

Photovoltaic in Germany 2011

Presentation held at E-World 2011

Dear Reader,

The presentation you have obtained is an extract of a presentation that **Hugo Birkelund** with Mkonline.com during E-World 2011.

Please be advised to run it in presentation mode for best view.

Note that we have withheld the parts of the presentation linked to our price simulations. I regret the incomplete picture this may leave. However, if you have questions to this in particular or other parts of the attached presentation please feel free to contact me. Feedback is always appreciated!

Hugo.Birkelund@mkonline.com ; Phone: 0047 9187 7970

Photovoltaic on MKonline

Started Mid August 2010

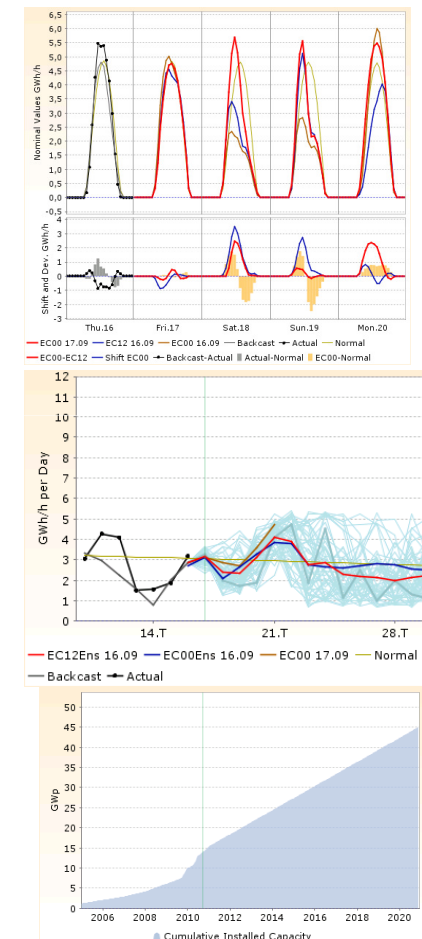
Delivered on MKonline

- 4 forecasts each day, Live updated
- Monitors data, Actuals, Capacity, Technology
- Backcast for modeling purposes (1.Jan 2005 and on)
- Normals
- Future capacity exceptions
- Consistent Load paths (Cons – Wnd –RoR – SPV)

Areas covered

- All relevant countries in Europe
- Aug. DE Germany and it's 4 TSO's
- Oct FR, CH, AT, IT, NL, BE, GR CZ
- Dec SP and PT
- Aim: Complete numeric description,
 - Forecast short term, Det and Ens
 - Expected, meaning, 30 weather years and future capacity

By definition **photovoltaic** is the conversion of sun light into electricity. The basic element is the solar cells where direct current electricity is generated. Solar cells are connected together in a frame to form a photovoltaic module.



The MKonline SPV model

Predominately physical model based on:

- Physical properties of the installed technology (different types),
- calibrated to local conditions and
- parameter optimized to fit available information for individual areas

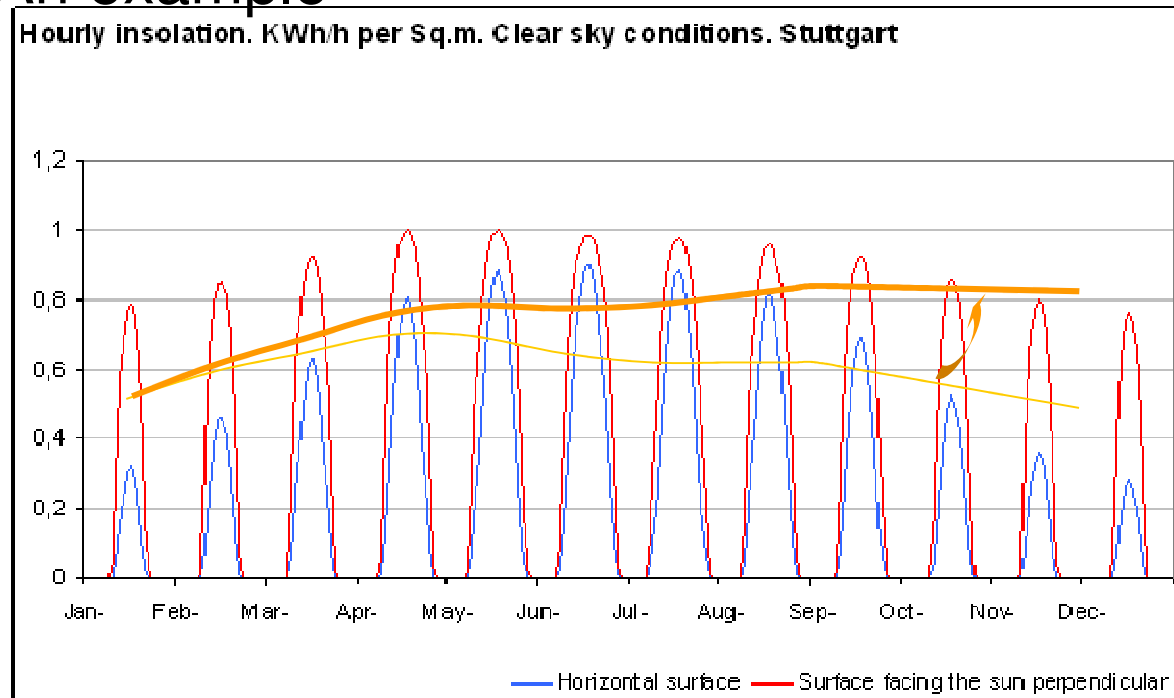
Input ranges from:

- Sun height/angle and Earth's distance to sun at any given time
- Local atmospheric conditions, density/pollution, climate, at any given time,
- Capacity, "Technology in time and space"; Simpler put
 - **how much** of each technology type,
 - **when** is it installed, (2005 – 2020), and
 - **where** is it installed (spatial distribution)
- Weather, calculating the time and spatial distribution of
 - beam radiation and
 - diffuse radiation
 - Temp and wind (cooling of the panels)
- Keep track of depreciation, by year and technology

It proved harder to put up the model than initial anticipated.

Most important the highly spatial distribution of the units, different technologies employed, and rapid expansion of capacity moving at different development phase.

Insolation, profile over a year, An example



Curve tilted upward, due to new installed cap
Net result has to be simulated

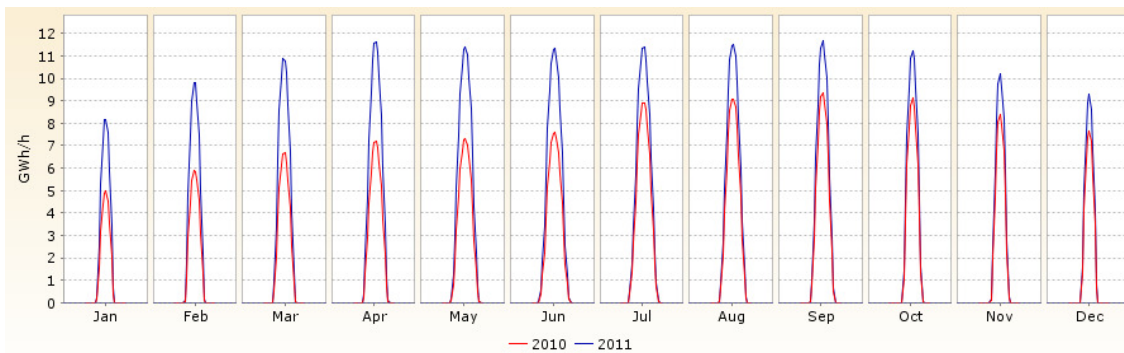
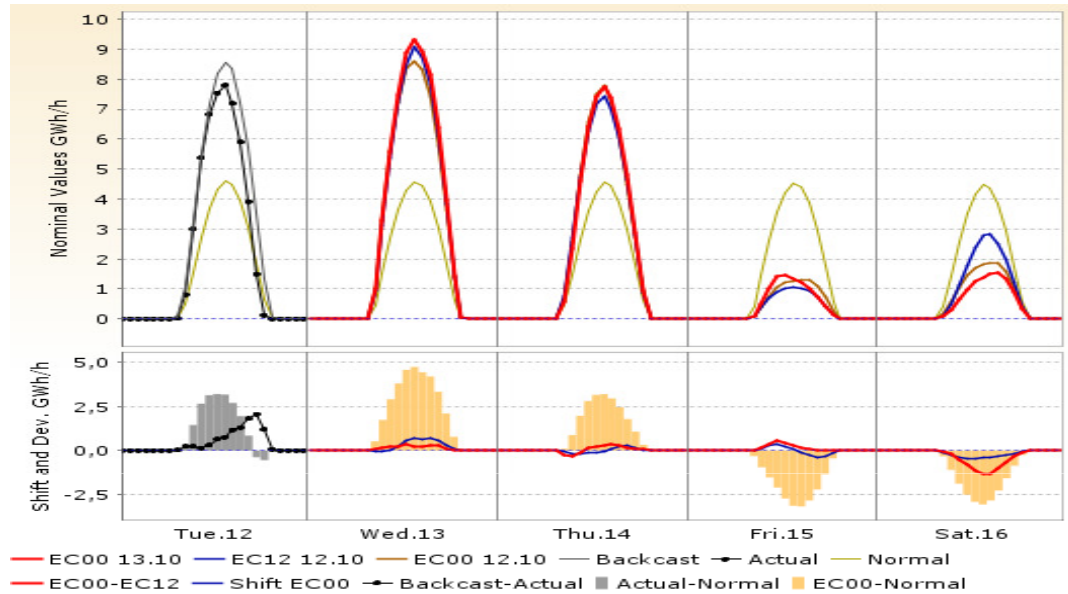
Horizontal surface,
Min Dec 22.th
Max June, 23.de.

Optimal surface
-2D adjustable
Max April/May
Min Dec

Start lower than if all capacity was optimal
Max in April/May
Decreases as
Sun height rises and
Atmospheric conditions deteriorate
Increases as Sun height decreases,
Result: a two topped curve

Technology mix,
- Roof top Fixed
-1 D adjusting
-2 D adjusting

SPV, what does it look like?



Market player said...
"SPV in DE represent one Nuclear block"

Energy wise, not far off.
 Load wise, far off

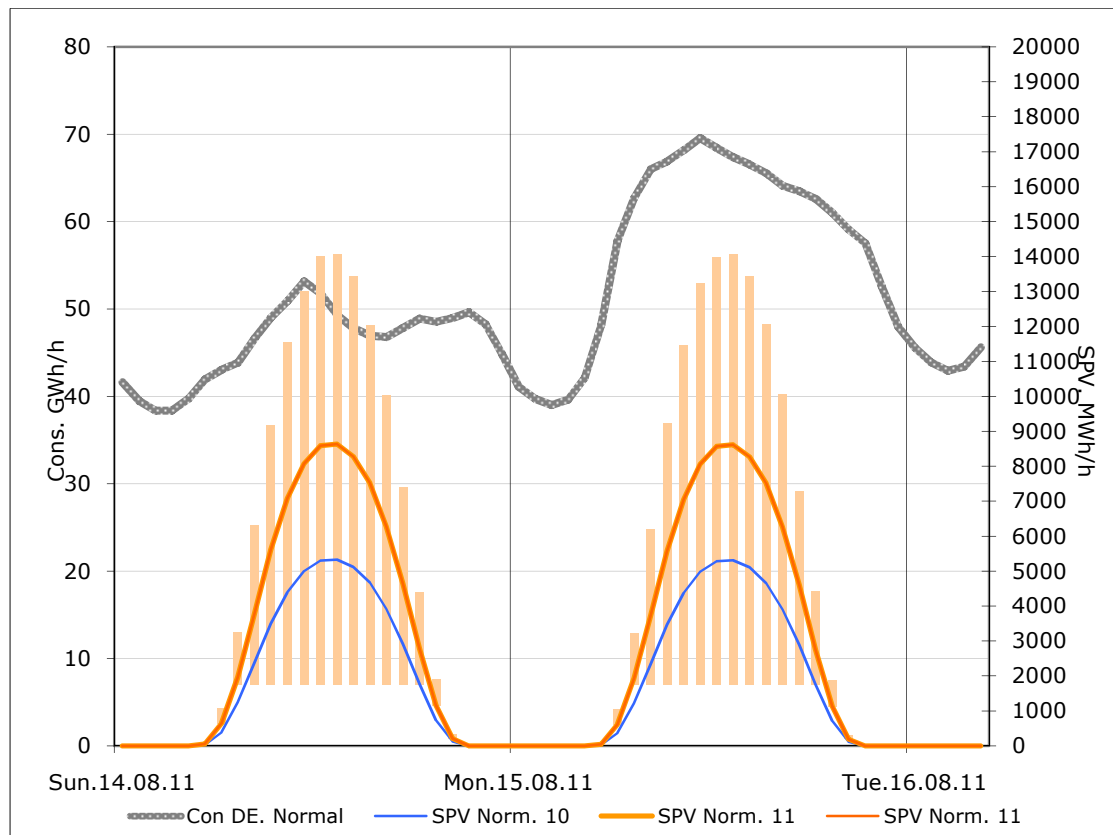
Energy Normal (Avg 30 weather years)
 2010 11 TWh
 2012 15 TWh

Compared to clear sky conditions,
 Halves of the energy is lost by cloud coverage

SPV compared to consumption Over a Day

Extreeme variation*

- During a day, from 0 to max 13.000+
- Between days, from 1500 to 11.000+

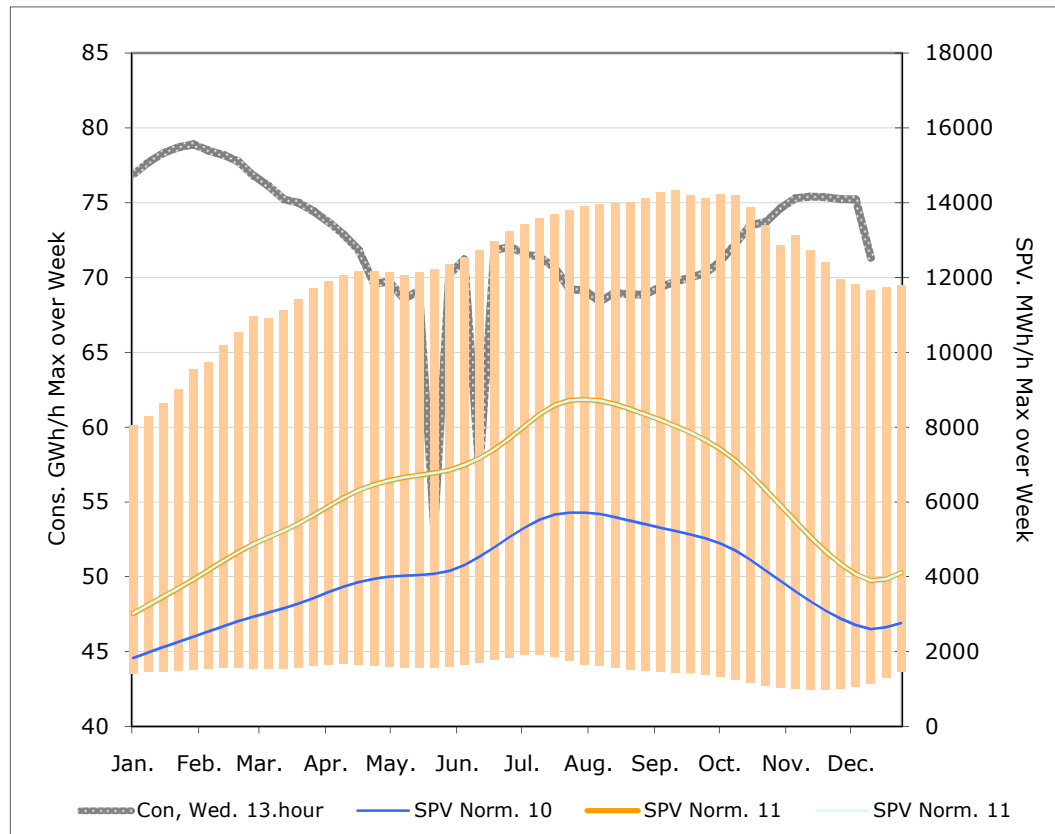


- 3000+ MWp installed 2011
- Yield 1900+ MWh/h
- Peak prod could reach above 11.000+ MWh/h

NOTE Data and graphs for illustrative purpose only. Data will changes as info arrives. But levels are not far off.

SPV compared to consumption Over a Year

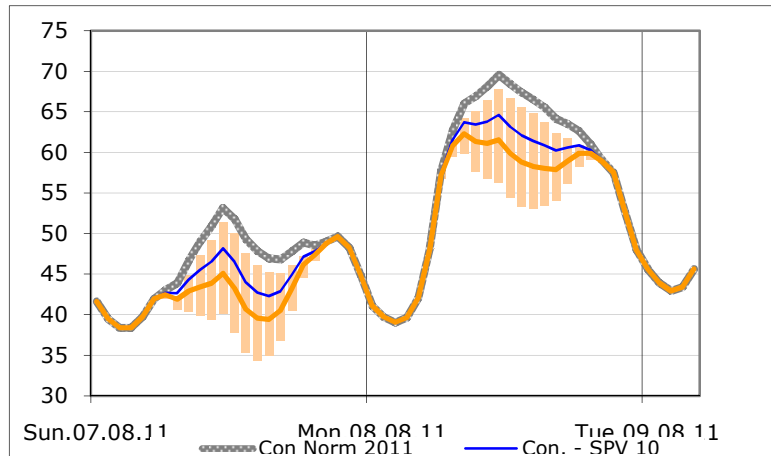
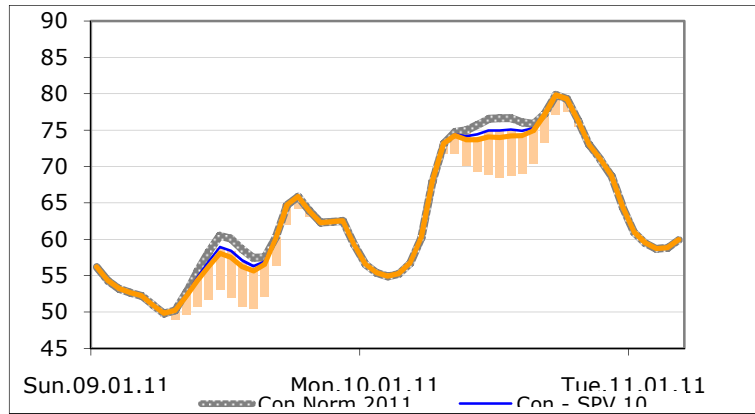
This graph shows normal consumption and SPV in DE during 2011 at 13 hour



Note:

- Large shift in expected SPV from 2010 to 2011
Clear sky, the max, is represented by the top of the bars....

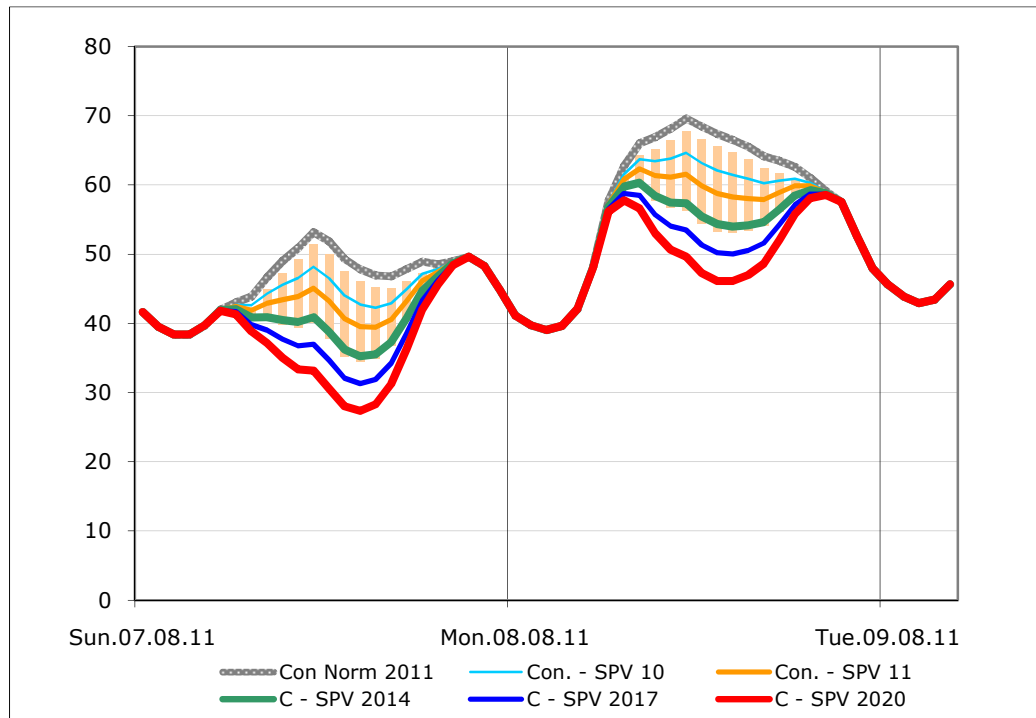
Shift in Price dependent production Summer day in 2011



A longer view on the profile

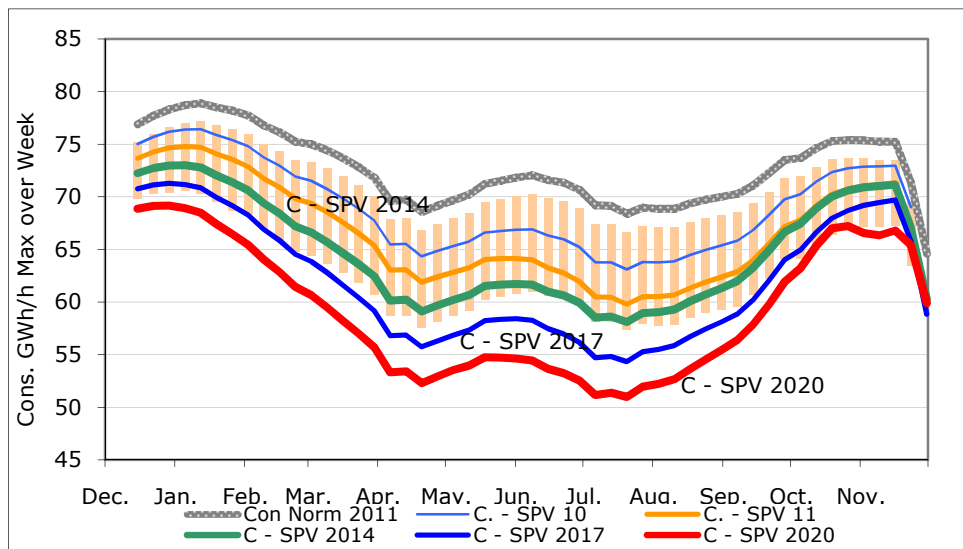
What if SPV Capacity growth continues at e.g. 3000MWp / Year?

A simple illustration, Comparing the 2011 consumption normal at 13 hour to future SPV normals, Con – SPV...

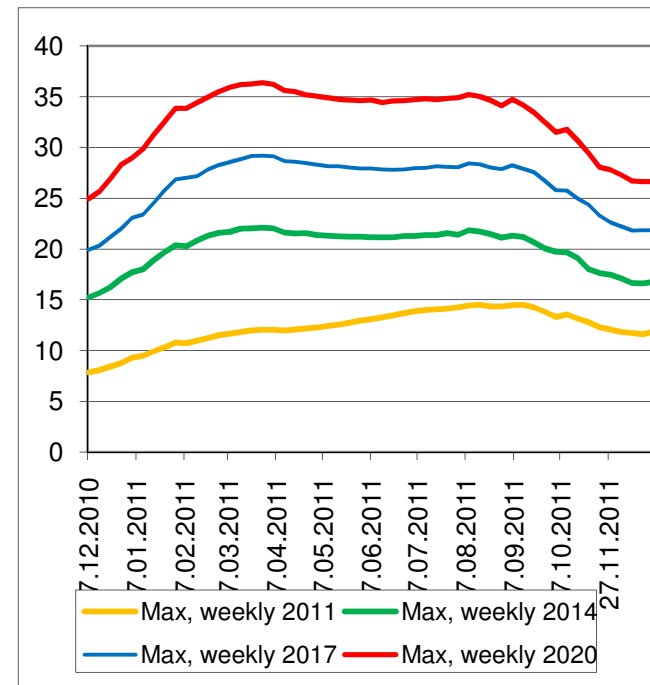


Shift in Price dependent production Over a Year, 2011

Comparing the normal consumption at 13h (2011)
to SPV Normals for 2011, 2014, 2017 and 2020



Clear Sky Output at noon
2011, 2014, 2017 and 2020
assuming 3000 MWp Yearly G.



Some Conclusion 1

- **Cap. growth outpaces our expectations**
Resembles the early days of WindPower 1999 and on..
- **Profound effect on production stack**
but only for some few hours
- **Highly volatile**, 2 to 14GWh/h Day-on-Day change.
- **Contributes to weather driven uncertainty**
Complex connection, Con – Wind – SPV - RoR

Withheld slides

MKonline has simulated the price effect of SPV during 2011, with relevant capacity growth and 30 Weather years as input. The results are quite striking and highly relevant for the FWD market. These slides are not included in this free version of the presentation.

For more info please contact

Hugo.Birkelund@mkonline.com

Pho: 0047 9187 7970