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Fast Start & Cycling HRSGs: Siemens DrumPlus™ Technology

by Sebastiaan Ruijgrok

Introduction

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Presentation contents

- Market trends & developments
- HRSG challenges
- DrumPlus™ technology
- Fast Start & DrumPlus™ benefits
- DrumPlus™ references

History and timeline

Siemens Heat Transfer Technology Core Products

Large HRSGs	Modular HRSGs	WHRU	EDS	Services

> 900 boilers installed worldwide and counting

Market trends and developments
Global power outlook

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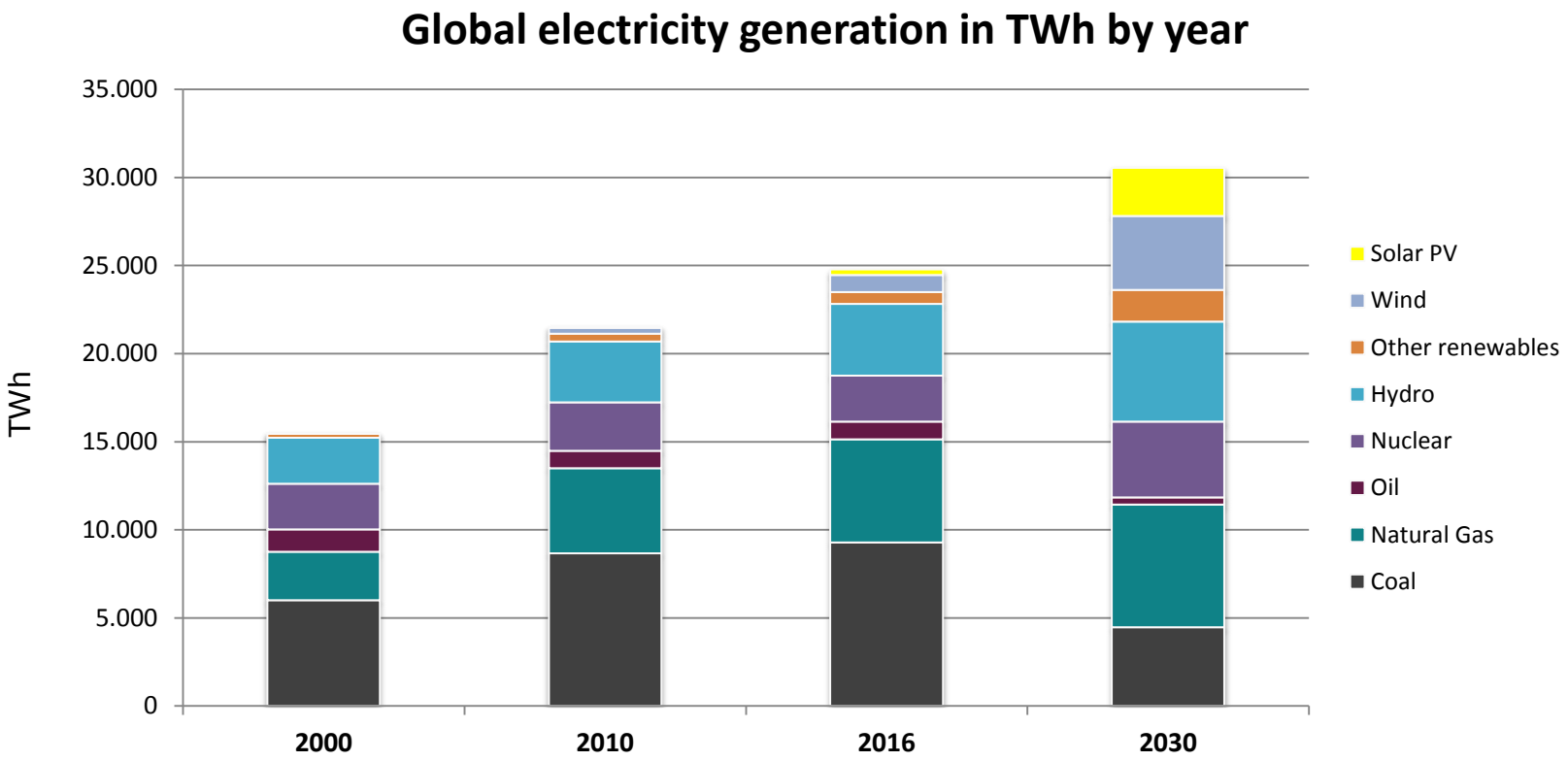

International Energy Agency
World outlook 2017

Solar generation to grow 900%!

Total renewable power generation from 24% in 2016 to close to ~ 50% of total in 2030!

How can we deal with these market expectations?

Market trends and developments
The impact of wind and solar - the grid of today

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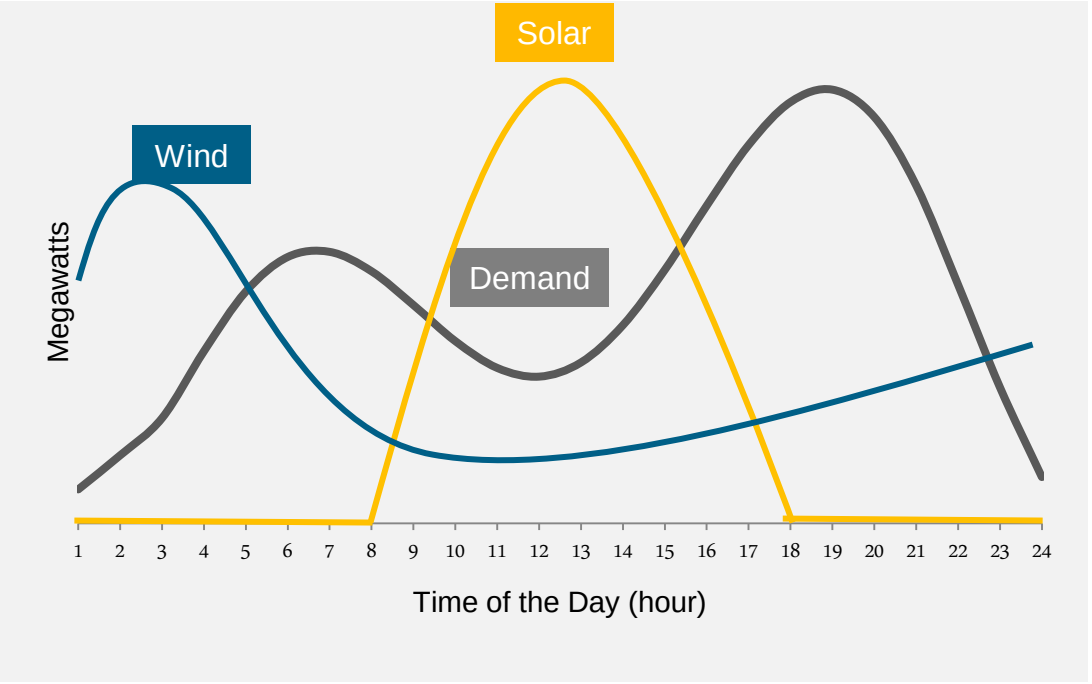
Traditionally

- Predictable load
- Limited renewable integration
- Generation from dispatchable units

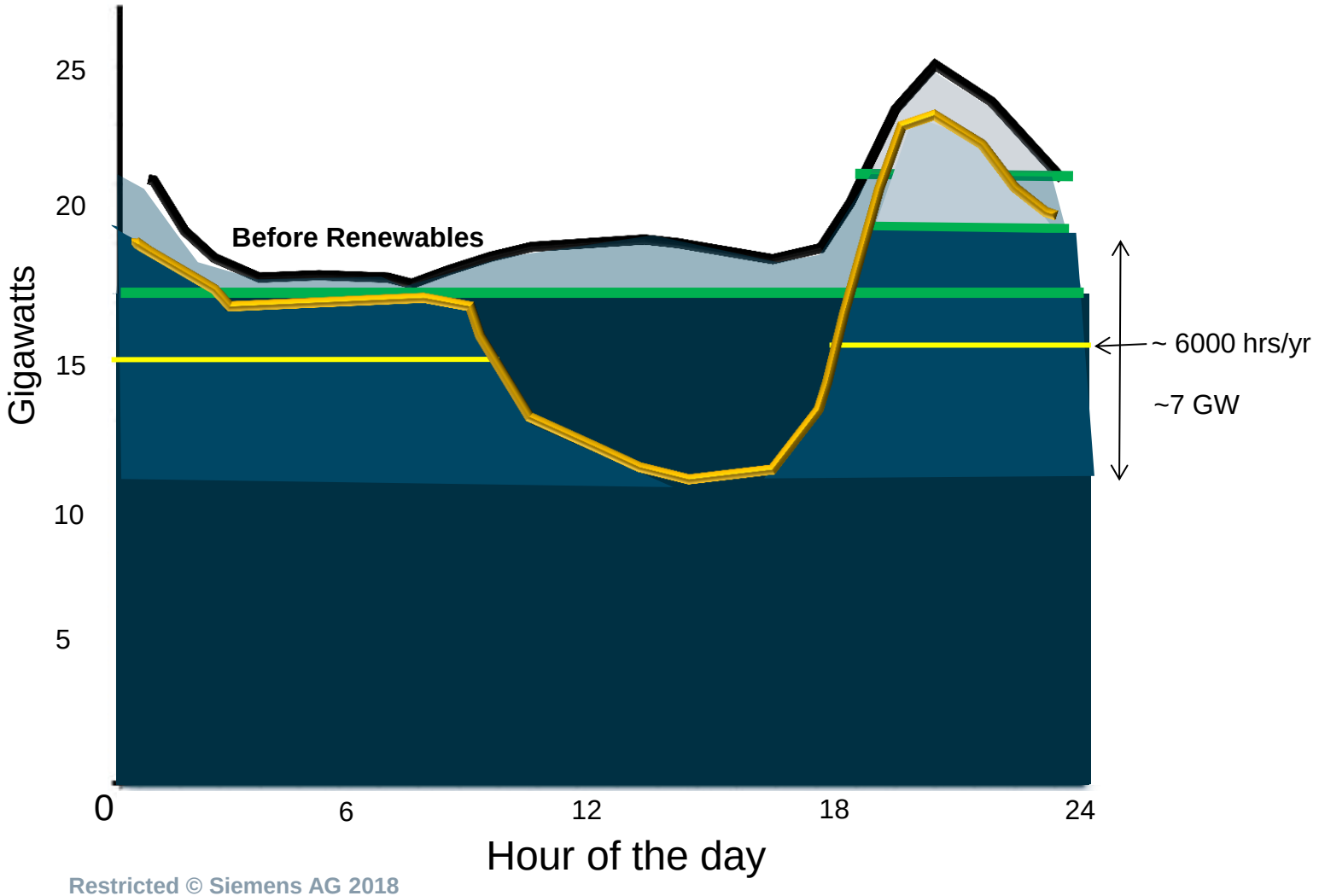


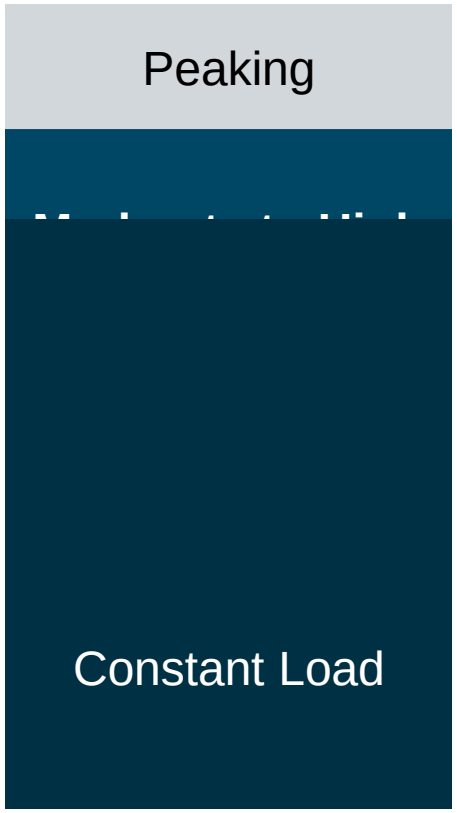
Modern grid

- Increasing renewables penetration
- Peaks are out of sync
- Fast, flexible resources required to balance grid

Wind and solar create a new reality for other generation sources

Market trends and developments
The effect on the market





Market trends and developments
Implications for CCPP

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Market requirements of today and tomorrow

- Flexible
- Cycling
- Fast

Impact on HRSGs

Plant efficiency

Increased steam pressure, temperature, flow

→ Thicker pressure parts

Increased thermal stress

Faster starts

Increased thermal stress

Increased expansion differences

More starts → lower thermal stress allowed

HRSG overview

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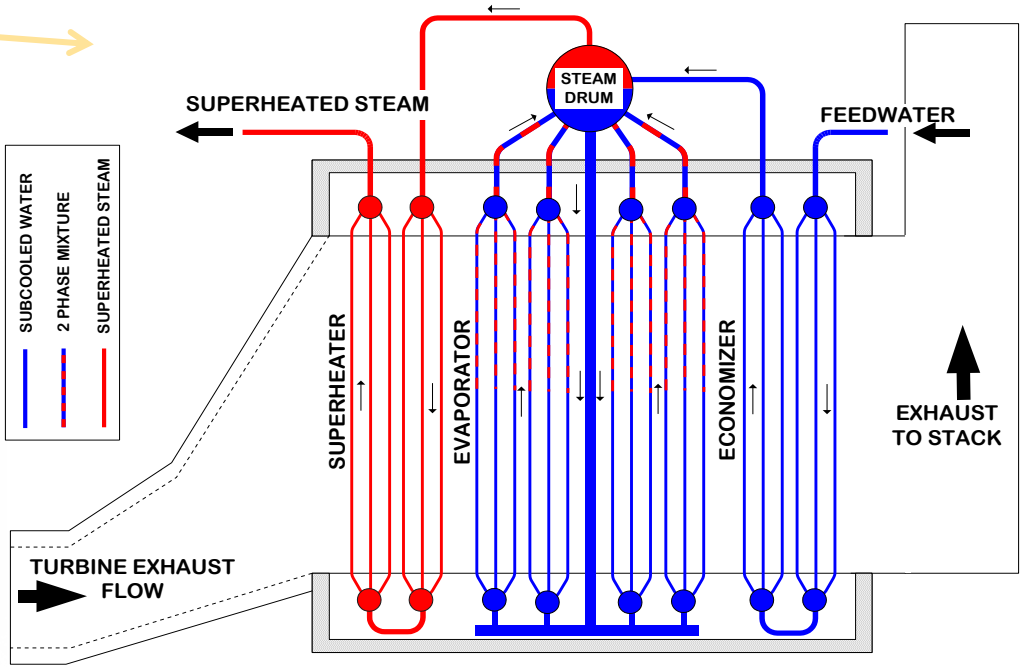
Combined Cycle Power Plant (CCPP)

Heat Recovery Steam Generator (HRSG)



Challenges for the HRSG
Lifetime impact of low cycle fatigue

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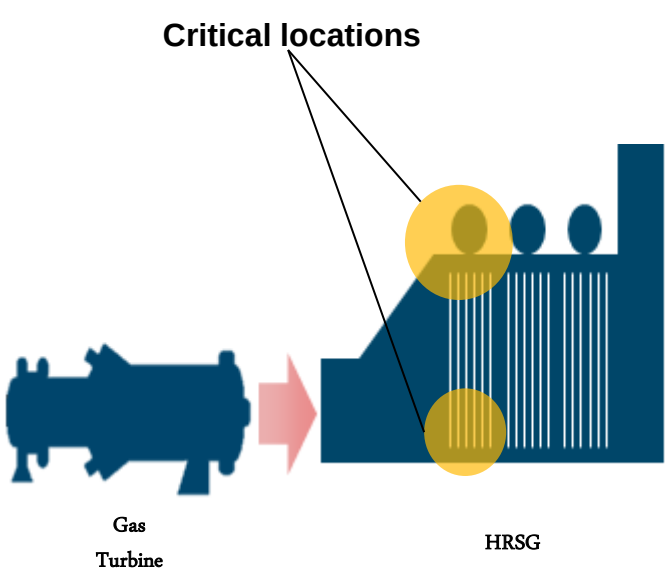
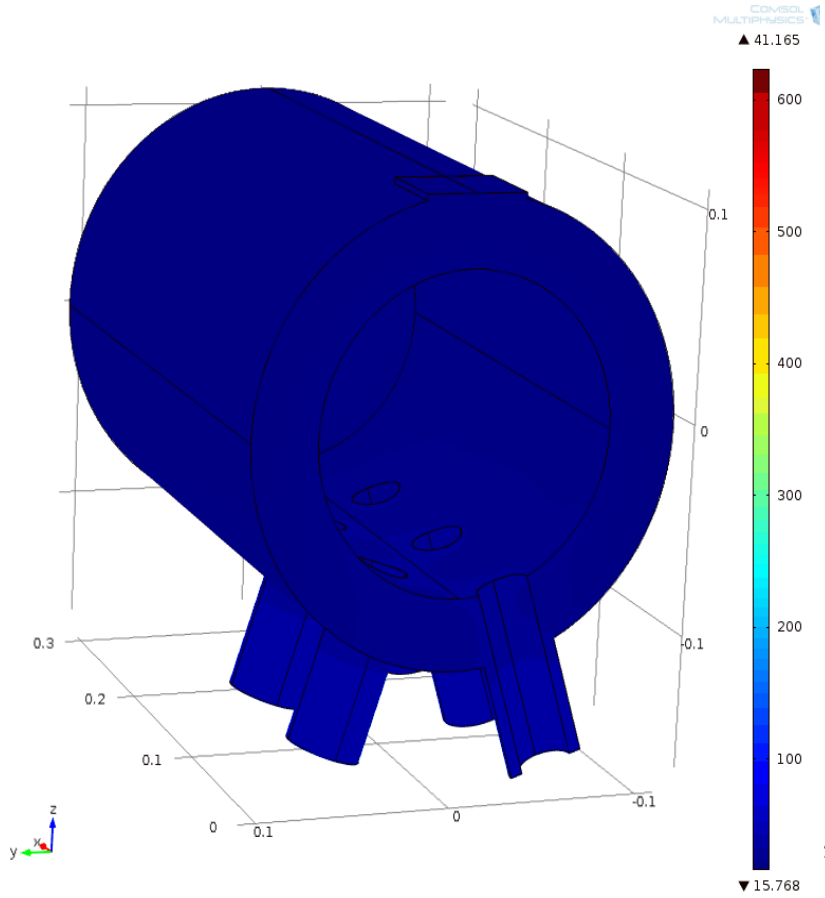
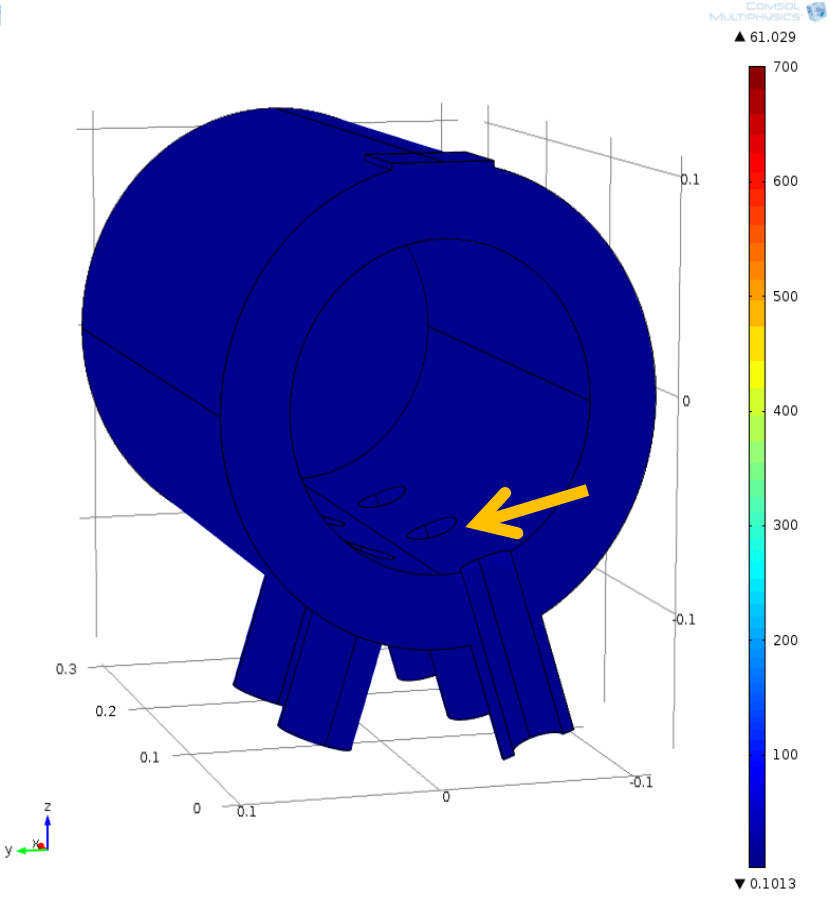




Temperature



Stress

Challenges for the HRSG
Lifetime impact from expansion differences

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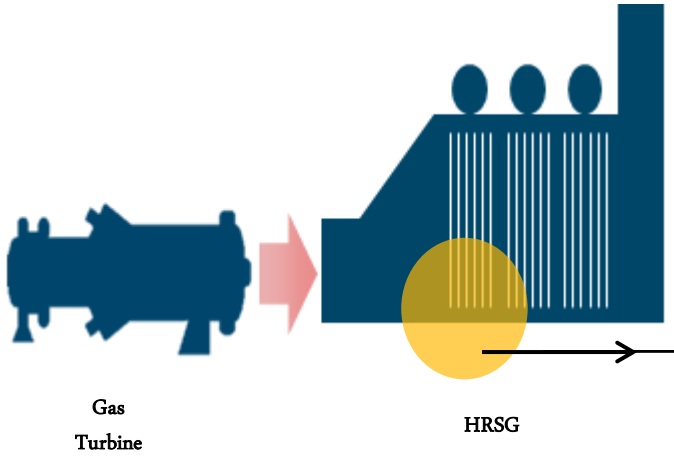

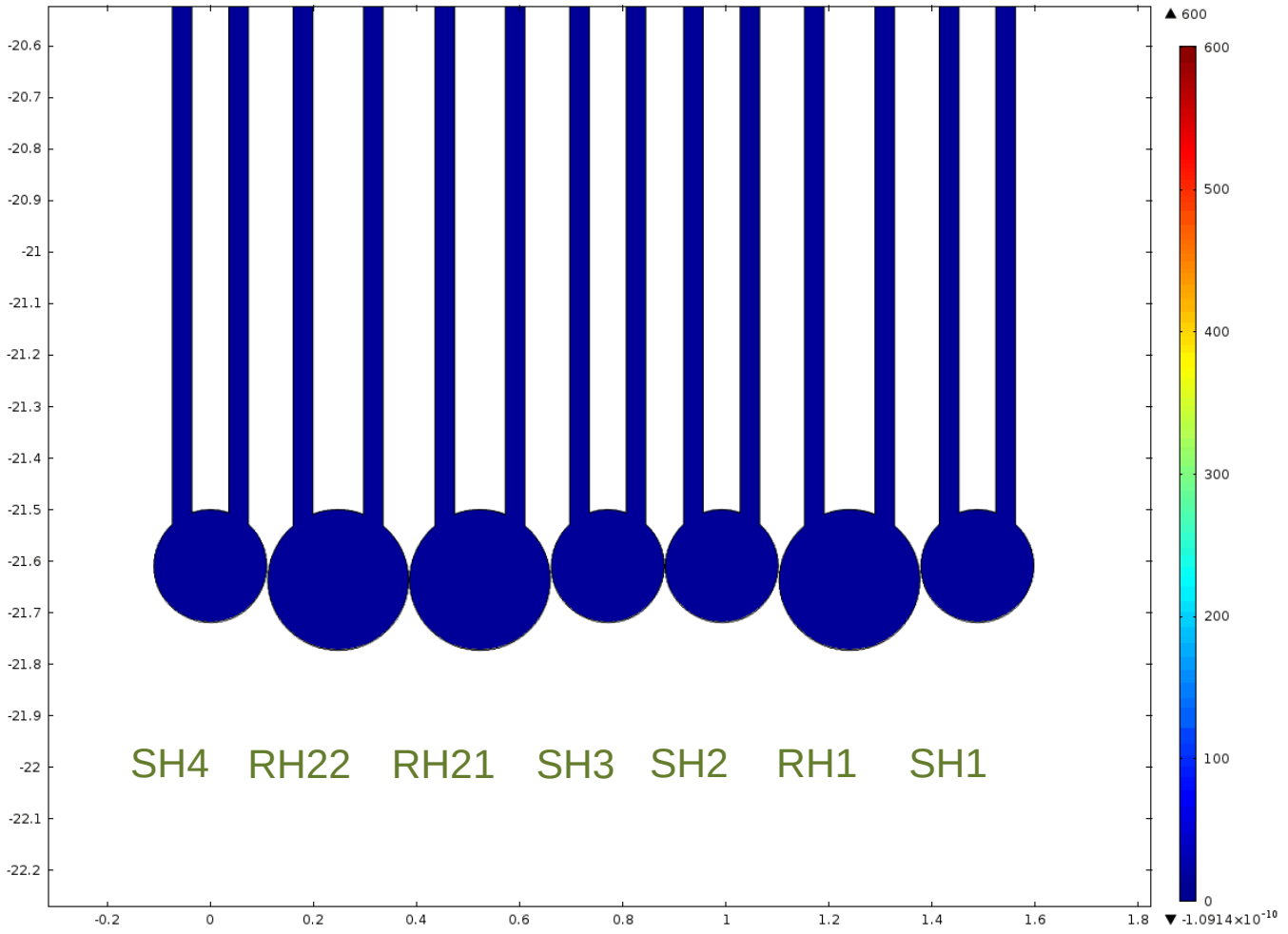

Cold start - response of HP SHs and RHs

DrumPlus™ technology & references
Adapting the complete HRSG system

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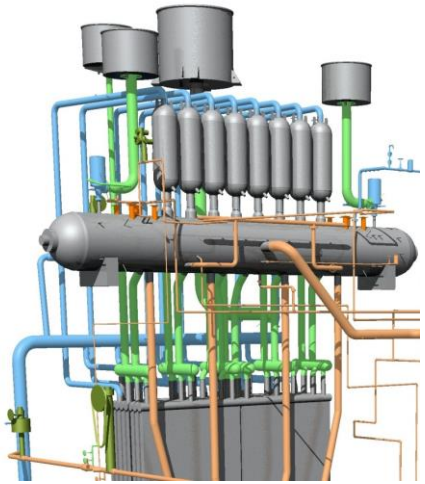
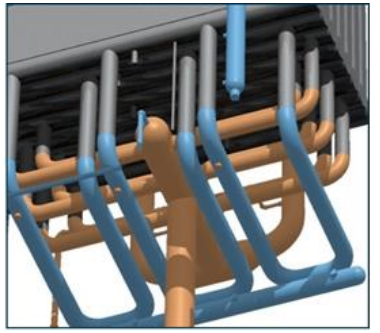
DrumPlus™: Siemens patented HRSG technology



Secondary steam separation in bottles outside drum

Enhancing the system to increase flexibility



Multiple inside downcomers

Expansion loops in EVAP feeder

Bundle spring supported

From design to reality

DrumPlus™ technology & references
HP drum comparison

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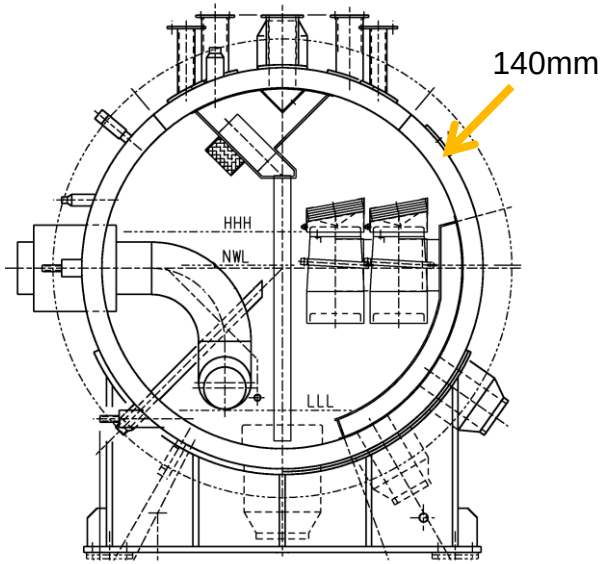
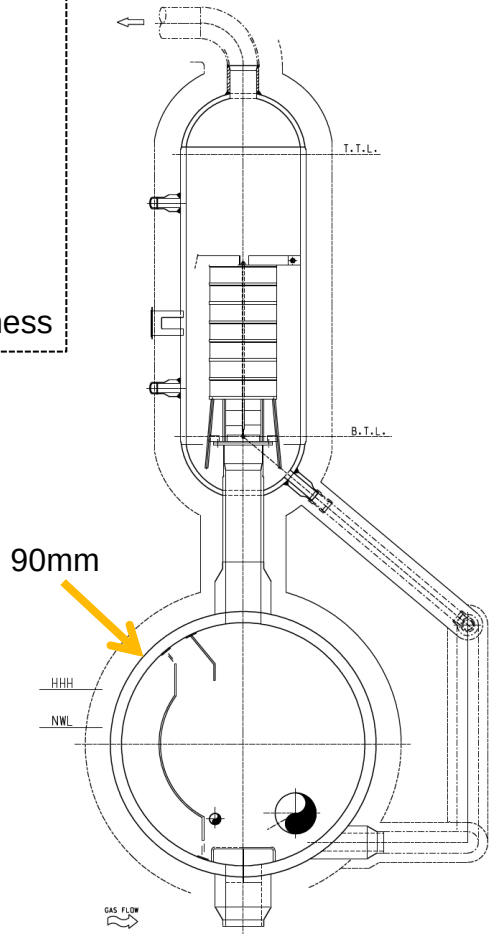
Dimensions comparison

DrumPlus: 1300 mm (51.2 inch) drum ID with 90 mm (3.54 inch) wall thickness

Conventional drum: 2000 mm (78.7 inch) drum ID with 140 mm (5.51 inch) wall thickness



Conventional drum

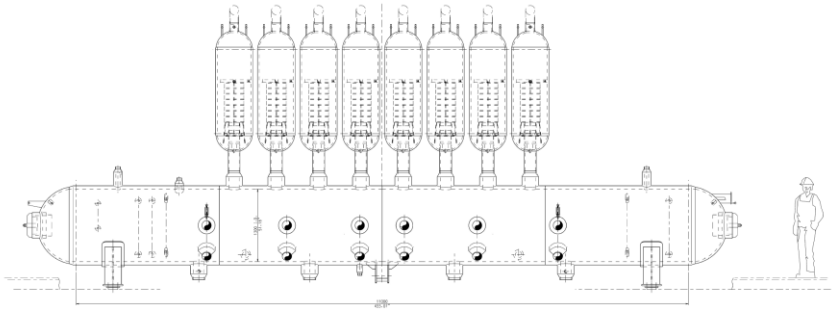


DrumPlus™

Conventional Drum	vs	DrumPlus
Primary and secondary steam separation in the drum.		Conventional primary steam separation, secondary steam separation in the bottles.
Conventional feedwater requirements up to ~170 bar.		Conventional feedwater requirements up to ~170 bar.

DrumPlus Benefit

- ✓ Overall comparable price level
- ✓ Improved performance
- ✓ Increased lifetime for fast start and cycling



Benefits of a fast start Drumplus™ HRSG

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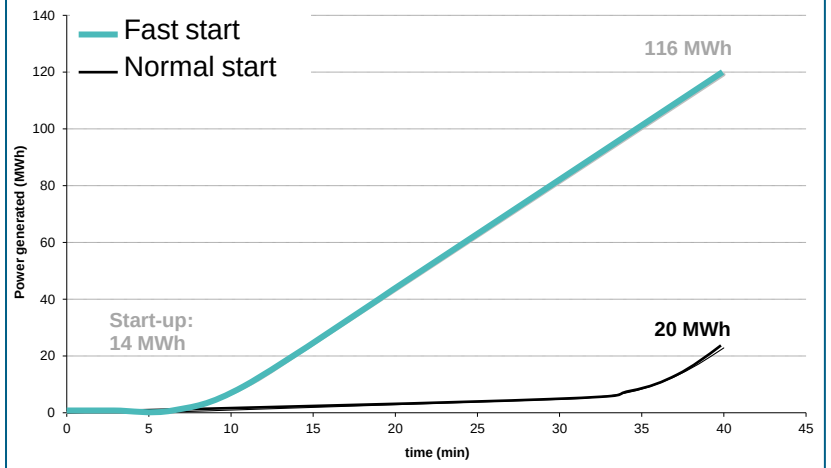
Quick response to power demand

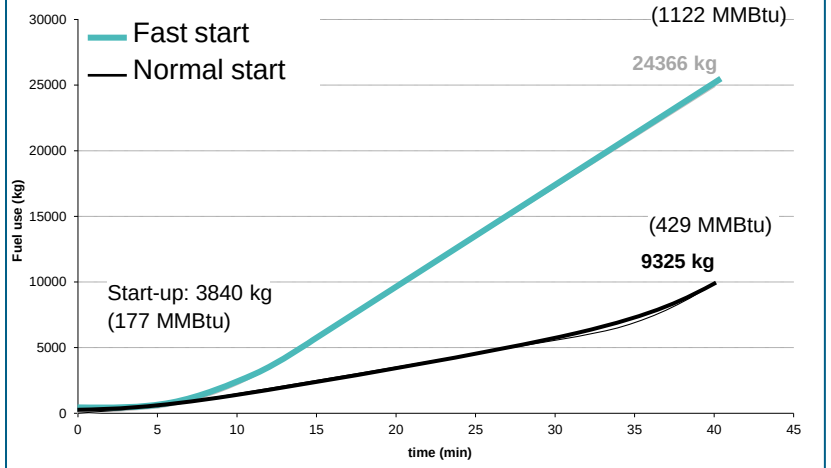
- ✓ Adapt to fluctuating renewables
- ✓ Ability to provide quick power to the grid
- ✓ Increased start-up power production



96 MWh x $50 x 250 = $1.1 Mln

Reduced start-up cost, profits up

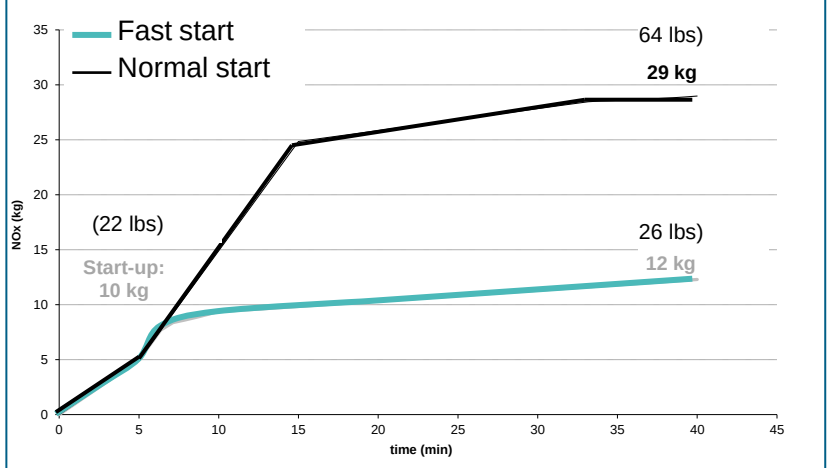
- ✓ Lower fuel need during start-up
- ✓ More efficient power supply
- ✓ Increased profits



252 MMBtu x $4 x 250 = $252,000

Lower emissions during start-up

- ✓ Faster warm-up of emission control system
- ✓ Significant lower NOx emissions
- ✓ Lower CO emissions



58% NOx emission reduction

Conventional versus DrumPlus™
Lifetime improvement – 7 times higher with DrumPlus™

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Highly flexible operation 30 years design lifetime	Conventional drum	DrumPlus™
300 cold starts	56%	9.5%
1500 warm starts	105%	13%
6000 hot starts	13%	2.4%
Total	**174%**	**25%**

DrumPlus™ excellent lifetime expectations for fast start and cycling

Global DrumPlus™ references

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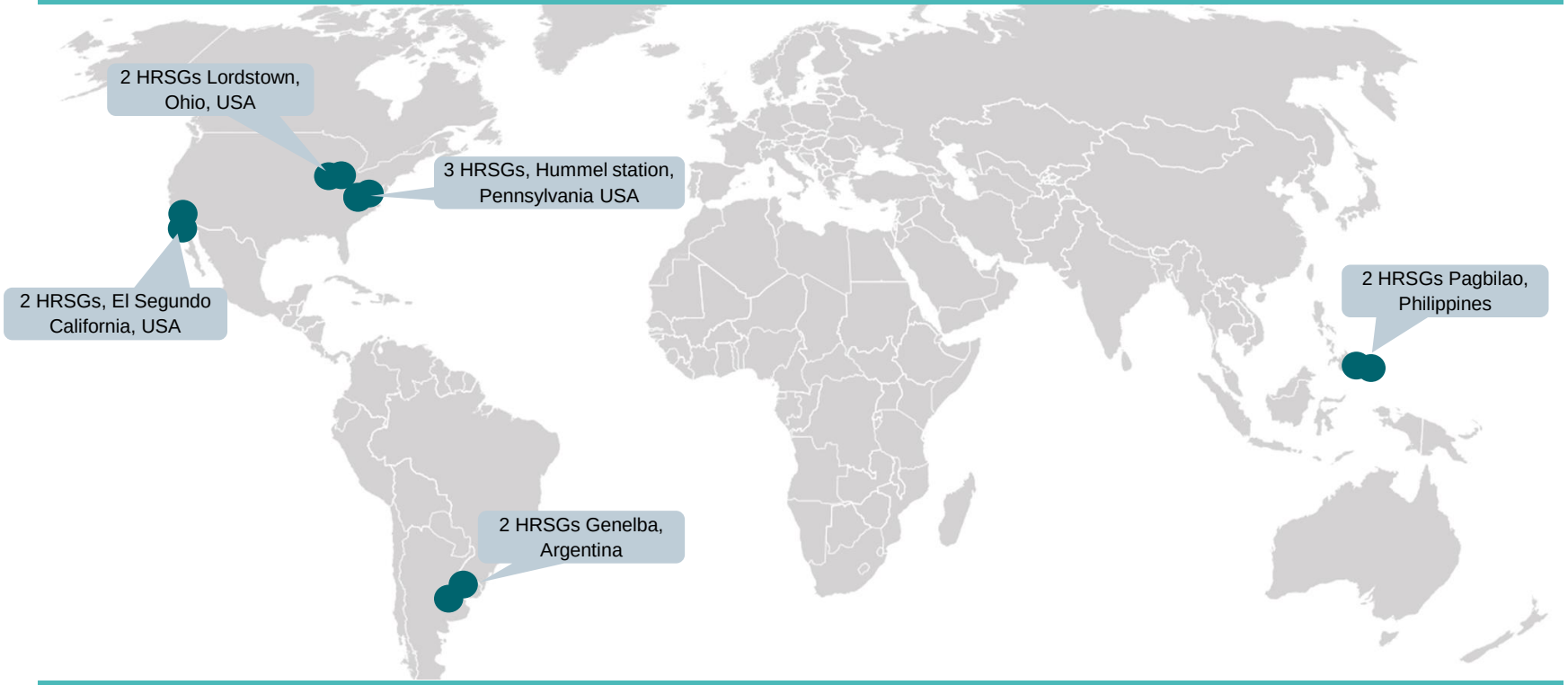
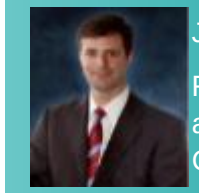
DrumPlus™ technology global references



2 units in successful operation, 3 in commissioning and 5 under construction

> “Siemens Flex-Plant technology is helping California to meet aggressive environmental goals regarding intermittent resources and new clean air standards.”



John Chillemi,

President of NRG’s West Region, owner and operator of El Segundo Energy Center (USA)

DrumPlus™: Fast Start & Cycling HRSGs

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Operational experience

- Name: El Segundo
- Location: California, USA
- Gas turbine: SGT6-5000F ~190 MW
- HP drum pressure: ~100 bar (1450 psi)
- Number of units: 2
- Year of operation: 2013

Field data – unrestricted GT ramp-up

Fast: 150 MW in 10 minutes from GT ignition

Ramp rate of 30 MW/min after synchronization

Reliable: Drum size sufficient to contain swell

Cycling proof: ~1200 starts in first 4 years

New DrumPlus™ HRSGs under construction

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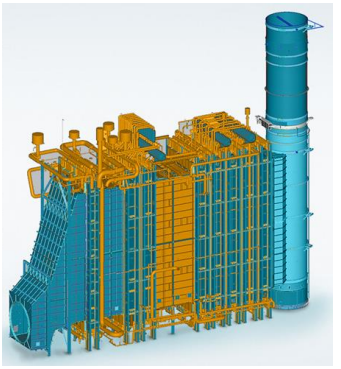
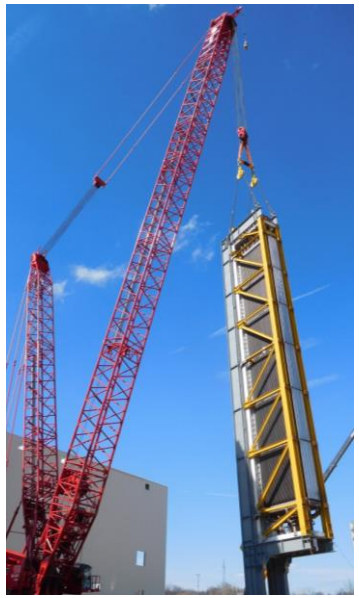
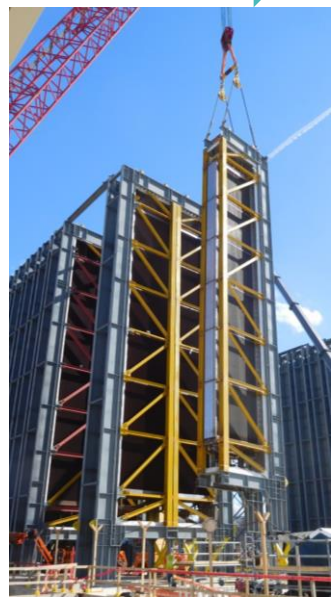
Lordstown, USA
Gas turbine: SGT6-8000H ~300 MW
HRSG type: DrumPlus™ 3 pressure + Reheat
HP pressure: ~165 bar (2390 psi)
Duct burner: ~45 MW heat input
No. of units: 2



Build Fast, Start Faster





Siemens DrumPlus™ HRSG Technology

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Innovative & Future Proof design

Faster, Cleaner & Cost Effective

YOUR fast start HRSG partner

El Segundo 550 MW Combined Cycle Power Plant, California, USA.

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