report 4th edition 2012 world energy scenario

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Sydney Summer School

February 2013

The Energy [R]evolution 2012

The Role of Energy Efficiency and Peak Demand Management

For all Energy [R]evolution scenario details go to:
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Efficiency Pathways of the Energy [R]evolution Scenario:

Electricity Sector

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global: development of electricity demand by sector in the energy [r]evolution scenario

('EFFICIENCY' – REDUCTION COMPARED TO THE REFERENCE SCENARIO)

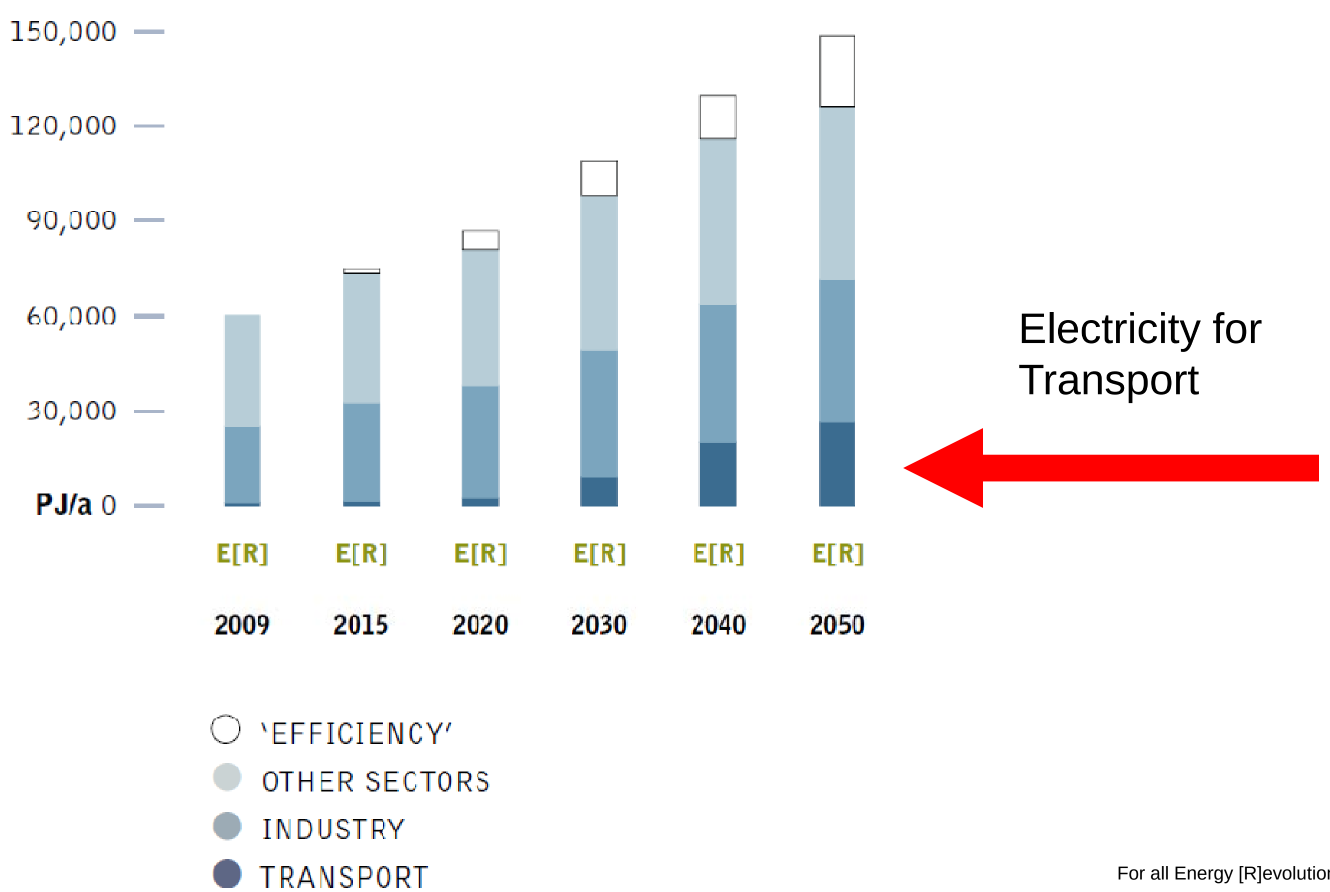

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table 10.1: reduction of energy use in comparison to the reference scenario per sector in 2050

	IRON & STEEL		ALUMINIUM PRODUCTION		CHEMICAL INDUSTRY		NON-METALLIC MINERALS		PULP & PAPER		OTHER INDUSTRIES	
	Industry fuels	Industry electricity	Industry fuels	Industry electricity	Industry fuels	Industry electricity	Industry fuels	Industry electricity	Industry fuels	Industry electricity	Industry fuels	Industry electricity
OECD Europe	45%	45%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
OECD North America	64%	64%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
OECD Asia Oceania	51%	51%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
China	69%	69%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
Latin America	79%	79%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
Africa	70%	70%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
Middle East	52%	52%	0%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
Eastern Europe/Eurasia	79%	79%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
India	63%	63%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
Non OECD Asia	33%	33%	40%	38%	32%	7%	0.6%	0.6%	10%	10%	48%	48%
World	**66%**	**66%**	**40%**	**38%**	**32%**	**7%**	**0.6%**	**0.6%**	**10%**	**10%**	**48%**	**48%**

INDUSTRY ELECTRICITY

OECD North America	80%	80%	80%	80%	80%	80%	80%	80%	80%
OECD Asia Oceania	70%	70%	70%	70%	70%	70%	70%	70%	70%
OECD Europe	80%	80%	80%	80%	80%	80%	80%	80%	80%
Eastern Europe/Eurasia	80%	80%	80%	80%	80%	80%	80%	80%	80%
India	70%	70%	70%	70%	70%	70%	70%	70%	70%
China	70%	70%	70%	70%	70%	70%	70%	70%	70%
Non OECD Asia	70%	70%	70%	70%	70%	70%	70%	70%	70%
Latin America	70%	70%	70%	70%	70%	70%	70%	70%	70%
Middle East	80%	80%	80%	80%	80%	80%	80%	80%	80%
Africa	70%	70%	70%	70%	70%	70%	70%	70%	70%
World	**80%**	**80%**	**80%**	**80%**	**80%**	**80%**	**80%**	**80%**	**80%**

reference

145 ECOFYS (2005), BLOK (2005), ODYSSEE (2005), IEA (2011C).

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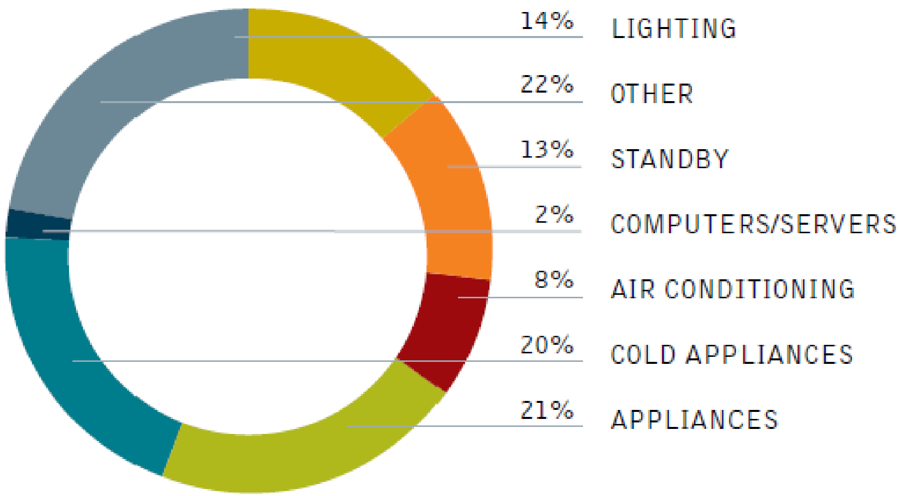
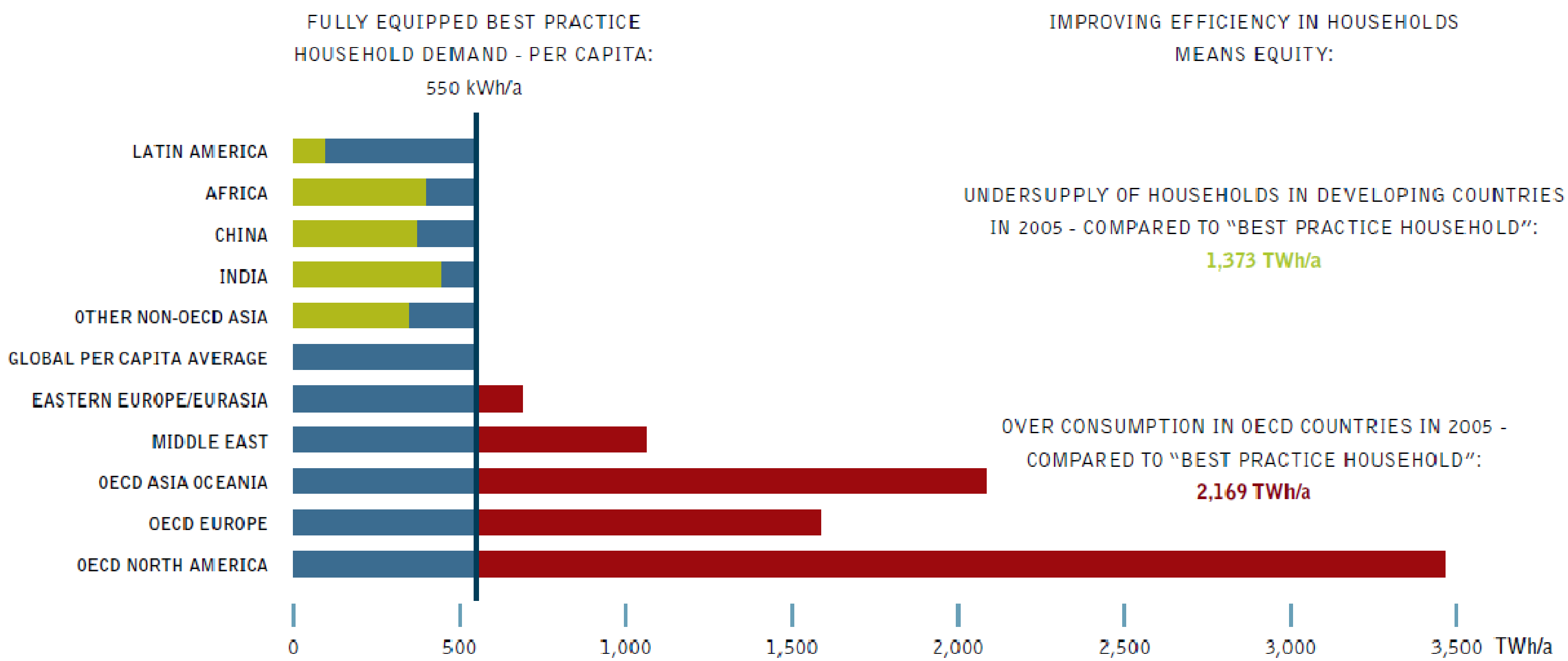
figure 10.20: electricity savings in households (energy [r]evolution versus reference) in 2050



note

BY 2050, STRICT ENERGY EFFICIENCY STANDARDS, WOULD MEAN ALL GLOBAL HOUSEHOLDS COULD SAVE OVER 4,000 TWH COMPARED TO THE REFERENCE SCENARIO. THIS WOULD TAKE OVER 570 COAL POWER PLANTS OFF THE GRID.

figure 10.19: efficiency in households - electricity demand per capita IN TWH/A



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Power Generation in the Energy [R]evolution Scenario:

Case: Flexible Power Generation in the EU 27

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EU 27 Power Supply:

2009: 19% Renewables

2020: 44% - 2030: 68%

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figure 5.5: electricity generation structure under the reference scenario and the energy [r]evolution scenario (INCLUDING ELECTRICITY FOR ELECTROMOBILITY, HEAT PUMPS AND HYDROGEN GENERATION)

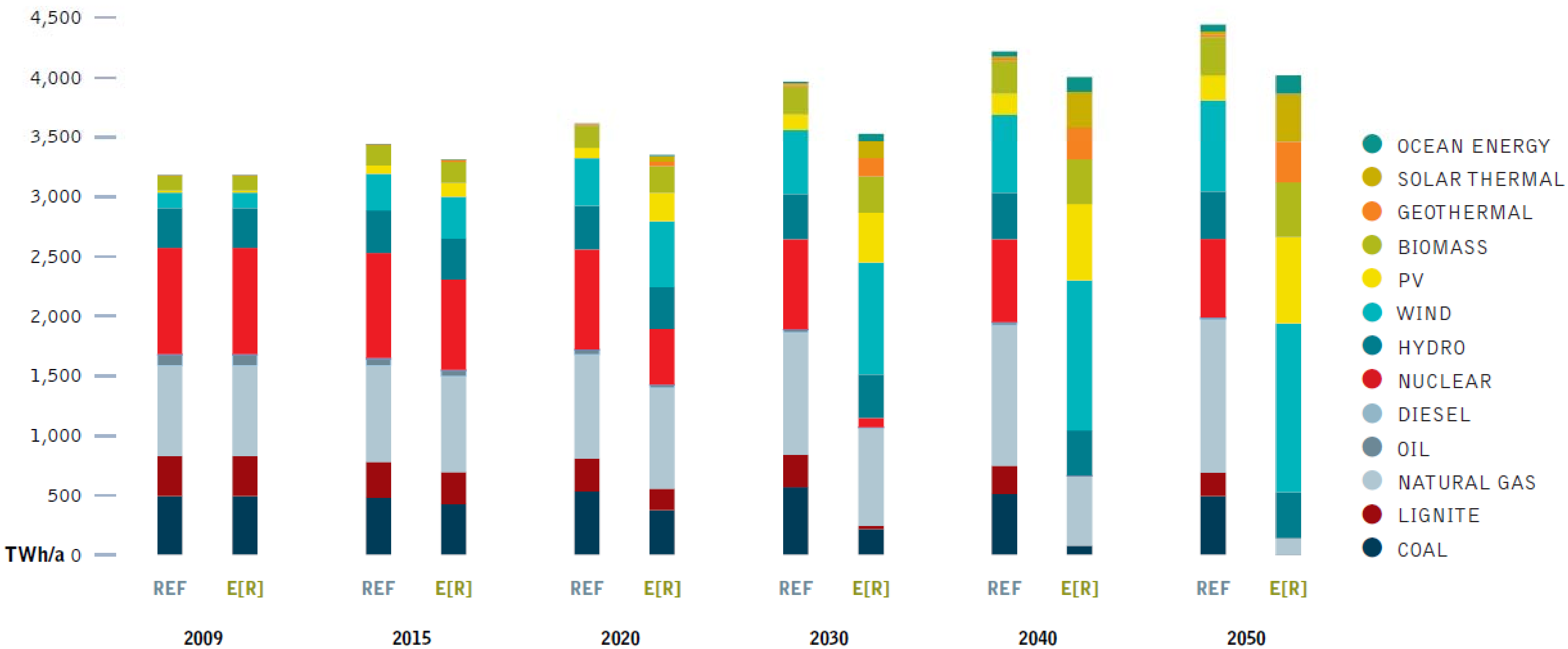

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table X.X: EU27: projection of renewable electricity generation capacity under the Reference and the Energy [R]evolution scenario

in GW

		2009	2020	2030	2040	2050
Hydro	REF	146	155	161	164	168
	E[R]	146	151	155	161	165
Biomass	REF	20	29	36	42	47
	E[R]	20	35	47	57	72
Wind	REF	75	189	243	275	298
	E[R]	75	246	368	458	492
Geothermal	REF	1	2	2	3	4
	E[R]	1	6	25	45	56
PV	REF	14	77	110	137	163
	E[R]	14	213	345	498	570
CSP	REF	0	2	4	5	6
	E[R]	0	11	31	62	81
Ocean	REF	0	0	2	11	16
	E[R]	0	3	18	36	44
Total	REF	256	455	558	636	702
	E[R]	256	666	989	1.316	1.480

Flexible Generation

Flexible Generation

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Power Supply Strategy in the Energy [R]evolution Scenario:

The End of Baseload Power Plants

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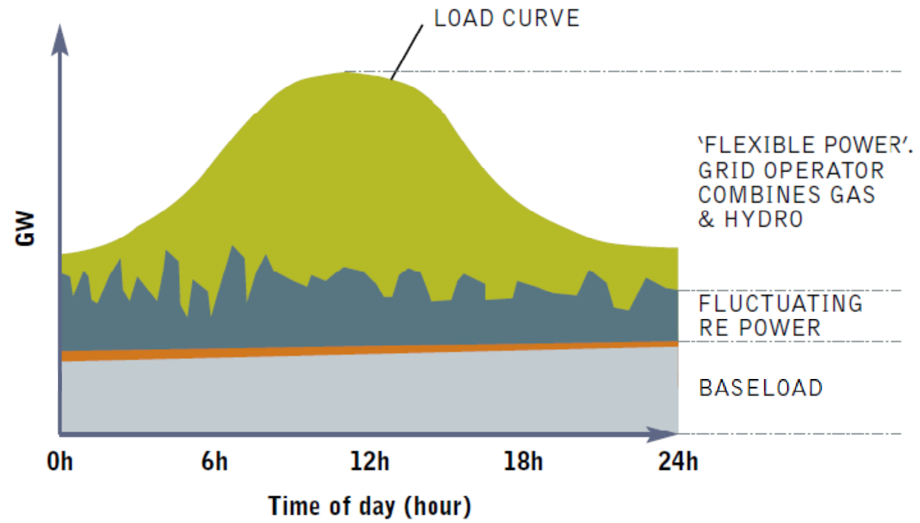
Current supply system

- Low shares of fluctuating renewable energy
- The 'base load' power is a solid bar at the bottom of the graph.
- Renewable energy forms a 'variable' layer because sun and wind levels changes throughout the day.
- Gas and hydro power which can be switched on and off in response to demand. This is sustainable using weather forecasting and clever grid management.
- With this arrangement there is room for about 25 percent variable renewable energy.

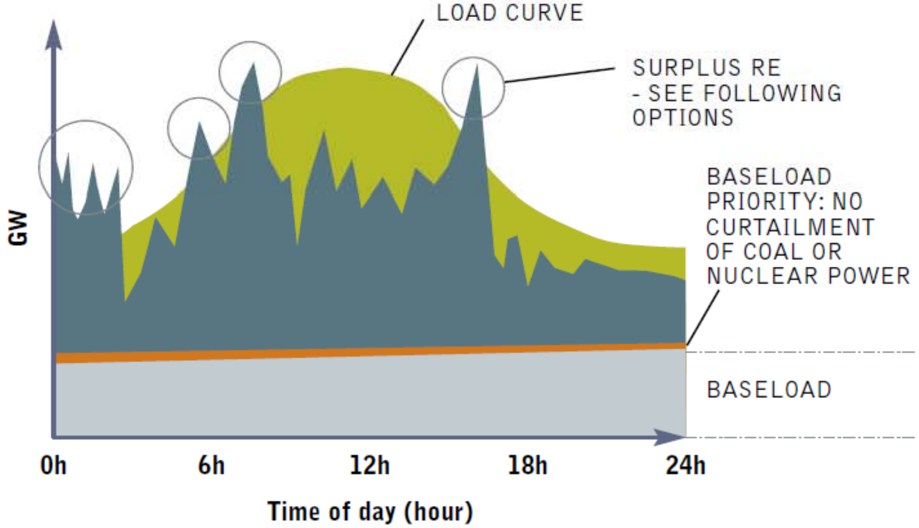
To combat climate change much more than 25 percent renewable electricity is needed.



Supply system with more than 25 percent fluctuating renewable energy > base load priority

- This approach adds renewable energy but gives priority to base load.
- As renewable energy supplies grow they will exceed the demand at some times of the day, creating surplus power.
- To a point, this can be overcome by storing power, moving power between areas, shifting demand during the day or shutting down the renewable generators at peak times.

Does not work when renewables exceed 50 percent of the mix, and can not provide renewable energy as 90- 100% of the mix.



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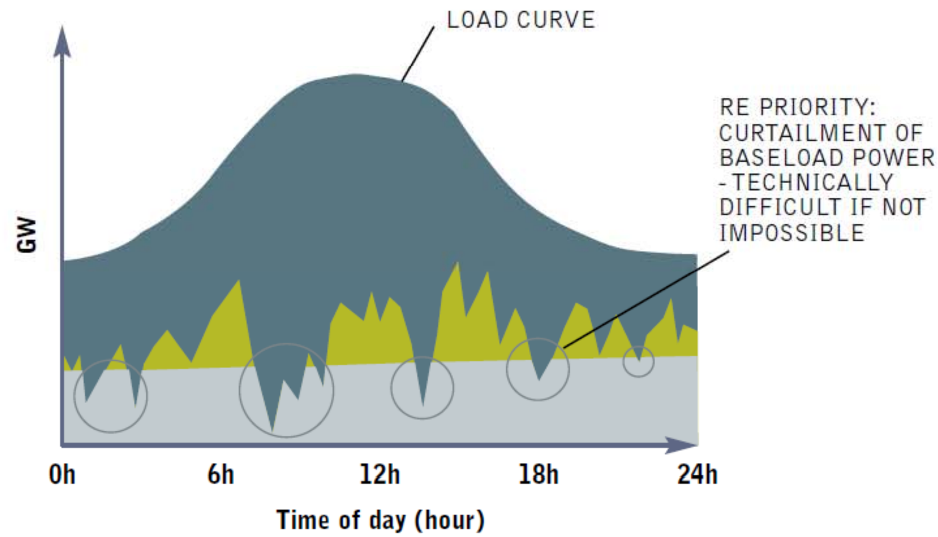
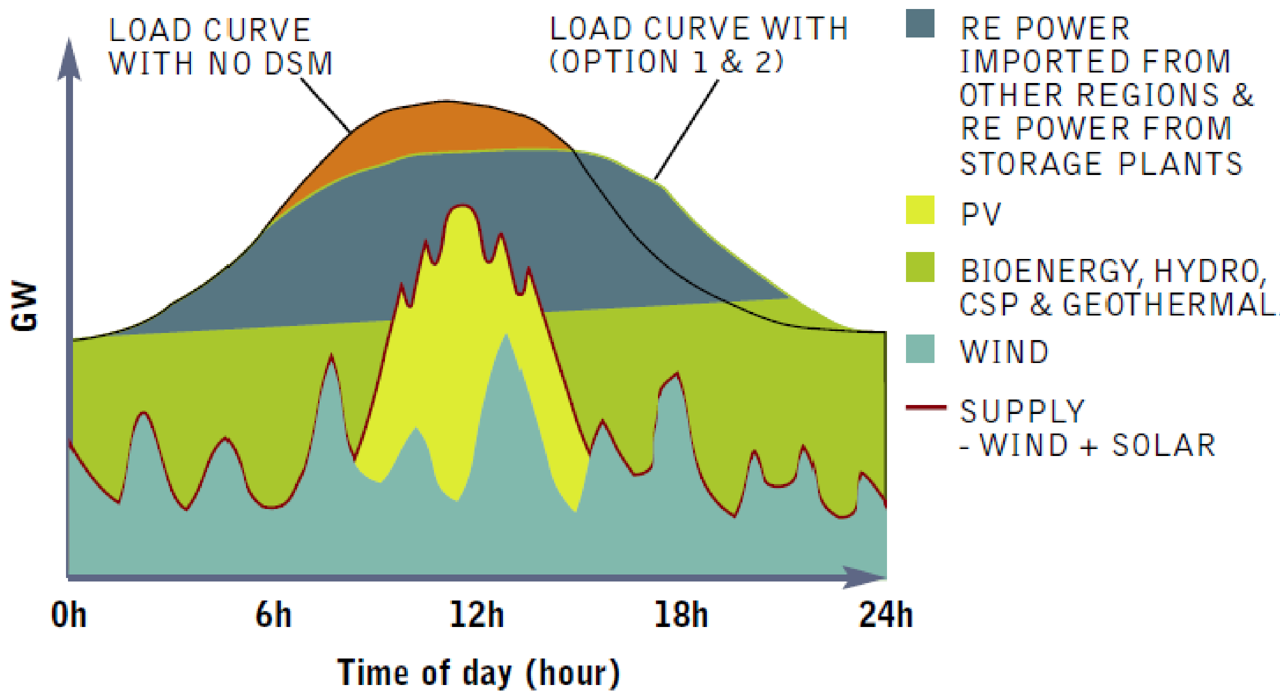
Supply system with more than 25 percent fluctuating renewable energy – renewable energy priority

- This approach adds renewables but gives priority to clean energy.
- If renewable energy is given priority to the grid, it "cuts into" the base load power.
- Theoretically, nuclear and coal need to run at reduced capacity or be entirely turned off in peak supply times (very sunny or windy).
- There are technical and safety limitations to the speed, scale and frequency of changes in power output for nuclear and coal-CCS plants.

Technically difficult, not a solution.





The solution: an optimised system with over 90% renewable energy supply

- A fully optimised grid, where 100 percent renewables operate with storage, transmission of electricity to other regions, demand management and curtailment only when required.
- Demand management effectively moves the highest peak and 'flattens out' the curve of electricity use over a day.

Works!

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Power Supply Strategy in the Energy [R]evolution Scenario:

Simulation of the EU power Grid

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Questions for the report „renewables 24/7“ Part 1 – extreme weather events:

-How often can we expect extreme events with a share of 50% solar pv and wind power generation

> High demand and low wind and/or solar power generation

> Low demand and high wind and/or solar power generation

- Recommendations for Grid improvements

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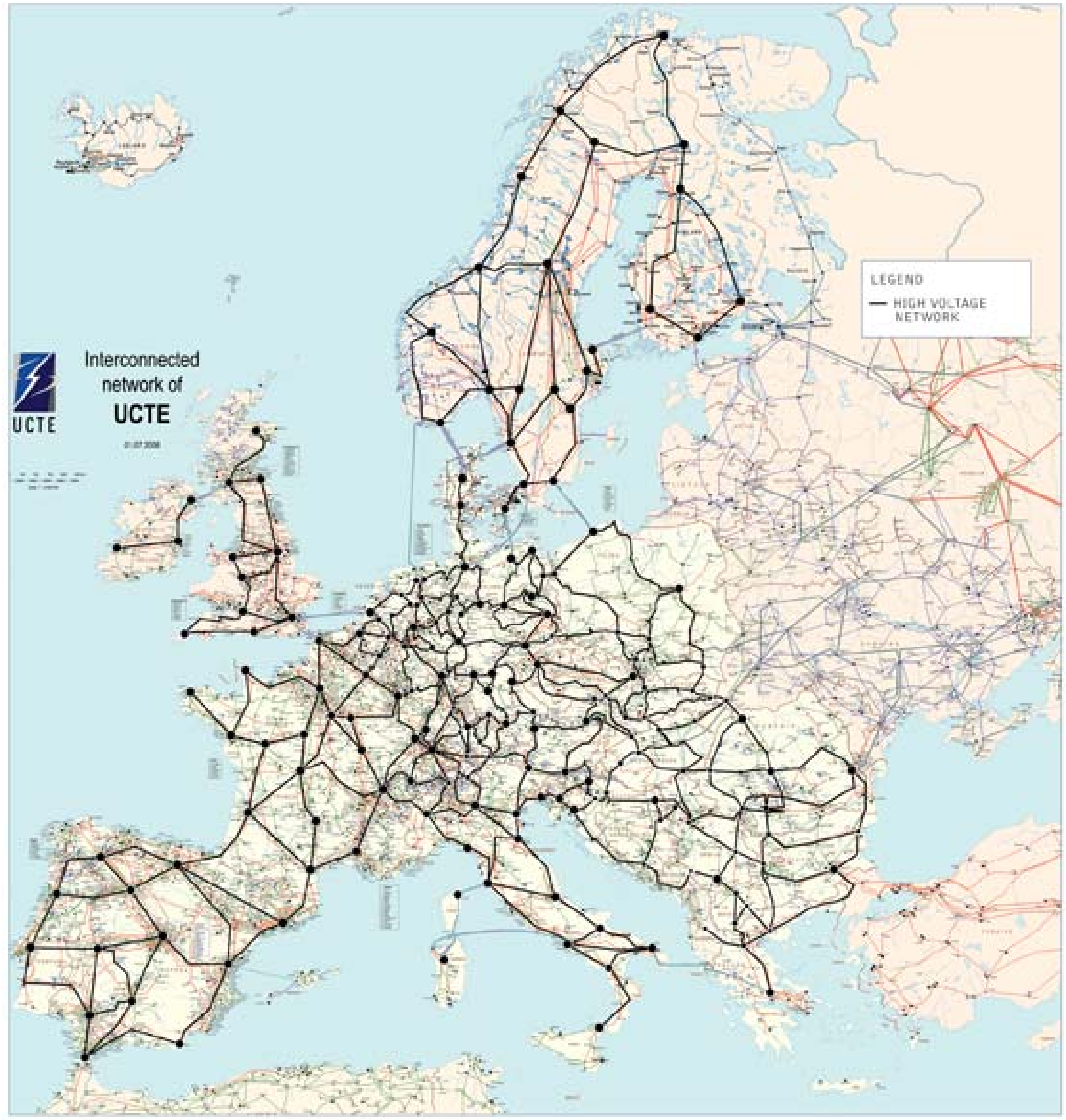
figure 23: **map of the high voltage network of europe with the overlaying simplification of the european power system**



source UCTE, NORDEL & ENERGYNAUTICS

Methodology:

Simulation of the European power grid with the Energy [R]evolution power generation mix during extreme events

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figure 33: **wind speed in the north sea during august 2003 (extreme summer event).**

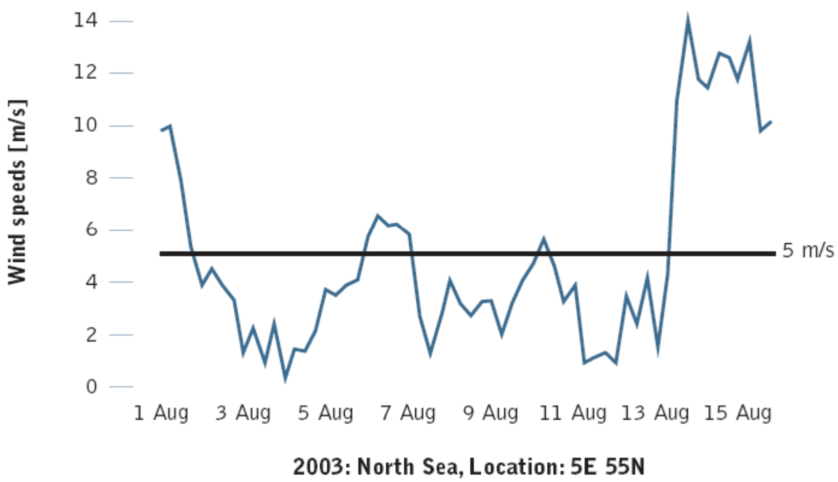
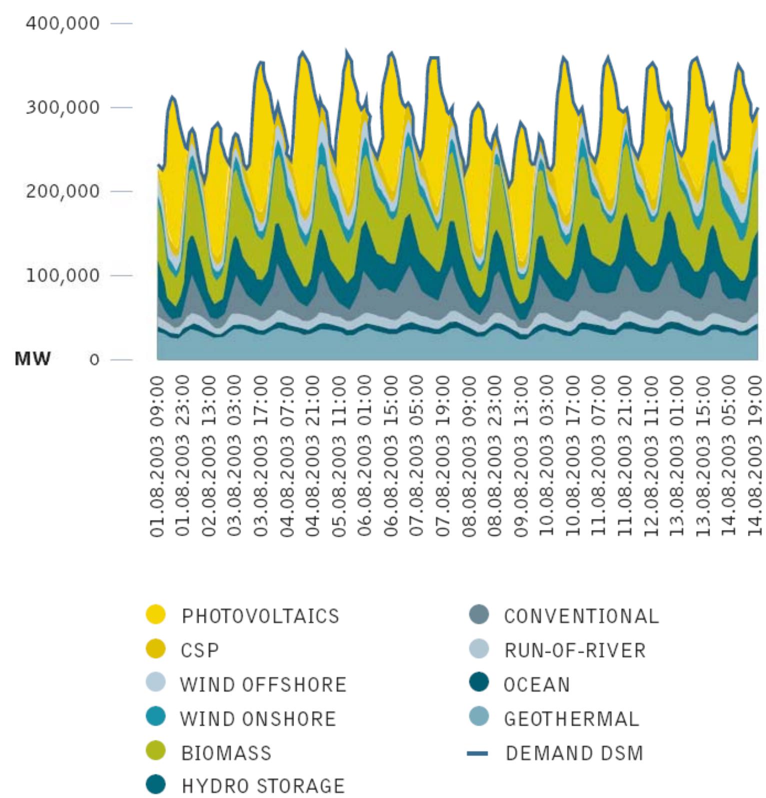


figure 36a: **power production (in MW) from different sources and overall demand in europe during extreme august event.**



No problem, as solar photovoltaic power can fill in
– grid expansion not needed

figure 32: available wind power (in GW) according to energy [r]evolution scenario in january 1997 compared to 30 years average. (6 hour values)

figure 30: available solar PV power (in GW) according to Energy [R]evolution scenario in january 1997 compared to 5 years average. (1 hour values)

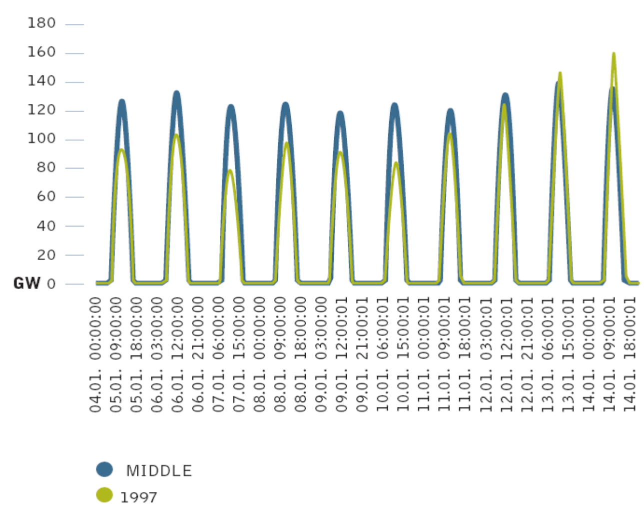
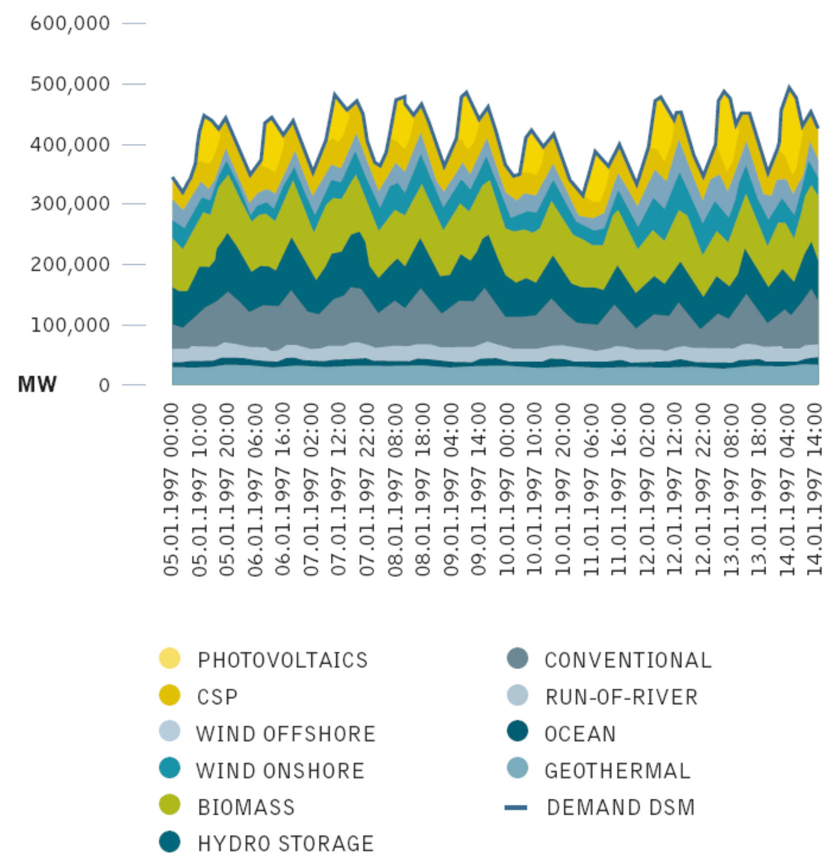


figure 35: power production (in MW) from different sources and overall demand in Europe during extreme January event.



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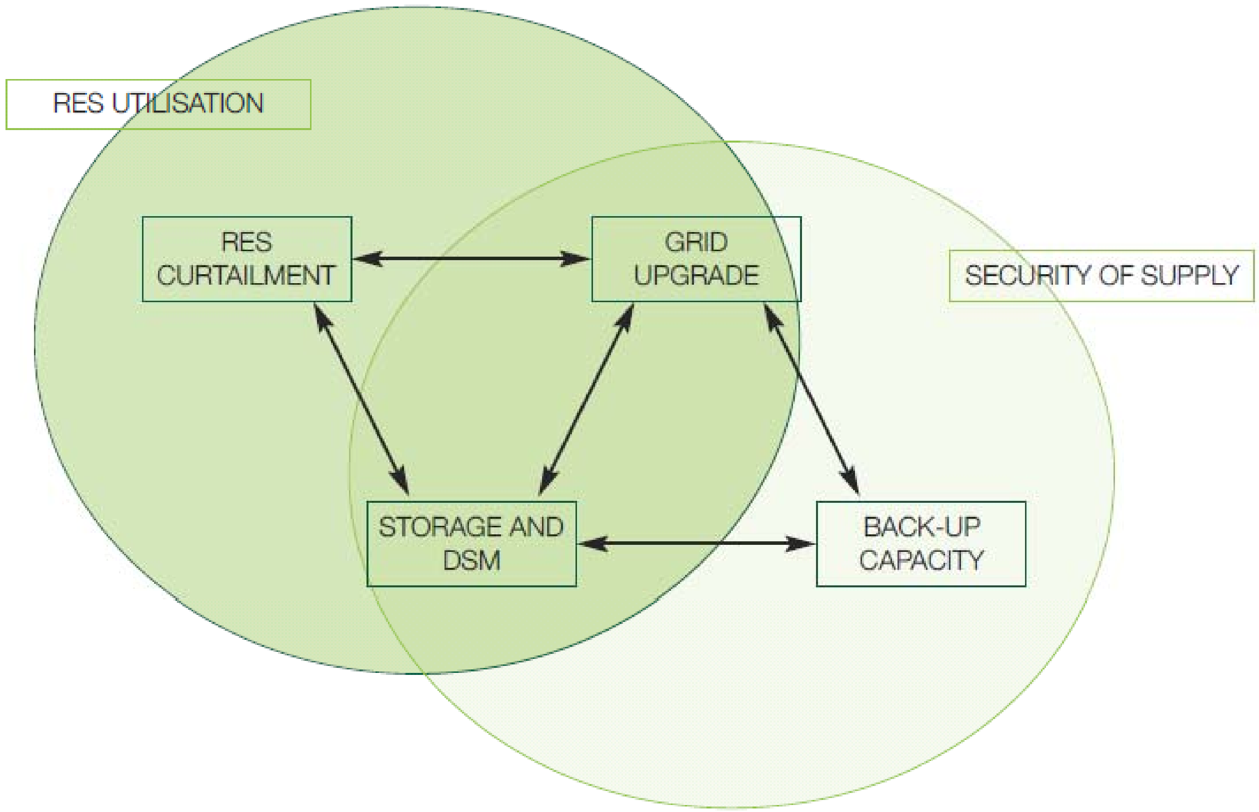
RES UTILISATION
RES CURTAILMENT
GRID UPGRADE
SECURITY OF SUPPLY
STORAGE AND DSM
BACK-UP CAPACITY

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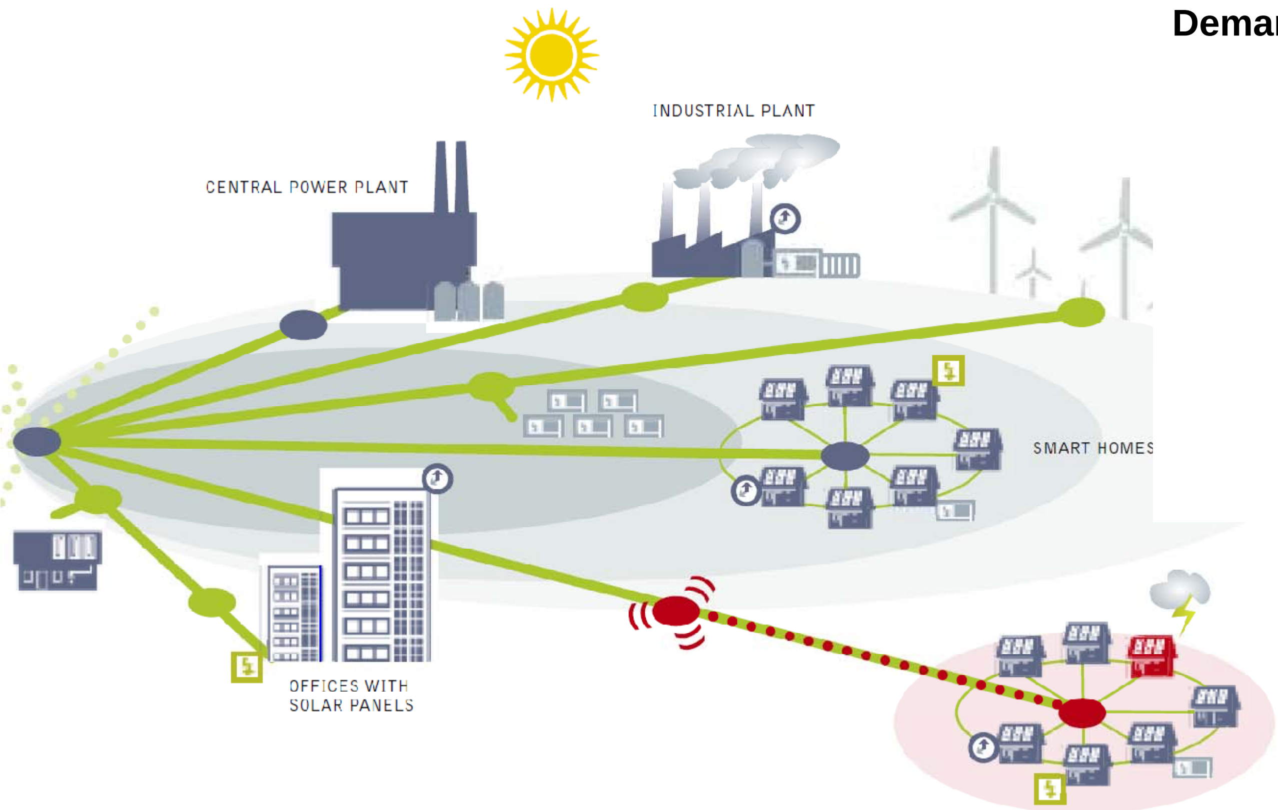
Options and measures to balance power grids with increasing shares of variable renewables

A VISION FOR THE FUTURE – A NETWORK OF INTEGRATED MICROGRIDS THAT CAN MONITOR AND HEAL ITSELF.



Examples for

Demand Side Management Options:

- Heating with e.g. heat pumps
- Air Conditions
- Cooling Applications
- Large Food Storage Buildings
- Water Pumping (utilities)
- Industry Processes
-

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Climate Infrastructure: 5 Steps towards the Energy [R]evolution:

Step 1: Priority for renewables in the European grid to reduce losses

Step 2: Demand side management and smart grids to reduce further grid expansion

Step 3: Reduce bottle necks via additional lines (offshore – onshore connection)

Step 4: More lines to deliver renewable electricity where it is needed (long distance)

Step 5: Adding storage capacity to the system (2030 – 2050)

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Thank you very much!

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sven.teske@greenpeace.org

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