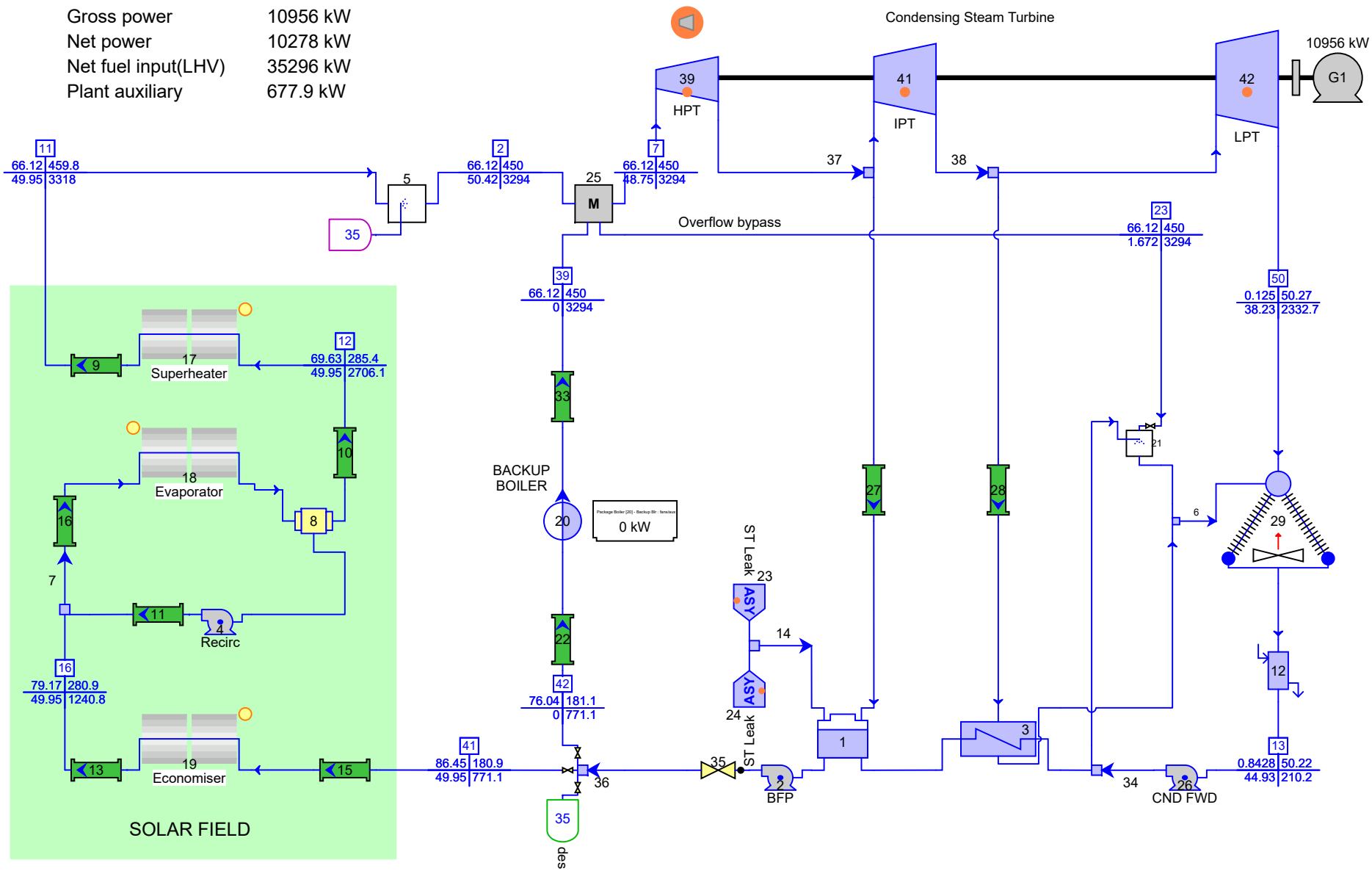
Model of a condensing steam turbine power plant with an air-cooled condenser and two feedwater heaters. Steam is generated in a solar field and/or by a gas-fired package boiler installed in parallel. The solar field uses Linear Fresnel Collectors (LFC) and directly heats water, generates steam, and superheats steam in the receiver tubes. No thermal oil and separate heat exchangers are needed with this design. The solar field consists of three separate sections, one to heat water, one to evaporate water, and the final section to superheat steam. The evaporator produces 30% quality steam. A moisture separator separates the phases. Liquid water is recirculated back to the evaporator inlet. Mostly dry steam is sent to the superheater field. The fields were sized for approximately 110% of full load (50 t/h) steam generation at noon on day 82 (spring equinox). The site is situated in the southwestern US at 35 degrees North latitude.

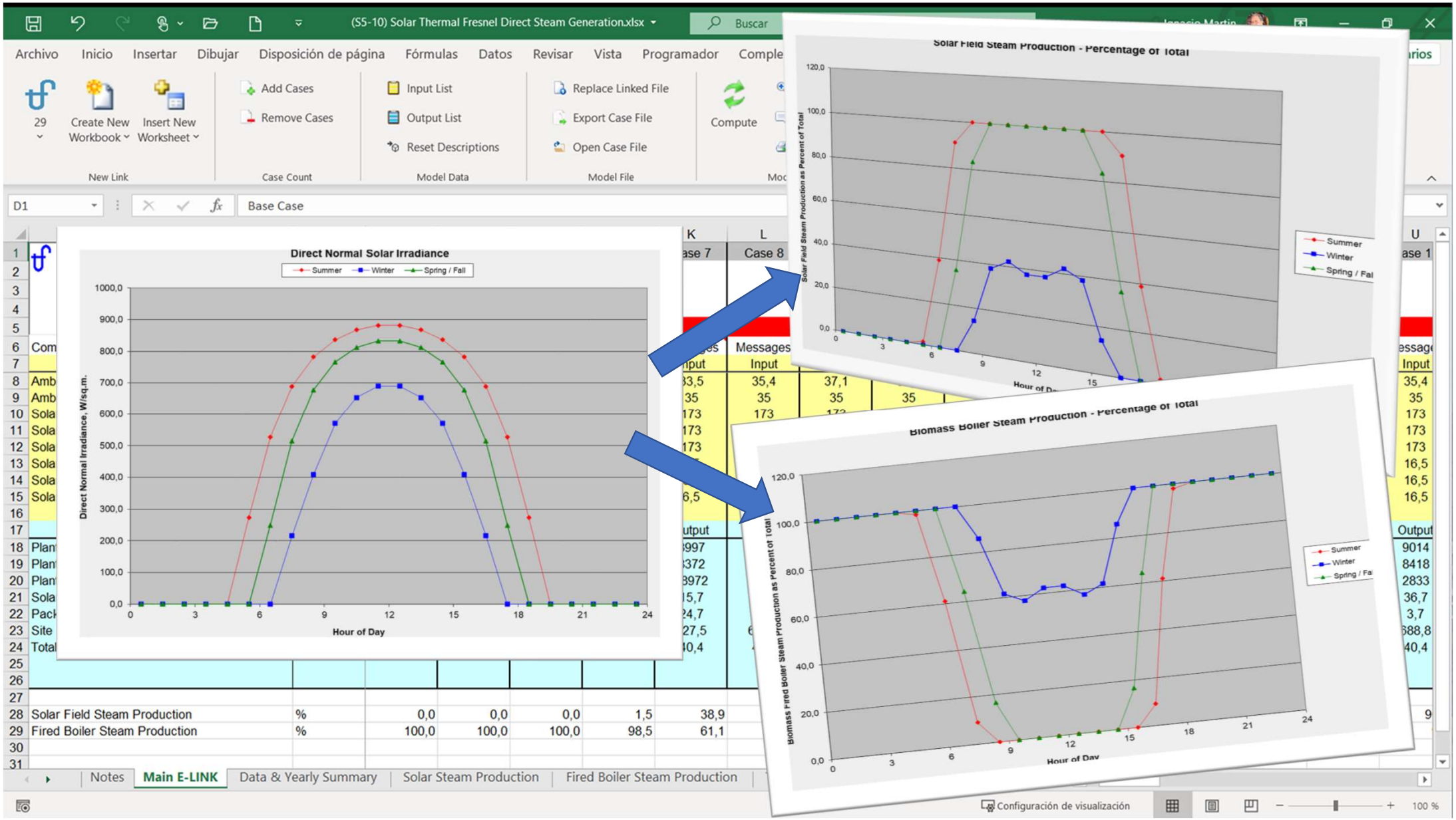
The steam cycle is small and does not include reheat. This results in a rather low cycle efficiency, but one with modest cost and easily adapted for operation in full solar mode, full gas-fired mode, or in hybrid mode when some steam is generated in the field and the balance is provided by the fired boiler. This arrangement allows operation at full load or fixed power regardless of weather conditions or time of day.

The Flow Limiter (icon #25) is used to maintain plant net power output between roughly 8 and 11 MW. If the solar field can generate the minimum required steam to satisfy minimum flow required, the backup boiler is shutdown. When the field is incapable of generating minimum required steam the backup boiler makes up the difference. Simulating this plant over a 24 hour period results in the backup boiler generating all the steam in the overnight hours while it generates little or no steam during the main part of the sunny day.

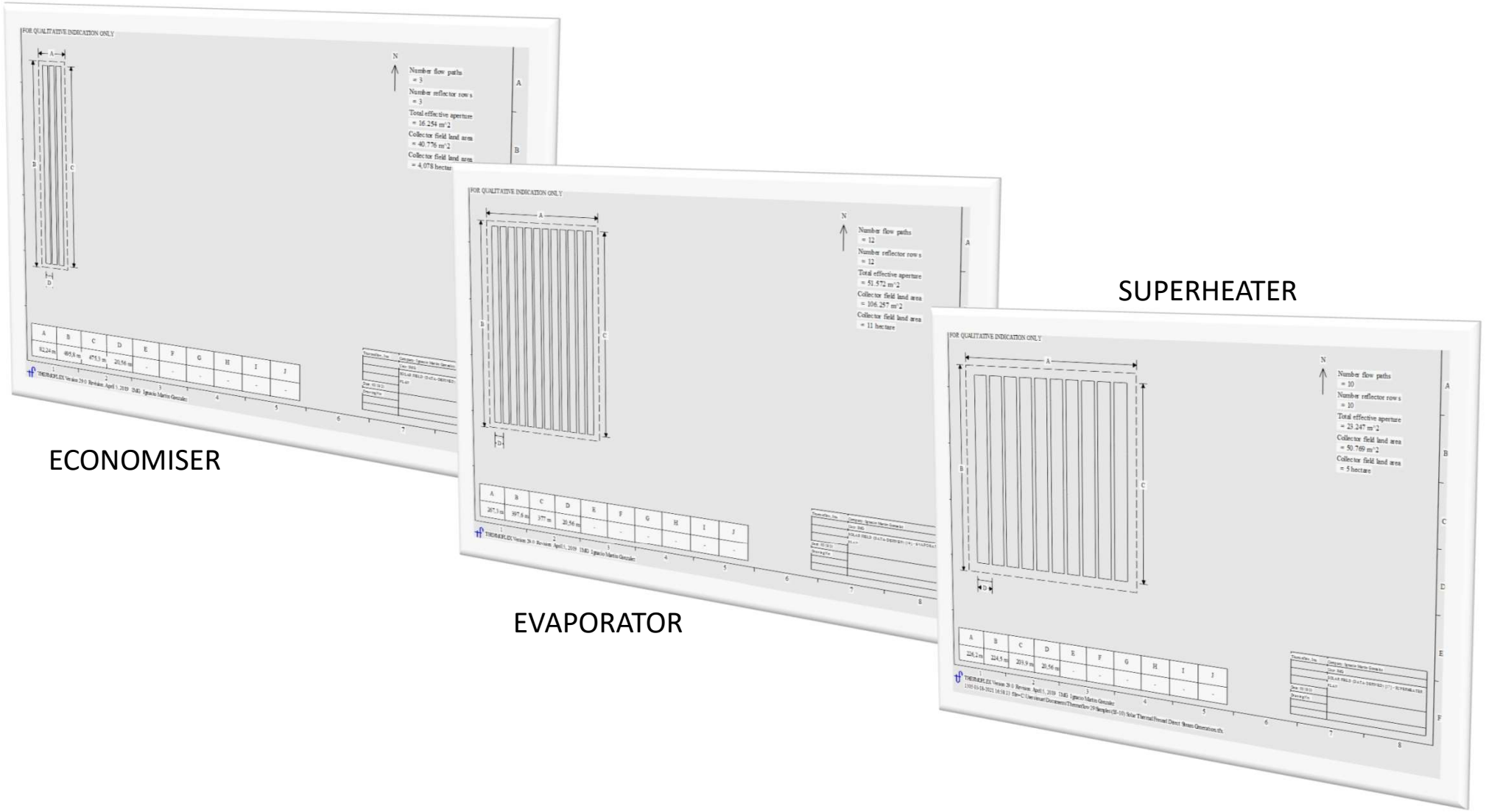
An ELINK model, (S5-10) Solar Thermal Fresnel Direct Steam Generation.xlsx, is available to demonstrate plant operation over 24 hour periods in mid-summer, mid-winter, and on the spring and fall equinoxes. The ELINK model has additional calculations included to estimate yearly power capacity, yearly fuel consumption, and overall effective efficiency for a yearly operating scenario. This relatively low efficiency cycle can operate at net LHV electric efficiency exceeding 41% on a yearly average basis due to the contribution of the fuel-free solar field steam production.



Thermoflow Sample File Predates THERMOFLEX 12 (2003)


(S5-10) Solar Thermal Fresnel Direct Steam Generation.xlsx
Archivo Inicio Insertar Dibujar Disposición de página Fórmulas Datos Revisar Vista Programador
Create New Workbook
Insert New Worksheet
New Link
Add Cases
Remove Cases
Case Count
Input List
Output List
Reset Descriptions
Model Data
Replace Linked File
Export Case File
Open Case File
Model File
Compute
D1
Base Case
Direct Normal Solar Irradiance
Summer
Winter
Spring / Fall
Direct Normal Irradiance, W/sq.m.
Hour of Day
Solar Field Steam Production - Percentage of Total
Solar Field Steam Production as Percent of Total
Biomass Boiler Steam Production - Percentage of Total
Biomass Fired Boiler Steam Production as Percent of Total
Case 8
Messages Input
Solar Field Steam Production % 0,0 0,0 0,0 1,5 38,9
Fired Boiler Steam Production % 100,0 100,0 100,0 98,5 61,1
Notes
Main E-LINK
Data & Yearly Summary
Solar Steam Production
Fired Boiler Steam Production
Configuración de visualización
100 %

SOLAR BOILER Collector Plan Drawings



ECONOMISER

EVAPORATOR

SUPERHEATER