



The Norwegian Research Centre for Solar Cell Technology

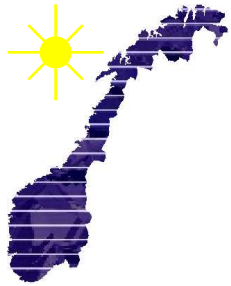
Tor Grande

NTNU

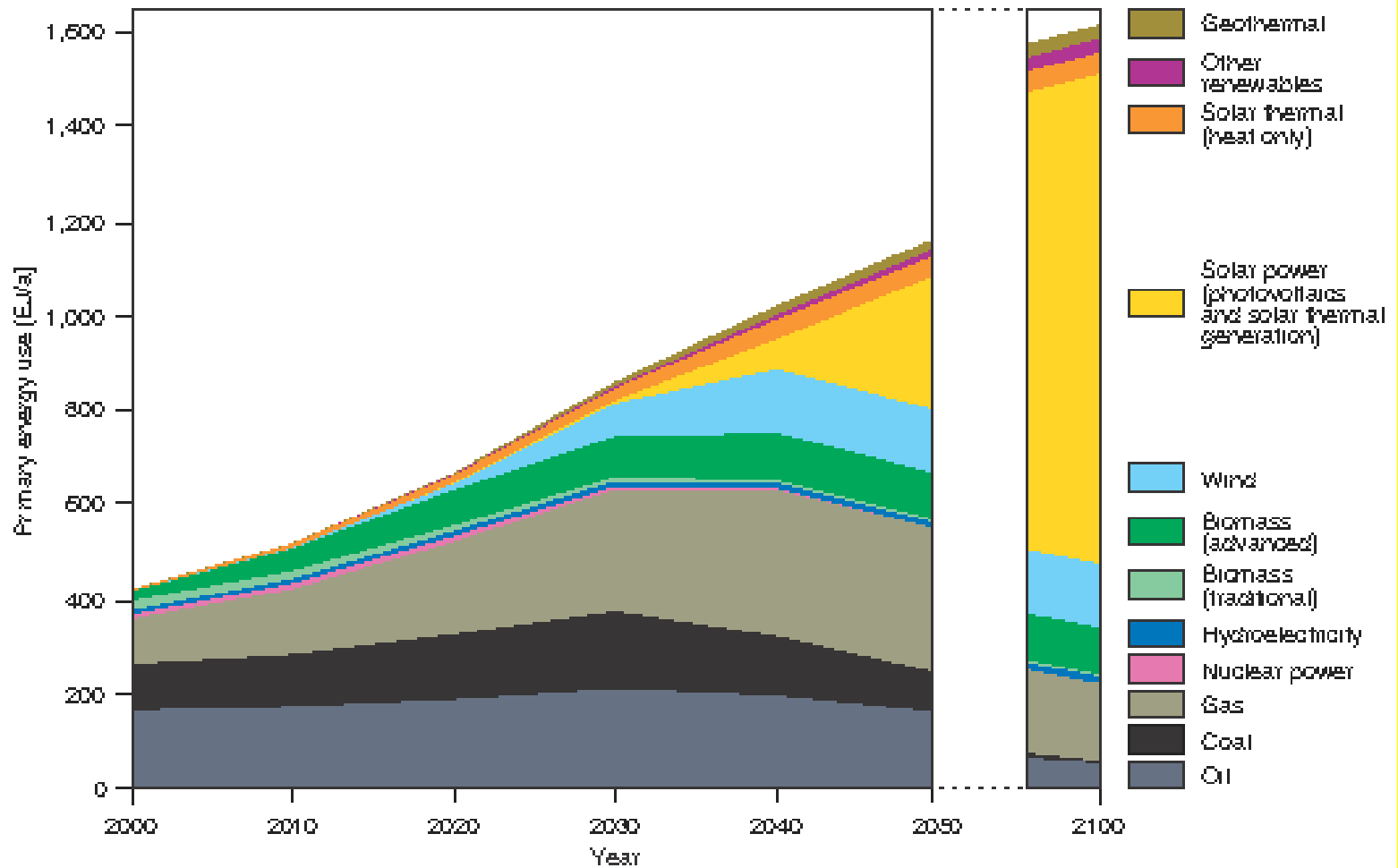
Erik Stensrud Marstein

Solar Energy Department – IFE



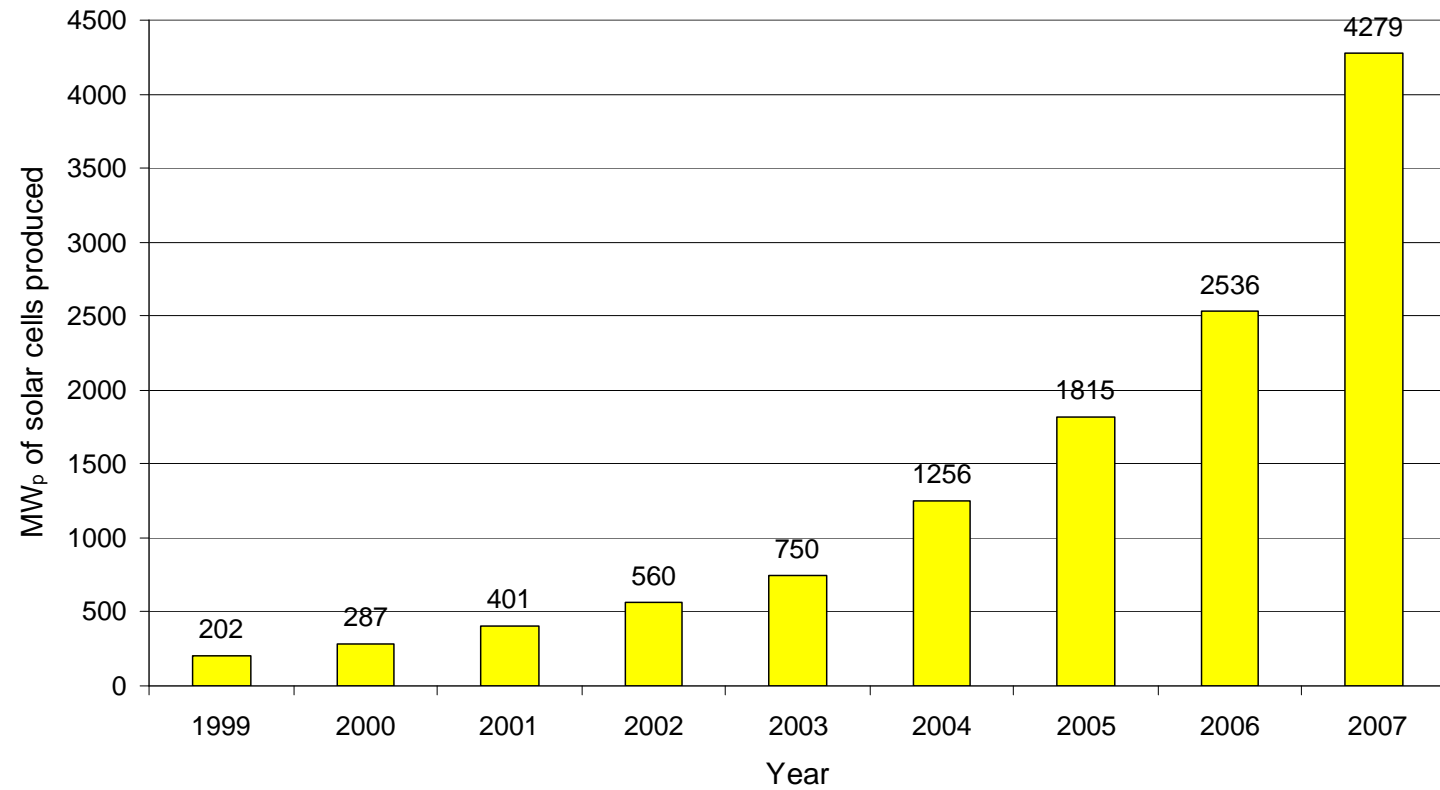


Solenergi – avgjørende for verdens energiforsyning





Sterkt voksende marked





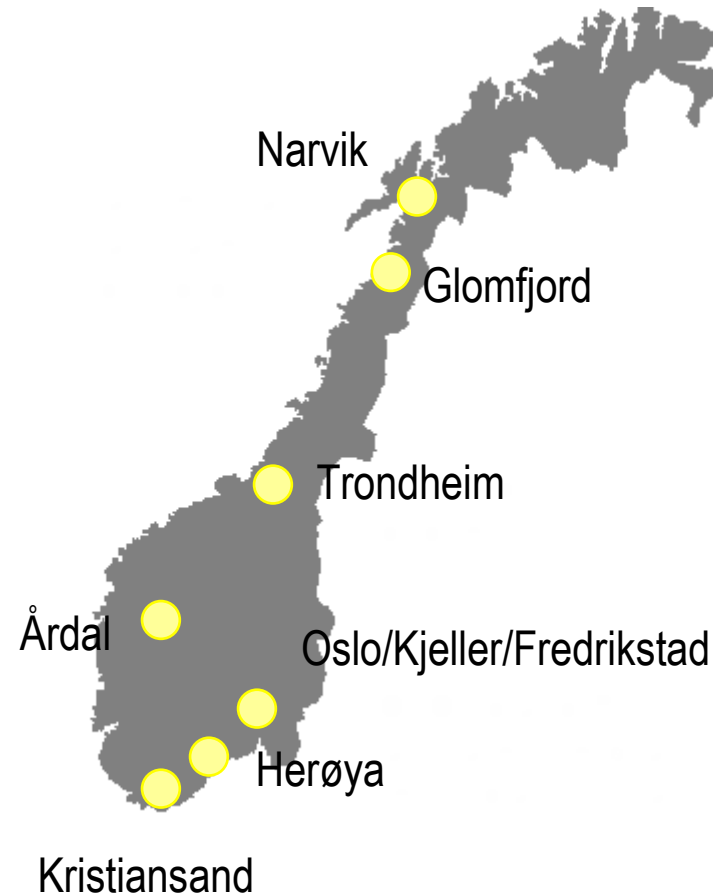
Who are the Centre?

”Solar United”

- The Norwegian Research Centre for solar cell technology joins the major research groups and important industry partners in the PV sector in Norway



"Solar United"



Centre partners: IFE, NTNU, SINTEF, UiO, Elkem Solar, Fesil Sunergy, Hydro, Norsun, Prediktor, REC, Scatec, Solar Cell Repower, Umoe Solar

Associated partners: NORUT and UiA



Industry partners

- **Elkem Solar** produces new Si materials for the solar cell industry.
- **Fesil Sunergy** plans to produce Si feedstock with the new Solsilc process.
- **Hydro's** solar ambitions include becoming a supplier of high quality solar grade Si based on exploitation of new production processes.
- **Norsun** is a producer of Cz Si for the PV industry.
- **Prediktor** supplies manufacturing execution systems to the PV industry.
- **REC group** is a company with broad and integrated presence across the value chain reaching from the high purity solar grade poly-Si and silane gas as the first step, to Si wafers, solar cells, solar modules and to final installation of solar modules into the field of operation.
- **Scatec** is devoted to the development of new business ideas within the areas of renewable energy, with a primary focus on PV.
- **Solar Cell Repower** plans to process non-prime solar cells from the PV industry in order to increase the solar cell efficiencies.
- **Umoe Solar** plans to produce new Si materials.



Main objective

- To give current and future companies in the Norwegian PV industry long-term access to world leading technological and scientific expertise, thereby enabling this industry to become one of the most important land-based industries in Norway.
- Research infrastructure covering the whole value chain
- Innovation
- National arena for PV research and education
 - 23 PhD and 21 post.doc candidates
 - Research school in solar cell science and technology
 - 150 articles in high-impact scientific journals



The deal

- Budget

- Total budget of the FME centre: 373,5 MNOK

- Financial contributors

- Industry partners: 92,8 MNOK (24,8 %)
 - Universities and research institutes : 120,7 MNOK (32,3 %)
 - Research Council of Norway: 160 MNOK (42,8 %)

- Timeframe

- 8 years of state-of-the-art PV research (5 + 3)



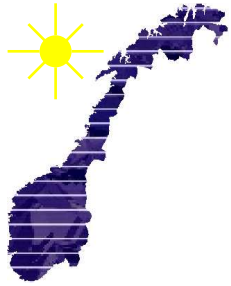


Work packages

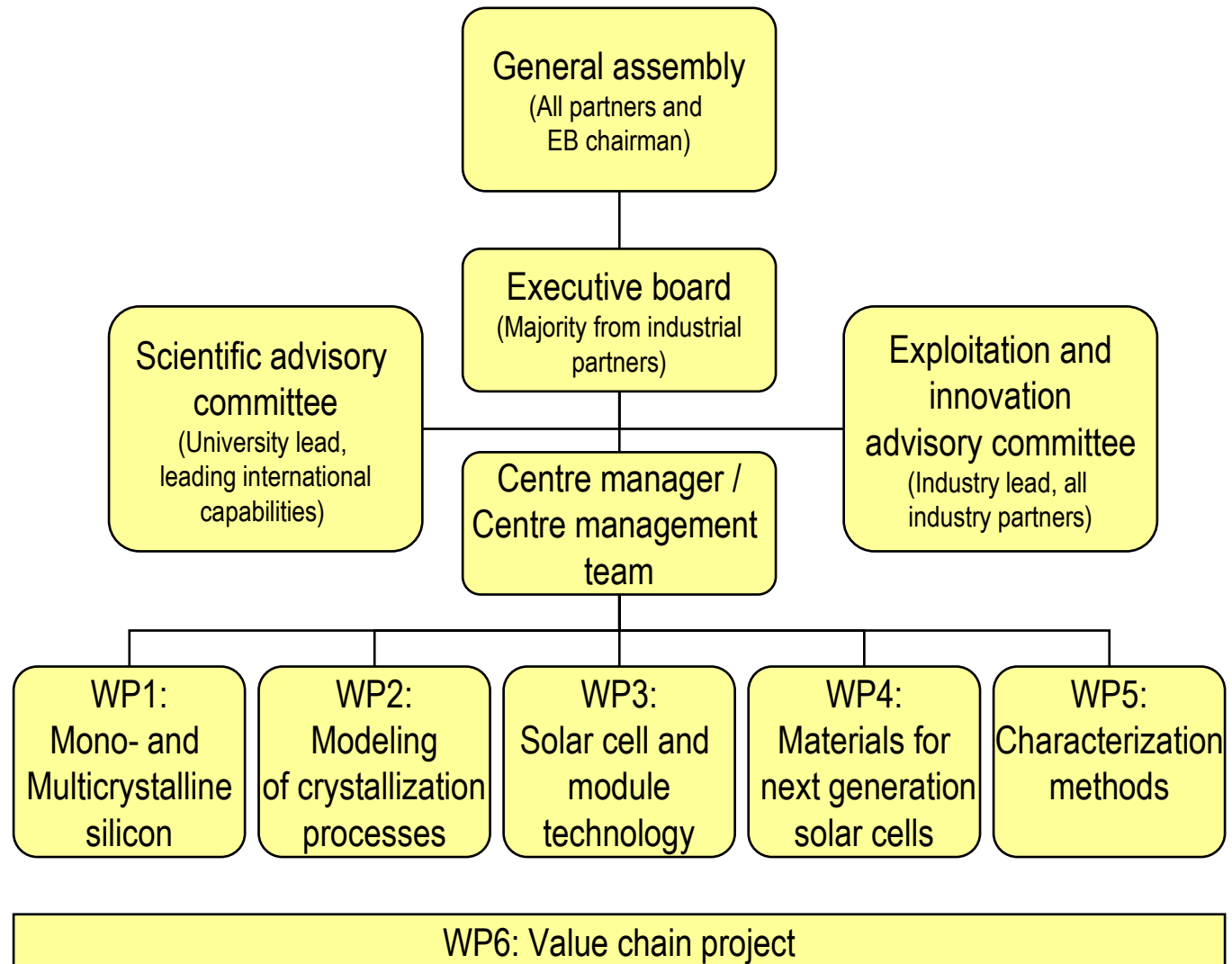
Research	WP6	Education
WP1: Mono- and multicrystalline silicon		MSc
WP2: Modeling of crystallization processes		PhD
WP3: Solar cell and module technology		Professional
WP4: Materials for next generation solar cells		
WP5: Characterization methodology development		
		Network
		Conference
		Workshops
		Exchange programme

WP1-5: Competence-building work package

WP6: Value chain project



Centre organization





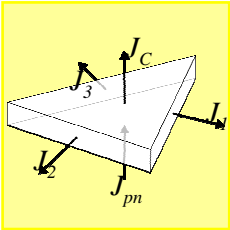
WP 1: Mono- and multicrystalline Si

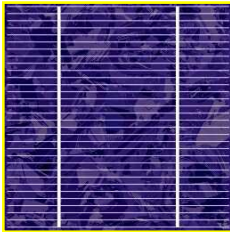
- Research goals
 - Optimize the Cz Si fabrication process
 - Improved control of defect density and impurity concentration distribution
 - Optimize the mechanical quality of thin wafers by the use of O and N.
 - Establish tolerance levels for defect and impurity levels in Cz Si
 - To acquire fundamental data regarding the Cz Si and Si casting processes
 - Important input for the modeling in WP2.
 - Develop methods for defect engineering at ingot and wafer level in order to reduce light induced degradation
 - Cast high quality Cz Si and mc-Si ingots with highly reproducible microstructure, including defect and impurity concentration
 - To be used for the production of high efficiency solar cells
 - Modeling and characterization of microscopic defect and impurity complexes



WP 2: Modelling of crystallization processes

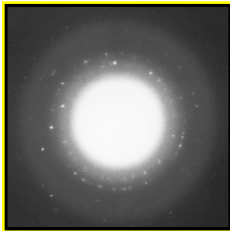
- Research goals
 - To develop an integrated software package (“SiSim”)
 - Simulation of Si casting/crystallization, cooling and reheating processes within the first 5 years of the duration of the Centre.
 - High level of interest from the industry partners
 - A long-term ambition is to become an internationally leading developer of modelling tools for the Si PV industry.





WP 3: Solar cell and module technology

- Research goals
 - Develop new materials and processes for highly efficient Si solar cells
 - Improve light harvesting in solar cells and modules
 - Establish baseline solar cell processes for mc Si and Cz
 - Fabricate efficient wafer-based Si solar cell with an efficiency of 20 %



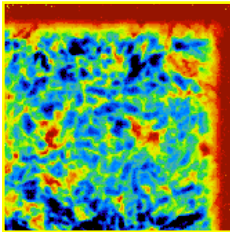
WP 4: New materials for next generation solar cells

- Research goals
 - Develop new absorber materials for
 - Nanowires for solar cells
 - Oxide materials for tandem solar cells
 - Intermediate-band solar cells
 - Develop materials and structures that will increase the light harvesting for both conventional and unconventional solar cells and modules.
 - Challenges
 - Master band gap engineering in ZnO
 - Fabricate IB solar cell with efficiency of 20 %
 - Demonstrate hybrid Si/oxide tandem solar cell
 - Implement down conversion layers



WP 5: Characterization methodology development

- Research goals
 - To development and improvement of tools and methods for materials and component characterization
 - Impurity levels
 - Lifetime techniques
 - Imaging
 - Establish tools for modelling, characterizing and predicting the optical properties of full solar modules

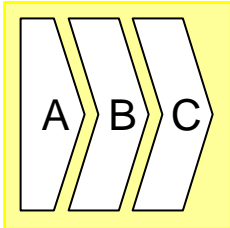


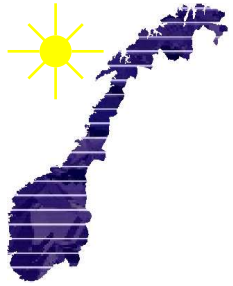


WP 6: Value chain projects

- Task

- To combine the results, tools and methods to be developed in the different work packages to fabricate working demonstrators of selected solar cell technologies, including
 - An IB solar cell with efficiency of 20 %
 - A hybrid Si/oxide tandem solar cell
 - A solar cell with down-conversion layer
 - A wafer-based Si solar cell with an efficiency of 20 %





Summary

- The FME centre joins all major research and industrial environments in Norway
- The FME will become an important meeting place for the Norwegian solar cell community and an important platform for new, coordinated project applications
- The FME is established at a very interesting time in history and will contribute to and see major breakthroughs, both scientific and industrial, before its expiry date in 2017





Acknowledgements

- The Research Council of Norway
- The Norwegian solar cell research community
- All FME partners, who have prioritized using their own funds for realizing this ambitious Centre
- The members of the interim board
- "Skivegruppa"