Grid parity in Israel
Initial study

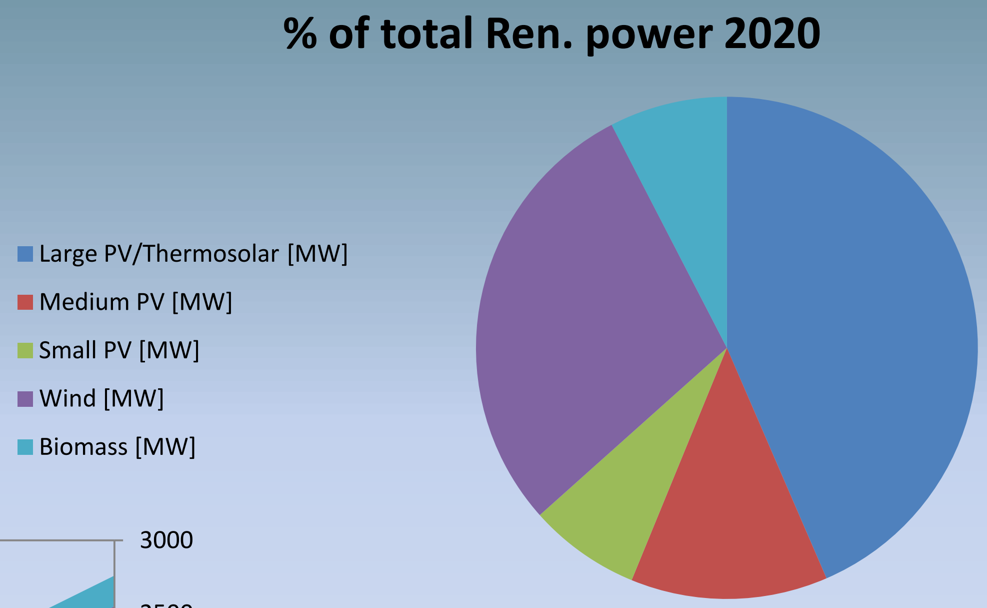
Hanan Einav Levy
Faculty of Aero-Space engineering, Technion institute of technology,
Haifa 32000,Israel, Israel

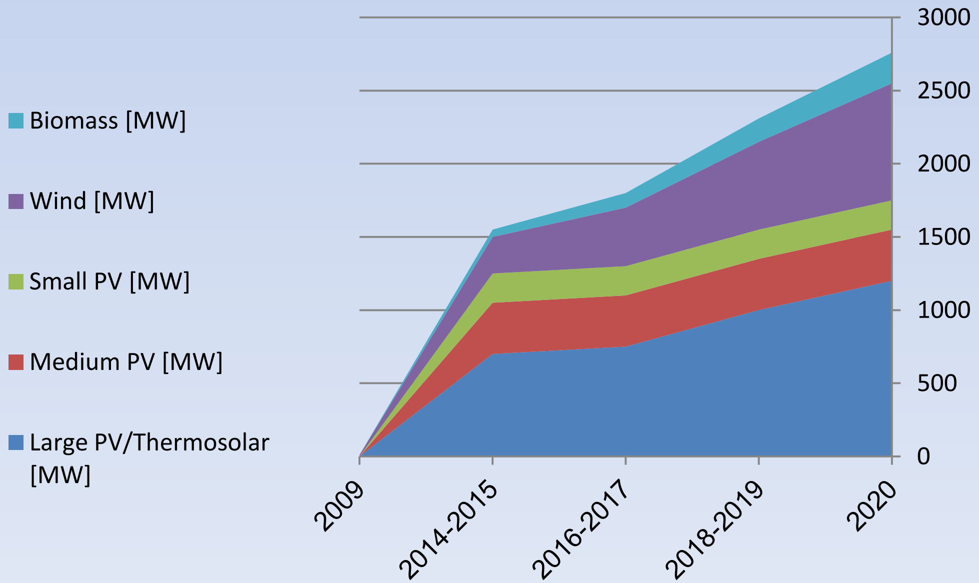
Yoel Cohen
Chief Scientist Office, Ministry of Energy and Water Resources, Israel

Outline

- Current road map implementation in Israel
- Current status and market cost at Israel
- Additional considerations for large scale implementation of grid parity renewable energies
  - Matching to demand profile
  - Land resources
  - Stability of supply and CC
- Summary

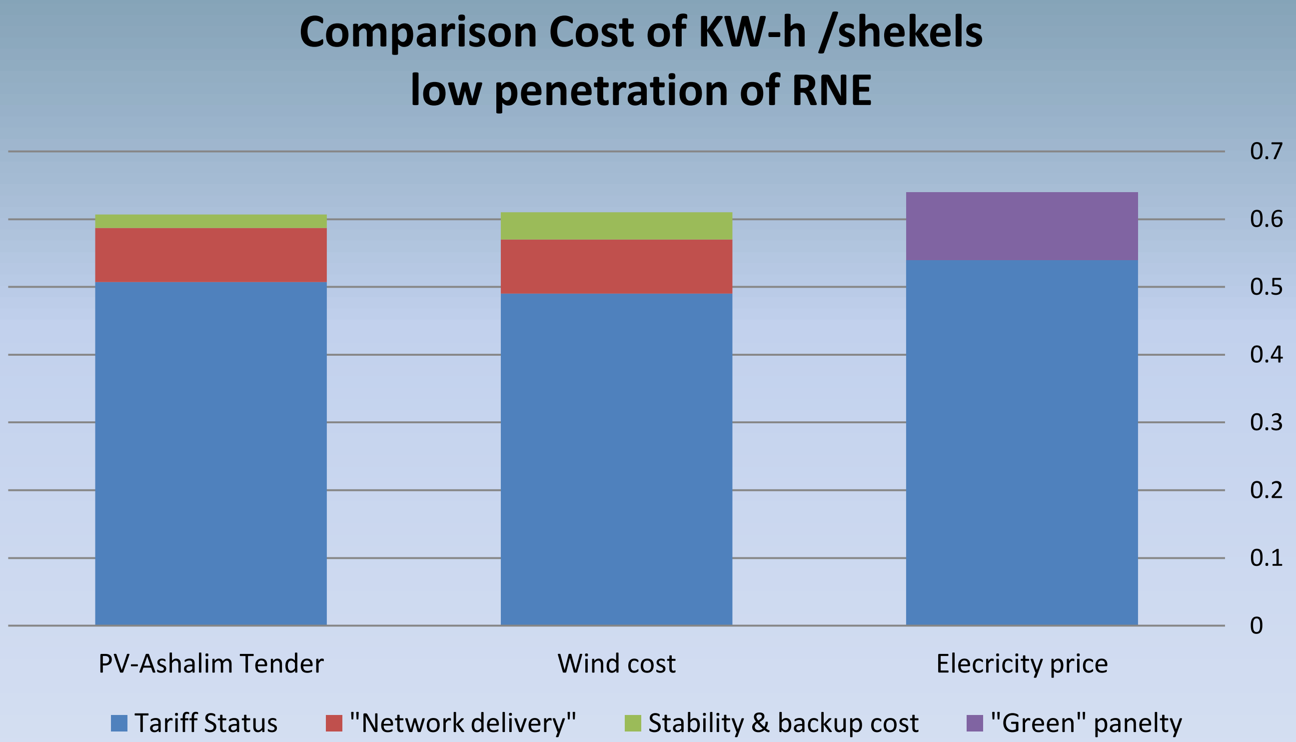
Current road map



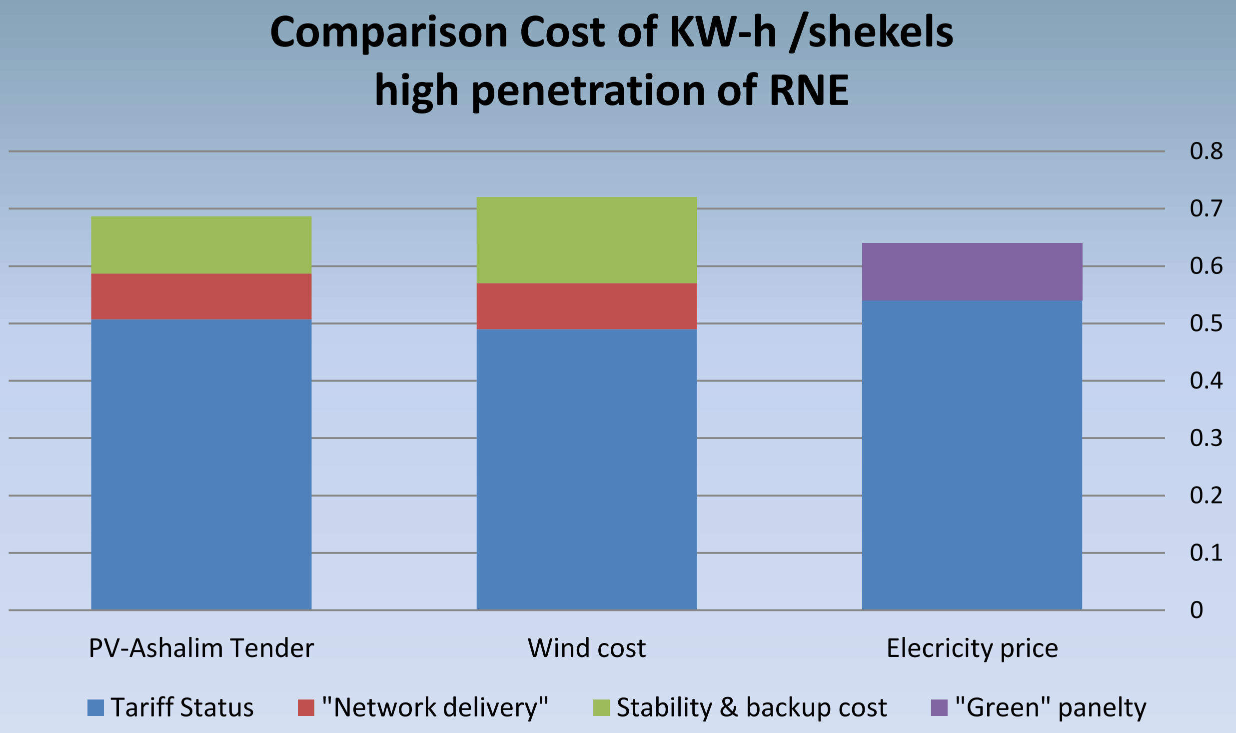


Price status PV and wind

low penetration levels – no special stability and backup compensation needs



Price status PV and wind

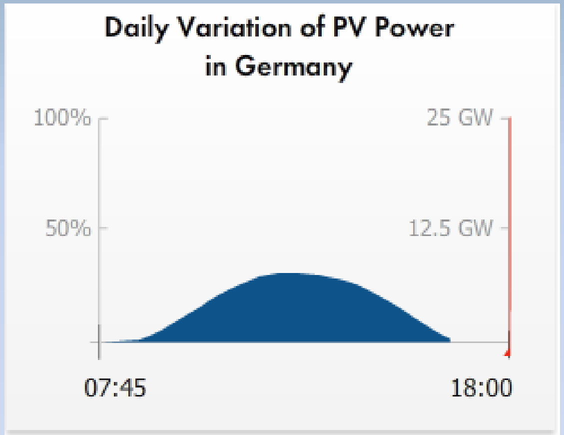


Conclusions and Remarks

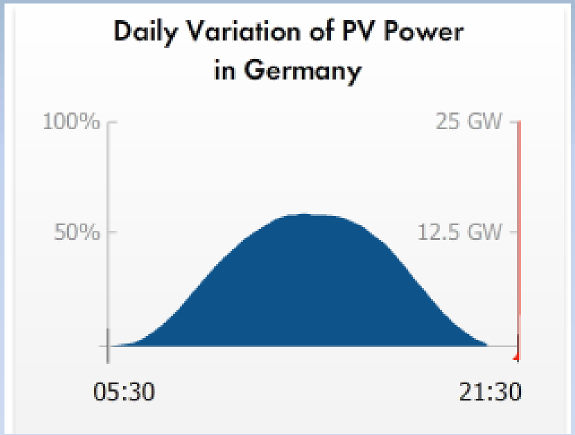
- Without need for stabilization and backup PV and wind have better cost
- In small penetration levels this issue is negligible
- In large penetration levels of these variable resources there is a need to verify the stability of supply:
  - Wind
  - PV
  - Wind & PV combined
  - Per season and peak of demand

Issue # 1: Is there a need for short term compensation of wind and PV?

Winter cloudy day



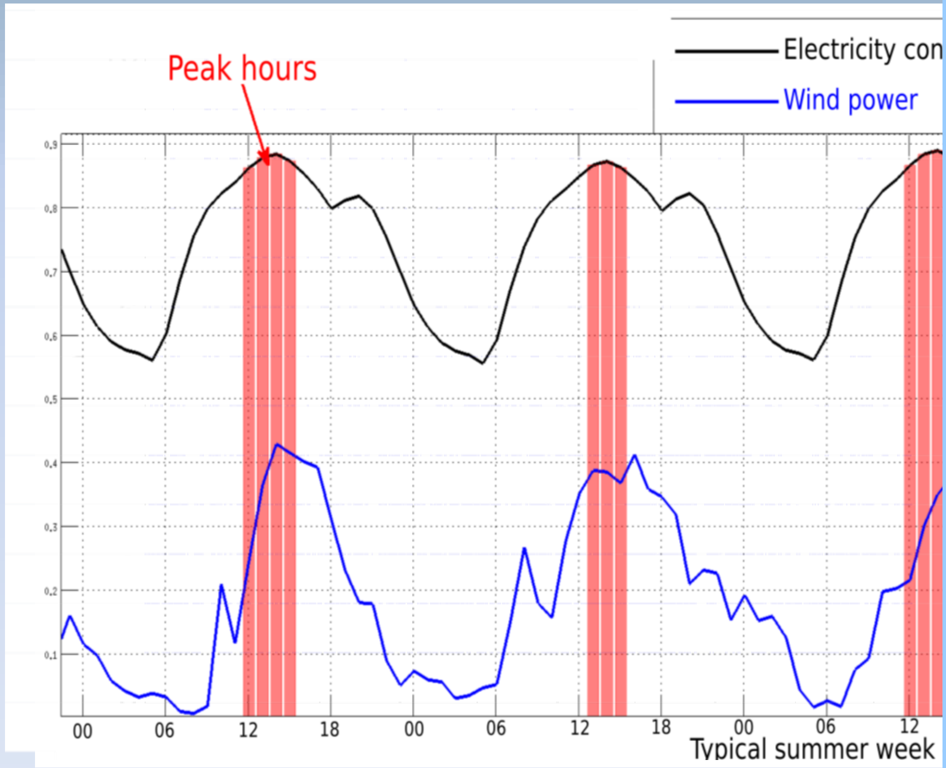
Sunny day



- The energy generation function is smooth in all cases
- The size is large
- The geographical spread is wide

Issue # 2:
Need for compensation of RNE at the peak hours

Example wind farm:
Installed capacity – 10 Mw



$$CC = \frac{\bar{P}_{peak\ period}}{P_{rated}} = \frac{3\,Mw}{10\,Mw}$$

$$example : CC = 30\,\%$$

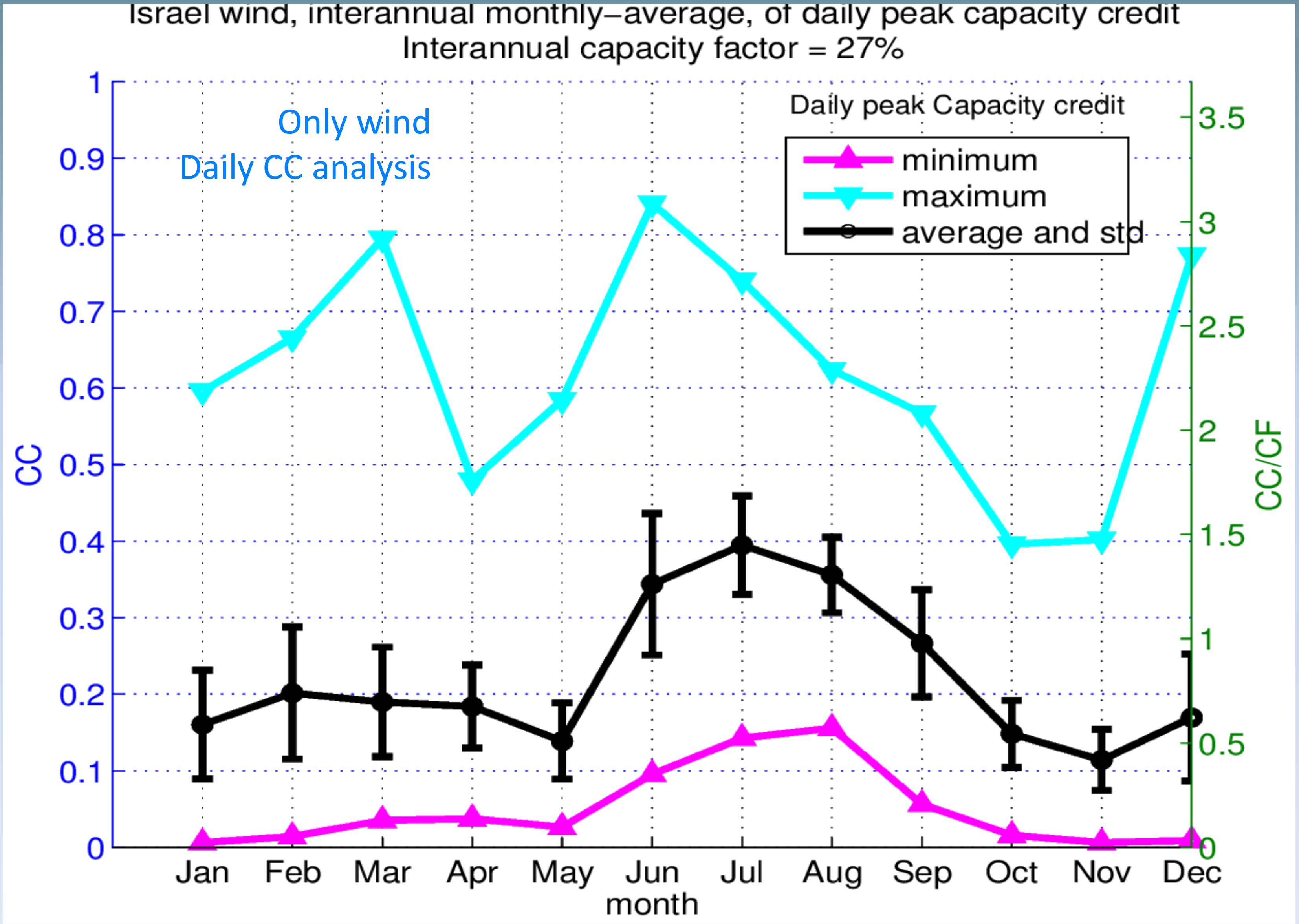
Capacity credit is dependent on:

- Capacity factor
- **Correlation between electricity consumption and wind energy**

Introducing the final metric - **CC/CF**

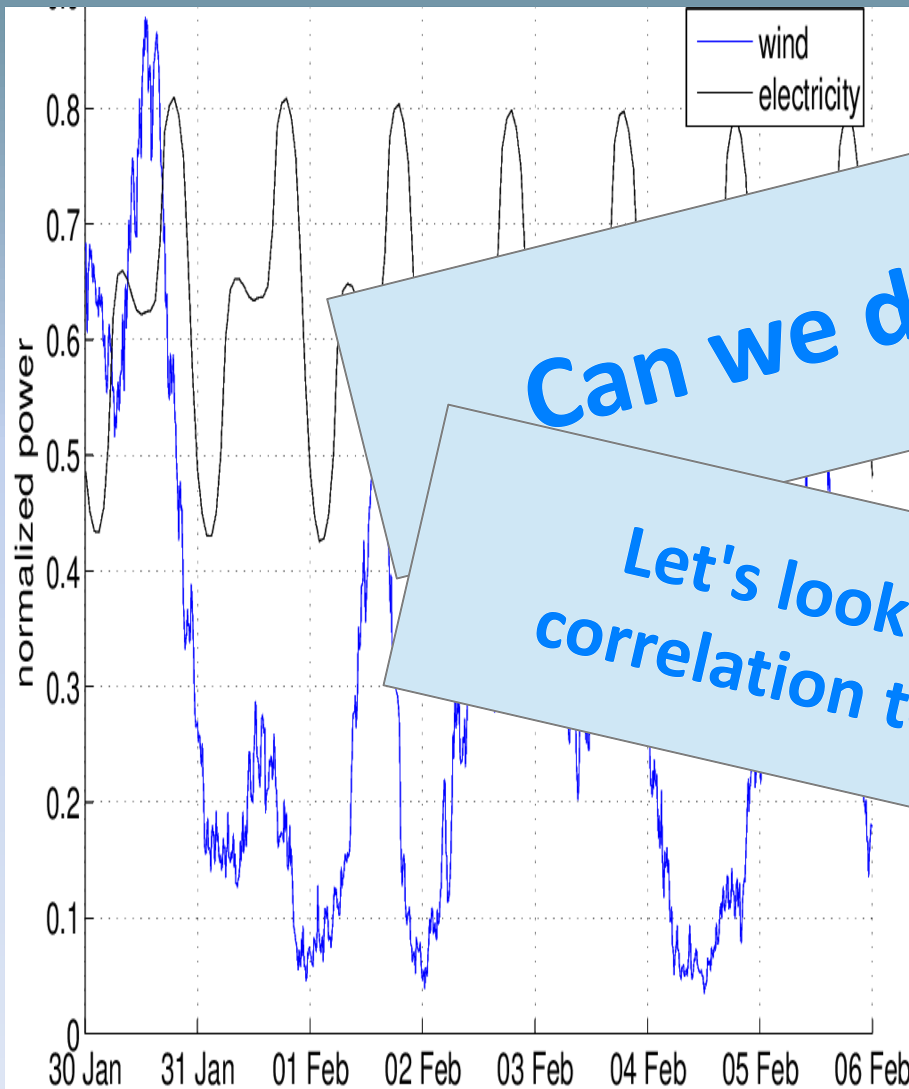
- The simulations presented are based on low height wind measurements
- Therefore – instead of looking at the CC and the CF, it makes more sense to look at the ratio – CC/CF
- This ratio shows “how well the wind-electricity produced fits the electricity-consumption trend”
- Less sensitive to actual simulated CF
- CC/CF = 0 --> no correlation (all wind blows at night for example)
- CC/CF >> 1 --> perfect correlation

Monthly variation of daily peak CC

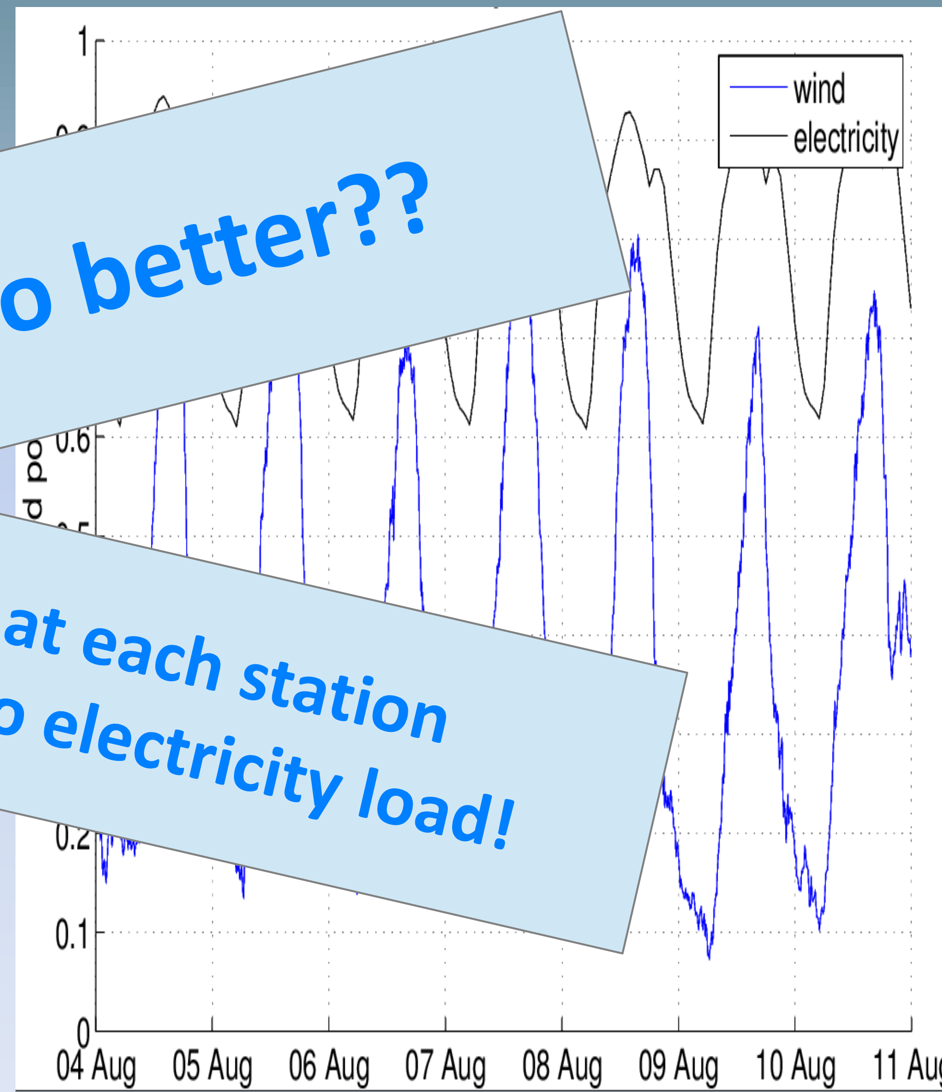


Taking these 26 stations together

Winter



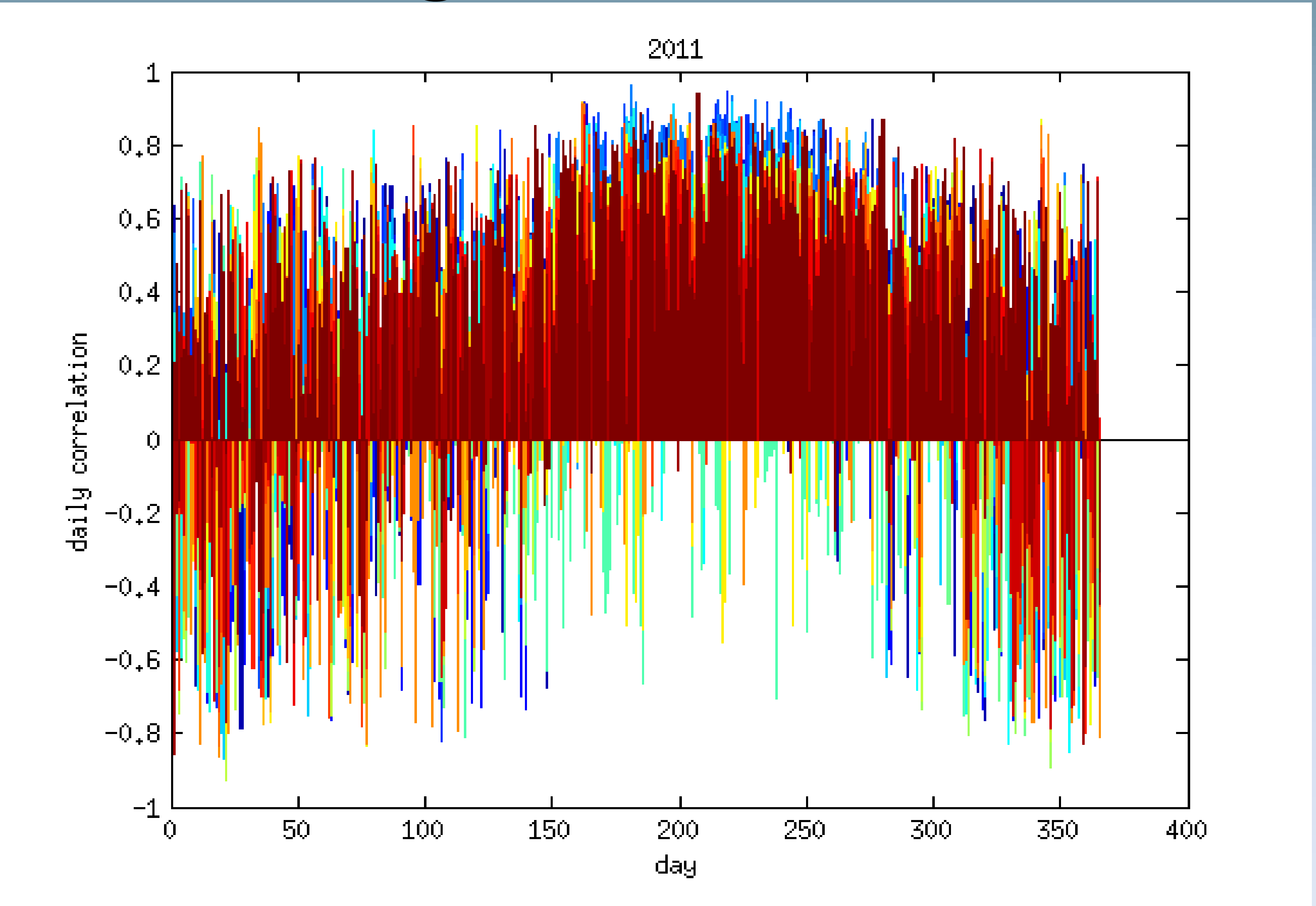
Summer



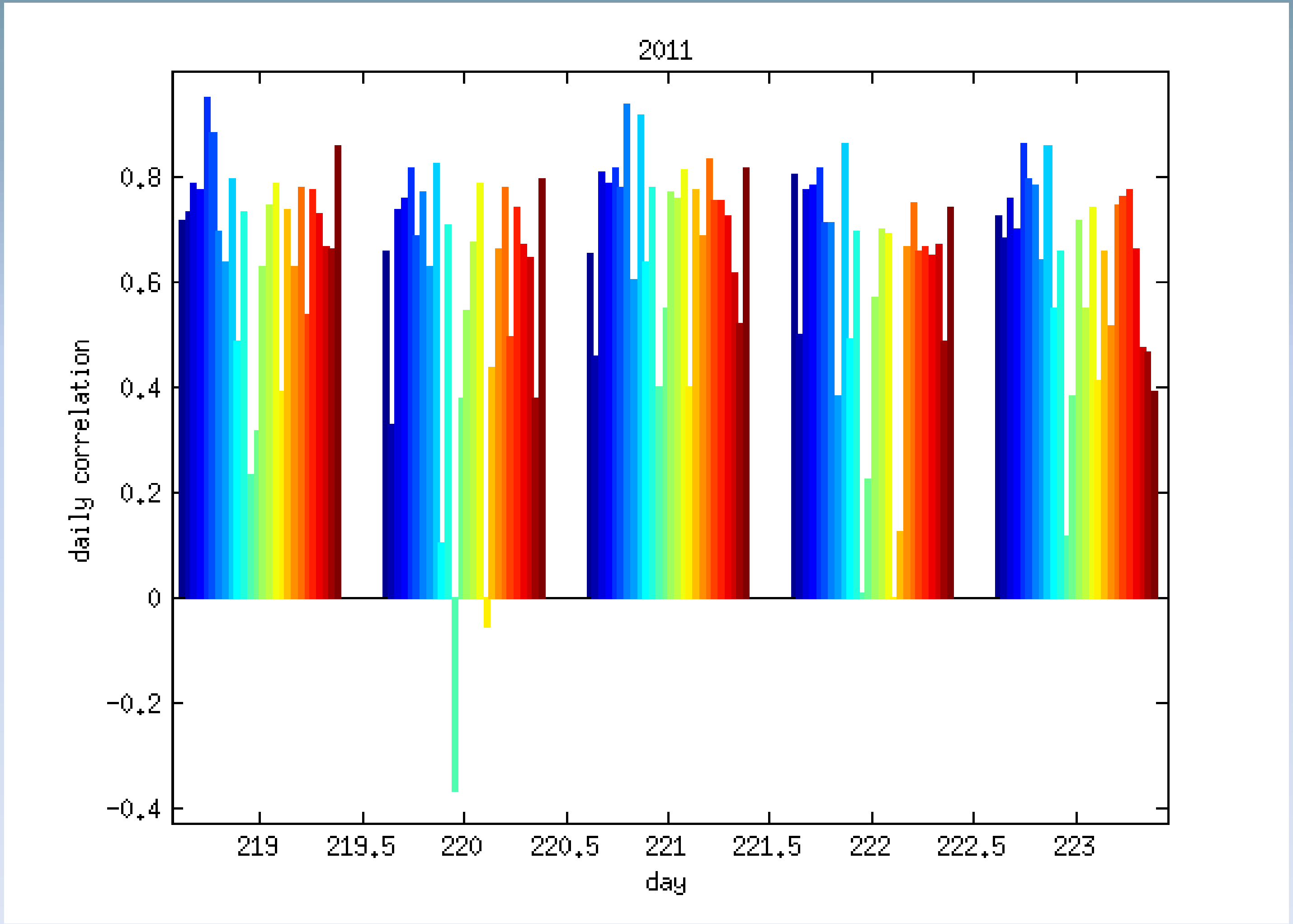
Can we do better??

Let's look at each station correlation to electricity load!

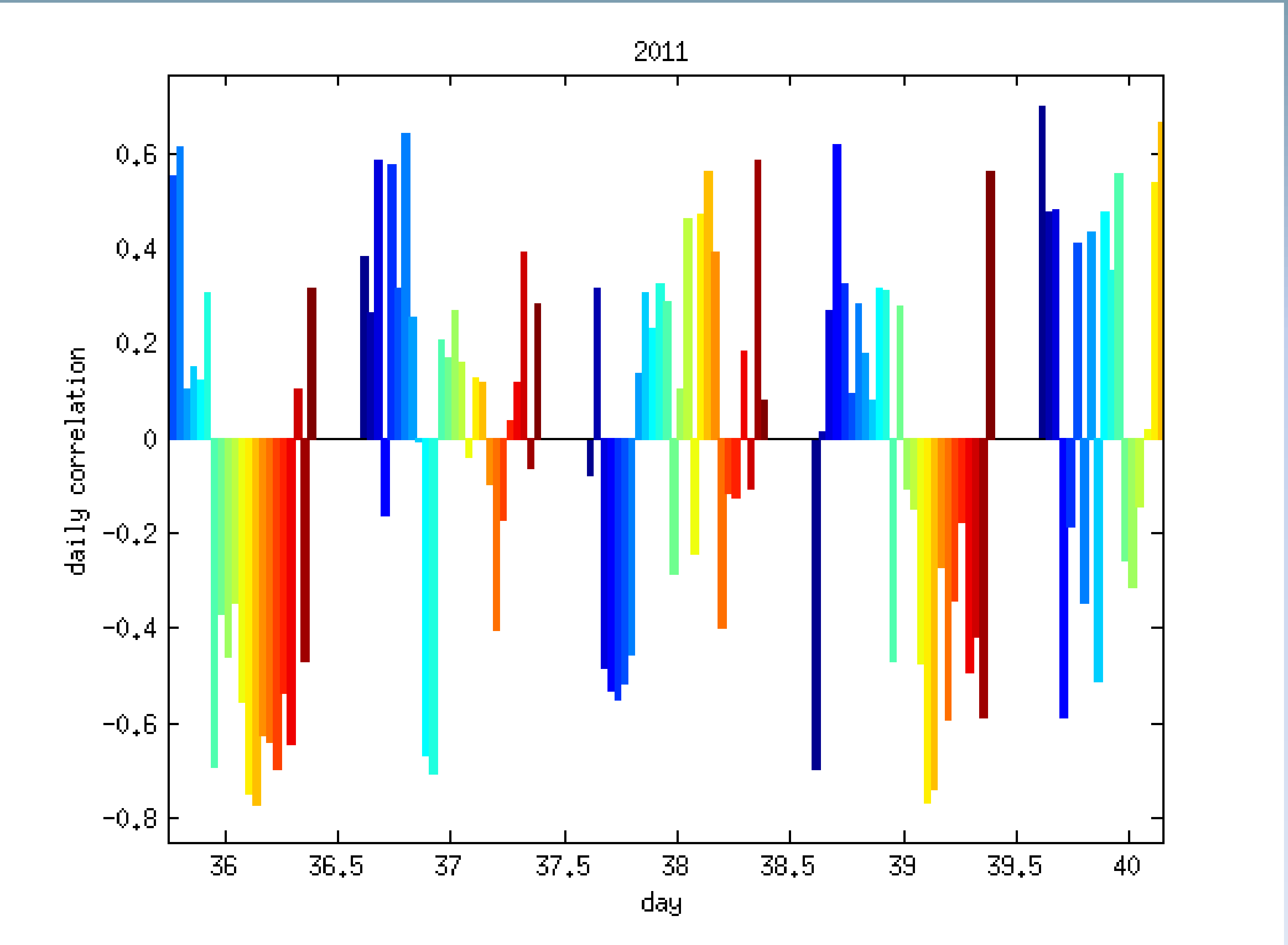
Daily correlation to electricity usage – 26 stations



Typical summer correlation



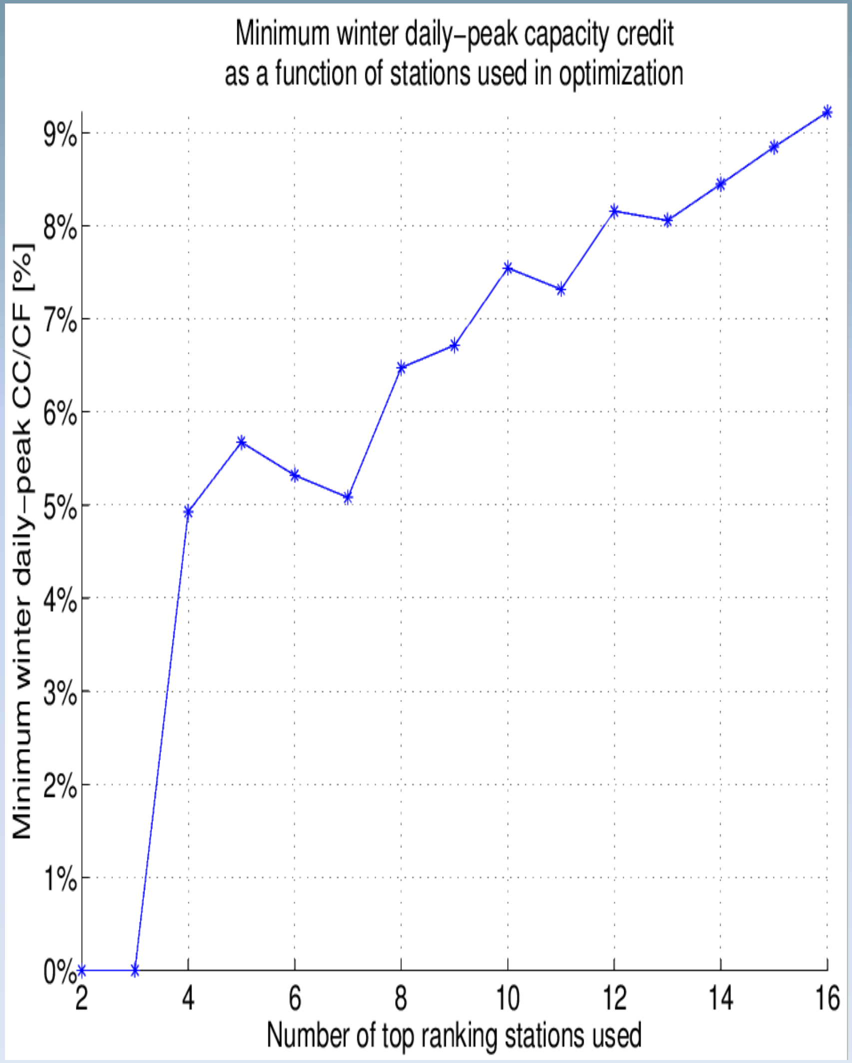
Typical winter correlation



Improvement of minimal CC in the winter

Winter

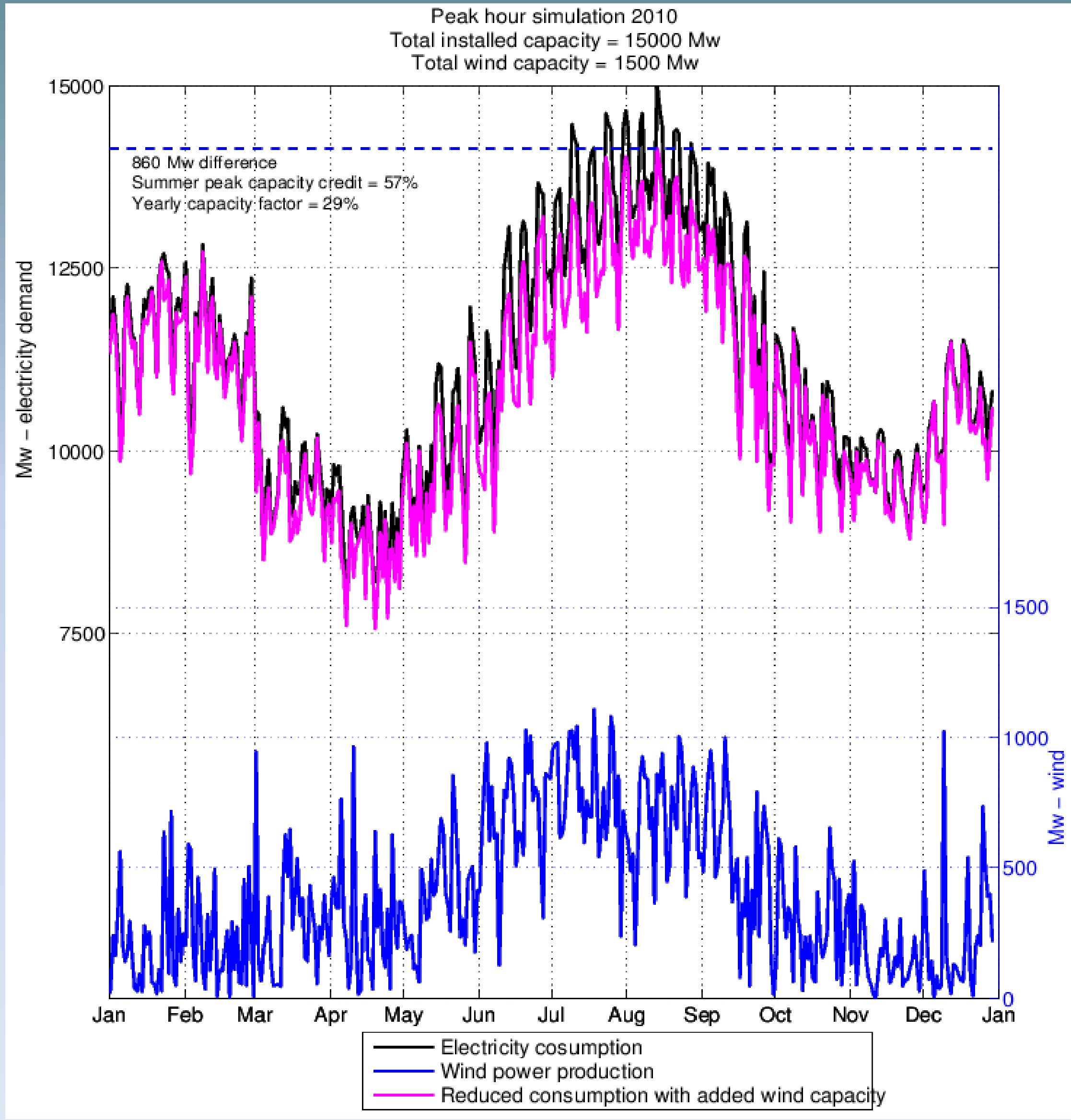
- More stations better capacity credit – but overall small benefit



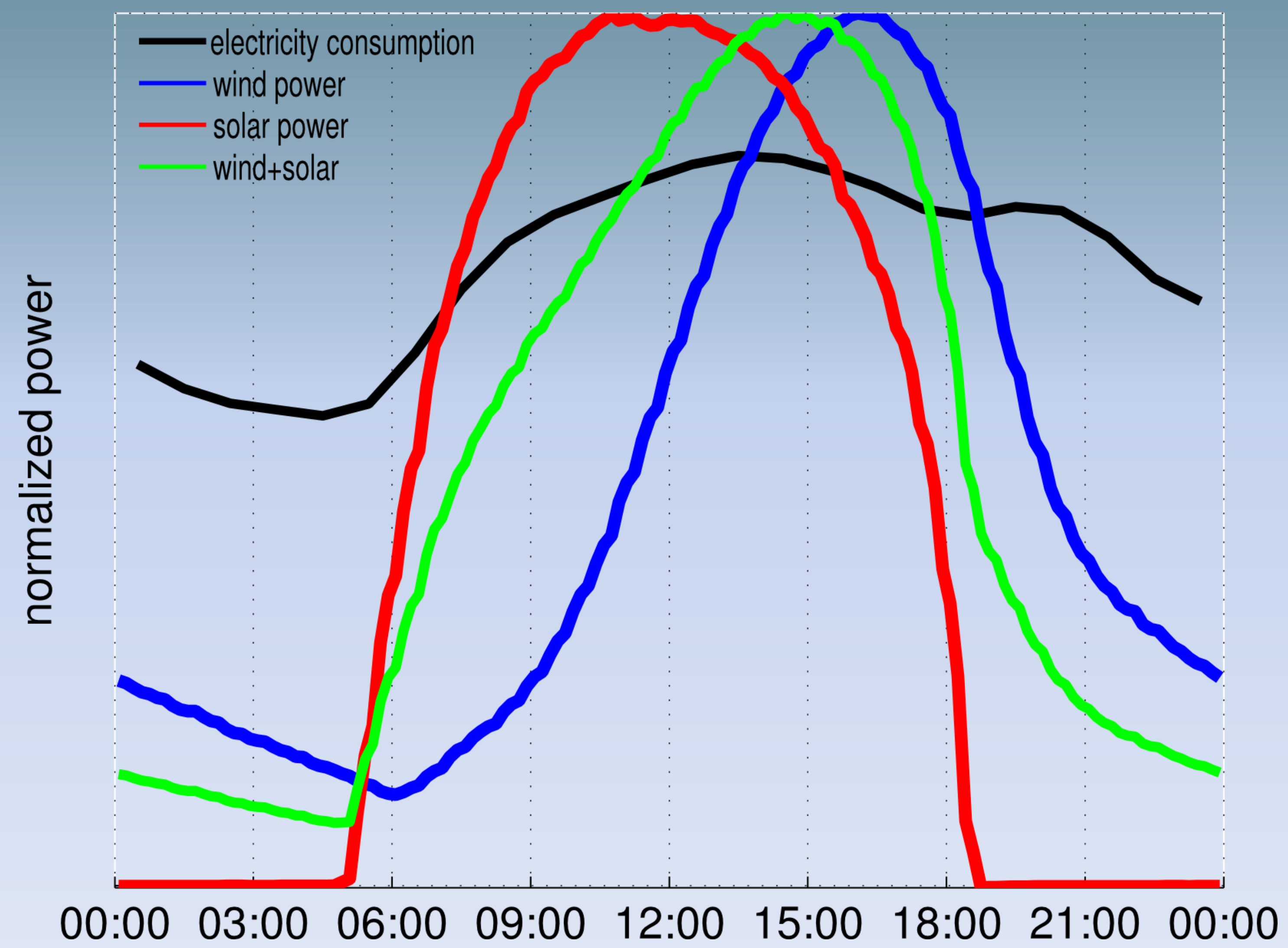
Optimization – results

<u>Summery</u>

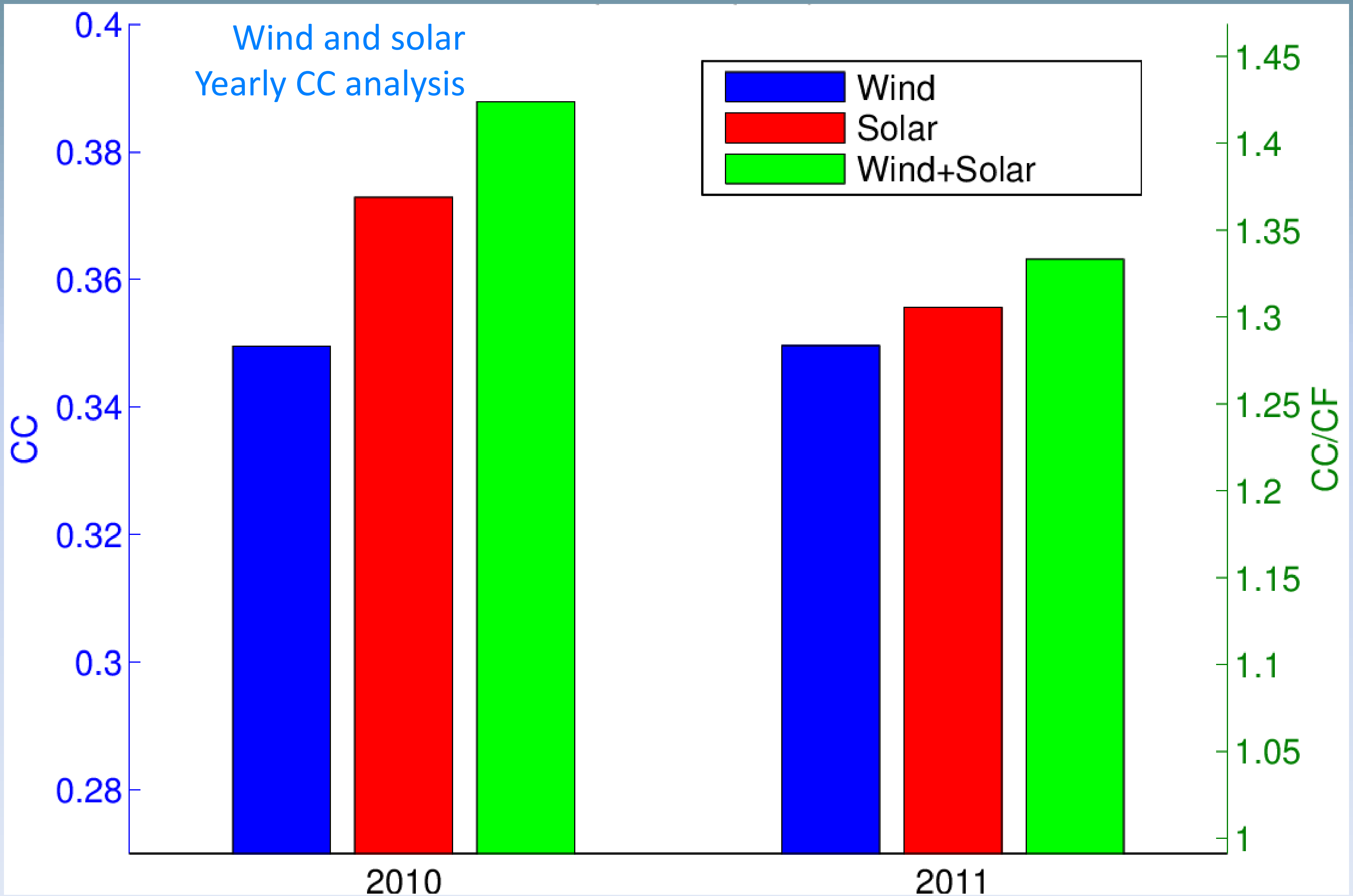
- In the summer a 1500 Mw installation throughout Israel could peak-shave more then 500 Mw (860 in this scenario)
- At winter ~50 Mw



The synergy between Solar and Wind



What's Old: Wind + solar > wind or solar what's New: <u>quantifiable</u>



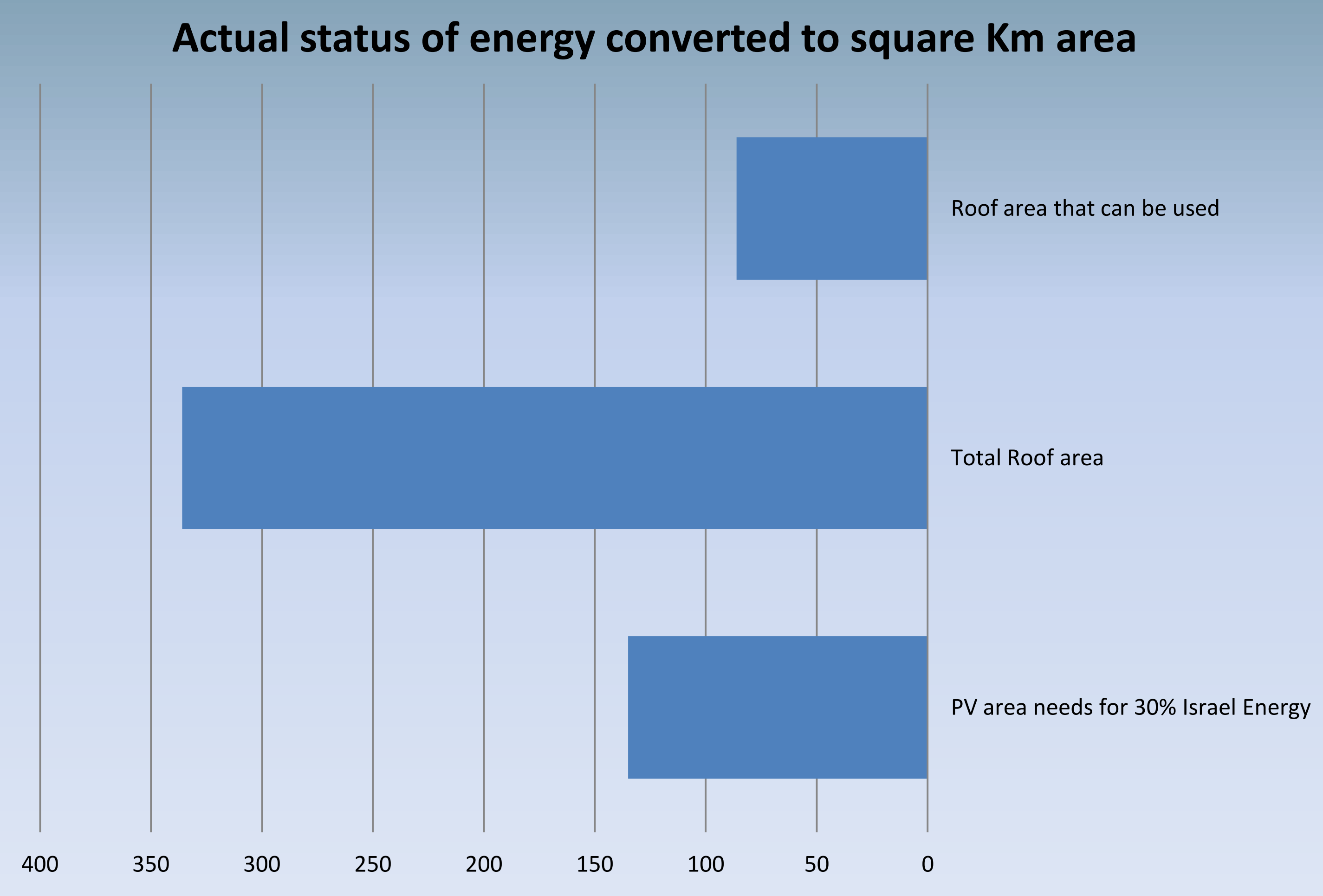
Issue # 3: PV area resource and needs
Basic assumptions

- **We used the following**
  - Output per Panel: Each square meter of PV panel will be able to use 1750 sun hours → With the latest development of 17.5% efficiency and 0.81 PR we get optional 250kW-h annual output per square meter.
  - Area use: We can use more then 25% of pitched (sloped) roofs areas and aggressive target 60% of [illegible] roofs as available place for panels.

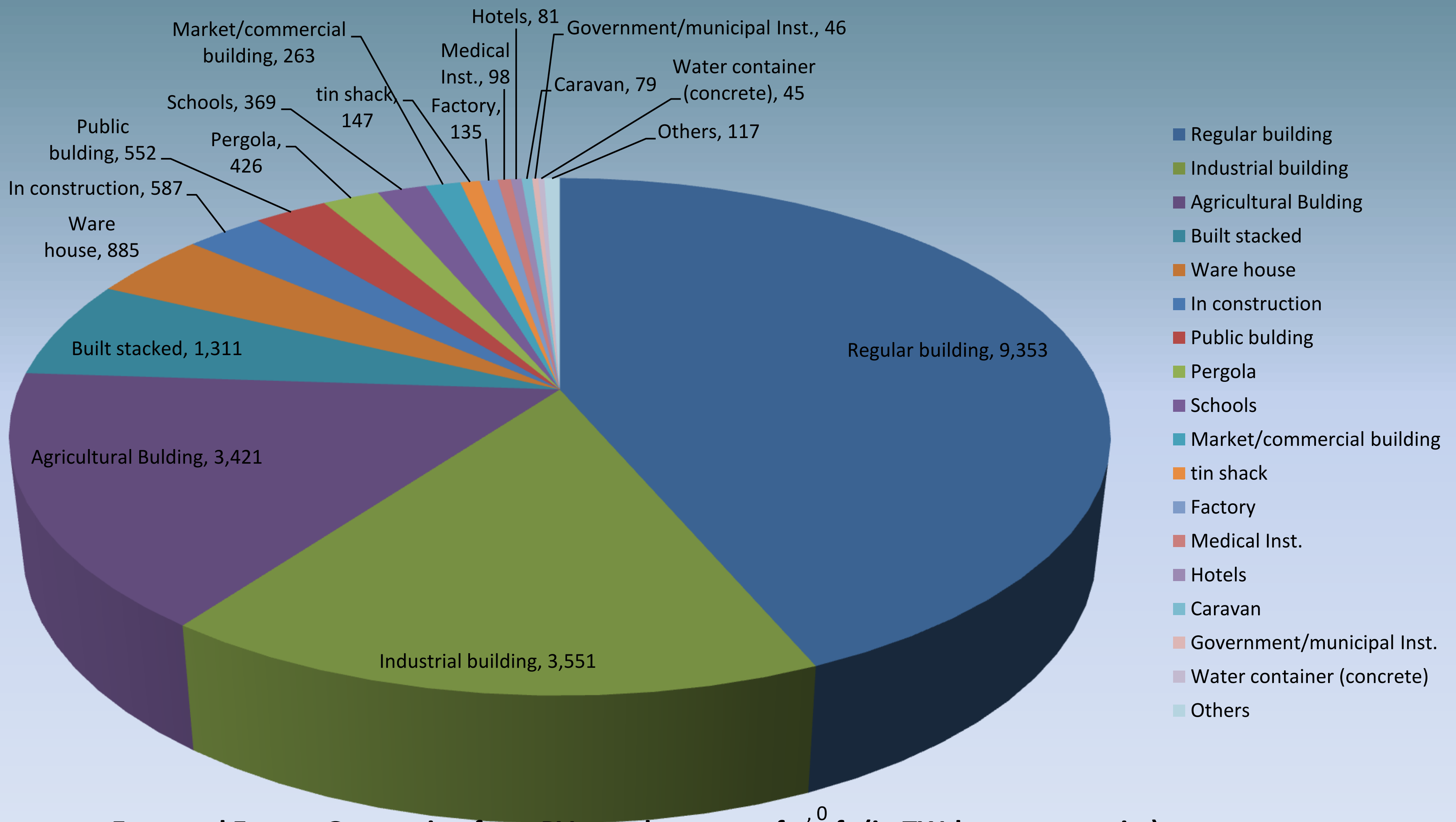
How to achieve ??

Israel Needs vs. resources

Based on GIS data

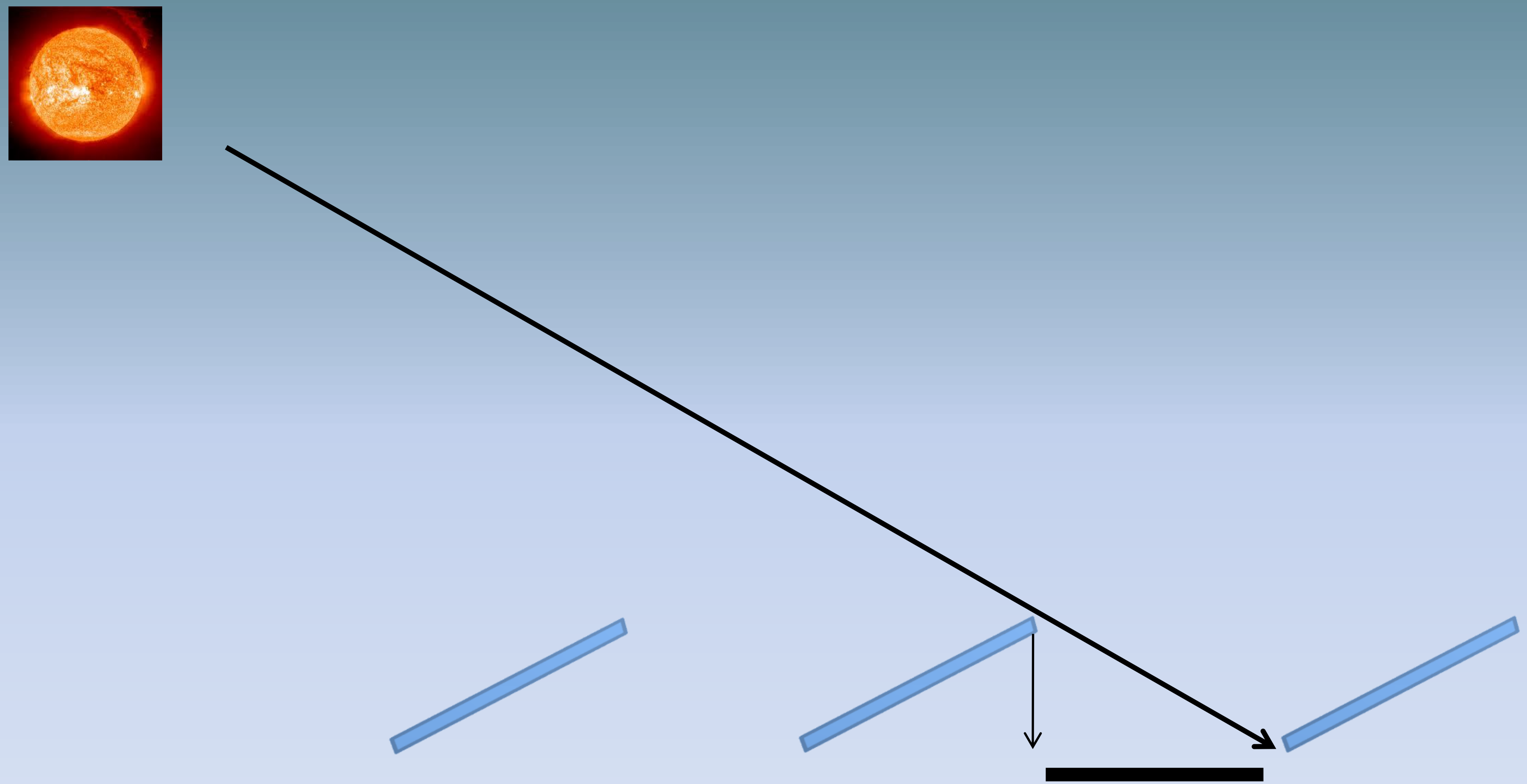


The distribution of roof areas PV potential based on GIS data [TW-h]

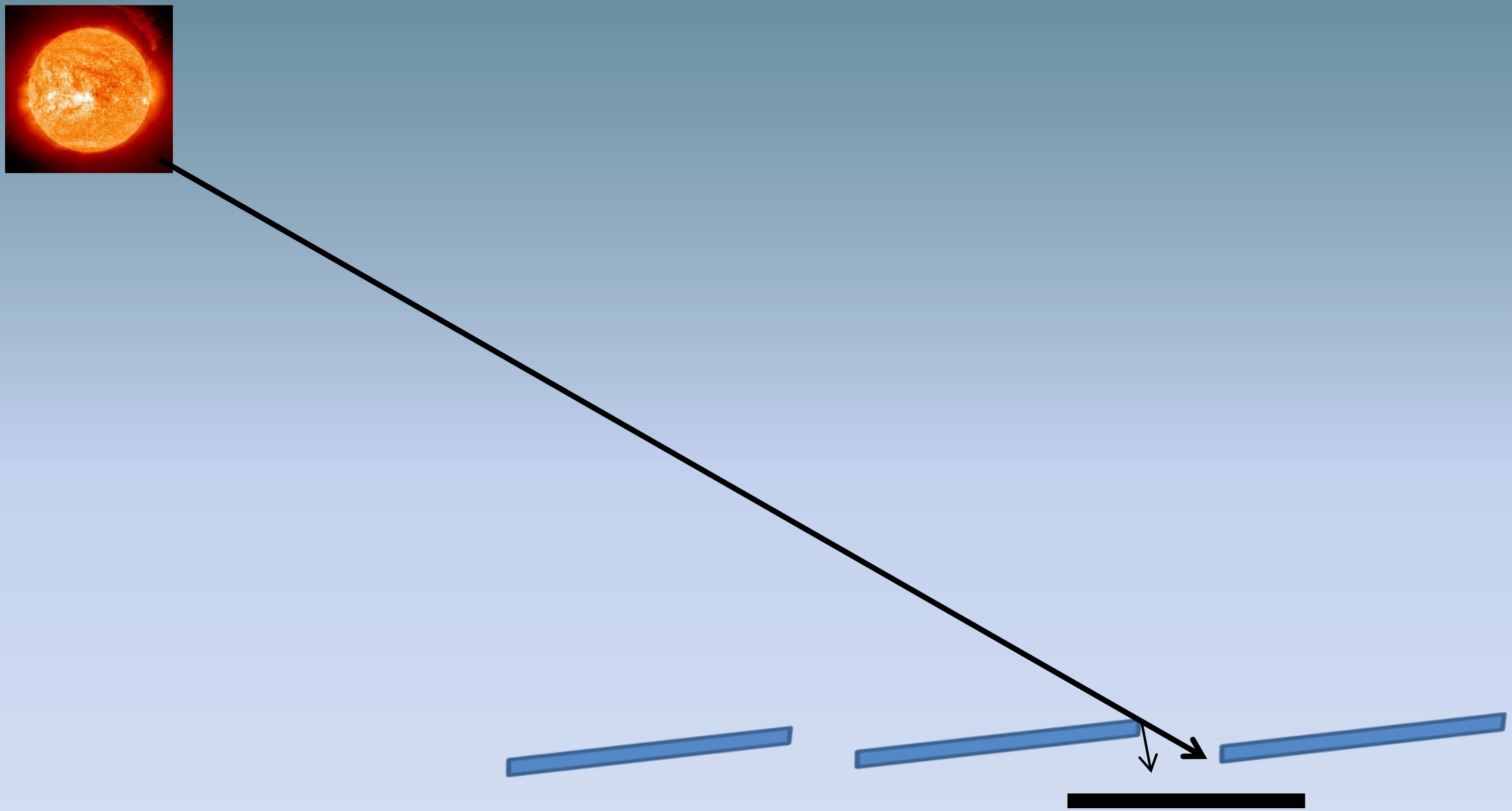


Expected Energy Generation from PV panels on top of roofs (in TW-h per year units)

The use of available area is based on zero shadowing and minimum PV investments



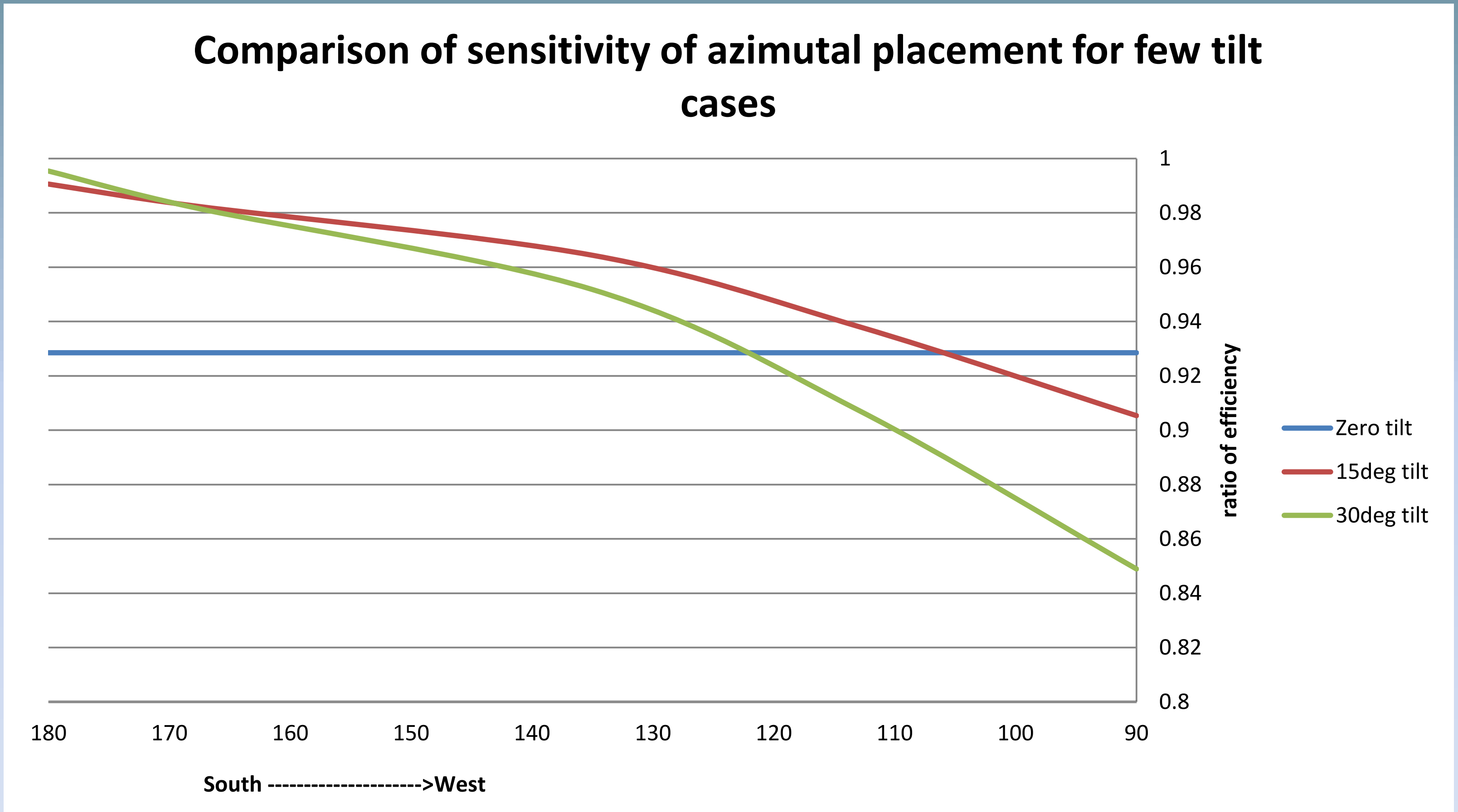
The use of available area is based on zero shadowing and minimum PV investments



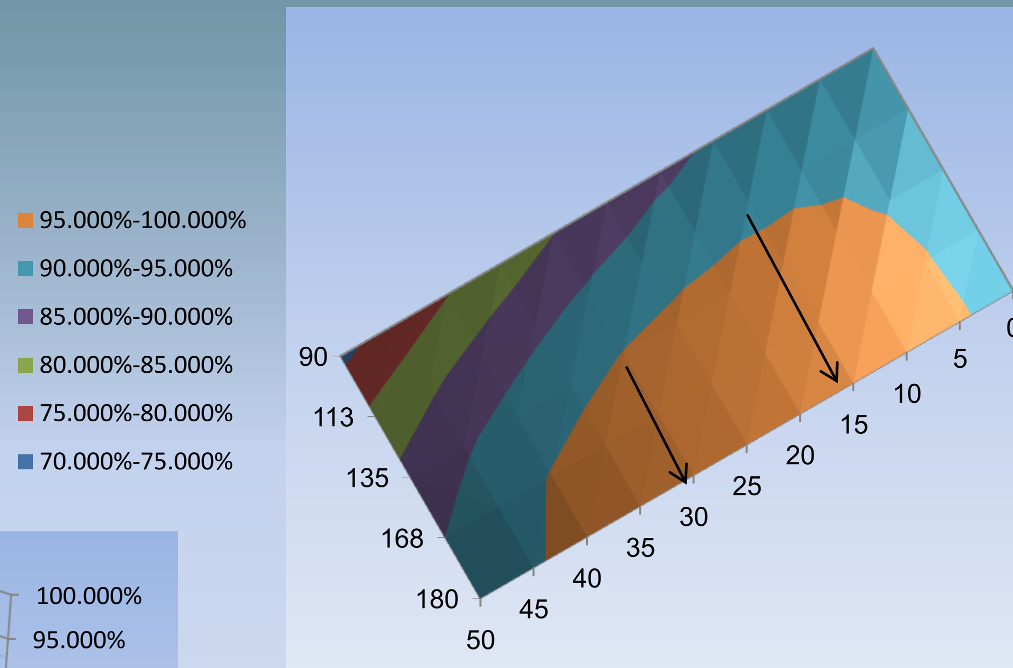
Some additional remarks

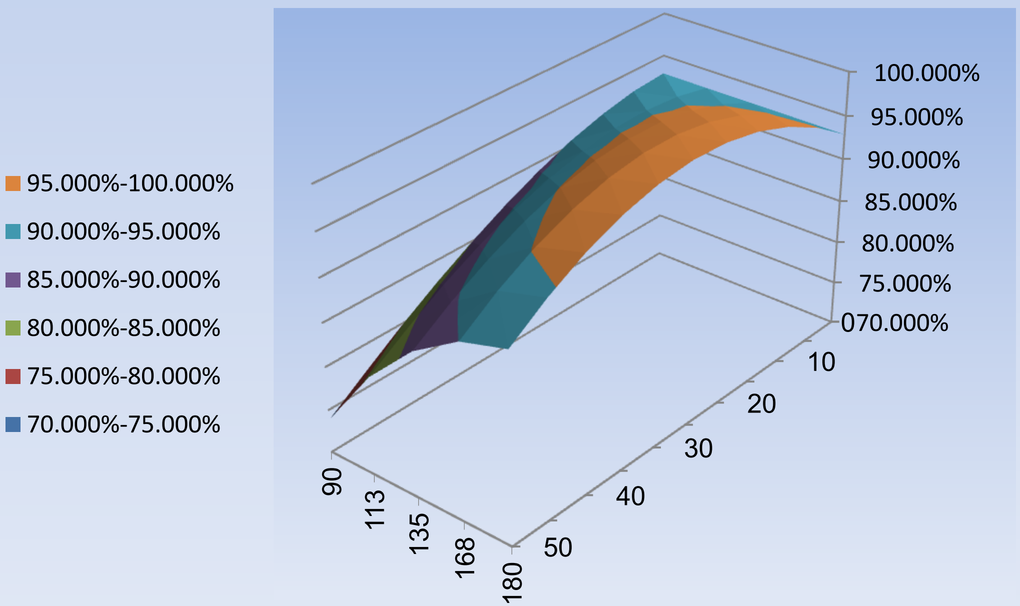
- Proper calculations should take the reflectivity changes per angle as another parameter – this was checked and found to have contribution < 1%
- There is additional impact of the temperature vs. tilt that will not allow flat tilt orientation

The advantage of working at “non best mode of tilt” annual data



The advantage of working at “non best mode of tilt” annual data





Conclusions

- Large scale implementation of wind
  - Need to **consider** preferable installation locations
  - There is a correlation of the wind to the summer peak , therefore there is no need for summer backup. However we need 90% Backup in winter.
  - Use of combined wind and PV synergy will ensure large CC in the summer
  - Take advantage of the of difference between summer peak of the demand and winter peak of demand to minimize backup
- Large scale PV implementation
  - Preferable Distributed installations
  - Use nearly flat tilts for efficient use of roof and land resources
  - Take advantage the difference between summer peak of the demand and winter peak of demand for installations without any need for backup