ORANGE BUTTON

September 12, 2017
Mandalay Bay Convention Center
Las Vegas, NV

ORANGE BUTTON

Raymond Kaiser
Local Focus. Global Reach.
Amzur Technologies

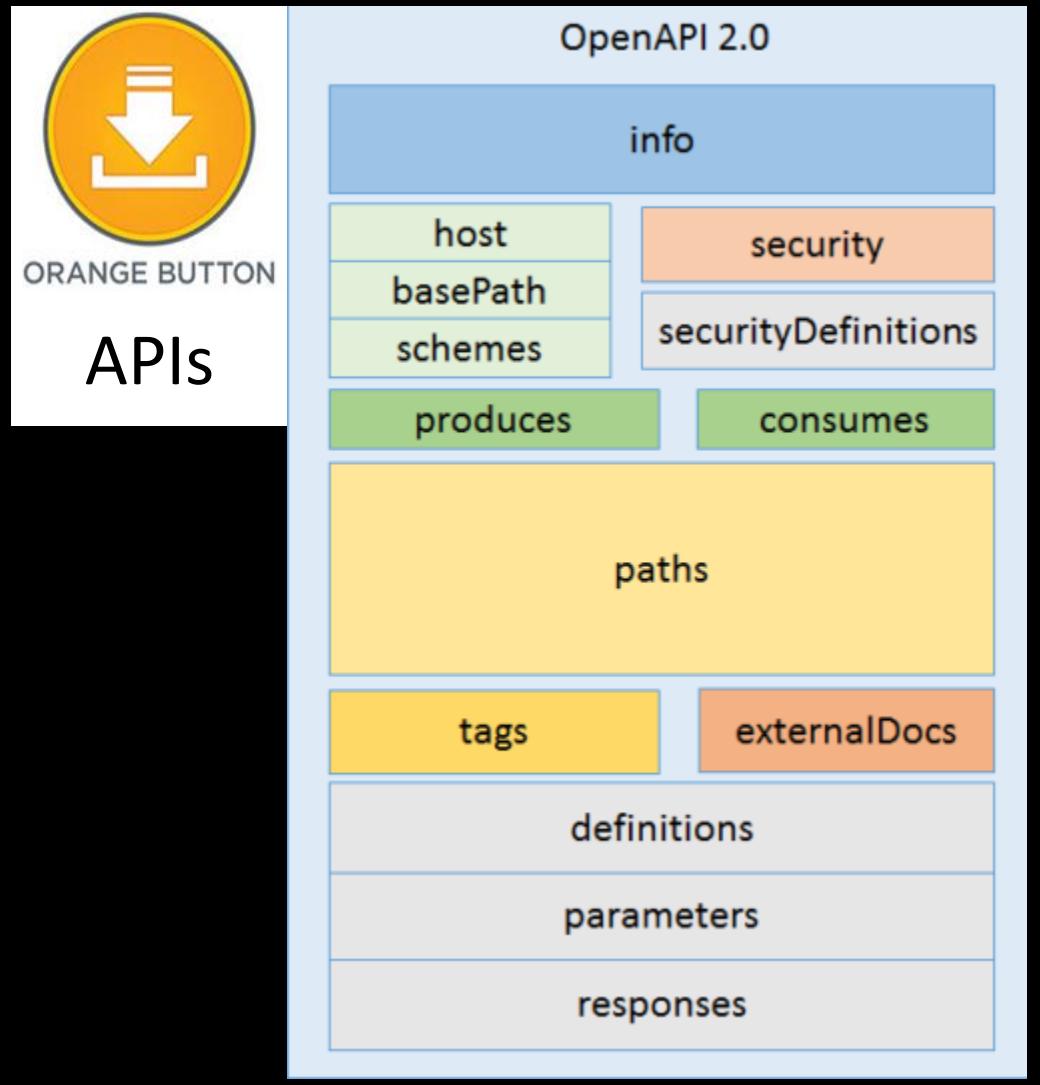
APIs FOR SOLAR PV ASSET MANAGEMENT

Verify and validate model and APIs

@ Net Zero Energy
mixed use
commercial
campus

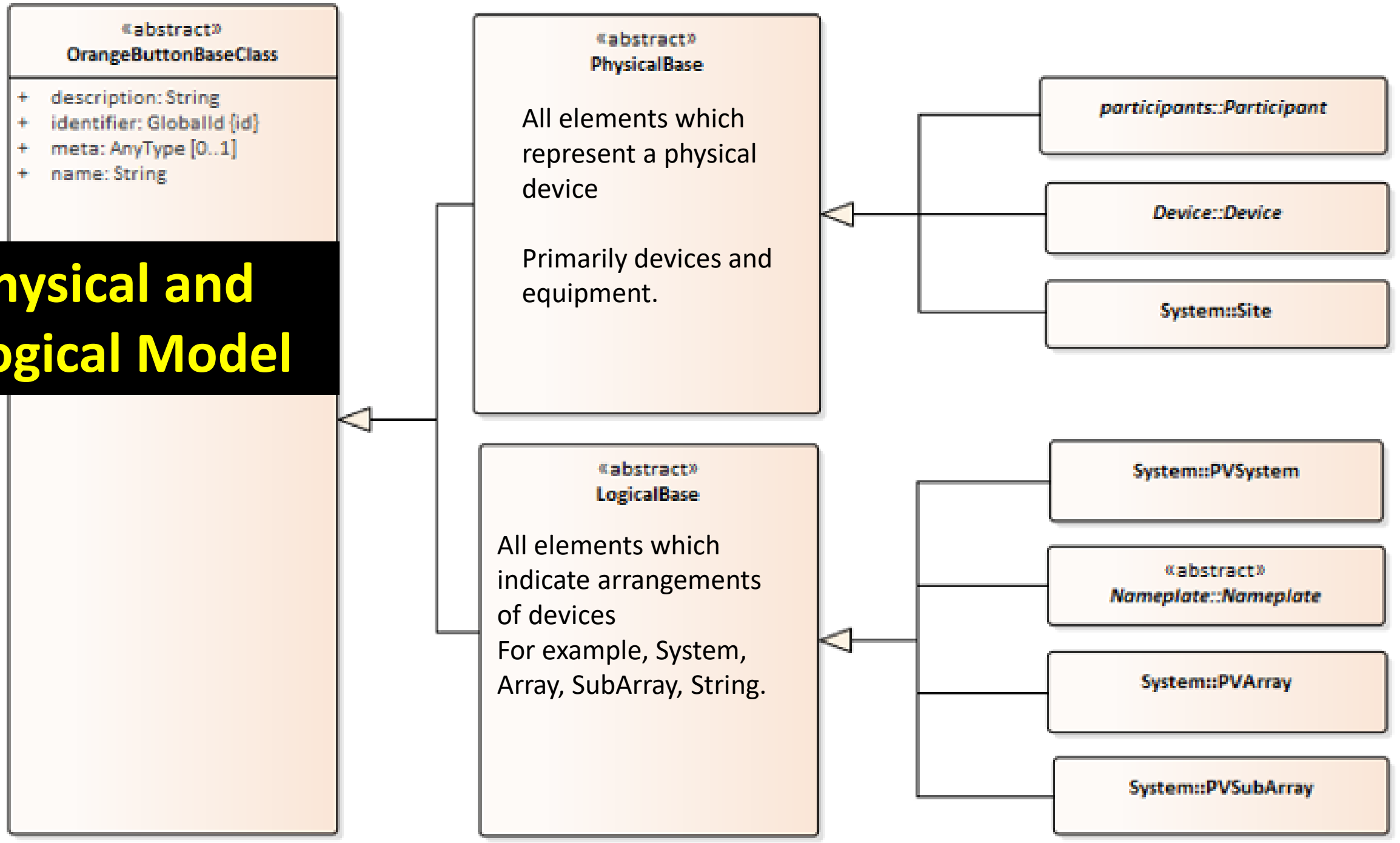
Technology Stack

- APIs - OpenAPI 2.0 spec written in Java
- TSDB – influx db
- Metadata – mySQL
- App – Ruby on Rails
- User Interface – Angular JS
- Cloud service – AWS
- Local deployment - Docker

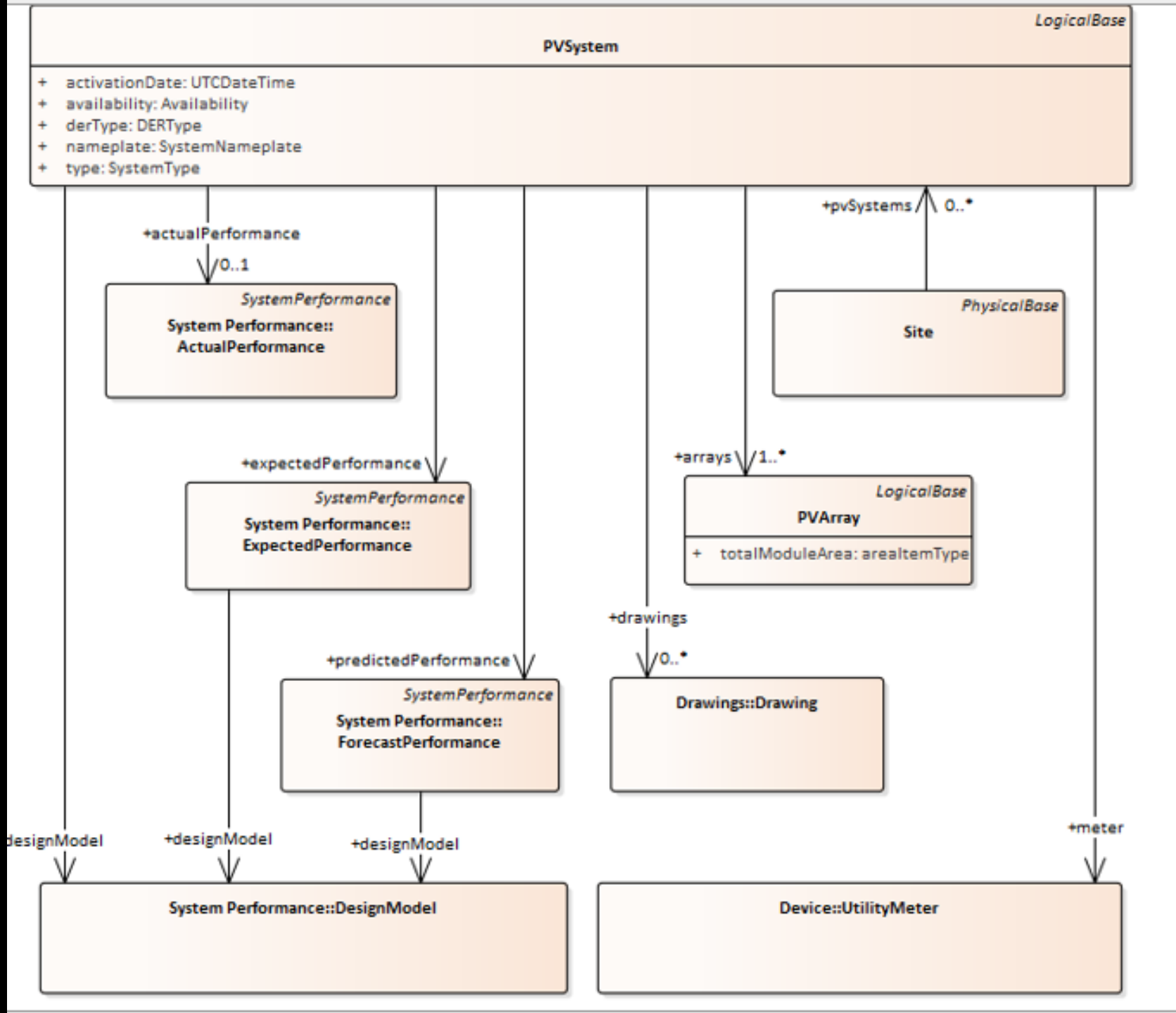


UML Model	http://18.220.143.240/static/html/index.htm
API Staging server	http://18.220.143.240:8080/swagger-ui.html
API Documentation	http://18.220.143.240:6080
HGV Dashboard	http://hgv-ob.s3-website-us-west-2.amazonaws.com/#/dashboard

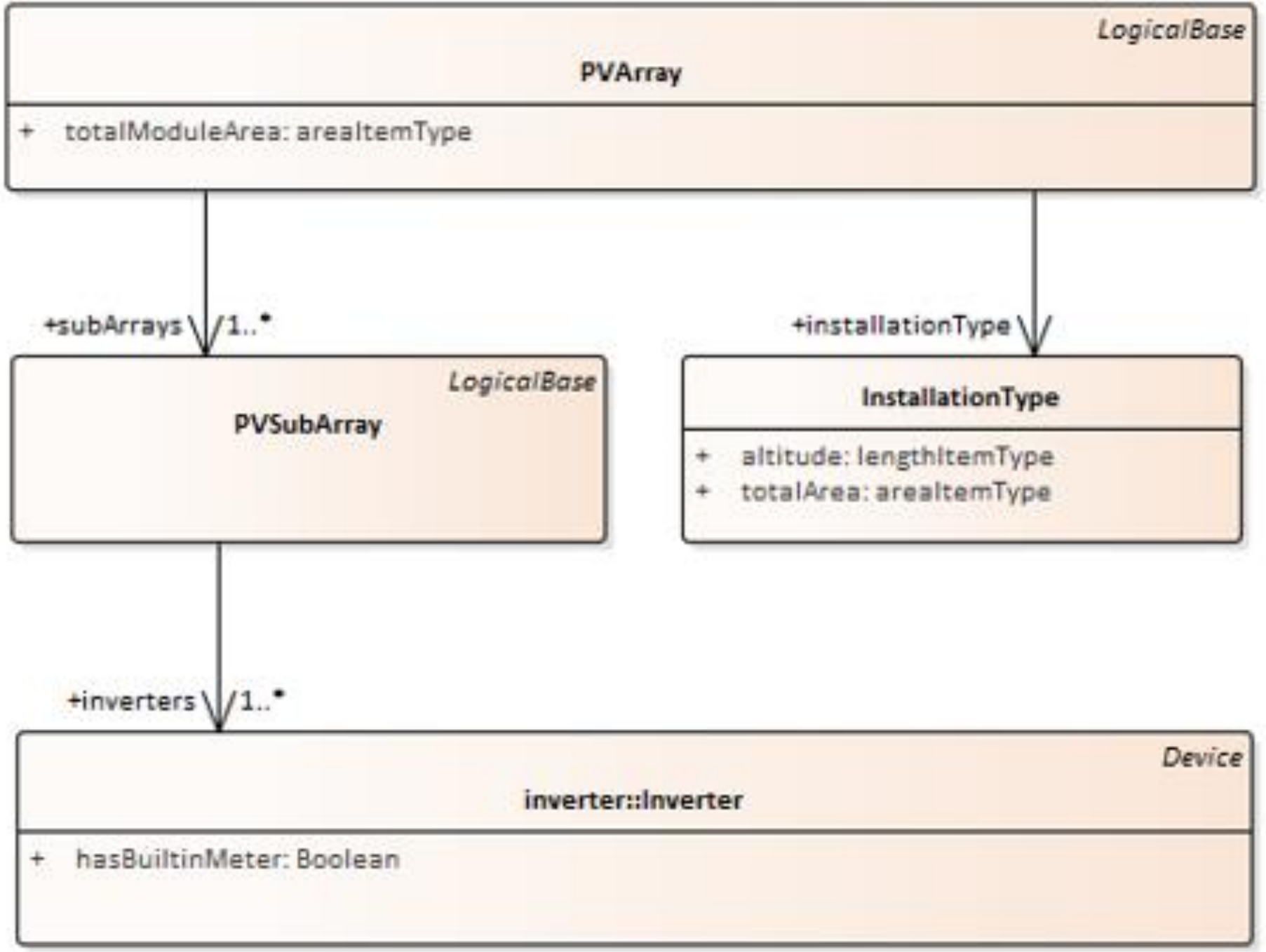
Physical and Logical Model



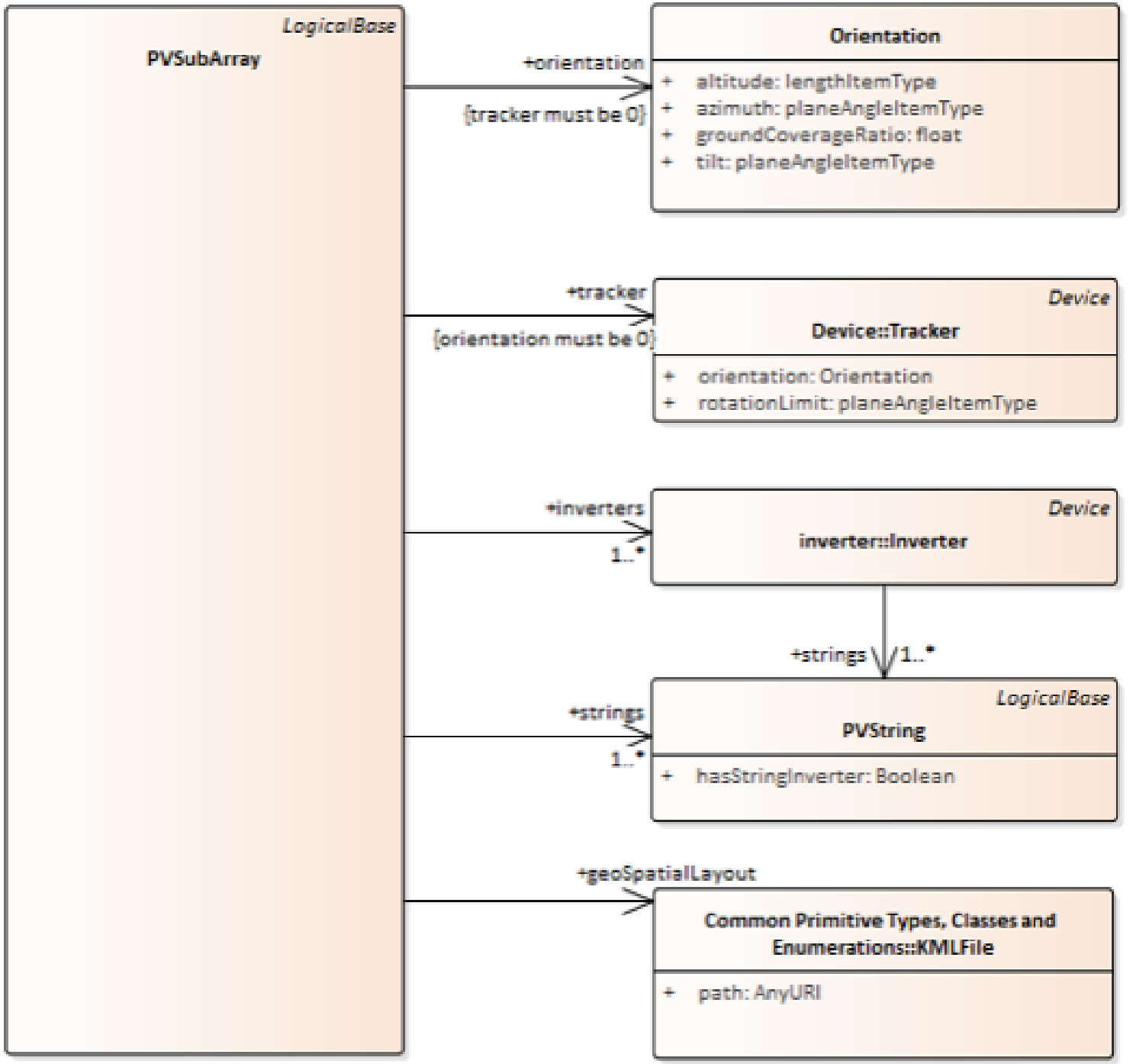
PV System


LogicalBase
PVSystem
+ activationDate: UTCDateTime
+ availability: Availability
+ derType: DERType
+ nameplate: SystemNameplate
+ type: SystemType
+actualPerformance
0..1
SystemPerformance
System Performance::
ActualPerformance
+pvSystems
0..*
PhysicalBase
Site
+expectedPerformance
SystemPerformance
System Performance::
ExpectedPerformance
+arrays
1..*
LogicalBase
PVArray
+ totalModuleArea: arealtemType
+drawings
0..*
+predictedPerformance
SystemPerformance
System Performance::
ForecastPerformance
Drawings::Drawing
designModel
+designModel
+designModel
+meter
System Performance::DesignModel
Device::UtilityMeter

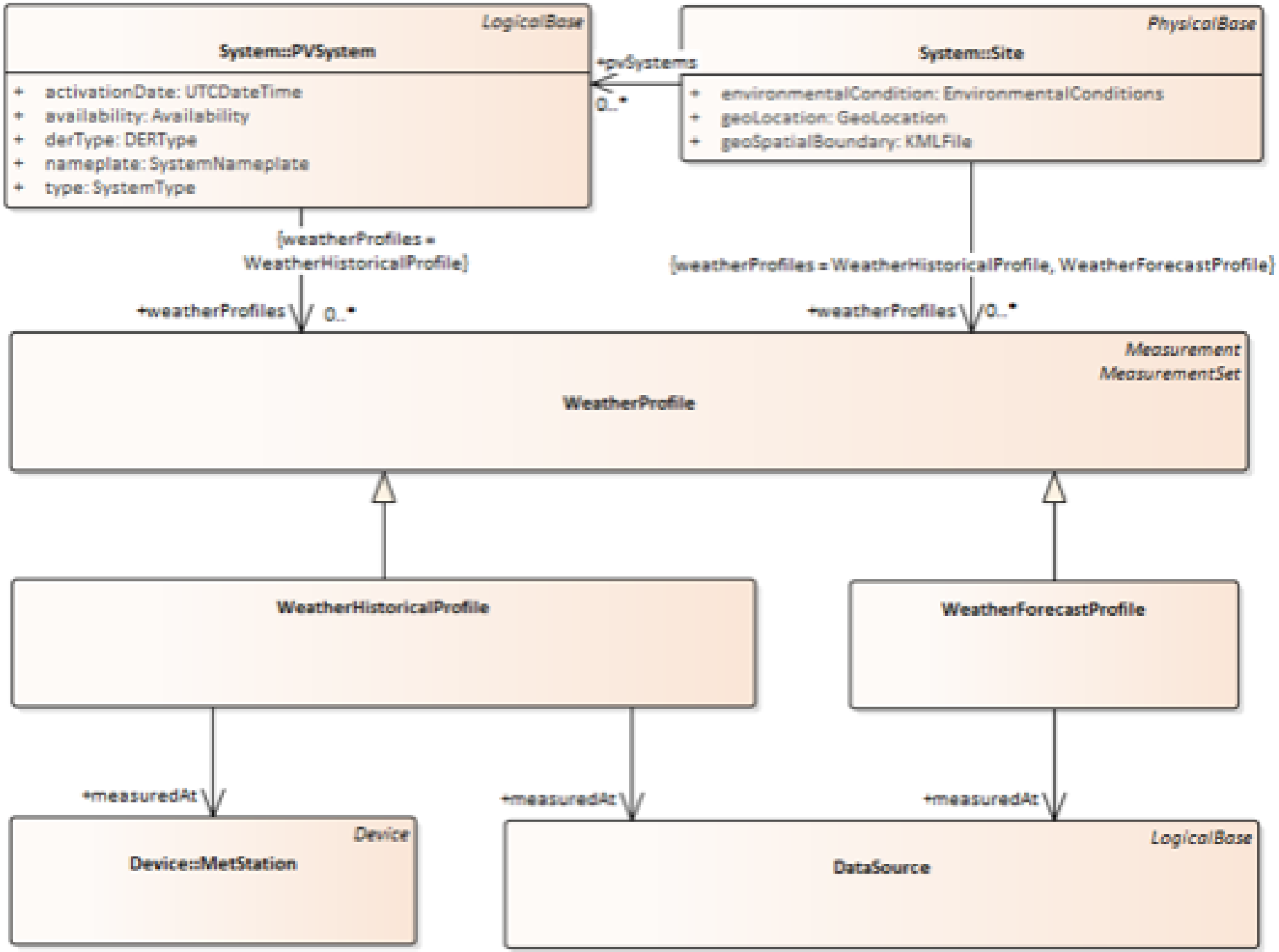
PV Array


LogicalBase
PVArray
+ totalModuleArea: arealtemType
+subArrays
1..*
+installationType
LogicalBase
PVSubArray
InstallationType
+ altitude: lengthItemType
+ totalArea: arealtemType
+inverters
1..*
Device
inverter::Inverter
+ hasBuiltinMeter: Boolean

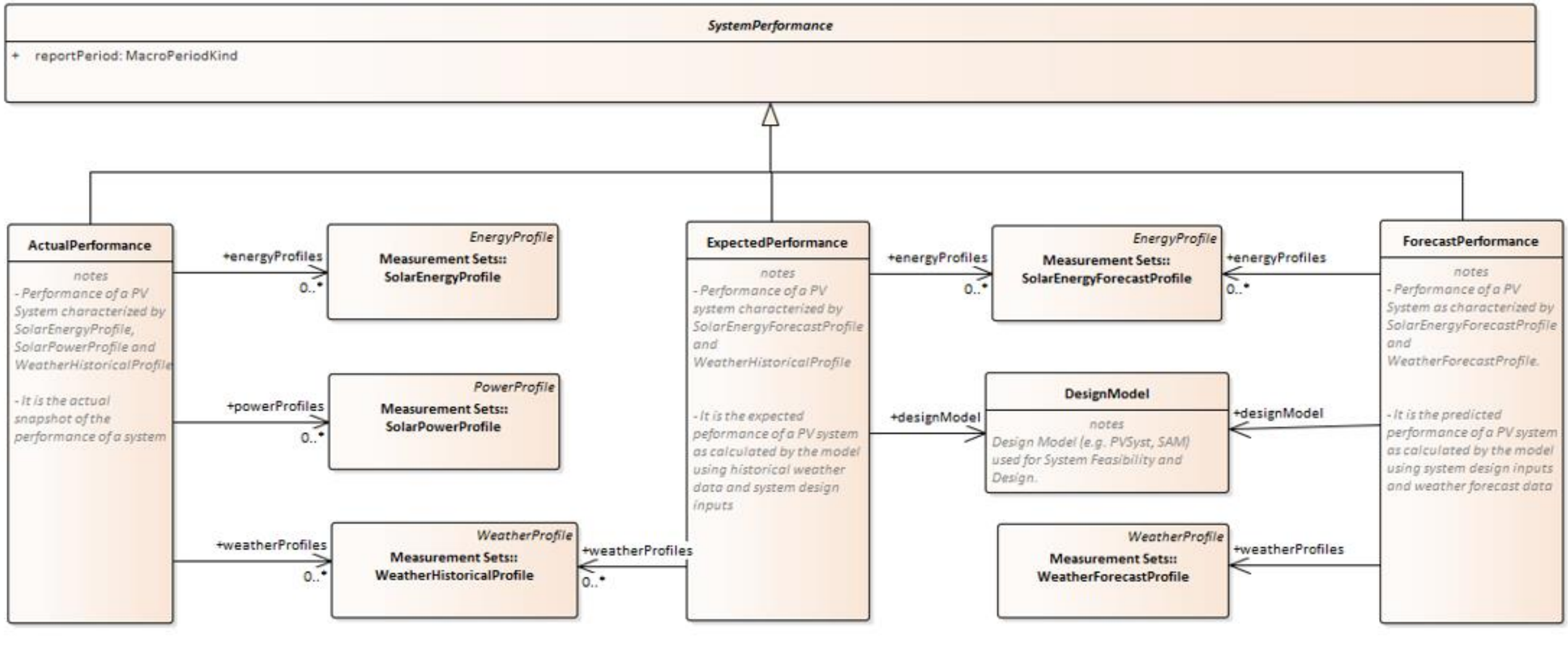
PV SubArray


LogicalBase
PVSubArray
+orientation
{tracker must be 0}
Orientation
+ altitude: lengthItemType
+ azimuth: planeAngleItemType
+ groundCoverageRatio: float
+ tilt: planeAngleItemType
+tracker
{orientation must be 0}
Device
Device::Tracker
+ orientation: Orientation
+ rotationLimit: planeAngleItemType
+inverters
1..*
Device
inverter::Inverter
+strings
1..*
+strings
1..*
LogicalBase
PVString
+ hasStringInverter: Boolean
+geoSpatialLayout
Common Primitive Types, Classes and Enumerations::KMLFile
+ path: AnyURI

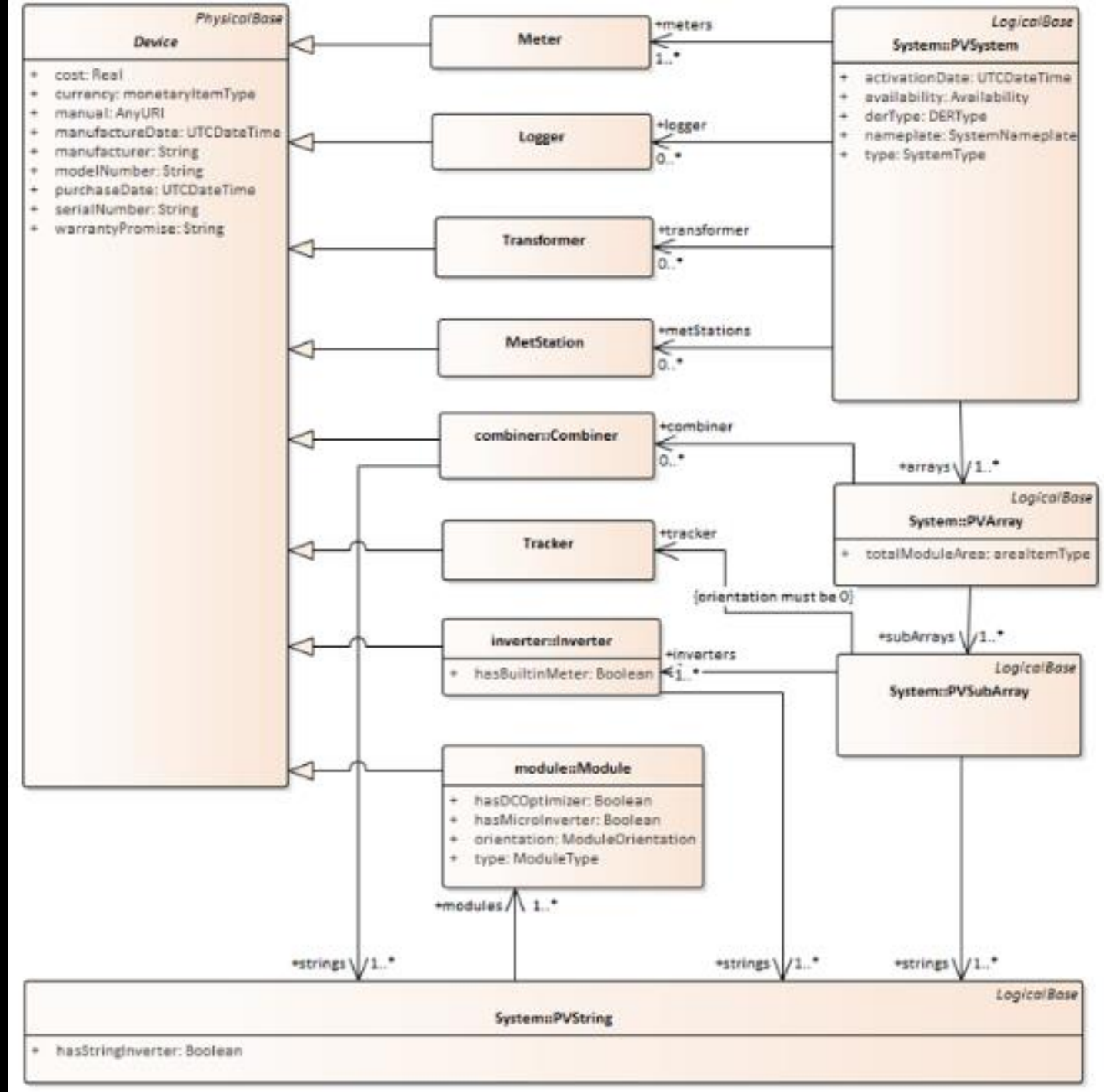
Weather Profile



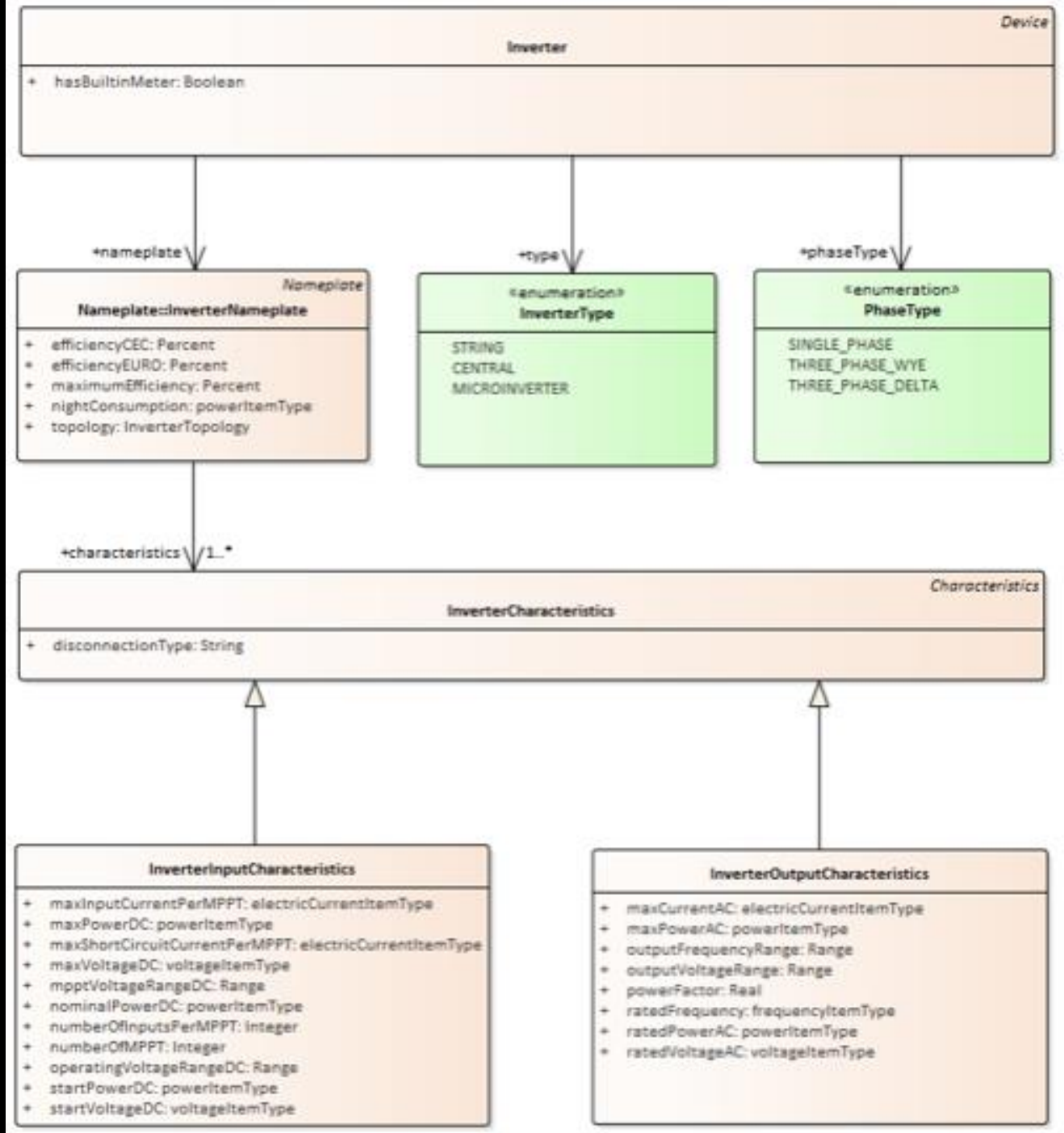
System Performance



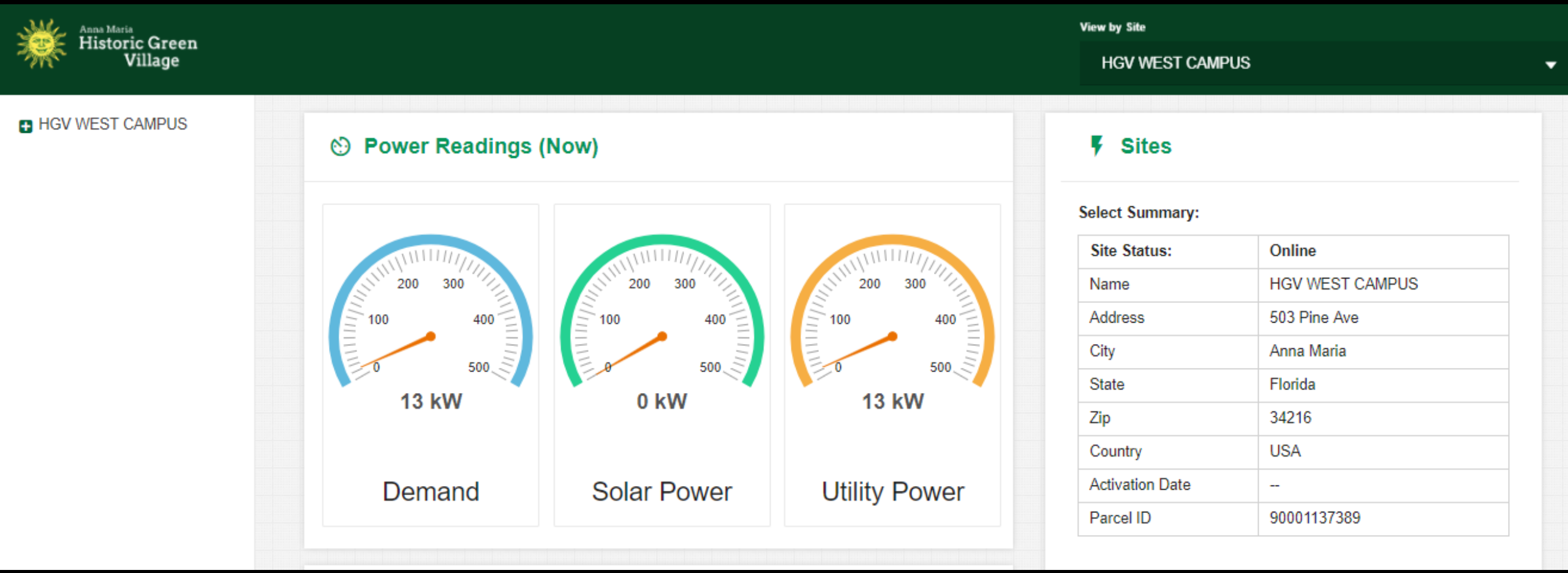
Device View


PhysicalBase
Device
+ cost: Real
+ currency: monetaryItemType
+ manual: AnyURI
+ manufactureDate: UTCDateTime
+ manufacturer: String
+ modelNumber: String
+ purchaseDate: UTCDateTime
+ serialNumber: String
+ warrantyPromise: String
Meter
+meters
1..*
Logger
+logger
0..*
Transformer
+transformer
0..*
MetStation
+metStations
0..*
combiner::Combiner
+combiner
0..*
Tracker
+tracker
inverter::Inverter
+ hasBuiltinMeter: Boolean
+inverters
1..*
module::Module
+ hasDCOptimizer: Boolean
+ hasMicroInverter: Boolean
+ orientation: ModuleOrientation
+ type: ModuleType
+modules
1..*
LogicalBase
System::PVSystem
+ activationDate: UTCDateTime
+ availability: Availability
+ derType: DERType
+ nameplate: SystemNameplate
+ type: SystemType
+arrays
1..*
LogicalBase
System::PVArray
+ totalModuleArea: arealtemType
{orientation must be 0}
+subArrays
1..*
LogicalBase
System::PVSubArray
+strings
1..*
+strings
1..*
+strings
1..*
LogicalBase
System::PVString
+ hasStringInverter: Boolean

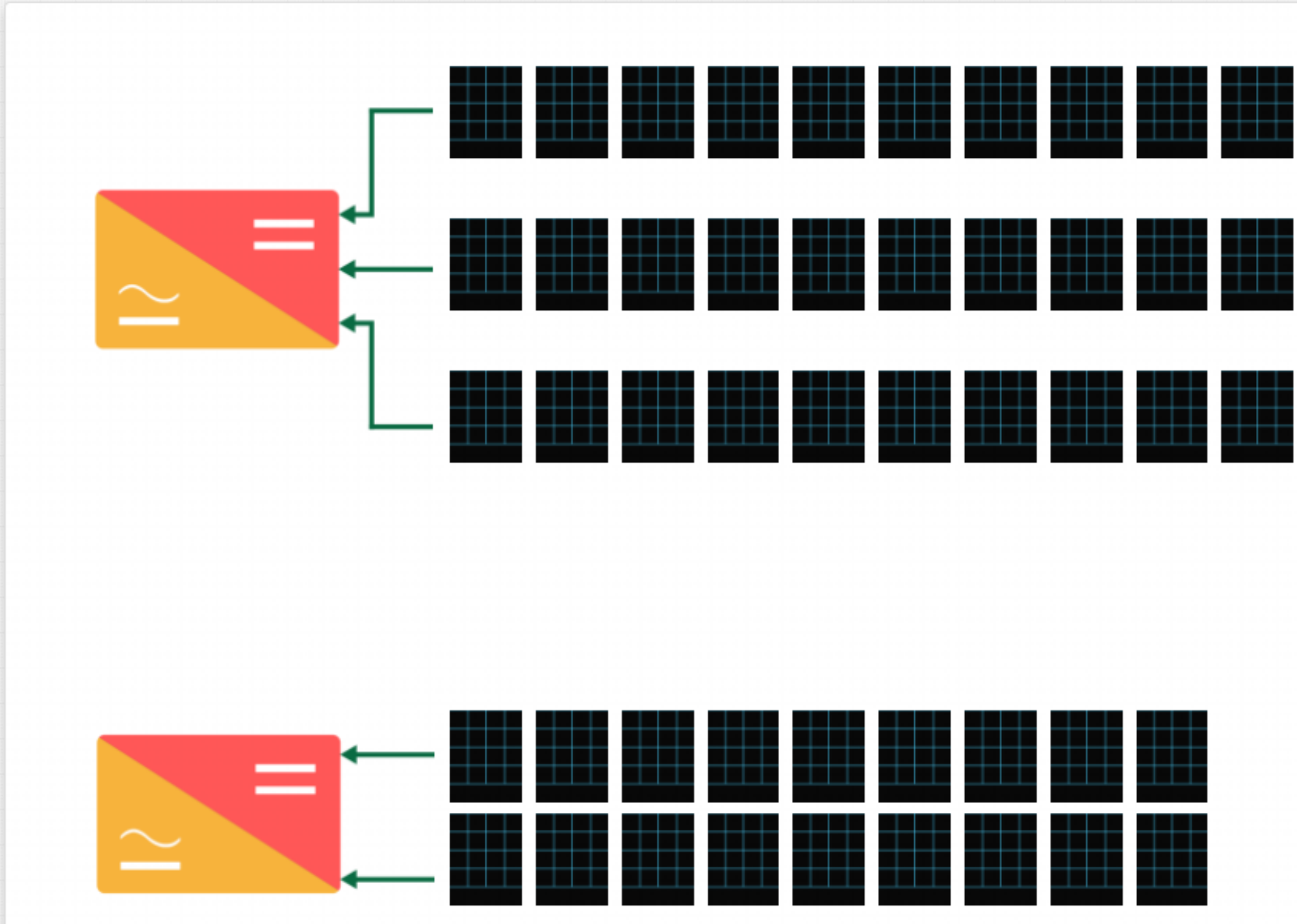
Inverter


Device
Inverter
+ hasBuiltinMeter: Boolean
+nameplate
+type
+phaseType
Nameplate
Nameplate::InverterNameplate
+ efficiencyCEC: Percent
+ efficiencyEURO: Percent
+ maximumEfficiency: Percent
+ nightConsumption: powerItemType
+ topology: InverterTopology
«enumeration»
InverterType
STRING
CENTRAL
MICROINVERTER
«enumeration»
PhaseType
SINGLE_PHASE
THREE_PHASE_WYE
THREE_PHASE_DELTA
+characteristics
1..*
Characteristics
InverterCharacteristics
+ disconnectionType: String
InverterInputCharacteristics
+ maxInputCurrentPerMPPT: electricCurrentItemType
+ maxPowerDC: powerItemType
+ maxShortCircuitCurrentPerMPPT: electricCurrentItemType
+ maxVoltageDC: voltageItemType
+ mpptVoltageRangeDC: Range
+ nominalPowerDC: powerItemType
+ numberOfInputsPerMPPT: Integer
+ numberOfMPPT: Integer
+ operatingVoltageRangeDC: Range
+ startPowerDC: powerItemType
+ startVoltageDC: voltageItemType
InverterOutputCharacteristics
+ maxCurrentAC: electricCurrentItemType
+ maxPowerAC: powerItemType
+ outputFrequencyRange: Range
+ outputVoltageRange: Range
+ powerFactor: Real
+ ratedFrequency: frequencyItemType
+ ratedPowerAC: powerItemType
+ ratedVoltageAC: voltageItemType

APIs in Action



- HGV WEST CAMPUS
  - North Carport
    - Sub Array 1
      - String 1
      - String 2
      - String 3
      - String 4
      - String 5
      - String 6
      - String 7
      - Inverter 1
      - Inverter 2
      - Inverter 3
  - South Carport
  - Sears
  - Rosedale
  - Thelmas



Subarray Detail

- HGV WEST CAMPUS
  - North Carport
    - Sub Array 1
      - String 1
      - String 2
      - String 3
      - String 4
      - String 5
      - String 6
      - String 7
      - Inverter 1
      - Inverter 2
      - Inverter 3

Orientation Details:

Altitude	: 10 ft
Azimuth	: 135°
Tilt	: 9.5°
Tracker Rotation Limit	:
Tracker Type	: fixed
Ground Coverage Ratio	:

Inverter Detail

Inverter 1

Inverter ID	:
Manufacturer	: SMA
Model	: SMA SB 5000 US
Inverter Type	: String
Cost per Unit	:
Manuals	:
Manufacture Date	:
Number of Units	: 1
Purchase Date	:
Warranty Promise	:
Firmware Version	:

Name Plate Details :

CEC Efficiency	: 95.50%
EURO Efficiency	:
Maximum Effiency	: 96.80%
Night Consumption	: 0.1W
Topology	: transformer

Inverter Input Characteristics :

Maximum Input Current Per MPPT	: 20A
Maximum DC Power	: 5300W
Maximum Short Circuit Current Per MPPT	:
Maximum DC Voltage	: 600V
MPPT DC Voltage Range	: 250-480V
Operating DC Voltage Range	:
Nominal DC Power	: 5300W
Number of Inputs per MPPT	: 4
Number of MPPT	: 1
Startup DC Power	:

Inverter Output Characteristics :

Maximum AC Current	: 21A
Maximum AC Power	:
Output Frequency Range	: 59.3-60.5Hz
Output Voltage Range	: 211-264V
Power Factor	: 1
Rated AC Power	: 5000W
Rated AC Frequency	: 60Hz
Rated AC Voltage	: 240V

Module Detail

Module Details

Model	: STP 190
Module Type	:
Cost per Unit	:
Manuals	:
Manufacture Date	:
Purchase Date	:
Warranty Promise	:
Firmware Version	:

Module Characteristics

Current at maximum Power	: 5.20A
Voltage at Maximum Power	: 36.6V
Nominal Maximum Power	: 190W
Open Curcuit Voltage	: 45.2V
Short Circuit Current	: 5.62A

Name Plate Characteristics

Back Material	:
Fire Rating	:
Front Material	: tempered glass
Frame Material	: Anodized aluminium alloy
Junction Box Rating	: IP67
Length	: 1580mm
Width	: 808mm
Weight	: 15.5kg
Maximum Fuse Rating	: 15A
Maximum System Voltage	:
Maximum System Voltage Standard	: 1000VDC
Module Efficiency	: 14.90%
Power Tolerance	: 5W
Temparature Coefficient Maximum Power	: -0.48 %/C
Temparature Coefficient Operating Voltage	: -0.34 %/C
Temparature Coefficient Short Circuit Current	: 0.037 %/C
Cell Orientation	:
Cell Area	: 15625mm2
Count	: 72
Row Count	: 6
Colmn Count	: 12