ON Semiconductor®

Enabling Efficient Solutions for Power Supplies

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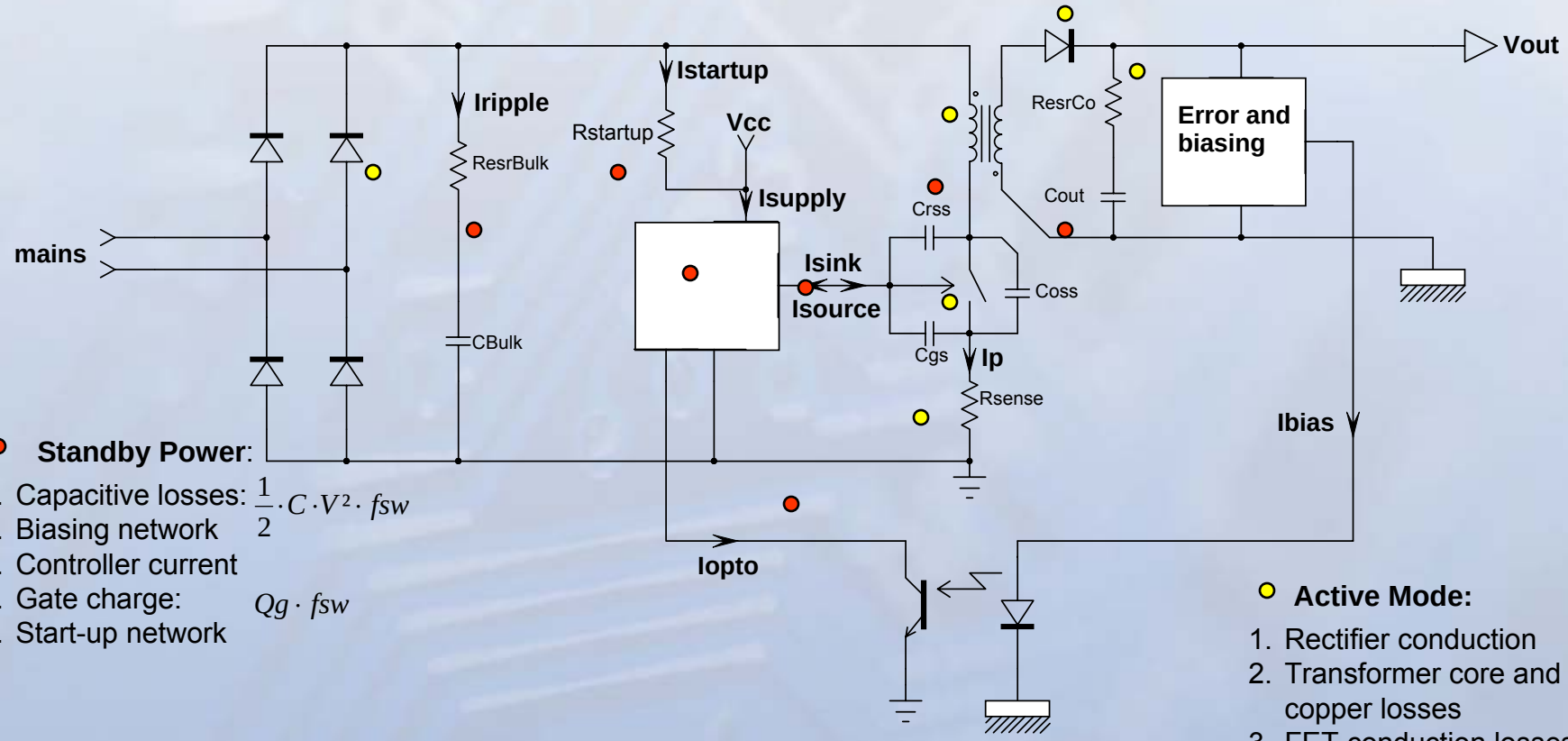
Regulatory Challenges

- Standby Power Reduction
  - 25% of total energy consumption is in low power/sleep/standby mode
  - Concerted effort by CECP, Energy Star, IEA and other international agencies to limit standby power
- Active Mode Efficiency Improvement
  - 75% of total energy consumption is in active mode
  - Changing efficiency from 60% to 75% can result in 15% energy savings
  - Next focus area for agencies
- Judicious combination of the above two strategies to achieve optimum energy savings (optimized for the usage profile of the application)

Semiconductor Industry Response

- Standby Power Reduction
  - Semiconductor solutions available to facilitate low power mode
  - Cost impact on end systems has been negligible
  - As power levels go up, more innovation required to meet the challenge
- Active Mode Efficiency
  - Improving efficiency requires component level improvements AND topology changes
  - Semiconductors to play a key role in facilitating the transition

Where are the *losses* occurring? (with prevalent topology)



Standby Power:

1. Capacitive losses: $\frac{1}{2} \cdot C \cdot V^2 \cdot fsw$
2. Biasing network
3. Controller current
4. Gate charge: $Qg \cdot fsw$
5. Start-up network

Active Mode:

1. Rectifier conduction
2. Transformer core and copper losses
3. FET conduction losses
4. Resistor dissipative loss
5. Snubber losses

What is standby power...?

■ The power drawn from the mains when an external power supply is left connected to the line without load

➔ battery chargers, AC/DC wall adapters etc.

■ The power drawn when a system goes into sleep-mode while still having some intelligent activity is sleep mode

➔ TV sets (LED on, µP waiting for remote), Notebook Adaptors

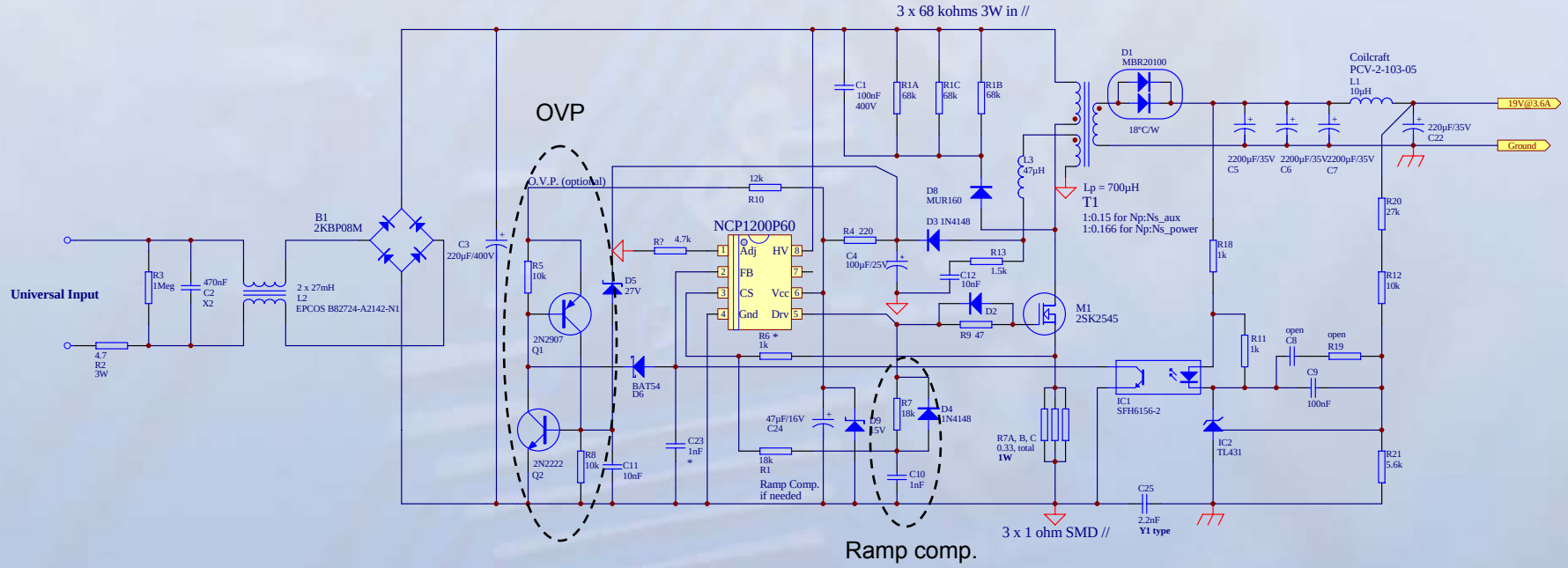
EC recommendations:

Rated Input Power	No-load power consumption		
	Phase 1 1.1.2001	**Phase 2 1.1.2003**	**Phase 3 1.1.2005**
≥ 0.3 W and < 15 W	1.0 W	0.75 W	0.30 W
≥ 15 W and < 50 W	1.0 W	0.75 W	0.50 W
≥ 50 W and < 75 W	1.0 W	0.75 W	0.75 W

Energy Star recommendations: 0.5 W for <10 W, 0.75 W for >10 W

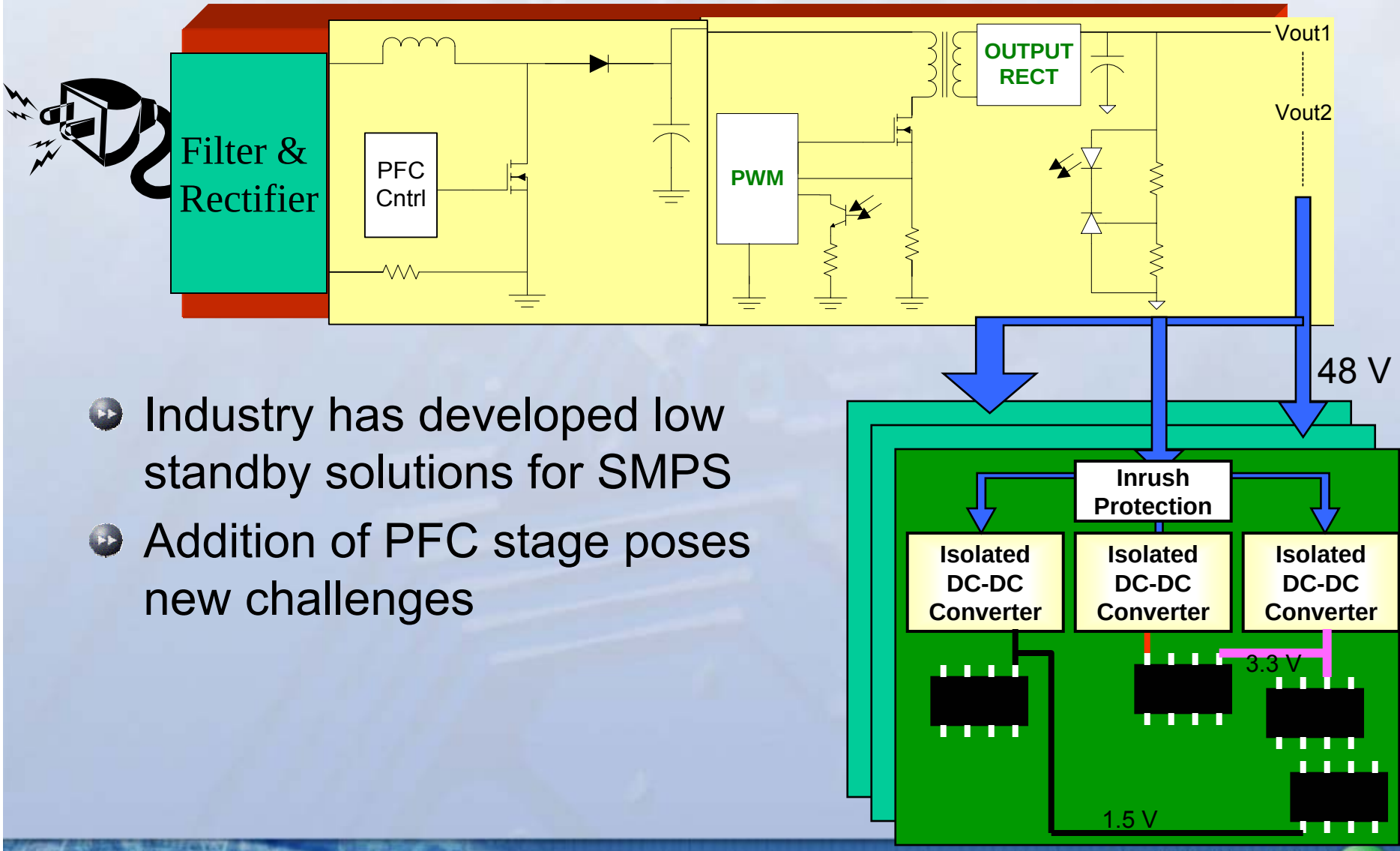
•High level of integration has allowed <200 mW standby consumption for 150 W systems – easy to design

A Practical Solution Example – 70 W Universal Input Power Supply



A 84 mW@230 VAC standby power at no-load was measured!

The Power Train – Line to Load



- Industry has developed low standby solutions for SMPS
- Addition of PFC stage poses new challenges

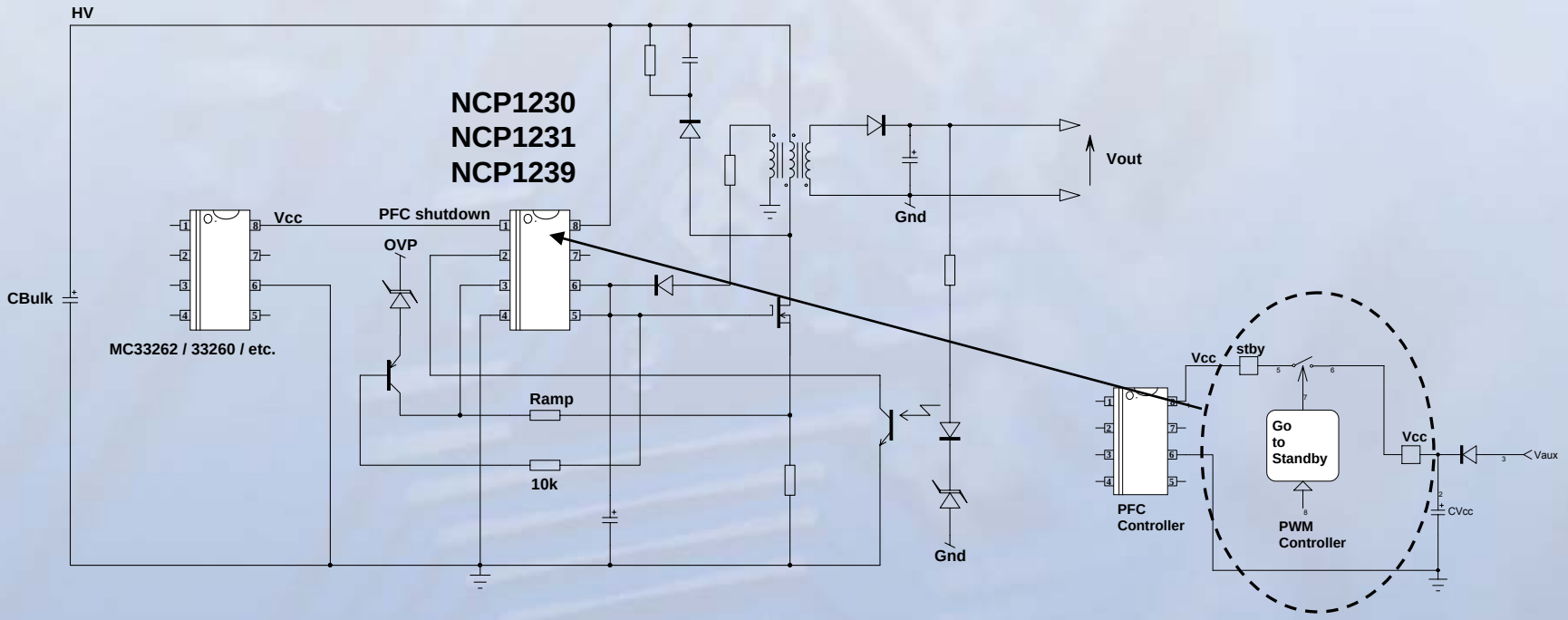
Benefits of Power Factor Correction

- RMS current for non-PFC circuits is 70% higher compared to PFC circuits:
  - this causes stress on the wiring
  - limits usable power from an electrical outlet
  - sometimes this trips circuit breakers
  - higher RMS current raises the cost of generation / distribution

- In Europe and other parts in the world (not yet US), governments mandate clean, low distortion currents…
- Regulations are derivatives of the IEC 1000-3-2 or the EN61000-3-2 (EC)
- 4 classes: A (all eq. except:) B (portable tools), C (lighting) and D (PC, monitors, TVs)

PF correction is **mandatory** for Pin > 75W!!

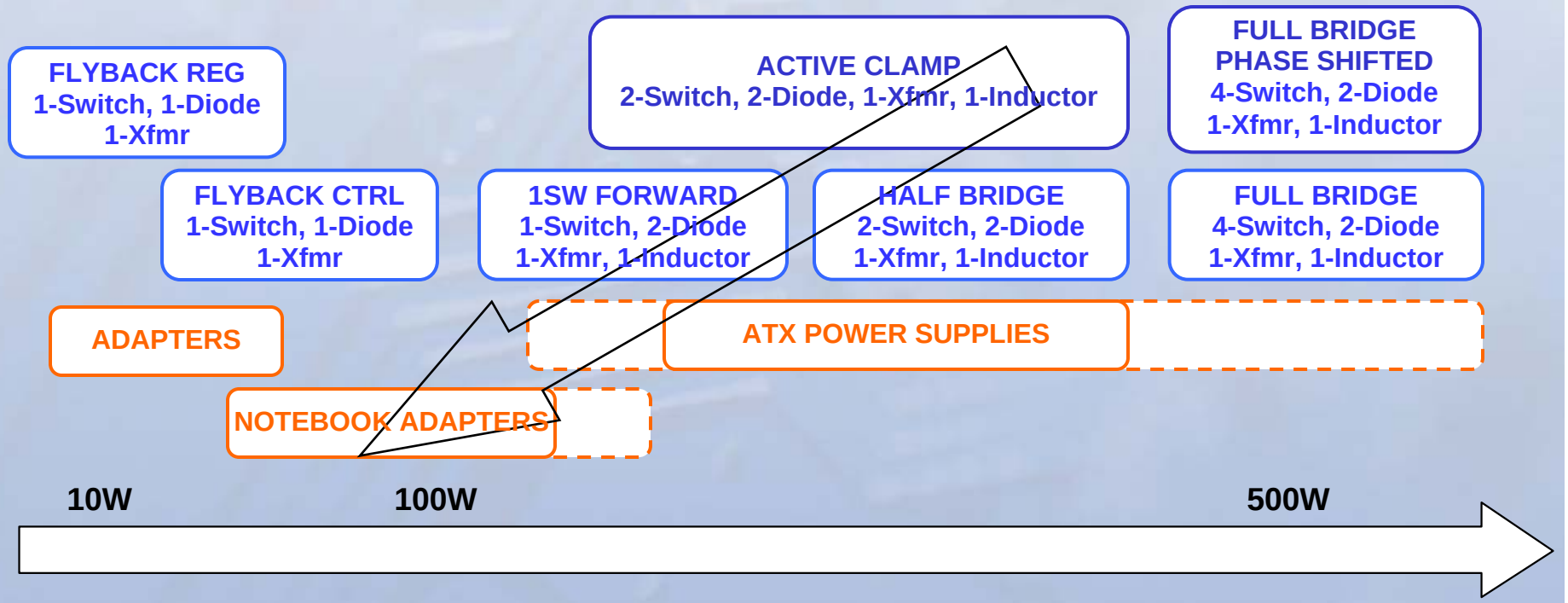
Emerging techniques to meet the standby power challenge with PFC



Shut-down your PFC in standby-mode and pass the 100 mW barrier…

Power Supply Roadmaps - Topologies

- Higher power applications are technology leaders
  - Spillover to lower power as technology matures
- External power supplies are market impact leaders
  - Can drive innovation through customer perception



Increasing Efficiencies

- Breakdown of the efficiency challenge and ON Semiconductor response
- 250 W Output Desktop Power Supply

TODAY

69% Full Load Efficiency

Loss Break Down

MOSFETs	= 25W
Rectifiers	= 37W
Passives	= 30W
Misc	= 20W
TOTAL	= 112W

1 Switch Forward using today's MOSFETs & Rectifiers

MID 2005

75% Full Load Efficiency

Loss Break Down

MOSFETs	= 12W
Rectifiers	= 28W
Passives	= 28W
Misc	= 15W
TOTAL	= 83W

1 Switch Forward using **improved components**

2006

85% Full Load Efficiency

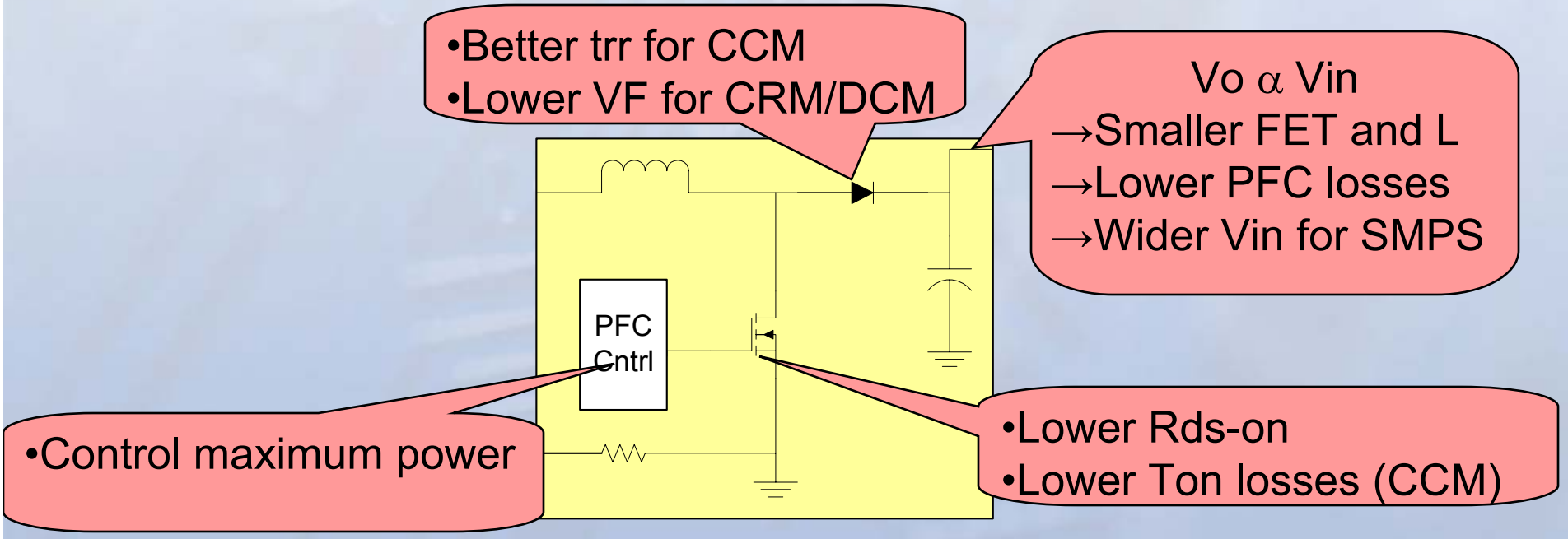
Loss Break Down

MOSFETs	= 7.5W
Rectifiers	= 12W
Passives	= 16.5W
Misc	= 8W
TOTAL	= 44W

New Topology using **improved components**

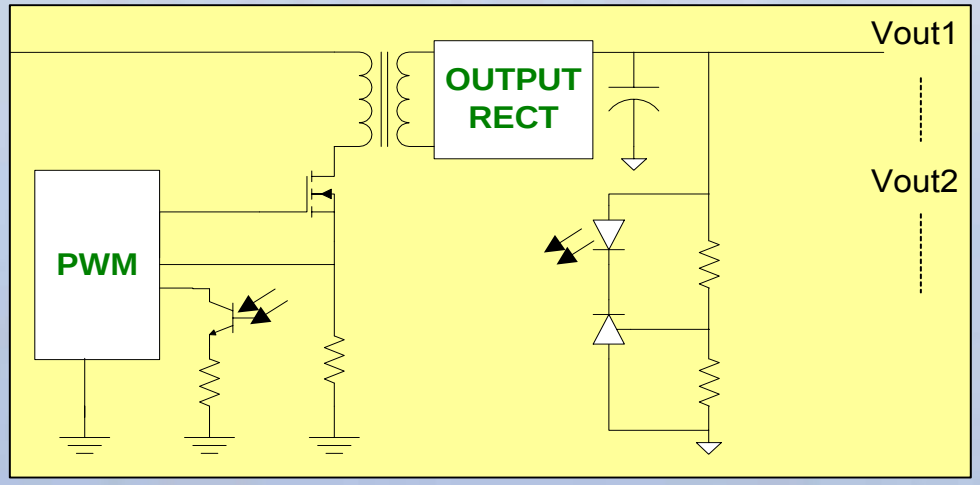
Improving PFC Efficiency

- CCM for higher power, CRM/DCM for lower power
- Topology improvements drive component changes



Improving SMPS Efficiency

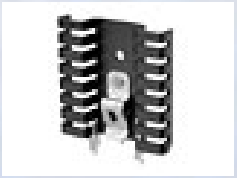
- Topology Upgrade (Flyback -> Forward -> Bridge)
- Soft-switching extends range (QR, Active clamp etc)
- Component level improvements (FET, sync rec etc)



Benefits of Higher Efficiency to the End User

- To control heat build-up designers need…

Fans



Heatsinks

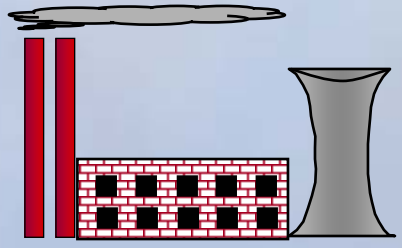
Lower **cost, weight, noise** and **bulk** to the end product

- Reduced power losses save the consumer money

We pay for power that is turned into heat!

- Governmental power loss regulations being implemented

USA Energy Star



Energy saved = fewer power plants = less pollution

ON Semi's Support for Efficient Power

- ON Semiconductor is committed to improving the energy efficiency in power supplies
- Has played a leadership role in delivering cost effective standby power solutions
- Improved efficiency solutions allow ON Semiconductor to
  - Differentiate itself from competition
  - Demonstrate innovative semiconductor solutions to help advance the state-of-the-art
  - Be seen as a market leader
- ON welcomes more stringent future specifications
  - Sets the challenge for innovation
  - Helps drive technology curve (akin to Moore's Law)

ON Semi's Market Success

- Recognized world-wide as innovative power supply solution provider
- Market Leader in controllers for external adapters
  - Revolutionary product-line – NCP12XX series
  - Leading customers: Delta, Astec, Lite-On, Bestec
- Significant success in China Consumer Power market through industry leading standby solutions
  - 2 Consecutive years of CECP awards
  - Leading customers such as TCL, Haier, Foxlink
- Global customers include:
  - Philips, Motorola, Vestel, Beko, Hipro, Celetron

ON Semiconductor®

Thank You!

Questions?