

Information documents are not authoritative. Information documents are for information purposes only and are intended to provide guidance. If there is a discrepancy between an information document and any authoritative document in effect, the authoritative document governs.

1 Purpose

This information document relates to the following authoritative document¹:

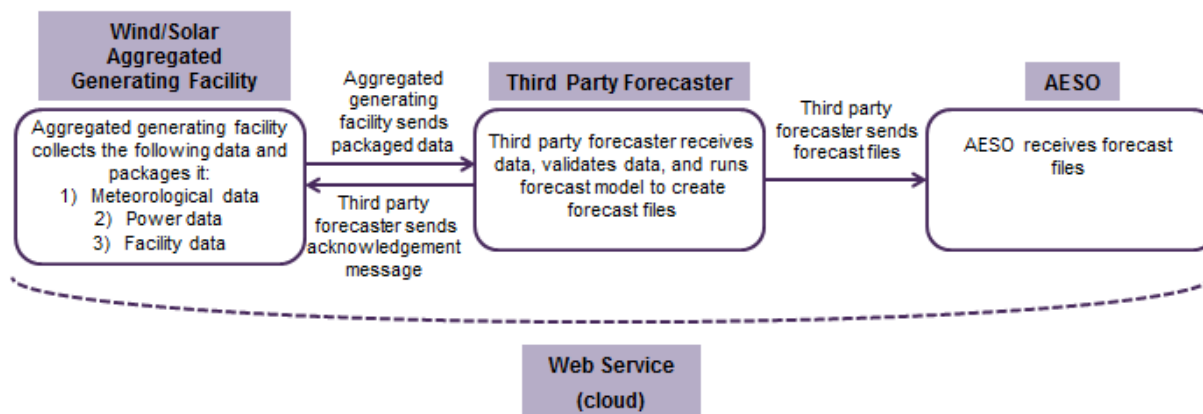
- Section 304.9 of the ISO rules, *Wind and Solar Aggregated Generating Facility Forecasting* (“Section 304.9”)

The purpose of this information document is to provide a legal owner of a wind or solar aggregated facility with information regarding the method and format that its forecasting data must be submitted to the AESO; and with information to clarify forecasting data.

2 Overview of Forecast Data Method and Format Requirements

Pursuant to subsection 5(2) and subsection 8(2) of Section 304.9, the AESO specifies that a legal owner of a wind or solar aggregated generating facility must use the AESO’s third-party forecaster for submitting meteorological, power and facility data specified in Section 304.9. Figure 1, which is shown below, provides an illustration of this method:

Figure 1: Provision of data to third-party forecaster



2.1 Onboarding Process

The legal owner of a wind or solar aggregated generating facility that has not previously provided forecast data for its facility pursuant to Section 304.9 is required to undertake an onboarding process. This may include the legal owner of a new aggregated generating facility or a new legal owner of an existing aggregated generating facility.

The legal owner of a wind or solar aggregated generating facility must work with the AESO’s third-party forecaster to integrate its facility data using the AESO’s wind and solar forecasting method and format.

2.2 User Access

The legal owner of a wind or solar aggregated generating facility will acquire a unique username and access key to log in to the wind and solar forecast data upload site by sending a request to:

¹ “Authoritative documents” is the general name given by the AESO to categories of documents made by the AESO under the authority of the *Electric Utilities Act* and associated regulations, and that contain binding legal requirements for either market participants or the AESO, or both. Authoritative documents include: the ISO rules, the reliability standards, and the ISO tariff.

info@aeso.ca. The use of this unique username and access key will ensure the wind or solar aggregated generating facility is authenticated to the third-party forecaster for the upload of data.

2.3 Pre-production Testing Site

The pre-production site for a legal owner of a wind or solar aggregated generating facility to test its data system and connection to the third-party forecaster is:

<https://windsolardata.aeso.ca/preprod/>

3 Wind and Solar Data Transfer Process

3.1 Data Transfer Protocol Requirement

The legal owner of a wind or solar aggregated generating facility must use a minimum Transfer Layer Security protocol of version 1.2 or newer to access the third-party forecaster site.

3.2 Data Upload Site

The site for a legal owner of a wind or solar aggregated generating facility to upload production data is:

<https://windsolardata.aeso.ca/prod>

3.3 Data Schemas

The information below provides additional information relating to data schemas including the following data schemas that the legal owner and the third-party forecaster must use, as applicable, for the transfer of data. The data schemas are found in the appendices indicated.

- (a) facility data schema:
 - (i) wind facility data schema – see Appendix 1
 - (ii) solar facility data schema – see Appendix 2
- (b) meteorological data schema:
 - (i) wind meteorological data schema – see Appendix 3
 - (ii) solar meteorological data schema – see Appendix 4
- (c) net-to-grid real power and real power limit data schema - see Appendix 5
- (d) gross real power capability schema – see Appendix 6
- (e) communication layer schema – see Appendix 7

The legal owner can use the communication layer with the following 4 data types from multiple facilities: meteorological; net-to-grid real power and real power limit; gross real power capability; and facility data. This layer provides the authentication in combination with the encoded facility name; only the valid combination authorizes for delivery of the envelope.

- (f) message response schema – see Appendix 8

This schema is used for the message acknowledgement response that is sent from the third-party forecaster to the legal owner of wind or solar aggregated generating facility to acknowledge the transmission of data and includes error messages, when applicable.

3.4 Data Transfer Frequency and Time Stamps

The legal owner submits forecast data through the data upload production site under specified timing requirements. Different types of data have different transfer frequency requirements outlined in subsection 4, subsection 5, and subsection 8 of Section 304.9. In addition, the legal owner must transfer data to the third-party forecaster using the following data transfer frequencies.

- (a) The real power limit and actual net-to-grid real power data set out in subsection 4(7) of Section 304.9, at 1-minute intervals.

- (b) The facility data is submitted upon initial connection of a wind or solar aggregated generating facility data system to the third-party forecaster, and when changes occur to facility data set out in subsection 8 of Section 304.9. For example, if new wind turbines are added to an existing wind aggregated generating facility, the legal owner of the aggregated generating facility must submit new facility data that captures this change.

The legal owner must provide 2 time stamps, in Coordinated Universal Time, with each data transfer: one that indicates the time the data was processed; and one that indicates the time the data was sent as shown in Table 1. This will provide the third-party forecaster with more accurate data if there is a delay between data processing and send times.

Table 1: Date and Time Stamps

Activity	Source	Date/Time Stamp
Process	Facility	ValidTimeOfData
Send	Facility	Generation_of_XML_and_Send

3.5 Multiple Aggregated Generating Facilities Owned by the Same Legal Owner

The WindSolarComLayer allows for the legal owner of multiple wind or solar aggregated generating facilities to post all data as one message, rather than sending multiple messages for every interval specified in subsection 4, subsection 5, and subsection 8 of Section 304.9. This reduces the number of messages that are sent; therefore, the AESO encourages the legal owners of multiple wind or solar aggregated generating facilities to utilize this option. The details of the WindSolarComLayer schema are provided in Appendix 8 of this information document.

3.6 Data Integrity Check

The legal owner of the wind or solar aggregated generating facility is to calculate, for data integrity purposes, the Secure Hash Algorithm, (SHA)256 checksum hash value, for the entire message, which will be added into the http header.

The third-party forecaster will recalculate the SHA256 checksum hash value upon receiving the forecast data from the wind or solar aggregated generating facility and compare them to ensure that data integrity is maintained throughout the data transfer process.

3.7 Data Transfer Failure

The legal owner, when notifying the AESO, pursuant to subsection 6 and 7 of Section 304.9, must use the following email address: info@aeso.ca.

The AESO expects the legal owner of the aggregated generating facility to send all of the most recent unsent power, gross real power capability, and meteorological data to the third-party forecaster, up to a maximum of 12 hours once its connection is restored.

3.8 Message Acknowledgement and Error Messages

The third-party forecaster will provide the legal owner of a wind or solar aggregated generating facility with an acknowledgement response for every data submission they receive. This response will include a return code of "0" for a failure and "1" for success. If there is an error with the data transfer, an error message, and a error level code will also be provided. Error level details are outlined below, and the details of the acknowledgment schema are provided in Appendix 8 of this information document.

(a) Error Message Examples in Acknowledgment Response

Some typical examples of error messages and their respective error level code are provided in Table 2 below. The relevant information for the legal owner is provided in the error message. The error level codes have no direct relevance for the understanding of the error.

Table 2: Error Message Examples

Return Code	Error Level	Message Example
0	2	Authentication problem
0	2	No valid XML header found
0	3	Access not granted for facility=xx with Access Key=xx for schema=xx
0	4	Invalid request structure - got xx bytes out of expected xx
0	8	validation result: line:19: element BarometricPressure: Schemas validity error
0	9	The process time and send time differ with more than 3 minutes
0	10	The send time is more than 12 hours old

(b) Email Error alerts

If the third-party forecasting software detects a data validity issue, the third-party forecaster will send email error alerts to the legal owner every 2 hours. For example, if a power or meteorological value is repeated or missing for 2 consecutive hours. These email error alerts will continue to be sent until the error has been resolved.

4 Data Definitions

4.1 Meteorological Data

Pursuant to subsection 4 and 5 of Section 304.9, for each measurement type listed, the legal owner must ensure that the meteorological data collection equipment and related sensing devices are installed at the height specified in Table 1 of Section 304.9. The legal owner may choose to obtain and send data with accuracy or precision greater than or equal to the accuracy and precision measurement listed in Table 1 of Section 304.9.

The meteorological tower ID is a facility-specific unique ID which differentiates multiple meteorological towers. The legal owner may choose this unique ID. The AESO recommends using the facility ID followed by measurement height and GPS co-ordinates.

For example:

“ABCD850115”

The AESO further recommends that this unique ID be consistent with the Meteorological Tower Unique ID provided in the facility data schema.

(a) Wind Meteorological Data

Pursuant to subsection 4(2) of Section 304.9, the legal owner must send 2 data sets to the third-party forecaster obtained at the locations listed as “Set 1” and “Set 2” in Table 1 of Section 304.9.

The following provides further explanation of the data requirements set out in Table 1 of Section 304.9:

- (i) Ambient Temperature - in the case where the temperature sensor is installed a few metres below the hub height anemometers and wind vanes, provide the exact height where the sensor is installed to the third-party forecaster.

- (ii) Ice-up Parameter Measured with an Icing Sensor - This represents the measurement of ice build-up as measured by an independent instrument in millimetres.

For example, 0 mm icing thickness is equal to 0; 40 mm icing thickness is equal to 0.4; and 80 mm of icing thickness is equal to 0.8.

- (iii) Precipitation - Only consider rain measurement for the precipitation measurement.
- (iv) Dewpoint - The AESO prefers a dedicated instrument for the dew point measurement. In the case where a suitable instrument is not available, the legal owner may calculate dew point using temperature and relative humidity data.
- (v) Dew Point Calculation Methodology:

A legal owner may use the following formulae to calculate the dew point from the temperature and relative humidity.

$$P_{s,m}(T) = ae^{(b-\frac{T}{d})(\frac{T}{c+T})}$$

$$\gamma_m = \ln\left(\frac{RH}{100} e^{(b-\frac{T}{d})(\frac{T}{c+T})}\right)$$

$$T_{dp} = \frac{c\gamma_m(T, RH)}{b - \gamma_m(T, RH)}$$

where:

The following are constants: a = 6.112 millibars; b = 17.67; c = 243.5°C; d = 234.5°C

RH = relative humidity (%)

T_{dp} = temperature at dew point (in degrees Celsius)

γ_m = dew point (in degrees Celsius)

P_{s,m} = saturation vapour pressure (hPa)

- (b) Solar Meteorological Data

Pursuant to subsection 4(3) of Section 304.9, a complete set of all meteorological data sets obtained must be sent to the third-party forecaster.

4.2 Real Power Capability Data

The following provides further explanation of the real power capability information that is required pursuant to subsections 4(6) and 4(7) of Section 304.9. The real power capability data requirements for wind and solar aggregated generating facilities are the same.

- (a) Gross Real Power Capability – reduction may be due to unscheduled outages.
- (b) Real Power Limits - this is the AESO power limit, sent from the AESO to a wind or solar aggregated generating facility, which is the current value in the power limiting control system at the wind or solar aggregated facilities.
- (c) Grid Real Power Production - the real power output at the point of connection.

4.3 Facility Data

Additional clarity regarding the facility data requirements set out in subsections 8(4) and 8(5) of Section 304.9 are provided in Tables 3 and 4 below.



Table 3: Wind Aggregated Generating Facility – Facility Data Requirements

Measurement Type	Notes
Meteorological Tower Unique ID	This is a facility-specific unique ID which differentiates multiple meteorological towers. The legal owner may choose this unique ID. The AESO recommends using the facility ID followed by measurement height and GPS co-ordinates. For example: "ABCD3550115" The AESO further recommends that this unique ID be consistent with the Meteorological Tower Unique ID provided in the wind meteorological data schema.
Meteorological Tower Data Collection Height	The height at which the meteorological data is measured.
Turbine Model Name	The manufacturer's turbine model name
Turbine Wind Cut-in	The manufacturer's turbine wind cut-in point
Turbine Wind Cut-out	The manufacturer's turbine wind cut-out point
Turbine Temperature Cut-out Lower*	The manufacturer's turbine temperature cut-out lower point
Turbine Temperature Cut-out Upper*	The manufacturer's turbine temperature cut-out upper point
Site Latitude and Longitude	Site latitude and longitude should have a precision of 0.000001. Latitude falls between 48 degrees and 60 degrees and longitude falls between -110 degrees and -120 degrees.
Turbine Power Curves	Submit the manufacturer's turbine power curve in the table (MW v/s wind speed) format with a precision of 0.1 MW and 1.0 m/s (windspeed).

* There is normally a lower and higher temperature cut-out; both are relevant in Alberta. The AESO requires an indicator to confirm that the numbers are ambient temperature within the rotor or air temperature.

Table 4: Solar Aggregated Generating Facility – Facility Data Requirements

Measurement Type	Units	Precision	Notes
Meteorological Tower Unique ID	N/A	N/A	This is a facility-specific unique ID which differentiates multiple meteorological towers. The legal owner may choose this unique ID. The AESO recommends using the facility ID followed by measurement height and GPS co-ordinates. For example: “ABCD850115” The AESO further recommends this unique ID be consistent with the Meteorological Tower Unique ID provided in the solar meteorological data schema.
Site Latitude and Longitude	Degrees	0.000001	Site latitude and longitude. Latitude falls between 48 degrees and 60 degrees and longitude falls between -110 degrees and -120 degrees.
Direct Current (DC) Real Power Rating	MW	0.1	Direct current real power rating of the aggregated generating facility
Alternating Current (AC) Real Power Rating	MW	0.1	Alternating current real power rating of the aggregated generating facility
Mounting Height from Ground		1 Meter	Height of the weather station from the ground
Tilt Angle or Range of Tilt Angles to Horizontal Plane		1 degree	in the case of a tracking type mounting, the range of tilt angles relative to the horizontal plane.
Azimuth Angle		1 degree	
Alternating Current (AC) Real Power Capacity per Solar Array		0.1 MW	

5 Data Transmission Timeline

5.1 Position ID Interval Data

In order for the legal owner to slice the data, the legal owner must use the position ID with sub-position ID, to divide the data into time intervals. The 6 position IDs within each hour are 10 minutes in length and are as follows:

- (a) Position ID 1 (00:00 - 9:59 in minutes:seconds)
- (b) Position ID 2 (10:00 - 19:59 in minutes:seconds)
- (c) Position ID 3 (20:00 - 29:59 in minutes:seconds)
- (d) Position ID 4 (30:00 - 39:59 in minutes:seconds)
- (e) Position ID 5 (40:00 - 49:59 in minutes:seconds)
- (f) Position ID 6 (50:00 - 59:59 in minutes:seconds)

There are 10 sub-interval IDs within one position ID that are each 1 minute in length. Position IDs and sub-interval IDs are included as part of the XML schema. For example,

- (a) Position ID 1, sub-interval min 0 (00:00 – 00:59 in mm:ss)
- (b) Position ID 1, sub-interval min 1 (01:00 – 01:59 in mm:ss)

Table 5 below provides an example, from 00:00 – 9:59 in mm:ss, of the sub-interval IDs:

Table 5: Example of Data Intervals and Data Transmission Requirements

Position ID	Time Range of Data Intervals (MM:SS)	Time Range of Data Transmission Requirements (MM:SS)
1 sub 0	00:00 – 0:59	XXh:01:00 – 01:05
1 sub 1	01:00 – 1:59	XXh:02:00 – 02:05
1 sub 2	02:00 – 2:59	XXh:03:00 – 03:05
1 sub 3	03:00 – 3:59	XXh:04:00 – 04:05
1 sub 4	04:00 – 4:59	XXh:05:00 – 05:05
1 sub 5	05:00 – 5:59	XXh:06:00 – 06:05
1 sub 6	06:00 – 6:59	XXh:07:00 – 07:05
1 sub 7	07:00 – 7:59	XXh:08:00 – 08:05
1 sub 8	08:00 – 8:59	XXh:09:00 – 09:05
1 sub 9	09:00 – 9:59	XXh:10:00 – 10:05

5.2 Allowable Tolerance to Submit Data

The maximum allowed tolerance to package and submit the interval data to the third-party forecaster is 5 seconds, examples of which are shown in Table 6 below.

Table 6: Data Processing and Data Transmission Time Ranges

Time Range of Data Intervals (MM:SS)	Time Range of Data Transmission Requirements (MM:SS)
00:00 – 29:59	XXh:30:00 – 30:05
30:00 – 59:59	(XXh+1):00:00 – (XXh +1):00:05

Appendices

Appendix 1: Wind Facility Meteorological Data Schema

Appendix 2: Solar Facility Meteorological Data Schema

Appendix 3: Wind Facility Data Schema

Appendix 4: Solar Facility Data Schema

Appendix 5: Net-to-Grid Real Power and Real Power Limit Data Schema

Appendix 6: Gross Real Power Capability Data Schema

Appendix 7: Communication Layer Schema

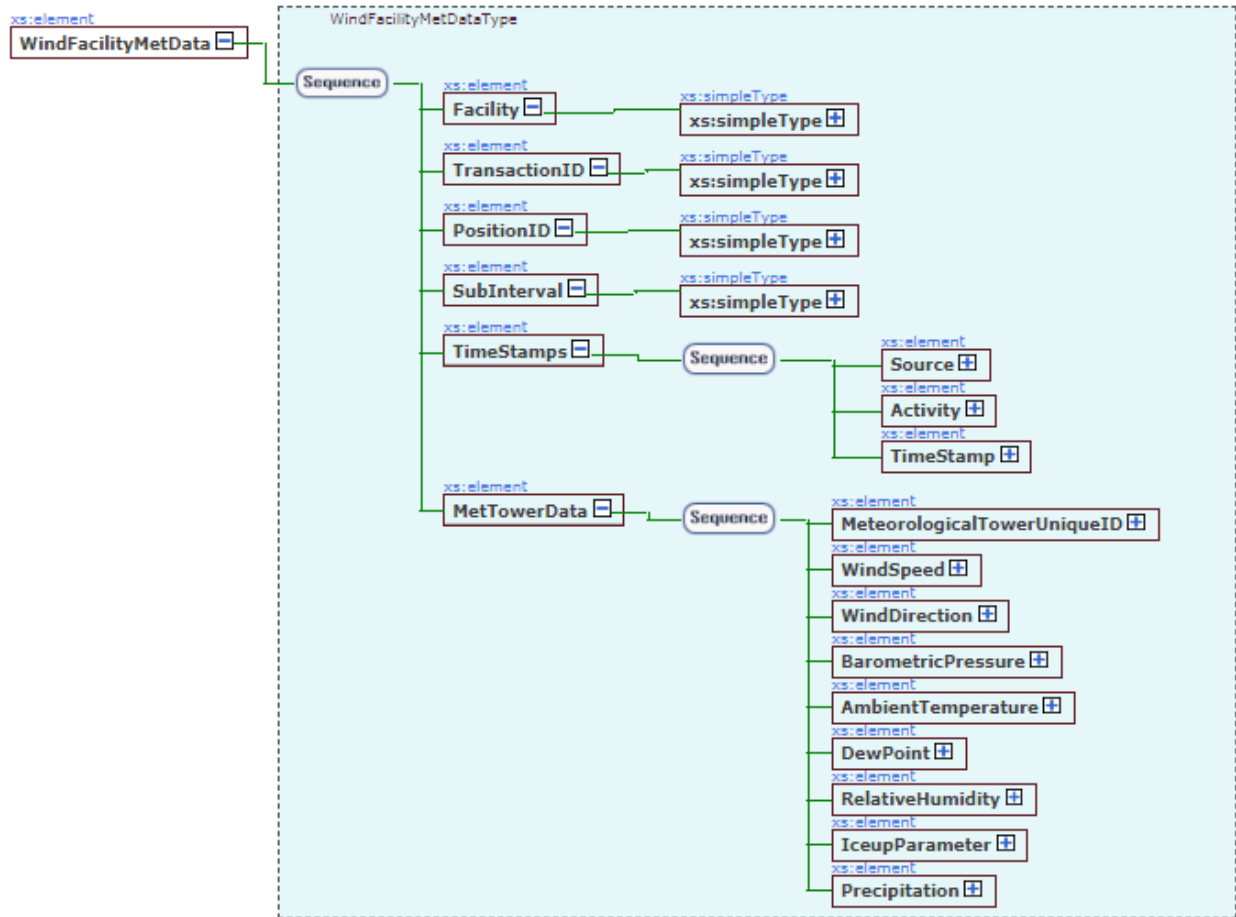
Appendix 8: Message Response Schema

Revision History

Posting Date	Description of Changes
2021-03-30	<p>Removed content related to past compliance timelines and Appendix B Forecast Process as per Section 502.1 Wind Aggregated Generating Facility.</p> <p>Removed content that is sufficiently communicated in Section 304.9.</p> <p>Amended language throughout to align with the AESO's information document drafting standards.</p>
2019-05-16	Added minimum Transfer Layer Security requirements to section 3.1 in Appendix A.
2019-01-30	<p>Dew point calculation methodology added in section 4.1.1 in Appendix A.</p> <p>Added table names in Appendix B.</p>
2018-10-29	<p>Updated sections 4.1.1 and 4.1.2 in Appendix A, additional information provided for Meteorological data.</p> <p>Updated Figure 1 in Appendix A to clarify that eligibility for the transition period is dependent on whether an aggregated generating facility connected in accordance with previous forecasting requirements.</p> <p>Updated position IDs from 0-5 to 1-6 in Appendix A, section 5.1</p> <p>Minor updates to XML schema.</p> <p>Added figure and table names in Appendix A</p>
2018-09-04	Removed 1 hour limit in section 2.2
2018-08-07	Revised to include the wind and solar aggregated generating facility forecast process required under Section 304.9.
2016-09-28	Administrative amendments
2011-06-23	Initial Release

Appendix 1: Wind Facility Meteorological Data Schema

Overview of Data Schema



Detailed Data Schema

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<?xml version="1.0" encoding="UTF-8"?>
```

```
<
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

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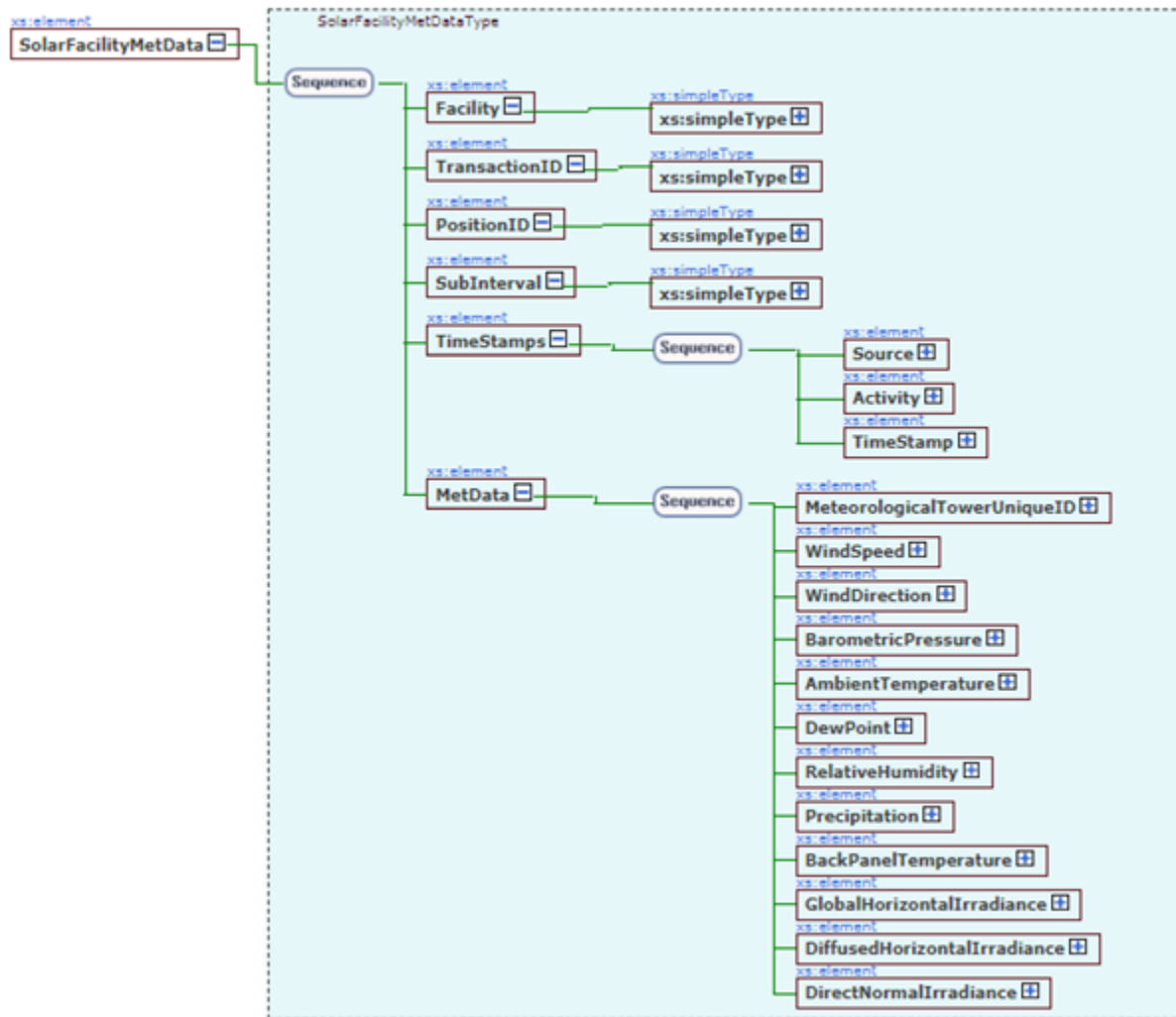
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Appendix 2: Solar Facility Meteorological Data Schema

Overview of Data Schema



Detailed Data Schema

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```

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<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

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```
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  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MetData" maxOccurs="unbounded">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="MeteorologicalTowerUniqueID">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:minLength value="0"></xs:minLength>
            <xs:maxLength value="90"></xs:maxLength>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="WindSpeed">
        <xs:simpleType>
          <xs:restriction base="xs:float">
```

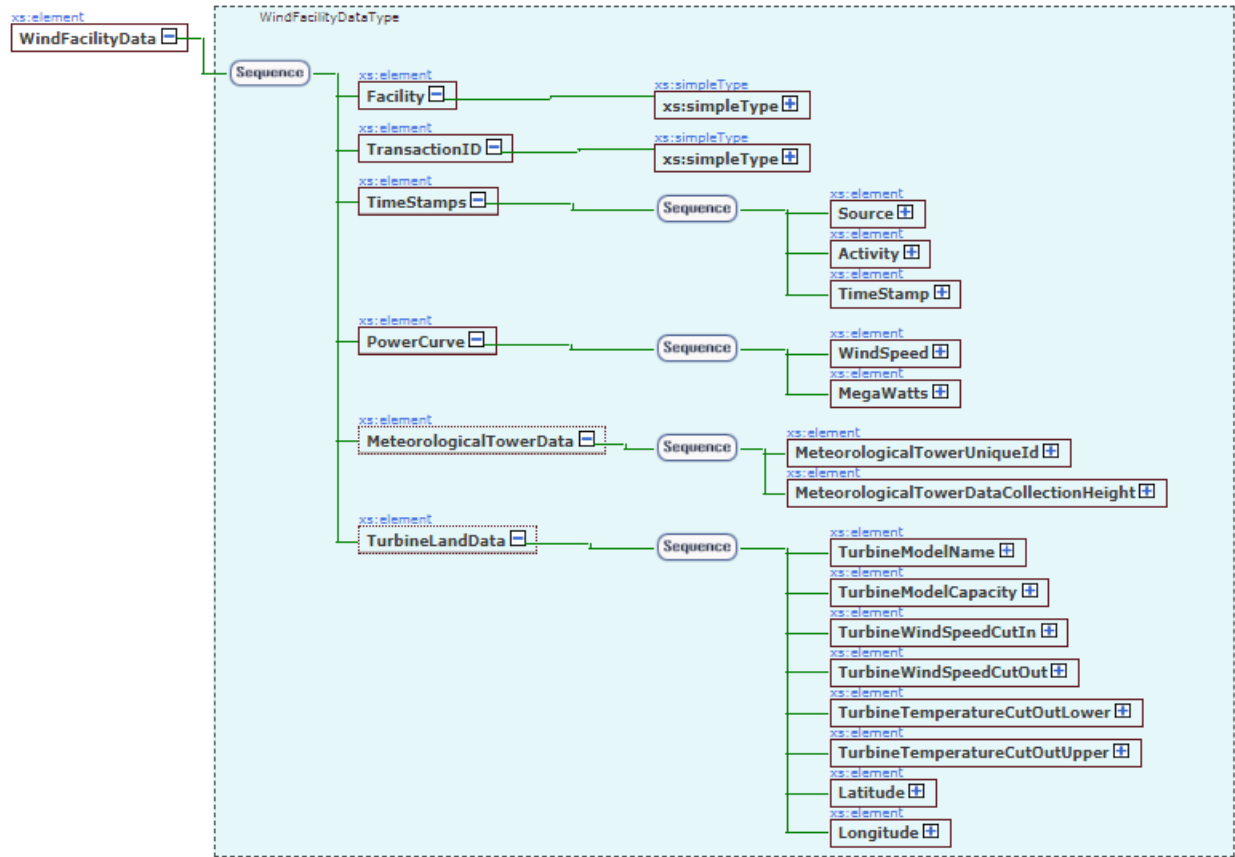
```
        <xs:minInclusive value="0"></xs:minInclusive>
        <xs:maxInclusive value="50"></xs:maxInclusive>
    </xs:restriction>
</xs:simpleType>
</xs:element>
 $\square$  <xs:element name="WindDirection">
     $\square$  <xs:simpleType>
         $\square$  <xs:restriction base="xs:float">
            <xs:minInclusive value="0"></xs:minInclusive>
            <xs:maxInclusive value="360"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
 $\square$  <xs:element name="BarometricPressure">
     $\square$  <xs:simpleType>
         $\square$  <xs:restriction base="xs:float">
            <xs:minInclusive value="800"></xs:minInclusive>
            <xs:maxInclusive value="1000"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
 $\square$  <xs:element name="AmbientTemperature">
     $\square$  <xs:simpleType>
         $\square$  <xs:restriction base="xs:float">
            <xs:minInclusive value="-50"></xs:minInclusive>
            <xs:maxInclusive value="50"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
 $\square$  <xs:element name="DewPoint">
     $\square$  <xs:simpleType>
         $\square$  <xs:restriction base="xs:float">
            <xs:minInclusive value="-50"></xs:minInclusive>
            <xs:maxInclusive value="50"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
```

```
</xs:element>
  <xs:element name="RelativeHumidity">
    <xs:simpleType>
      <xs:restriction base="xs:float">
        <xs:minInclusive value="0"></xs:minInclusive>
        <xs:maxInclusive value="100"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="Precipitation">
    <xs:simpleType>
      <xs:restriction base="xs:float">
        <xs:minInclusive value="0"></xs:minInclusive>
        <xs:maxInclusive value="11"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="BackPanelTemperature">
    <xs:simpleType>
      <xs:restriction base="xs:float">
        <xs:minInclusive value="-50"></xs:minInclusive>
        <xs:maxInclusive value="50"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="GlobalHorizontalIrradiance">
    <xs:simpleType>
      <xs:restriction base="xs:float">
        <xs:minInclusive value="0"></xs:minInclusive>
        <xs:maxInclusive value="4000"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="DiffusedHorizontalIrradiance">
    <xs:simpleType>
      <xs:restriction base="xs:float">
```

```
<xs:minInclusive value="0"></xs:minInclusive>
<xs:maxInclusive value="4000"></xs:maxInclusive>
</xs:restriction>
</xs:simpleType>
</xs:element>
<xs:element name="DirectNormalIrradiance">
  <xs:simpleType>
    <xs:restriction base="xs:float">
      <xs:minInclusive value="0"></xs:minInclusive>
      <xs:maxInclusive value="2000"></xs:maxInclusive>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:schema>
```

Appendix 3: Wind Facility Data Schema

Overview of Data Schema



Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

```
  <xs:element name="WindFacilityData" type="WindFacilityDataType"/></xs:element>
```

```
  <xs:complexType name="WindFacilityDataType">
```

```
    <xs:sequence>
```

```
      <xs:element name="Facility">
```

```
        <xs:simpleType>
```

```
          <xs:restriction base="xs:string">
```

```
            <xs:maxLength value="255"/></xs:maxLength>
```

```
          </xs:restriction>
```

```
        </xs:simpleType>
```

```
      </xs:element>
```

```
      <xs:element name="TransactionID">
```

```
<xs:simpleType>
  <xs:restriction base="xs:string">
    <xs:maxLength value="255"/></xs:maxLength>
  </xs:restriction>
</xs:simpleType>
</xs:element>
<xs:element name="TimeStamps" maxOccurs="unbounded">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Source">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Wind
Facility"/></xs:enumeration>
            <xs:enumeration value="Wind
Forecaster"/></xs:enumeration>
            <xs:enumeration value="B2B
Provider"/></xs:enumeration>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="Activity">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Send"/></xs:enumeration>
            <xs:enumeration value="Receive"/></xs:enumeration>
            <xs:enumeration value="Process"/></xs:enumeration>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="TimeStamp">
        <xs:simpleType>
          <xs:restriction base="xs:dateTime">
            <xs:pattern value="\d\d\d\d-\d\d-
\d\dT\d\d:\d\d:\d\dZ"/></xs:pattern>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:element>
```



```
        </xs:complexType>
    </xs:element>
    <xs:element name="PowerCurve" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="WindSpeed">
                    <xs:simpleType>
                        <xs:restriction base="xs:float">
                            <xs:minInclusive value="0"></xs:minInclusive>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="MegaWatts">
                    <xs:simpleType>
                        <xs:restriction base="xs:float">
                            <xs:minInclusive value="0"></xs:minInclusive>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="MeteorologicalTowerData" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="MeteorologicalTowerUniqueId">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:minLength value="0"></xs:minLength>
                            <xs:maxLength value="90"></xs:maxLength>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="MeteorologicalTowerDataCollectionHeight" type="xs
:float"></xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>

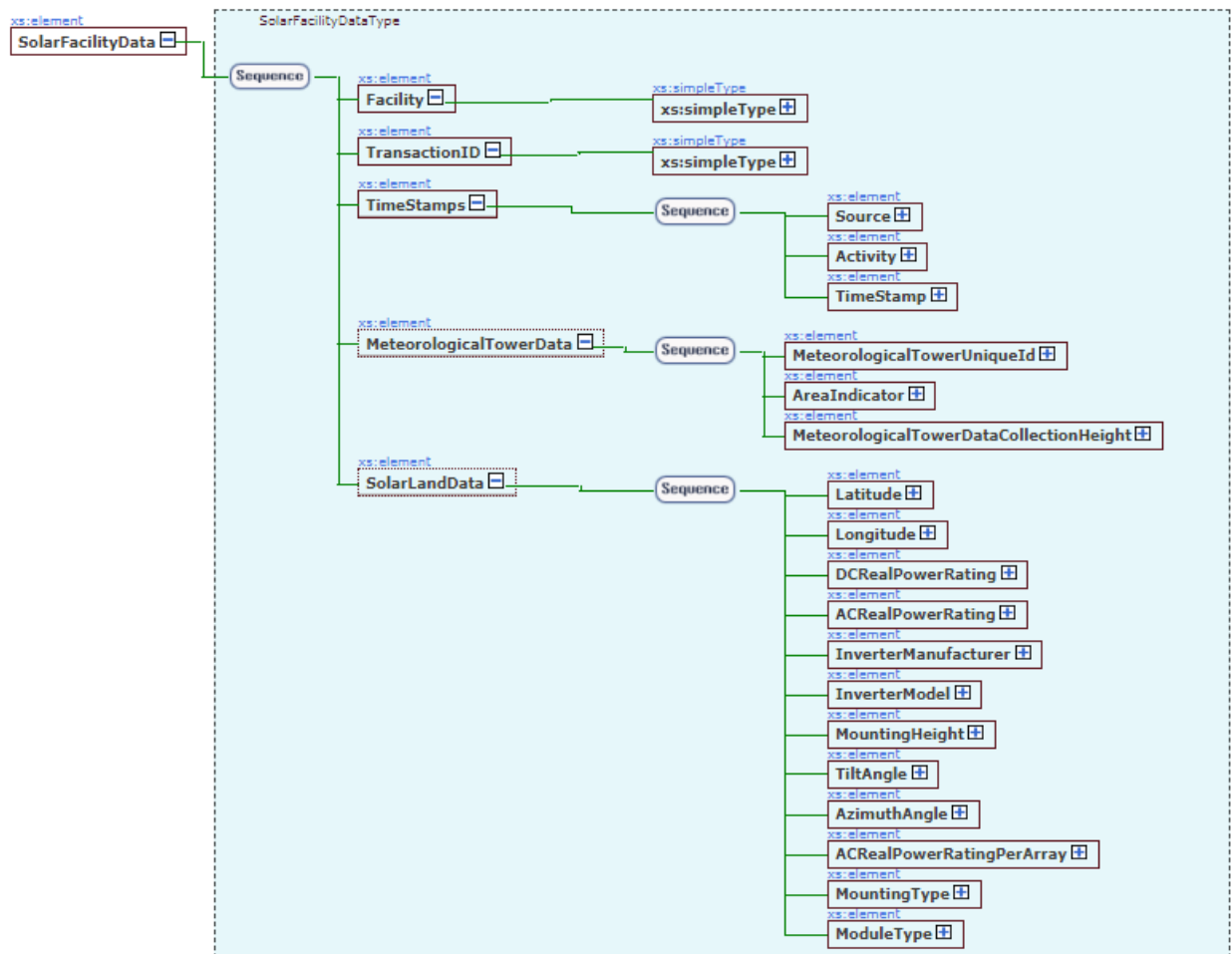
```

```
</xs:element>
  <xs:element name="TurbineLandData" minOccurs="0" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="TurbineModelName" type="xs:string"></xs:elemen
t>
        <xs:element name="TurbineModelCapacity">
          <xs:simpleType>
            <xs:restriction base="xs:float">
              <xs:minInclusive value="0.1"></xs:minInclusive>
              <xs:maxInclusive value="20.0"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="TurbineWindSpeedCutIn">
          <xs:simpleType>
            <xs:restriction base="xs:float">
              <xs:minInclusive value="0"></xs:minInclusive>
              <xs:maxInclusive value="50"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="TurbineWindSpeedCutOut">
          <xs:simpleType>
            <xs:restriction base="xs:float">
              <xs:minInclusive value="0"></xs:minInclusive>
              <xs:maxInclusive value="99"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="TurbineTemperatureCutOutLower">
          <xs:simpleType>
            <xs:restriction base="xs:float">
              <xs:minInclusive value="-50"></xs:minInclusive>
              <xs:maxInclusive value="+50"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
```

```
    <xs:element name="TurbineTemperatureCutOutUpper">
      <xs:simpleType>
        <xs:restriction base="xs:float">
          <xs:minInclusive value="-50"></xs:minInclusive>
          <xs:maxInclusive value="50"></xs:maxInclusive>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="Latitude">
      <xs:simpleType>
        <xs:restriction base="xs:float">
          <xs:minInclusive value="48"></xs:minInclusive>
          <xs:maxInclusive value="65"></xs:maxInclusive>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="Longitude">
      <xs:simpleType>
        <xs:restriction base="xs:float">
          <xs:minInclusive value="-125"></xs:minInclusive>
          <xs:maxInclusive value="-98"></xs:maxInclusive>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:schema>
```

Appendix 4: Solar Facility Data Schema

Overview of Data Schema



Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```



```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

```
  <xs:element name="SolarFacilityData" type="SolarFacilityDataType"></xs:element>
```

```
  <xs:complexType name="SolarFacilityDataType">
```

```
    <xs:sequence>
```

```
      <xs:element name="Facility">
```

```
        <xs:simpleType>
```

```
          <xs:restriction base="xs:string">
```

```
            <xs:maxLength value="255"></xs:maxLength>
```

```
          </xs:restriction>
```

```
    </xs:simpleType>
  </xs:element>
  ☐<xs:element name="TransactionID">
    ☐<xs:simpleType>
      ☐<xs:restriction base="xs:string">
        <xs:maxLength value="255"></xs:maxLength>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  ☐<xs:element name="TimeStamps" maxOccurs="unbounded">
    ☐<xs:complexType>
      ☐<xs:sequence>
        ☐<xs:element name="Source">
          ☐<xs:simpleType>
            ☐<xs:restriction base="xs:string">
              <xs:enumeration value="Solar Facility"></xs:enumeration>
              <xs:enumeration value="Solar Forecaster"></xs:enumeration>
              <xs:enumeration value="B2B Provider"></xs:enumeration>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        ☐<xs:element name="Activity">
          ☐<xs:simpleType>
            ☐<xs:restriction base="xs:string">
              <xs:enumeration value="Send"></xs:enumeration>
              <xs:enumeration value="Receive"></xs:enumeration>
              <xs:enumeration value="Process"></xs:enumeration>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        ☐<xs:element name="TimeStamp">
          ☐<xs:simpleType>
            ☐<xs:restriction base="xs:dateTime">
              <xs:pattern value="\d\d\d\d\d\d-\d\d-\d\dT\d\d:\d\d:\d\dZ"></xs:pattern>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="MeteorologicalTowerData" minOccurs="0" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="MeteorologicalTowerUniqueld">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:minLength value="0"></xs:minLength>
              <xs:maxLength value="90"></xs:maxLength>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="ArealIndicator">
          <xs:simpleType>
            <xs:restriction base="xs:integer">
              <xs:minInclusive value="1"></xs:minInclusive>
              <xs:maxInclusive value="2"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="MeteorologicalTowerDataCollectionHeight" type="xs:integer"></xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="SolarLandData" minOccurs="0" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Latitude">
          <xs:simpleType>
            <xs:restriction base="xs:float">
              <xs:minInclusive value="48"></xs:minInclusive>
              <xs:maxInclusive value="65"></xs:maxInclusive>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
```

```
        </xs:simpleType>
    </xs:element>
    ☐ <xs:element name="Longitude">
        ☐ <xs:simpleType>
            ☐ <xs:restriction base="xs:float">
                <xs:minInclusive value="-125"></xs:minInclusive>
                <xs:maxInclusive value="-98"></xs:maxInclusive>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    ☐ <xs:element name="DCRealPowerRating">
        ☐ <xs:simpleType>
            ☐ <xs:restriction base="xs:float">
                <xs:minInclusive value="0.1"></xs:minInclusive>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    ☐ <xs:element name="ACRealPowerRating">
        ☐ <xs:simpleType>
            ☐ <xs:restriction base="xs:float">
                <xs:minInclusive value="0.1"></xs:minInclusive>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    ☐ <xs:element name="InverterManufacturer">
        ☐ <xs:simpleType>
            ☐ <xs:restriction base="xs:string">
                <xs:minLength value="0"></xs:minLength>
                <xs:maxLength value="90"></xs:maxLength>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    ☐ <xs:element name="InverterModel">
        ☐ <xs:simpleType>
            ☐ <xs:restriction base="xs:string">
                <xs:minLength value="0"></xs:minLength>
```

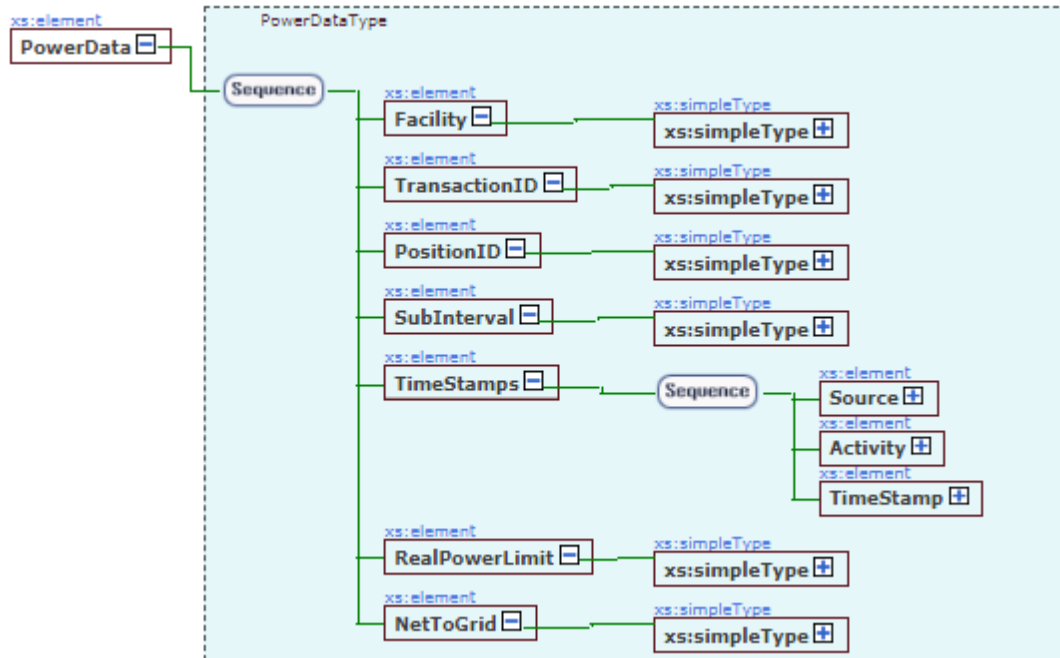


```
        <xs:maxLength value="90"></xs:maxLength>
    </xs:restriction>
</xs:simpleType>
</xs:element>
☐<xs:element name="MountingHeight">
    ☐<xs:simpleType>
        ☐<xs:restriction base="xs:float">
            <xs:minInclusive value="0"></xs:minInclusive>
            <xs:maxInclusive value="50"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
☐<xs:element name="TiltAngle">
    ☐<xs:simpleType>
        ☐<xs:restriction base="xs:string">
            <xs:minLength value="1"></xs:minLength>
            <xs:maxLength value="30"></xs:maxLength>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
☐<xs:element name="AzimuthAngle">
    ☐<xs:simpleType>
        ☐<xs:restriction base="xs:float">
            <xs:minInclusive value="0"></xs:minInclusive>
            <xs:maxInclusive value="360"></xs:maxInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
☐<xs:element name="ACRealPowerRatingPerArray">
    ☐<xs:simpleType>
        ☐<xs:restriction base="xs:float">
            <xs:minInclusive value="0"></xs:minInclusive>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
☐<xs:element name="MountingType">
```

```
    <xs:simpleType>
      <xs:restriction base="xs:string">
        <xs:minLength value="0"></xs:minLength>
        <xs:maxLength value="90"></xs:maxLength>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="ModuleType">
    <xs:simpleType>
      <xs:restriction base="xs:string">
        <xs:minLength value="0"></xs:minLength>
        <xs:maxLength value="90"></xs:maxLength>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:schema>
```

Appendix 5: Net-to-Grid Real Power and Real Power Limit Data Schema

Overview of Data Schema



Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

```
<xs:element name="PowerData" type="PowerDataType"/></xs:element>
```

```
<xs:complexType name="PowerDataType">
```

```
<xs:sequence>
```

```
<xs:element name="Facility">
```

```
<xs:simpleType>
```

```
<xs:restriction base="xs:string">
```

```
<xs:maxLength value="255"/></xs:restriction>
```

```
</xs:simpleType>
```

```
</xs:element>
```

```
</xs:sequence>
```

```
<xs:element name="TransactionID">
```

```
<xs:simpleType>
```

```
<xs:restriction base="xs:string">
```

```
<xs:maxLength value="255"/></xs:restriction>
```

```
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
  <xs:element name="PositionID">
    <xs:simpleType>
      <xs:restriction base="xs:integer">
        <xs:minInclusive value="1"></xs:minInclusive>
        <xs:maxInclusive value="6"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="SubInterval">
    <xs:simpleType>
      <xs:restriction base="xs:integer">
        <xs:minInclusive value="0"></xs:minInclusive>
        <xs:maxInclusive value="9"></xs:maxInclusive>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="TimeStamps" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Source">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:enumeration value="Wind Facility"></xs:enumeration>
              <xs:enumeration value="Solar Facility"></xs:enumeration>
              <xs:enumeration value="Wind Forecaster"></xs:enumeration>
              <xs:enumeration value="Solar Forecaster"></xs:enumeration>
              <xs:enumeration value="Forecaster"></xs:enumeration>
              <xs:enumeration value="B2B Provider"></xs:enumeration>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="Activity">
          <xs:simpleType>
```

```
    <xs:restriction base="xs:string">
      <xs:enumeration value="Send"></xs:enumeration>
      <xs:enumeration value="Receive"></xs:enumeration>
      <xs:enumeration value="Process"></xs:enumeration>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
<xs:element name="TimeStamp">
  <xs:simpleType>
    <xs:restriction base="xs:dateTime">
      <xs:pattern value="\d\d\d\d\d\d-\d\d-\d\dT\d\d:\d\d:\d\dZ"></xs:pattern>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="RealPowerLimit">
  <xs:simpleType>
    <xs:restriction base="xs:float">
      <xs:minInclusive value="0"></xs:minInclusive>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
<xs:element name="NetToGrid">
  <xs:simpleType>
    <xs:restriction base="xs:float">
      <xs:minInclusive value="0"></xs:minInclusive>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:schema>
```

Appendix 6: Gross Real Power Capability Data Schema

Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```



```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

```
  <xs:element name="GrossRealPowerCapabilityData" type="GrossRealPowerCapabilityDataType" /></xs:element>
```

```
  <xs:complexType name="GrossRealPowerCapabilityDataType">
```

```
    <xs:sequence>
```

```
      <xs:element name="Facility">
```

```
        <xs:simpleType>
```

```
          <xs:restriction base="xs:string">
```

```
            <xs:maxLength value="255"/></xs:maxLength>
```

```
          </xs:restriction>
```

```
        </xs:simpleType>
```

```
      </xs:element>
```

```
      <xs:element name="TransactionID">
```

```
        <xs:simpleType>
```

```
          <xs:restriction base="xs:string">
```

```
            <xs:maxLength value="255"/></xs:maxLength>
```

```
          </xs:restriction>
```

```
        </xs:simpleType>
```

```
      </xs:element>
```

```
      <xs:element name="TimeStamps" maxOccurs="unbounded">
```

```
        <xs:complexType>
```

```
          <xs:sequence>
```

```
            <xs:element name="Source">
```

```
              <xs:simpleType>
```

```
                <xs:restriction base="xs:string">
```

```
                  <xs:enumeration value="Wind
```

```
Facility"/></xs:enumeration>
```

```
                  <xs:enumeration value="Solar
```

```
Facility"/></xs:enumeration>
```

```
                  <xs:enumeration value="Forecaster"/></xs:enumeration>
```

```
Forecaster"/></xs:enumeration>
```

```
                  <xs:enumeration value="Solar
```

```
Forecaster"/></xs:enumeration>
```

```
                  <xs:enumeration value="Wind
```

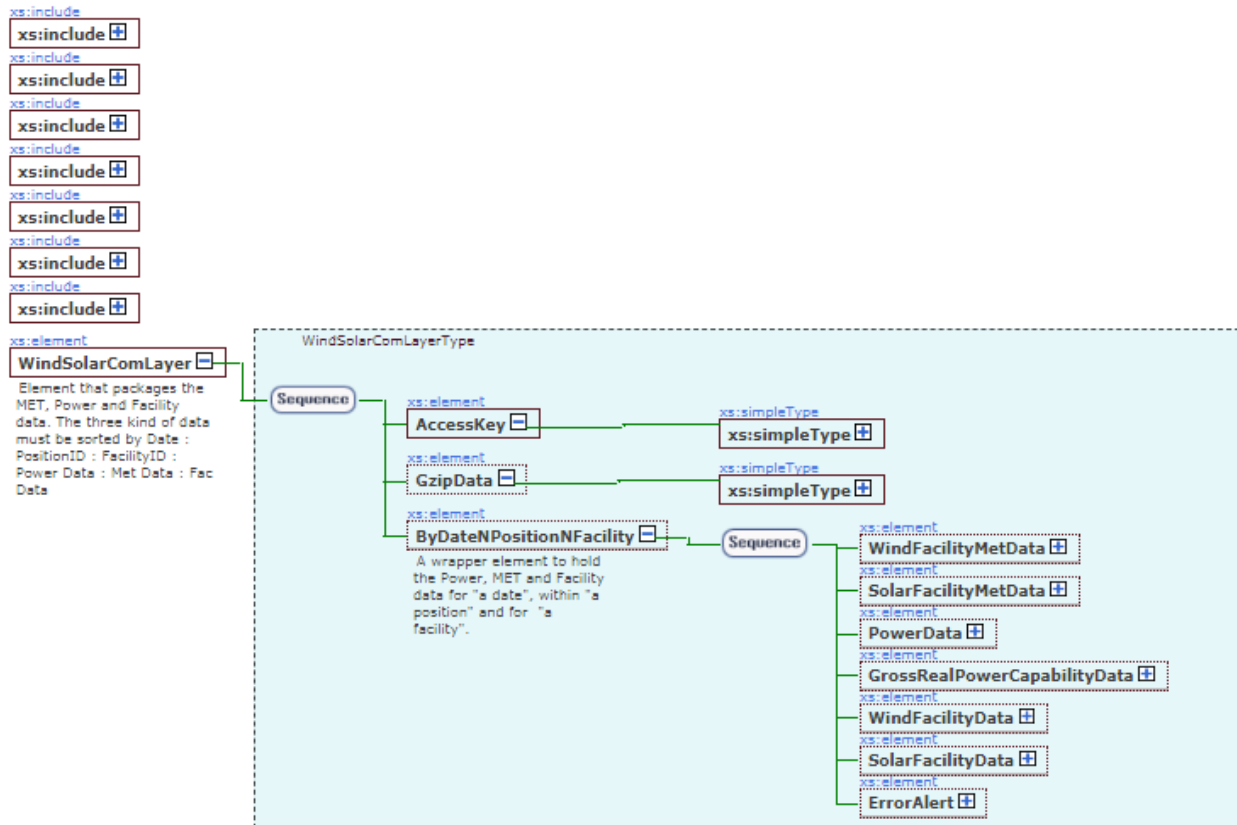
```
Provider"></xs:enumeration>
    <xs:enumeration value="B2B"
    </xs:restriction>
  </xs:simpleType>
</xs:element>
  <xs:element name="Activity">
    <xs:simpleType>
      <xs:restriction base="xs:string">
        <xs:enumeration value="Send"></xs:enumeration>
        <xs:enumeration value="Receive"></xs:enumeration>
        <xs:enumeration value="Process"></xs:enumeration>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
  <xs:element name="TimeStamp">
    <xs:simpleType>
      <xs:restriction base="xs:dateTime">
        <xs:pattern value="\d\d\d\d-\d\d-
\d\dT\d\d:\d\d:\d\dZ"></xs:pattern>
      </xs:restriction>
    </xs:simpleType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
  <xs:element name="GrossRealPowerCapability" maxOccurs="unbounded">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="TimeStampBegin">
          <xs:simpleType>
            <xs:restriction base="xs:dateTime">
              <xs:pattern value="\d\d\d\d-\d\d-
\d\dT\d\d:\d\d:\d\dZ"></xs:pattern>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="TimeStampEnd">
          <xs:simpleType>
            <xs:restriction base="xs:dateTime">
```



```
        <xs:pattern value="\d\d\d\d-\d\d-  
        \d\dT\d\d:\d\d:\d\dZ"></xs:pattern>  
        </xs:restriction>  
    </xs:simpleType>  
</xs:element>  
    <xs:element name="CapacityAverage">  
        <xs:simpleType>  
            <xs:restriction base="xs:float">  
                <xs:minInclusive value="0"></xs:minInclusive>  
            </xs:restriction>  
        </xs:simpleType>  
    </xs:element>  
</xs:sequence>  
</xs:complexType>  
</xs:element>  
</xs:sequence>  
</xs:complexType>  
</xs:schema>
```

Appendix 7: Communication Layer Schema

Overview of Data Schema



Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<
```

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://windforecasting.public.aeso.ca" targetNamespace="http://windforecasting.public.aeso.ca" elementFormDefault="qualified" attributeFormDefault="unqualified">
```

```
<xs:include schemaLocation="WindFacilityMetData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="SolarFacilityMetData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="PowerData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="GrossRealPowerCapabilityData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="WindFacilityData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="SolarFacilityData.xsd"/></xs:include>
```

```
<xs:include schemaLocation="Error_Alert.xsd"/></xs:include>
```

```
<xs:element name="WindSolarComLayer" type="WindSolarComLayerType">
```

```
<xs:annotation>
```

`<xs:documentation>`Element that packages the MET, Power and Facility data. The t3 kind of data must be sorted by Date : PositionID : FacilityID : Power Data : Met Data : Fac Data`</xs:documentation>`

`</xs:annotation>`

`</xs:element>`

`<xs:complexType name="WindSolarComLayerType">`

`<xs:sequence>`

`<xs:element name="AccessKey">`

`<xs:simpleType>`

`<xs:restriction base="xs:string">`

`<xs:maxLength value="255"></xs:maxLength>`

`</xs:restriction>`

`</xs:simpleType>`

`</xs:element>`

`<xs:element name="GzipData" minOccurs="0">`

`<xs:simpleType>`

`<xs:restriction base="xs:string">`

`<xs:maxLength value="100000"></xs:maxLength>`

`</xs:restriction>`

`</xs:simpleType>`

`</xs:element>`

`<xs:element name="ByDateNPositionNFacility" minOccurs="0" maxOccurs="unbounded">`

`<xs:annotation>`

`<xs:documentation>`A wrapper element to hold the Power, MET and Facility data for "a date", within "a position" and for "a facility".`</xs:documentation>`

`</xs:annotation>`

`<xs:complexType>`

`<xs:sequence>`

`<xs:element name="WindFacilityMetData" type="WindFacilityMetDataType" minOccurs="0" maxOccurs="unbounded"></xs:element>`

`<xs:element name="SolarFacilityMetData" type="SolarFacilityMetDataType" minOccurs="0" maxOccurs="unbounded"></xs:element>`

`<xs:element name="PowerData" type="PowerDataType" minOccurs="0" maxOccurs="unbounded"></xs:element>`

`<xs:element name="GrossRealPowerCapabilityData" type="GrossRealPowerCapabilityDataType" minOccurs="0" maxOccurs="unbounded"></xs:element>`

`<xs:element name="WindFacilityData" type="WindFacilityDataType" minOccurs="0" maxOccurs="unbounded"></xs:element>`

```
<xs:element name="SolarFacilityData" type="SolarFacilityDataType" minOccurs="0" maxOccurs="unbounded"/></xs:element>  
<xs:element name="ErrorAlert" type="ErrorAlertType" minOccurs="0" maxOccurs="unbounded"/></xs:element>  
</xs:sequence>  
</xs:complexType>  
</xs:element>  
</xs:sequence>  
</xs:complexType>  
</xs:schema>
```

Appendix 8: Message Response Schema

Detailed Data Schema

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<WindSolarResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-  
instance" xmlns="http://windforecasting.public.aeso.ca" xsi:schemaLocation="http://windforecasting.public  
.aeso.ca WindSolarResponse.xsd">
```

```
  <ReturnCode>0|1</ReturnCode>
```

```
  <TransactionID>unique_string</TransactionID>
```

```
  <ErrorLevel>detailed_error_number</ErrorLevel>
```

```
  <Message>descriptive_text</Message>
```

```
</WindSolarResponse>
```