Role of digitalization in growing RE landscape

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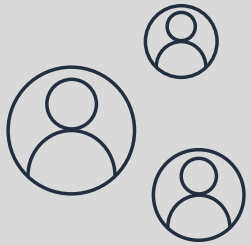
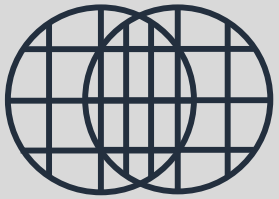
Energy transition: rising opportunities and challenges



Expanding RE landscape.



Growing grid congestion.

Evolving customer energy needs.

New Innovation Opportunities

Energy transition: rising opportunities and challenges

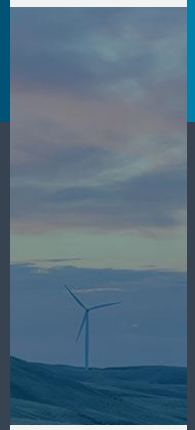
KEEPING UP WITH GROWTH

Legacy on-premise infrastructure struggle to handle the scale of digital capabilities needed to support the growth of renewable energy generation.

170 GW (2023) → 500 GW (2030)

HOLISTIC ASSET INSIGHTS

IT and OT data are not integrated to provide holistic insights of asset operational performance in the context of site and environmental conditions, work orders, and enterprise processes.

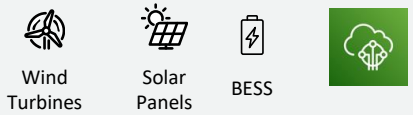


CROSSFUNCTIONAL OPTIMIZATION

Customer face interoperability challenges when pursuing workflows that cut across multiple digital capabilities; e.g. Asset Performance Management, Field Service Management, and Asset Integrity.

*https://www.iea.org/reports/renewables-2022/renewable-electricity

Digitalization levers for RE to grid integration flexibility

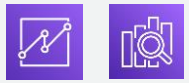


Observability

- Near real-time data from RE assets (device to cloud, SCADA to cloud)
- Security controls for edge and data in transit(device to cloud)
- Observability of RE generation, ESS state of charge parameters and Asset health parameters
- Use scalable and reliable IoT layer for data ingestion

Renewable data lake

- Integration of multiple data sets at a single place and correlation (RE gen, grid frequency from SCADA, feeder meters, storage charge level, geospatial etc.)
- Forecast for each element to be corelated (demand and supply side)
- Build a renewable data lake scalable to handle large volume of data



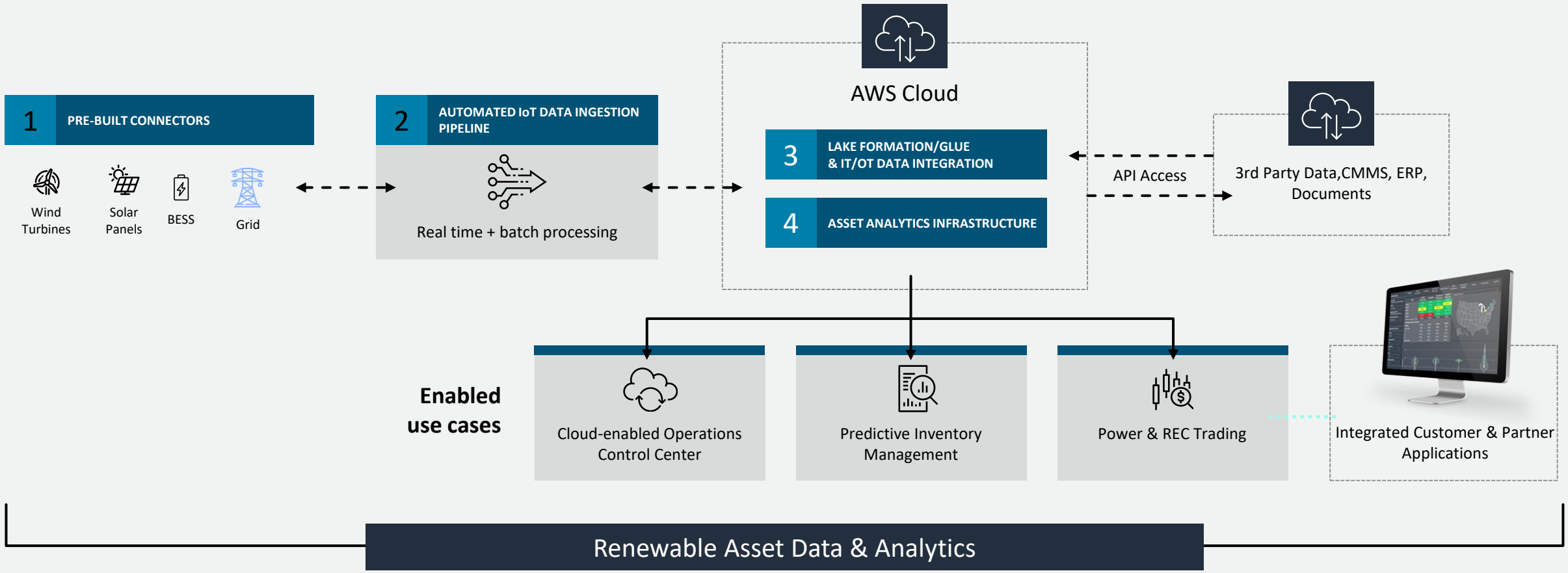
Right paced decision making

- Decision making based on near real-time and non real time (RE gen vs ESS charge level, day ahead vs medium term forecast, temperature alarm from ESS etc.)
- Real-time processing vs batch processing
- Architectural decisions vary based on use cases

Maintenance improvisation

- Asset availability is highly important to increase RE integration
- holistic view of asset performance bringing together asset base data, real-time data, alarms,
- events, and other operational data
- Use AI for fault prediction, visual inspection and building digital twins for remote inspection

Renewables Data Lake



Thank you!

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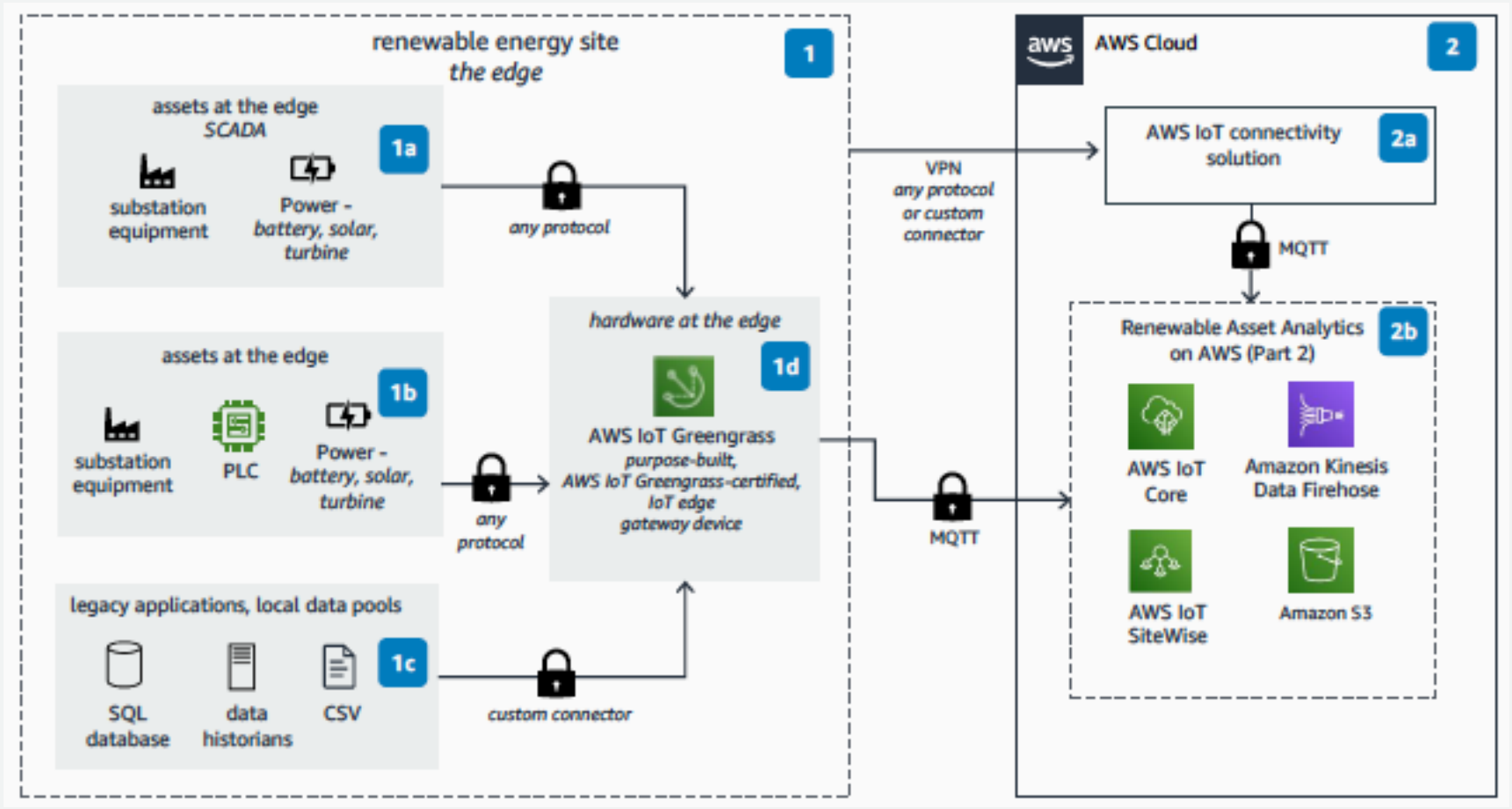
Renewables Data Lake and Analytics (1/2)



1 The renewable energy site represents the edge and includes multiple assets, topology, and device configurations.

1a **Configuration scenario:** Supervisory control and data acquisition (SCADA) is available for assets **substation equipment** and **power - battery, solar, turbine.**

1b **Configuration scenario:** When SCADA is not available (for example, when the energy output of a site doesn't justify the investment in a SCADA system). In this case, you communicate directly with the programmable logic controller (PLC) of the assets **(substation equipment** and **power - battery, solar, turbine).**

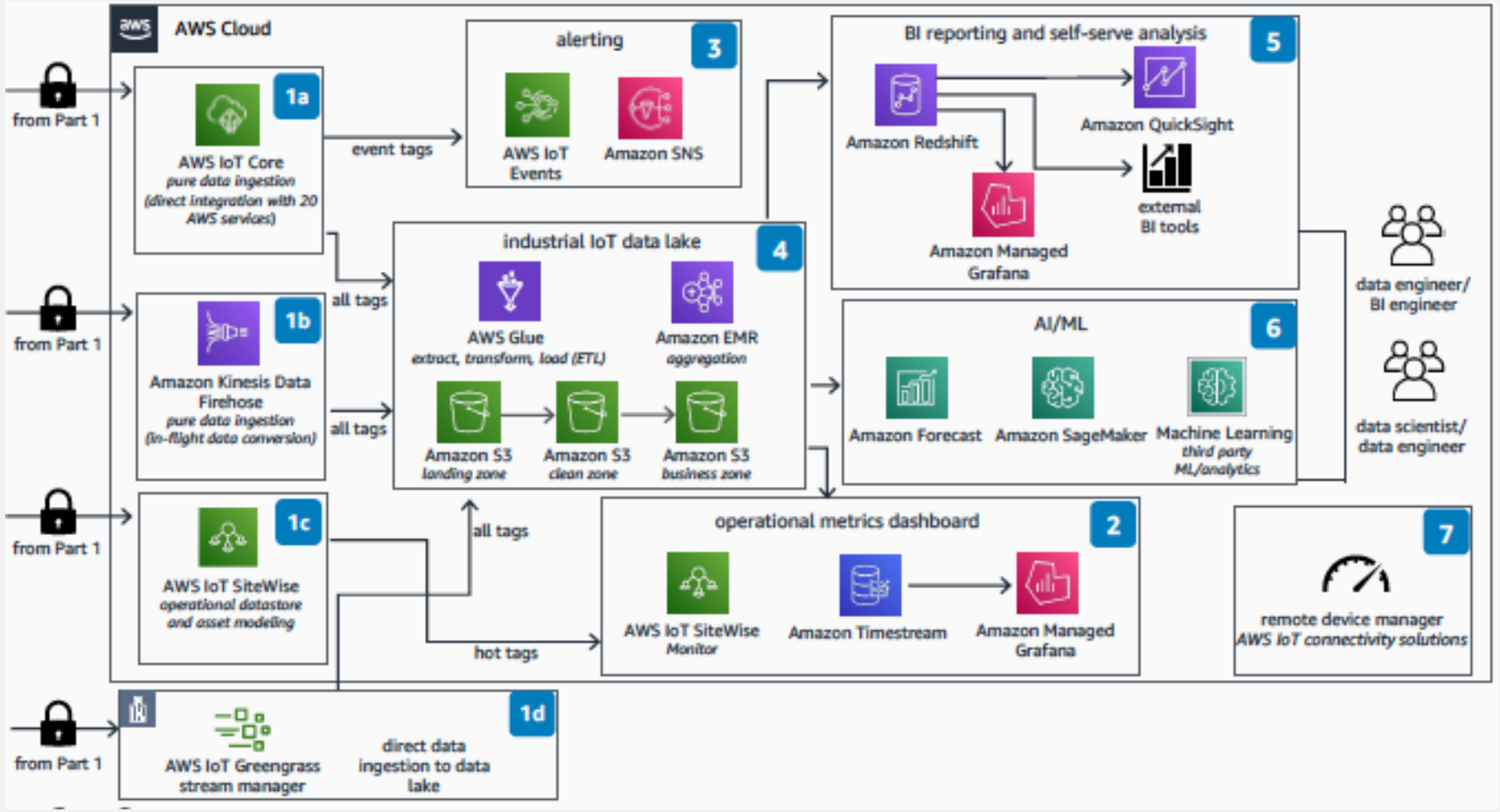
1c **Configuration scenario:** SCADA isn't available and there is no access to PLCs. This might be due to regulatory, compliance, or security reasons. In this case, the renewable energy operators deposit the asset data in an external application. This can be a **Structured Query Language** (SQL) **database**, **data historian**, or **CSV** files.

1d **Hardware at the edge option:** The device can ingest Internet of Things (IoT) data from SCADA or PLCs in any protocol (for example, Open Platform Communications Unified Architecture (OPC-UA), Distributed Network Protocol 3 (DNP3), Modbus, and Sunspec). For legacy applications, the device connects through prebuilt or custom connectors. It communicates the IoT data over the internet and through Message Queuing Telemetry Transport (MQTT) protocol to the Part 2 solution hosted in the Cloud. All traffic is encrypted through x509 certificates.

2 The AWS IoT connectivity solution and the Part 2 solution are hosted within the AWS Cloud.

2a No hardware at the edge option - Sometimes it is too costly to install an IoT edge gateway device at each renewable site. In this case, we use an AWS IoT connectivity solution, hosted entirely in the Cloud. The SCADA, PLCs, or legacy applications communicate the IoT data through the native device protocol, over a secure virtual private network (VPN) connection, to the AWS IoT connectivity solution. The connectivity solution forwards the IoT traffic over MQTT for performance analytics, as shown in part 2. All traffic is encrypted through x509 certificates.

Renewables Data Lake and Analytics (2/2)



1a Data is ingested to **AWS IoT Core**, for non-asset modeled data, including native integration with 20 AWS services.

1b Data is ingested through **Amazon Kinesis Data Firehose** to **Amazon Simple Storage Service** (Amazon S3) with optional in-flight data conversion (for example, conversion from JSON to Parquet).

1c Data is ingested at scale with detailed asset modeling in **AWS IoT SiteWise**.

1d AWS IoT Greengrass stream manager transfers high volume data directly to the AWS Cloud, with low latency.

2 **AWS IoT SiteWise**, **Amazon Timestream**, and **Amazon Managed Grafana** make up the near real-time operational dashboard of "hot tags" (critical tags for health monitoring of assets).

3 Build detector models in **AWS IoT Events** to continuously monitor the state of assets and issue immediate alerts in **Amazon Simple Notification Service** (Amazon SNS). This done through email and short message service (SMS) to operational staff.

4 The industrial data lake is hydrated by different sources at different velocities. The data lake serves as a single version of truth for all consumers. Data lands "as-is" from sources, in a landing zone **Amazon S3** bucket. From here, it is cleansed and normalized through **AWS Glue** ELT into a curated state and placed in a clean zone **Amazon S3** bucket. **Amazon EMR** consumes this curated data to calculate 10-minute averages. **Amazon EMR** also converts the clean data into the IEC-61400-25-2 standard for wind and IEC 61850-7-420 standard for solar. **Amazon EMR** then deposits the aggregated and standardized data in an **Amazon S3** bucket called *business zone*.

5 Data from the **Amazon S3** bucket *business zone* is loaded into **Amazon Redshift**. Detailed business intelligence (BI) reporting can be done using **Amazon Managed Grafana** or **Amazon QuickSight** which uses Super-fast, Parallel, In-memory Calculation Engine (SPICE). It is also possible to connect with external BI tools like Tableau.

6 Artificial intelligence and machine learning (AI/ML) services like **Amazon SageMaker**, **Amazon Forecast**, and third party ML/analytics use curated data from the data lake for predictive health analysis and assessment.

7 AWS IoT connectivity solutions have the full range of remote device management capabilities.