First Learning's of Fukushima

Mario van der Borst

RWE
The energy to lead

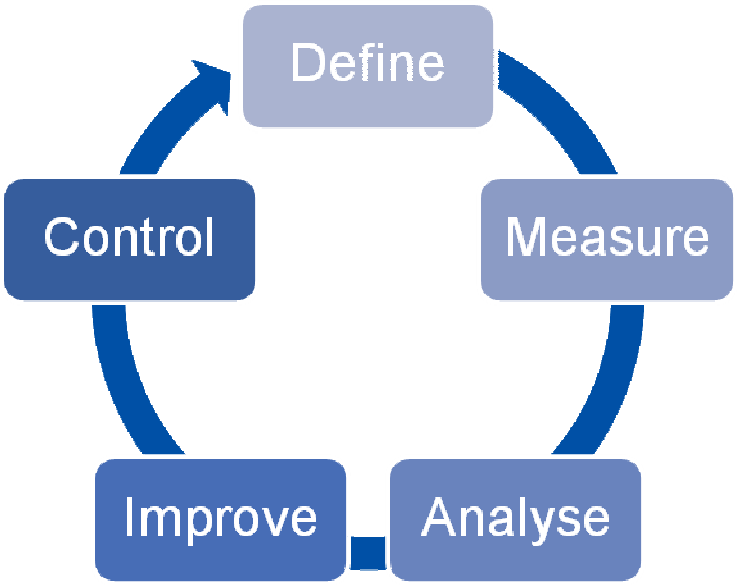
KIVI Kerntechniek
Den Haag, May 13th, 2011

WARNING

Since not all information is analyzed these lessons learned can only be PRELIMINARY

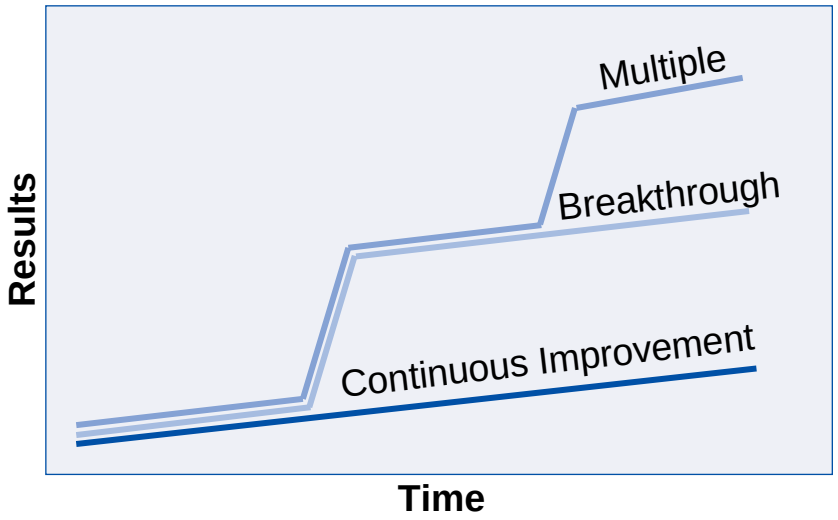
Improvement – A Continuous Process

- Learning is essence of quality circles
- Essential to maintain and improve safety
- Many of these circles are in place at Nuclear Power Plants



Learning and improvement is a MUST

Better to learn from minor incidents and near misses, …



Serious Accidents

> Give some extra information

> Give burst to improvement

> Opens Eyes, removes barriers

European Stress Tests

What to learn from Fukushima?

- New phenomena/insights
- Old lessons not Implemented

Attitude: Learning / Questioning

- Not to say: Can not happen at our plants, but **is this happening at our plants in another way?**

The First Lessons

Earthquake

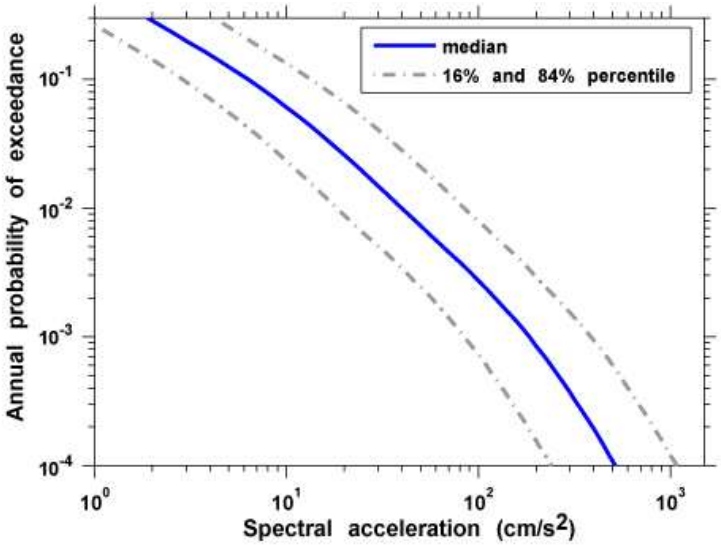
> Design Upgraded after Yoshi EQ 2007

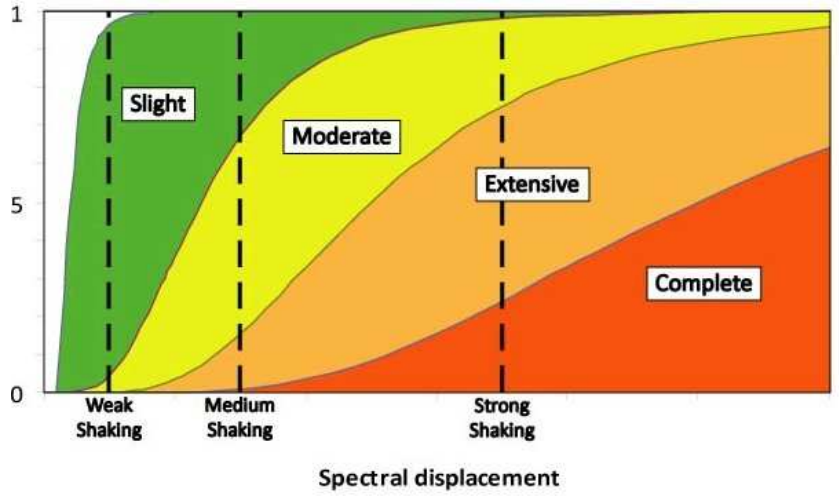
> Really beyond design basis?

> Does this matter?

Observation Point (The lowest basement of reactor buildings)		Observed data (*interim) Maximum Response Acceleration (gal)			Maximum Response Acceleration against Basic Earthquake Ground Motion (Gal)		
		Horizontal (N-S)	Horizontal (E-W)	Vertical	Horizontal (N-S)	Horizontal (E-W)	Vertical
Fukushima Daiichi	Unit 1	460*2	447*2	258[2]	487	489	412
	Unit 2	348*2	550*2	302*2	441	438	420
	Unit 3	322*2	507*2	231*2	449	441	429
	Unit 4	281*2	319*2	200*2	447	445	422
	Unit 5	311*2	548*2	256*2	452	452	427
	Unit 6	298*2	444*2	244	445	448	415

Design Margins External Hazards





- Historical approach
- Maximum approach
- Probabilistic
- Cliff Edge

Tsunami

- Tsunami Design Basis 5.7m, reality was >12m
- Historical/geologicalTsunami's e.g. 869 (Jogan Tsunami)
- Defense in depth?
- Diesel fuel tanks? Areal separation?

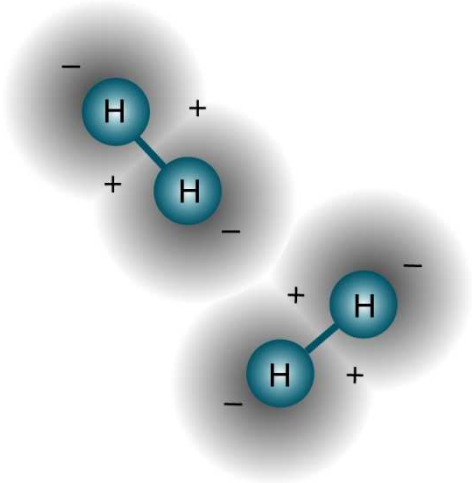
Station Blackout

- Importance of batteries
- Importance of diversity; independent of AC power
- Steam pumps, emergency condenser, secondary F&B: to be independent of DC
- Passive systems: idem

Loss of ultimate heat sink

- Diversity: cooling independent of ultimate heat sink. (water supplies, ground water, aircooling)
- Decouple loss of main and loss of emergency cooling
- Measures to prevent loss of cooling channel

Hydrogen



- Hydrogen not new
- Hydrogen leakage to secondary containment under-estimated?
- Nitrogen inertisation prevents hydrogen recombination

Secondary containment
Fuel Pool

- Integrity secondary containment
- Pressure release capabilities
- Accessible alternate cooling possibilities
- Status monitoring
- Pool leak suppletion
- Fuel capacity, criticality

Severe accident measures

- Filtered Venting
- Ex-vessel cooling
- Possibility to depressurize (no DC)
- Alternate injection possibilities
- Minimum monitoring capabilities, without normal DC

Off-site supplies/repairs

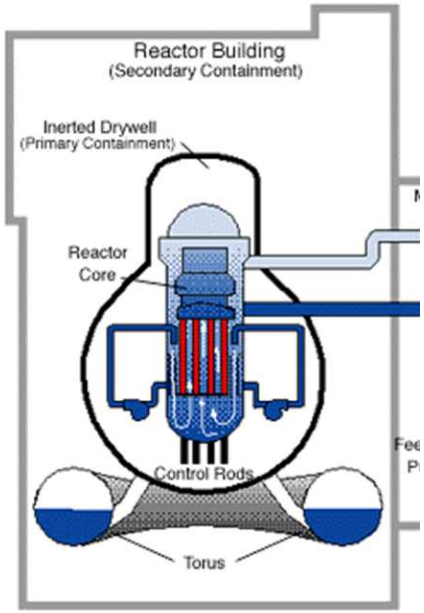
- Resources for multiple unit site
- Local and remote storage
- Bunkered local supplies
- Helicopter transport
- Skilled people/Drills
- Accessibility

Comparison with modern BWR

Fukushima 1

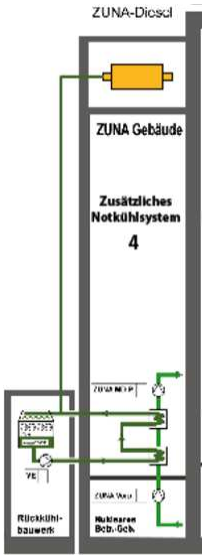
2 Low pressure cooling trains

Not designed against flooding



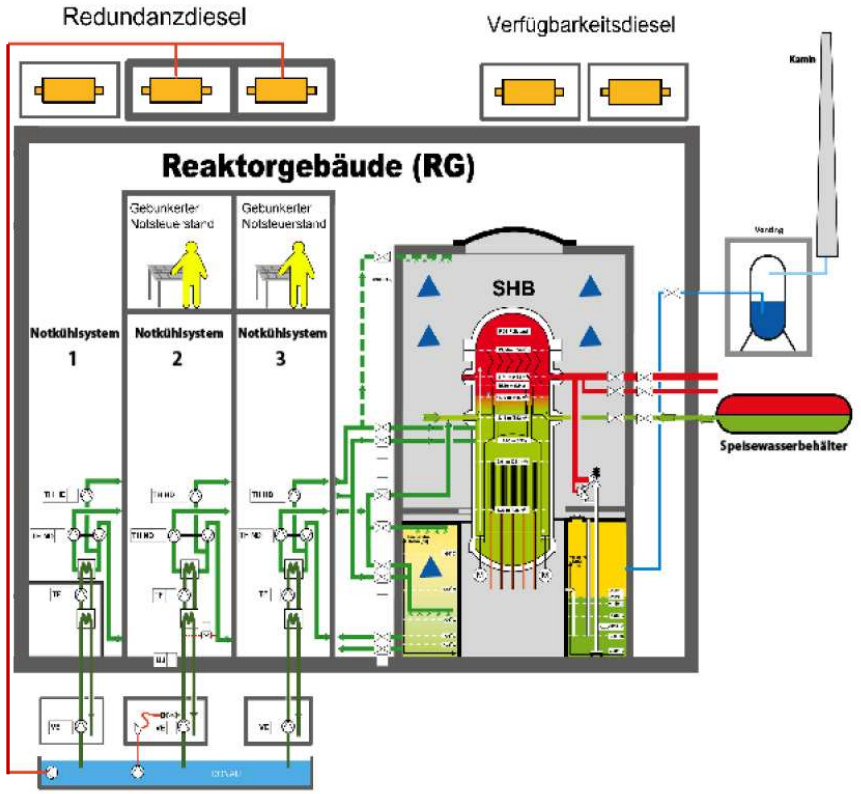
1 extra

cooling train



German BWR

3 LP cooling trains, designed against flooding, bunkered and separeted.



RWE
The energy to lead

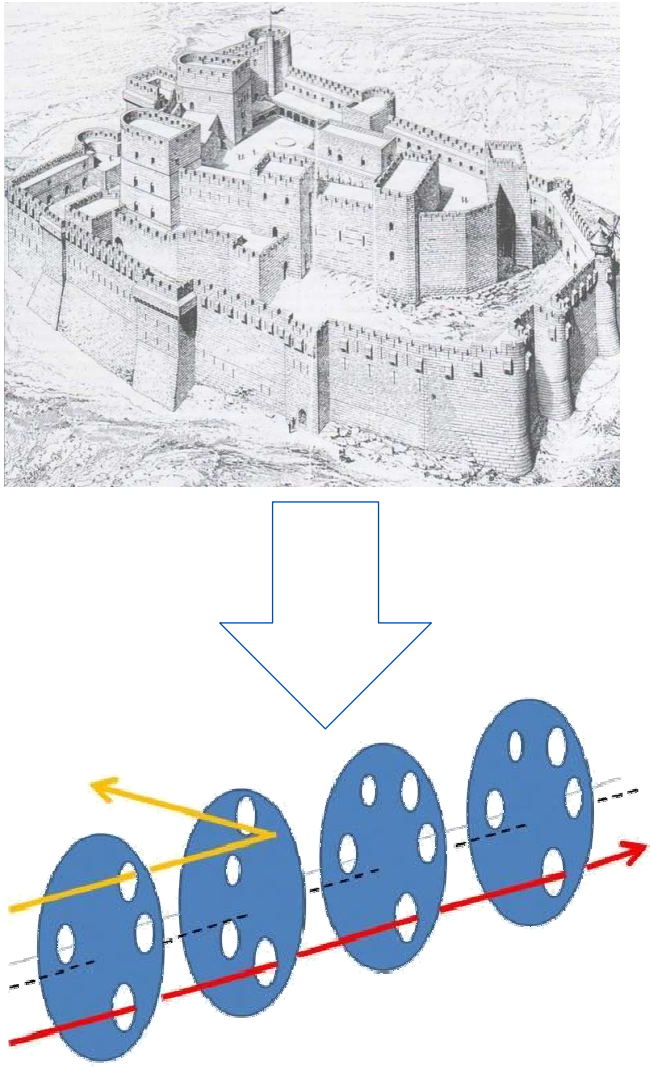
Nuclear Safety Principles

Still Apply after Fukushima

> Margin

> Defense in Depth

> Dependency



All barriers need same attention

RWE
The energy to lead

Learning from TMI and Chernobyl

Technical

- SB-LOCA's and non-LOCA's can be more limiting than the DBA.
- Symptom based accident procedures, operator training and simulators developed.
- Design improvements to improve non-LOCA response
- Examples: extra diesels, batteries, F&B, diverse systems, diverse ultimate heath sink, etc
- Deterministic and probabilistic approach
- Better understanding of physics, thermo-hydraulics etc.

Organizational

- Importance of human factor
- Safety culture
- International cooperation and exchange
- Benchmarking and Peer Reviews
- Periodic Safety Assessment

FUKUSHIMA ?

Summary

> International cooperation was unable to prevent this accident in a high-tech nation

> More focus on Design and Operation

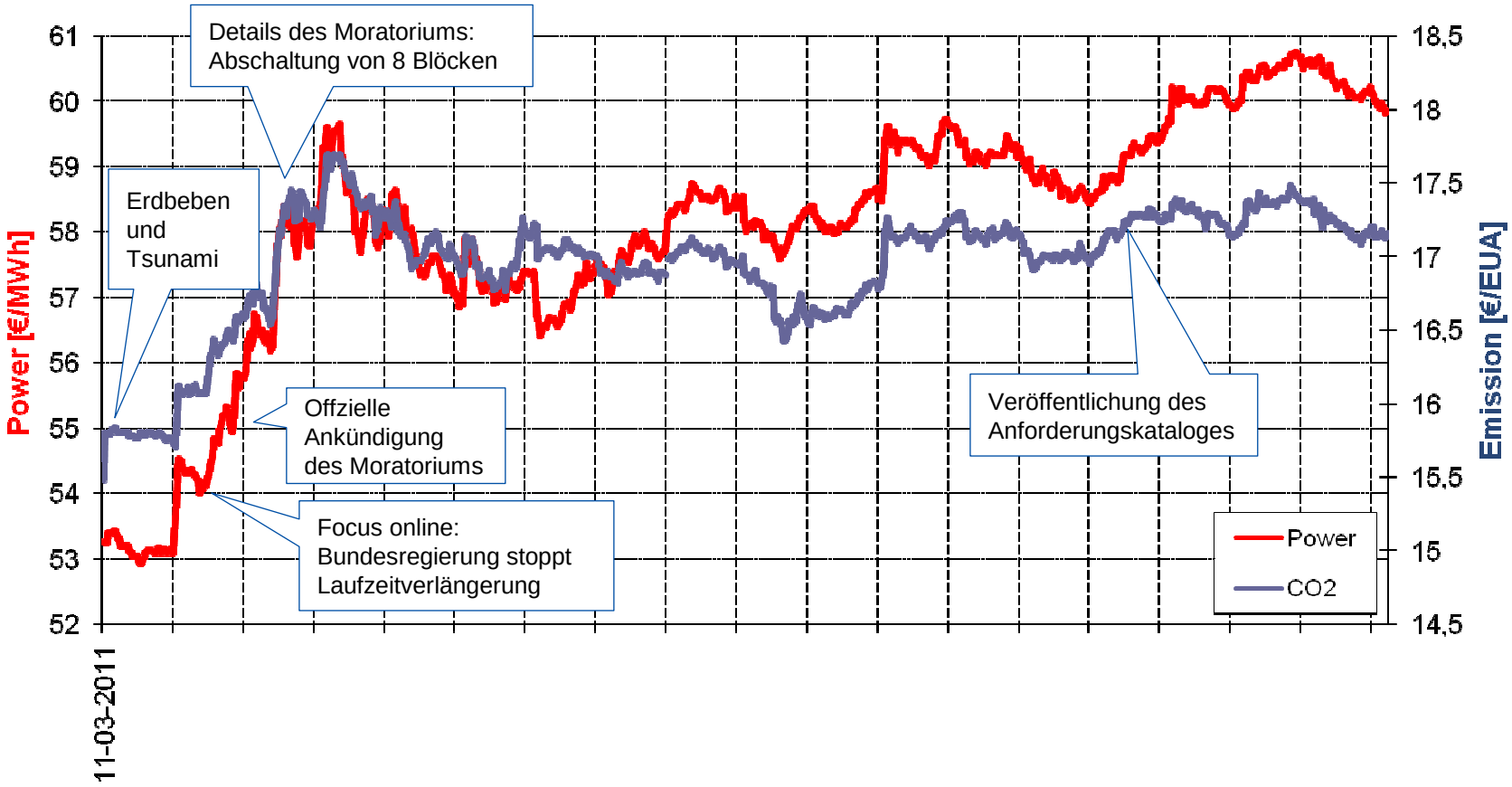
> Revisit design basis

- against external events and combinations
- Beyond design margins, incl. Station Blackout capabilities
- Preparedness severe accident situation, including effectiveness of hydrogen explosion prevention
- Design of fuel pools and fuel pool building

Thank you for your attention

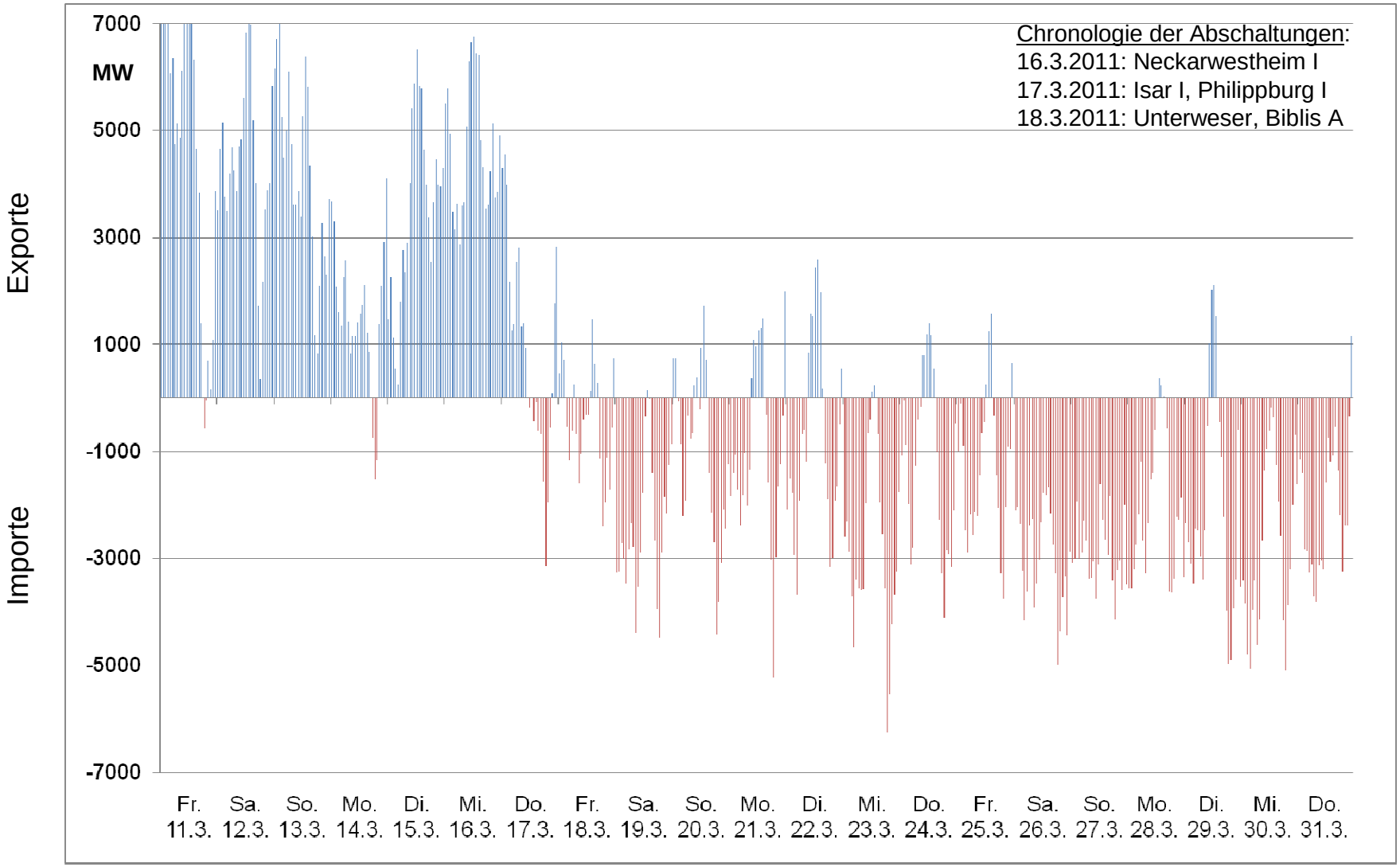
RWE
The energy to lead

Energiewirtschaftliche Folgen von Erdbeben und Moratorium: Strompreise steigen – der Markt reagiert



Deutschland wird vom Stromexporteur zum Stromimporteur

Bilanzierung Cross-Border Commercial Schedules für den Zeitraum 11.3. – 31.3.2011



Quelle: www.entsoe.net
Stundenmittelwerte