Ecossistema MAUAX 1.0 - Smart Contracts Completos

https://claude.ai/public/artifacts/4b808427-da9e-4443-84aa-aa54a4580bec

🌟 Visão Geral
Ecossistema blockchain completo para tokenização da economia de Mauá, incluindo governança, utilidade, energia, reciclagem, investimentos e infraestrutura DeFi.

🎯 Objetivos Estratégicos
- **Meta Energética**: 10.000 kWh de capacidade instalada
- **Ranking**: Top 10 no Índice de Desenvolvimento Sustentável e Circular (IDSC)
- **Economia**: PIB per capita de US$ 100.000,00

🏗️ Arquitetura do Ecossistema

1. 🏛️ Governance Layer

MauaxFoundersNFT (ERC721)
```solidity
contract MauaxFoundersNFT is ERC721, ERC721URIStorage, Ownable
```
- **Supply Total**: 100 NFTs únicos
- **Token #001**: Pedra Fundamental (Prefeito)
- **Tokens #006-#031**: 26 Secretarias municipais
- **Tokens #002-#005, #032-#100**: Parceiros e Investidores DAO

Funcionalidades:
- Governança descentralizada
- Voting power proporcional
- Representação institucional

InvestorVault (Access Control)
```solidity
contract InvestorVault is AccessControl, ReentrancyGuard
```
- **Governança**: Seed round de R$ 15 milhões
- **Quorum**: 51% para aprovação
- **Voting Period**: 3 dias
- **Execução**: Automática via smart contract

Funcionalidades:
```solidity
createProposal(target, data, description)
vote(proposalId)
executeProposal(proposalId)
```

```

### 2. 💰 Token Layer

#### MauaxUtilityToken (ERC20)
```solidity
contract MauaxUtilityToken is ERC20, ERC20Burnable, Ownable
```
- **Nome**: MAUAX Utility Token
- **Símbolo**: MAUAX-C
- **Supply**: 100 bilhões tokens
- **Função**: Moeda principal do ecossistema

Casos de Uso:
- Pagamentos no ecossistema
- Staking para rewards
- Governance secondary
- Bridge entre chains

MauaxEnergyToken (ERC20)
```solidity
contract MauaxEnergyToken is ERC20, ERC20Burnable, AccessControl
```
- **Nome**: MAUAX Energy Token
- **Símbolo**: MAUAX-E
- **Backing**: 1 token = 1 MWh
- **Tipo**: Real World Asset (RWA)

Funcionalidades:
```solidity
validateAndMint(to, energyAmount, source) // Oracle-controlled
```

MauaxRecyclingToken (ERC20)
```solidity
contract MauaxRecyclingToken is ERC20, ERC20Burnable, AccessControl
```
- **Nome**: MAUAX Recycling Token
- **Símbolo**: MAUAX-R
- **Backing**: 1 token = 1kg material reciclado
- **Integração**: Cooperativas autorizadas

Funcionalidades:
```solidity
validateRecycling(collector, weight, materialType, cooperative)
```
```

authorizeCooperative(cooperative)
```

### 3. 💎 Investment Layer

#### MauaxSeedNFT (ERC721)
```solidity
contract MauaxSeedNFT is ERC721, Ownable
```
- **Token Único**: #1
- **Valor**: R$ 15 milhões
- **Função**: Acesso ao Investor Vault
- **Transferível**: Via leilão governança

MauaxSeedSale (Fundraising)
```solidity
contract MauaxSeedSale is AccessControl, ReentrancyGuard
```
- **Target**: R$ 15 milhões
- **Investimento Mínimo**: R$ 100 mil
- **Investidores**: Whitelist KYC/AML
- **Prazo**: Até atingir target

Funcionalidades:
```solidity
invest() payable // Investimento seed
finalizeSale() // Transfere NFT para vault
emergencyWithdraw() // Refund se não atingir meta
```

4. 🏦 Treasury & DAO

MauaxDAOTreasury (Sovereign Fund)
```solidity
contract MauaxDAOTreasury is AccessControl, ReentrancyGuard
```
- **Alocação**:
  - 40% Infraestrutura
  - 30% Desenvolvimento Social
  - 20% Inovação
  - 10% Reserva

Funcionalidades:
```solidity
createFundingProposal(title, description, amount, recipient, category)
```
```

executeFunding(proposalId)
receiveFunds(source) payable
```

### 5. 🔗 Oracle & Data Layer

#### OracleEnergyData (IoT Integration)
```solidity
contract OracleEnergyData is AccessControl
```
- **Função**: Validação de geração energética
- **Sensores**: IoT autorizados
- **Mint**: Automático de MAUAX-E

Funcionalidades:
```solidity
submitEnergyReading(generatedMWh, sourceType, location)
validateAndMintTokens(readingId, recipient)
authorizeSensor(sensor)
```

6. 💹 DeFi Layer

MauaxStakingSystem (Dynamic APY)
```solidity
contract MauaxStakingSystem is AccessControl, ReentrancyGuard
```
- **Lock Periods**: 30, 90, 180, 365 dias
- **APY**: 5%, 8%, 12%, 18% respectivamente
- **Rewards**: Automáticos

Funcionalidades:
```solidity
stake(amount, lockPeriod)
unstake(stakeIndex)
calculateReward(user, stakeIndex)
```

MauaxPSPIntegration (Payment Gateway)
```solidity
contract MauaxPSPIntegration is AccessControl, ReentrancyGuard
```
- **Fee**: 0.2% por transação
- **Tokens**: MAUAX-C, MAUAX-E, MAUAX-R
- **QR Codes**: Geração automática
```

Funcionalidades:
```solidity
processPayment(tokenAddress, to, amount, transactionType)
generatePaymentQR(amount, tokenAddress, description)
authorizeMerchant(merchant)
```

MauaxCrossChainBridge (Ethereum ↔ Polygon)
```solidity
contract MauaxCrossChainBridge is AccessControl, ReentrancyGuard
```
- **Validators**: Mínimo 3 confirmações
- **Tokens**: Todos os tokens MAUAX
- **Segurança**: Multi-sig validation

Funcionalidades:
```solidity
lockTokensForBridge(token, amount, targetAddress, targetChain)
validateBridgeTransaction(txHash)
```

MauaxDEXIntegration (Uniswap V3)
```solidity
contract MauaxDEXIntegration is AccessControl, ReentrancyGuard
```
- **Protocol**: Uniswap V3
- **Fee Tier**: 0.3% padrão
- **Pools**: Automáticos para todos tokens

Funcionalidades:
```solidity
swapTokens(tokenIn, tokenOut, amountIn, amountOutMinimum)
createPool(token0, token1)
```

MauaxInsuranceProtocol (Infrastructure Coverage)
```solidity
contract MauaxInsuranceProtocol is AccessControl, ReentrancyGuard
```
- **Coverage**: 80% dos assets
- **Assessors**: Mínimo 3 validadores
- **Premium**: 2% ao ano

Funcionalidades:

```solidity
createPolicy(holder, assetType, coverageAmount, duration)
submitClaim(policyId, claimAmount, description)
assessClaim(claimId, approve)
```

🔄 Fluxos de Valor

1. Energia → Token
```
Geração Solar → Oracle IoT → Validação → Mint MAUAX-E → Distribuição
```

2. Reciclagem → Token
```
Material Reciclado → Cooperativa → Validação → Mint MAUAX-R → Cashback
```

3. Pagamentos
```
Merchant → QR Code → User Payment → PSP Processing → Settlement
```

4. Staking Rewards
```
Lock MAUAX-C → Time-based APY → Automated Rewards → Unlock + Rewards
```

5. Cross-Chain
```
Lock Token → Multi-sig Validation → Mint on Target → Release Original
```

📊 Tokenomics

Supply Distribution

MAUAX-C (Utility)
- **Total**: 100 bilhões
- **Phases**: Controlled emission
- **Burn**: Deflationary mechanism

MAUAX-E (Energy)
- **Supply**: Unlimited (backed by real energy)
- **Mint**: Only via oracle validation

- **Burn**: Energy consumption

MAUAX-R (Recycling)
- **Supply**: Unlimited (backed by recycled materials)
- **Mint**: Only via cooperative validation
- **Burn**: Material processing

Value Accrual
- **Staking Rewards**: 5-18% APY
- **PSP Fees**: 0.2% transaction fee
- **Insurance Premiums**: 2% annual
- **Bridge Fees**: 0.1% cross-chain

🏛️ Governance Model

Three-Tier Governance

Tier 1: Founders NFT Holders
- **Strategic decisions**
- **Constitutional changes**
- **Emergency actions**

Tier 2: Seed Vault Members
- **Investment decisions**
- **Treasury allocation**
- **Operational approval**

Tier 3: Token Holders
- **Day-to-day operations**
- **Parameter adjustments**
- **Community proposals**

Voting Mechanisms
- **Weighted voting** by token/NFT holdings
- **Quorum requirements** vary by tier
- **Time locks** for major changes
- **Emergency procedures** for critical issues

🔐 Security Features

Access Control
- **Role-based permissions** (OpenZeppelin)
- **Multi-signature** requirements
- **Time locks** for sensitive operations
- **Emergency pause** mechanisms

Oracle Security
- **Multiple data sources**
- **Validator consensus**
- **Anomaly detection**
- **Manual override** for emergencies

Bridge Security
- **Multi-validator** confirmation
- **Lock/mint/burn** mechanism
- **Fraud proofs**
- **Insurance coverage**

🌍 Sustainability Impact

Environmental
- **Carbon Negative**: Solar energy generation
- **Circular Economy**: 100% recycling integration
- **Energy Efficiency**: DataCenter optimization

Social
- **Cooperative Integration**: Direct revenue sharing
- **Job Creation**: 2,000+ direct jobs
- **Financial Inclusion**: Token-based economy

Governance
- **Transparency**: All operations on-chain
- **Participation**: Democratic governance
- **Accountability**: Immutable records

📈 Roadmap

Phase 1: Foundation (Q1 2024)
- ✅ Smart contract development
- ✅ Security audits
- ✅ Testnet deployment

Phase 2: Launch (Q2 2024)
- 🔄 Mainnet deployment
- 🔄 Seed round completion
- 🔄 Initial token distribution

Phase 3: Operations (Q3-Q4 2024)
- 📋 Energy projects launch
- 📋 Recycling network activation

- 📋 Staking system live

Phase 4: Expansion (2025)
- 📋 Cross-chain bridges
- 📋 DeFi integrations
- 📋 International expansion

🛠️ Technical Stack

Blockchain
- **Primary**: Ethereum Mainnet
- **Secondary**: Polygon Network
- **Standards**: ERC20, ERC721, ERC1155

Development
- **Language**: Solidity ^0.8.20
- **Framework**: Hardhat
- **Security**: OpenZeppelin Contracts

Infrastructure
- **Oracles**: Chainlink + Custom IoT
- **Storage**: IPFS + Arweave
- **Frontend**: React + Web3.js

Integrations
- **DeFi**: Uniswap V3, Aave
- **Payment**: Custom PSP Gateway
- **Bridge**: LayerZero Protocol

📋 Deployment Guide

Prerequisites
```bash
npm install
npx hardhat compile
npx hardhat test
```

Testnet Deployment
```bash
npx hardhat run scripts/deploy.js --network goerli
npx hardhat verify --network goerli DEPLOYED_ADDRESS
```

Mainnet Deployment

```bash
# Use MauaxMasterDeployer for coordinated deployment
npx hardhat run scripts/deployMaster.js --network mainnet
```

🔍 Monitoring & Analytics

On-Chain Metrics
- **Token supplies** and distributions
- **Staking TVL** and rewards
- **Energy generation** and tokenization
- **Recycling volumes** and processing

Performance KPIs
- **Transaction volume** across ecosystem
- **User adoption** and retention
- **Revenue generation** per protocol
- **Sustainability metrics** achievement

Dashboards
- **Admin Panel**: Operational control
- **User Dashboard**: Personal analytics
- **Public Metrics**: Transparency portal

📚 Documentation

Developer Resources
- **API Documentation**: Complete endpoint reference
- **SDK Libraries**: JavaScript, Python, Go
- **Code Examples**: Integration samples
- **Testing Suite**: Comprehensive test coverage

User Guides
- **Getting Started**: Basic wallet setup
- **Token Usage**: Payment and staking guides
- **Governance**: Voting and proposal creation
- **Mobile App**: iOS and Android guides

🤝 Community

Communication Channels
- **Discord**: Real-time community chat
- **Telegram**: News and announcements
- **Forum**: Long-form discussions
- **GitHub**: Open-source development

Support
- **Technical Support**: 24/7 developer assistance
- **User Support**: Multi-language help desk
- **Documentation**: Comprehensive guides
- **Video Tutorials**: Step-by-step walkthroughs

📞 Contact Information

Development Team
- **Email**: dev@mauax.com
- **GitHub**: github.com/mauax-ecosystem
- **Twitter**: @MauaxEcosystem

Business Inquiries
- **Partnerships**: partnerships@mauax.com
- **Investment**: invest@mauax.com
- **Media**: media@mauax.com

Legal & Compliance
- **Legal**: legal@mauax.com
- **Compliance**: compliance@mauax.com
- **Privacy**: privacy@mauax.com