Controlling Groundwater Pumping Online

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Why users over-pump? Economists' view

- GW is an open access resource
  - Missing property right: National Wealth!!
  - No effective exclusion mechanism
- Users have no incentives to save water
  - GW conserved by one party may simply be used by someone else because the conserver has no exclusive right to the water saved
- The burden of the over-pumping would not be shared uniformly
  - The party who saves water could be a victim
  - Future generations will pay a heavy price

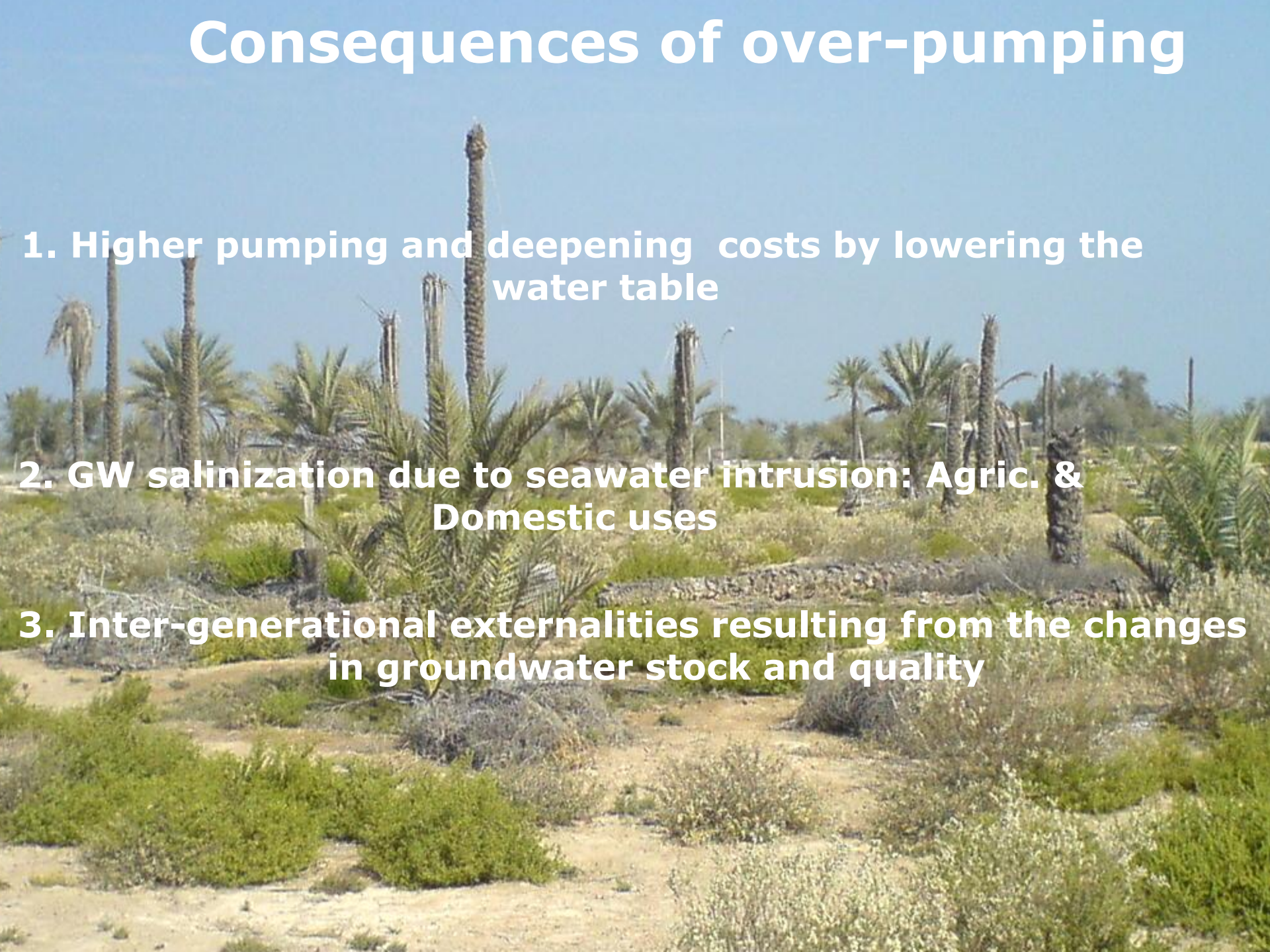
GW over-pumping: Approaches

- Participation and awareness raising
- Subsidies for water-saving technologies
  - No water saving per se. Higher water use efficiency
- GW use rights, permits and quotas
  - Groundwater pricing
    - municipal & industrial uses only: little impact due to the small share
  - Water metering is too costly
    - Few countries adopted it: Jordan, Nebraska, South Australia
- Remote sensing tools: crop mix control
  - Not accurate: could be challenged in courts
- Energy pricing
  - Politically hard to justify
- Energy quota
  - Objective of this presentation

GW over-pumping & seawater intrusion in Oman

- Seawater intrusion is a major problem in the coastal Batinah area
  - 53% of Oman's agricultural cropped land
- Safe yield: 415 Mm3/year
- GW over-pumping: 177 Mm3/year
- Reduce pumping by 30%

Consequences of over-pumping



1. Higher pumping and deepening costs by lowering the water table

2. GW salinization due to seawater intrusion: Agric. & Domestic uses

3. Inter-generational externalities resulting from the changes in groundwater stock and quality

Options for Oman

1. Wells metering: tube-wells only
   - Less than 8% of the wells are tube-wells
2. Energy pricing
   - Increase electricity price by 212%
   - 100% Price increase & energy quota through high price ½ Rial per kWh
   - Implementation is not possible
3. Water quota converted into Energy quota
   - Electricity quota/farm/year according to current cropped area

Rationale for quotas

- RD. 29/2000 "*Water in the Sultanate of Oman is considered a national wealth, the use of which is subject to **controls** set by the Ministry to **regulate** its optimum exploitation for the benefit of the overall development plans of the state*"
- MD 264/2000 article (21.A) "*The Ministry shall determine the quantity of water to be taken from each well. In doing so the Ministry may compel the owner to install a water meter according to specified conditions and specifications. Installation of water meter may be undertaken by the Ministry at the expense of the well owner. The well owner must stick to the amount of water determined by the Ministry. Meter reading shall constitute sufficient evidence in regard to the amount of water abstracted from the well.*

How to do it???

- Koundouri(2004) and Kemper(2007):" few countries practice water flow metering and control because of the disproportionately high transaction costs of individual monitoring of users involved in groundwater abstraction"
- Squeeze the cost of monitoring
- HOW????
- Convert water quota into electricity quota
- New electricity metering technology

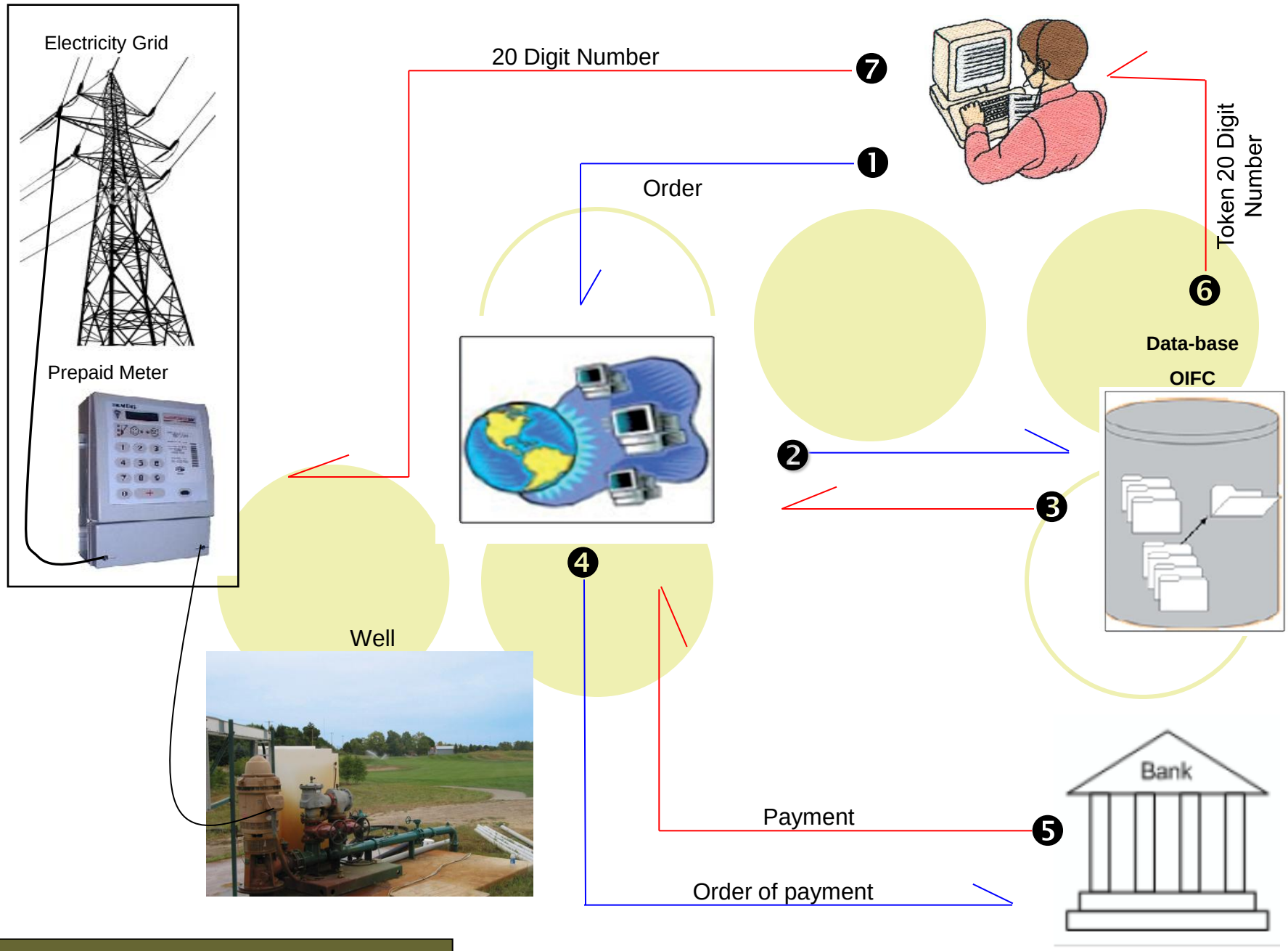
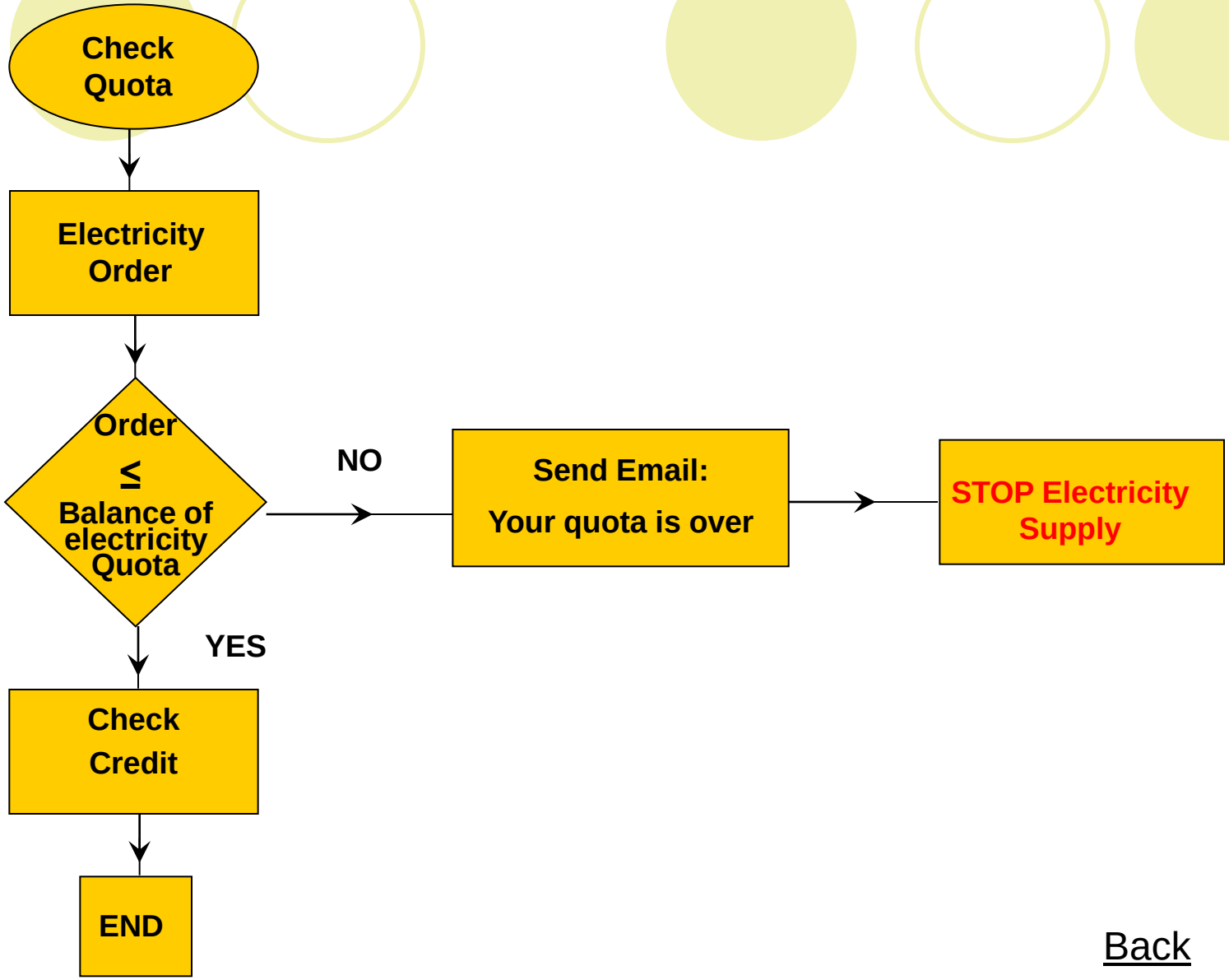
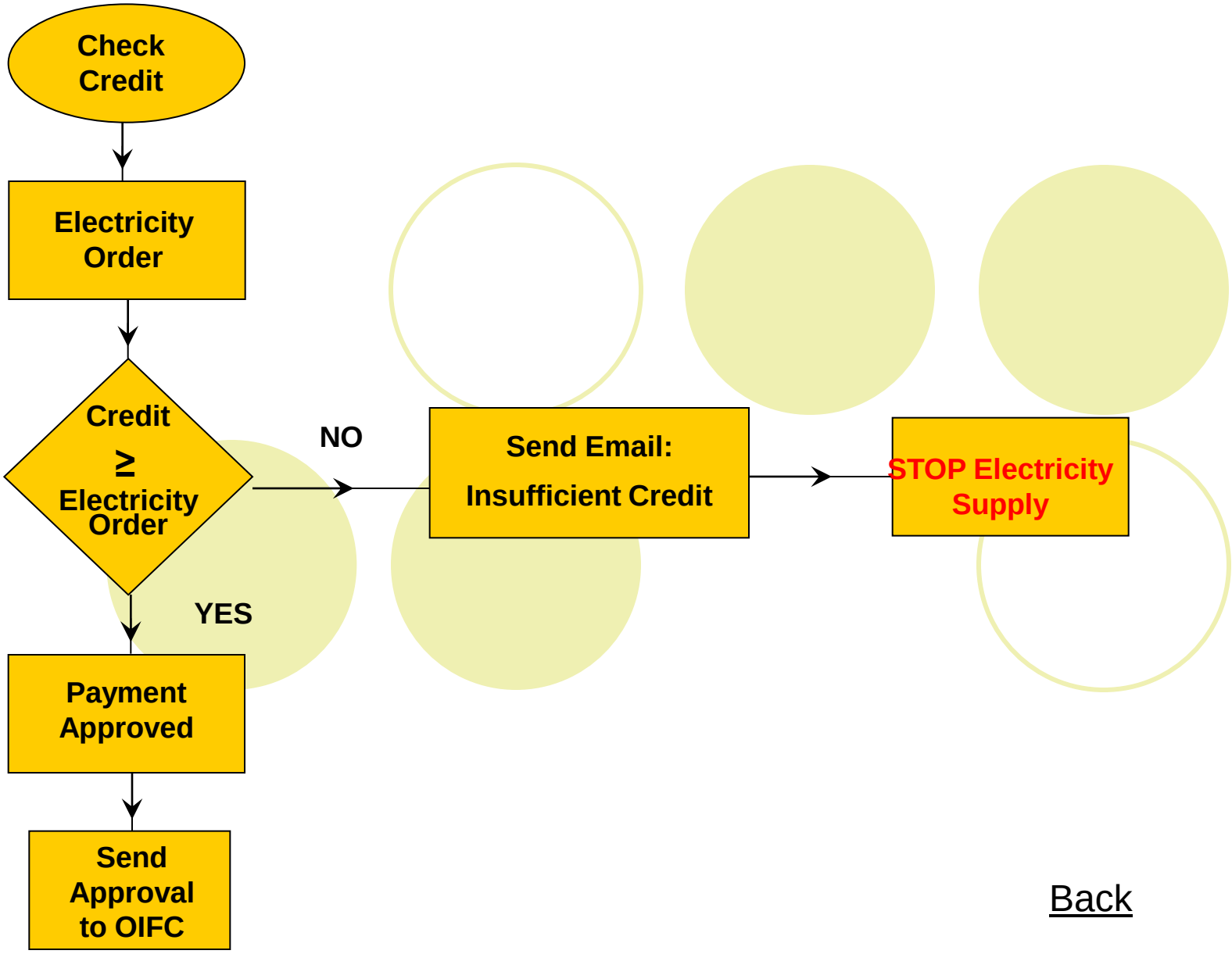


Figure 1: On-Line Electricity Payment


Check Quota
Electricity Order
Order ≤ Balance of electricity Quota
NO
Send Email: Your quota is over
STOP Electricity Supply
YES
Check Credit
END

Back


Check Credit
Electricity Order
Credit ≥ Electricity Order
NO
Send Email: Insufficient Credit
STOP Electricity Supply
YES
Payment Approved
Send Approval to OIFC

Back

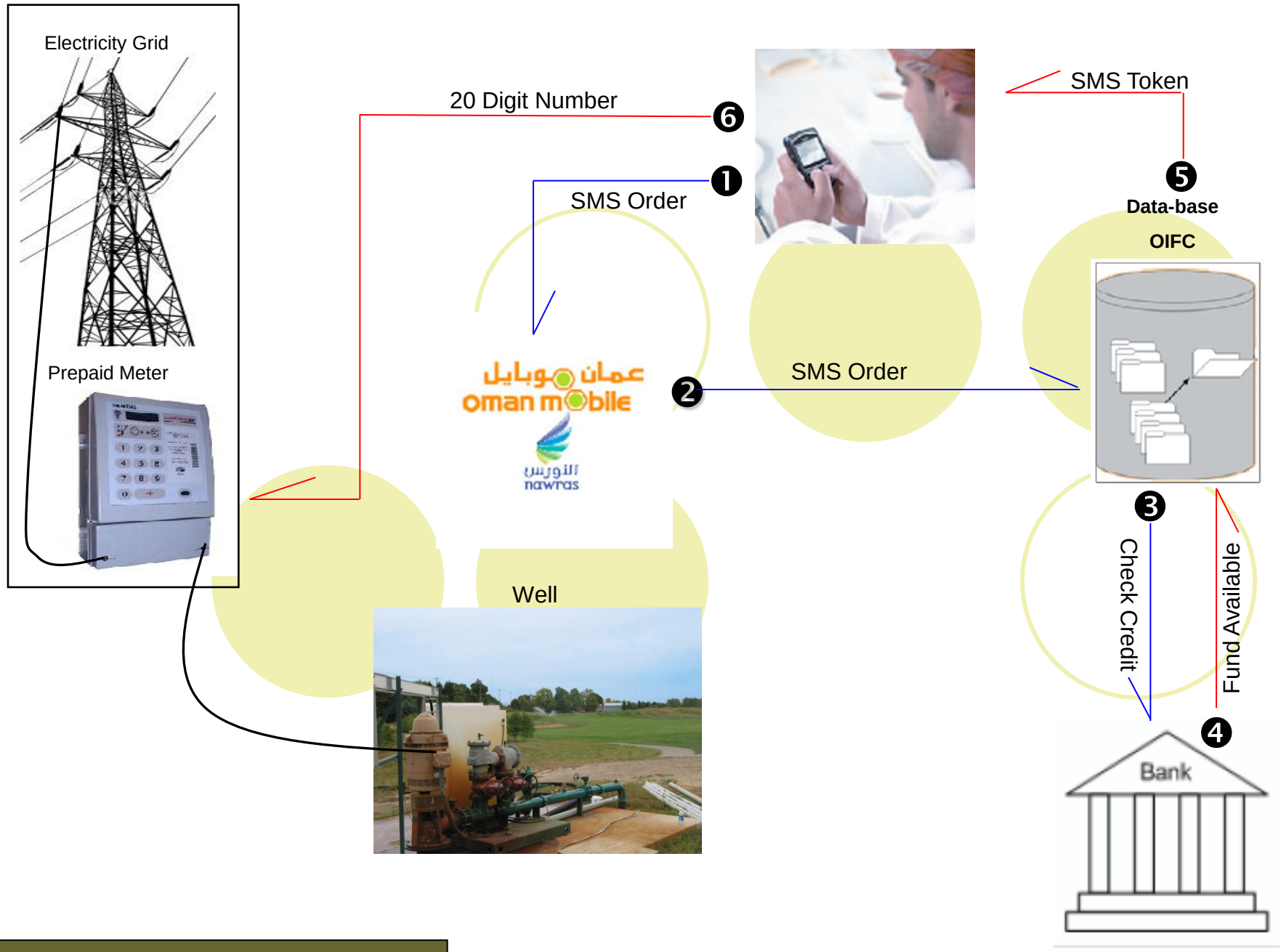
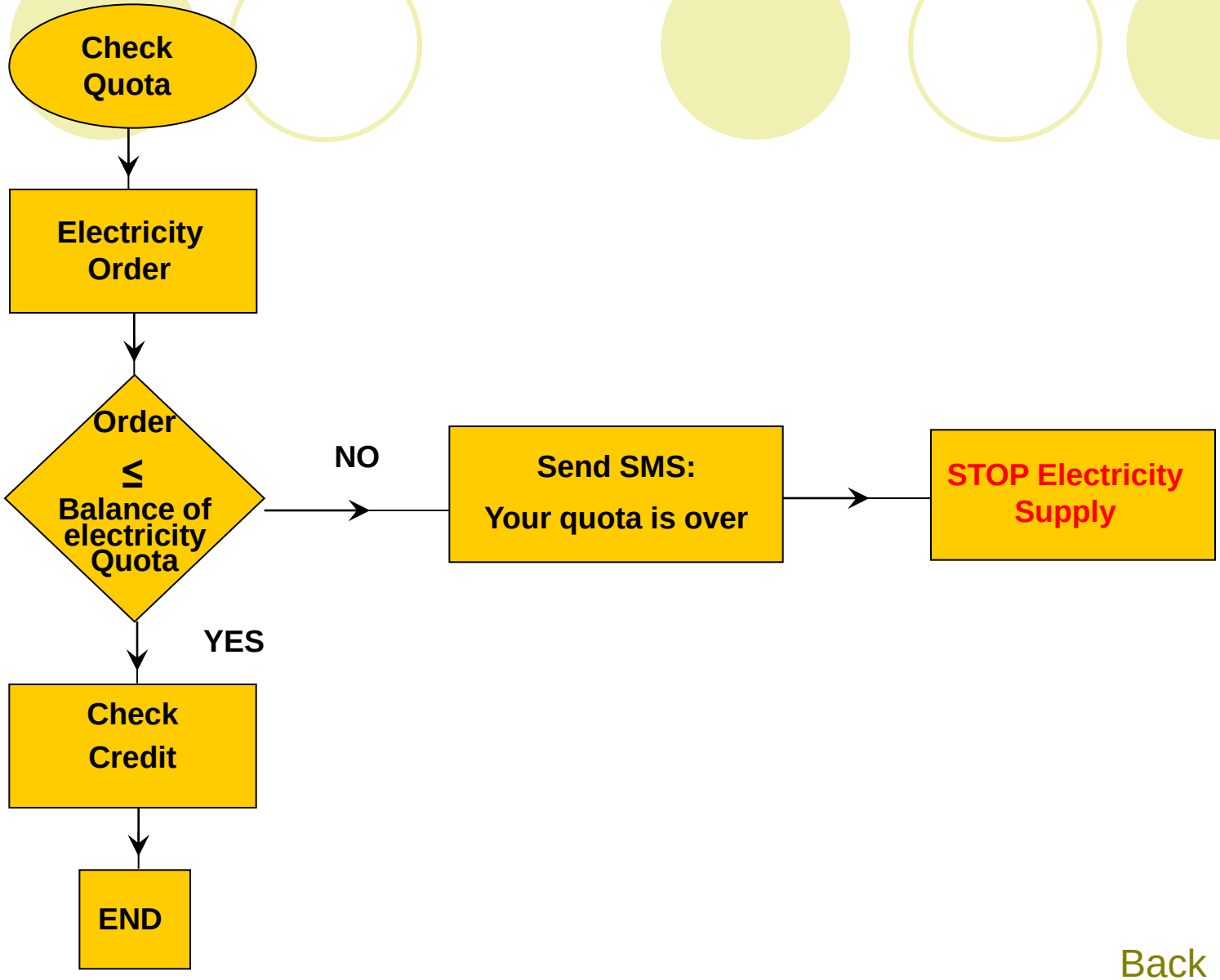
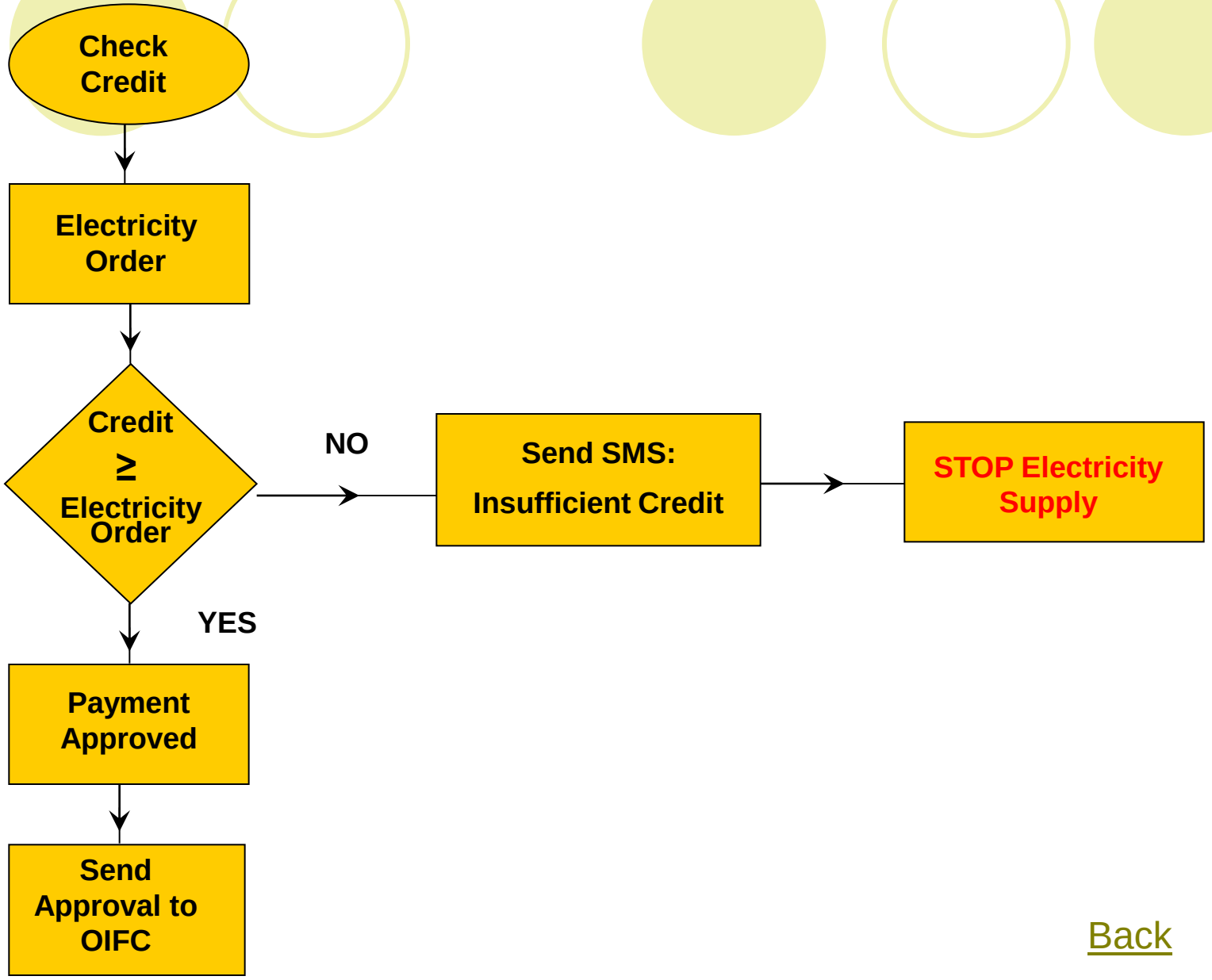


Figure 2: SMS Electricity Payment


Check Quota
Electricity Order
Order ≤ Balance of electricity Quota
NO
Send SMS: Your quota is over
STOP Electricity Supply
YES
Check Credit
END

Back


Check Credit
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Credit ≥ Electricity Order
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STOP Electricity Supply
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Methodology: cost-benefit analysis

- **Benefits**

1. Stopping the water table decline
2. Preventing Aflaj from drying-up
3. Protecting farmers and domestic users from increased salinity
4. Ensuring sustainability for future generations
5. Energy saving due to the reduction of volume of water pumped.

- **Costs**

1. Investment & operating costs of prepaid electricity meters
2. Financial losses of farmers due to the introduction of restrictive water quotas
3. Cost of the online system to monitor the electricity meters
4. Implementation cost of a participatory approach and an extension program for stakeholders

Results

- **“Business as usual” scenario**
  - Net Present Value= $ million -411 @6% disc. rate
- **Installation of prepaid electricity meters**
  - Net Present Value= $ million 308 @6% disc. rate
  - ١٧٧ Million m3 of water saved
  - Land protected from desertification
  - Aquifer protected for future generations

Conclusions

- Groundwater pumping control is
  - Possible
  - Cost effective
  - Easy to monitor
  - Profitable
  - Allows sustainability
- But it requires
  - Farmers' involvement
  - Participatory approach
  - Political will
  - Technology alone is not the solution
  - Government investment in the pre-paid electricity meters


Thank you

What was recommended in 1991?

- the improvement of irrigation efficiency through the introduction of modern irrigation systems
- the substitution of palm trees for winter vegetable crops
- the use of an appropriate water tariff structure for non agricultural purposes
- the re-use of treated wastewater for municipal irrigation

What was achieved?

- Only 19.2% of the cropped area is currently under MIS (2004-05 census)
- 4% of the palm trees are under MIS
- ¼ Million R.O/year is spent on subsidizing MIS
- More vegetables are grown in summer due to the MIS→ more pumping
- In 10 years the number of palm trees decreased by ½ Million trees (unwanted result)
- Increased use of GW for landscaping
- 15 recharge dams in the Batinah region were built between 1990 and 2005
- Cost of the Dams ≈ **64 Million R.O** (2006 value)
- Recharging ≈ **28** Mm3/year
- Cost per m3 ≈ 0.08 to 0.300 Rial Omani
- Return from agriculture/m3 ≈ 0.02 to 0.100 R.O

Wells Metering Experiences

- Wells metering: meter's cost & installation at farmer's expense
  - Jordan
  - Nebraska
  - Texas
  - Georgia
  - South Australia
- Energy pricing
  - Mexico (over 100 thousand wells) 2 block electricity tariffs since 2003 (NAFTA effect)