A Digital Technology Course   ENERGY**XCHAIN**

Transaction Management: An Overview of
Digital Tools for Managing Complex Transactions

Module 4: Transforming Natural Gas Transaction Management

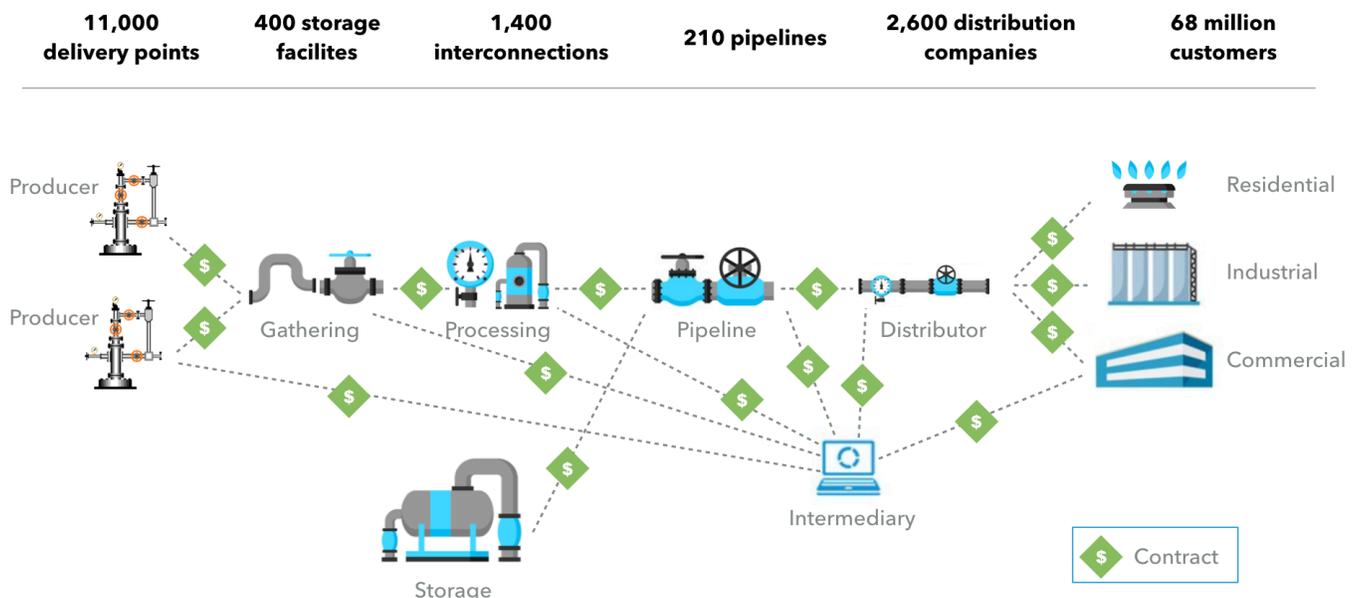# Module 4: Transforming Natural Gas Transaction Management (90 minutes)

EnergyXchain genesis

The 3 Founders met at a 2017 Charlotte Blockchain conference organized by David, hosted by K&L Gates and including speakers from GE, EY and IBM.

EnergyXchain was incorporated in May of 2018 and held an on-site blockchain working session with Vectren Energy at its headquarters that summer. Based on David's industry expertise, and with Vectren's support, we applied for a research grant from the National Science Foundation in August.

The National Science Foundation awarded a Small Business Innovation Research Phase I grant, entitled "Transforming Complex Utility Transaction Management", to EnergyXchain, LLC in January 2019. Our research included interviews with 35 (now over 100) industry insiders and narrowed our scope to focusing on midstream collaborators.

| 11,000 delivery points	400 storage facilites	1,400 interconnections	210 pipelines	2,600 distribution companies	68 million customers

During Phase I, the project team investigated possible ways to transform transaction management processes using Blockchain, distributed ledger and other digital technology across natural gas industry production, transmission, distribution and consumption functions. We dissected example PDF contracts line-by-line to see how digital solutions might improve them.

Proof of Concept

EnergyXchain mapped the business flow of the current industry standard natural gas purchasing and transport customer relations processes. Once mapped the individual processes revealed significant process commonality, leading EnergyXchain to research the possibility of a single Blockchain-based technology platform. The integrity of each process was retained while the technology supporting their execution was designed as a single platform offering fluidity, precision and security of data among processes and parties and singularity of permissions and entity identification. This platform goal will become EnergyXchain's blockchain as a service (BaaS).
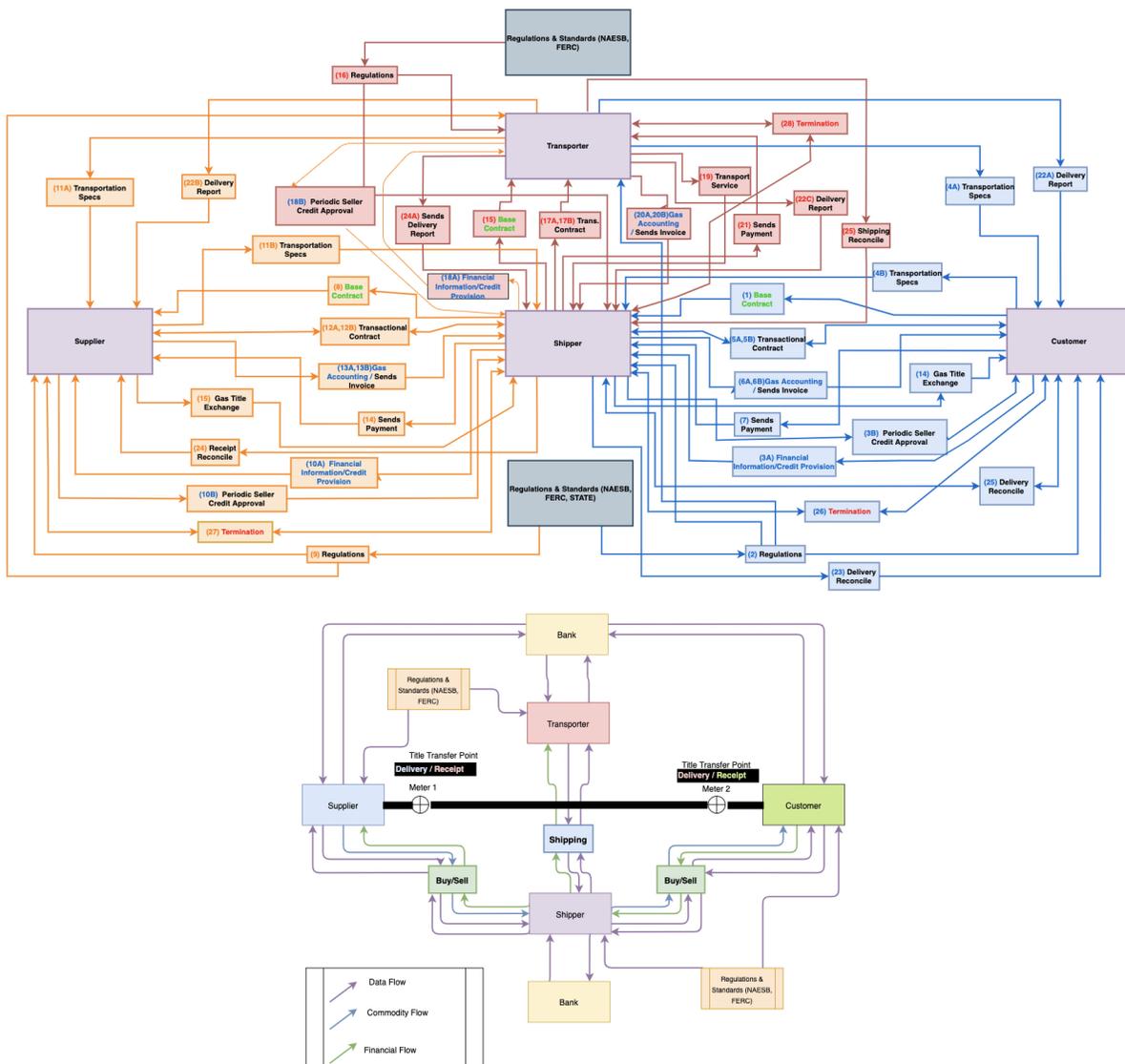
This solution, which will digitally transform select natural gas transaction processes is illustrated below. Each subscriber has the potential to employ the BaaS as a supplier, consumer, shipper or transporter, using some or all those roles as is appropriate for their transaction participation. Common aspects of both natural gas purchasing and transporter customer relation processes include contract origination and management, credit authorization, transaction initiation, billing, payment and transaction reconciliation. The processes differ slightly with regard to the data required for initiating natural gas purchasing or transport transactions.
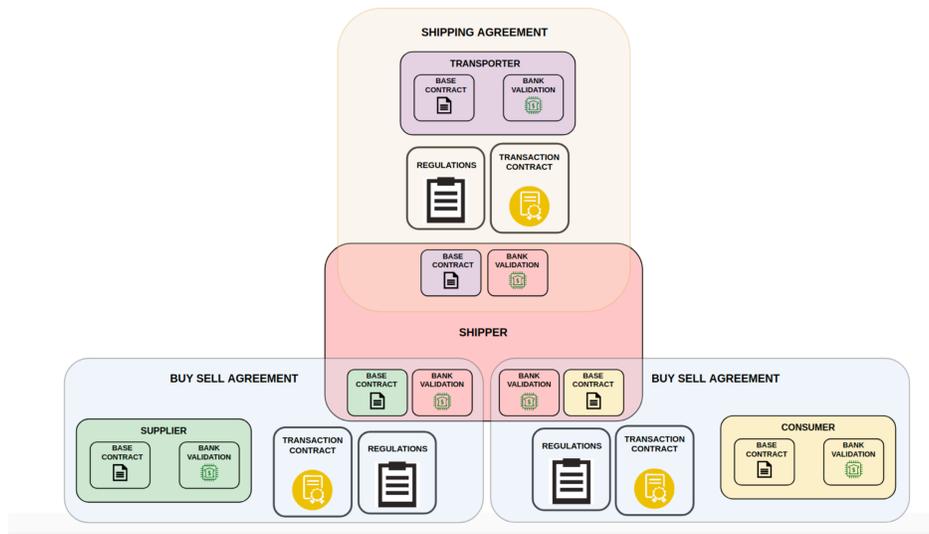
EnergyXchain made three disruptive discoveries during Phase I which were documented in the Phase II Project description and proposed for commercial refinement. These include:

- Interactive smart contracts

- Predictive smart contracts (potential for employing artificial intelligence)

- Blockchain asset portability (employs file server in parallel with blockchain dlt)

These discoveries are the subject of a provisional patent application filed by EnergyXchain with the U.S. Patent and Trademark Office on August 30, 2019 (finalized August 2020)

We submitted a Phase II grant - and added Smart Codex refinement to our patent thinking.

We filed a second U.S. Provisional Patent Application for the Method and Technology for Managing Complex Natural Gas Transactions Employing Blockchain and Smart Codex invention with the U.S. Patent and Trademark Office on February 17, 2020 (finalized in February of 2021).

Phase II - May 2020

When we won our Phase II NSF grant, our software needs shifted from "create a working proof of concept" to build a platform that can handle scale and hide the complexity from end users.

Rob Norris' experience in financial services and insurance guided EnergyXchain to hire a few experts to help us frame up this platform and spend grant consulting dollars for proven experience. We improved our team in 2020, and started outlining the application stack seen in the next diagram.
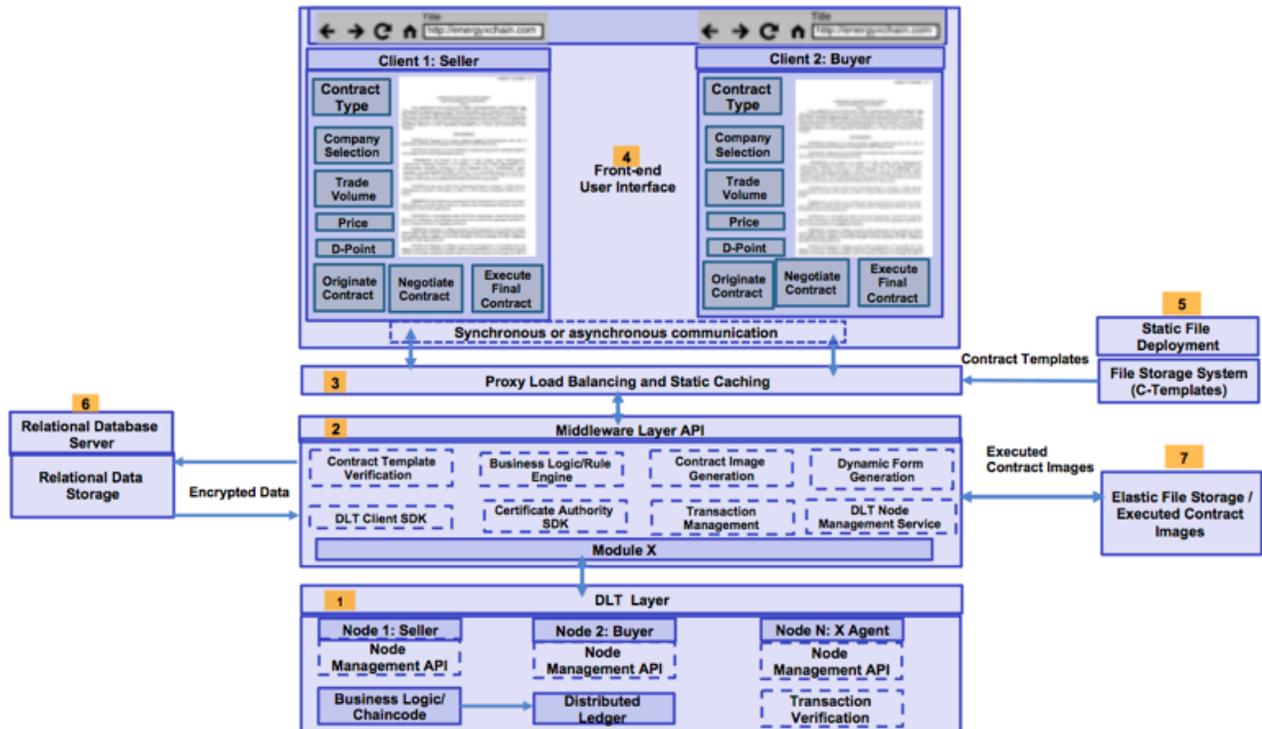
Our developers experience in the medical insurance industry with multiple vendors, disparate data feeds, HIPPA security and various in-house solutions had been leveraged for EnergyXchain framework planning. We treat the middleware application as a client to the blockchain.

We keep the middleware open enough to add additional services as needed. The middleware contains both services and support for UI as well as the data layer (blockchain part of the data layer). The client needs a way to talk to the blockchain network. Browser / client points at the middleware. So the browser is a client to the middleware and indirectly the blockchain.

A standalone uber jar that can act as an endpoint (API) on the prospective DLT node.

It will process a request from the middleware layer and translate that into meaningful system commands to be executed on the node to install chaincode or perform other command line task.

This is not a finished application - it is part of a 3 step process:

1. The first was creating a prototype that worked on a research bench - in our offices.

2. The second is what we are creating today: a prototype that can demonstrated to possible partners and collaborators.

3. The third step will be to build a commercially viable software product based on collaborators inputs and real business needs.

It is important to note that this framework allows us to edit and add services as determined by our collaboration partners. Our technology stack supports the new digital technologies and integrates with tradition technologies.

End users don't "see" new technologies – they see only familiar screens which lead them through familiar transactions, but offer some innovative choices by which users may create more value. Ease-of-use will be a critical component of a successful commercial product.

Transaction Creation Business Logic

The process starts with identifying the desired transaction party.
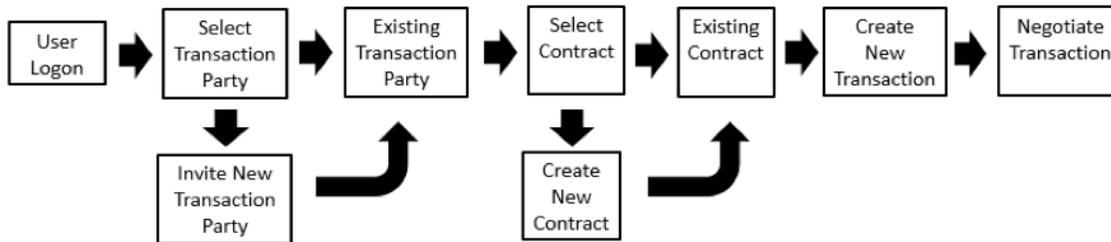
- If not existing, the user invites the desired (new) transaction party to create an account on the private blockchain.
- Once the desired transaction party is selected the contract by which business will be transacted with that transaction party is selected.
- If not existing, the desired (new) contract is created
- Once the desired transaction party and contract is selected, a new transaction with that transaction party using the selected party may be created and proposed to the selected transaction party.

Now, let's walk through the screens by which that is accomplished.
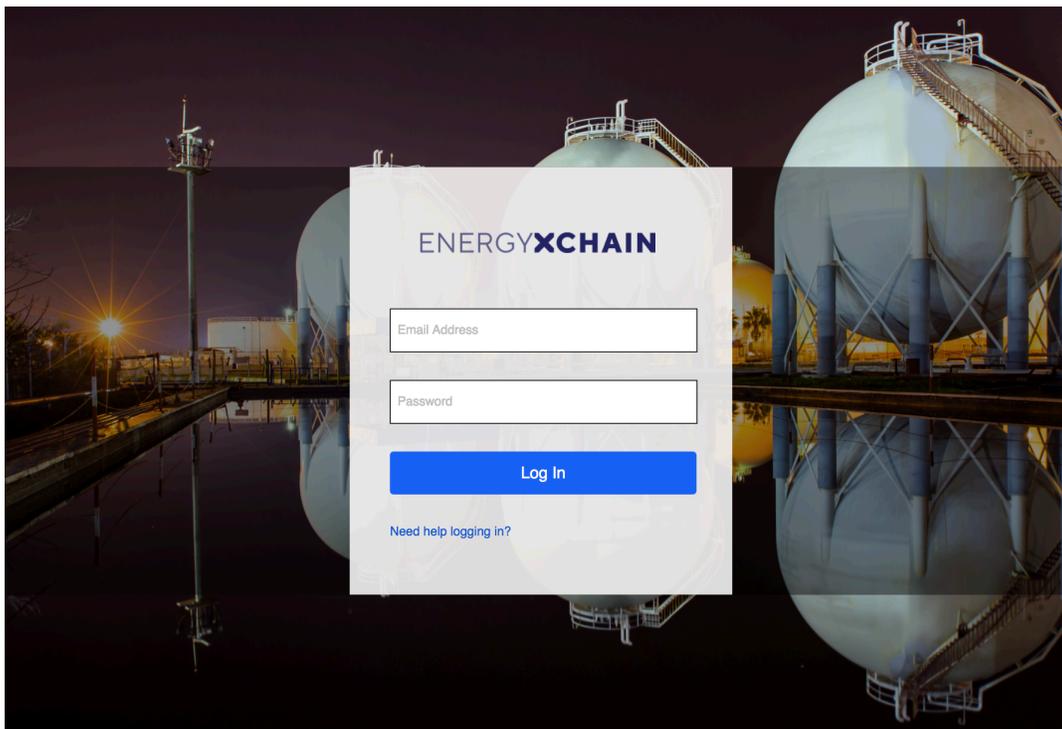
After login, select Transaction Type and Transaction Party

In this case, we are logged on as David Davidson of Alpha Energy Corp. In the display window David sees a brief list of recent contracts and has the opportunity to search by all existing using filters established. He can also start the process of creating a new contract or new transaction party if necessary.

Users can search by:

- Search for a specific (existing) Transaction Party displays in window
- Search by Name in search box
- Search by Date
- Search by State
- Search by Volume
- Search by Price
- Search by Transaction Type – <pulldown menu>

Filter the Transaction Type pulldown menu by:

- All Transactions
- All Firm Transactions
- All Interruptible Transactions
- All Purchase Transactions
- All Firm Purchase Transactions
- All Interruptible Purchase Transactions
- All Transport Transaction
- All Firm Transport Transaction
- All Interruptible Transport Transaction
- All Sale Transaction
- All Firm Sale Transaction
- All Interruptible Sale Transaction

ENERGYXCHAIN   David Davidson ⌄

Alpha Energy Corporation | Account Settings

Contracts   Transaction Parties   Reports

🔍 Search Transaction Party   Create Transaction Party

Filter by

Transaction Type ▼ | Contract Date 📅 | State ▼ | Dth Day ▼ | $/Dth ▼ | + more filters | Create Contract

All Transactions >

All Firm Transactions

All Interruptible Transactions

	Transaction Party	Date	State	Volume (Dth)	Price ($)	Actions
All Purchase Transactions	Beta Production	3/1/2019	TX	1,000	3.25	•••
All Firm Purchase Transactions						
All Interruptible Purchase Transactions	Gamma	11/30/2019	NY	2,100	3.65	•••
All Transport Transaction	Delta Pipeline	2/1/2020	WV	2,100	.25	•••
All Firm Transport Transaction						
All Interruptible Transport Transaction	Epsilon Processing	5/30/2020	OK	1,100	3.22	•••
All Sale Transaction						
All Firm Sale Transaction						
All Interruptible Sale Transaction						

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Or search by Transaction Parties to get list view of all existing parties.

ENERGY**XCHAIN**				David Davidson ⌄

Alpha Energy Corporation | Account Settings

Contracts   **Transaction Parties**   Reports

🔍 Search Transaction Party   **Create Transaction Party**

Filter by

| This ▾ | Should ▾ | Match ▾ | Filterable ▾ | + more filters | **Create Contract** |

Agency	Phone	ID	Address		Actions
Beta Production	**555-555-5550**	**12345XY**			•••
Gamma	**555-555-5552**	**23456AB**			•••
Delta Pipeline	**555-555-5553**	**34567CD**			•••
Epsilon Processing	**555-555-5556**	**45678DE**			•••

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If the desired Transaction Party does not exist, click the Create Transaction Party button to initiate the process of inviting a new party.

Invite the desired Transaction Party to create an account on the private blockchain

This invite essentially is for a new party to join the private blockchain. When they confirm (and fill out remainder of necessary fields) they are automatically added to the Transaction Party results found in the search box on landing page.

Once the Transaction Party has been selected, choose the desired contract type.

If the contract type does not exist, select the desired Transaction Party, select the desired contract type and create the (new) desired contract between you and the desired Transaction Party.

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Create the desired transaction, using the desired contract (including smart contract provisions) with the desired Transaction Party by selecting:

- Transaction Party
- Based Contract Template
- Start Date
- Term (number of days)
- Receipt/Delivery Point(s), as appropriate
- Volume(s)
- Price(s)

Clicking "negotiate" sends to Transaction Party

Transaction Party may click "accept" or change a term(s) and click "negotiate"

The process described thus far only contractually documents the transaction parties' transaction. It has automatically created a contract amendment to the desired base contract with the desired transaction party. That may be how a company wishes to employ blockchain and Distributed Ledger technology.

This provides security, speed, economy and transparency (trust) for the contracting process, as well as an instantly auditable record of a transaction's history. There is no opportunity for someone to have the contract file "on their desk" when you need it. Everyone has the identical contract file at the identical time and can have it "on their desk" and not disrupt anyone else's work or create a disparity of terms, as any change to the contract on the blockchain is immediately updated for all. And, with EnergyXchain's innovation of integrating portable document technology with blockchain technology, a party can take the contract from the blockchain and literally have it on their desk while maintaining an immutable contract record on the blockchain.

Smart Codex Credit Management example

When creating their base contract, the transaction parties could also have included one smart contract feature by which to digitally manage an aspect of their transaction. Looking back at the screen used to create the contract, examples of possible smart contract provisions are shown which may be selected and added to the base contract being created. In this example we'll assume the transaction parties chose Smart Codex Credit Management. In doing so, they add a contract provision which adopts code included in the contract appendix that when added to the blockchain becomes operational.
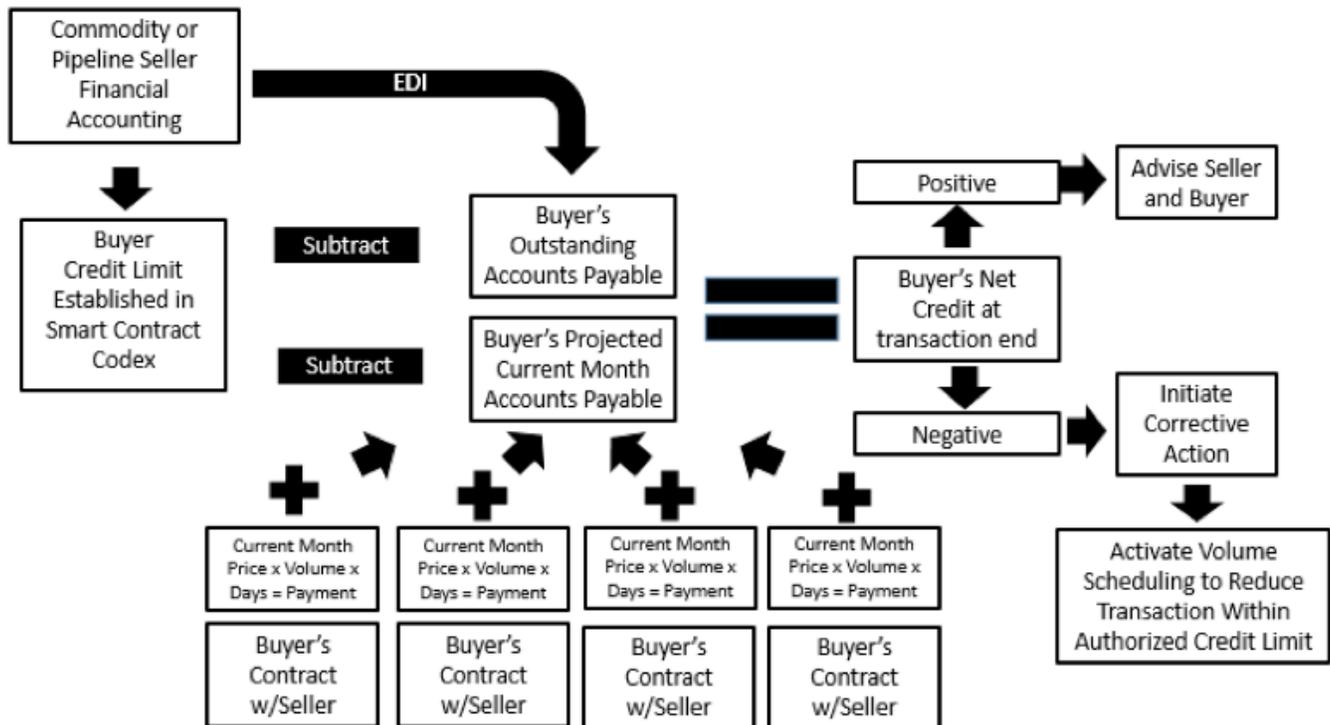
The business logic that underlies the credit management function is described in the sketch below.


The commodity seller (producer, broker, etc.) or the pipeline/LDC selling the transportation service has the credit risk and has established a credit limit for a commodity buyer or a shipper. That credit limit is added by the commodity or transport seller to the Smart Contract Codex associated with the buyer's unique identity. This is a onetime entry, based on the Seller's credit analysis of the Buyer. It can be updated in the Codex at any time, but only by the seller. The Credit Management code of the Smart Contract upon receiving updated EDI data on the Seller's accounts payable balance queries the Smart Contract Codex to secure the latest credit limit set by the seller and queries all current transactions between the Seller and Buyer to calculate the accounts payable obligation to be created by all current transactions. The operation of simple math produces the Buyer's net credit balance at the transaction(s) end. If positive, Seller and Buyer are advised of this condition. If negative, the Seller and Buyer can be advised to undertake corrective action or that corrective action can be part of the smart contract code whereby a volume change is automatically calculated and nominated or a payment initiated which brings the Buyer into compliance with the credit limit.

This example demonstrates both how the Smart Contract Codex and a smart contract feature (credit management) could perform. Remember, Module 2 described the use of an "oracle", a trusted third party data source, to provide data to a single smart contract initiating some function. The Smart Contract Codex is an EnergyXchain innovation which from a central data source provides trusted or "agreed" data to all smart contracts of a particular definition. In this example the smart contract code of all the Buyer's contracts interacts with the Smart Contract Codex to receive the credit limit information.

Invoicing and Payment example

Another example of smart contract operation is Invoicing and Payment. The Transaction Parties when creating their base contract under Smart Contract Provisions select Invoicing/Payment. In doing so, they add a contract provision which adopts code included in the contract appendix that when added to the blockchain becomes operational.

The business logic that underlies the Invoicing/Payment function is described in the sketch below.
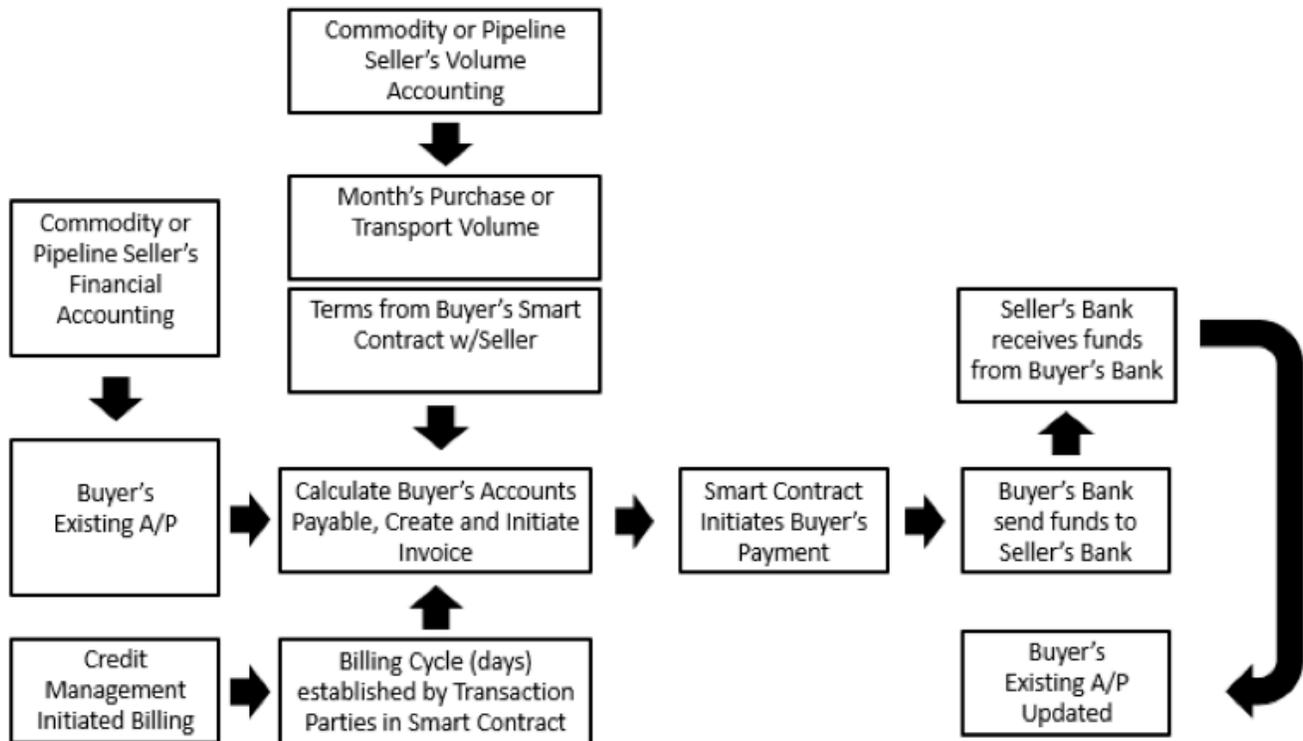
This smart contract process is controlled by the transaction parties' selecting a billing cycle. It could be monthly, but it also could be on the 10th, 20th and last of each month. Note that the billing cycle could also be initiated by Invoicing/Payment smart contract process's interaction with the Credit Management smart contract process we reviewed in the previous example. This billing might be initiated out of cycle in order to bring a buyer's projected accounts payable amount in conformance with the credit limit established in the Smart Contract Codex.

When the smart contract reaches the billing cycle time, its code initiates the calculation of the Buyer's accounts payable balance and the creation of a digital invoice with detail. Information from the Seller's financial accounting function has been provided the blockchain on the Buyer's existing accounts payable balance whenever this balance changes. What is on the blockchain is always current. Information from the Seller's volume account function has been provided to the blockchain on the volume of natural gas sold to/transported for the Buyer under each contract between Seller and Buyer whenever this information is available. Again, what is on the blockchain is always current. Each Seller/Buyer contract's terms stored on the Blockchain are used to create the Buyer's invoice.

All the information described resides on the blockchain and can be accessed by Seller and Buyer at any time to research an issue – there is no contacting the other party to ask for their records. The creation of a digital invoice initiates the Buyer's payment. Payment may be instantaneous or, if the Seller offers payment terms, the Buyer can specify a payment period that must expire before payment is initiated. When the payment period expires, the smart contract code initiates an electronic funds transfer from Buyer's bank to Seller's bank. Upon receipt of payment by Seller's bank, the Buyer's accounts payable balance is updated.

Literally all natural gas transaction processes may be similar managed by smart contract code and initiated by the receipt of data from trusted sources.

Additionally, data analytics may be added to these smart contract processes to bring artificial intelligence to transaction management. For example the examination of historic natural gas deliveries at a particular receipt point may tell a buyer that purchase above a certain amount are unreliable, leading it to specify a purchase amount not greater than the historic reliability amount and to establish first priority on allocations. Once data analytics reveals and quantifies this risk, the terms can then be imbedded as code in a smart contract.

Discussion - Q&A Day 4