# Software development at DLR-PSA

Simulation tools for renewable energy systems

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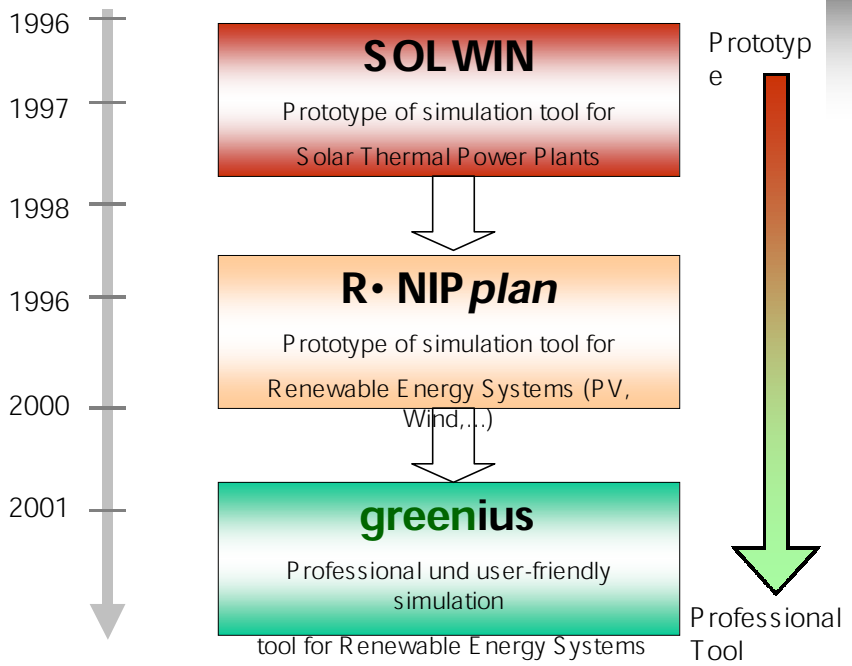
Rainer Kistner.



## Evolution of different simulation tools





Software development at DLR-PSA

## Defining Requirements for the New Software

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- ✓ Extensive technical and economical analysis
- ✓ High accurate simulation algorithms
- ✓ Extremely low calculation times
- ✓ User-friendly interfaces
- ✓ Comfortable data import and export modules
- ✓ High flexibility of input parameters

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## greenius - Implemented Renewable Technologies

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Dish/Stirling Systems

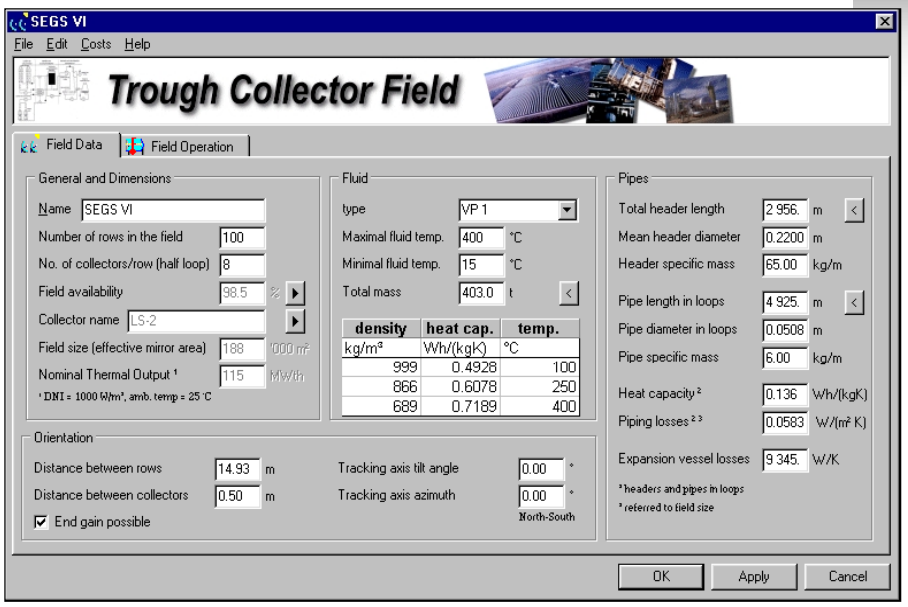
Photovoltaic Systems

Parabolic Trough Power Plants

Wind Power Plants

# Modeling Trough Fields

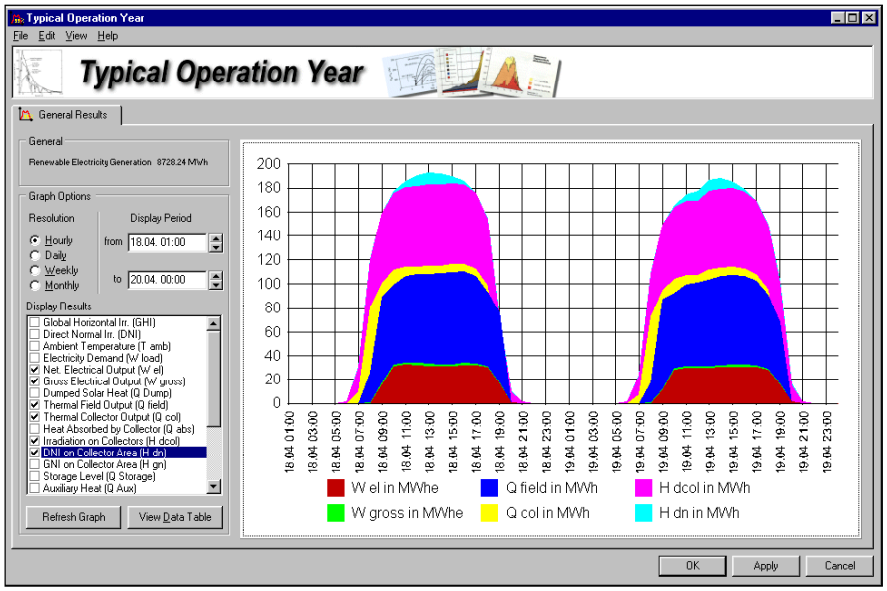







# Simulation Results





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## Verification of the Simulation Algorithms

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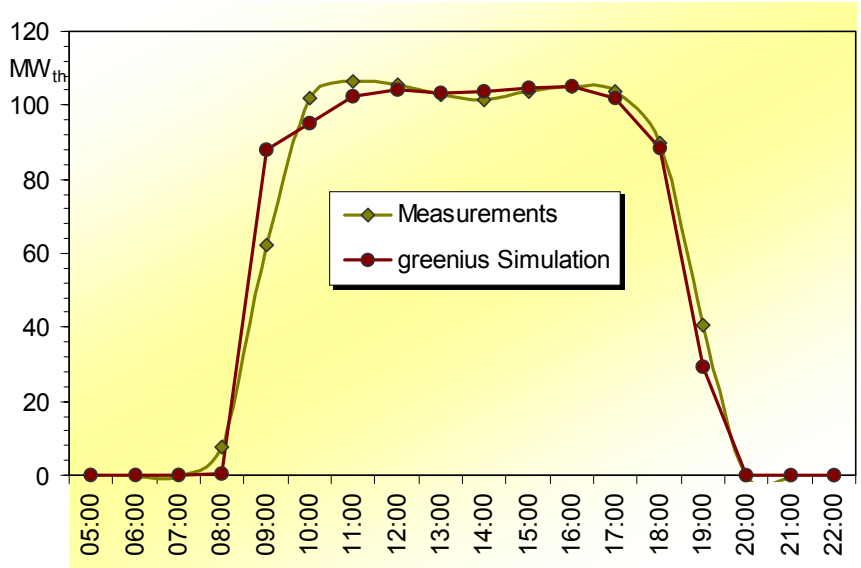


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## Cost Comparison of PV and STPP

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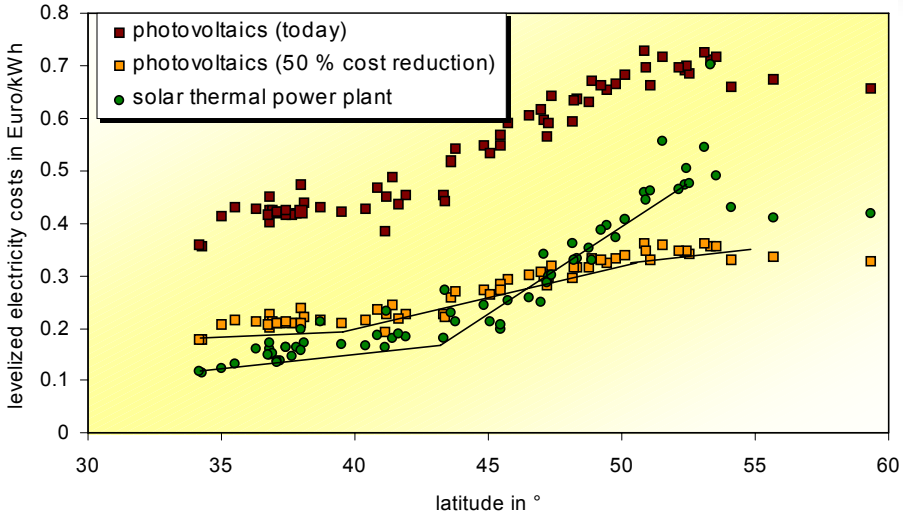

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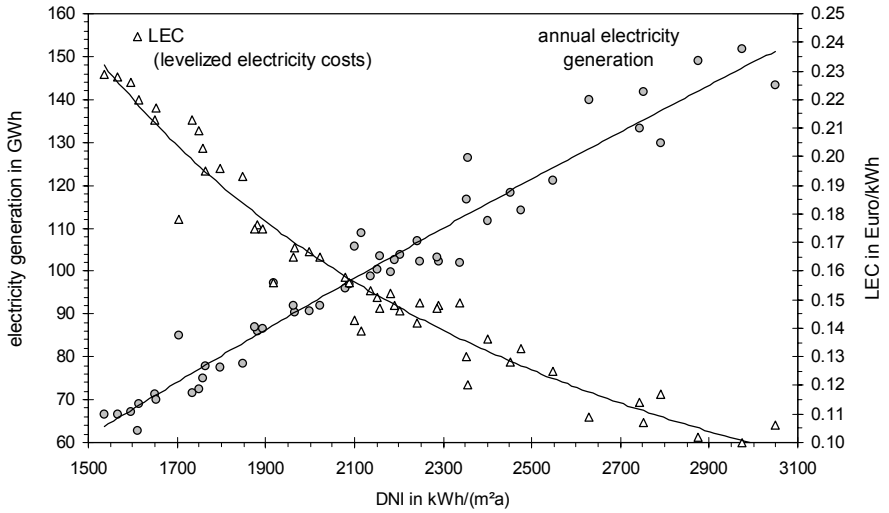
## LEC and $E_{gen}$ of PTPP as a function of DNI

9




50 MWe trough plants in dependence on the DNI for 50 random chosen sites with a 375,000 m² solar field size

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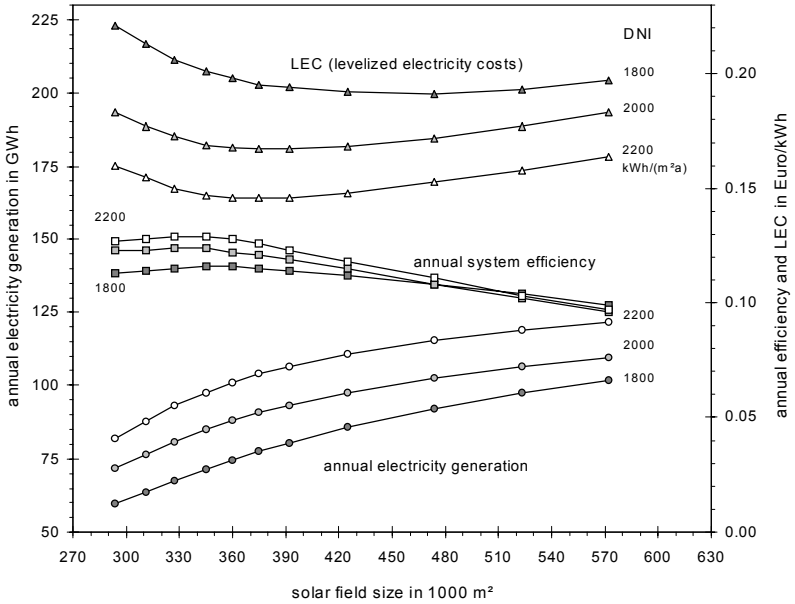
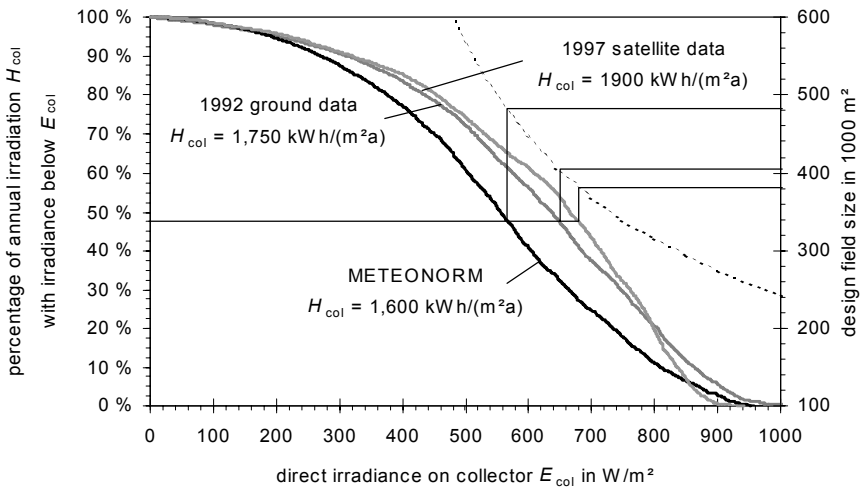
## LEC, $E_{gen}$, $\eta_{tot}$ of PTPP as function of solar field size

10



# Determination of design radiation





# MARKET DEVELOPMENT

SolarPACES

# MARKET DEVELOPMENT

Solar PACES

Task 1.3

Thomas R. Mancini

June 20, 2001

*TRM 06/20/01 -- 1*

# MARKET DEVELOPMENT

SolarPACES

At the 60th EXCO, Cuernavaca, Mexico May 8 – 9, 2001, the SolarPACES Executive Committee decided

- **Decision 1.1.1:** *Merge Sectors I.3 and I.4 into a New Sector I.3 "CSP Market Development"*

*TRM 06/20/01 -- 2*

# MARKET DEVELOPMENT

SolarPACES

## What were Sectors 1.3 and 1.4?

- Sector 1.3: START Missions
- Sector 1.4: Market Barriers & Opportunities

## What are the reasons for the merger?

- Success of the START missions in Egypt, Jordan and Brazil.
- No further interested candidates are on the horizon.

*TRM 06/20/01 -- 3*

# MARKET DEVELOPMENT

SolarPACES

## Reasons for the merger (cont.)

- The current experience with CSP market introduction suggests a need of a new approach to CSP Market Development.
- The ExCo therefore decided to merge the two capacities of Sectors 1.3 and 1.4 into *CSP Market Development.*
- The EXCO requests Tom Mancini to develop a new program of work for this new Sector.

*TRM 06/20/01 -- 4*

# MARKET DEVELOPMENT

SolarPACES

## Other guidance provided

- Work more closely with WB and GEF
- Missions to Govmts to address barriers
- Highlight sustainable MD
- Make CSP Projects happen
- Better in-country teaming: broader involvement -- jobs, content, opportunity
- "focus more broadly"

*TRM 06/20/01 -- 5*

# MARKET DEVELOPMENT

SolarPACES

## How do we go forward with this?

- Discussion -- a number of "key" issues.
- Identify what we want to do. What results do we want?
- Identify what we CAN do.
  - Not just what needs to be done
  - What are our strengths? How do we use them?
- Then, proceed to draft Work Plan.

*TRM 06/20/01 -- 6*

# MARKET DEVELOPMENT

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## Some questions we need to address:

- Can WE make a project happen?
- Can WE do market development?
- Can WE do "sustainable" market development?
- Do WE know much about markets and market development?

*TRM 06/20/01 -- 7*

# MARKET DEVELOPMENT

SolarPACES

## What are our collective strengths?

- Technology development
- "Honest" technology status brokers
- Providers of technical information
- International networking
- Other strengths?

*TRM 06/20/01 -- 8*

# MARKET DEVELOPMENT

SolarPACES

## Suggested Activities for Sec. 1.3 MD:

- OUTreach
  - Providers of technical information
  - Resources for WB and GEF
  - Resource for Govmts seeking information
- Inreach
  - Provide forums for educating ourselves and industry on opportunities -- project development, project finance, insurance, etc.

*TRM 06/20/01 -- 9*

# MARKET DEVELOPMENT

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## Suggested Activities (cont.)

- Project Support and Facilitation
  - Develop in-country models for projects
  - Work to integrate in-country capabilities
  - Be THE facilitating organization for the project

*TRM 06/20/01 -- 10*

## MARKET DEVELOPMENT

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Are we willing to invest the time and resources to make these activities successful?

Who is willing to take the lead?

One activity under each area for now?

What do we want to pursue?

Where is the greatest benefit/cost?

*TRM 06/20/01 -- 11*

## MARKET DEVELOPMENT

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Where do we go from here?

- More discussion?
- Develop a "strawman" of activities?
- Evaluate some options?
- Start to work on activities?
- Go have a beer?

*TRM 06/20/01 -- 12*

World-Wide Concentrating Solar Power Projects - Netscape

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Bookmarks Location: http://www.energylan.sandia.gov/sunlab/SolarPaces/main/csp_main.cfm

# Concentrating Solar Power Projects

## Project Summary by SolarPACES

**Important Notice!**

The following table provides information on Concentrating Solar Power (also known as solar thermal) projects world-wide. To sort by project name, location, contact, or last edit, click on the column heading. Each column originally sorts in ascending order. If you wish to sort in descending order, after sorting the desired option, re-sort by clicking that option again.

To view the full data for a project, click on project name. You will be linked to a page that contains additional data, such as the full descriptions, current status, and issues associated with that project.

View details on all reports.

| Project Name (Default Sort) | Location | Contact | Brief Description | Brief Status/ Upcoming Activities |
|---|---|---|---|---|
| GEF India | Rajasthan, India | Michael Geyer (DLR/PSA) | 35MW trough in 140MW naphtha-fueled combined cycle plant | GEF Block C grant approved for $50M; plant definition underway. |
| GEF Egypt | Egypt | Michael Geyer (DLR/PSA) | Hybrid plant with about 30 MW solar and 100-160 MW total capacity. Technology is open (troughs or to | GEF Block C grant approved; RFQ being prepared. |
| GEF Morocco | Morocco | Michael Geyer (DLR/PSA) | Troughs in combined cycle plant? | No Input |
| GEF Mexico | Mexico | Greg Kolb (Sandia) | No Input | GEF Block B grant approved. |
| GEF Brazil | Northeast, Brazil | Patricia Cordeiro | Best CSP project definition available; preparation for pilot | PDF-B grant approved by GEF March 1998, Terms of Agreement |

World-Wide Concentrating Solar Power Projects - Netscape

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Bookmarks Location: http://www.energylan.sandia.gov/sunlab/SolarPaces/main/WWmile.cfm?ProjectNumber=14.0

# Concentrating Solar Power Projects

## Project Summary by SolarPACES

View all projects in detail || Project Summary

### Project Name: Solar Tres

**Project Location: Near Cordoba, Spain**
**Contact: James Pacheco, Sandia**

**Participants:**
Nexant (A Bechtel Technology & Consulting Company), Ghersa, Boeing

**Brief Description:**
15MW molten salt power tower with 16 hours of storage with a capacity factor of 65%. The receiver thermal rating is 120 MW and the collector area is approximately 265,000 m2.

**Brief Status/Upcoming Activities:**
Nexant and Ghersa have formed a company, Solar Tres, SA. Solar Tres is pursuing grants and equity partners.

**Issues:**
None.

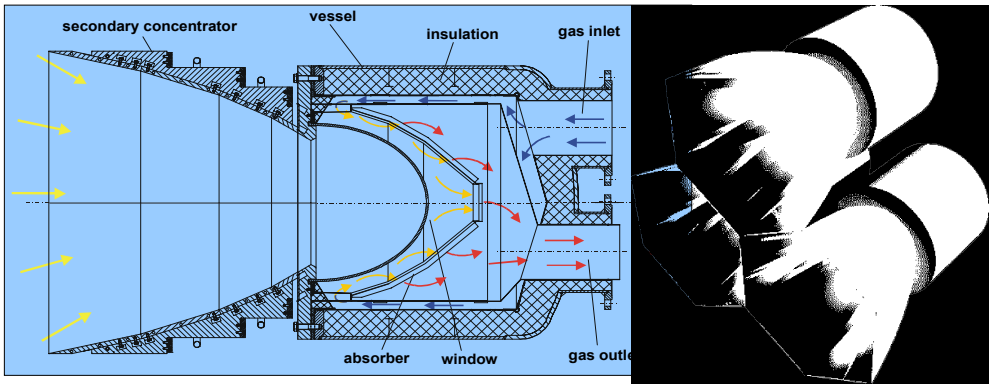
**Key Event Dates:**

The participants are submitting applications for grants. The results of these applications should be known this summer (summer 2001). They are also seeking equity partners. Once the grants have been awarded and the financing closed, the construction duration is expected to last 36 months.

**Last Edit:** 12-Jun-01

# Solar-hybrid Tower Systems

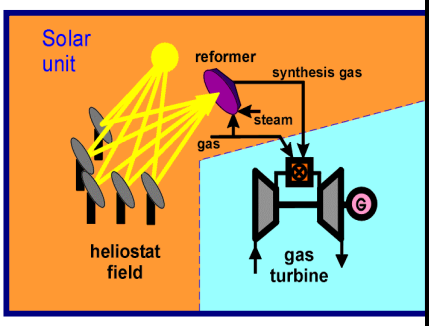
- ***volumetric receiver unit***
- ***hexagonal secondary concentrator***
- ***cluster for power scale-up***






# SOLASYS Project

Demonstration of solar steam reforming of methane for electricity production with reduced $CO_2$ emissions („fuel saver“)




- co-funded by EC
- duration: 6/1998 – 11/2001
- hardware part: ORMAT, WIS and DLR
- accompagnied by fuel cell study: ECN, SPE
- DLR task: development of volumetric receiver for solar steam reforming of methane

## Project Status

- receiver is installed (3/01)
- solar tests with $N_2$ for system checkout are about to start
- solar reforming test: July 2001
- cost assessment

10/22/01 solarpaces_task3_0601 / 3

## SOLGATE: Solar air preheating for gas turbines

*Project goals:*

- integration of 3 receiver modules with a gas turbine
- development and test of a low temp. module (600°C)
- development and test of a high temp. module (1000°C)
- detailed layout studies (definition of prototype plant)

*Project partners:*

- ORMAT (Israel)
- CIEMAT, INABENSA (Spain)
- DLR (Germany)
- TUMA (Switzerland)
- HERON (The Netherlands)

1/2001 - 6/2003, co-funded by EU

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# SOLGATE

*Current Status:*

- component design and manufacturing (receiver, gas turbine)

*Time Schedule:*

- integration of components into PSA testbed: 1/2002
- system test 3/2002
- prototype plant layout: by 5/2003