)	1.78	1.56	① Premise change of equipment heat dissipation from shift to 300mm fabrication ② Equipment efficiency improvement
	Cooling Water (32-37C)	0.25	0.26	
	UPW (DIW)	10.2	5.2	50% reduction of water plant electricity

Heat Dissipation	Item	Existing ECF (kW/kW)	Proposed ECF (kW/kW)	Rational
	Cleanliness Class 1 Class 1000	 0.122 0.012	 0.0657	Class 1000 (0.5 µ/ft^3) Fed. Std 1000 ---> Class 1000 (0.1µ/ft^3) ISO Class 4.5
	Cooling for heat generated from equipment	0.26	0.222	
	Whole heat dissipation coefficient	0.382 (Class 1) (0.272 in case of Class 1000)	0.287	

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Correction of ECF Calculation for Cooling Water

- **Rational**
  - ✓ **ΔT=5C is a premise of exiting SEMI S23.**
  - ✓ **As a water cooling system at ΔT=2C needs higher flow rate than a water cooling system at ΔT=5C in order to dissipate the same heat load, energy consumption rate for using cooling water at ΔT=2C is calculated by the S23 ECF becomes higher than actual. This could mislead S23 users into a belief that heat dissipation to clean room air reduces total energy consumption rate than heat dissipation to cooling water at ΔT=2C.**
  - ✓ **ΔT should be included as a factor for ECF in order to facilitate accurate energy consumption analysis.**
- **Calculation corrected**
  - ✓ **ECF for cooling water = 0.258 x ΔT + 0.273kwh/m^3**

Correction of ECF Calculation for Cooling Water (cont'd)

B4={(C + P) x 0.22 + P } / L = C x 0.22 / L + P x 1 .22 / L

B4:ECF, C: Cooling water heat exchange task, P: Pump kinetics (74kw), L: flow rate (332m^3/h) ,

0.22 kwh / kw: : energy coefficient for cooling

ΔT=5C -> ΔT' : L' = L x 5 / ΔT' , P' = P x 5 / ΔT'

Here, C = 1.16 X L' x ΔT , P' / L = 74 / 332 = 0.222

Proposed ECFs

ECF	Current Value	Change Proposal
Exhaust	0.004	0.0033 – JWG 0.004 - NAWG
Vacuum	0.075	0.045 – JWG too low – NAWG
Dry Air	0.147	Consensus
HP CDA	---	0.175 – NAWG
Nitrogen	0.25	Consensus
Cooling water tower	0.25	0.26 – JWG
Heat (Cooling) Load	0.382	0.287 – JWG
Cooling water refrig	1.78	0.258 x Dt + 0.273 – JWG
UPW	10.2	5.2 – JWG 9.2 - NAWG
Hot UPW	---	92.2 – NAWG

JWG = Japan WG Proposal, NAWG = North American WG Proposal

NA WG Proposal for High Pressure CDA and Hot UPW

energy factor computations 5A...

High pressure CDA became a new requirement with 300 mm Litho tools from certain manufacturers. It created a significant capital expense to install booster compressors, dryers, filter, and additional distribution piping throughout the subfab. The flow is perhaps 10% of the CDA system size. A supplier that did not require high pressure CDA for their tools would have a several million dollar capital advantage + operating cost advantage in an evaluation. That is the reason we are in favor of inclusion. Capping pressure for High Pressure CDA at 150 psig would be very acceptable.

Hot UPW accounts for approximately 13% of total UPW flow on a typical fab. But since the proposed ECF is about 9X the value of the UPW ECF, overall fab impact is roughly comparable to UPW on a total energy basis. Hot UPW has been used in semiconductor fabrication. It rinses more effectively than cold water, apparently. So from that perspective, hot UPW is important.

The normal to high pressure CDA transition will be 827kPa (about 1200psi) at the tool. A cap will be put on "normal" UPW temperature at 25degC. Hot UPW will start at 85degC

- A reference to the ISMI TEE tool will not be included at this time.
- The information from R1-2.1.1 should be removed as it does not contribute to determining ECFs.

If people are very interested in the SEAJ work that lead to the original ECFs they can research the referenced documents and find the same information.

- Do not make any changes to the nominal hours distribution in R1-2.2.1
- Change terminology throughout the document from "heat burden" to "cooling load"

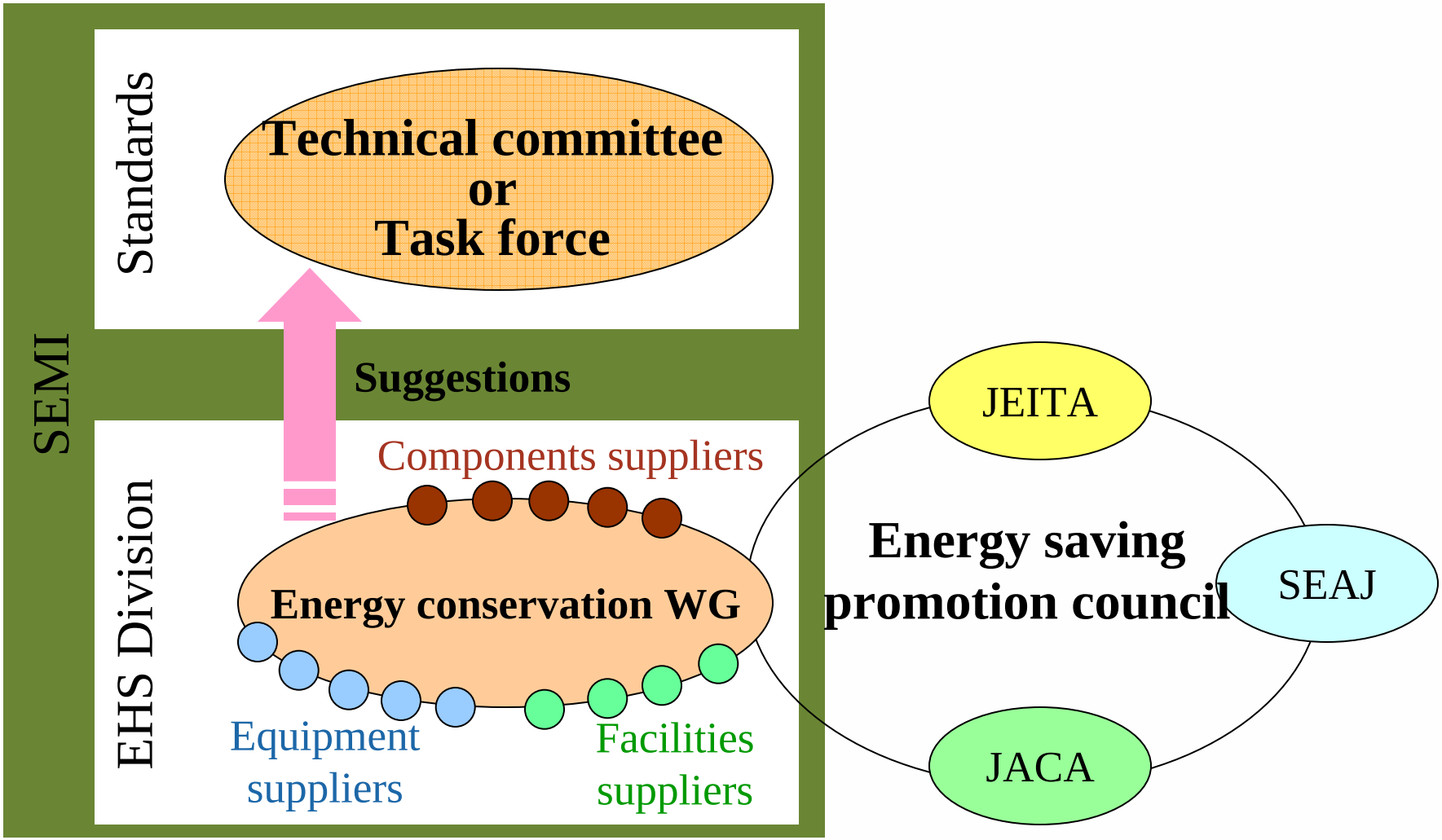
Including the definition and adding a note to the def.

- Move the ECF basis information from the body of the document to the RI.
- Provide a notes column in the ECF table in the body of the document.
- Do not make changes regarding the term "source" and "supply" in the ECF basis table in the RI.
- Add the notes in the ECF table advising that N2 and CDA volumes should be taken at 1atm-20degC.

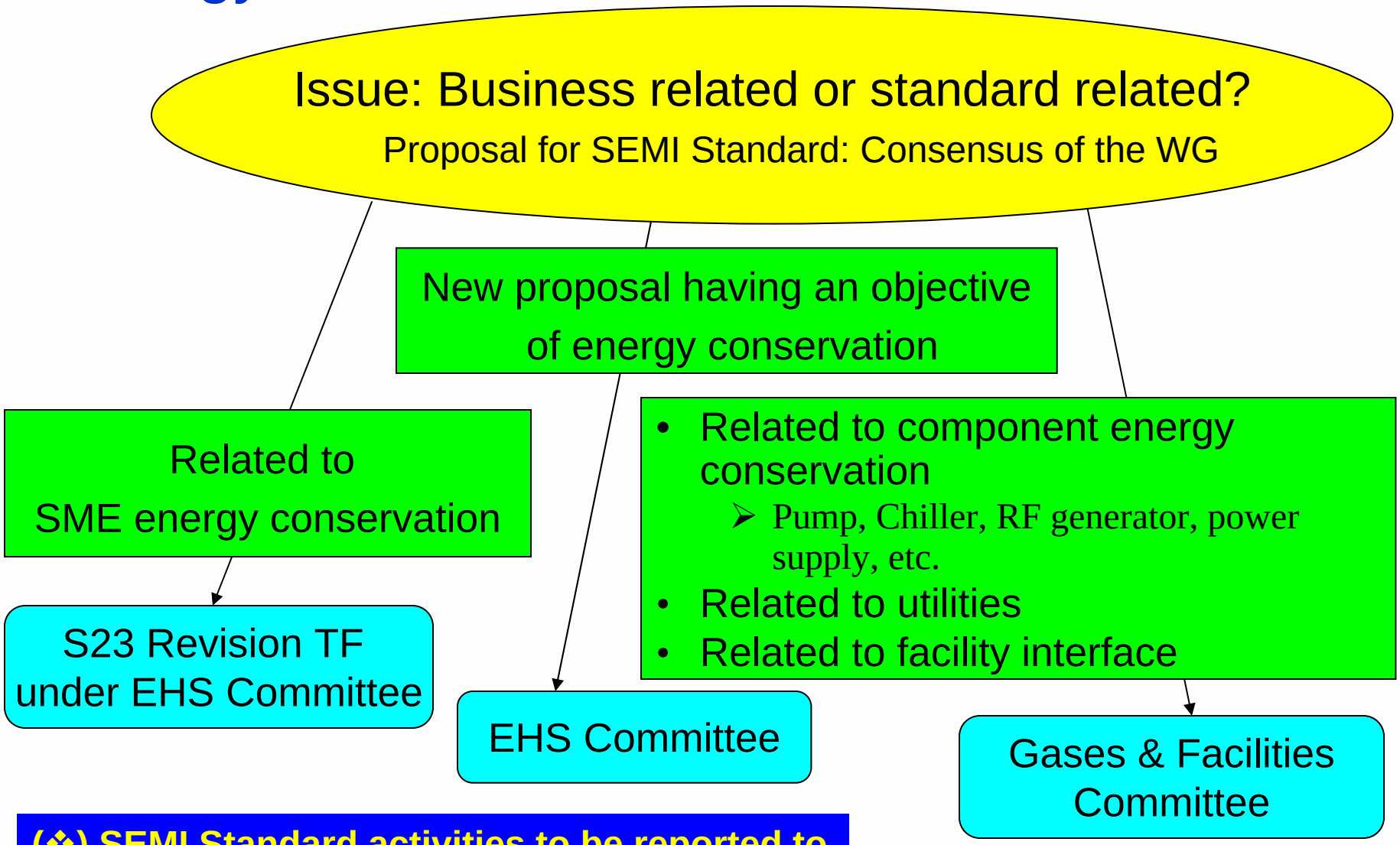
Development Plan of S23 Revision

- **Technical Ballot: Cycle 5, 2007**

Energy Conservation WG in SEMI Japan



Energy Conservation WG & SEMI Standard



(❖) SEMI Standard activities to be reported to SEMI Energy Conservation WG