

Homer Simulation with Digital Twin Microgrid Controller

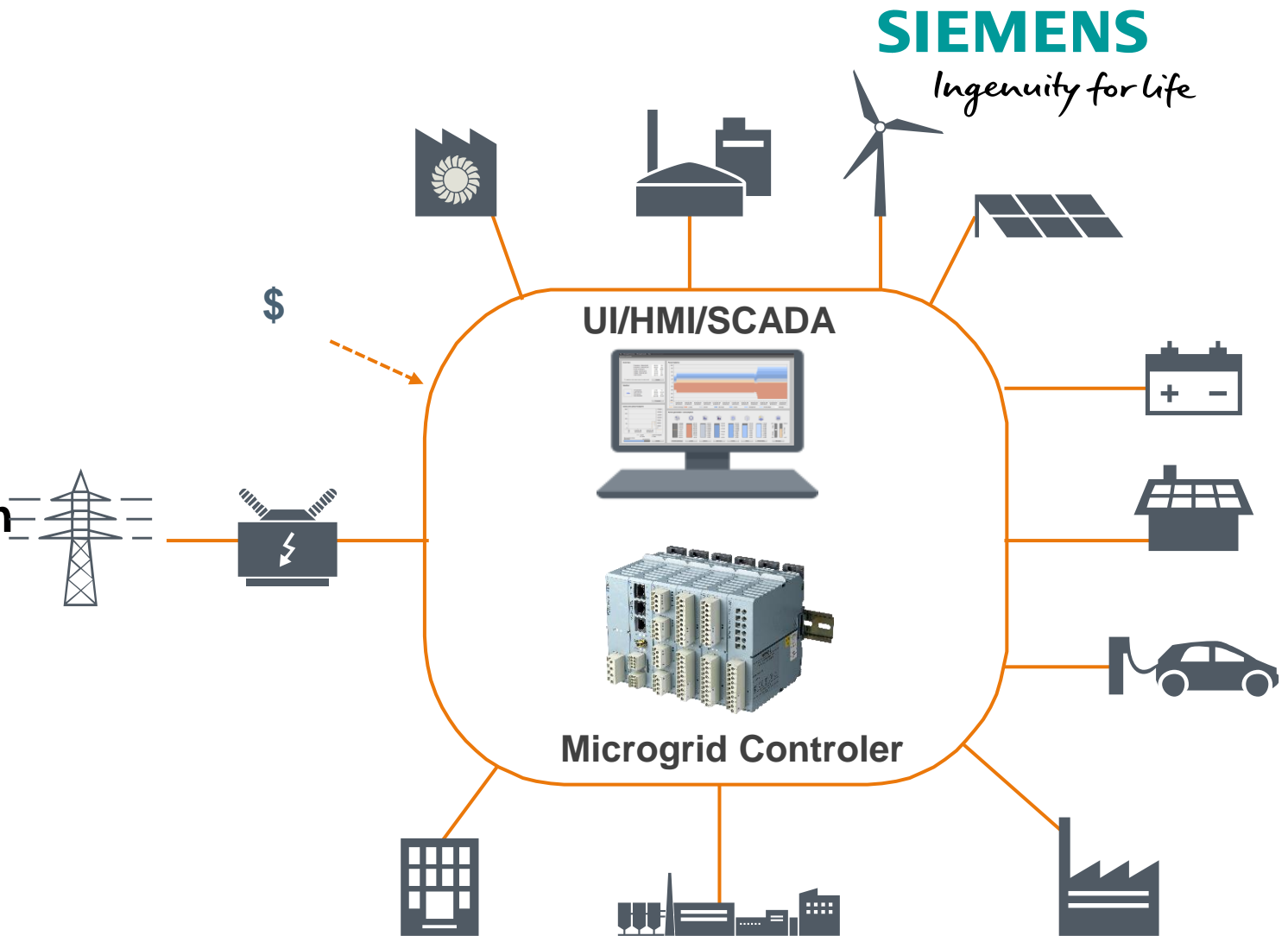
Dino Ablakovic - Senior Solutions Architect

SIEMENS AG - Germany

Microgrid Controller

Main functions:

1. Genset, PV and BESS control
2. Islanding/Grid connection
3. Tie line control
4. Operation modes - Dispatch
5. Tariff monitoring and supervision
6. Monitoring and Archive
7. Event Alarms
8. User Interface (SCADA)
9. Web and Remote connection



Microgrid Controller Digital Twin

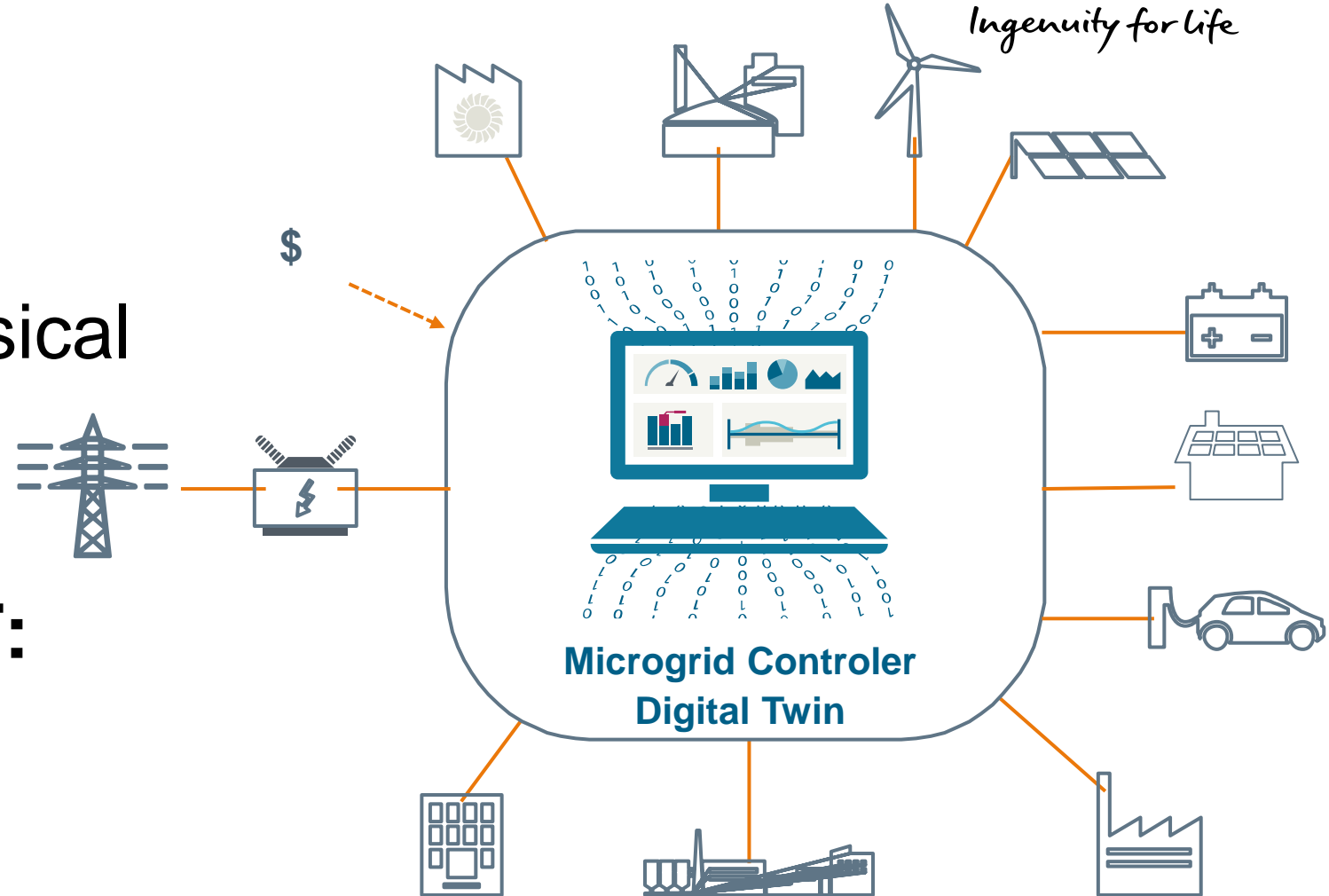
SIEMENS
Ingenuity for Life

Digital Twin

A digital twin is a virtual representation of a physical product or process

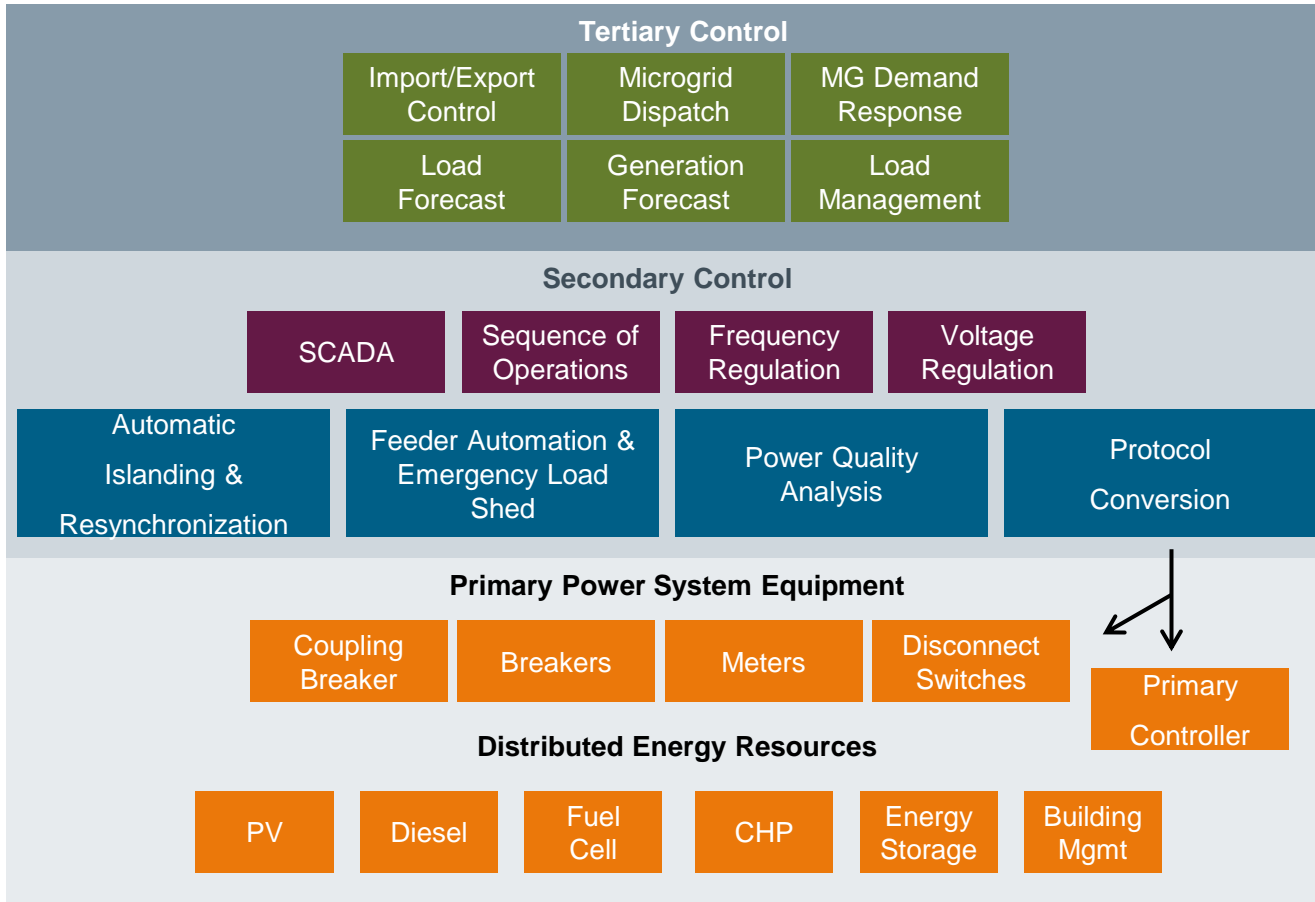
Types of Microgrid DT:

- Software Digital Twin
- RT Digital Twin



Microgrid Control Hierarchy

SIEMENS
Ingenuity for life



Microgrid Controller
Fast /Periodic



Software MG DT
Slow



Automation Systems

Very Fast



RT Simulator
Very Fast



Primary Controllers

Very Fast

Real-Life Control

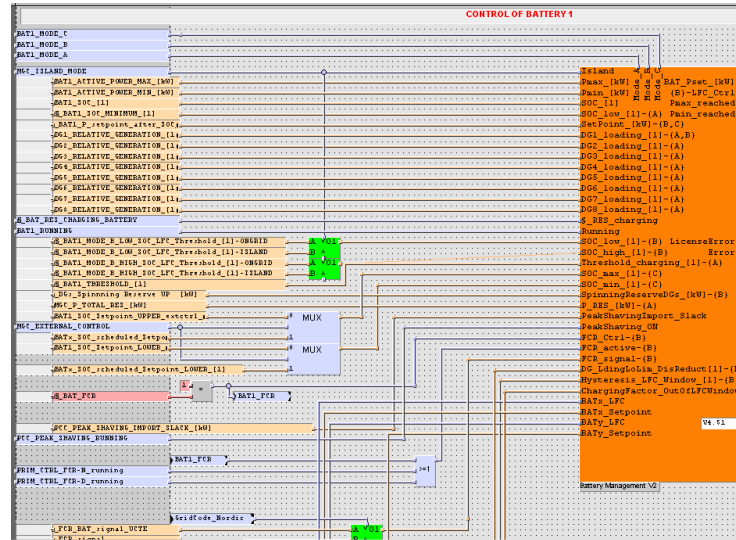
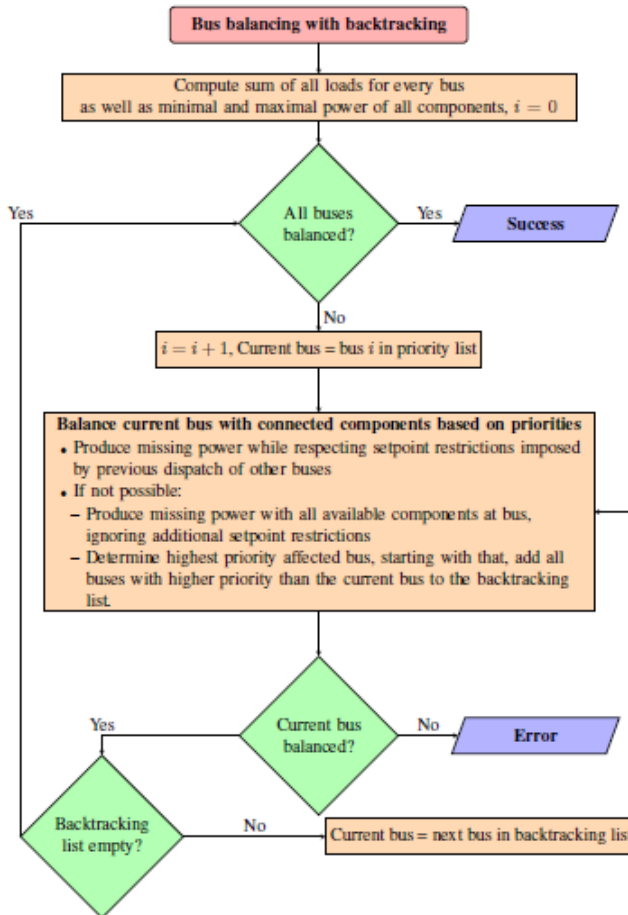
Digital Twin

Digital Twin - Dispatch Algorithm

Microgrid Controller Dispatch Algorithms in Homer

- Cycle Charging
- Load Following
- Generator Order
- Predictive
- Combined (Load following or Cycle Charging)
- **Custom Microgrid Controller Digital Twin**

Digital Twin - Dispatch Algorithm



Microgrid Controller

```

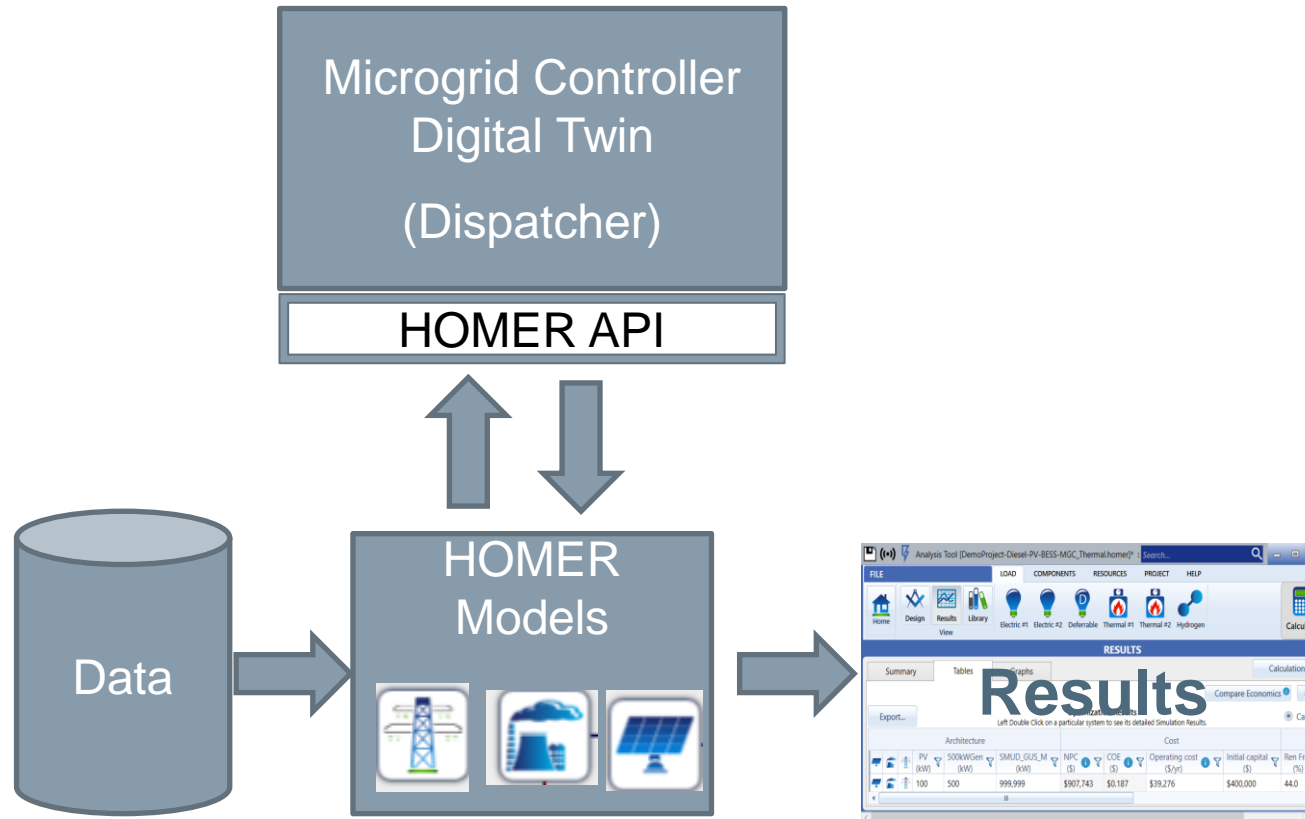
1 #include "MatrixComplFloatSolver.h"
2
3 #include <complex>
4
5 int
6 MatrixComplFloatSolver::setupMatrixComplFloatSolver()
7 {
8
9     loadInputFile("InputFile.txt");
10
11     /* allocate and init memory used by host matrixX[width0][height0]*/
12     cl_uint inputSizeVector = numOfMatrices * 3 * 2 * sizeof(cl_float);
13
14     vectorU = (cl_float *) malloc(inputSizeVector);
15
16     if(vectorU==NULL)
17     {
18         sampleCommon->error("Failed to allocate host memory. (matrixX)");
19         return SDK_FAILURE;
20     }
21
22     /* allocate and init memory used by host matrixX[width0][height0]*/
23     cl_uint inputSizeBytes0 = numOfMatrices * dimension * sizeof(cl_float);
24
25     matrixX = (cl_float *) malloc(inputSizeBytes0);
26
27     if(matrixY==NULL)
    
```



Digital Twin

Fig. 2. Phase 1: Bus Balancing Algorithm with Backtracking

Architecture



FILE LOAD COMPONENTS RESOURCES PROJECT HELP

Home Design Results Library Controller Generator PV Wind Turbine Storage Converter Custom Boiler Hydro Reformer Electrolyzer Hydrogen Tank Hydrokinetic Grid Thermal Load Controller Calculate



LIBRARY

Delete Copy To add a new component, start by copying an existing one. Import...

- Components
 - Controller
 - HOMER Cycle Charging
 - HOMER Load Following
 - HOMER Pro Matlab Link
 - HOMER Generator Order
 - HOMER Combined Dispatch
 - SIEMENS MicroGridController**
 - HOMER Predictive
 - Generator
 - Storage
 - PV
 - Wind Turbine
 - Converter
 - Custom
 - Hydroelectric
 - Hydrokinetic
 - Thermal Load Controller
 - Boiler
 - Reformer
 - Electrolyzer
 - HydrogenTank

SIEMENS MicroGridController - this item is in your library.

General Defaults Capabilities

Name: SIEMENS MicroGridController Last Modified: 10/7/2019 8:47:42 AM

Abbreviation: MGC

Manufacturer: Siemens AG

Notes: Siemens Microgrid Controller in Homer is a Digital twin component whcih simulates the dispatch algorithm of real SICAM A8000 Microgrid Control Application of Siemens AG

Requires one minute timestep

External Controller

External DLL Details

File Name: MGCX64.dll	Processor Architecture	Floating Point Instructions
Id: 98d88f80-675f-40f8-9b80-5915d07b8694 <input type="button" value="New Id"/>	<input type="radio"/> x86 <input checked="" type="radio"/> x64	<input checked="" type="radio"/> None <input type="radio"/> SSE <input type="radio"/> AVX <input type="radio"/> AVX2

Search path for additional libraries (DLL's):

FILE LOAD COMPONENTS RESOURCES PROJECT HELP

Home Design Results Library Controller Generator PV Wind Turbine Storage Converter Custom Boiler Hydro Reformer Electrolyzer Hydrogen Tank Hydrokinetic Grid Thermal Load Controller

Calculate

SCHMATIC

Take Tour

Setup Assistant


REQUIRED CHANGES

- Add a load
- Add a power source
- Add a renewable energy source

HOMER Pro

DESIGN

Add/Remove HOMER Cycle Charging HOMER Load Following **SIEMENS MicroGridController**

CONTROLLER  Name: SIEMENS MicroGridContro Abbreviation: MGC Remove

Copy To Library

Component	Min Qty	Max Qty	Bus
Generator	0	10	AC
PV	0	10	AC
WindTurbine	0	10	AC
Storage	0	10	AC
Grid	0	1	AC
Converter	0	0	AC
Hydroelectric	0	0	AC
Hydrokinetic	0	0	AC
HydrogenTanl	0	0	Hydrogen
Electrolyzer	0	0	Hydrogen
Reformer	0	0	Hydrogen
Boiler	0	10	Thermal
ThermalLoadC	0	10	Thermal

Cost

Capital (\$)	Replacement (\$)	O&M (\$/year)
0.00	0.00	0.00

Lifetime time (years): More...

Maximum Renewable Penetration [%]:

RE Self Consumption

Grid: Priority Rank:

Generator: Priority:

Configuration
1 Delete

Storage Target Discharge Period [h]:

Storage Preferred Rest State 'Empty'


Grid: Storage Charge Threshold [€/kWh]:

Grid: Storage Discharge Threshold [€/kWh]:

Grid: Demand Charge Limit [kW]:

Priority: Electric Bus

Siemens Microgrid Controller in Homer is a Digital twin component which simulates the dispatch algorithm of real SICAM A8000 Microgrid Control Application of Siemens AG

Generic homerenergy.com 

Unrestricted © Siemens 2020

FILE | **LOAD** | **COMPONENTS** | **RESOURCES** | **PROJECT** | **HELP**

Home | Design | Results | Library | View | Electric #1 | Electric #2 | Deferrable | Thermal #1 | Thermal #2 | Hydrogen | Calculate

RESULTS

Summary | Tables | Graphs | Calculation Report

Compare Economics ⓘ | Column Choices...

Optimization Results Categorized Overall

Left Double Click on a particular system to see its detailed Simulation Results.

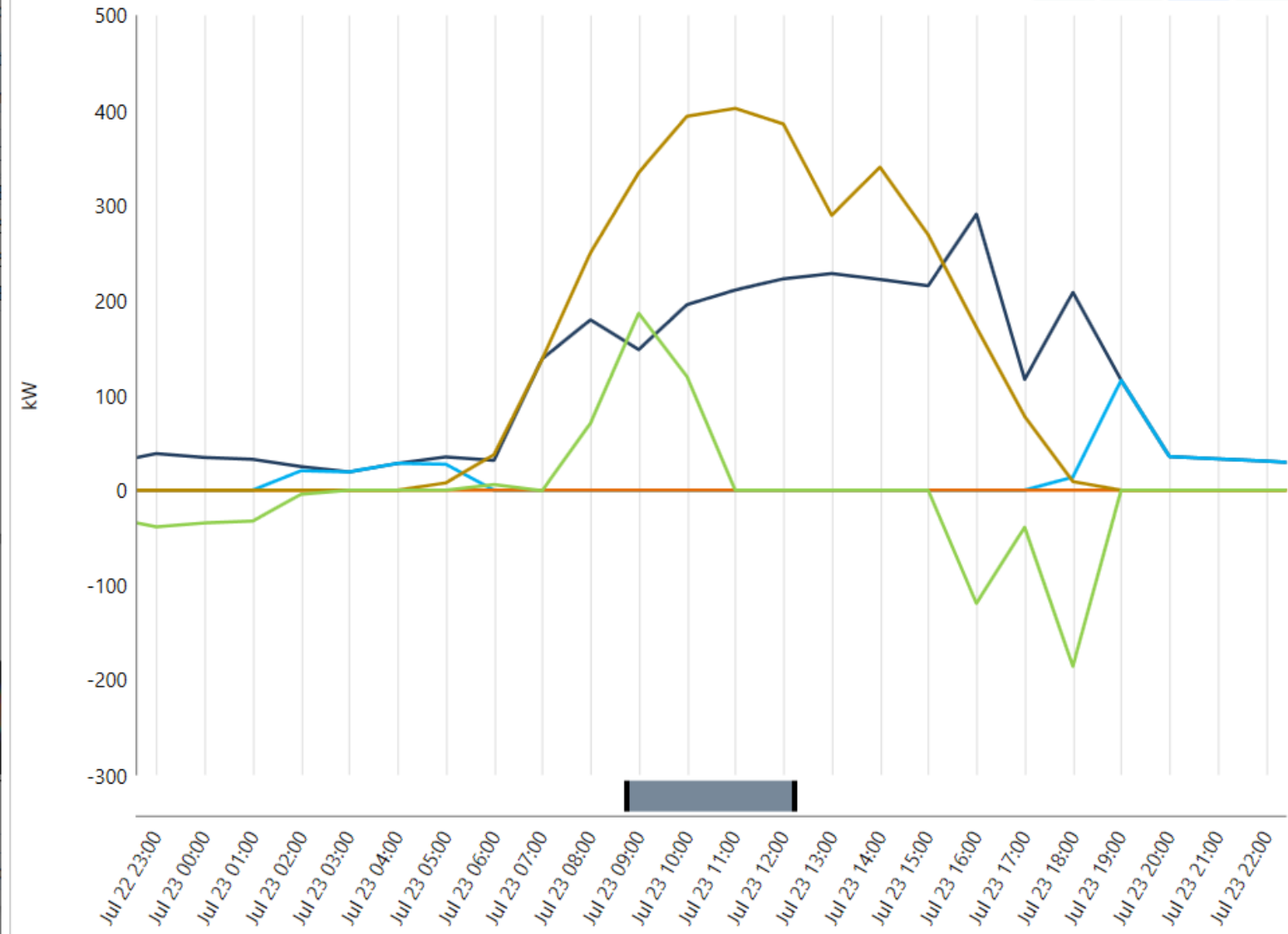
Architecture								Cost				System	
				PV (kW)	500kWGen (kW)	QINOUS_230kW/453kWh	SMUD_GUS_M (kW)	Dispatch	NPC (\$)	COE (\$)	Operating cost (\$/yr)	Initial capital (\$)	Ren Frac (%)
				500		1	999,999	MGC	\$2.03M	\$0.164	\$29,209	\$1.65M	84.9
				500	500	1	999,999	MGC	\$2.14M	\$0.173	\$26,498	\$1.80M	84.9
				500		1	999,999	CC	\$2.15M	\$0.154	\$38,883	\$1.65M	76.6
				500		1	999,999	LF	\$2.15M	\$0.154	\$38,883	\$1.65M	76.6
				500	500	1	999,999	CC	\$2.27M	\$0.163	\$36,173	\$1.80M	76.6
				500	500	1	999,999	LF	\$2.27M	\$0.163	\$36,173	\$1.80M	76.6

||

Hourly Monthly Profile DMap Histogram CDF DC

Display pre-set plot: Power Sources ▾ Date: 7/23/2007 10:00:00 AM Values:

Detailed View < > + -



- Legend**
- Total Electrical Load Served
 - Grid Purchases
 - Generic 500kW Fixed Capacity Genset Pov
 - Generic flat plate PV Power Output
 - Storage_230kW/453kWh Input Power

All Data Series

You are viewing plot: Power Sources
[Make Default](#) [Delete](#)

Benefits vs Challenges

Benefits

- Digital Twin replicates the dispatch of a real Microgrid controller delivering same KPIs
- Digital Twin is a software product tightly related to the real product in the lifecycle
- Digital twin can be used for prototyping

Challenges

- Simulation results are still mostly dependent on the input data
- Compatibility of Homer and Digital Twins
- Limited ability to simulate the effects of RT Control on the Dispatch Algorithm
- Different development platforms of real product and digital twin
- Versioning, Maintenance, Certifications

Contact Details



Dino Ablakovic
Senior Solution Architect - Microgrid
dino.ablakovic@siemens.com

For the U.S. published
by Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA 30005